ABOVE: The 'New' South Foreland lighthouse was exciting to contemporary readers of the *Illustrated London News*. Its modern site, enhanced by James Walker's buildings, were an ideal location for scientific and engineering development. Notice the square lantern panes in the original form. Once it was realised that each vertical caused a serious diminution of light to an observer, these were replaced in 1870 by the diamond-shaped panes (in the photo opposite) which were less obstructive.

A New Era For Light Keepers

Extracted from: Light On The Forelands by Ken & Clifford Trethewey, Jazz-Fusion Books (2022)

The great advances offered by science and engineering to marine safety are hindered by politicians; The 1871 Census data leads to a good description of life at South Foreland during a period of great scientific and engineering activity; The South Foreland lighthouses are the focus of world-changing developments; Gradually, a detailed picture of the staff changes at the station emerges

Government Inertia

Since the coronavirus pandemic of 2020-21, it has become clear to national populations - if it had not done so before - that there is sometimes philosophical disagreement between science and government. Without wishing to challenge scientists who present us all with the new knowledge we need to progress, government spending is often the limiting factor in whether new ideas are adopted or not. Even if finance is available, sometimes the compatibility of science with the needs of the people introduces good reason why the science is not taken up.

In the 19th century, lighthouse technology was at the cutting edge of contemporary science, yet frequently came into conflict with the bean counters and bureaucrats in charge. In a recent study, McLeod[1] wrote about the impact of the state upon the provision of lighthouses. Statistics he gathered were as follows. In the two decades between 1860 and 1880, Britain commanded up to 55% of all seagoing trade. Government could have argued that with so many ships at sea, high numbers of casualties of both hulls and personnel were inevitable. Even so, during the same period nearly 1200 ships were lost at sea and typically 800 to 1200 lives were lost each year. Most civilised minds would be appalled at such tragedy, but clearly there was much inertia separating government action and the need for maritime safety. It was well known that most of these losses were preventable, but politicians would have argued that a balance had to be struck between an acceptable level of loss versus the required expenditure.

In 1859 two serious tragedies occurred when ships were lost in the Irish Sea resulting in 870 drownings. Much critical public comment followed in which Sir David Brewster, one of Britain's leading scientists, criticised the poor provision of lighthouses to aid navigation and prevent these kinds of accidents. His comments helped to establish a Royal Commission to investigate. The following year, as if to underline the significance of Brewster's criticism, a further 250 wrecks took place within two weeks.

One of the significant issues to emerge concerned the methods of providing illumination. It was now

1 McLeod, Roy M: Science And Government In Victorian England: Lighthouse Illumination And The Board Of Trade, 1866–86. *Isis*, (1969) Vol. 60, No. 1, Spring, pp4–38.

that science and policy locked horns. It seemed that no longer could scientists claim that their assessments were inevitably correct. Public opinion had already begun to suspect that finances of the three national lighthouse authorities – Trinity House, Northern Lighthouse Board and the Commissioners of Irish Lights[2] - were perhaps not being spent appropriately, and, as a result, Parliament placed their financial supervision under the Board of Trade. However, this introduced a new tier of bureaucracy by which stakeholders could argue amongst themselves about the efficacy of a suggested change in the system. These three General Lighthouse Authorities (GLAs) continued to retain management authority over the lighthouses, whilst always reporting their finances to the Board of Trade, which remained ultimately toothless. Nevertheless, under its long-term civil servant leader, Thomas Farrer, the Board constantly demanded expenditure to be minimized, even when change was absolutely necessary. Thus calls for more efficient lighting of the coastlines often fell upon deaf ears with the decision that funds were not available.

As the 19th century progressed and the engineering of lighthouses became increasingly developed so the engineers, who, until then, had been largely responsible for construction of the buildings, found themselves out of their depth in decisions regarding the application of new science to industry.

Three prime examples concerned:

(1) The balance of effectiveness between different methods of illumination – oil, gas or electricity;

(2) The use of optics for magnification;

(3) The requirement for audible warnings in fog.

All required deeper understanding of science by engineers than had been necessary heretofore. Suddenly it was necessary to make complex judgements about the merits of application of these different technologies. Experimentation became critical in assisting decision-making, but interpretation of the results was subject to considerable controversy, even amongst the scientists themselves. Added to this was the ever-present shadow of corruption cast by the lure of financial gain, for it was often the case that participating personnel – especially in the world of engineering - had significant interests in the success or otherwise of competing technologies. This is not to suggest that overt corruption took place, but simply that there were many other considerations of political and financial import apart from making a choice between options based solely upon scientific analysis. One particularly aggravating factor was partisan competition between English and Irish interests. Curiously, it was not (this time) the age-old bad feeling between English and French that was at fault, for - generally speaking - there was a good dialogue at play here. However, the way English people looked down upon the Irish, and, of course, the vexatious issue of independence for Ireland that propped up much of the debate, was a big sticking point.

The biggest issue of the time surrounded an amateur inventor from Dublin named John Richardson Wigham (1829-1906). Born into a family of quakers in Newington, Edinburgh, John was the son of John Wigham (c1784-1845), a shawl manufacturer, and his wife Jane Richardson (d.1830). Wigham developed an excellent design of gas burner that seemed to be far superior to burners using oil. Working in collaboration with the Irish authorities in Dublin, Wigham gained their trust that, despite having no professional track record, he was not only competent but had made a significant step forward in technology design. He quickly had considerable success in establishing his improved light, not just by demonstrating its superiority in an Irish lighthouse, but when he gained the support of the chief scientific advisor to Trinity House, John Tyndall. The latter found himself in conflict with the interests of his colleague, Sir James Douglass, whose own plans for improvements centred around oil burners of his own design. Since Douglass was in charge of engineering in Trinity House there was clearly a conflict of interest. For him to adopt Wigham's design - placed alongside the Irish political issue in the background - seemed overwhelming in retrospect. Arguments raged over a long period of time between Trinity House and the Irish Commissioners with Tyndall in the middle of the storm working for Trinity House whilst supporting Wigham's systems. The issue was finally resolved by the Corporation taking the side of their Engineer-In-Chief, Tyndall's acrimonious resignation from his post and the outright refusal of Trinity House

2 We must remember that the British nation was at this time comprised of England, Scotland, Wales and the whole of Ireland. Trinity House was responsible for England, Wales and also the Channel Islands; the Northern Lighthouse Board in Scotland was also responsible for the Isle of Man. In Dublin, the Irish Commissioners administered the whole island of Ireland.

ABOVE: The lighthouse to the north of Dublin Bay at Howth Head. It was built to house the newly invented and powerful gas light of John Wigham in 1865. The engraving was used by Major Elliott in his report to the US Lighthouse authorities.

to adopt gas burners as the main light source. The Douglass oil burners continued to be the preferred option, even as new systems of electrical lighting gradually came into use.

The Irish were not, however, in any doubt, and Wigham's system was adopted in 1865 by the Irish Commissioners who sanctioned a gas light on Howth Bailey, a foreland on the north side of Dublin Bay. Viewing it from the other side of the Bay, Tyndall inspected the light from it in 1869 and found it to be no less than twelve times as strong as any in England. Furthermore, there were unmistakable benefits for the gas light in fog that did not seem applicable to the English oil lights.

Another eminent scientist, Sir William Thompson (later Lord Kelvin), supported Tyndall's analysis but even that did not change minds; the opinions of the Elder Brethren were not to be changed. In Scotland, the Stevensons also were not convinced that gas was preferable and they reported it as much more expensive than oil for the same power of light. They too had already put their weight behind the same designs of four-wick Douglass-designed oil burner used by the Trinity House. The arguments were submitted to 'independent arbitration' in the form of a wonderfully named group, the London Gas Referees. They were not inclined to support oil, and to John Tyndall it seemed that black was being argued as white. This conflict of scientific analysis was inexplicable to many independent observers.

Reacting to much criticism, and in an effort to appear unbiased, Trinity House, committed to an experiment in 1872 in the Happisburgh Lighthouse on the Norfolk coast where Captain Nisbet, one of the Elder Brethren called the newly installed gas light "perfectly beautiful!" It was still not enough to change the course of events. Throughout 1874, further experiments, analyses, and reports on the part of Tyndall remained unacceptable to the Elder Brethren. Douglass could not be persuaded and received the full support of his employers who could well have valued his services too highly to have placed him in a position where he - like Tyndall - might resign. The House raised a continuous stream of counter-arguments against the use of gas.

The long program of experimentation and reporting fell foul of the Board of Trade on the grounds of expense and they tried to bring the arguments to a close rather than continually fund experiments out of the mercantile marine fund (the purse that collected light dues for the British Isles) just to obtain inconclusive results and arouse more argument. By 1879, Wigham had been granted £2,500 in royalties for the use of his invention in Ireland and the Board considered the matter closed. Tyndall had resigned and enormous bad feeling existed between all parties. Even then, the arguments did not end. Throughout all this, the light keepers carried out their duties to the best of their abilities, blissfully unaware of the hiatus sweeping through the upper levels of management.

The Lighthouse Manifest

It was 1869 and Henry Knott's 72nd birthday. His relief as Principal Keeper had already arrived. Trinity House had announced that they had acquired land between the High and Low South Foreland lighthouses for the erection of buildings and engine houses, workshops, and living accommodation for three keepers. The 1871 census taken on the 2nd April indicates the changes at the site, whilst at the same time revealing the long awaited name of the new Principal Keeper.

