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Jas. D Brewster

Controversy with the

Stevensons.

1859.

J. F. Campbell Esq
From
the Author

ON

THE LIFE-BOAT,

THE LIGHTNING CONDUCTOR,

AND

THE LIGHTHOUSE.

BY

SIR DAVID BREWSTER, K.H., F.R.S.

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1859.

ART. X.—1. *The Report of the Evidence and other Proceedings in Parliament respecting the Invention of the Life-Boat.* By HENRY GREATHEAD, of South Shields. Lond. 1804. Pp. 71.

2. *The Invention, Principles of Construction, and Uses of Unimmergible Boats, stated in a Letter to His Royal Highness the Prince of Wales.* By LIONEL LUKIN. Lond. 1806. Pp. 43.

3. *Shipwreck Investigated.* By HENRY TRENGROUSE, Helston. Falmouth, 1817. Pp. 112.

4. *Our Life-Boat.* Communicated by RICHARD LEWIS, of the Inner Temple, and Secretary to the National Life-Boat Institution. Reprinted from the United Service Magazine, Sept. and Oct. 1857. Lond. 1857. Pp. 27.

5. *An Essay on the Preservation of Shipwrecked Persons.* By Capt. MANBY. Lond. 1812.

6. *A Lecture on the most Efficacious Means of Saving Shipwrecked Sailors.* By Capt. MANBY. Yarmouth, 1829.

7. *Invention for Saving from Shipwreck.* By JOHN MURRAY, F.G.S.A. Lond. 1831. With Supplement.

8. *The Life-Boat; a Journal of the National Life-Boat Institution, from the 1st of March 1852 to the 1st of July 1859.* 33 Nos., in 4 vols. Lond. 1852–1859.

9. *Instructions for the Management of Open Boats in Heavy Surfs and Broken Water, issued by the Royal National Life-Boat Institution.* Lond. 1859.

10. *Annual Report of the Committee of the Royal National Life-Boat Institution for 1859.* Lond. 1859.

11. *On the Nature of Thunderstorms, and on the Means of Protecting Buildings and Shipping against the Destructive Effects of Lightning.* By Sir W. SNOW HARRIS, F.R.S. Lond. 1843.

12. *The Meteorology of Thunderstorms, with a History of the Effects of Lightning on 210 Ships of the British Navy.* By Sir W. SNOW HARRIS. Lond. 1844.

13. *Remarkable Instances of the Protection of Certain Ships of Her Majesty's Navy from the Destructive Effects of Lightning.* By Sir WILLIAM SNOW HARRIS, F.R.S., etc. Lond. 1847. Pp. 70.

14. *Treatise on Burning Instruments, containing the Method of Building large Polyzonal Lenses, and an Apparatus for Increasing the Intensity and the Size of the Refracted Beams.* By DAVID BREWSTER, LL.D., F.R.S. In the Edinburgh Encyclopædia, vol. v., p. 140, 143. Edin. 1812.

15. *Memoire sur un Nouveau Systeme D'Eclairage des Phares.* Par M. A. Fresnel. Paris, 1822.
16. *On the Construction of Polyzonal Lenses and Mirrors of Great Magnitude for Lighthouses and for Burning Instruments*, etc., etc. By David Brewster, LL.D., F.R.S. Lond., and Sec. R.S. Edin. Edin. Phil. Journal, vol. viii., p. 160. Jan. 1823.
17. *Account of a New System of Illumination for Lighthouses.* By David Brewster, LL.D., F.R.S. Edinburgh Transactions, vol. xi., p. 33. Edin. 1827.
18. *On the British Lighthouse System.* Edin. Review, vol. lvii., p. 169, Oct. 1833. (By Sir David Brewster.)
19. *Report and Evidence from the Select Committee of the House of Commons on Lighthouses.* Aug. 1834.
20. *Review of the Parliamentary Report on Lighthouses.* Edin. Review, vol. lxi., p. 221. Jan. 1835. (By Sir David Brewster.)
21. *Papers on the Comparative Merits of the Catoptric and Dioptric Lights for Lighthouses.* Issued by the Board of Trade. Lond. 1857.
22. *Memorial on the New System of Dioptric Light, invented and introduced* by Sir David Brewster, B.H., F.R.S.A. Cupar, 1859.

While the battle-field is yet red with blood, and the wail of widows and orphans ringing in our ears, and while the havoc of war is still visible in desolated fields and dismantled hamlets, it may be some consolation to the friends of humanity to know that there are special arts of peace, and special applications of science, by which human life is saved, and property, individual and national, rescued from destruction. To the philanthropist who looks upon war but in its social aspect, and as an institution under which the lives of the brave are wantonly and wickedly sacrificed, the amount of life which science has rescued from destruction may appear a trivial source of gratification, and merely a fractional offset against the countless victims of war; but it is in its moral phase that the Christian patriot must make the comparison. We cannot highly estimate the value of that life of which the owner is prodigal,—which he voluntarily hazards for lucre or for fame, or which he squanders on the forlorn hope, or throws away in the personal encounter. The hero is a martyr by choice—a victim self-laid upon the altar of ambition; and to bewail his fate is to make light of his calling, and question the whole aim and end of his being. His profession is to slay and be slain, and when he falls—"he falls in the blaze of his fame."

How different is the fate of those who in mid-ocean are over-

taken by the thunderbolt or the tornado, or who, within sight of their native shore, are dashed upon the wild shelves by which it is defended. The merchant returning to his home—the traveller to his country—the emigrant to his friends—the soldier to his family—and the mariner to his haven, all instinct with life and hope, become the sudden victims of those disasters at sea which science alone can counteract or alleviate. Escaping from the fatal cyclones of the tropical seas, and unscathed by the lightning bolt that has rushed through its masts into the deep, the joyous vessel approaches its destination at midnight, anticipating the greetings of a happy morning. A cloud-spot in the azure vault reveals an element of danger. The stars disappear in the rising haze; the beacon-lights shine feebly or falsely; the gentle breeze freshens into a gale, and amid the discord of rending canvas, of creaking timbers, and clanking chains and raging waves, the startled passenger rushes from his couch to witness his ship in the arms of breakers,—to welcome the life-boat that has been sent to save him, or to bid God-speed to the rope of mercy that is to connect him with the shore. To what extent the science of the boat-builder and the intrepidity of the crew may compensate for the darkness of the lighthouse or the uncertainty of its beams, must be gathered from those painful records which annually chronicle our disasters at sea.

In contrasting the fate of the thousands who are annually lost at sea with the more numerous victims of war, our Christian sympathies are very unequally divided. To each of us, of whatever caste, Death is the greatest of physical evils—the severest punishment which society awards to crime; but in its relation to the future it wears very different aspects. The soldier who devotes himself professionally to arms, or who courts "the bubble reputation even at the cannon's mouth," must, occasionally at least, stand in awe of a sudden or a violent death, and desire to be prepared for the mysterious change. Even in the battle-field the prayer for mercy may be breathed and answered, but on board the ship in flames, or the plunging life-boat, or the sinking raft, the interests of the future are merged in the exigencies of the present, and in the last struggle for life the cry of help from man is louder and more earnest than that of mercy from heaven.

Hence it is that the victims of sudden death by shipwreck have ever excited the warmest sympathies of the Christian philanthropist, and that it has always been regarded as one of the most urgent of social and religious duties to provide for the safety of the seafaring traveller—to protect his ship from the electric fire of the tropics—to light up our headlands for his safe return, and to place a life-boat for his use at every point of danger.

But important as these objects were, both nationally and in

dividually, yet it is only within the memory of living men that any real attempts were made to promote them. The thunderbolt continued to burst upon the unprotected masts, to set fire to the ship, and to decimate its crew. The home-bound mariner "struck his timorous sail" when in sight of his native shore, welcomed to it only by feeble coal-fires, or flickering lights, or tinkling bells, while the children of the storm were suffered to perish in the sight and amid the lamentations of friends who were powerless to save them. The Governments of the day, ever ready to reward the inventions for destroying life, placed but little value on the lives that were risked at sea; and it was through the generous sympathy of individuals that the life-boat, the lightning conductor, and the improvements in our light-houses, became the safeguards of our royal and commercial navy.

As in the case of all great inventions, it is difficult to ascertain who was the inventor of the life-boat, and who had the merit of bringing it into practical use. Although this invention has been generally ascribed to Henry Greathead of South Shields, yet it is certain that a boat called "an unimmergible boat" for saving lives in cases of shipwreck had been previously invented and constructed by Mr Lionel Lukin, a coach-builder in London, and it gives us much pleasure in adding that it was owing to the liberality of the Prince of Wales that the ideas of Mr Lukin were carried into effect. Having learned that many valuable lives had been lost "by the oversetting and sinking of both sailing and rowing boats, Mr Lukin's attention was turned to the subject in 1784. When the Prince of Wales, to whom Mr Lukin was personally known, heard of his experiments, he not only encouraged him to proceed with them, but offered to pay the whole expense which he might incur. He accordingly purchased a Norway yawl, and having fitted it up, and tried it on the Thames, he took out a patent for his invention on the 2d of November 1785.[1] To the outside of the upper frame of the Norway yawl, Mr Lukin added "a projecting gunwale of cork, the projection along the middle being nine inches, and gradually diminishing to very little at the head and stern; and he formed a hollow enclosure within the boat from the top to the floor, running nearly from head to stern, made water-tight, and containing a sufficient quantity of air to give the buoyancy required." By these means "the vessel had such a power of buoyancy in its upper part, as to render the specific gravity of the whole vessel and its contents less than the specific gravity of the body of water it would displace in sinking." "In order to give it a weight or ballast under the keel sufficient to keep it in an upright position, or to give it the power of regaining in a fluid

[1] The specification appeared in the third volume of the *Repository of Arts.*

medium that position when thrown out of it by the violence of the winds or waves," he added "a false keel of iron, bolted under the common keel; and as the cork and air at the upper part will always keep above water and prevent sinking, so the cast-iron false keel will act as ballast, and prevent oversetting, and also protect the boat's bottom in landing on a rough shore." The general safety of the vessel was also increased by two water-tight enclosures, one at the head, and the other at the stern.

Several boats of this kind were constructed by Mr Lukin, and found "to be strictly unimmergible." A boat called a *cobal* sent to him by the Rev. Dr Shairp of Bamborough, as treasurer of a charity founded for saving persons and property from wrecks, was fitted up by Mr Lukin, and was the means of saving many lives in the course of the first year.

Although Mr Lukin submitted his invention to the Dukes of Northumberland and Portland, to various admirals and captains of the navy, to the First Lord of the Admiralty, and to the Deputy-Master of the Trinity House, and though the Prince of Wales took an interest in the subject, yet no means were taken to place "unimmergible" boats in dangerous localities; and Mr Lukin, who had never derived any advantage from his invention, found it more profitable to build coaches for princes and cabinet ministers, than to construct boats for saving life and property at sea.

