Brilliance & Prejudice – Part One
The Inventive John R. Wigham

By Thomas A. Tag

Introduction

This is the story of a brilliant engineer who created some of the most interesting lighthouse equipment ever developed. His designs would be both praised and maligned and would lead to jealousy, conflict, prejudice, plagiarism, and the ultimate resignation of one of the leading scientists of the day. Part Two will appear in the next issue of *The Keeper's Log.*

Background

Our story begins in Scotland in the year 1829 when John Richardson Wigham was born to Quaker parents in Newington, a part of Edinburgh. John attended school in Edinburgh until age 15 when he was sent to Ireland to work as an apprentice for his brother-in-law Joshua Edmundson. Joshua owned a firm that worked in iron, brass and tin as well as paintwork known as Japanning. The firm was named Edmundson & Co. and was located on Capel Street in Dublin. At the time John joined the company it had just started production of small coal-gas generation plants that could be installed on the estates of the landed gentry of Ireland to produce gas used for lighting. These gas generators were very effective in areas where gas mains were not available.

John Richardson Wigham (1829-1906). Photo Courtesy Wigham Collection.

Unfortunately, on January 26, 1848, only four years after the start of John's apprenticeship, his brother-in-law died suddenly. John was only nineteen, and was forced to take over the operation of the firm for the support of Joshua's family and himself.

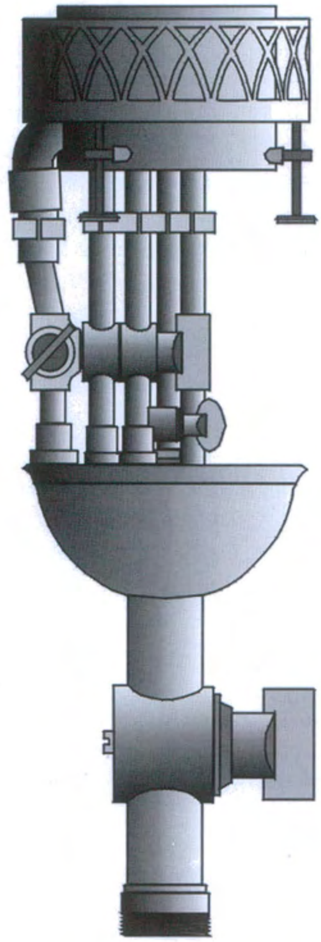
John Wigham proved to have excellent business acumen and was known for his Quaker trait of honest dealings. The demand for coal-gas generation plants allowed the Edmundson Company to thrive over the ensuing years. John concentrated on new and more efficient gas-plant designs. He also became an engineer and shareholder in the Commercial Gas Company of Ireland, which developed large town-sized gas plants.

Wigham later became a Director of the Alliance & Dublin Gas Company and the Dublin United Tramways.

Coal Gas Use in Lighthouses

The first reported testing of coal gas was made by the Trinity House in England in 1780. In France, Monsieur Phillip Le Bond d'Hambersin was given a patent for producing illuminating gas from wood in 1799, which was made by carbonizing wood in a closed retort. He called his invention the Thermo Lamp, used at the Le Havre Lighthouse in France that year. In America, David Melville built a coal-gas plant at the Beavertail Lighthouse at Newport, RI in 1817. Although a success, the trial of coal gas at the Beavertail light lasted just one year because of the strong opposition to the use of gas by Winslow Lewis and the whale oil industry, so it was never used to any extent in America. In 1818, coal gas was first used in Italy at the Salvore light near Trieste by Giovanni Aldini.

Oil gas was first employed at the Holyhead Lighthouse in Wales in 1820. From 1819 to 1827 Fresnel and Arago experimented with the use of gas burners for use within the new Fresnel lenses. In the end, they chose to continue with the use of their multi-wick oil lamps. Also in 1823, another form of oil gas made by Pintsch was tried at the South Foreland Lighthouse in England. All of these early experiments with gas used single-tube or multiple-tube burners.

