*(Paper No. 2593.)*

# "The Illumination by Gas of Tory Island Lighthouse, County Donegal."

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THE Author proposes to give an account of the various alterations made, during the years 1885–1887, to provide for the adoption of gas as an illuminant at the lighthouse on Tory Island, situated on the north-west coast of Ireland, off county Donegal, which works were carried out by him under the Engineer to the Commissioners of Irish Lights, Mr. William Douglass, M. Inst. C.E. The question of gas as an illuminant for lighthouses had been carefully considered, prior to its adoption, and the results of the experiments and discussions were given in a Parliamentary Blue Book.[1]

The lighthouse was first lit in the year 1832, and, at the time of the commencement of the works here recorded, consisted of a six-wick, first-class dioptric, fixed oil-light, which was extinguished 6th April, 1887. The dioptric apparatus consisted of a bee-hive shaped lens of the usual type, with central annular lens, top prisms, and bottom prisms.

In the interval between the extinction of the old light and the establishment of the new, the illumination of the station was maintained by a temporary apparatus, similar in arrangement to those used on lightships; this was secured round a mast at a height sufficient to prevent obscuration by the erection of the new works, the mast being properly needled and guyed to the tower, with ladder communication from the gallery, as shown on Plate 7.

## GENERAL DESCRIPTION OF STATION.

Plate 7 shows the lighthouse tower as it stands at present, rising 60 feet from the level of the yard paving to the top of the gallery, and having an internal diameter of 11 feet 9 inches. The walls are 7 feet thick at the first floor, gradually tapering

[1] "Lighthouses. Papers relative to a proposal to substitute gas for oil as an illuminating power." Folio. London, 1869–75.

upwards to a thickness of about 3 feet 6 inches under the gallery level. The walls are of granite, mostly quarried at the site; and the tower contains five floors, all lighted by windows, and reached by a stone winding stair. The top of the vane is 36 feet above the gallery floor, and the centre of the light is 130 feet above high-water level. Around the tower are situated the station buildings, the keepers' dwelling-houses facing the entrance to the tower, and the various workshops flanking each side, the vacant side being enclosed by a wall 9 feet high. Standing further away are two new dwelling-houses; and enclosed in a yard, apart from all the other buildings, are placed two gas-tanks, the gas house, coal stores, purifying shed, and station-meter house. The siren house also stands by itself, about 70 yards distant, nearer the edge of rocks; in this position it commands the open sea, and the notes given forth by the sirens are not obstructed or diverted in any way. Inside the lantern watch-room is fixed an electrical indicator, with separate communication to four dwelling-houses, the gas house, and siren house, with return bells from each, so that in case of a fog arising at night, the keeper in charge can ring up additional help, at the same time turning on the increased light power.

Ample storage for water for domestic use is provided by concrete tanks, which receive all that can be gathered from the roofs. There is also a spring on the island, almost uninfluenced by the dry season. The remaining portions of the ground are enclosed by high walls, 2 feet thick, with a strong iron entrance gate. The staff consists of a principal keeper, two assistants, and a gas man.

## New Light.

The new light consists of what is known as a "Wigham" triform gaslight, of the latest improved construction, and, as is implied by its name, is formed by three superincumbent tiers of lenses placed inside the lantern, Plate 7. In the focus of each tier of lenses is placed a 108-jet gas-burner, making, when full on, a total of three hundred and twenty-four burners, equal practically to nine thousand candles; and, taking into consideration this illuminating power, the hyper-radiant long-focus lenses used are capable of making the light from the three burners equal to about seven million candles, according to Mr. Allard's formula. A feature of these burners is that no glass chimneys are required. The full tiers of lenses are made to revolve, thus giving forth a full, concentrated beam every minute, which is again subdivided into flashes. The lenticular apparatus is hexagon on plan, each

side containing twenty-two annular rings on each tier, varying in thickness from $1\frac{7}{16}$ inch to $1\frac{11}{16}$ inch, the bull's-eye being $14\frac{3}{4}$ inches in diameter, and $1\frac{3}{16}$ inch thick at the centre; and each side contains about $85\frac{1}{4}$ square feet. In ordinary fine weather, thirty-two jets in the bottom light are sufficient to reach the horizon; but when a fog comes on, the seventy-six additional jets are lighted in this burner, and at the same moment the other two burners of one hundred and eight jets each are used. The changes from one power to another can be made very quickly by the aid of a peculiar arrangement of mercurial joints.