From this disregard for the shipwrecked mariner, and for the many valuable lives risked at sea, the public were not roused till the "Adventure" of Newcastle was wrecked, in September 1789. While this vessel lay stranded on the Herd Sands, on the south side of Tynemouth Haven, in the midst of tremendous breakers, her crew "dropped off one by one from her rigging," only three hundred yards from the shore, and in the presence of thousands of spectators, not one of whom could be bribed to venture to her assistance in any boat or cobble of the common construction. Under the strong feelings excited by this disaster, a committee was appointed, at a meeting of the inhabitants of South Shields, to offer premiums for the best models of a life-boat "calculated to brave the dangers of the sea, particularly of broken water."

Out of the many plans which were offered to the committee, two were selected—one by Mr William Wouldhave, a painter; and the other by Mr Henry Greathead. "The former of these was made on the flaunching plan, and rendered buoyant by cork, and was found, on being thrown in among the breakers, incapable of being either sunk or overset."

In that of Mr Greathead "there was nothing particular," says an anonymous writer "excepting the *curved keel*, which unhappily, however, would not prevent it turning bottom upward,

and continuing in that position. These models remained for some time before the committee, till two ingenious and scientific members of it—Mr Forster, the chairman, and Mr Rockwood—formed a plan of the intended boat in clay, from the two models, and gave it to Mr Greathead, who is a boat-builder by business, to copy from. Mr Greathead recommended, as an additional improvement, that it be built with a curved keel."[1] The extreme length of this boat was 30 feet; the length of its keel 20 feet; its breadth of beam 10 feet; the depth of waist outside $3\frac{1}{4}$ feet, and depth inside to deck $2\frac{1}{2}$ feet. The stem and stern were alike, $5\frac{3}{4}$ feet high, and it was made to pull ten oars double-banked. The depth of the main keel was 4 inches, with great camber or curvature, and three sliding keels. A cork lining 12 inches thick ran fore and aft on each side, reaching from the deck to the thwarts (or seats); and there was a cork fender outside 16 inches deep, 4 wide, and 21 feet long.[2] The boat had no means of freeing herself of water, or of self-righting in the event of being upset. It was at first moved along the shore upon four low wheels: but another plan was afterwards adopted. "Two wheels of 12 feet diameter, with a moveable arched axis, and a pole affixed thereto for a lever, were constructed, and the boat was suspended near her centre between the wheels under the arched axis, toward each extremity of which is an iron pin. When the pole is elevated perpendicularly, the upper part of the axis becomes depressed, and a pair of rope slings, which go round the boat, being fixed to the iron pins, she is raised with the greatest facility by means of the pole, which is then fastened down to the stern of the boat."

Although this boat, like that of Mr Lukin, has its buoyancy increased by the quantity of cork attached to it, yet "the pecu-

[1] This account of Mr Wouldhave's boat is taken from an anonymous article in the *Gentleman's Magazine*, signed "W. N. C.;" but it seems to have been written by Mr W. A. Hailes, the author of a pamphlet entitled, "An Inquiry into the Invention of the Life-boat," in which the same facts are stated. Mr Wouldhave's boat was for a long time known at Shields "by the appellation of *Wouldhave's Cork Boat*." From the little interest which the construction of Greathead's boat excited, Mr Wouldhave never thought of claiming the invention; but when Mr Greathead applied for a parliamentary reward, and had received a certificate "from three of the committee out of five, purporting that he was the inventor of the curved keel, and was *selected* to build the first boat, the unfortunate Wouldhave, stung with a sense of the injustice done to him, imprudently made use of some hasty and intemperate expressions in remonstrating with the gentlemen, which they found it difficult to forgive, and which, it is thought, operated materially to his injury. Mr Greathead, however, persevered, and has obtained a multitude of rewards, whilst the meritorious and industrious Wouldhave is compelled to sit in silent mortification, and see his rival claimant bedecked with honours, to which, in justice, himself alone is entitled."—*Gentleman's Magazine*, vol. lxxvi., 1806, pp. 421, 422. It is stated by this writer that the committee "flatly refused to give Mr Greathead a certificate of his being the inventor of the life-boat."

[2] The quantity of cork affixed to the boat was nearly 7 cwt.

liar nature of the curvature of the keel is reckoned the basis of its excellence; and it is owing to this peculiarity, which is the undoubted invention of Mr Greathead, that he has been regarded as the inventor of the life-boat, and entitled to a national reward.

Although the life-boat thus constructed by Mr Greathead was built in 1789, yet it performed no useful service till 1791, when it saved the crew of a Sunderland brig which was stranded at the entrance of the Tyne. On the 1st of January it saved the crew of the ship "Parthenius" of Newcastle, and also those of the "Peggy." In 1796 it did the same service to the crew of a Scottish sloop, the "Countess of Errol;" and in 1797 to the "Fruit of Friends," from Leith, and the "Planter," from London, in which fifteen lives were saved. Notwithstanding these numerous acts of humanity, no other life-boat was made till 1798, when the Duke of Northumberland ordered one to be built at his own expense by Greathead, and endowed it with an annuity for its preservation. It was stationed at North Shields; and soon after it was finished it saved seven men of the sloop "Edinburgh" of Kincardine, which was wrecked on the Herd Sands. It saved also the crew of the brig "Clio;" and in 1799 the crew of the ship "Quintilian" from St Petersburg. The Duke of Northumberland also ordered a life-boat for Oporto in 1800; and in the same year Mr Cathcart Dempster ordered one for St Andrews, where, on the 10th of January 1803 it was the means of saving the crew, twelve in number, of the "Meanwell" of Scarborough.[1] In consequence of these proofs of its value, Mr Greathead received numerous orders, and before the end of 1803 he had built no fewer than *thirty-one* life-boats—*five* for Scotland, *eight* for foreign countries, and *eighteen* for England.

In the beginning of 1802, when two hundred lives had been saved at the entrance of the Tyne alone, Mr Greathead applied to Parliament for a national reward; and, after a committee of the House of Commons had taken evidence and reported on the value of the invention, the sum of L.1200 was voted to him. Sums of L.1500 and L.2000 were proposed by different members of the House. The Trinity House added L.105, Lloyds' the same sum, the Society of Arts 50 guineas, and the Emperor of Russia a diamond ring.

Although the value of life-boats was thus recognised by the nation, yet their number was not increased so rapidly as might have been expected; and it was not till the year 1824 that the subject of the preservation of life from shipwreck excited the

[1] On this occasion the storm was so violent, that the fishermen could not be persuaded to enter into the boat, till Mr Dempster, one of the magistrates, Major Horsburgh, and Mr David Stewart, a shipmaster, nobly volunteered their services.

attention of the philanthropist, and called forth the benevolence and liberality of the public. Sir William Hillary, Bart.—a name which will be ranked among the benefactors of his country —had often witnessed from his residence in the Isle of Man many of the shipwrecks which took place on its shores, and had assisted at some of the harrowing scenes which accompany them. In the year 1822 he had laboured personally in saving the crew of the Government cutter the "Vigilant," and other vessels that had been wrecked in Douglas Bay, and he was present at the total wreck of H.M. brig "Racehorse" on Langness Point, in the Isle of Man. He was thus led to place before his countrymen the whole subject of shipwrecks, and "boldly to appeal to them whether they would quietly look on and see hundreds of their fellow-creatures annually perish on the shores of the United Kingdom, when the means of rescue were within their reach." This appeal to the nation, which might have been appropriately made to the sovereign and the Government, was published in February 1822, and was warmly responded to by the public. Mr Thomas Wilson, M.P., and Mr George Hibbert, M.P., were particularly active in promoting the views of Sir William Hillary; and, by their influence, a public meeting was convened at the London Tavern on the 4th March 1824. At this meeting, which was numerously attended, and presided over by the Archbishop of Canterbury, the Royal National Institution for the Preservation of Life from Shipwreck was founded and established on a permanent basis.

On his return to the Isle of Man, Sir William Hillary, supported by the Lieut.-Governor and other officers of the island, established in 1826 a District Life-boat Association. The first life-boat, built by Plenty, of Newbury, was stationed in Douglas Bay, another at Castletown in 1827, a third at Peel in 1828, and a fourth at Ramsay in 1829. Between the years 1821 and 1846 no fewer than 144 wrecks had taken place on the island, and 172 lives were lost, while the destruction of property was estimated at a quarter of a million. In 1825, when the "City of Glasgow" steamer was stranded in Douglas Bay, Sir William Hillary assisted in saving the lives of 62 persons; and in the same year 11 men from the brig "Leopard," and 9 from the sloop "Fancy," which became a total wreck. In 1827 and 1830, Sir William, accompanied by his son, saved many other lives; but his greatest success was on the 20th November 1830, when he saved in the life-boat 22 men, the whole of the crew of the mail steamer "St George," which became a total wreck on St Mary's Rock. On this occasion he was washed overboard among the wreck, with other three persons, and was saved with great difficulty, having had six of his ribs fractured.

The Royal Life-Boat Institution, of which Sir W. Hillary was the founder, was nobly supported by the liberality of the public. In 1825 Mr Hecker subscribed L.1000, in 1830 Mr Prior L.1827, and in 1832 Mr Duppa L.1000, in 1854 Mr S. J. Lowe L.1000, and Captain Hamilton Fitzgerald L.10,000; and so numerous have been the subscriptions, that the Institution has been able to establish efficient life-boats on the points of the coast most exposed to shipwreck—to organise and train crews who shall be at all times ready to man the boats in case of wreck—to grant pecuinary rewards to persons who go off in life-boats, and to confer honorary gold and silver medals for distinguished gallantry in such services.

In 1852, when the Duke of Northumberland was First Lord of the Admiralty and became President of the Institution, his noble liberality and active exertion gave a new impulse to all its operations. In that year the *Life-Boat*, a monthly journal of the National Shipwreck Institution, was published, with the view of laying before the public all the information respecting the construction and establishment of life-boats,—the number of shipwrecks,—the exertions made to safe life and property,—and the prizes and medals awarded to those who have been most active in that noble service. In order to promote the great objects of the Institution, the Duke of Northumberland offered, in 1851, a prize of L.100 for the best model or design of a life-boat. The number of competitors was 280, and the prize was gained by James Beechings of Yarmouth, who built boats for Ramsgate and Boulmer upon the prize model; but, having unfortunately deviated from that model in constructing the Lytham and Rhyl boats, these boats were upset in a heavy sea, chiefly from their imprudently carrying sail, which ought not to be permitted in any of our life-boats. These boats were also faulty in their fittings and their mode of ballasting, and required a fuller or more bulging form under water-line than was even given in the model.

In order to correct these errors, the committee appointed by the Duke of Northumberland to decide on the relative merits of the models, employed Mr Peake, assistant master-shipwright in Her Majesty's dockyard, Woolwich, to give new plans for a life-boat, after a careful examination of all the competing designs. After devoting much time to the subject, he produced the "Percy" life-boat, which was built at the expense of the Government at Woolwich dockyard, and which is considered the best that was ever launched in any country. The Duke of Northumberland, with his usual generosity, presented Mr Peake with a silver model of his boat, and it is now regarded as our national life-boat, and employed at a great number of the stations of the Royal Institution.

The first trial of it was made at Brighton, on the 3d February 1852, in a strong south-west breeze, under the charge of Captain Ward, R.N., who volunteered to go out in her. The Duke of Northumberland and a distinguished party were present, and, along with a large body of the fishermen and boatmen of the place, watched the trial with the deepest interest.