This census was the first not to record a member of the Knott Family at the South Foreland lighthouses, but as I investigated the names of the new keepers, their families and their backgrounds, I could not help but feel a distinct sense of empathy with the Knotts. It was almost as if they wanted to share the tradition of the Knott Family and to say that they had been on the light in which almost no one else had set foot for more than a century. This was hallowed ground and it was about to change dramatically.

The number of light keepers had increased and, inevitably, so had the buildings, but it was not entirely straightforward. There were six light keepers and six houses, yet subsequent ground plans allowed for eight residences.

In 1871 one house was unoccupied with no further comment concerning its condition, so it must be assumed that it was finished or nearly finished. George Thomas, the Principal Keeper, had two lodgers, both unmarried. One was a light keeper, the other was an engine fitter. Each family seemed to number about seven people; one young couple without any family must have been sharing though wasn't shown as such.

Before looking more closely at the physical developments on the foreland let us look at the manning of the lighthouses and the first major change since they were rebuilt in 1843.

Edward Rogers

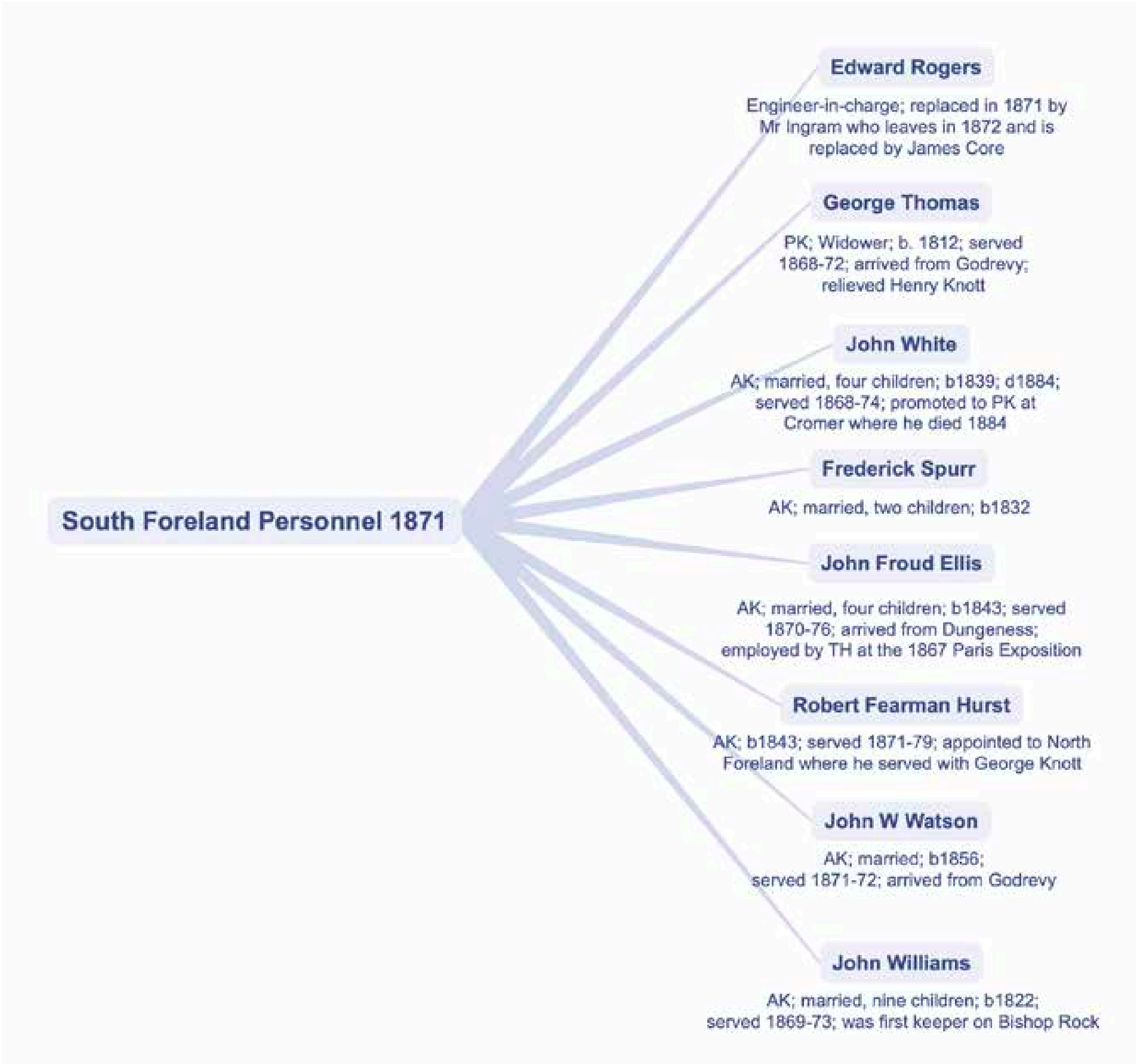
The most significant difference from before was that Edward Rogers was not a simple 'Light Keeper' but the 'Engineer Mechanic in charge of the Lighthouse Establishment.' This suggests that the structure of the new engine house must have been completed and work was underway to install the machines with all their ancillaries. That conclusion is further supported by the presence of a house carpenter lodging with John White's family, as he may have been putting the finishing touches to the accommodation for which John Watson and his wife were waiting. Rogers, was living in the house of Frederick Spurr.

George Thomas

The census confirms the name of the Principal Keeper who, having relieved Henry Knott in 1868, took on the task of maintaining the South Foreland lights with five assistant keepers. He was George Thomas aged 59 (c68-72), born in Ramsgate in 1812. He was a widower nearing the end of his time in the Trinity House service, but his common surname precludes any realistic chance of discovering when his wife, Sarah Elizabeth, had died. It is fair to say that she did not die at St. Margaret's, so George had come to the light as a widower, but oddly he had with him a very young grandson. Harry Thomas was only 6 years old and that was very young with two other male lodgers in the house. George Thomas may have come direct from Godrevy Island Light off St. Ives in Cornwall, where he was the Principal Keeper in 1861 and he may have been familiar with the tragedy of Henry's daughter, Ann Hood, which occurred at that time. He may have asked for a transfer to South Foreland simply to share that loss with Henry, whom he would not have met before, and his unusually compassionate behaviour around the death of Henry (see p150) tends to support that supposition. At Godrevy, he was living in Westcotts Lane, St. Ives with Sarah and their son Robert who had been born on the Hurst Point lighthouse in 1846.

Robert Hurst

George Thomas's lodger, Robert Fearman Hurst (c71-79), had also been born in Ramsgate in 1843 and had also come to South Foreland from Godrevy where he had been an Assistant Keeper since 1868. He stayed at South Foreland until 1879



before moving up the coast to the North Foreland. He was there to meet George Knott in 1888 and they both left in 1890, Robert to Flatholm and George to Dover on pension.

John and Elizabeth White

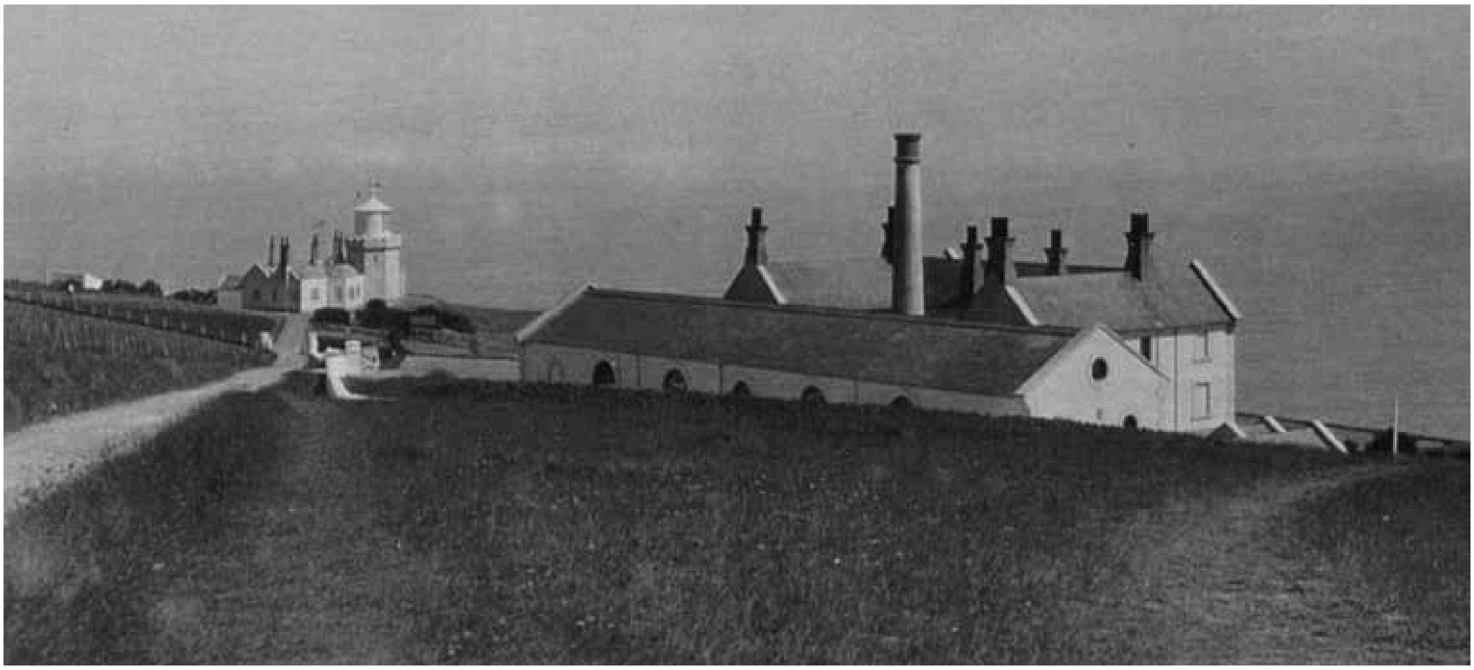
The next house was occupied by John White (c68-74), his wife Elizabeth and their four children. John had been born in 1839 at Blackwall on the Thames the location of the Trinity House buoy wharf and lighthouse, but his wife came from Stowmarket in Suffolk. The last two boys had been born at St. Margaret's at Cliffe, so it can be said that the family had arrived at the lighthouse before April 1868 and William (the last son) had been born just a month before the census.