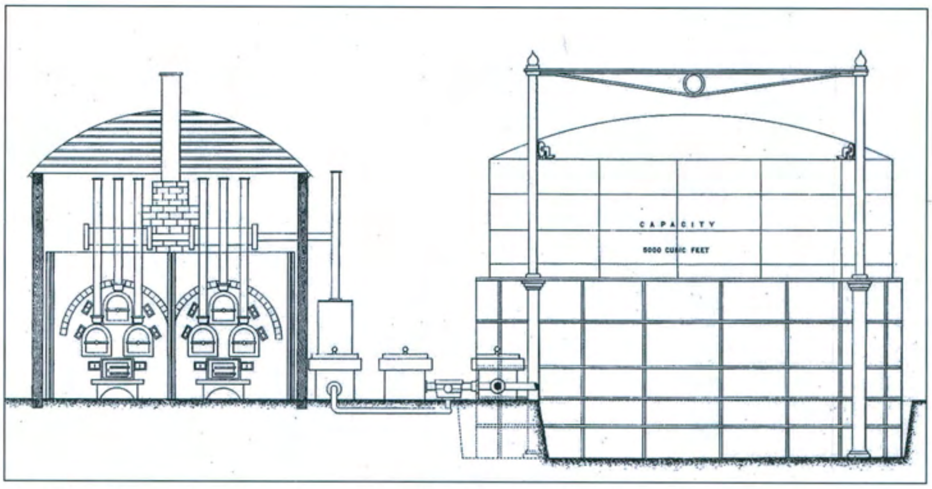


The Fresnel–Arago Gas Burner 1824. Drawing by author from drawing in *Oeuvres Completes de Fresnel*.

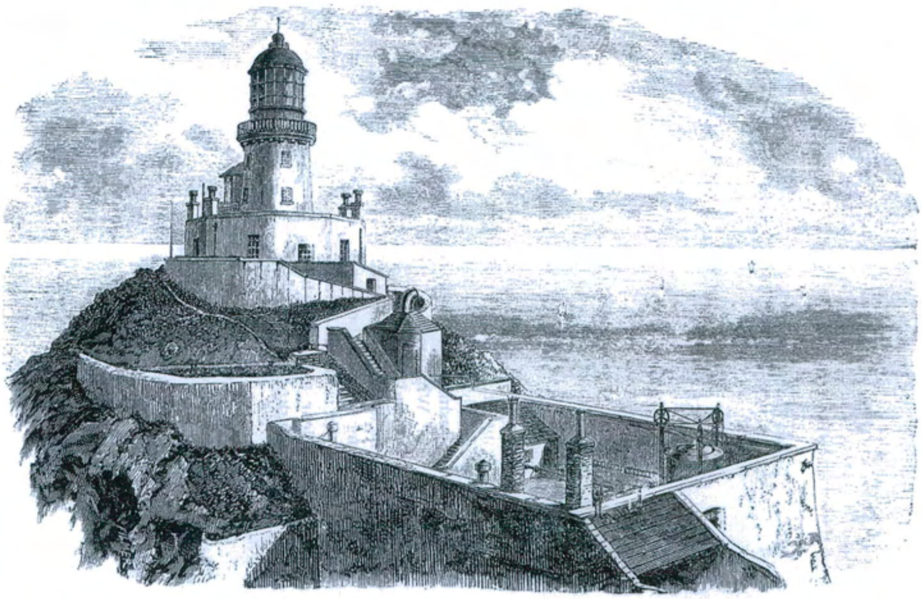
A lighthouse built on Lake Erie in 1829 known as the Barcelona light, or sometimes the Portland light, was unique because of its fuel source. The nearby town of Fredonia, NY was the first site in North America to commercially use natural gas, starting in 1821. The Barcelona Lighthouse was located 18 miles west of Fredonia and, for part of its life, it used a nearby 'spring' of natural gas carried a distance of two miles in pipes to the tower to light its lamps. Unfortunately, the natural gas gave out in 1838 and the gas lamps were removed.

In 1837, coal gas was used in the pier light at Troon, England, and in 1847, in the lighthouse at Hartlepool, England with a newly designed burner by Mr. McNeil. While coal gas generated a bright flame and was relatively inexpensive, it was difficult to produce because it required the erection of a complete gas-production plant at each lighthouse. It was never very popular outside Ireland and was used at few lighthouse locations.

An effort was made in 1841 to use another form of wood gas known as rosin gas, at the Christina Creek Light Station, near Wilmington, Delaware. Rosin gas was made through the heating of pinesap (rosin) or pine logs in a retort (an enclosed vessel). After about a year of trial, the effort at Christina Creek was abandoned as impractical.



The Wigham cannel-coal gas generation plant. Drawing from the author's collection.



Baily Lighthouse Howth Head. Note gas-holding tank in far right corner. Drawing from the author's collection.

A Wigham lighted buoy of a later style. Photo from the author's collection.

The Lighted Buoy

In 1861, Wigham patented one of the first successful lighted buoys, which was installed on the River Clyde, in Scotland.