Its extreme length was 30 feet, its length of keel 24 feet, its breadth of beam 8 feet, its depth 3½ feet. It pulled ten oars double-banked (or twelve if required). It had side air-cases under the seats, and raised air-cases, 4 feet long, in the extremes up to gunwale height, the tops being covered with a good coating of cork, to prevent their being stove if jumped upon. The air-cases were built of Mr Forster's patent material, consisting of gutta-percha between two layers of thin wood, at once light, tough, and water-tight, and a disc valve was introduced into each of the cases to let out any water that might have got into them. In order to free the boat of any water she might ship. 8 tubes closed by self-acting valves, passed through the deck and bottom. With the ballast of an iron keel of 7 cwt., the boat weighed 46 cwt. The draft of water was 15 inches, and 18 inches with the crew on board. It was proved by this trial—

1. That when the boat had been hove keel up by a crane, she righted herself in five seconds.

2. That when light she entirely freed herself from water in 55 seconds.

3. That on taking the beach through heavy rollers the boat showed great buoyancy and stability, and brought her crew on shore without shipping water.

4. That she will carry thirty persons besides her crew, or forty-two in all. Life-boats of this description, with boat harness and carriages, life-belts, were established at Cullercoats, two miles north of Shields; at Newbiggin, a fishing village eleven miles north of the Tyne; at Hauxley, nine miles from the last station; at Boulmer, six miles north of Hauxley; and at North Sunderland, ten miles north of Boulmer. The whole coast of Northumberland was thus prepared for the preservation of the ship-wrecked mariner; and the whole expense of the establishment was defrayed by the Duke of Northumberland, on the sole condition that the local committees, in conjunction with the Ship-wreck Institution, shall keep the boats in repair, and regularly exercise the crews at least once a quarter.

This noble liberality inspired other philanthropists with a desire to labour in the same cause of humanity. In the beginning of 1852 the number of life-boats fitted for their work were very few. In Scotland, with a seaboard of 1500 miles, there were only eight life-boats, of which some were quite unservice-

able. In England and Wales, with a seaboard of 2000 miles, there were seventy-five life-boats;—forty-five on the east coast, namely, fifteen on the coasts of Durham and Yorkshire, four in Lincolnshire, and ten in Norfolk and Suffolk. From Dover to the Land's End there were seven boats; twelve on the west and north coast of Wales, and nine in the port of Liverpool. During the previous eleven years these boats had brought on shore 1128 persons. In the Isle of Man there was not a single boat, those established by Sir W. Hillary having been allowed to fall into decay. In Ireland, with an extent of 1400 miles of coast, upon which wrecks were very frequent, there were only eight life-boats, and these of a very inefficient kind.

To this unsatisfactory state of the life-boat system, the public attention was specially drawn by the Life-Boat Institution, and the noble example of the Duke of Northumberland; and since 1852, a large number of life-boats have been built and stationed on dangerous localities by associations supported mainly by the Institution, and by others founded by local subscriptions. In the beginning of 1854, there were no fewer than *eighty-nine* efficient life-boats under the management of the Institution, requiring a large permanent income to maintain them in a state of thorough efficiency. The practice of the Institution is to co-operate with and assist local associations in establishing an efficient life-boat. The sum required for a life-boat, boat-house, boat-carriage and gear, of the most approved description, is about L.400. Of this sum the Institution would expect as large a proportion to be raised in the locality as could be obtained, but at the least one-third. An annual sum of not less than L.20 for the payment of the coxswain of the boat, and for the quarterly exercise of her crew, is likewise expected from the local subscribers.

In consequence of the upsetting of some of the safest boats in seas unusually tempestuous, it became a matter of dire necessity to supply the crew with life-belts of the best construction. Captain Ward, R.N., inspector of life-boats to the Institution, has successfully devoted his attention to this point. Cork belts having been found too rigid to allow of the free use of the arms and muscles, dried rushes and hair in a waterproof cover had been substituted for it; but as the dried rushes used by the six sailors who were drowned at Rhyl, by the upsetting of the life-boat, had proved useless, Captain Ward made many experiments with belts made of cork (thirty-two cubical inches of which will support a man), of cork shavings, of hair, and of Macintosh, and preferred the air-belts divided into four compartments, and inflated by two valves at the upper edge, and two at the lower; but as one or more punctures might be fatal to belts containing air, Captain Ward

set himself to the construction of cork belts, and succeeded in inventing a form which, while it has ample floating power, does not in the least interfere with the necessary movements of the body. These belts, of which 800 have been supplied to all the crews of the boats belonging to the institution, have a buoyant power of from twenty to twenty-four lbs. Every belt consists of two rows of narrow pieces of cork, each of which is sown separately to a strong linen or duck belt, which covers the body from the armpits to below the hips. It is tied round the waist by strings, and secured by other strings passing like braces over the shoulders. As Captain Ward has declined making any profit by his invention, these belts are manufactured at a very cheap rate, and ought to be provided for all the crews in our royal and mercantile navy, and purchased by every individual who exposes himself to the dangers of the ocean.

The following table shows the number of lives saved from shipwreck since the establishment of the Institution :—

Years.	Lives saved.	Years.	Lives saved.
1824-25	124	1842–43	276
1825–26	218	1843–44	236
1826–27	175	1844–45	193
1827–28	163	1845–46	235
1828–29	301	1846–47	134
1829–30	463	1847–48	157
1830–31	372	1848–49	123
1831–32	287	1849–50	209
1832–33	310	1850–51	470
1833–34	449	1851–52	430
1834–35	214	1852–53	773
1835–36	364	1853–54	678
1836–37	225	1854–55	355
1837–38	272	1855–56	406
1838–39	456	1856–57	473
1839–40	279	1857–58	374
1840–41	353	1858–59	427
1841–42	128		
Total, ...			10,902

In addition to this vast saving of human life, the Institution has, from 1824 to 1859, awarded 81 gold medallions and 629 silver medals for distinguished services, besides pecuniary rewards, amounting together to L.11,651. In 1858, the income of the Institution was L.7803, and its expenditure L.10,390; and the sum expended on life-boats, life-boat transporting carriages, and boat-houses, has since its institution been L.28,266.

Having thus laid before our readers a statement of the number of lives saved by the life-boats of the Institution, and the rewards given to the brave men who risked their lives in the cause, they will naturally desire to know how many lives and how much property have been lost at sea, in those cases in which no human

arm could help, as well as in those where the want of life-boats or of lighthouses has been the cause of the loss. It would be difficult to gratify this desire; but the Life-boat Institution has made great exertions to supply this information by an annual register of shipwrecks on the coast and in the seas of the United Kingdom; comprising total wrecks, vessels foundered or sunk through leaks or collision, abandoned, stranded, or damaged so as to require to discharge their cargo. These registers commenced with 1851, and were accompanied with engraved wreck-charts of the British Isles, compiled from the Admiralty Register, and showing the present life-boat stations, and the spot at which the wreck or other accident occurred, and the port to which the damaged vessel returned for repairs. These charts exhibit to the eye a frightful scene of disasters occurring principally between the Firth of Forth and Dover, and on both sides of the Irish Channel; the west coast of Ireland and the east and west coast of Scotland are but slightly darkened with the black spots which mark these calamities at sea.

The following table shows the number of shipwrecks and lives lost between the years 1850 and 1859:—

Years.	No. of Wrecks.	Lives Lost.	Years.	No. of Wrecks.	Lives Lost.
1850	692	780	1855	1,141	469
1851	701	750	1856	1,153	521
1852	1,115	990	1857	1,140	532
1853	800	584	1858	1,170	343
1854	987	1,549			
	Total in Nine Years, . . .			9,899	6,418

While we thus record the great services of the Royal Life-boat Institution, we must not omit to do justice to the exertions of the Board of Trade in the same cause of humanity. It is, indeed, a singular fact, and one hardly credible, that the British Government should have so long allowed a private institution to furnish the means of saving from shipwreck the sailors of the Royal Navy, as well as those of foreign and merchant vessels. The Governments of Lord Aberdeen and Lord Palmerston had the honour of so far removing this stain upon the national honour, as to issue a circular from the Board of Trade, offering most valuable aid for increasing the efficiency of life-boats, by advancing money to perfect the existing machinery of the service. In cases where there is a necessity for such assistance, the Board, upon certain conditions, will contribute to the manning and exercise of the boats, and towards defraying expenses connected with actual service, rendered in saving or endeavouring to save life from shipwreck.[1]

[1] The Circular issued by the Committee of Privy Council, offering this assistance, was dated February 22, 1855, and refers to a previous circular, dated 13th September 1854.—See the Merchant Shipping Act, 1854, Section 459.

As many shipwrecks occur by the stranding of vessels on a lee shore, where a life-boat is of no use, it is of the highest importance to have some method of saving the crew. In cases of this kind, whether the ship's distance from the shore be 200 or 300 yards or half a mile, there is little chance of the sailors saving themselves by swimming; and they are so well aware of this, that they generally stick to the vessel while the planks hold together. The first attempt to save life on such occasions was made in 1791, by Sergeant Bell of the Royal Artillery, who communicated to the Society of Arts a plan for throwing on shore a rope attached to a loaded shell, by means of a mortar on board the vessel in distress.[1] Although the society awarded to Mr Bell a premium of fifty guineas on the success of his experiments at Woolwich, yet no attempts were made to bring the plan into actual use, till the reverse of the same method was proposed by Captain G. W. Manby, who had never heard of the experiments of Mr Bell. When Captain Manby was a cadet at the Royal Military Academy at Woolwich (previous to 1783), he had thrown a line from a pewter mortar, cast by himself, over Downham Church at Norfolk, in order to enable him to pass a rope over the church to get at a screech owl's nest, built over one of the windows. Recollecting this fact, it occurred to him that he might succeed by the same means in throwing a rope over a stranded vessel; and this idea was more firmly fixed in his mind when, on the 18th February 1807, he witnessed the wreck of the *Snipe* gun-brig, and saw sixty-seven persons drowned within fifty yards of the shore, at the back of Yarmouth pier, after they had remained five or six hours on the wreck without a possibility of being rescued by any of the methods then in use. After many unsuccessful experiments, he obtained a mortar from the Board of Ordnance; but every rope and chain which he tried broke when discharged, till he used strips of raw hide closely plaited. Repeated trials with this rope in high gales of wind gave him confidence in his plan; and on the 12th February 1808, when a brig ran aground at Yarmouth about 150 yards from the shore, he had an opportunity of trying it with success. At daybreak, while a hard gale was blowing from the N.E., and the waves were breaking over the crew lashed to the rigging, every attempt failed to send a life-boat to their assistance. At this crisis Captain Manby appeared with his mortar, and to the wonder and delight of all the spectators threw a line over the vessel by which a boat was hauled off, and the crew, consisting of seven persons, were brought in safety to the shore. In 1809 Captain Manby rescued the crews of several vessels; but though forty-five mortars were sent to various parts of the coast, yet up to 1823, when the House of Commons

[1] *Transactions of the Society*, 1792, vol. x., pp. 203, 269.

granted him a reward of L.2000 in addition to the sums which he had previously received, only nineteen persons had been saved by the method on all the coasts of the kingdom, with the exception of Norfolk and Suffolk, where it had been zealously practised, and where 220 persons had been saved by it.