Groups of flashes are caused by breaking up the full beam from the lens, by continually shutting off and turning on the gas. This is accomplished by a cam fixed on the rotating clockwork, placed under the lens table, from which a connecting-rod rises up through the lantern; and as the cam revolves, the cogs lift and raise the rod, shutting or opening the valves at the same moment. The result of the group flash is that the mariner sees, instead of a long flash of light recurring at certain intervals, a group of shorter flashes; and by this arrangement the lighthouse is identified. This device is a distinguishing and much required feature on a great landfall such as Tory Island.

## Lantern.

After clearing away the old lantern down to the gallery level, and carefully levelling over all the surface of the stone floor left, a cast-iron gallery flooring was laid down in sections, and secured to the stone gallery with $1\frac{1}{4}$-inch wrought-iron bolts. On this a cast-iron pedestal of $\frac{1}{2}$-inch metal was built in segments, standing 6 feet high all round, with side flanges about 5 inches deep (one section being for the doorway), and ribs recessed at the top to receive the ends of the lantern standards; and the pedestal sections are bolted together and down to the cast-iron gallery. To the top flange of the pedestal are secured sixteen vertical standards of milled steel, $5\frac{1}{2}$ inches by $1\frac{1}{4}$ inch, fitting tightly into the holes slotted in the top. The bars had to stand a tensile strain of 28 tons per square inch of sectional area, with a contraction of area of 35 per cent. On the top of these standards, a wrought-iron cornice plate, 6 inches by $\frac{5}{8}$ inch, is formed of thirty-two pieces, and joined and jointed with countersunk rivets, a wrought-iron screw being tapped into each of these standards. From this cornice, sixteen wrought-iron T bars spring, 3 inches by 3 inches by $\frac{3}{8}$ inch, shaped at the ends to take a wrought-iron cornice plate and connecting

ring at the top, being secured by $\frac{5}{8}$-inch bolts. The ring is 3 feet in diameter, 12 inches deep, and $\frac{3}{8}$ inch thick. The roof is covered with copper sheets, 3 lbs. to the foot, fitted in between the T bars, bedded in lead, and secured with $\frac{1}{4}$-inch brass bolts. The gutter round the lantern is also of copper, 4 lbs. to the foot; the upper edge of the gutter being wired with $\frac{1}{2}$-inch wrought-iron wire. Gun-metal covering plates were cast to cover the joints, and all bolted together. The down-pipes are of copper, and are carried down in front of the standards. The neck of the lantern is likewise of copper, and overlaps the roof sheeting. On the upper end of this neck was fixed a wrought-iron ring, carrying four arms to steady the spindle, which is also strengthened by two strong wrought-iron cross-bars fixed to the neck.

The cowl on the top is of copper, raised with the hammer, and shaped as shown in Plate 7. On the crown is fixed a case-hardened, steel step, which works on the point of the spindle. The spindle is pointed with steel and bolted to cross arms, and passes through rings at the end of the neck, and gun-metal bushing in the arms of the cowl. The cowl is surmounted by a vane, the shaft being of wrought-iron, the ball of copper, and the feather and barb of strong hammered copper. The standards of the lantern were fitted in with three tiers of wrought-iron astragals, $4\frac{1}{2}$ inches by $2\frac{3}{4}$ inches by $\frac{1}{2}$ inch thick, secured at the ends to standards with $\frac{1}{2}$-inch bolts. The astragals have a copper strip, $1\frac{3}{8}$ inch broad and $\frac{1}{8}$ inch thick, fitted with four brass studs and nuts tapped into them, the studs forming the rebates for the glass. Down the outer edge of the standards are tapped brass studs with nuts to take glass, and copper cover-strips, $\frac{1}{8}$ inch thick; and to each standard are secured four malleable iron handles, bolted with studs to the standards.

The whole of the lantern is glazed with $\frac{3}{8}$-inch plate-glass, the edges of the glass touching the brass studs on all sides; the space was packed in with red and white lead putty; and the copper strips were then screwed on, and made watertight. The centre space between the cast-iron gallery boxing is filled in with a circular riveted girder, 12 inches by 5 inches, with arms of the same section riveted with angle bars to the centre one, and also bolted to the inner side of the cast-iron gallery, thus forming a floor for the base of the lenses. The floor of the lantern is fitted in between the girders with cast-iron gratings in sections. On the top of this floor, and bolted to the girders, is built the base of the lenses, formed in sections of cast-iron and glazed; and the clockwork machine is placed inside. On the top of the base are the roller-

path and live-ring, on which the steel lattice girder carrying the lenses sits.