At the end of 1863 John Wigham, representing the firm of Edmundson & Co., sent a letter addressed to the Ballast Board of Ireland. In it he suggested that a lighthouse flame far superior to any obtainable from oil could be yielded by gas distilled from oil. In the oil burner the oil was vaporized by the heat of the flame, while the new proposal was to convert the oil into gas in a retort prior to its ignition in a new high-power gas burner. He wanted the Board to fund, or at least agree to test, his design if he developed such a burner. A small grant in aid of the experiments was sanctioned by the Board. There was a considerable period of experimentation before a burner fit to cope with this gaseous illuminant could be produced. In early 1865, John Wigham completed the design of his high-power 'crocus' burner, which had 30 fish-tail gas jets formed in a large cluster. The power of this burner was obtained not only by the clustering of a large number of fish-tail gas jets, but by suspending a kind of funnel, called an oxidizer, above the collective flame of the jets. The oxidizer enhanced the amount of oxygen at the tips of the flames by burning the remaining carbon in them; this greatly increased the brightness of the flames. The experimental evidence in favor of gas, as compared with oil, was so overwhelming that the Ballast Board of Ireland and the Board of Trade in England sanctioned the use of the new illuminant in a lighthouse.

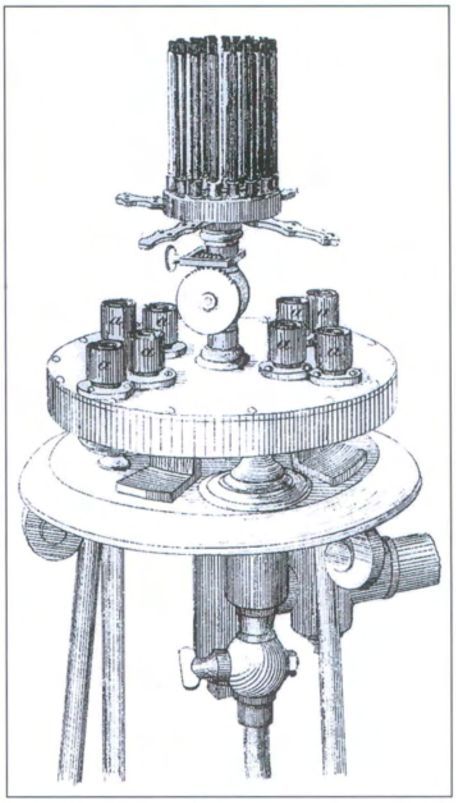
Wigham's 'crocus' burner was first used at the Baily Lighthouse on Howth Head (known as Howth Baily) near Dublin, Ireland at the end of June 1865. It was measured as being four times more powerful than the standard 4-wick oil burner then in use. It was named the 'crocus' burner by a member of the Irish gas committee who was a florist and thought he saw a resemblance in shape between the burner's flame and a crocus flower. The crocus design was very short lived. It was used solely at Howth Baily Lighthouse and for only about three years.

The first gas Wigham experimented with was made by heating oil in a retort. Later he used shale, and still later, he used Stockwell-Cannel Coal in the retort, which produced a much richer gas flame. At each lighthouse a gas generation plant was built that consisted of a furnace building housing the gas retorts. While expensive Cannel coal was used to produce the gas, the retorts were heated by a cheaper kind of coal, or by the tar produced during the gas-making process. The ordinary operation of gas making had to occur daily, with great attention paid to the purifying process. The resulting gas was then sent to a large gas-storage tank that was known as the 'gas-o-meter'. Mr. Wigham later recommended the use of ordinary gas enriched by passing it through naphthaline or albo carbon, whereby its illuminating power or intensity was approximately doubled.