While Captain Manby was occupied in improving the mortar apparatus and extending its use, Mr Henry Trengrouse of Helston was engaged in the same work of benevolence. Residing at Mouat's Bay, in Cornwall, a short distance from the sea, Mr Trengrouse had opportunities of witnessing many shipwrecks. In 1807 he saw the Jane and Rebecca transport wrecked, with the loss of fifty of her crew; and in the same year he witnessed, within 60 yards of the shore, the wreck of the Anson frigate, of sixty-four guns, in which her brave commander and a hundred men lost their lives. The idea of inventing a life-preserving apparatus was thus forced upon his mind, and he thought of three ways by which a line might be thrown over a ship. The first was to throw by the hand a ball of lead attached to a string; the second was to use a kite; and the third was to throw from the ship to the shore, or over the ship from the shore, by means of a musket, a rocket and a line attached to it, after obtaining a communication with the shore by means of a rope, a hawser roller or traveller, to which is fixed a *chaise volante*, which could "afford accommodation and security to an infirm man, woman, or child," and bring them safely on shore. This apparatus, which is not only simple and cheap, but can be contained "in a chest in a small compass," is placed on board every ship, so that "at all times and places every vessel has the means of salvation in her power" when stranded on a lee shore. This invention met with general acceptance, and its author received in 1821 a substantial mark of approbation from the Society of Arts. Since that time mortars and rockets, and other means, have been extensively employed for establishing a communication between a stranded vessel and the shore, and many lives have been thus saved. A most valuable addition has been recently made to the mortar and rocket apparatus by an American gentleman, Mr Francis, the inventor of the corrugated metallic life-boats. By means of a *life car*, which will hold four or five persons at a time, and drawn along a hawser, he succeeded in saving the passengers and crew of the Ayrshire, 200 in number, when that vessel was wrecked on the coast of New Jersey in 1850. This car is in the form of a whale-boat, with a single opening on the roof, which has a lid for preventing the admission of water "whilst battling with the surf in its passage shoreward." It is 10 feet 9 inches long, and 3 feet 9 wide. It is rendered buoyant by air chambers at its extremities; and as the air to be breathed

by its inmates is admitted through small holes, they cannot even be wetted in their passage through the heaviest breakers, whereas by the ordinary conveyances one person only can be taken on shore, and must always be liable to be injured and even drowned while he is being hauled through the sea.

Notwithstanding the great value of the mortar apparatus, and the rockets of Trengrouse as improved by Dennet and Carte, great difficulties have stood in the way of their being generally adopted. Some of the difficulties of casting a line to the coast are surmounted by the Patent Ship Communicator, invented by Mr Sibbald, a surgeon in Liverpool, who proposes to float a line to the shore, or sufficiently near it to be grappled by persons on the look-out for it. "It consists of two flat-headed drums, made of waterproof and air-tight cloth stretched on light wooden hoops, and so united at one end of each as to form, when inflated, somewhat the shape of a dum-bell or double-headed shot. It is then about 3 feet high, the diameter of the cylinders being about 30 inches. When collapsed, it is in the form of a cheese 6 inches thick, and therefore stowing in a small compass. A light Manilla or other floating line, 400 or 500 yards long, is coiled round it between the two cylinders. When required for use the two cylinders are inflated by simply pulling them asunder; the end of the line being then made fast on board the vessel.

As the Government had liberally undertaken to supply the mortar and rocket apparatus to every station where it was desirable to place it, it is now in general use in every part of the kingdom, and will no doubt be kept in efficient repair, and ready for its work whenever it may be required.

At the commencement of the present year there was

	Life-Boats.	Mortar and Rocket Stations.
In England, . .	115	157
In Scotland, . .	7	22
In Ireland, . .	14	37
Total, .	136	Total, . 216

If the nation has taken a warm interest in every invention for the preservation of life and property from shipwreck, and liberally rewarded the inventors, their sympathy is not less required in reference to those awful disasters which overtake a ship in mid-ocean, where there is no human arm to help, and no retreat from the lightning bolt or the hurricane. Science has provided the seaman with some useful rules for braving the revolving tempest, or escaping from its fury; but it is only recently, by the invention of Sir William Harris, that she has succeeded in arresting the electric fire, and sending it innocuous into the deep. Of the gale or of the tornado, the sailor may be forewarned, and even

prepared for its approach; but no sagacity can avail when the fire-charged cloud gathers over the life-freighted vessel, and pours its artillery into her unprotected masts, smiting them with its livid fire, transfixing the crew upon its deck, setting on flames the floating ark, and consigning its occupants to a watery grave.

An invention to save life and property thus endangered may well be considered as one of the highest value, and worthy of the highest reward. Although the protection of buildings by lightning conductors has been long known, yet it is singular how little has been done since electricity became a science, in studying its destructive powers, or in providing against their approach. In some cases this improvidence has doubtless arisen from a distrust in the resources of science; but in others it may have originated in the fear that some grasping Chancellor of the Exchequer might tax the lightning conductor as an insurance against fire, or view it as an invasion of window duty by a light borrowed from above! But however this may be, we can make no apology for the negligence of public men in having so long withheld this species of protection from our cathedrals, our palaces, our public monuments, and even our magazines of powder[1] and other combustible materials. "After England," as we have elsewhere stated, "had become a great naval power, covering the ocean with her ships of commerce and of war, we might have expected some energetic measures for protecting the adventurous mariner and his far-floated cargo, when fire and tempest simultaneously assailed them; but when great interests on shore were committed to inefficient hands, it was scarcely to be expected that greater interests at sea would be better managed. If Boards of Longitude consisted of rear-admirals who had forgotten their lunars, and politicians who had reached only one side of the asses bridge—if Fishery Boards consisted of notables who ate fish, but knew not how to catch them—and if Lighthouse Boards were composed of barristers and burgh bailies who could hardly choose a pair of spectacles—we need not wonder that the hapless seaman was allowed to perish at his mast foot, and our 'hearts of oak' to be rent by the lightning, or consumed by its fire."

Philosophers were, as usual, the first to press upon the Government the practical application of their electrical knowledge. So

[1] It will scarcely be credited that, so late as 1838, the East India Company, on representations made to them by some of their officers, *removed the lightning conductors from their powder magazines and other public buildings*, on the ground that buildings with conductors were more frequently struck than those which had no such protection! The blowing up of their unprotected powder magazines at Dum Dum, and a corning gunpowder house at Mazagon, soon convinced them of their folly. Sir W. Harris justly observes, in reference to this subject, "that conductors can no more be said to attract or invite a discharge of lightning, than a *water*-course can be said to attract the water which flows through it at the time of heavy rain."

early as 1762 Dr Watson addressed a letter to Lord Anson, then First Lord of the Admiralty, recommending the application of lightning conductors to the Royal Navy; and, what was a most unusual result, his advice was listened to by that intelligent nobleman, and each of His Majesty's ships was supplied with a conductor consisting of long links of copper rod, forming a chain which was attached to a hempen line to be fixed to the mast head, and carried over the ship's side into the sea. This chain was packed in a box, and was only to be erected on the approach of a storm. These conductors, however, were soon found to be inefficient. The erection of them was frequently neglected, the chains were always out of order, and the sailors were sometimes killed by lightning while in the act of putting the conductor into its place. Thus inefficient, they soon fell into disuse, and the Royal as well as the Mercantile Navy have been virtually exposed during the last seventy years to the most dangerous of the elements. The most appalling statements of the loss of life and property by electrical explosions occur in the journals of the East India Company's ships. "Within a few years, Sir W. Harris tells us, the merchant ships *Tanjore*, *Poland*, *Logan*, *Ruthelia*, *Bolivar*, *Boston*, *Lydia*, and *Sir Walter Scott*, are known to have been entirely consumed." In the Royal Navy, in 150 cases which occurred chiefly between 1799 and 1815, nearly 100 lower masts of line-of-battle ships and frigates, with topmasts and various stores, were wholly or partially destroyed. One ship in eight was set on fire—upwards of 70 seamen were killed and 133 wounded. In one-tenth of these cases fourteen ships were completely disabled, and that too in the time of war.

One of the first persons whose attention was drawn to the imperfect state of the naval lightning conductors was the late William, Lord Napier, who had himself witnessed several accidents from this cause. When on board the Kent, of seventy-four guns, she was shattered by lightning in July 1811, and several men killed upon her masts. On another occasion, when on board a line-of-battle ship of seventy-four guns at Port Mahon, and when all her yards were manned in the operation of furling sail, the rigging was struck "and not less than *fifteen* most valuable men, all upon the bowsprit and jibboom, were killed or dreadfully scorched, as it were in the twinkling of an eye, some being precipitated into the water, and others lying dead across the boom in the very posture they were in before the ship was struck." With such experience of the inefficacy of the existing conductor, this active and highly intelligent naval officer, whose sad fate his country has had occasion to lament, made many valuable suggestions for their improvement, which the writer of this article induced him to communicate to the

public. Lord Napier was of opinion that every mast should be protected, and suggested an inquiry into the subject.

Without any knowledge of Lord Napier's suggestions, Sir W. Harris had, so early as 1820, proposed to the Lords of the Admiralty to make the masts themselves virtually lightning conductors, by incorporating with them a double set of metallic plates. He considered it essential that a conductor should be as continuous and direct as possible from the highest points to the sea—that, throughout their whole extent, they should be permanently fixed, so as to allow one part to be moved on the other, and that if any part of the mast should be removed along with its metallic plates, the remaining portion of the conductor should still be so complete as to carry the electric discharge into the sea. For this purpose his conductor was made double, consisting of two laminæ of sheet copper placed one above the other, so that the extremities of the laminæ of one layer should be opposite the middle of the laminæ of the other layer. These copper laminæ are fixed by copper nails in a dovetailed groove, so that their surface may lie a little beneath the surface of the wood. The metallic line thus constructed passes down from the respective mast head to the bottom of the masts, where it meets with other pieces of copper continued through the keel to the sea. In this way a continuous metallic line, from the highest points of the ship to the keel, will not be interrupted by the elongation or contraction of the masts, and therefore the electricity which enters the masts will be carried by the shortest and best conducting line into the sea.