John and Elizabeth Williams

John Williams (c71-73) has already appeared in our story (p204). He had been in the light service for many years. Born in Cornwall at St. Enoder in 1822, his wife Elizabeth was also Cornish, having been born in St. Just in 1827. They had a large family whose births were recorded either at St. Just in Cornwall (1845, 47 & 51) or St. Mary's on the Scilly Isles (1849, 53, 56, 59, 66 & 69) when it is believed that John was on the Bishop Rock light. This length of time on a rock light is most unusual during Trinity House's management and that may reflect John's unusual desire to serve there. Once again it is apparent that John arrived at South Foreland sometime during or following 1869. However, the child named Clara alleged (in 1871) to have been born on Scilly in 1868 does not appear in the GRO Index. One more child was born to the couple at South Foreland in 1873.

John and Jane Watson

The next entry on the page following Clara Williams is blank and the enumerator records an uninhabited house, yet the next Assistant Keeper,



ABOVE: The engine house construction took place from 1869 to August 1871. It was a large facility, running left to right in the centre of the photo, and was designed to house the numerous magneto-electric generators selected for test. The tall chimney indicates that steam plant was also required to power the generators. The new office and accommodation two-storey house are on the far side, nearest the sea. The Low Lighthouse can be seen on the left; the High Lighthouse is behind the camera. Electricity from the chosen generators was sent to both High and Low lighthouses (the matrix of combinations is shown on p226) and the intensity of light produced by each was compared from the THV Galatea some 11.5 mi distant in the English Channel.

John William Watson, was not attributed to a house of his own, which may reflect the current state of the building project. Watson (c71-72) was born at Wells (next the Sea) in Norfolk in 1846 and he had a young wife with him. Jane had been born in Zennor, Cornwall in 1849, but the couple arrived at the light having newly married early in 1871 in the Penzance District. John was South Foreland's newest keeper and this probably accounts for the peculiar record of his living accommodation. John would later spend a number of years on the Longships lighthouse as Principal Keeper, retire, and then live well into his 90s.

John and Mary Ellis

John Froud Ellis (c70-76) entered the service in 1865 and went on to be one of its longest serving and most experienced light keepers ending his career as PK at Beachy Head sometime after 1901. John Ellis had been born on Tresco in the Isles of Scilly in 1843 and he married his sweetheart Mary J Higinton (1843) from Streatham early in 1866. They came to South Foreland from Dungeness with four children and the last two were twins born there in May 1870, but the lighthouse at South Foreland gave life to two more Ellis children in 1872 and 1874. John spent a lot of time on the curious, skeletal river lights on the Thames – Maplin, Gunfleet and Chapman. He also played an unusual part in the great Paris Exposition in 1867 (see p170) and as a consequence was invaluable at South Foreland.

Frederick and Sophia Spurr

The last assistant keeper was Frederick Spurr who, with his wife Sophia, were both Londoners born in Westminster in 1832 and 1829 respectively. He was one of those who met Major Elliott (p204). Unlike the long tradition of lighthouse keeping in the Ellis Family, Fred Spurr didn't seem to last very long in the service. A son was born at the Trevose Head light in 1864 and a second son in Plymouth in 1868, but after completing his time at South Foreland nothing more is known of him.

So the record shows that there were now 32 people on the station. Six were keepers, five of whom were married and they brought 15 children with them aged from 18 years to 1 month. Three more were born at the light before the end of 1874. Three of the Assistant Keepers went on to earn their right to their own lighthouse in the rank of Principal Keeper, but John White died in 1884 soon after his promotion to PK at the Cromer light in Norfolk. South Foreland was now a dynamic community, uniquely responding to the great scientific interest the site had attracted. No one stayed for very long. All of them had arrived gradually over the period

Above: The repainting of the High tower in 1871 might have looked similar to this image taken in 2022.

1868-71. The fact that the station crew expanded from four to six keepers is beyond dispute, but why were six keepers thought to be necessary? After the initial experiments with electricity, both lights had been restored to their Argand oil lamps and all keepers were familiar with them. However, they had been caught up in an evolving process that had begun in March 1869 when the Trinity House Board had decided to create an 'electric establishment' at South Foreland.

The Brave New World of Electricity

During Faraday's experiments in 1859 he had noticed that the vertical glazing bars were causing an intermittent obstruction to the light, so that a mariner saw it from the Channel as 'blinking'. As a consequence it had been decided to re-design and rebuild the lantern with diagonal glazing bars which was undertaken during the latter half of 1870. This work was done in parallel with the rectification of another problem that had been noted by Holmes in that too much of the light was wasted in all directions when it needed to be gathered and focused to shine forward out across the Channel in an arc calculated to be 226° for the Upper Light; the arc of the Lower Light was slightly smaller at 199°.

In September 1870 James Chance agreed to re-design the optic individually for each lighthouse and he completed this work in January 1871 with the new lenses being installed later the same year. His advice to Trinity House was that they should install the improved version of Holmes's magneto generator into the new engine house and this was the activity that was reflected in the census of April 1871.

On the 5th May 1871 the *Dover Express* carried an advertisement from the Secretary of Trinity House, Robin Allen, dated 27th April seeking tenders to repaint eight light stations. Top of the list was South Foreland Upper and Lower lights. Among the others were the South Bishop and Skerries, as well as the three lights of Alderney known as the Caskets (sic), so South Foreland would soon be 'as good as new.' All the mechanical installation work was complete by August 1871, but it was decided that it would not be officially 'switched on' until 1st January 1872.[3]

Shortly before sunset on the Monday afternoon of New Year's Day, a worthy gathering of gentlemen led by Sir Frederick Arrow, Deputy Master of the Trinity Board, assembled in the engine room at South Foreland to inaugurate the major change that had been effected to the lighting system of the South Foreland lights.

It was an eminent gathering which should have been led by Prince Arthur who had promised his presence, but a mix up in the correspondence caused a clash of dates and Sir Frederick was asked to deputize for His Royal Highness. In any event it was an eminent gathering with two Elder Brethren, Captains Drew and Nesbitt, the Engineer to the Board, Mr. Douglass, the Inspector of Lighthouses, Captain Tucker, and the Superintendent of Pilots, Captain Cow. The original concept had two completely different functions, the most important of which was the power house of the project to provide the electricity supply to both lighthouses. The lesser known function was the provision of extra accommodation originally intended for two

3 The new Souter Point light had already been lit on 11 Jan 1871.

engineers and two light keepers described thus in the *Canterbury Journal*:

> *"During his preliminary address Sir Frederick referred to the electric triangle that had been formed by the long use of the Holmes' generator at Dungeness now supplemented by the permanent electrical supply to the South Foreland lights, whilst across the Channel the French had recently electrified the light at Cap Grinez to provide a triumvirate of lights and a well lit passage for mariners passing through the narrowest part of the Channel. At the close of his inaugural address, Sir Frederick set the machinery in motion and in an instant, two light towers four hundred yards from the engine house, flashed forth a light of dazzling brilliancy.*[4]

Buildings for the machinery had been erected by Mr. A. Matthews of Dover mid-way between the two light towers, which were 449 yards (411 m) apart and consisted of an engine house, boiler house, coke store and workshop. The electricity to produce the light for each lighthouse was generated by one of Professor Holmes's magneto-electric machines worked by a small, horizontal condensing engine. There were four of these engines, two for each lighthouse. Although one of the pair is necessarily a spare engine, both were needed in times of fog. The engines made 400 revolutions per minute and the electric current was sent by underground cable to the lanterns in each light. The engine, boiler and generator were all duplicated in case of accident or repair and the engines, boilers and pumps were supplied by Messrs Hunter & English of London.

The supply of water for the boilers was a very curious arrangement. It was supplied from a deep well sunk 280 feet through the chalk to the high water mark. It was remarkably pure and free of salt, but it only supplied its water during an ebb tide, whilst on the flood tide it was dry. This, however, did not impair the working of the machinery since a reservoir was used to store water.[5]

The report continued by describing the optics as third order[6] dioptric equipment specially made for the purposes of electric light. From the High Light 226˚ of surface arc were illuminated and from the Low Light it was 199˚.[7] The landward arc of the light, instead of being waste light to the mariner, was also collected by reflecting prisms arranged on each side of the main apparatus, and was equally distributed over the same arc as the former, thus adding considerably to its power. Each apparatus was provided with an independent oil lamp should the electric spark fail.

After visiting every part of the station from the new accommodation to the lanterns in each lighthouse, the visiting guests wished a Happy New Year to all the staff and returned to Dover at 7 pm.

