The law that the force between electric charges varies inversely with the square of the distance between the charges was proved experimentally by the British chemist Joseph Priestley about 1766. Priestley also demonstrated that an electric charge distributes itself uniformly over the surface of a hollow metal sphere, and that no charge and no electric field of force exists within such a sphere. Coulomb invented a torsion balance to measure accurately the force exerted by electrical charges. With this apparatus he confirmed Priestley's observations and showed that the force between two charges is also proportional to the product of the individual charges. Faraday, who made many contributions to the study of electricity in the early 19th century, was also responsible for the theory of lines of electrical force.

The Italian physicists Luigi Galvani and Alessandro Volta conducted the first important experiments in electrical currents. Galvani produced muscle contraction in the legs of frogs by applying an electric current to them. In 1800 Volta demonstrated the first electric battery. The fact that a magnetic field exists around an electric current was demonstrated by the Danish scientist Hans Christian Oersted in 1819, and in 1831 Faraday proved that a current flowing in a coil of wire can induce electromagnetically a current in a nearby coil. About 1840 James Prescott Joule and the German scientist Hermann von Helmholtz demonstrated that electric circuits obey the law of conservation of energy and that electricity is a form of energy.

An important contribution to the study of electricity in the 19th century was the work of the British mathematical physicist James Clerk Maxwell, who proposed the idea of electromagnetic radiation and developed the theory that light consists of such radiation. His work paved the way for the German physicist Heinrich Hertz, who produced and detected electromagnetic waves in 1886, and for the Italian engineer Guglielmo Marconi, who in 1896 harnessed these waves to produce the first practical radio signalling system.

The electron theory, which is the basis of modern electrical theory, was first advanced by the Dutch physicist Hendrik Antoon Lorentz in 1892. The charge on the electron was first accurately measured by the American physicist Robert Andrews Millikan in 1909. The widespread use of electricity as a source of power is largely due to the work of such pioneering American engineers and inventors as Thomas Alva Edison, Nikola Tesla, and Charles Proteus Steinmetz. *See also* Electronics.

2.0 Electricity Generation

I INTRODUCTION

Electricity Generation, is the process of converting energy stored in fuels or drawn from the environment into electrical energy. It embraces numerous complex technologies.

Energy appears in nature in two forms, disordered and ordered (*see* Physics: *The Second Law of Thermodynamics*). The disordered form, of which heat is a prime example, can be converted into other forms, such as mechanical energy, through a heat engine. Typical heat engines are piston engines, as used in cars, or gas turbines, as used in jet aircraft. The efficiency of practical heat engines is rather low—in general, less than 40 per cent. This means that less than 40 per cent of the energy output from the engine is in a useful form.

The ordered form of energy, of which mechanical and electrical energy are prime examples, is “high-grade” energy, as one type can be converted to other types at nearly 100 per cent efficiency. For example, electrical energy can be converted into mechanical energy in a motor at an efficiency of over 90 per cent.