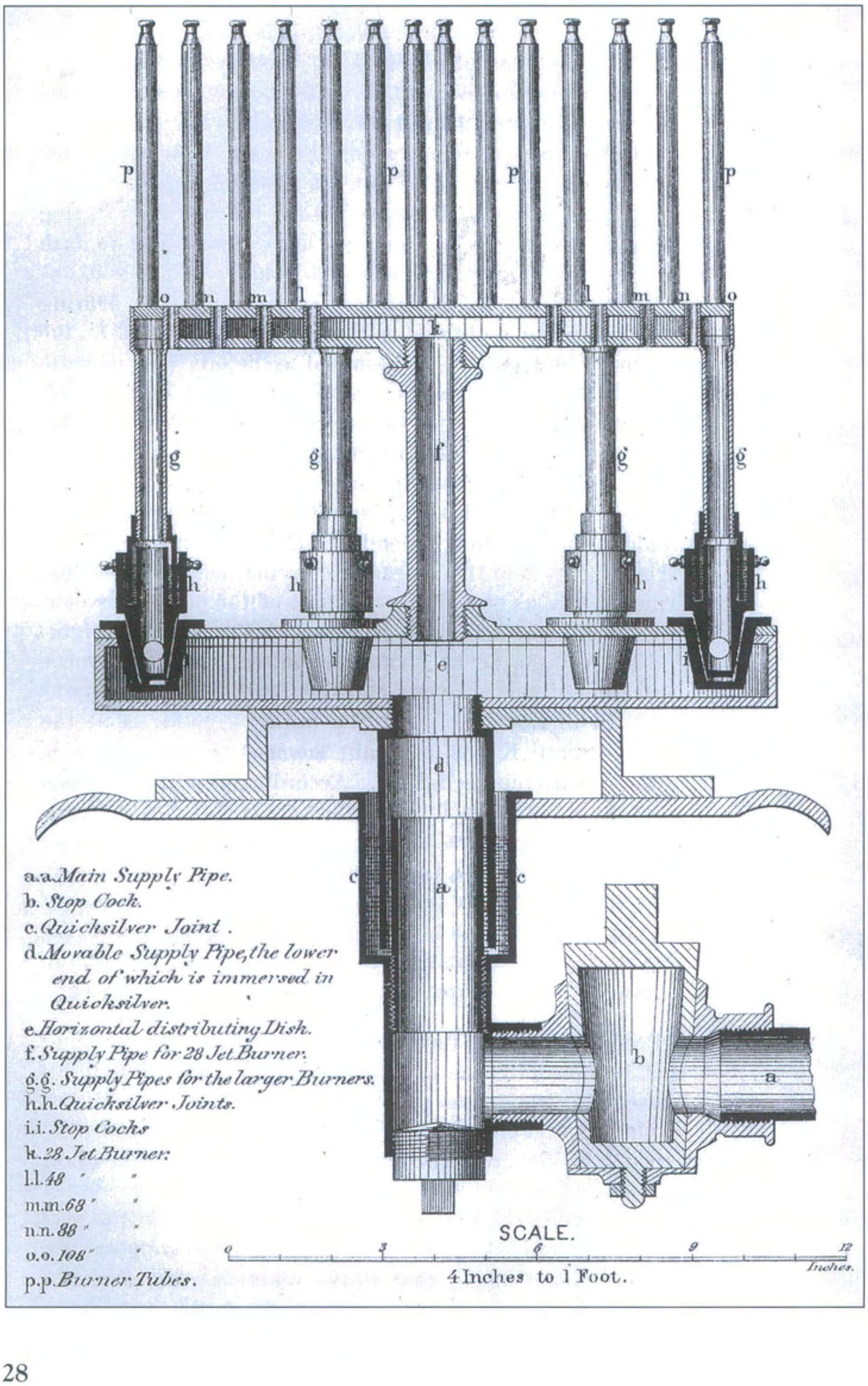
The Composite Burner

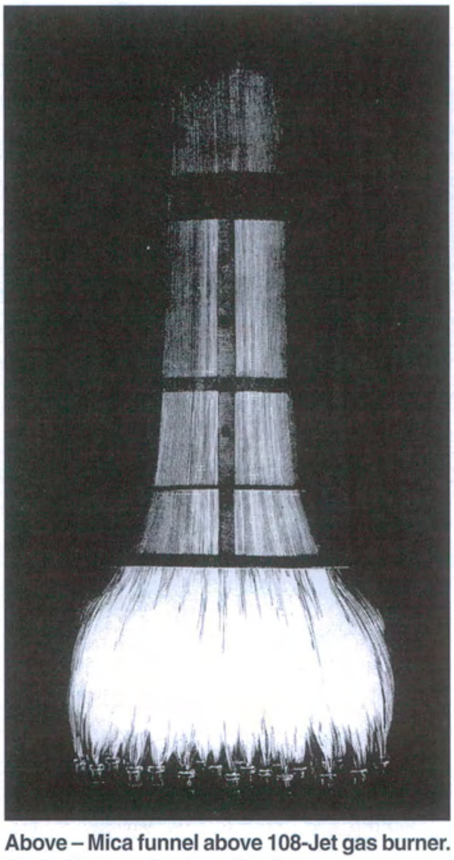
Wigham produced a more powerful 'composite' burner in the autumn of 1868. The 'composite' burner had an inner group of 28 jets with outer rings of 20 jets each, allowing a total of 108 gas jets. When fully configured to 108 jets, the burner produced nearly 3000 candle power.