There was one name in the report that has not, so far, been mentioned. It was Mr. Ingram the 'fully qualified' engineer in charge of the station and this is a function that I believe has been overlooked by lighthouse historians, because the romance of the locations in the imagination of artists and poets did not include men with spanners, oil cans and dirty hands. Only eight months previously another engineer named Edward Rogers was on the station and he had probably left because his task of setting it all to work was complete. Yet it is unusual in the naval tradition for an engineer not to benefit from the knowledge gained from installing the equipment he was due to maintain in daily operation. However, that was the way it was on New Year's Day 1872.

The presence of an Engineer-in-Charge also made a difference to another man – the Principal Keeper. It is very likely that George Thomas also perceived that his job was done. He had eased his predecessor Henry Knott through the pain of losing his employment and he had eased Henry's wife Margaret through her pain of losing her husband. It was time to move on. Sometime during 1872 George Thomas was relieved by another unidentified PK.

A large scale Ordnance Survey map dated 1900 gives a very detailed outline plan of the site showing a number of features which can be compared with a plan of the engine house site made by Major George Elliot of the US Army Corps of Engineers.[8] He was the Engineer-Secretary to the American Lighthouse Board and was on an extensive tour of Europe when he visited South Foreland on the 19th May 1873. (See p194.) Elliot's plan revealed that the living accommodation was not arranged as expected. There was a bedroom beside a living room at the back of the house on either side, but the front of the house had on its south east corner a room designated as 'the inspector's living room.' Next to it, in the middle front, was a store and on the lower side of the front, a bedroom and double aspect living room. It was also a ground plan and no account was taken of the arrangement of the

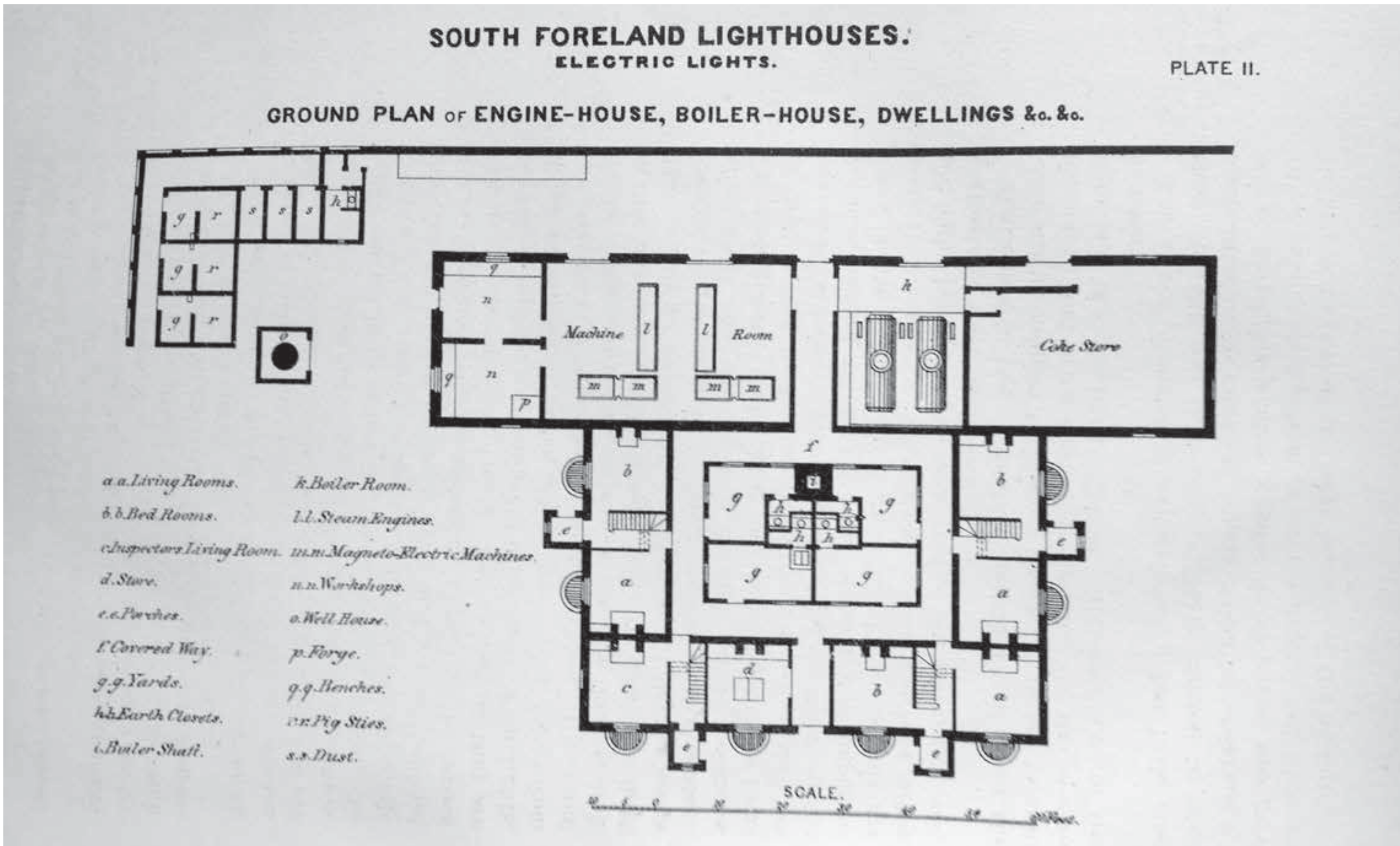
4 *Canterbury Journal*, Saturday 6 January 1872.

5 The remains of this system are discussed further on p396ff.

6 The 'order' of a light was determined by its focal length - that is, its physical size, first order being the largest.

7 Note the High Light surface arc is different from that recorded in the SFL/CMP Page 107

8 SFL/CMP Page 109



Above: A plan of the engine house, boiler house and dwellings as drawn by Major Elliott in 1873. Sadly, there is no information about the layout of the upper storey.

upper floor in what was clearly a 2-storey house. The great chimney stack stood in the courtyard that was created behind the accommodation along with two earth closets (lavatories) at its centre, but the courtyard was covered, almost like a cloister, to give ease of access into the engine house. It was a totally enclosed environment in direct contrast to the open sweep of the Foreland.

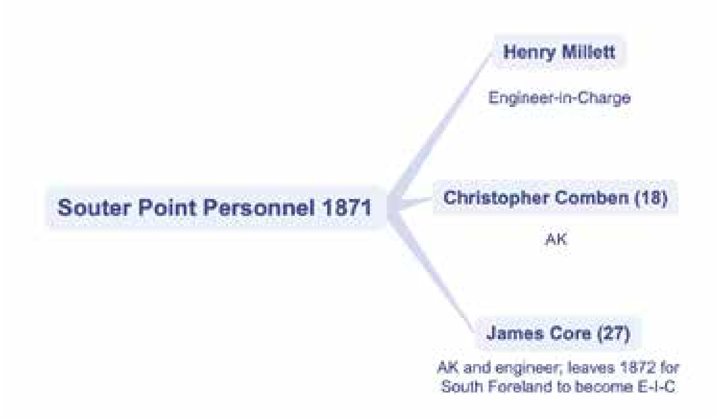
The real surprise was that in the corner of the new compound was a set of three pig sties not many paces from the houses. It was also here that the top of the well shaft reached the surface but there is no detail concerning its use. Exactly, how did the housewives access their water?

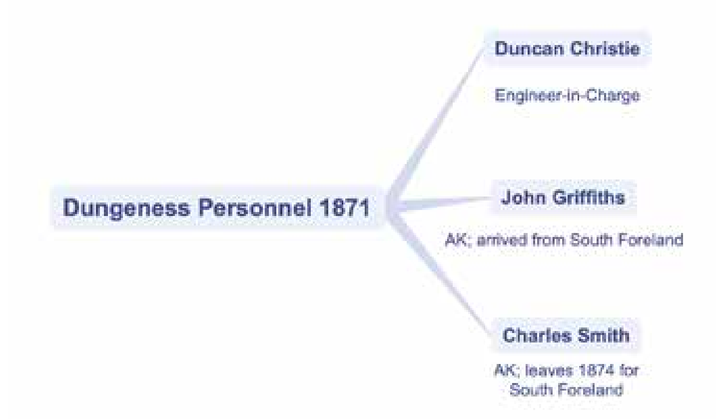
The inauguration of the engines took place three weeks beyond twelve years after the first electric beam of light shone from the lantern of the Upper Lighthouse with Henry and George Knott in attendance. That was on the 8th December 1859, only six years after Frederick Holmes had demonstrated that his design for generating practical amounts of electricity was possible. History had been made and a major step had been taken in the long history of technological innovation. Michael Faraday had died in August 1867 and Henry had been dead for 18 months. George and his brother Henry were traditional light keepers. George's sons Henry Thomas and Edmond were little different, but the truth is inescapable: they were there at the beginning of a new era for all light keepers.

South Foreland Becomes A Permanent Test Bed

South Foreland will forever carry the accolade of being the first lighthouse in the world to shine an electric light. The point that is often overlooked is that it was a temporary experiment, as it was too at Dungeness immediately following the trial at South Foreland. The first lighthouse to use electricity as its permanent and primary source of power was the brand new lighthouse at Souter Point near Sunderland which was lit on the 11th January 1871 after a considerable delay. The apparatus used was the same apparatus that had been devised by Professor Holmes and it is frequently referred to by this name, but it is a pity that Michael Faraday's role in its promotion, trial and recommendation, has been largely ignored. The original electricity-generating apparatus from Souter Point still exists and can be seen today among the exhibits at the Science Museum in London. One writer noted:

ABOVE: The lighthouse at Souter Point, Marsden - between Sunderland and South Shields. Following trials at both South Foreland (1859) and Dungeness (1861), it was built as the first fully electric lighthouse and lit on 11 January, 1871. The electric generator designed by Holmes that was installed at the time is preserved in the Science Museum (see p141).
BELOW: Souter Point lighthouse in 2012, its familiar red livery still in place since it was built.