This valuable invention, upon which the Royal Society gave a favourable report, was pressed upon the notice of the Admiralty by Sir W. Harris and his friends; but it was not till after a siege of nine years that this impregnable board capitulated, and agreed in 1830 to fit up at least 30 ships with the new conductors. The experiment was thoroughly successful. During ten years' exposure to severe thunder-storms, these 30 ships suffered no damage, while about 40, without conductors, were struck and injured; but, notwithstanding the obvious advantages of the conductors, the Admiralty declined to introduce them into every ship of war. They grudged the sum of L.100 for insuring from lightning a line-of-battle ship worth L.120,000, and for protecting the lives of the many hundreds of brave men whom it sheltered! In 1840, however, a Naval Commission appointed by Parliament unanimously recommended the general adoption of the conductors in the Royal Navy, and Sir W. Harris considered his triumph as complete. A fatal counter-influence, however, the spawn of envy or of self-interest, was secretly at work to subvert truth and to resist the authority of the Commission. When the ships that

had returned uninjured by the thunderbolts to which they had been exposed were paid off, *the conductors were torn from the spars and thrown aside as old copper, in place of being replaced on other ships.* This practical rejection of the new conductors continued both under Whig and Tory administrations, and, under the usual pretence of financial difficulties, a cheap modification of Sir W. Harris' invention, patronised by the Surveyor of the Navy, was ordered to be submitted to trial.[1] The Commission, however, resisted this strange attempt to take the invention entirely out of the hands of the inventor, and in 1842 the Admiralty was virtually compelled to save the British Navy from lightning. Sir W. Harris' plans were adopted. He was authorised to superintend their execution; and his conductors, constructed in all her Majesty's dockyards, were applied to every ship in the Royal Navy. The injury done to Sir William by the minute of the Admiralty was thus speedily repaired, and a pension of L.300 a year was granted to him by Lord Melbourne for his general services to science. This liberality of the Crown, which had been shown to various other individuals distinguished in science and literature, who had not done any special service to the nation, seems to have been regarded for many years as a compensation for the invention of lightning conductors; and when the Queen had in 1847 conferred upon Sir William the dignity of knighthood, after he had been instrumental in securing her Majesty's private residence at Osborne from lightning, the pension and the rank were held by some persons in authority to have been given as a reward for the same invention.

This illiberal sentiment found little favour with the Treasury, who, by a minute of the 5th July 1859, and on the report of the Admiralty, awarded to Sir William Snow Harris the sum of L.5000 "for the time and labour and anxiety incurred in the prosecution of his invention of electrical conductors for ships, and as an acknowledgment of the benefit derived by the public service from that invention." In making this award, the Lords of the Treasury state, "that, though they may feel that the grant of a pension for scientific attainments cannot be altogether separated from the results of those attainments, yet beyond this they do not wish to be understood to connect either of the marks of favour

[1] This extraordinary measure—passed when Lord Melbourne was Minister, and Lord Minto First Lord of the Admiralty—is recorded in the following Admiralty minute, dated August 27th, 1841:—"All ships ordered to be brought forward are to be fitted with wire-rope lightning conductors, unless others be applied for, when the request is to be referred to their Lordships." The design of this minute was to supersede an invention which had been tested by actual experience. It might be useful to the country, as well as to men of science who have served it, to ascertain how far the minute was prompted by a false economy, and how far by the influence of interested parties. Lord Aberdeen, who was then Minister, and Sir James Graham, who was at the head of the Admiralty, deserve the highest praise.

enjoyed by Sir William Snow Harris with the particular question under consideration."

The value of Sir W. Harris' lightning conductors was so generally appreciated, that he was induced by his friends to apply for an additional reward. After the application of the conductors had become general, damage and destruction by lightning vanished from the records of the Royal Navy, while, in the space of twenty or twenty-five years, no fewer than 100 ships of the Merchant Navy had been totally destroyed or severely damaged. In addition to his services in protecting her Majesty's ships, Sir William has been employed by the Government since 1845 in superintending the erection of conductors upon some public buildings, such as the Houses of Parliament, Buckingham Palace, Greenwich Hospital, Osborne House, and various powder magazines; and he justly considers his labours in this department as adding to his other claims for an increased reward. Seeing that Mr Archer received L.4000 for his machine for perforating postage stamps, and Sir William Armstrong L.20,000, or L.2000 for ten years, for his invention of rifled cannon, Sir William is encouraged to expect an additional reward of L.5000 for his lightning conductors, and also a further remuneration from the Civil List of L.500 a year as an equivalent for his past and future services in superintending the protection from lightning of all the public buildings belonging to the nation. When the public money is so liberally granted for inventions calculated to destroy life and property, and which may only be made useful to the nation at distant times, we cannot but express the hope that inventions and services which are every day successful in the saving of life and property risked at sea, and of public buildings which have been erected at the expense of millions of money, may be considered as equally meriting the liberality of the State.

If the life-boat and the lightning-conductor have been such unspeakable boons to humanity, as the safeguard of life and property, the lighthouse has at least an equal claim to the gratitude of the philanthropist and the statesman. An ordinary boat, manned with an intrepid crew, has been frequently launched upon a tempestuous sea to save the shipwrecked mariner, and therefore could not be regarded in the light of an invention; but a life-boat constructed upon scientific principles, and capable of living amid billows and breakers, was an invention of the highest order. The protection of a ship from lightning by a conducting chain applied in the hour of danger, was never claimed as an invention; but a lightning-conductor like that of Sir William Harris was the work of science and of genius, and entitled to be regarded as one of the most valuable of modern inventions. In like manner, a lighthouse established at our harbours, and on our headlands, and throwing out the light of a coal fire, or of

tallow candles and oil lamps concentrated by mirrors, was a contrivance which had been used for centuries, and with which no inventor's name has ever been associated. But a lighthouse in which every ray of a brilliant flame is thrown into a condensed beam of light, penetrating a hazy atmosphere, reaching to great distances at sea, and indicating by its colour or by the number and nature of its changes the very spot on which it stands, is an invention of pre-eminent value, demanding from every government its patronage and support.

The history of the lighthouse, and the improvements which have been made upon it, is a subject of social and national interest, and the time is not distant when it must be investigated in all its bearings by the Legislature. The establishment of new lighthouses on various parts of our coasts, the universal introduction of the dioptric system, and the invention of better distinguishing lights than those we possess, are topics of increasing importance which must sooner or later force themselves on the attention of Parliament. All that we can do in our limited space, is to give the history of those changes in our lighthouse system which have received the sanction of science, and the approbation of the various boards to which the lighting up of our rugged shores has been entrusted.

There is no country in the world where the extent of its coasts bears such a large proportion to its size as Great Britain, and there is none which presents such a repulsive aspect to its seafaring visitors. Guarded in one place by precipitous and rugged rocks, indented in others with irregular firths and inlets, beset with sunken reefs and shifting sandbanks, chafed with rapid and opposing currents, and exposed to all the fogs and tempests of a rigorous climate, it might have been expected that all the resources of science and art would have been exhausted in lighting up its shores, and in guiding the seamen through the intricacies of its navigation, and amid the Cimmerian darkness of its winter. These expectations, however, were not realised. Foreign nations, inferior in trade and commerce, and with coasts less extensive and dangerous, outstripped us in this great work of mercy and civilisation; and England, for the first time in her history, had the mortification of applying to continental industry for the apparatus in her lighthouses.

The Government, indeed, by a system of unwise and unjust taxation, had provided ample funds for the erection of new lighthouses and the introduction of new improvements; but they committed the grievous error of placing these funds under the administration of unpaid, unqualified, and irresponsible boards, who necessarily transferred all their functions to incapable and ill-educated engineers.

The Lighthouse Board of Scotland, to whom the new system

of dioptric lights was first submitted, and who were urged by a long-continued pressure to be the agents of its introduction into the English and Irish lighthouses, was established by Act of Parliament in 1786, for the purpose of lighting the Scottish coasts. Its composition was very remarkable. While the French Lighthouse Board, ten in number, was composed of admirals, engineers, inspectors of naval constructions, and eminent men of science, the Scottish Board did not contain a single naval officer, a single engineer, nor a single man of science! It consisted of twenty-two persons—his Majesty's Advocate and Solicitor-General for Scotland; the Lord Provost and Eldest Bailie of Edinburgh and Glasgow; the Provosts of Aberdeen, Inverness, and Campbelton; the Sheriffs-Depute of the maritime counties of Edinburgh, Lanark, Renfrew, Bute, Argyle, Inverness, Ross, Orkney, Caithness, and Aberdeen, to which Ayr, Fife, and Forfar were added by another Act.

It is difficult to understand how a board composed of lawyers, with a small per-centage of municipal functionaries, changeable every two or three years, could discharge those scientific duties which in France were entrusted to admirals, engineers, and men eminent in science. How they did discharge them, and how they treated the scientific men who gratuitously helped them, and whose inventions they unwillingly adopted, and took the credit of introducing, will be shown in the sequel.

The three great lighthouses which existed before the dioptric system was introduced, were the Tour de Corduan on the coast of France, the Eddystone on the coast of England, and the Bell Rock on the Scottish coast. The Tour de Corduan was founded in 1584, and completed in 1610. It is 197 feet high, and is surrounded with a circular wall 134 feet in diameter. Flaming billets of wood were the first lights which it exhibited. A coal fire with its flame of gas was the first improvement which it received. In 1780, Mr Lenoir, a French optician, replaced the coal fire with lamps and parabolic reflectors of metal; and in 1822 the lenses of Brewster and Fresnel gave to that model lighthouse the high character which it bears, and to its engineers an European reputation.

The first Eddystone lighthouse, constructed of timber, was erected in 1696, but with so little skill, that though it was 60 feet high, it was often "buried beneath the water." In 1703, when the engineer went to repair the structure, which he had previously raised to the height of 120 feet, the whole fabric was demolished by a storm, and the engineer and all his workmen were buried under its ruins. Thus shorn of their warning light, those dreaded rocks were soon the scene of a still more painful disaster. The Winchelsea man-of-war was wrecked on this fatal reef, with the loss of almost all her crew. In 1708 a new light-

house of timber was completed, and after being renewed in 1743, it continued to guide the mariner till 1755, when it was destroyed by fire. As these three fabrics were constructed of wood, Mr Smeaton recommended a stone building, which was finished under his direction on the 24th August 1759. It is constructed of red and white granite in alternate horizontal bands, and its height from its base to its vane is 89 feet. On the 16th October 1759 it was ready to throw its light over the fatal reef which surrounded it; but such was the science of the day, that *tallow candles* were the brilliants which this noble casket was to enclose! After twinkling over the deep for nearly half a century, this "Will of the Wisp" illumination was exchanged in 1807 for Argand lamps and parabolic reflectors of plated copper, and these some years ago for the "lenses of Brewster and Fresnel," constituting a dioptric light of the second order, which, in clear weather, now throws its beams to the distance of *thirteen* miles.

