Topic Page: lighting

Summary Article: **lighting**
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light produced by artificial means to allow visibility in enclosures and at night. For stage lighting, see scene design and stage lighting.

Early Sources of Artificial Lighting

The earliest means of artificial lighting were the open fire, firebrands, and torches. The first lamp was a dish of stone (later of clay, pottery, or metal) containing vegetable or animal oil and a wick. This was succeeded by the candle, first made of wax and later also of tallow, and by the lantern, which is of early origin. The Argand burner was an improved oil lamp with a burner and a chimney, and this type of lamp was widely used after the Canadian geologist Abraham Gesner popularized the use of kerosene.

The Introduction of Gas as a Fuel

Coal gas was first used as an illuminant in the late 18th cent. by the engineer William Murdock in England and by the engineer Philippe Lebon in Paris. It was used in London in 1802, in Baltimore in 1817, and in New York state in 1823. The invention of the Bunsen burner by the German chemist Robert Wilhelm Bunsen and the invention of the Welsbach mantle, a device developed by the Austrian scientist Carl von Welsbach that gives off bright light when placed over a flame, greatly stimulated the use of gas for lighting purposes.

Electric Lighting Comes of Age

The first development in electric lighting was the arc lamp, which was evolved from the carbon-arc lamp demonstrated in 1801 by Sir Humphry Davy, in which an electric current bridges a gap between two carbon rods and forms a bright discharge called an arc. Early lamps of this type were made with an open arc; later ones were enclosed in glass and thus made more practicable. Carbon-arc street lamps, first produced by the American scientist Charles F. Brush, were used in Cleveland in 1879 and soon came into wide use in other cities. The mercury-vapor electric lamp was devised by the American inventor Peter Cooper Hewitt in 1903. This type of lamp makes use of a pool of mercury liquid in a condition of high vacuum; when an electric current passes through the mercury it produces ionized vapor, which gives off a blue-green light. Modern improvements have given this lamp a much greater efficiency. The neon lamp, developed by the French physicist Georges Claude in 1911, has been largely used in commercial signs.

The Incandescent Lamp

The incandescent electric lamp, in which an electric current passing through a resistance filament (e.g., one of carbon and tungsten) enclosed in a vacuum tube heats the filament until it glows, was developed by the American electrician Moses G. Farmer in 1858–59 but was not practicable. Sir Joseph Swan in England and Thomas Edison in the United States, working independently, developed lamps of this kind; the lamp patented by Edison in 1879 was the first widely marketed incandescent lamp and was the forerunner of the modern Mazda lamp that utilizes a filament of drawn tungsten hermetically sealed in a glass envelope. A gas-filled incandescent lamp was invented by the American chemist Irving Langmuir in 1913. In the United States, the Energy Independence and Security Act of 2007 mandated the sale of more energy-efficient incandescent (and other) lamps; the phase-in of the requirement for lamps that

use 30% less energy began in 2012.

The Fluorescent Lamp

The French physicist A. E. Becquerel constructed a fluorescent lamp and described (1867) the preparation of fluorescent tubes basically similar to those made today. Considerable progress in developing fluorescent lighting was made in several European countries, and during the 1920s high-voltage fluorescent tubes were used in advertising signs. In the United States the first practical hot-cathode, low-voltage fluorescent lamp was marketed in 1938. This is the form of lamp still commonly used. It consists of a long, sealed glass tube with an electrode at each end; a small amount of mercury is contained within the tube. The inside surface of the tube is coated with a mixture of fluorescent powders. When an electric current is maintained through the lamp, the mercury becomes vaporized and gives off invisible ultraviolet radiation that is absorbed by the fluorescent coating. The coating then emits visible light. The fluorescent lamp is often easily distinguished by its tubular design—straight, circular, or bent in a U or other shape. Compact fluorescent lamps, usually designed to screw into the socket originally made for an incandescent lamp, are now also shaped to resemble the less efficient incandescent lamps that they are intended to replace.

Contemporary Lighting Technology

The search for efficient artificial lighting during the 20th cent. first focused on improving incandescent lamp technology and high-intensity discharge (HID) lamps. The tungsten-halogen lamp, often called a halogen lamp, like the other incandescent lamps uses a tungsten filament as the light source, a gas filling that includes a halogen, and a quartz bulb. The halogens help preserve the filament and prevent lamp walls from darkening as quickly as those of the other incandescent lamps by causing the tungsten that evaporates during lighting to be redeposited on the filament instead of the bulb; more light is thus available to the task or work surface.

HID is the term commonly used to designate four distinct types of lamps—mercury vapor, metal halide, high-pressure sodium, and low-pressure sodium—that actually have very little in common. The mercury vapor lamp produces light when the electrical current passes through a small amount of mercury vapor. The color rendering qualities of the mercury vapor lamp are not as good as those of incandescent and fluorescent lamps. The metal halide lamp is similar to the mercury vapor lamp, the major difference being that the metal halide lamp contains various metal halide additives in addition to mercury vapor. The efficiency of metal halide lamps is twice that of mercury vapor lamps. Some of the newer metal halide lamps provide color similar to that of incandescent lamps while others emulate daylight. The high-pressure sodium (HPS) lamp has the highest lamp efficiency of all lamps commonly used indoors. It produces a golden-white light when electricity passes through a sodium vapor. The low-pressure sodium (LPS) lamp, the most efficient of all, is used where color is not important because all colors illuminated by an LPS light source appear as tones of gray or yellow.

The most promising technology is that of the light-emitting diode (LED). A tiny semiconductor microchip, an LED consumes little power, is long lasting, and is relatively inexpensive. It produces visible or infrared light when subjected to an electric current. First demonstrated in 1962 and appearing in a commercial product in 1968, LEDs were limited to small applications until 1985, when more powerful LEDs were produced. Their major limitation was that only red and green microchips were possible. In 1993 researchers at several universities in the United States and Japan developed an LED that produced blue light, which in conjunction with the red and green chips could produce white light. This

made the LED a major player in illumination technology, and LED lightbulbs that can replace incandescent and compact fluorescent ones have been developed. The discovery of organic light-emitting diodes (OLEDs), made with plastics rather than silicon and other traditional semiconductor materials, opened the door for many specialty applications under the mantle of solid-state lighting. LEDs also offer the possibility of adjustable colors, permitting the use of lighting that enhances alertness during the daytime and aids sleeping during the nighttime, or that enhances different aspects of crop growth during a plant's life cycle.

Functional Selection of Lighting

The incandescent lamp was long the basic light source, and still remains the one in most common use, though it is being superseded by compact fluorescent and LED lamps. While the least expensive to buy, it is the most expensive to own due to its low efficiency and relatively short life. The fluorescent lamp is the second most common light source. It is widely used in factories, offices, stores, and public buildings because it produces far more light for the same expenditure of electricity than do incandescent lamps. Compact fluorescent bulbs that can act as replacements for standard incandescent bulbs are sold for their long life and energy efficiency. However, to many observers the colors of objects illuminated by a fluorescent lamp often appear quite different than they would appear if the objects were illuminated by an incandescent lamp or sunlight. More efficient LED lamps that also are capable of producing a more natural light than fluorescent lamps are increasingly replacing both fluorescent and incandescent lamps, especially in commercial settings. Sodium vapor lamps are used on some highways, as are color-corrected mercury-vapor discharge lamps. Tungsten-halogen lamps are used for lighting sports arenas and stadiums, in automobile headlights, and for residential lighting. Xenon lamps are used in flash photography as well as in cinema projectors and lighthouses.

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