The lamp consisted of a horizontal hollow-circular disk about one foot in diameter, supported upon a stand and into which the tubes supplying the burners were connected by joints sealed with mercury.



The 28-jet burner. Drawing from the author's collection.





Above – Mica funnel above 108-Jet gas burner. Photo from author's collection.

Left – The 108-jet burner. Drawing from the author's collection.

The lamp was designed to burn 28 jets in clear weather. The 28 jets were arranged in concentric rings, the diameter of the outer row being about the same as that of the outer wick of the ordinary four-wick lamp, i.e., four inches.

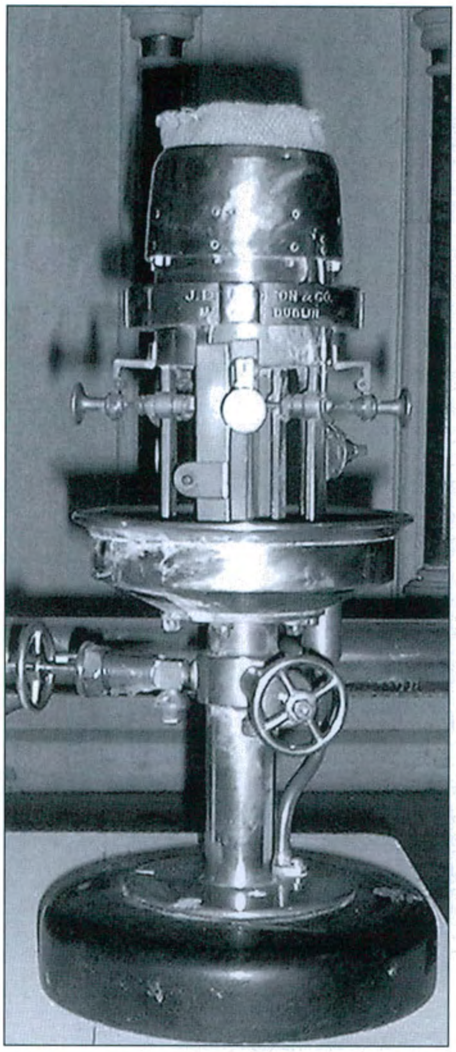
When the atmosphere became hazy, an additional exterior half-ring of 20 jets was simply hand set in position and had two tubes with tapered endings extending downward. The tapered ends of these tubes fit into precision-ground sockets, partially filled with mercury, in the base gas-distribution plate. The mercury created a seal to prevent gas leakage.

During this operation the flames from the 28 jets forming the nucleus were turned low, and when the gas cocks were reopened, the flame from these lit the added exterior row. Additional rows of jets were successively added, as required by the increasing density of fogs or thick weather, each increasing the number by 20, so that from 28 (the number in the nucleus) the various powers were 48, 68, 88 and 108 jets, the latter being used only in very thick weather or dense fog.

There was no chimney directly surrounding the flame. Instead above it, at a distance of about 12 inches, was suspended a funnel made of mica, into which the upper part of the flame was guided by the funnel shape and carried by the draught through the cowl of the lantern. The mica funnels varied in diameter to suit the different sizes of the flames, and were changed in accord with the number of jets used. Mica is a mineral that can be split into very thin slices. The frame of the funnel was made of metal with mica inserts that were so thin that the light from the flames could be seen through the mica as shown in the drawing on page 28.

The entire operation of changing from one set of jets to the next higher or lower, and also changing the mica funnels, took less time than the trimming of a four-wick lamp.

The diameter of the flames corresponding to the different powers of the lamp were, respectively, $3\frac{3}{4}$, $5\frac{1}{2}$, $7\frac{1}{2}$, $9\frac{1}{4}$, and $10\frac{1}{2}$ inches for the 28, 48, 68, 88, and 108 jets. It will therefore be observed that a great part of the larger flames became ex-focal because the Fresnel lenses in use had been designed for a smaller 4-inch diameter flame at the focus. The larger gas flames increased the divergence of the light, and also increased the intensity of the light due to the great thickness of the flame.



Wigham 4-concentric-wick oil burner. Photo courtesy Maritime Institute of Ireland's Museum.

Wicklow Head Lighthouse, gas holding tank at the right of the lighthouse. Drawing from the author's collection.

