

THE EDDYSTONE LIGHTHOUSE.

In the English Channel, fourteen miles south-southwest of the port of Plymouth, and twelve and a half from Rame Head, stand the Eddystone Rocks, a cluster of twenty-three gneiss rocks about 650 feet long from north to south, spurs and detached reefs covering about the same distance from east to west. They are almost in the line which joins the Start and Lizard points, and in the fair-way of all vessels coasting the southern shore of England. So exposed are they to the ocean swell from all the south and west, that even in comparatively calm weather the waves go raging and thundering over their ledges, and their name indicates the incessant swirl of the deep about them. Excursion steamers run there often during the summer, but rarely land their passengers. On these rocks three light-houses have been built in the last hundred and eighty years, since Europe became civilized enough to make such works practicable. Henry Winstanley, a retired London mercer, was the architect of the first, which was begun in 1696 and completed in 1699. He had such a taste for mechanics—for the bizarre in mechanics, that is—as Robert Houdin displayed so ingeniously in his villa near Paris, to the consternation of all his acquaintances, and amused his leisure at Littlebury, where he lived, by constructing chairs which told their arms round those who sat down on them and held them prisoners, though less cruelly than the maiden statue filled with knives at Baden, and by arranging an innocent slipper in the middle of a room, which, when the unwary visitor paid it the passing tribute of a kick, caused a frightful ghost to start up from the floor. The idea of his light house was suggested to him by a picture of a Chinese pagoda, and he built it of wood, in a polygonal shape, about a hundred feet high, and set it upon a polygonal stone base twelve feet high and twenty-four feet in diameter. Its form of course rendered it peculiarly liable to be swept away by the waves, while its huge gables, vanes, cranes, and wooden candlesticks exposed it to the action of the wind. It was gaily ornamented with painted and gilded suns and compasses and mottoes, such as "Post Tenebras Lux," "Pax in Bello," and "Glory be to God," and to protect its occupants against the attacks of foreign enemies, Frenchmen, Dutchmen, Spaniards or Turks, there was a platform from which, by means of a movable shoot, masses of rock could be hurled upon assailants. There was a kitchen, accommodation for the keepers, a state parlor carved and painted, with a chimney, two closets, and two windows giving upon a spacious balcony, and a splendid bed-chamber richly gilded and painted. Winstanley is represented in an engraving of this light-house (which was virtually a huge cockney summer-house set on stilts) as fishing out of the parlor window. Engineers and scientific men even then knew that he was mad, and warned him that the structure was a mad-house, but to no effect. He insisted on spending a portion of his time in it as a point of honor, and declared his anxiety to "be in it during the greatest storm that ever blew under the face of heaven." His wish was gratified. He had visited it in November, 1703, to superintend some repairs when what is remembered still as the "Great Storm" burst over the English coasts, the ever-memorable tempest which destroyed many of Sir Cloudesley Shovel's vessels then in the Downs, unroofed half of London, and inspired Mr. Addison, then "distressed by indigence," to compare the Duke of Marlborough, at Blenheim, with the angel riding in the whirlwind and directing the storm, a simile which earned for its author the Commissionership of Appeals. When the sun rose on the 27th November there was no vestige of the pagoda to be seen, and with it Winstanley and his five men had been swept away.

In 1706 the erection of the second light-house was begun at the expense of another London silk mercer, Mr. John Rudyard. It was completed in 1709, and was a very creditable piece of engineering. In form it was the frustum of a circular cone. For twenty-seven feet it was nearly solid, the filling consisting of courses of cut-stone alternating with courses of squared timber, the outside casing being of seventy-two oak posts fastened into the rock by heavy irons let into lewis holes, this being the first recorded application of the lewis for this use. The tower stood till the night of December 3, 1755, when it caught fire in the lantern and was destroyed. The keepers had to retreat from room to room as the fire gained till they reached the rock. For a wonder the weather was calm enough to admit of a boat landing in the morning and taking them off. Mr. John Smeaton was selected to build the third light-house, the type of all structures of the kind that have since been erected. His studies of wave action convinced him that no building can stand the continuous shock of wave after wave if the blocks are merely laid

