Ohm’s law is the generalization that for many materials over a wide range of circumstances, *R* is constant. It is named after the German physicist Georg Simon Ohm, who discovered the law in 1827.

When an electric current flows through a wire, two important effects can be observed: the temperature of the wire is raised, and a magnet or a compass needle placed near the wire will be deflected, tending to point in a direction perpendicular to the wire. As the current flows, the electrons making up the current collide with the atoms of the conductor and give up energy, which appears in the form of heat. The amount of energy expended in an electric circuit is expressed in terms of the joule. Power is expressed in terms of the watt, which is equal to 1 J/sec. The power expended in a given circuit can be calculated from the equation $P = E \times I$ or $P = I^2 \times R$. Power may also be expended in doing mechanical work, in producing electromagnetic radiation such as light or radio waves, and in chemical decomposition.

## V ELECTROMAGNETISM

The movement of a compass needle near a conductor through which a current is flowing indicates the presence of a magnetic field (*see* Magnetism) around the conductor. When currents flow through two parallel conductors in the same direction, the magnetic fields cause the conductors to attract each other; when the flows are in opposite directions, they repel each other. The magnetic field caused by the current in a single loop or wire is such that the loop will behave like a magnet or compass needle and swing until it is perpendicular to a line running from the north magnetic pole to the south.

The magnetic field about a current-carrying conductor can be visualized as encircling the conductor. The direction of the magnetic lines of force in the field is anticlockwise when observed in the direction in which the electrons are moving. The field is stationary so long as the current is flowing steadily through the conductor.

When a moving conductor cuts the lines of force of a magnetic field, the field acts on the free electrons in the conductor, displacing them and causing a potential difference and a flow of current in the conductor. The same effect occurs whether the magnetic field is stationary and the wire moves, or the field moves and the wire is stationary.

When a current increases in strength, the field increases in strength, and the circular lines of force may be imagined to expand from the conductor. These expanding lines of force cut the conductor itself and induce a current in it in the direction opposite to the original flow. With a conductor such as a straight piece of wire this effect is very slight, but if the wire is wound into a helical coil the effect is much increased, because the fields from the individual turns of the coil cut the neighbouring turns and induce a current in them as well. The result is that such a coil, when connected to a source of potential difference, will impede the flow of current when the potential difference is first applied.

Similarly, when the source of potential difference is removed the magnetic field "collapses", and again the moving lines of force cut the turns of the coil. The current induced under these circumstances is in the same direction as the original current, and the coil tends to maintain the flow of current. Because of these properties, a coil resists any change in the flow of current and is said to possess electrical inertia, or inductance. This inertia has little importance in DC circuits, because it is not observed when current is flowing steadily, but it has great importance in AC circuits. *See* Alternating Currents *below*.