### Clockwork Machine.

The clockwork for driving the lens table is constructed of gun-metal and brass with ball bearings, and is driven by an endless chain connected with a weight cage running down a recess in the tower wall, and wound up every four hours.

### Gas Apparatus.—Retort-Bench.

The retort bench consists of seven cast-iron **D**-shaped retorts, 14 inches by 15 inches inside, by 7 feet long, and of $1\frac{1}{4}$-inch metal, set in two single, one double, and one three-tier settings; the retort bench being built with fire-bricks, and tiles built in fire-clay. The mouthpieces of the retorts project 10 inches, and have a faucet cast on to take the ascension pipes. These pipes are of $\frac{3}{4}$-inch metal, and tapering from 4 to 5 inches diameter, are carried up to the hydraulic main over the bench. The main, of 12-inch bore and $\frac{1}{2}$-inch metal, is in two parts, standing 18 inches over the bench top, and supported on cast-iron crutches. The ends are closed with flanges secured by bolts and nuts, one end being blank with cleaning doors, and the other end having a socket to receive a 5-inch pipe, which is reduced to 4 inches at the tar tank.

The gas from the hydraulic main passes into a condenser, consisting of a bottom box in one casting, with divisions arranged to pass the gas up and down eight pipes, each pipe being 9 feet long and 4 inches bore. From the bottom of the tank is carried a 2-inch overflow pipe to the tar tank, provided with a seal to prevent the escape of gas. The gas is then passed from the condenser, by a 4-inch pipe, to the vertical scrubber, and passes down through the scrubber. The latter is 8 feet high and 2 feet in diameter, formed of cast-iron, and is provided with a flushing rose and cistern, and tar-pipe outlet to the tank.

The gas passes from the scrubber through two dry-lime purifiers, each 4 feet 4 inches long, 2 feet 5 inches wide, and 2 feet 3 inches deep, with a division plate, each purifier being in two castings, with cast-iron covers provided with air and testing plugs, and five tiers of wooden turned-bar sieves for lime. There is a water seal round the top of the purifiers, 8 inches long by $2\frac{1}{2}$ inches wide. The lids are lifted by means of a 10-cwt. differential pulley-block and chain. Between the purifiers is placed a change valve,

arranged so as to pass the gas through either or both of the boxes, or past them direct, by the 4-inch main, to the station-meter, which is capable of passing 1,000 cubic feet per hour. Between the purifiers and the meter, a second by-pass valve is placed, so that in case of any breakdown of the meter, the gas can pass on to the gasholder. This expedient is adopted throughout, so that all direct parts of the apparatus are in duplicate. The gas passes from the meter on to the valve house, where there is an arrangement of valves and by-passes by which it can reach either gasholder. The gas passes by a 4-inch pipe from the valve house into the tank, and down into the cast-iron tank siphon, 3 feet 6 inches long, 1 foot 8 inches wide, and 10 inches deep, made in one casting of $\frac{1}{2}$-inch metal, with a division plate; it thence proceeds to the gasholder, and leaving the latter, passes back down a pipe into the box, and so reaches the valve house. The siphon box has a $\frac{3}{4}$-inch gun-barrel pipe passing down its inlet pipe, with connections at the top where a small pump can be attached for cleaning the box.

## Gasholders.

The gasholders are well-constructed vessels, 25 feet in diameter by 10 feet deep, with two curb rings, $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches by $\frac{1}{4}$ inch, the bottom curb being placed outside. There are four principal rafters of flat iron on edge, $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch; four secondary rafters of flat iron, $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch, and purlin bars, $2\frac{1}{2}$ inches by $\frac{3}{8}$ inch, on edge; tension rods, each $\frac{7}{8}$ inch diameter, attached to the principal rafters; and a centre truss cap, which is of cast-iron. The crown plates are 2 feet 6 inches in diameter, $\frac{1}{4}$ inch thick, with two circles of No. 14 B.W.G.; the outer circle is of No. 13 B.W.G., and all the side sheets are of No. 14 B.W.G., except those of the top course, which are of No. 13 B.W.G., and the sheets of the bottom course, which are of No. 12 B.W.G. Four top guide-rollers are fixed to work against 2 inches by 2 inches by $1\frac{1}{4}$ inch T bar guides secured to the columns, with four guide-rollers at the bottom to work on the wrought-iron guide built in the masonry walls of the tanks. The rise of the roof of the gasholders is 1 foot 9 inches. The framing for bearing the tanks consists of four cast-iron columns, 12 inches in diameter, 9 feet high, with cap and base moulding, bolted down to piers in the wall of the tanks. On the top of each column is a sheer, 3 feet 6 inches high, to receive the chain wheels, 3 feet in diameter. The columns are attached at the top by lattice girders, 18 inches deep, with top and bottom flanges

of angle bars, $1\frac{1}{2}$ inch by $1\frac{1}{2}$ inch by $\frac{1}{4}$ inch, the lattice bars being of iron, $1\frac{1}{2}$ inch by $\frac{1}{4}$ inch.