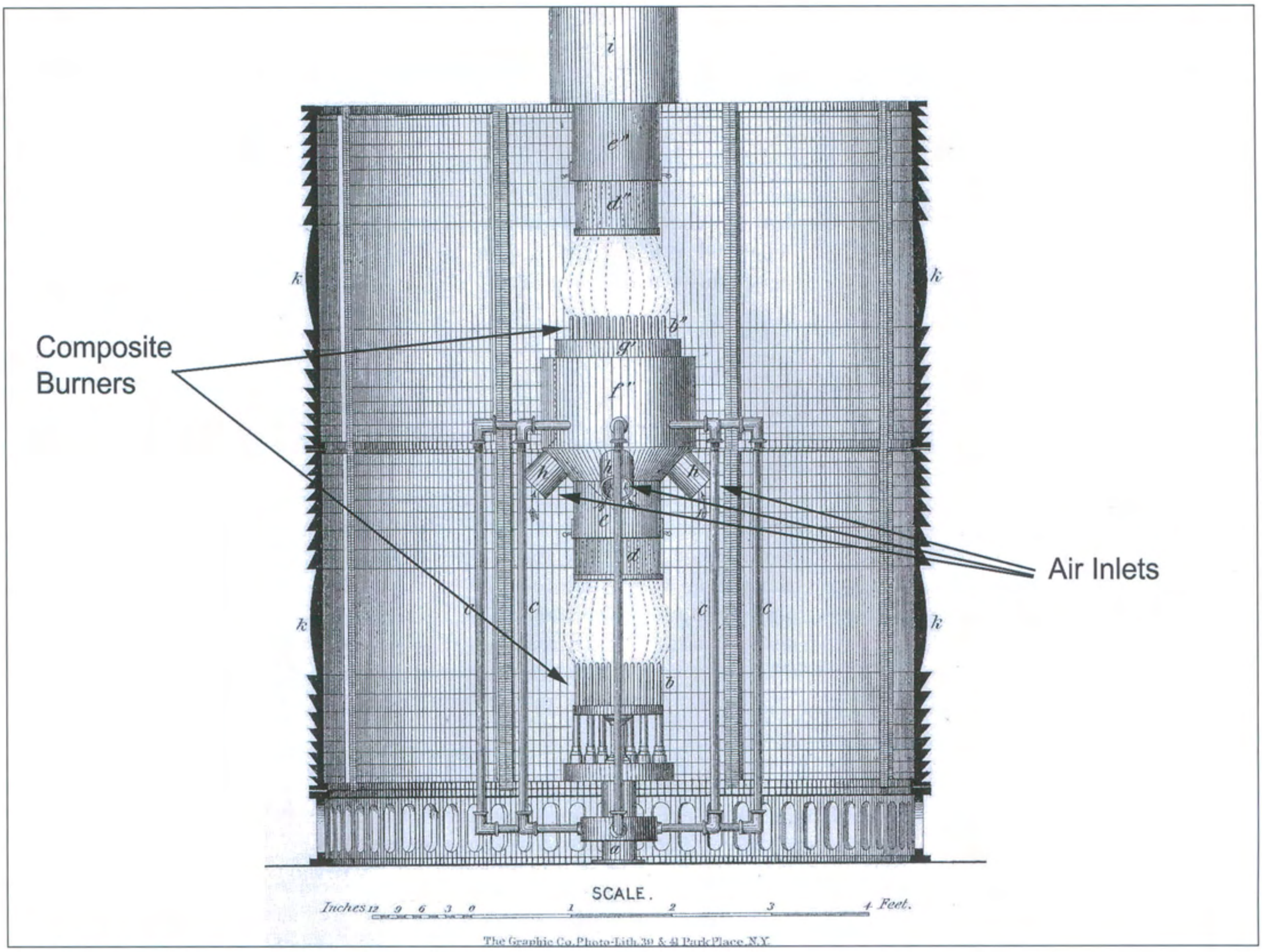
The Wigham Standard Oil Burner – During this time period, Edmondson & Co. also produced standard multi-wick oil and later kerosene burners for lighthouses, along with lantern room equipment and many other lighthouse related items.

The Fixed Lens and Burner – The first high power 'composite' burner replaced the 'crocus' burner in the fixed lens at the Howth Baily Lighthouse in 1868. This burner was described by Dr. Tyndall, scientific advisor to the Trinity House in England as being "13 times more powerful than the most brilliant light then known."