Such was the state of the science of lighthouses in 1786, when the Scottish Lighthouse Commissioners were installed into office, and previous to the completion in 1810 of the Bell Rock Lighthouse, the magnificent ocean-light which it became their privilege as well as their duty to superintend. The reflectors used in the Scottish lighthouses had been rudely constructed of facets of mirror-glass about an inch square, fixed in parabolic moulds of plaster, which, even if the paraboloid had been mathematically correct, gave multiple images of the flame which they reflected, and, consequently, a very imperfect and comparatively feeble beam of light. These reflectors are described as the invention of "Mr Thomas Smith, tin-plate worker in Edinburgh," and who, being at that time engineer to the Scottish Commissioners, employed this combination of little squares of looking-glass "in all the lighthouses erected by him at the expense and by the authority of Government." This construction of reflectors was continued in the Scottish lighthouses from 1786 to 1810—for a quarter of a century, though parabolic reflectors of silvered copper had been used in the Corduan Lighthouse since 1780, and in the Eddystone Lighthouse. The article in the "Encyclopædia,"[1] now referred to, was either written by Mr Smith or by a friend to whom he had communicated his invention and method, with the theory of its operation. If the invention and use, so early as 1780, of metallic reflectors, which are incomparably superior to those of glass squares, had remained so long concealed from the Scottish Commissioners, men educated at our universities, we should have been surprised at the perfunctory manner in which they discharged their duties. We cannot blame so humble an individual as Mr Smith for being ignorant of the excellent

[1] *Suppl. Encycl. Britannica*, vol. ii., p. 397. Art., Reflector for a Lighthouse.

reflectors used in France (recommended by so distinguished a philosopher as the Chevalier Borda, and executed by so eminent an optician as Lenoir), which were in use in the great Corduan Lighthouse; but we think that one of the score of Scottish Commissioners might have made it their business to learn something about the French apparatus. It does appear, however, that so early as 1801 the proposal to use metallic reflectors was known in Edinburgh, but not adopted because "any person who had merely dipped into the science of optics would consider its adoption as obviously wrong!" "It has been proposed," says Mr Smith or his friend, "to make the concave surface of the parabola one speculum of metal, instead of covering it over with a multitude of plain glass mirrors. *To any man who has but dipped into the science of optics, it must be obvious that this alteration would be wrong. The brightest metal does not reflect such a quantity as well foliated* (*i.e.*, well covered with tinfoil) *clear glass.*"!!

Such was the state of lighthouse science in 1801 in our Scottish Athens, where the learned Commissioners must have frequently met in society with Professor Robison, Professor Playfair, and others, who could have told them, on the authority of direct experiment, that a reflector of metal was infinitely superior to their combinations of glass squares, even if there had been no defalcation of light at their numerous joints. But if it is too much to have expected that they would either make inquiry or ask counsel, they might have learned that in 1807 the metallic reflectors were dispensing a comparatively brilliant light from the Eddystone Lighthouse, and that they had been introduced even into Ireland, the darkest seat of lighthouse science and œconomy.

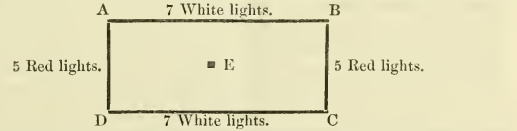
In the history of the Bell Rock Lighthouse, the third grand light tower which we have to notice, we shall find the same incapacity to understand and unwillingness to adopt the most obvious and valuable improvements. This lighthouse stands upon a dangerous reef, which in early times was indicated to the mariner by the tolling of a bell, attached to a float fixed upon the rock. The importance of this lighthouse is established by the fact that the York man-of-war, of seventy-four guns, was wrecked upon it with the loss of all her crew; and also by the wreck of the Pallas of thirty-two guns, and the Nymphen of thirty-six, on the coast of Dunbar in the morning of the 19th December 1810, two frigates which were valued at upwards of L.100,000. This wreck is said, by Mr Stevenson[1] and others, to have been owing to the pilot's "mistaking a lime-kiln burning at Broxmouth for the May light, and the May light for the Bell Rock."[2] But though this mistake probably was made, yet it is obvious, from the documents in the Admiralty, that a

[1] *Account of the Bell Rock Lighthouse*, p. 38.
[2] *Edin. Annual Register*, 1810. p. 258.

temporary light on Arbroath Pier, and the floating light on the Bell Rock, and the Isle of May light were all confounded with one another; and so completely had the lights deceived the master and the pilot, that when the ship struck the master thought it was on the Bell Rock;—when land was seen he believed that they had struck on the Isle of May, while the pilot was of opinion that they were on shore in St Andrew's Bay!

In less than six weeks after this accident, more destructive of property than of life, the Bell Rock light was exhibited, with the following notice to the public:—"To distinguish this light from others on the coast, it is made to revolve horizontally, and to exhibit a bright light of the natural appearance and a red-coloured light alternately, both respectively attaining their greatest strength, or most luminous effect, in the space of every four minutes; during that period the bright light will, to a distant observer, appear like a star of the first magnitude, which, after attaining its full strength, is gradually eclipsed to total darkness; and is succeeded by the red-coloured light, which in like manner increases to full strength, and again diminishes and disappears. The coloured light, however, being less powerful, may not be seen for a time after the bright light is first observed."[1]

The light thus described is produced by *twenty-four* metallic reflectors placed on the sides of a rectangular frame, ABCD,



which revolves round a vertical axle, E. *Seven* white lights are placed on the largest sides, AB, CD, and *five* red lights on the shorter sides, AD, BC; so that the two beams of light that are to be seen in succession, and are to constitute the distinction between this light and others, are *seven* of *white* and *five* of red. As there were fixed lights in the Firth of Forth and revolving lights on the Fearn Islands, and as the mariner, as Mr Stevenson the engineer remarks, "is liable to mistake the appearance of the lights in stormy weather, or from an error in his course in returning from a distant voyage, *it was of the last importance* that the Bell Rock Lighthouse should *be easily distinguishable*."

Such is an accurate description of the distinguishing light which was placed, in 1810, on what was then (excepting the Tour de Corduan) the finest light tower in the world—an edifice designed by Mr Rennie, the most eminent of our English engineers,

[1] This notice was advertised in twenty-seven English, twenty-two Scotch, and two Irish newspapers.

and executed under his superintendence[1] at the expense of L.61,331. That such a noble and expensive building should exhibit the most perfect light that science could produce, might reasonably have been expected; that it was the intention of the engineer that this should be its character, is evident from his declaration, "that after executing such a fabric, no pains will, of course, be spared upon *such an essential part as the quality or description of the light.*"

What the pains were that were not spared upon this essential part—in giving a soul to this Frankenstein of stone—we cannot conjecture. The Commissioners and their engineer may have studied the best optical works, and clubbed all their science in the cause, but we know that they never consulted a single theoretical or practical optician; and we have no hesitation in asserting that the distinguishing light on the Bell Rock is a disgrace to science, that it defeats the very purpose for which it was erected, and has for half a century been a source of positive danger to the life and property that is risked at sea.

Mr R. Stevenson, the engineer, tells us that the light was once seen at the distance of thirty-five miles—that is, the light of seven reflectors, giving white light, was seen at that distance. It is therefore quite certain that the light of five such reflectors would reach only to the distance of twenty-five miles. But as the red glass absorbs or destroys about one-half of the light which falls upon it, the red light will penetrate only to the distance of thirteen or fifteen miles. According to the Admiralty List, the Bell Rock light as a distinguishing light is seen at present, in clear weather, at the distance of fifteen miles—that is, the red light ceases at that distance—but the seven white lights were seen thirty-five miles off; and therefore the Bell Rock ceases to be a distinguishing light within that vast extent of ocean which lies between the range of the five red lights and that of the seven white ones—that is, between thirteen or fifteen and thirty-five miles. A ship, therefore, navigating that vast extent of ocean, will conclude that he is approaching a lighthouse in which a revolving bright light is eclipsed during eight minutes.

Thirteen years after this light was first exhibited, some kind friend told the engineer of the egregious blunder which he had committed, and, in order to correct it, he had the boldness *to extinguish four of the white lights*, thus making the red and white lights equal. This partial correction of his error was, we believe, made without giving due notice of the change, which

[1] Mr Rennie was appointed chief engineer, and recommended Mr Stevenson as his assistant. Mr Rennie's duties related only to the erection of the building. See the *Civil Engineer* and *Architect's Journal* for February 8th, 1849, where Sir John Rennie has claimed for his father the design and superintendence of the work.

should have been communicated to the fifty-one newspapers that announced to the seafaring public the character of the distinguishing light. From 1823 to the present hour, five red lights are matched with five white ones—a blunder as great in quality, though less in quantity, than the one we have exposed. Had the engineer placed seven red lights in the longest sides of his rectangular frame, and five white ones on the other sides, which ought to be done without delay, he would have nearly equalised their range, and made an approximation to a true distinguishing light. In making a perfect distinguishing light, the scientific engineer will equalise the range of his two colours, by ascertaining when they equally penetrate either a natural or an *artificial* haze or fog, or the opacity produced by ground glass or other substances that are copious absorbents of light. He will also ascertain the kind of glass which produces a colour sufficiently distinctive, while it absorbs the smallest quantity of light. The importance of this subject cannot be overrated. The distinction which is required for lights is necessary also for lighthouses when a ship approaches them by day.

Circular bands, black or white, or both, which can be seen with a telescope at a greater or less distance, should be painted on every lighthouse, so as to give them a distinctive character; or a number, such as 1, 2, 3, or 4, should be painted in large white figures on a black ground, upon four sides of the tower, corresponding with the four points of the compass.

The same plan might be adopted for distinguishing lighthouses *at night* when the ship is not very distant. The figures should be formed on ground glass in openings on the four sides of the lighthouse, and illuminated by a light behind the figures.

The necessity of such a mode of distinguishing lighthouses was painfully displayed in the wreck of the "Columbus" on the 6th January 1852, when two lighthouses, the one fifty, and the other twenty feet high, and standing thirty miles apart, were mistaken for each other *in the day-time*—an almost incredible mistake, though asserted by the master, and confirmed by the mate—which led to the loss of a vessel worth L.50,000, and of thirteen of her passengers and crew. In like manner, though not in the day-time, the American clipper "Pomona," with 444 emigrants and crew, was wrecked on the 30th April 1859 on the coast of Wexford. The captain mistook the Blackwater floating light for the Tuskar light; and no fewer than 385 of the passengers and crew perished in the wreck.[1]

Having thus failed so signally in the most important of their

[1] We have now before us, as reported to the Board of Trade, a list of *twelve* vessels which have been either wrecked with loss of life, or seriously damaged, in consequence of the want of lighthouses, during the years 1856, 1857, and 1858. We may add that of the "Alma" in 1859, from the want of a lighthouse on the Abos Islands in the Red Sea.

lighthouse operations, we can hardly expect that our Scottish Commissioners will be more successful when they are called upon to decide upon other questions that require optical knowledge. However important it may be that a lighthouse should be seen or indicated at a great distance in clear weather, it is infinitely more so that its light should be intense enough to penetrate the thick fogs which are so prevalent on our coast, and during which so many wrecks have taken place. Every man of science, and every practical optician, knew that lenses gave a much more condensed and penetrating beam of light than reflectors; and an attempt had been made to use them in an English lighthouse. When a lens of short focus and large diameter, however, was required, the thickness of the glass at its central part was so great as either to absorb the light by its colour, or refract it irregularly by its want of homogeneity. Lenses, therefore, were for this reason rejected as elements of our lighthouse apparatus. In making experiments with lenses, as burning instruments in which the parallel rays of the sun were condensed into a focus, Buffon proposed to grind away from a solid lens a large portion of the glass of which it consisted, and which was not required for the condensation of the incident light. As such a lens was very difficult to make, even if a large piece of glass of good quality could have been obtained, it was never executed of any size. In giving an account of this invention of Buffon's,[1] Sir David Brewster described in 1812 a method of constructing a lens which should not only have the smallest possible quantity of glass, but which should be more perfect in its refraction of light than if it consisted of one piece of the purest glass. He proposed to build up the lens of separate concentric rings, each ring consisting of several portions. To this lens he gave the name of the Polyzonal Lens; and though he first proposed it for condensing the sun's rays and producing intense heat, he saw its application to every purpose to which lenses had been applied. In order to obtain a greater degree of heat in the focus of this lens, he placed behind it a complex apparatus of lenses and plain and spherical mirrors, which was equally applicable to lighthouses; because, if a light were placed in the focus of the lens, every ray which emanated from it would be thrown into a condensed and parallel beam of light, visible at great distances, and fitted to penetrate fogs better than the more diverged beams produced by reflectors.