one upon the other as in ordinary masonry, so he set himself to make a tower which should be practically a monolithic prolongation of, and so be equally stable with, the rock beneath. He took stone for his material, and for the lines of his model measurements of the proportions of the trunks of the old oaks in Windsor Forest. The general form of the "deep-sea lamp-post" is "the frustum of a solid of revolution formed by revolving a vertical plane bounded on one side by a concave curve around a vertical axis." It was built of large blocks weighing from a ton to a couple of tons of the strongest Portland oolite, cased in granite, the expense of using nothing but granite being thought too great. The stones of each course were joined by dovetailing, and the courses were connected by stone dowels, and the upper surface of the rock was cut in horizontal bed. The combinations devised for obtaining the greatest strength by dovetailing, dowelling, cramping, and the use of hydraulic mortar have never been surpassed; indeed Smeaton's discovery has been called "a revolution in architecture as great as that effected by the use of the keystone in the arch, or the introduction of the iron girder in buildings of the Italian style." The diameter of the lower partial course of masonry is 32 feet, that of the lowest entire course 26 feet. To a height of 35 feet it is solid; the whole height of the masonry is 77 feet. Under the coping the course is 16 feet in diameter; the tower is surmounted by a parapet wall 6½ feet high and 8½ feet in internal diameter. There are four rooms, one above the other, and at the top a gallery and the lantern. The stone floors are flat above and concave below, and are kept from pressing against the sides of the building by a chain let into the walls. The light-house was begun on the 2nd of April, 1757, and when it was finished, August 24, 1759, Smeaton said that nothing but an earthquake could destroy it.

And yet this splendid tower had one fatal fault—it was too strong! The waves have smitten it in vain—the keepers say that each blow sounds like a cannon-shot, and the lighthouse vibrates like the trunk of a wind-shaken tree as the waves actually overleap the lantern, and the only accident in its history was the burning of the wooden part of the structure in 1770. It stands on an irregular shaped crag, the House Rock, the upper surface of which more or less overhangs its actual foundations, and the waves have gradually undermined this precipitous submarine wall: at the same time so solid is the light-house that it has played the part of a rigid crowbar thrust into the rock and violently worked to and fro, creating fissures in the foundation crag; it has been an immense lever, and sooner or later will break or pry off the rock and tumble with it into the waves. In 1839, and again in 1865, iron bands were introduced into the interior of the superior portion; part of the projecting crag was cut away to lessen the leverage of the water, and the cornice which Smeaton placed near the top, partly for ornament, partly to protect the lantern, was bevelled off, but all in vain, and the fine old monument of engineering skill was condemned. Twice already, indeed, on the 3rd of February, 1869, and on the 9th of October, 1878, it has been reported as destroyed. The Elder Brethren of the Trinity Board have now prepared a light-ship, which can be moored close by, should the present structure tumble ere the new one is completed.—*Exchange*.

CENTRIFUGAL FORCE AND FLY-WHEELS.

It is not always that practical men are willing to admit the value and importance of scientific knowledge as regulating the operations and accidents of a workshop. We had a valuable incident of the kind that forced itself upon our notice, says a foreign contemporary, a few days back. A large pulley or rigger, three feet in diameter, and very wide, was split across its rim by carelessness in unloading; at the same time it was noticed that two of the arms out of six were cracked by contraction in cooling. In order, however, to save expense it was proposed to patch the broken rim of the pulley with wrought-iron plates, which was done. *Per se*, the iron plates were stronger than the original casting, but the whole weight of the patch amounted to about 15 pounds. As the pulley revolved at the rate of 600 revolutions a minute, this unbalanced weight on the rim became by calculation as much as 7½ cwt. radial force outwards. This scientific result was brought to the knowledge of the practical men, but they could not see why the pulley would not do very well if the patch was as strong as the rest of the rim. The pulley was accordingly run under protest, and hardly had the maximum speed been attained before the pulley flew in pieces, and might have been dangerous to life and limb. The pulley, undoubtedly, broke, as above indicated, by centrifugal force, which, by the