

and ideal from that of his fellow exhibitors. His inspiration for these paintings was not the French Post-Impressionists as it was for the core of the Camden Town Group; in *Frank* he looked back to Whistler and Velázquez, and in the tondo *Mother and Child* (a theme he explored in 1911) he recalled Italian Renaissance models. His work was acclaimed by the critics who were surprised at his association with the Camden Town Group. The artist himself regretted his membership and resigned. Three months later he killed himself.

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W. Baron: *The Camden Town Group* (London, 1979)

WENDY BARON

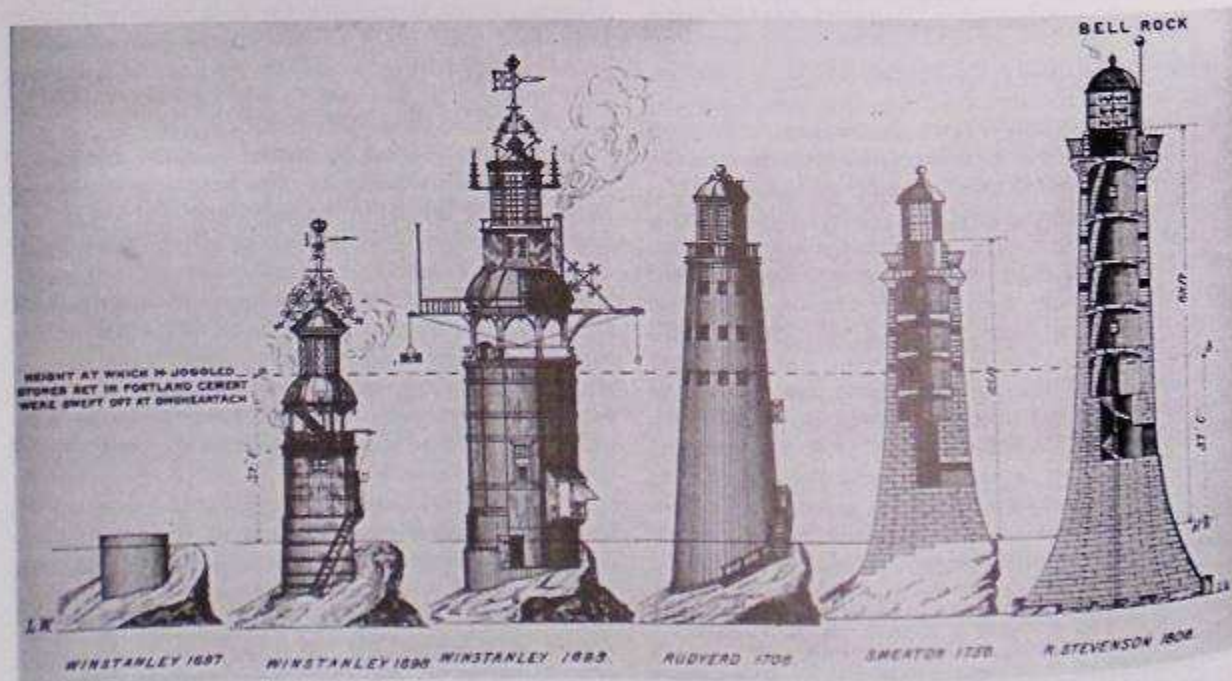
Lightfoot Runner. See WEST, RICHARD.

Lighthouse. Structure built on a coast or on a rock in the open sea that exhibits a powerful light to aid navigation and warn of hazards to shipping. The most renowned lighthouse of antiquity—one of the seven wonders of the ancient world—was built c. 280 BC on the island of Pharos at Alexandria. Constructed of stone in three storeys (h. c. 137 m), the lower storey was 30 m square, the second octagonal and the top circular, with a wood fire on its roof. From this structure (destr. 13th or 14th century) the word 'pharos' came to be generally adopted as denoting a beacon, although not necessarily one bearing a light. The Romans built numerous lighthouses: the pharos at the entrance to Ostia harbour, completed by Emperor Claudius c. AD 50, was similar in form to the one at Alexandria but only a quarter its height. At least 30 lighthouses existed before AD 400, including surviving examples at Dover and La Coruña (refurbished late 18th century).

Lighthouses were built in several areas of the Islamic world along navigable rivers and coastlines, for example

the cylindrical tower (AD 821) at Sousse on the Tunisian coast, which, as indicated by its Koranic inscription, was used to guide ships into harbour. In Europe lighthouse construction recommenced from c. 1100. An outstanding example is the Lanterna at Genoa, built before 1161 and reconstructed in its present form in 1544; it comprises two pillars, 9.1 m and 7 m square respectively, each over 30 m in height, set one upon the other on a rocky eminence. Cordouan Lighthouse, a notable French example, was designed in 1581 by the engineer-architect Louis de Foix to replace an existing structure; built on an islet in the estuary of the River Gironde, it was the first lighthouse since Roman times to be entirely surrounded by water. The barrel-shaped building (upper part replaced 1788-90) contained two vaulted rooms: a great hall (diam. 15.8 m) and a spacious chapel above. The principal dome carried an open lantern crowned by a turret, which enclosed the fire, with a tapering chimney above. Externally the lighthouse was profusely decorated with parapets and pilasters, which disguised the building's unattractive form. It was not until 1610 that work was sufficiently advanced to allow a navigation fire to be shown. The principal unforeseen difficulty was erosion by the sea, and an encircling wall and parapet (begun 1595; subsequently enlarged) saved the lighthouse from destruction.