Many lighting experiments were carried out at South Foreland between 1858 and 1885. The strongest artificial light known, Professor Holmes's magneto-electric lamp, was tested, but it was not until fifteen years had passed that the electrical system finally replaced oil (at that light). Holmes's lamp was followed by Dr. Siemen's dynamo, which was considerably more efficient. Experiments with coal gas as a source of light were carried out over a number of years, and tests were made of the efficiency of sirens and gun shots as fog signals. [9]

It was perhaps inevitable that the Trinity House Board would require some form of testbed during a period of enormous technological innovation, but until now they had been reliant on their Principal light keepers to take charge of a station. Things were now different. Engines were being installed, and engines needed someone who understood them. Trinity House needed engineers and there was now a subtle difference between a mechanical engineer and an electrical engineer, but the time had not yet come for these to be in plentiful supply. An engineer understood boilers, cylinders, pistons and valves. The engines were mechanical, driven by steam. Many engineers originated in the shipbuilding yards of the Clyde or were familiar with railway locomotives: the two boilers that had been installed at South Foreland were described by Major Elliot as being akin to that of a locomotive. When the engines at South Foreland were set in motion by the Deputy Master he referred to electric lights at Dungeness and Souter Point, and if the installations were similar then who were the men in charge? How were these two stations manned in 1871?

Henry Millett

At Souter Point the Engineer-in-Charge was Henry Millett, unusually a Wiltshire man. It is quite difficult to uncover the background to the men who had aspired to be 'lighthouse engineers,' but Millet (sic) is one who I found living with his uncle in Stratford by Bow, Poplar in 1851 and working as a millwright, a trade that was very well received among those practising mechanical engineering. His uncle was an 'iron engineer' and several neighbours advertised similar trades. Unfortunately their address in Albert Terrace is no longer listed, but may have been close to the railway works at Stratford.[10]

Christopher Comben

Millett had, as a lodger, an 18 year-old assistant light keeper named Christopher Comben (c76-77) who would arrive at South Foreland in 1876.

James Core

Lodging with one of the other light keepers was another of Henry Millett's assistants, an engine fitter named James Core. He was only 27 and from Scotland. He was about to leave Souter Point and travel to South Foreland to become its Engineer-in-Charge sometime during 1872 following the departure of Mr. Ingram.

Duncan Christie

Dungeness was the only other light station to boast an engineer who in 1871 styled himself as the Principal Engineer, no doubt copying the hierarchy of the light keepers. This was another Scotsman named Duncan Christie who shared the station with two familiar keepers.

John Griffiths

One was John Griffiths who had attracted Faraday's attention at South Foreland a decade earlier. The experience he had gained at South Foreland and Dungeness had made him of immense value, yet history would not consider him important enough to rate a mention.

9 Derrick Jackson: *Lighthouses of England and Wales*, David & Charles (1975) p76/77.

10 1851 Census HO107/1555 Folio 209 Page 9

Charles Smith

The second keeper of note at Dungeness was Charles Smith and he would bring the knowledge he had gained there to South Foreland when he arrived in 1874.

So, at this point in the narrative, 1873, four engineers were known to have served at South Foreland - Rogers, Ingram, Heath and Core whilst Millett was at Souter Point and Christie at Dungeness. This tiny group of six engineers had converted the hard work of Holmes and Faraday into a daily operation at three lighthouses around England's coasts.

The *Dover Express* added further detail of the daily reality for a light keeper at an electric light, all of whom were young men in their 20s. These were the light keepers who were expected to adjust and adapt and learn new tricks as the experiments became a part of their daily routine. Although the report covers a number of the technical facts already known, it is written in a quaint style that is worth extracting for its additional insights into the workings of the new system. Its publication came almost exactly one year from the 1872 inauguration ceremony, so there followed a lengthy summary of the history of the lights. It then elucidated the technicalities of the machinery until it reached the point where it said:

"Telegraphic communication exists between the engine house and the beacons by means of which messages are sent between the keepers and the engineers. The lanterns contain optics of the third order for fixed lights specially designed and manufactured for electric light. At sunset the attendant places the (electrical) apparatus at the centre of the lantern and having guarded his eyes with a pair of green spectacles, he communicates by telegraphic wire with the engine room on the Wheatstone principle. The moment the machinery is set in motion, a brilliant light bursts out between the two fine points of carbon nearly touching each other which are held in the apparatus lengthways and are kept in position by a delicate clockwork mechanism. Should any accident occur to the light such as a broken carbon rod, the centre apparatus is immediately removed and a duplicate substituted for it and within a minute the light is again in focus. In the event of a failure of the electric apparatus, the dioptric oil (lamp) is raised to the centre and within three minutes is burning brightly in place of the electric spark. The staff employed consists of the Chief Engineer James Core and seven assistants all of whom reside either in the cottages attached to the engine house or the light towers." [11]

This 'telegraphic communication' has not been recorded anywhere else and there is some confusion concerning the 'speaking tubes' noticed by Major Elliot on his visit to the lights on the 19th May 1873, but these were no more than 'voice pipes' used within each lighthouse, similar to those found on a steam vessel between the bridge and engine room. For the first time too, we read of the need for eye protection against the immensely bright arc light.

More difficult to explain are the **seven** assistants to the Engineer James Core. Undoubtedly one of them was Samuel Heath, an engine fitter aged 40 and another Scotsman from Dundee, but three of the five assistant keepers identified at the census were in their 20s and likely to have still been there at the start of 1873.

The Fog Returns

The report in the *Dover Express* concluded thus:

"The fog horns with which it is intended to supply the South Foreland will not be completed until the autumn of the present year. In fact there are no signs yet of them being commenced. They will be sounded by compressed air and will be heard some seven miles inland or almost double that distance at sea. Professor Holmes is the patentee of the fog horns as he is of the electrical equipment."

We have already met John Tyndall whose mind was occupied in the early 1870s with fog, this insuperable problem for mariners. South Foreland was now in the fortunate situation of being able to generate and supply steam which would facilitate the trial of various horns, sirens and whistles.

Paul Rees, writing for the National Trust[12], has seen the reports submitted by Tyndall that describe what was tested, but after two comprehensive tests in May and October 1873 the results were inconclusive. Two sites were used at the top and bottom of the cliff, because there was a very convenient vertical shaft that had been used by a telegraph cable laid across the Channel from France. This allowed a 2½ inch (63 mm) diameter steam pipe to be laid to each location. At the top of the cliff two horns of enormous size were mounted. They were over 11 feet (3.3 m) long with a diameter at the mouth of almost 23 inches (584 mm) and when steam pressure was applied it vibrated a reed inside.

11 *Dover Express*, 3 January 1873

12 SFL/CMP Pages 151-53.

To these trumpets were added two locomotive steam whistles that had been manufactured to a much larger scale. One was 6 inches (150 mm) in diameter and the other one was 12 inches (300 mm), which required a considerably higher steam pressure to operate. At the base of the cliff the two horns were of similar dimensions, but mounted vertically with the horn turned through 90˚ to face out to sea and to them was added the 6-inch steam whistle.

With best scientific practice three cannons were brought to the cliff top from Dover Castle and manned by gunners loaned from the Royal Garrison Artillery. These were the fog signals favoured by Trinity House, so it was only right that they should be available for comparison.

On the 8th October a steam siren that had been patented in America was imported and mounted for trial as it had been adopted for use in the United States Lighthouse Service and I suspect that Major Elliot's visit in May of that year may have had a bearing on that decision. However, Paul Rees could find no evidence that Frederick Hale Holmes's patent siren was ever used at South Foreland in spite of the suggestion in the *Dover Express*.

At the conclusion of these experiments all the equipment was dismantled and removed much to the relief of the keepers' families and the local inhabitants. The attendants no longer needed to negotiate 12 flights of ladders, like Cornish copper miners, descending 50 fathoms (91 m) to reach the base of the cliff. But if some people were relieved, there were others who would curse the absence of a fog warning signal at the South Foreland. It is ironic that the next incident should occur immediately beneath the lighthouses. Perhaps the indecision concerning their installation at South Foreland played a part in the stranding of the *Ellen Stuart*, but it was most likely to have been simply … Fog.

DENSE FOG OFF THE FORELAND VESSEL COMES ASHORE BENEATH THE LIGHTHOUSES

Saturday 30th May 1874

The iron vessel *Ellen Stuart*, Captain Calvert, of Liverpool, 1572 tons burden, and bound from Calcutta for London went ashore in dense fog in Fan Bay, just under the South Foreland Lighthouse, at about 5 o'clock on Sunday evening. She came up the Channel under easy canvas, soundings being made every five minutes. The anchor was let down in nine fathoms of water but did not hold. Attempts were made to get her off by means of tugs, but without avail, and a Deal lugger took out an anchor for the ship receiving £100 for the job. The attempt to get the vessel off by this means also failed and she was soon surrounded by Deal boatmen, all of whom prognosticated that the ship must be lightened and, of course, offered their services. These, however, were refused by the captain and on Monday evening his ship was safely got off uninjured, with the aid of London steam-tugs.

