SHOW A LIGHT!

2000 years of technology and effort lie behind today's automated and highly efficient lighthouses. *Neville Billington* charts the progress.

There is reason to believe that lighthouses were built at least as far back as 850 BC along the coast of Lower Egypt. The earliest recorded lighthouse was the Pharos at Alexandria, built by the Pharaoh Ptolemy II about 260 BC. The tower stood upon a podium some 100 m sq and 7 m high. The overall height was some 140 m. It was the tallest roofed structure ever to be built until the skyscrapers of today.

The erection of lighthouses was halted in the Dark Ages, and not resumed until the revival of trade which began again in the 12th century.

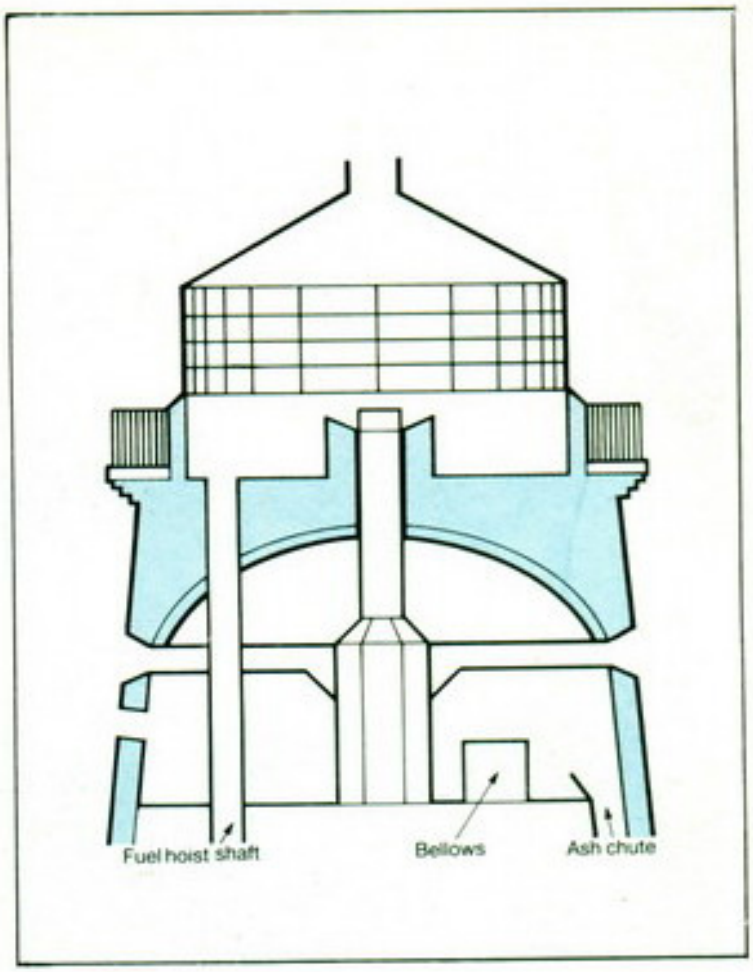
Churches were associated with lights in mediaeval times. One of the earliest in Britain is that at Hook Point, Waterford, and is the oldest lighthouse still in use in these Isles.

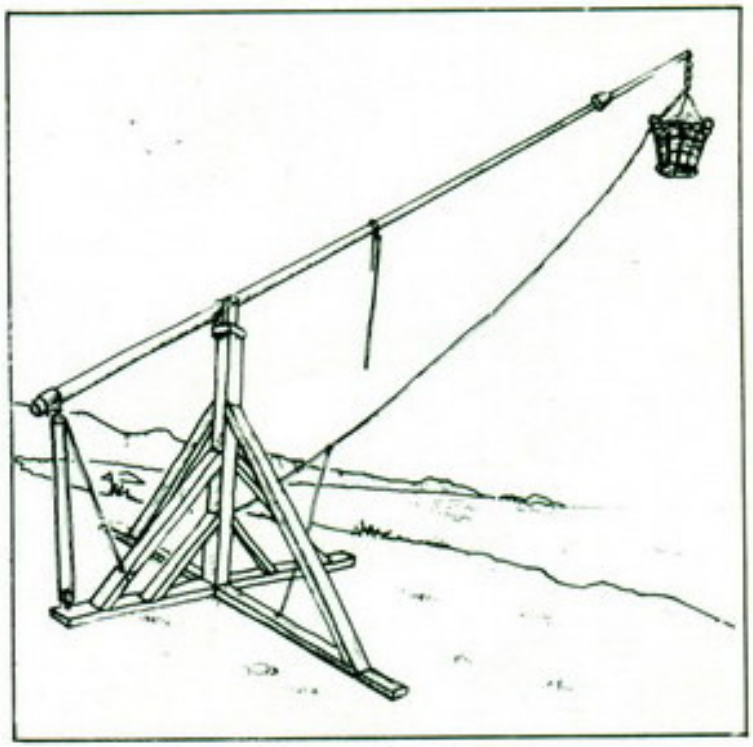
Many of the first lights were no more than beacon fires of wood. The brazier offered a more efficient way of burning the fuel, and it was, of course, obvious from the beginning that the range of visibility would be increased by elevation on a headland or a tower. The tower however, posed some problems of access for both fuel and fireman. These were circumvented by the "swape". This was a long pivoted beam from which a fire-basket hung. The basket could be tended on the ground, and then raised by pivoting the beam. One of the last swapes to be used was on Gothland in Denmark in 1905.