The first lighthouse to be completely exposed to the sea was built in 1696-8 on the wave-swept Eddystone Rock in the English Channel, c. 22 km from Plymouth, by Henry Winstanley (1644-1703); it was subsequently rebuilt and enlarged (1699; destr. 1703). Both were extraordinarily ornate designs (see fig.). The third Eddystone Lighthouse was a simple, conical tower (1706-8) built by John Rudyerd (d 1713); sheathed with caulked planking like a ship, it was destroyed by a fire that started in its timber lantern in 1755. The fourth Eddystone tower (1756-9) by JOHN SMEATON revolutionized lighthouse design. It was



British lighthouses, 1697-1806; from T. Stevenson: *Lighthouse Construction and Illumination* (London, 1881), pl. 1.

built entirely of stone with concentric courses of interlocking dovetailed blocks secured vertically by stone cubes to prevent sliding. To combat the destructive effect of wave action on traditional lime mortar he developed a hydraulic mortar using Italian pozzolana, a natural volcanic ash (see CONCRETE, §II, 1(ii)). This achieved a homogeneous structure with greater weight, strength and durability, which was enhanced by the wide-based, tapering form of the tower, inspired by the shape of the bole and trunk of an oak tree (see fig.). The light at its summit was provided by a chandelier of candles.

Smeaton's structure was highly influential on lighthouse design throughout the world for the next 150 years, as seen in two outstanding wave-swept lighthouses off the Scottish coast, Bell Rock (1807-11; see fig.) by Robert Stevenson and Skerryvore (1838-43) by his son Alan Stevenson (1807-65), both of which, when built, were the largest of the type. A new, much larger Eddystone Lighthouse, also built of interlocking masonry, was later constructed (1882) on a different rock due to erosion of the first; it was designed by James Douglass (1826-98), who also built the second Bishop's Rock Lighthouse (1852-8; enlarged 1882-8), Scilly Isles, and Wolf Rock Lighthouse (1862-9) off Land's End. The upper part of Smeaton's tower was re-erected as a monument on Plymouth Hoe. The Fastnet Rock Lighthouse (completed 1904), by Douglass's son William Tregarthen Douglass, also followed Smeaton's concept.

Important developments in lighting and optical technology for lighthouses took place in the 18th and 19th centuries. In 1782 the Swiss scientist Aimé Argand invented an oil lamp that gave a steady, smokeless flame, providing a major improvement in illumination. Argand lamps remained the standard form of lighthouse illumination until the late 19th century, although gas-mantle and pressurized-kerosene lamps were also developed in the late 19th century and early 20th. The first optical system designed to concentrate and focus the light was the catoptric system, in which light is distributed by metallic reflectors in the form of a parabolic curve. It was introduced at Liverpool by William Hutchinson, dockmaster in 1763. Revolving catoptric lights were first used at Carlsten Lighthouse by the Swedish engineer Jonas Norberg in 1781. Early independently designed revolving catoptric systems were installed in the new upper tower at Cordouan (1788-90) and in St Agnes Lighthouse, Scilly Isles, in 1790. Robert Stevenson introduced improved parabolic reflectors, developed intermittent and flashing lights and in 1810 designed a double light for the Isle of May Lighthouse. The dioptric system, using concentric prisms of glass around a lens to refract the light into a narrow, horizontal beam, was invented in 1822 by the physicist Augustin Fresnel (1788-1827). He also initiated the catadioptric system, with combined refracting and reflecting prisms. Alan Stevenson and Thomas Stevenson (1818-87) developed Fresnel's work. The invention by Thomas Stevenson in 1849-50 of holophotal systems, which combined the whole spectrum of rays diverging from a light source into a single beam of parallel rays, marked a major improvement in lighthouse illumination that came into universal use for about a century. In 1890 a method was invented to reduce friction in revolving lights by floating

the apparatus on a bath of mercury, and this allowed the frequency of rotation to be increased.

In the 20th century the development of reinforced-concrete and steel construction, electric lighting, electronic communications and the use of helicopters for construction and servicing have all facilitated lighthouse provision and operation. Prefabricated reinforced-concrete construction techniques for lighthouses resulted in the telescopic method of erection using caissons that was established in the late 1950s, while Ve Skerries Lighthouse (1979), West Shetland, designed by Robert MacKay (b 1929) has a tower (h. 15.7 m) built of prestressed, post-tensioned concrete shafts anchored into the rock. In the 1960s US Coastguard towers were built off Texas in the Bay of Mexico with open frames of braced steelwork resembling oil rigs. Incandescent electric lamps became the standard form of illumination in lighthouses from the 1920s, but later developments included sophisticated arc lamps and lights powered by solar cells and sealed-beam lamp arrays; radio and radar beacons are also used for navigational purposes. Such developments resulted in manned lighthouses gradually being automated or superseded by automatic lights, which are continuously monitored from a central headquarters. A new automatic lighthouse was built to MacKay's design at North Rona (1984), off Cape Wrath on the Scottish coast; the last manned lighthouses in the USA were automated in the late 1980s and in Britain automation is planned for completion in 1998.

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Lighting. Architectural use of natural and artificial light. The lighting of buildings has two aspects: functional, in which interiors need to be efficiently lit by both daylight and artificial light to enable human activities to take place over an extended period of time, and aesthetic, in which the qualities of light and its form-giving potential can be used to achieve effects of great beauty, on both the exteriors of buildings and their interiors. For thousands of years the production of artificial light depended on combustion and the brightness of a flame, initially by fire and then by burning fats and oils. During this period, most