The fog which prevailed on Sunday and Monday was one of the densest known in the Channel for some time, and it is rather singular, that at a time when they were most wanted, the fog horns at the Foreland were not there, the consequence being that the *Ellen Stuart* went ashore just under the lights.[13]

During the 1870s there were many newspaper column inches devoted to collisions and strandings off the South Foreland that culminated in disputes concerning seamanship and claims for compensation. Every collision demanded a court of inquiry. These were usually conducted by the Admiralty Courts to which the Trinity Board contributed through its legally trained Elder Brethren. Sometimes cases were taken to the High Court and there was one such claim in January 1880 with fog as a significant issue.

The collision occurred at 6 pm, four miles off Folkestone between the *Bokhara* carrying iron rails from Antwerp to New York and the steam ship *Milanese* carrying cattle from Boston to London. The bow of the steam ship struck the starboard fore quarter of the sailing vessel which promptly sank, fortunately without loss of life. Inevitably there was a dispute concerning the right of way of the sailing vessel and the speed of the steam ship in poor visibility. As part of the evidence all the log books in the vicinity were consulted with the following result. Sunset had been at 4.17 pm and the night was unusually dark. At South Foreland High Light, 8 miles (13 km) away, it was overcast, misty with drizzling rain. At the Low Light it was cloudy and misty. At the Dungeness Light, 13 miles (21 km) from the collision, it was overcast, misty and drizzling. The lightships at the Varne and South Sands Head had also been consulted, and, although the foghorn had been sounded after sunset by the latter vessel, the weather had cleared by 6 pm. Eye witnesses gave varying opinions and the court concluded that the evidence was 'unreliable' and could not be considered – such was the nature of fog[14]

13 *Whitstable Times & Herne Bay Herald*, Saturday 30th May 1874.

14 *Shipping & Mercantile Gazette,* 23 January 1880.

Charles and Anne Smith

Dungeness was Charles Smith's first light station after joining Trinity House. Whether there was any special reason for sending him to an 'electric lighthouse' is not apparent. He had been born at Hakin near Milford in Pembrokeshire in 1845 (2Q). Smith had arrived at Dungeness with his young family by April 1871 when we learn that his wife, Anne, was only 21 and their first son, also Charles, was just 1 year-old. The boy had been born in Cardiff, where his mother had been born, so it is apparent that she had remained at home whilst her new husband was in training at Blackwall. There were two birth registrations in Cardiff for a boy named Charles – 1869/3Q and 1870/1Q – both of whom would have made him about 1-year-old. However, their second child was a daughter and Amelia Mona was registered in Dover in 1871/3Q indicating the date of their arrival at South Foreland. This is considerably earlier than has been suggested by others who also believed that he stayed at the light until 1879 when he moved to Nash Point in Glamorgan, not far from Cardiff. Charles's common surname has made it impossible to locate a marriage from which Anne's maiden name would be revealed and that is a great pity as so much more could have been learned about their background.

Samuel and Helen Hast

Another young keeper who would share the decade with Charles Smith was Samuel Mayor Hast (1872-84) who was only 25 when his first child was born at South Foreland during the first weeks of 1875. In 1871 Samuel was a steward on the SS *Great Yarmouth* among a crew of 17 on board that night. Nine of them, including Samuel, hailed from Harwich in Essex. It was not a life that suited him and within two years he had joined Trinity House and was to be found at the training establishment on the Thames in Poplar. It was here that he brought his sweetheart Helen Elizabeth Thompson from Great Yarmouth to be married in Poplar towards the end of 1875 when he had successfully completed his training as a light keeper. This information would seem to negate any suggestion that he was the Principal at the light, but one thing was certain: he stayed at South Foreland for about ten years and, together with Smith, they would share the activity involved in the next series of trials.

In 1881, the Lizard Light had been electrified and James Core had left South Foreland to take charge of it. That electrification began here at South Foreland during the dark months of 1876-77 with James Core in charge. South Foreland had been in operation with Holmes's magneto generators for five years and their reliability was not in doubt, yet it was gradually realised that they were losing output due to a deterioration in their permanent magnets. This was an opportunity to try other, newer machinery that had been developed during the intervening period. These trials, briefly mentioned by Jackson, were completely ignored by the press, but a recent account by the National Trust, although detailed in some respects, is lacking in others and I will explain.

Two manufacturers were chosen to supply two machines each: the German manufacturer Siemens and a French manufacturer named Gramme. The Holmes machines had also come in pairs, one pair for each lighthouse, but was that the intention here? It is not said. As large machine-shops proliferated across the industrial Midlands and the North of England, it was common to see many machines standing together driven by belts from overhead shafts with the engine source often in another, separate location. This had been replicated in miniature at South Foreland's engine house, so a new machine just needed to be bolted to its bed and belted up to its overhead shaft. Yet that was not as simple as it sounds. Was one machine used or both? Could all four be bedded down together or not? There is no description of this aspect of the trial beyond the date of their installation – 21st November 1876.

New machines were used to power one of the existing electric arc lamps whilst a standard 6-wick colza oil lamp of 722 candle power was used as a comparator and measurements were taken from both ashore and afloat. It must be assumed that the oil lamp was the standby oil lamp in the Lower Light that had been placed in its operational position. There had been no criticism of the performance of the Holmes generators, but Douglass was intent on seeking commonality that could be transferred to other stations. His role as Engineer to the Trinity Board demanded that he seek reliability with economy.

When the trials ended on the 7th April 1877 the Siemens machines were in good working order. They were capable of producing twice the light output per horse power of the Holmes machines. They were smaller and cheaper and Tyndall recommended them to the Board.[15]

Electricity or Electrickery?

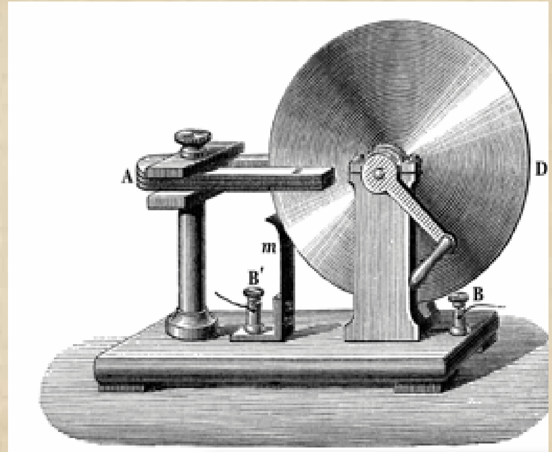
To many eyes, the creation of electricity is magical. Even today, most of us take it for granted and have little idea where it comes from beyond a socket in the wall, or a battery. Let's get the battery out of the way first.

A battery is simply a container of metals and chemicals with two 'ends', 'sides' or - more correctly - poles. One is positive and one is negative. When wires are connected to each of the poles such that a circuit is formed (perhaps containing a light bulb) a current of electricity flows from one pole to the other. We know today that current is actually negative electrons in motion and they are released from the negative pole and travel towards the positive pole. (Inside the battery, this emission of electrons causes chemical reactions that deplete the ability of the battery to supply electrons indefinitely and the battery eventually goes flat.)

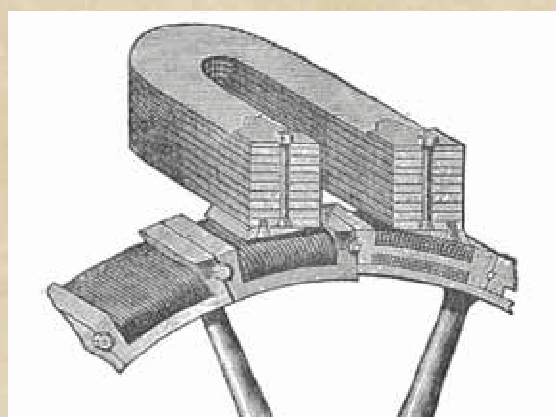
Sadly, before scientists could identify the exact nature of the current they had to choose between electricity being either positive or negative charges. They made the wrong choice! They decided that current was positive, and it is still the convention to talk of positive current flow from positive to negative, even though it is wrong! On most occasions when current flow is mentioned it refers to conventional current unless explicitly stated otherwise. Whether positive or negative, the current flows only in one direction and is called direct current (dc). The voltage from a single battery is almost never greater than 2 volts - chemistry doesn't allow it. Multiple batteries are used to make larger voltages.

Most electrical devices are designed to operate having current flow in one direction only, but, apart from the battery, the generators discussed here create alternating current (ac) in which the current changes direction many times per second. To make the early lights in lighthouses, dc current was required and so further invention was needed to convert ac into dc. Another device called a commutator was necessary.