Having been intimately acquainted with Mr Stevenson the engineer to the Scottish Lighthouse Board, with whom he often conversed on the subject of the Bell Rock Lighthouse, Sir David Brewster explained to him the application of these inventions to lighthouses, and so early as 1815 or 1816 he pressed them upon

[1] Article, "Burning Instruments," in the *Edinburgh Encyclopædia*, vol. v., p. 140.

his consideration for adoption by the Lighthouse Board. Mr Stevenson, who had no knowledge of optics, considered the hammered reflectors which were in use in the Scottish lighthouses as perfect instruments, and he therefore resisted, as we shall see, every attempt to have the new lenses and the relative apparatus subjected to an experimental trial. Having learnt that lenses had been used in some experiments in France, where a light was required to be seen at a great distance, Mr Stevenson, in an interview with Sir David Brewster, mentioned his intention of investigating the subject of the use of lenses in lighthouses. Sir David, as stated in his paper of January 1823, pointed out, as he had often done before, his improvement on lenses, and his method of arranging them for the purpose of illumination, and proposed that they should make some experiments with the view of introducing them into the northern lighthouses. Before proceeding, however, to this inquiry, Mr Stevenson was anxious to obtain an account of what had been done in France; and as it was afterwards understood that the Corduan Light on the coast of France was to be fitted up with lenses, Mr Stevenson's "intention, as he himself states, was to make personal observations upon it, whenever the alteration on that lighthouse should be completed."

The subject of the improvement of their lighthouses had long occupied the attention of the Lighthouse Commissioners of France; and though their reflectors, as executed by eminent opticians, were of a very superior kind, they were ready, from their theoretical and practical knowledge of optics, to appreciate and introduce any better system. M. Fresnel, so celebrated for his optical discoveries, had directed his attention to this subject, and in the month of July 1822 he communicated to the Academy of Sciences a memoir "On a New System of Illumination for Lighthouses." In this memoir, a copy of which he sent to Sir David Brewster and Mr Stevenson, he describes as his own invention the polyzonal lens, and the complex apparatus of lenses and mirrors which had been described in a work published in Edinburgh in 1812. So striking, indeed, is the similarity between the Scotch and the French system of illumination, that the late Captain Basil Hall, after a careful examination of them, remarks that "the very details of the disposition of the lenses and of the reflectors, are so exactly the same, that it is really too much to suppose that these complicated arrangements could have occurred to two persons."

When Sir David Brewster received this memoir, he was surprised at the similarity between his own lighthouse apparatus and that of Fresnel. He was delighted to find that his inventions were about to be adopted in the French lighthouses. He believed that M. Fresnel was an independent inventor; and seeing that the

French Lighthouse Board, consisting of the most eminent engineers, naval officers, and men of science, had, after a careful comparison of reflectors and lenses, adopted the latter, he never doubted that, with the sanction of such high authority, the great lenses, with their rotative apparatus of small lenses and mirrors, would be immediately introduced into the Scottish and all other lighthouses. Still less did he doubt that, after the Tour de Corduan had been fitted up with the dioptric lights, so as to exhibit to every observer the perfect success of the system—the *full swelling* beam of light which so surprised Sir John Robison, when he first saw it—the Scottish Commissioners would consider the question between lenses and reflectors as settled for ever, and would instantly and implicitly adopt the new system. There are men, however, who have no faith in science, and who even distrust their own senses when their prejudices stand opposed to their indications. The Commissioners of Northern Lighthouses were men of this order. Having no scientific knowledge themselves, they trusted implicitly in their engineer, who had still less. They did not deign to consult the eminent scientific men in Edinburgh, whom they met daily in society; and when Professor Barlow and Sir John Robison, and the Committee of the Royal Society, to whom they latterly were driven to appeal, saw and admired the superior brilliancy of the lenticular beam, neither they nor their engineer could be brought to see it. It required, as we shall see, the irresistible influence of a Committee of the House of Commons to open their eyes. Those of their engineer remained closed to the last.

Under these views, Sir David Brewster again put himself in communication with the engineer, and, immediately after the receipt of M. Fresnel's Memoir, he drew up the article, No. 16 in our list of books, which was printed in November 1822, after receiving some alterations and additions from Mr Stevenson, in which, as we have seen, he intimated his intention to make experiments and visit Corduan. Notwithstanding Sir David Brewster's repeated applications, *no step whatever was taken* in this important matter for upwards of *a year and a half*, and it was not till 1824 that the engineer went to France, and brought over one of the French lenses, 30 inches in diameter, for the purpose of making the experiments so often referred to. On that occasion he visited the Cordnan Lighthouse, and returned to Scotland with the opinion *that its light was not better than that of any lighthouse in England*.[1] This opinion he must have communicated to the Commissioners who sent him to France; and though it was never expressed in any of his reports, or to any of the third parties deeply interested in the matter, yet he continued to entertain it, as we believe, to the end of his life, and it affords us an explanation of all his dilatory and obstructive proceedings.

[1] Report of House of Commons, 1834, p. 214, § 2137, 2138.

Nay, even after all the experiments on Gulan Hill and in Edinburgh, he retained the same opinion; and when, on the 18th April 1834, he was asked in the House of Commons, "What was the result at the present moment of all his observations, as to *the most œconomical and best light that can be used?*" and was warned by Mr Hume to *consider well* his answer, he replied, "In the present state of my information, the result that I have come to is, that the simple Argand burner and reflector, as now used, is, on the whole, the most œconomical and the most manageable of any of the other systems of lighting with oil!"

But although the French lens arrived in 1824, yet that year passed away without the long-promised experiments being made with it. The year 1825 also passed away without trial of its powers; and when Sir David Brewster found that it was in vain, after ten years' importunity, to expect any experimental examination of his lenses and relative mirrors, he resolved to apply directly to the Board itself. With this view he addressed the following letter to Mr Sheriff L'Amy, one of the Commissioners, enclosing another of the same date to the chairman of the Lighthouse Board, Sir William Rae, explaining the nature of his inventions, and their application to the illumination of lighthouses:—

"*Edinburgh, January* 13, 1826.

"Dear Sir,—I beg leave to transmit through you the accompanying letter, addressed to the chairman of the Board of Commissioners of the Northern Lighthouses, which you would oblige me by putting into his hands.

"It may be proper to mention to you that I intend to make a similar application to the Trinity House of London, to the Board for Improving the Port of Dublin, and to the Admiralty.—I am, etc., etc.,

"D. Brewster."

The Board, on the 18th January, expressed through their secretary "their thanks for the communication made to them, and assured him that it should receive from them that consideration which its importance requires." "I have further to acquaint you," he adds, "that your paper was ordered to be engrossed in the minute-book of the Board, and to be remitted to the Standing Committee of the Commissioners, in the view of trying the effect on some of their new lighthouses."

More than two months having elapsed without any notice from the Committee, Sir David Brewster addressed the following letter to the chairman, Sir W. Rae, then Lord Advocate:—

"*Edinburgh, March* 30, 1826.

"My Lord,—I should esteem it a particular favour if your Lordship could give me the honour of a few minutes' conversation with you, respecting the new lenses which I have, during the last ten years, been pressing upon the consideration of Mr Stevenson, for adoption by the Lighthouse Board.—I have the honour to be, etc., etc.,

"D. Brewster."

In consequence of this letter and a conversation with Mr L'Amy, Sir W. Rae called a meeting of the Standing Committee on the 4th April 1826, and requested, through Mr L'Amy, Sir D. Brewster's attendance, to explain his wishes and plans. He accordingly attended the meeting, and was "requested to state in a report generally the properties of his discovery, when the Commissioners would take the same into their consideration, and would probably order an experiment to be made."

Sir David Brewster accordingly prepared a drawing of the polyzonal lens, and of the combination of lenses with plane and spherical mirrors, *for throwing into one parallel beam of light every ray that issues in all directions from an oil or gas lamp*,—an apparatus since called a *holophote*, from its condensing into one beam the *whole light* from any luminous centre. This description was sent to the Lord Advocate, with a letter pointing out the superiority of lenses to reflectors,—describing a new method of making good reflectors,—urging the introduction of gas, which he had tried, with a large burner, with five concentric wicks and 250 apertures,—and offering to superintend the construction of two sets of lenses, one of flint glass and the other of crown glass, should "the Board come to the resolution of replacing the worn-out reflectors with the lens apparatus."

In order that the Commissioners and the public might fully understand the nature and value of the dioptric system, Sir D. Brewster drew up a memoir of 40 printed pages, and illustrated with three plates (No. 17 in our list), which was read to the Society, printed in their Transactions, and sent to each of the Commissioners. In this memoir, the whole subject of lighthouse illumination was treated in the most popular manner. The author explained—

1. The imperfection of the present system of illumination by hammered reflectors.
2. The construction and properties of the polyzonal lenses.
3. The combination of lenses with plain and spherical mirrors for fixed and revolving lights.
4. The proper construction of distinguishing lights.
5. The occasional exhibition of powerful lights.
6. On the introduction of gas into lighthouses.

This memoir was concluded with the following observation, and the reader will see in the sequel that the prediction which it hazards has been amply fulfilled :—

"I have thus," says the author, "endeavoured to explain the new system of illumination for lighthouses. Discouraging, as its first reception has been, it requires no prophetic spirit to anticipate its early and complete triumph. I am aware of the prejudices, and I grieve to add, the sordid interests with which it must contend ; but these are not the days in which the tide of knowledge and improvement can be thus stemmed. The force of truth will gradually dispel the one, and before the frown of public opinion the other will disappear.

"It is in Great Britain, if anywhere, that the lighting of her shores ought to be an object of national concern. Her naval and commercial pre-eminence, the sum of human life, and the amount of valuable property risked at sea, call loudly for every aid which science can confer. The ingenuity which has been already exhausted, the humanity which has been roused, and the national liberality which has been freely dispensed in devising and promoting every scheme for saving the shipwrecked mariner, cannot now receive a nobler direction than in rendering more effective those beacons of mercy which light the seafaring stranger to our coasts, and warn him of the wild shelves with which it is defended."

The engineer of the Lighthouse Board considered this memoir as an intrusion into his professional field; and having at that time, and we doubt not honestly during the whole of his life, believed in the superiority of reflectors, his unwillingness to make experiments on the subject influenced all the proceedings of the Board; and it was not till the 13th January 1827, after *a delay of nine months*, that the Committee considered Sir D. Brewster's plans, and requested him to procure an estimate of two lenses of flint and crown glass. Estimates were accordingly produced, and by a minute of the 7th February 1827, he was authorised to order a flint-glass lens, "with the view of instituting a comparative experiment between it and the reflectors at present in use," and he and the engineer were requested to make arrangements for that purpose.