After the middle of the 16th century, coal was increasingly preferred to wood, and it was much better than oil lamps or candles. A coal lighthouse was built on the Isle of May in the Firth of Forth in 1635. The brazier was carried on a small pillar in the centre of the fire platform, at a height of 12·8 m. After the *Act of Union* of 1701, the Edinburgh Chamber of Commerce took up the matter of insufficiency of light, and as a result, the owner increased the size of the brazier to 3 ft sq, doubling the consumption of coal to 400 ton/annum.

The Isle of May light still used coal until 1816, when it was converted to oil. The last coal burning light to be displayed in Britain was at St Bees in 1823.

The tower of Tynemouth incorporated a shaft and winch for hauling up the fuel, and perhaps a chute for ash disposal. The North Foreland tower certainly included these, and an engraving of 1792 shows that the





Top: **The Spurn light of 1776.**
Above: **Typical swape design.**

flues from internal domestic fires were collected together to form the back of the open fire which was the light itself.

At some time during the mediaeval period, the brazier was enclosed in a lantern. This was primarily a safety measure, to prevent sparks and cinders from igniting heather or rigging etc. The best example in Britain is at St Catherine's Point (IoW).

The earliest attempt in modern times to enclose a fire in a lantern was in 1680 at St Agnes Head. The lantern was of wood, covered on both sides with lead. A chute was provided for dumping the hot ashes outside the base of the tower. The basket at St Agnes was about 0·9 m diameter and 0·5 m high.

At Spurn in 1776 the fire grate was supplied with air by a number of radial channels which could be closed according to wind direction. Bellows were provided for use in the absence of wind.

Candles and oil-lamps in lanterns with panes of glass or horn, were possibly used as early as the first century AD. Nevertheless one of the earliest records of the use of candles concerns the two lights at North Shields in 1540. Each comprised a single tallow candle. The towers were heightened in 1613, and each light doubled to two candles. When rebuilt, 1727, the number of candles increased to three.

Candles continued in use until recent times; eg Saundersfoot until 1861.

The first reference to oil as an illuminant is in Hakluyt's *Voyages* of 1595. A unique lighthouse cresset (a hollow bowl filled with oil or fat) is on the 14th century tower of the church of St Michael's Mount. It is a stone base 381 mm dia, 75 mm deep, with a central hole for the wick, surrounded by a pentagonal stone lantern with three leaded lights.

Argand, Carcel and Moderateur lamps were all used. Argand's circular wick was further improved by Rumford (who proposed several concentric wicks) and perfected by Arago and Fresnel. The Fresnel lamp had four concentric wicks. The oil was pumped by clockwork, and overflowed the wick constantly. The lamp could burn for long periods without attention; some Scottish lights burned for 17 hours, on colza oil.

Fresnel's multi-wick lamp enabled high power to be achieved in a single source, rather than a multiplicity of lamps. This greatly simplified the optical problems of focusing and beam control. The Argand/Fresnel lamp was the principal illuminant for more than 100 years. A simple Argand burner with reflectors could produce a light of 20 000 candle power. With a Fresnel lens, the intensity was raised to 80 000 cp.

Cordouan in 1782 was one of the first modern lights to have oil lamps. It had 24 lamps with reflectors. The original burners were flat-wick and were very smoky, but they were replaced by Argand burners, with parabolic reflectors in 1786. The Needles Point lighthouse was provided with Argand lamps in the early 19th century; it consumed, annually, some 700 gallons of oil. An old-style Argand burner remained in use at Buddonness until 1942.

Sperm oil was generally used in Britain until about 1845. Trinity House also used animal oils, followed by colza, but sperm oil was thought to give a better light. Seal oil, whale oil, lard etc were also used. Eventually, colza oil superseded spermaceti oil, being only about half the cost per candlepower. A 4-burner lamp could use up to 1000 gallons of colza oil each year.