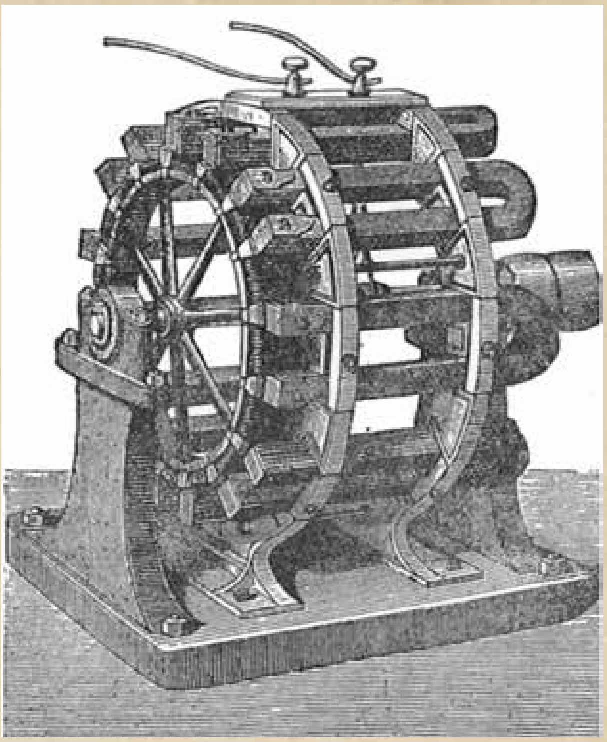
In the days of Faraday, the relationship between electricity and magnetism was not properly understood, but Faraday showed that rotating motion between metals and magnets caused electrons to flow. Faraday used a disc rotating over the poles of a horseshoe magnet and, as a first attempt, it looked like magic. It was also impractical as anything other than a scientific demonstration, but it was a start! This remains the fundamental principle of electricity generation. Even today in a power station turbines made of coils of wire and magnets rotate at high speed to make the power we rely upon. The only major differences are in the method used to rotate the shaft of the turbine. Steam power has been the method of choice since the start of the industrial revolution, but falling water also works, as in hydro-electricity. Any heat-producing process can work. Even a nuclear reactor - complicated though it is - is just a way of boiling water for steam.♦



ABOVE: The Faraday disc of 1831 was the first electromagnetic generator. The copper disk (D) rotated between the poles of a horseshoe-shaped magnet (A), creating a potential difference between the axis and rim. If an electrical circuit such as a galvanometer was connected between the connectors (B) and (B') the motion induced a radial flow of current in the disk, from the axle toward the edge. The current flows into the spring contact (m) sliding along the edge of the disk, out of connector (B') through the external circuit to connector (B) , and back into the disk through the axle. Turning it in the opposite direction reverses the direction of current. The Faraday disc was an inefficient generator because counter-currents flowed back through regions of the disk outside the magnetic field. Émile Alglave & J. Boulard: The Electric Light: Its History, Production, and Applications, translated by T. O'Conor Sloan, D. Appleton & Co., New York, (1884) p.224, fig.142 [Public domain image]



Above: Principle of rotation of coils over magnets in a magneto alternator (Rankin Kennedy, Electrical Installations, Vol III, 1903)



ABOVE: A 19th century permanent magnet ac generator made by de Meritens (Rankin Kennedy, Electrical Installations, Vol III, 1903)

ABOVE: A magneto generator of 2kW made by the Société de l'Alliance around 1870.

The Electric Light In Lighthouses.

[Extracted from *The Engineer*, Oct. 26th, 1877, p302]

A series of trials intended to determine the relative value of different systems of producing the electric light by the aid of electro-magnetic machines, has been carried out at the South Foreland light, under the direction of Professor Tyndall and Mr J N Douglass, CE, acting for the Trinity House. The results of these experiments are set forth in the following report, which explains itself:

Royal Institution, November 27th, 1876

Sir,

I beg to inform you that on the 21st of this month I had the honour of accompanying to Dover the Deputy Master and a committee of the Elder Brethren of the Trinity House, with a view to observing from the sea the comparative action of the magneto-electric machines now mounted at the South Foreland. The machines experimented on were the following: (1) Holmes machines, which have been already established for some years at the South Foreland (2) Gramme machines (3) Two Gramme machines coupled together. (4) Siemens' large machine (5) Siemens' small machine.

Observations afloat – The Corporation's steamer Galatea was employed in these observations, the position first chosen being not far from the Varne light, and at a distance of 11½ miles from the lighthouses on the Foreland. Observations were subsequently made at various other distances.

In the first place, the new machines sending their currents to the Low lighthouse were compared in succession with Holmes machine, which produced its light in the high lighthouse. Subsequently the new machines were pitted in pairs against each other, one of the two being in the high and the other in the Low lighthouse.

Care was taken in each instance to reverse their positions. Thus, whenever Siemens below was compared with Gramme above, the observation was immediately followed by a comparison of Siemens above with Gramme below, and so of the others. All irregularities arising from differences in the apparatus employed above and below were thus eliminated.

Briefly expressed, the following are the results of our observations on the nights of the 21st and 22nd of November:

(1) The new machines mark a great advance, both in economy and power, as regards the application of the electric light to lighthouse purposes.

Thus the machine of Holmes, which reflects great credit upon its maker, was found practically equalled by a single machine of Gramme, of considerably less volume and considerably smaller cost. This discrepancy as to cost and volume was still greater in the case of the small Siemens machine, which yielded a light sensibly equal to that of Holmes. I am not sure that this equality exists in all azimuth, for it was only towards the end of the observations that I learned that directions had been given to place the carbons of Gramme and Siemens in their best position. The section of this report entitled observations ashore will throw more light upon this point. The size and expense of the small Siemens machine are only fractions of those of Gramme, while the size and expense of Gramme are only fractions of those of Holmes. I was verbally informed by Mr Douglass that the relative cost of the small Siemens and the Holmes is as 1 to 10, the price of the former being £75, while the price of the latter is £750.

(2) The comparative merits of the single Gramme and the small Siemens is indicated in the foregoing paragraphs. They are sensibly equal to each other, both of them producing an exceedingly fine light.

I was particularly impressed by the performance of the small machine of Siemens. Its power, in relation to its size, is surprising.

(3) A large machine of Siemens, however, greatly transcends both his small machine and the single machine of Gramme. The Elder Brethren may accept, as closely approximating to the truth, the statements that the large machine of Siemens is sensibly equal to the 2 Gramme machines coupled together.

The light from the large Siemens, as also that from the two coupled grams, is of extra ordinary splendour.

In point of cost, however, the advantage rests with Siemens; for, whereas the price of his large machine is £265, the price of the two Gramme machines, producing the same light, is, as Mr Douglass informs me, £600.

The Gramme machines employed in these experiments were constructed in the workshops of Mr Robert Sabine. The French constructors of these machines have, I believe, found it difficult to send the currents from two of them through the self same lamp. This difficulty was successfully overcome by Mr Ross, the agent of Mr Sabine, at the South Foreland. The augmentation of light by the coupling together of the two Grammes was very great.

If the union of two small Siemens machines would produce an augmentation of the light similar to that obtained from the union of two Grammes, the employment of two such small machines would be extremely handy and economical. With a view to obtaining information on this head, I called upon Mr Carl Siemens, and learnt from him that, so far as he knew, no experiments had ever been made with the two machines acting together. He promised, however, to clear up this point by writing to his brother in Berlin; and, as soon as his answer reaches me, it shall be communicated to the Elder Brethren.

The heating of the coils by the induced currents is a point still to be determined, by subjecting the machines to long continued action. So far as I can judge from the experiments at the South Foreland, the heat developed in Gramme's machine is certain to be of no account, while in the machines of Siemens it is unlikely to be injurious.

In recording the observations made on the 21st and 22nd, numerical values, as the committee are aware, were assigned to the different lights. I have not thought it necessary to introduce such numbers here. They constitute a concise and convenient mode of recording equalities and differences; but, regarded quantitatively, they would, in my opinion, be but poor approximations to the truth. The time for numbers will arrive when the contemplated photometric comparison of the lights has been executed.

Siemens' and Gramme's inventions undoubtedly place at the disposal of the Elder Brethren electric lights of surpassing energy. Combining either the large machine of Siemens, the two Gramme machines, or, if practicable, the two small machines of Siemens, with one of the group flashing dioptric apparatuses which have been recently devised by Dr Hopkinson, a light transcending in power and individuality all other lights now existing would probably be obtained. Such a light would displace, with enormous advantage to the mariner, the two lights hitherto displayed at the Lizard. A fixed light, even should it be the electric light, at a distance is not to be distinguished from a ship light or an ordinary shore light near at hand. A few evenings ago, for example, I was unable to distinguish one of the Forelands lights from the lights of a lantern on the beach at Dungeness. Distinctiveness is sure to be more and more insisted on, as an essential feature of the lights of the future. It would not, therefore, in my opinion, be a wise application of the extraordinary means of illumination now at our disposal to copy the old arrangement at the lizard, by placing their two fixed electric lights, instead of the more powerful, more distinctive, and less expensive group flashing light to which I have above referred. (The character of the light to be exhibited when the electric system should be introduced at the Lizard has been discussed and determined in 1874 –5, and the lanterns, optical apparatus, and other costly items of the new outfits, were already completed when this report was received. The board, however, brought the question again under review, in connection with the above observations, and in the results confirmed their resolution to retain the distinctive character now belonging to the lights at Lizard.)

Observations ashore - On the 22nd of November we visited the South Foreland, inspected the arrangement of the machines, and observed their light producing power close at hand. Here the only points I have to submit to the Elder Brethren are the following:

In both Siemens' and Gramme's machines the induced currents are sent in a constant direction. One of the carbons is always positive and the other always negative – not alternately negative and positive as in the machine of Holmes. The positive carbon is heated more intensely, and it wastes more rapidly than the negative one; its shape, moreover, is a point of some practical importance. From the positive to the negative carbon there is a transfer of particles which usually produces a crater-like hollow in the positive carbon. The concave surface of this crater is the place of most vivid incandescence, and it is easy to see that the radiation from that surface, when the positive carbon is the higher one, as it is in the arrangements at the South Foreland, would be directed to the earth. To obviate this inconvenience, the negative carbon is usually somewhat displaced, so as to cause the most vivid incandescence to occur on one side of the positive carbon. The portion of space towards which this side is turned receives from it a greatly augmented radiation. But the radiant power this concentrated on one side is withdrawn from the other, which would be inadmissible if a whole circle had to be uniformly illuminated. In most cases, however, only a portion of the entire circle is required; and no disadvantage arises from the weakening of the landward radiation. If no valid mechanical grounds oppose the alteration, it would, I think, be a decided advantage to make the lower carbon the positive one. Its upward radiation would be utilised by the upper prisms to a far greater extent than its downward radiation is now utilised by the lower ones.