### Siren House.

The siren installation consists of two 8-HP. Otto gas-engines resting on concrete-block foundations. Facing these engines are placed two air-compressors, driven by belting, and capable of utilizing the full power of the gas-engines. The air-compressors communicate with two air reservoirs, 7 feet high, 4 feet 6 inches in diameter, and each fitted with a manhole door. These air reservoirs are supported on wrought-iron legs, and each is capable of sustaining a pressure of 100 lbs. to the square inch. In the centre of the room is fixed a siren stand or support for the trumpets, standing 6 feet high, 6 feet 6 inches by 5 feet 6 inches at the base, and 5 feet by 4 feet at the top, constructed of wrought angle bars, 3 inches by 3 inches by $1\frac{1}{2}$ inch, well braced, and bolted to the concrete floor. All the connections between air-compressors, air receivers, and sirens, are made of the best wrought-iron tubing, capable of bearing a pressure of 100 lbs., with $2\frac{1}{2}$ inches gun-metal screw-down stop-valves. On each receiver is fixed a safety-valve to blow off at 40 lbs. per square inch, and a pressure gauge to record to 80 lbs. per square inch. A wrought-iron water-tank is provided at each end, capable of holding 750 gallons for the use of the gas-engines. A gas regulator and gas bag for the engines are also provided. In the roof framing are fixed wrought-iron guide rings, with wheels for guiding the trumpets when they are being turned to face with the wind.

On the top of the siren stand are placed two sirens, making 1,200 revolutions per minute, with trumpets rising through the roofs. Thus every portion of the machinery is in duplicate, in case of a breakdown occurring in such an isolated position where communication with the mainland is not always certain. The best cannel coal is used for the production of the gas, which is usually landed during the summer months at the north landing, where a crane has been erected.

### Oil Lamps.

In case of breakdown of the gas apparatus, an ingenious arrangement is provided, whereby in a few seconds a six-wick oil-light can be substituted for the bottom gas one, a cistern for oil being

arranged behind the flue space. The oil-light can be shut off by an arrangement of clappers, which are made to open and shut round the light, and are worked by a lever off the same clockwork that revolves the lens table, so that the group flashing arrangement is retained.

The building contract was carried out by Messrs. Colhoun Brothers, of Londonderry, Ireland. The lantern and gas apparatus were supplied by Messrs. Edmundson and Company, Capel Street, Dublin, the lens being manufactured by Barbier, of Paris.

The Author has to accord his best thanks to the engineer, Mr. William Douglass, and the patentee of the gas apparatus, Mr. John R. Wigham, for their kindness in permitting him to describe this work, and for valuable information given.

The communication is accompanied by eight tracings, from which Plate 7 has been compiled.

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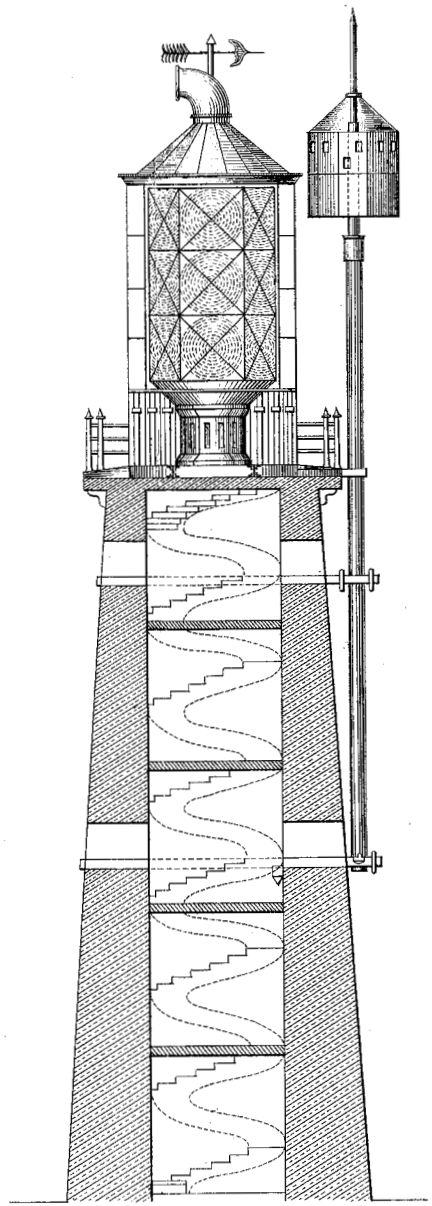
# TORY ISLAND LIGHTHOUSE.