To improve the viscosity of the oils, a fireplace was sometimes provided in the lamp room. The heavy oils were supplied to the burner either by a mechanical pump or by a weight-pressurised reservoir.

A ventilation system was devised by Faraday to minimise condensation on the lantern glass and windows. It consisted of a copper tube 4 in in diameter in three or four sections, placed above the lamp chimney. The base of each section was flared to 5½ in in diameter, to provide an opening for an induced air flow.

The first successful burner for paraffin was a wick lamp by Doty in 1868. This was used in a French lighthouse in that year and in a Scottish one two years later. Wigham's long-burning petroleum lamp used a continuous flat wick passing over a roller where burning took place without charring the wick.

Gurney proposed to oxygenate oil flames to increase the brilliance. Mantles were not used with oil lamps until 10 years after their introduction for gas. Kitson's lamp (USA, 1901) used pressured kerosene in a vapourising burner, with a mantle; it was capable of providing a light of up to one million candlepower!

Gas obtained from the distillation of wood was used at Parkkola in Finland in 1800-9; coal gas was employed at Salvore at Trieste in 1817-8. Admiral Sheringham then proposed the use of gas for buoys in 1852, and he experimented at Portsmouth. Guttapercha pipes 2 in in diameter were used to convey the gas. Copper wires inside the pipes led to a platinum igniter at the burner, the current being supplied by a battery on the shore. The scheme was however not immediately followed up. In 1861 at Port Glasgow, it was used for beacons. The beacon had a 10 ft 3 gasholder which maintained a pilot flame. A float valve on the beacon admitted gas to the burner and gas holder when the gas pressure in the supply main was sufficiently high. Regulation of the mains pressure at the shore end thus controlled the operation of the burner on the beacon. Pier-head lights at Portsmouth were gas-lit in 1865, and on IoW and Channel Islands by 1870.

Acetylene, butane and propane are still used, especially for unattended lights. A photometric valve, operated by sunlight or daylight was invented early this century by the Swede Gustav Dalen, to cut off gas supply in bright light. Its first use was at Furuholmen near Stockholm in 1907. It was due to Dalen that acetylene found large scale use in lighthouses. Its controllability made the automatic light possible.

Professor Holmes constructed a generator specially for use in lighthouses in 1853. It was tried by Trinity House in London in

1857, and "first showed to the sailor" in the following year. Dungeness was the first lighthouse to be so equipped, in 1862; the generator being driven by a steam engine. Electric light was installed at Cap La Heve in France in 1863.

The first mains-power light was at South Forceland which was also, in 1922, the first British light to use filament lamps.

The xenon lamp was introduced in 1947 and can be seen at a range of 32 km in daylight. An arc light, with searchlight mirror, at Heligoland in 1913, had a power of 38 million cp. The most powerful light, also a carbon arc, at Ile d'Omessant in France, provides 500 million cp!

This article has concerned itself almost entirely with the all important "flame". However, the visibility of a light obviously depends as much on the optical system as on the light source. Although it is no part of this article to discuss the optics in detail, some brief comments are pertinent.

The catoptric system relies on reflectors, the dioptric on refraction by lenses and/or prisms, and the catadioptric on a combination of the two. Their purpose is to channel as much of the light as possible from the source in the required directions. They appear to be a relatively recent development.

Metal reflectors are believed to have been used in 1532 at Gollenberg in Sweden in 1669-72.

A Trinity House keeper igniting a Hood petroleum vapour burner. This equipment was introduced in 1920 and developed by David Hood, engineer-in-chief of the Trinity House Lighthouse Service and was used by them until 1927 when the last station was electrified (St Mary's, Whitney Bay).

The principle of operation was that lighthouse mineral oil (similar to paraffin) was vapourised and then fed into an incandescent mantle. This expanded when ignited giving an intense white light (a light of over 1 million candle power was possible).

T Stevenson, an important name in lighthouse development, who contributed much to the design of lighthouse systems in the mid 19th century, noted that optical principles were first correctly applied in 1763, when a parabolic reflector was used in a Mersey light. Buffon in 1748 has suggested the "stepped" lens, and this was made by Abbe Rouchon in 1780. Fresnel, with whose name this lens construction is usually associated, seems to have been unaware of the work of these two men. Although a lens system was tried at South Foreland in 1752, its development had to await the Fresnel lens of 1819.

This article written by Neville Billington, when a member of the CIBSE Heritage Group, is from **Building News** *(The CIBSE Journal), October 1985*