It is proposed that a month's trial be given to the machines at the South Foreland. I would add that the trial would be rendered complete by observing the lights in all attainable azimuths, both when the carbons are in the same vertical plane, and when the negative carbon is displaced so as to give a preponderant outflow of light in a spatial direction.

The remainder of the report refers to fog signal experiments.

Robin Allen Esq

John Tyndall♦

FIG. 1

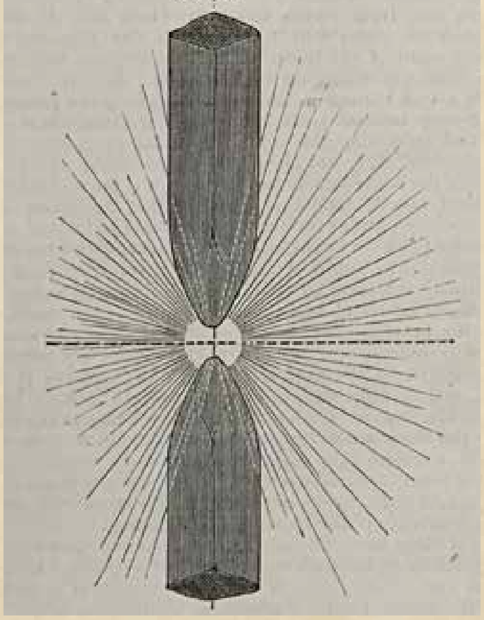


FIG. 2

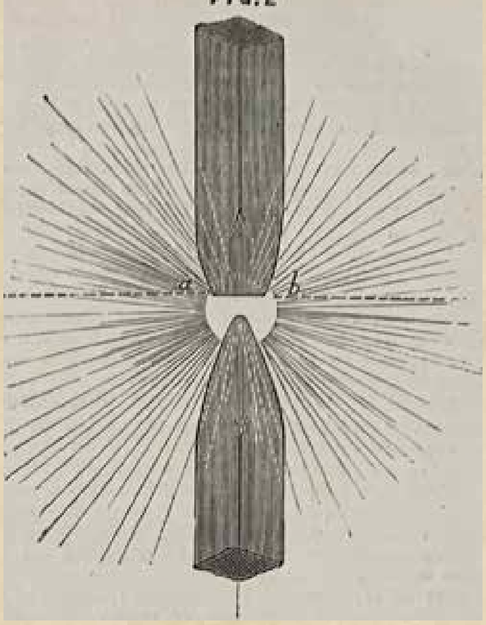
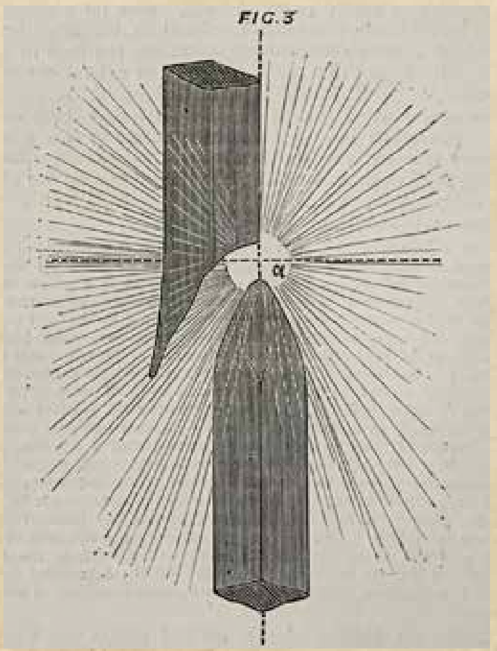


FIG. 3



Electric Light Experiments, South Foreland
Trinity House, 23rd April, 1877.

[Extracted from *The Engineer*, Oct. 26th, 1877, p302]

Sir,

Referring to the comparative trials which have lately been made at the South Foreland for the purpose of determining on the description of electric machines to be adopted at the Lizard, I beg to submit the following report.

In November last there were submitted for trial by Messrs Siemens Brothers two of their large and small dynamo-electric machines, numbers 1 and 58. There were also submitted by the British Telegraph Works Company two of their dynamo-electric Gramme machines, both of the same size, right and left-handed, numbers 1 and 2.

These machines were all erected in the engine room at the South Foreland, with the aid of an assistance from each firm, and tested by me on the 21st of November last, Messrs Siemens Brothers being represented on the occasion by Mr Risch and Mr Ebel, and the British Telegraph works company by Mr Ross; and arrangements were made for exhibiting the lights in the lantern of each Lighthouse, after sunset, in accordance with a programme which had been previously arranged by Dr Tyndall. Two series of observations were to be carried out from 8 to 11 pm. Each series was pursued in the following order:

High Lighthouse	Low Lighthouse
Holmes	Siemens No. 1
Holmes	Siemens No. 2
Holmes	Gramme
Holmes	Gramme
Gramme	Siemens No. 1
Siemens No. 1	Gramme
Gramme	Siemens No. 2
Siemens No. 2	Gramme

Each comparison lasted 10 minutes, the result being recorded in figures relatively to the lights from the High tower, which in every case was taken as five. The observations were made afloat from the Galatea, by a committee consisting of the Deputy Master, Captains Drew, Atkins, and Ladds, accompanied by Dr Tyndall, Mr Edwards, and myself.

The observations of the committee have been duly recorded.

On the following morning the committee visited the South Foreland and witnessed a trial of the machines thereat, and in the evening the observations afloat were repeated. I may, however, observe that much reliance is not to be attached to these or the previous nights observations, owing, first, to the want of experience in the manipulation of the machines and lamps, and secondly, to the fact, afterwards discovered, of a larger loss occurring in the intensity of the light in transmitting the currents of the new machines through the conducting cables of the establishment from the engine room to each lantern, a distance of about 694 feet to the High lantern and 592 feet to the Low lantern, than with the Holmes machine.

From the preliminary trials made with the new machines the number 58, or smaller sized machine of Messrs Siemens Brothers, appeared to be a more suitable one for lighthouse work, if used in combination with a duplicate machine during states of the atmosphere unfavourable for the transmission of light, than their number 1 machine. Messrs Siemens Brothers were therefore requested to furnish a second small-sized machine for the trials. In the meantime the assurance had been obtained from the competing firms thats the arrangements for the trial of the machines in charge of the engineer and light keepers at the South Foreland for regular lighthouse work were quite satisfactory. On January 15th last I dispatched Mr Ayres to the South Foreland, for the purpose of completing the arrangements for taking photometric measurements of the light produced by each machine, and the amount of hp absorbed in rotating it. On the 17th I joined Mr Ayres at the South Foreland when I found the arrangements all completed, and some preliminary measurements taken of the intensity of the light produced by the machines, and the horsepower absorbed in rotating them.

For the photometric measurements of the light, the flame of the Trinity House six-wick lamp, when consuming colza oil, was adopted as the standard. This lamp was placed at a distance of 100 feet from the electric lamp and the measurements were taken by a Bunsen photometer. The six-wick lamp was maintained, as nearly as practicable, at its intensity of 722 standard candles, and this intensity was checked from time to time by candle measurements taken with a separate Sugg photometer.

The adoption of the powerful flame of the six-wick lamp for the measurements of the intensity of the electric light has been found to materially facilitate, and add to, the certainty of the operation. The white colour of the flame of this lamp, compared with that of the English standard candle, or French standard Carcel lamp, is greatly in its favour for the purpose.

With reference to the method adopted for determining on a mean value of the electric light for lighthouse illumination a brief description would here appear to be necessary. With the magneto-electric machines in use at the South Foreland and Southern Point (Lizard) the currents are alternating, and the points of the upper and lower carbons are consumed at an equal rate; moreover, they both partake of the same pointed form, as shown in the margin, Figure 1. The form of these carbon points is very favourable for utilising a maximum vertical angle off the light; and horizontally the light is sent nearly equally in every direction, which for lighthouse purposes is not always required, as it more frequently happens that the sector of sea surface to be illuminated does not exceed 180°. In these cases the rear light is either wasted, or is utilised, as far as practicable, by special auxiliary optical apparatus. With the dynamo-electric machines of Gramme and Siemens the current is continuously in one direction, viz, through the top carbon to the bottom one. The top carbon is thus consumed at a greater rate than the bottom one, and a crater is formed in the top carbon, as shown in the margin, Figure 2. It will thus be seen that a portion of the light is prevented from being fully utilised in the extreme upper prisms of a dioptric apparatus by the edge a-b of the crater. In order to avoid this loss, and obtain the maximum of light from the carbon, they are usually so placed in the lamp that the axis of the bottom carbon is nearly in the same vertical plane as in the front of the top carbon, as shown in the margin, Figure 3. This arrangement has the effect of sending a condensed beam of light of maximum intensity in one direction, and moreover the light is much steadier than with any other arrangement of the carbon points, in consequence of the current through the upper carbon being held steadily at the front edge a. I have found with this arrangement of the carbons, and assuming the intensity of the light with the carbons having their axis in the same vertical line to be represented by 100, the intensity of the light in 4 directions in azimuth, say east, west, north, and south, will be nearly as shown in the margin, Figure 4.

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FIG. 4.