The Intermittent Burner – Wigham's next gas burner design was installed in the fixed lens at the Wicklow Head Lighthouse in 1868, and remained in use there until 1906. This burner consisted of a standard 'composite' burner that had a clockwork-operated valve that produced controlled flashes within the fixed lens; it became known as the 'intermittent' burner. The advantage of the 'intermittent' burner was that during the period of darkness, when the gas was turned low, the consumption of gas was reduced; whereas in the case of oil lights - the flames of which were merely eclipsed by a shade - the consumption of oil continued during the intervals of darkness as well as during the intervals of light. All of the four fog-powers of the 'composite' burner could be made intermittent, precisely as was the case with the basic 28-jet burner. This use of gas in a fixed lens produced an intermittent-light apparatus without altering the existing lens.

The Group-Flashing Burner

In 1871, Mr. Wigham first exhibited a 'group-flashing' burner at the Rockabill Lighthouse. Groups of flashes were produced by breaking up the full beam from a revolving flashing lens by continually shutting off and turning on the gas. This was accomplished by a cam fixed to the rotating clockwork of the lens, from which a connecting-rod went up to the 'composite' burner. As the lens revolved, the cam raised the rod, shutting or opening the gas valve. This arrangement did not cut the gas entirely off, and each jet during the three-second eclipse showed a tiny-blue flame, which, while it produced no illumination of the lens apparatus and could scarcely be detected in daylight, was still sufficient to light the main body of gas when the main-



A Typical bi-form lens and burners. Photo from the author's collection.

supply valve was again turned on. The result of the group-flash was that the mariner saw - instead of a long flash of light recurring at certain intervals - a group of shorter flashes. By this arrangement the lighthouse was more easily identified. Wigham's 'group-flashing' burner should not be confused with the 'group-flashing' lens invented by Dr. Hopkinson, at Chance Brothers in 1874.

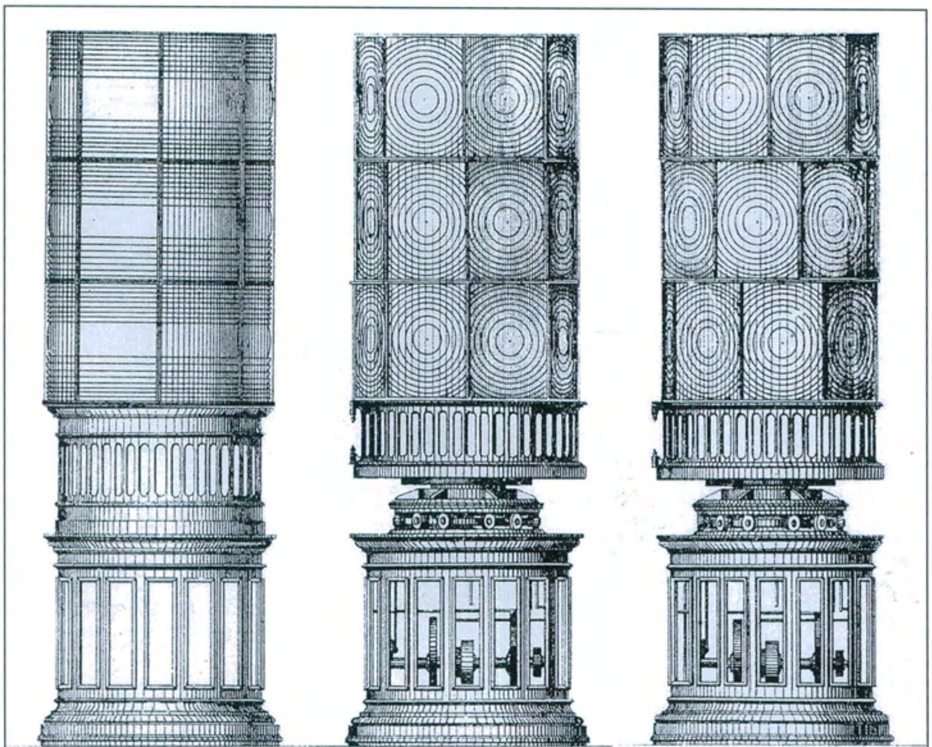
The eminent astronomical optician, Sir Howard Grubb, had been asked by Mr. Wigham to witness the performance of the group-flashing light. He did so, and he described what he saw. He attested to the constancy of the flashes in luminous power, and finished by saying: "I cannot close these remarks without bearing testimony to the effectiveness and very striking characteristics of the light experimented upon. During the flashing experiments I found I could turn myself round and direct my eyes to a point about 90º away from the direction of the light, and still could detect each flash perfectly distinctly, and this at ten miles distant on a night by no means very clear. In fact, if this light were flashing, say due north, it could not fail to catch the eye of an observer directing his view to almost any part of the northern horizon from east to west, and when the full light of 108 jets was turned on, the splendor of the light was such as to almost eclipse the Baily beside it."

