

VI CONDUCTION IN LIQUIDS AND GASES

When an electric current flows in a metallic conductor, the flow of particles is in one direction only, because the current is carried entirely by electrons. In liquids and gases, however, a two-directional flow is made possible by the process of ionization (*see* Electrochemistry). In a liquid solution, the positive ions move from higher potential to lower; the negative ions move in the opposite direction. Similarly, in gases that have been ionized by radioactivity, by the ultraviolet rays of sunlight, by electromagnetic waves, or by a strong electric field, a two-way drift of ions takes place to produce an electric current through the gas. *see* Electric Arc; Electric Lighting.

VII SOURCES OF ELECTROMOTIVE FORCE

To produce a flow of current in any electrical circuit, a source of electromotive force or potential difference is necessary. The available sources are: (1) electrostatic machines such as the Van de Graaff generator, which operate on the principle of inducing electric charges by mechanical means ; (2) electromagnetic machines, which generate current by mechanically moving conductors through a magnetic field or a number of fields (*see* Electric Motors and Generators); (3) batteries, which produce an electromotive force through electrochemical action; (4) devices that produce electromotive force through the action of heat (*see* Crystal: Other Crystal Properties; Thermoelectricity); (5) devices that produce electromotive force by the photoelectric effect, the action of light; and (6) devices that produce electromotive force by means of physical pressure—the piezoelectric effect.

VIII ALTERNATING CURRENTS

When a conductor is moved back and forth in a magnetic field, the flow of current in the conductor will change direction as often as the physical

motion of the conductor changes direction. Several electricity-generating devices operate on this principle, and the oscillating current produced is called alternating current. Alternating current has several valuable characteristics, as compared to direct current, and is generally used as a source of electric power, both for industrial installations and in the home. The most important practical characteristic of alternating current is that the voltage or the current may be changed to almost any value desired by means of a simple electromagnetic device called a transformer. When an alternating current passes through a coil of wire, the magnetic field about the coil first expands and then collapses, then expands with its direction reversed, and again collapses. If another conductor, such as a coil of wire, is placed in this field, but not in direct electric connection with the coil, the changes of the field induce an alternating current in the second conductor. If the second conductor is a coil with a larger number of turns than the first, the voltage induced in the second coil will be larger than the voltage in the first, because the field is acting on a greater number of individual conductors. Conversely, if the number of turns in the second coil is smaller, the secondary, or induced, voltage will be smaller than the primary voltage.

The action of a transformer makes possible the economical transmission of current over long distances in electric power systems (*see* Electricity Supply). If 200,000 watts of power is supplied to a power line, it may be equally well supplied by a potential of 200,000 volts and a current of 1 ampere or by a potential of 2,000 volts and a current of 100 amperes, because power is equal to the product of voltage and current. However, the power lost in the line through heating is equal to the square of the current times the resistance. Thus, if the resistance of the line is 10 ohms, the loss on the 200,000-volt line will be 10 watts, whereas the loss on the 2,000-volt line will be 100,000 watts, or half the available power.