The flint-glass lens was completed by Messrs Gilbert in October 1827, and a comparative experiment was made with it by persons more impartial than the inventor and the engineer. The members of the Trinity House wished the experiments to be made in presence of some of the elder brethren before the lens was sent to Scotland; and accordingly Professor Barlow of Woolwich attended two exhibitions of the lens to a committee of the elder brethren, "who were extremely pleased with the beautiful intensity of the light," while Professor Barlow found by computation that the intensity of the light by the lens was *twenty times greater than that by the reflectors*.

The result of this experiment produced no effect upon the Scotch Board or their engineer. It seems, indeed, to have deterred them from any further trial. The lens thus publicly tested arrived in Edinburgh in December 1827; but, instead of making experiments with it to confirm or refute the results obtained by Professor Barlow and the elder brethren, the *Commissioners allowed more than* THREE *years to elapse* before they even proposed to make the experiments they had so long and so repeatedly promised! At last, on the 10th February 1831, Sir D. Brewster received notice that the engineer would be ready to make them "at the commencement of the ensuing month," and that

Mr Stevenson would inform him of the precise time when he might come to Edinburgh for the purpose. The co-operation of the Royal Society was also requested, but, strange to say, nothing more was heard of the matter till January 7th, 1832 (a delay of *eleven months*), when Sir D. Brewster learned from Sir John Robison, the Secretary to the Royal Society, that the apparatus was nearly ready at Gulan Links, and that he was to be warned by one of the Commissioners when he should request Sir D. Brewster to come to town.

No such notice, however, reached any of these parties. *The whole year* 1832 *passed away*, and it was not till the evenings of the 12th, 13th, and 14th February 1833, that the experiments were made. The superior intensity of the light given by the lenses was obvious to every person but the engineer, whose opinion alone was asked and recorded by the Commissioners. The report, which he submitted to the Board, had no meaning either scientific or practical, and is thus characterised by Sir John Robison, to whom, as secretary of the Royal Society, it was communicated by Mr Macconochie, one of the Commissioners :—

" Mr Stevenson's report[1] has irritated me so much as to make me quite uncomfortable. As you will have got a copy also, you will see the cause of this. He does you the honour of connecting you with the lens only as having offered to superintend Gilbert in making a copy of the French one with the substitution of flint for crown glass. After all that has passed, this shows a perversity of misapprehension or of misrepresentation which is quite disheartening, as one cannot hope that the public cause can derive any benefit under the control of a person capable or incapable in this degree. He introduces the Secretary of the Royal Society as giving the profound advice of letting off a blue light, and afterwards lets off a red light (which was what the said secretary did recommend) as Mr Stevenson's own production."! —Feb. 23, 1833.

It was now obvious both to Sir D. Brewster and Sir John Robison, that an appeal to the public in favour of the dioptric lights had become necessary. But before taking this step, an elaborate paper on the dioptric lights was sent to the Lens Committee on the 16th Feb. 1833, appealing to the decisive experiments made in France and Russia, to the opinions of Sir John Herschel, and the distinguished philosophers, engineers, and naval officers in France, who had all decided in favour of lenses. When this communication was read, the Lord Provost of Edinburgh, who had expressed, in language too strong to be repeated, his indignation at the conduct of his brother commissioners and the engineer, insisted in the most urgent manner upon having an estimate of the relative expense of fitting up Inchkeith Light-

[1] See Report on Lighthouses by the Committee of the House of Commons, August 1834. App. p. 127.

house with lenses and reflectors. This estimate, thus forced from the engineer, was, as might have been expected, made favourable to reflectors; but in order to counteract the effect of it, an estimate was obtained from M. Fresnel of Paris, of the expense of fitting up a first-class lighthouse with lenses, which was L.413 cheaper than the equivalent apparatus of 24 reflectors.

Armed with this information, Sir D. Brewster made his last communication[1] to the Scottish Board, pressing upon their notice the economy, as well as the superiority, of the dioptric lights. The effect of this letter was to induce the Board to agree to the erection of a lens light upon Inchkeith. But as their engineer was opposed to this measure, Sir D. Brewster had no expectation that their resolution would be carried into effect; and he therefore wrote an article in the Edinburgh Review,[2] *On the British Lighthouse System*, in which he pointed out the inconvenience of placing the lighthouses of the kingdom under boards composed of unpaid and irresponsible individuals, who were neither men of science, nor engineers, nor naval officers; demonstrated the superiority of lenses to reflectors, and denounced the dangerous blunders committed by the Scotch engineer in the distinguishing light on the Bell Rock. He urged the House of Commons to inquire into the subject; and with this view he put himself in communication with Mr Joseph Hume, who, on the 13th Feb. 1834, obtained a select committee to inquire into the Lighthouse System of Great Britain and Ireland.

Before this impartial tribunal, witnesses of competent knowledge unanimously testified to the superiority of the dioptric system; and when their verdict was confirmed by the great success of the experimental dioptric lighthouse at Inchkeith, where the lens apparatus was in full action, on the 30th Sept. 1835, the triumph of the new system of illumination was achieved. The Royal Society reported that *the new light had a* PRODIGIOUS *superiority over the old.* The Tory Commissioners stood aghast at the necessity of a Radical reform, and the engineer wept bitter tears over the downfall of his reflectors.

For ten years the relentless enemies of the polyzonal lens, the Scottish Commissioners and their Clerk of Works became now its most devoted worshippers. In their report on the Lighthouse Bill, they declare that the superiority of the dioptric system was so great at Inchkeith, that "no room was left to doubt *that this system will be employed in all lighthouses hereafter erected*," and "*that the lighthouse (lenticular) in the Isle of May will be the most perfect that was ever exhibited* IN ANY COUNTRY!"

Amid this general ovation, the engineer of the Lighthouse

[1] Printed in the Report of the House of Commons, No. 130, p. 133.
[2] April 1833, vol. lvii., p. 169.

Board is silent; but it may be presumed that he speaks through his son and successor, Mr Alan Stevenson, the Clerk of Works, when he, who declared in 1833 "that the British and Irish lights were the best in Europe," now declares, in a report to the Lighthouse Board, that the lens lights in the Isle of May Lighthouse, *are more than twice as intense as the old ones*, and that *there is a positive saving in the expense of oil in the ratio of* 17 *to* 24!

The triumph of the dioptric lights was now complete. They were introduced into England, Ireland, and the Colonies, and wherever there were honest and intelligent administrators to appreciate their value; and the time is not distant when they will be hailed on every shore as beacons of mercy to the seafaring world. But while the philanthropist thus rejoices in the triumph of science over official incapacity and sordid interests, he cannot but deplore the resistance which was so long made to its lessons, and those worse qualities in our moral nature by which that resistance was maintained and prolonged. It will hardly be believed in another age, that men, occupying the station of judges in their respective counties,[1] should have been the dupes of an engineer as ignorant of the subject as themselves, at a time, too, when they were daily in the society of men of science, ready to help them, and when they had in their hands *the most positive evidence of the success of the dioptric system in France*, and *the testimony of the most distinguished men of science, engineers, and naval officers in Paris!*

The chronicle of the Scottish Lighthouse Commissioners, when read even in their own minutes, is to us, and doubtless will be to others, a mystery which time is not likely to disclose; but however it may be explained,[2] there is one truth upon which our readers will set their seal, that the hundreds of lives which were lost on the Scottish coast from the imperfections of its lighthouses, during the *ten* years that the engineer refused to listen to Sir D. Brewster's recommendation of the lens apparatus—that these lives, we say, lie at the conscience door of the engineer; and that during the following *nine* years that the Scottish Commissioners refused to surrender to science their ignorance and their prejudices, the souls of the men shipwrecked from the same cause may yet rise up in judgment against them.

But it is not only humanity that now lifts her feeble yet pierc-

[1] We mention the names of the acting Commissioners, that the reader may judge how far they were authorities in the optics of lighthouses:—Sir W. Rae, Mr Andrew Murray, Mr L'Amy, Mr Archibald Bell, Mr Robert Bruce, Mr Clephane and Mr Macconochie, the last of whom was, we believe, always friendly to the new system.

[2] Sir John Robison, writing on the 23d March 1833, says,—"I heard some curious circumstances to-day from a person who was long employed in working for the lighthouses. If his evidence were taken before the House of Commons, it would afford a curious explanation of the apparent apathy and slowness of proceedings in the Lighthouse Board."

ing voice. The Nemesis of justice summons these judges of others themselves to judgment. During the nine years in which they trifled with a subject involving domestic as well as national interests, the name of the inventor was associated with his invention; but after the curtain had fallen, and the actors were dispersed, they deliberately dissociated his name, not only from his lenses and apparatus, but from his gratuitous and unceasing labours to introduce them. In their reports to Parliament they omitted all notice of what he had done in their presence. They suppressed his name, and had the boldness to claim the merit of having themselves introduced the dioptric system! But even this lash, inflicted upon the inventor by their own hands, did not satiate the Commissioners; they either encouraged or allowed their underlings to publish pamphlets and write anonymous articles in magazines, attacking him with a violence and bitterness known only in political warfare. They strove, too, to deprive him and even Fresnel of the honour of having invented the polyzonal lens;[1] they laboured to carry off from England the merit of the invention of the dioptric system and hand it to France, and they did all in their power to wrest from their fellow-citizen the merit of its introduction into British lighthouses, and take it to themselves. This ignoble and unpatriotic act which crowned their offences; this act of persecution against English science, is without example in its history. No Englishman ever dared to give to Leibnitz and Germany the honour of the discovery of fluxions due to Newton and to England. None ever ascribed to Napier the invention of the steam-engine due to the Marquis of Worcester or Savary. None ever placed upon the brow of Lavoisier the laurel which the discovery of the composition of water had conferred on Watt and Cavendish; and no enemy of his country and of truth ever transferred to a foreign nation the English inventions of the electric and submarine telegraphs. We trust that the Board of Trade and the Admiralty, and the new Commission for Lighthouses, who have been misled by the reports of the Scotch Commissioners, will investigate for themselves the history of an invention which it is now their duty to perfect and extend.

[1] The following observations on the dioptric lights were made by Lord Brougham in his address at the meeting of the Association for the Promotion of Social Science, held at Bradford:—"The security of ships and buildings by Sir William Snow Harris' lightning rods has saved many lives and much property. Still more beneficial, because the risks from shipwreck are far greater than those from lightning, has been Sir D. Brewster's happy application of the science of which he is so great a master, to the construction of the Dioptric Lighthouse. Some absurd attempts have been made to represent M. Fresnel as having anticipated Sir David Brewster. He probably was ignorant of what Sir David had done long before, and therefore his originality, as the second inventor, may be admitted, on that supposition. But Sir D. Brewster published in 1812, M. Fresnel in 1822, and as early as 1816 he pressed upon the Lighthouse Engineer in Scotland the use of his method."