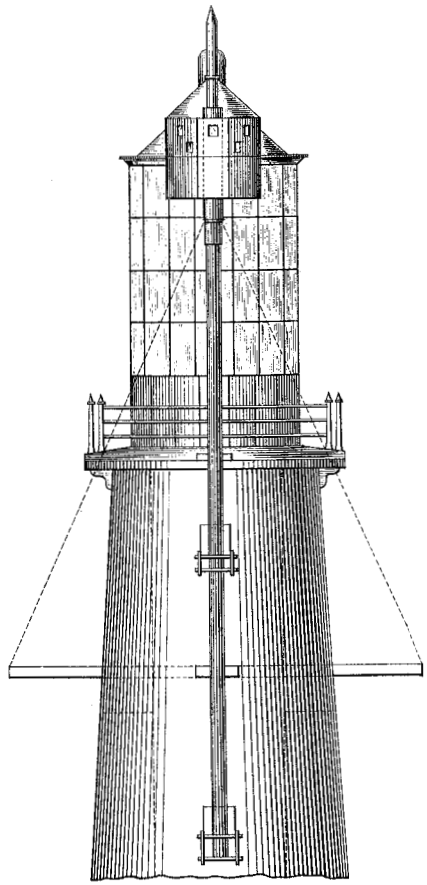


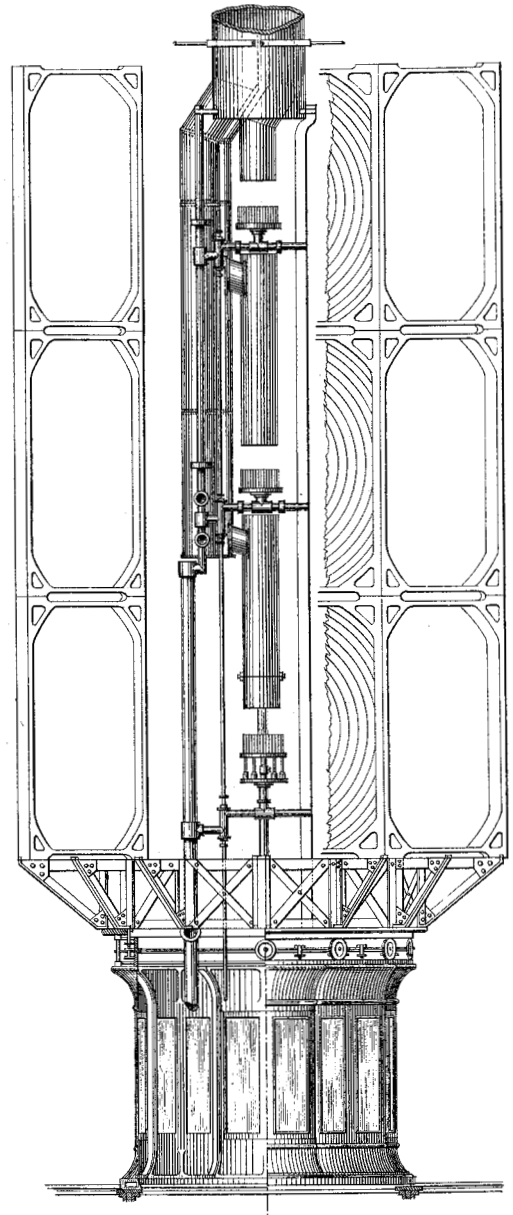


METHOD OF SECURING TEMPORARY LIGHT.

Scale 1/8th Inch = 1 Foot.

Feet 10 5 0 10 20 30 Feet





SECTIONAL ELEVATION.

Scale 1/4th Inch = 1 Foot.

Ins: 12 6 0 1 2 3 4 5 6 Feet.



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