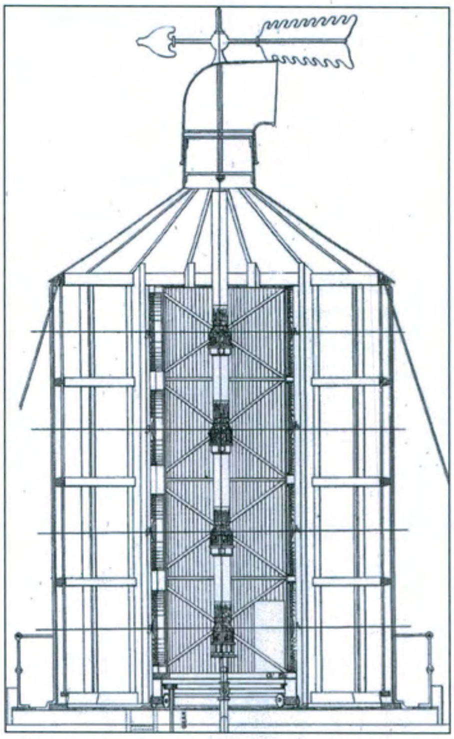
Later, Sir Leopold McClintock, in a letter addressed to Mr. Wigham, expressed himself as follows: "No better means could be devised for distinguishing a light from other lights than by the plan of a group of flashes. The half-minute interval between the groups is quite sufficient, and yet not greater than can easily be estimated by the observer without having recourse to a watch to measure the time, and the periods recurring within forty-five seconds, that short time is sufficient to determine which light it is, and both these are of great practical advantage. I consider that the superior brilliancy of gas to oil and its application both to revolving and fixed lights is most satisfactorily established, and as I regard the proposed change solely from the seaman's point of view, I look exclusively to their relative efficiency without any regard whatever to their comparative cost."

The power, individuality and complete practical success of the first 'group-flashing' burner were thus securely established by experiment.

The Bi-form Lens and Burners

In 1872, Wigham proposed superimposed (stacked) bi-form lenses for use with his gas burners. Superimposed lenses had been first proposed by J. W. D. Brown of Lewisham, England in 1858. It was not until 1872, at John Wigham's request, that the first superimposed lenses were actually produced. Later, Wigham proposed the addition of tri-form and quadri-form lenses to add to the power of his lighting systems.





Left– Various forms of tri-form Lenses – left to right: fixed, flashing, stepped flashing. Above – Quadri-form lens. Drawings from the author's collection.

In the bi-form lens, light was produced by two 'composite' burners, placed vertically over each other. The upper burner had four additional air-inlets for the supply of pure air to the flame and a chimney cylinder for carrying off the foul air from the flame of the burner below. The tubes for the introduction of pure air were placed on the lower sides of the upper burner housing. The effect of the arrangement was that the two burners maintained equal power, and the light was much intensified by the manner in which the burners were supplied with heated air. Located above the upper burner was the standard mica funnel, and above that, the regular exhaust flue.

In 1877, Wigham produced the quadri-form lens with four superimposed burners, which was first used in the Galley Head Lighthouse. The four lamps and four lenses at Galley Head Lighthouse produced over 1 million candlepower through the lenses when in full operation.

Wigham's 31-Day Buoy and Tower-Lamp Design

Wigham later designed a lamp that could be used on buoys or on beacons that could operate unattended for a period of 31 days. The Wigham 31-day lamp had a very unusual construction; it consisted of three main elements. It had a lantern, with the lens, which was sometimes enclosed in protecting panes of plate glass, and in the focus of the lens was the burner. Below the lens was the lamp's oil reservoir that fed the wick. The wick was more than five feet long and was mechanically moved through the burner over a roller. The oil reservoir for the lamp was circular in shape, shallow, and served as a deck on which the lantern was built. The third part of the lamp was a float cylinder made of copper and was attached to the underside of the lamp's oil reservoir. This float cylinder was filled with 9 ½ gallons of oil, which was kept separate from the lamp oil. Floating on this oil was a weighted copper drum float, to which one end of the wick was secured by means of a hook. The other end of the wick was attached to a small weight that acted as a tensioner by keeping a gentle pressure on the wick to assure that it moved smoothly over the roller in the lamp burner. The wick and weight were housed inside a long copper tube connected to the lamp's oil reservoir and filled with lamp fuel.

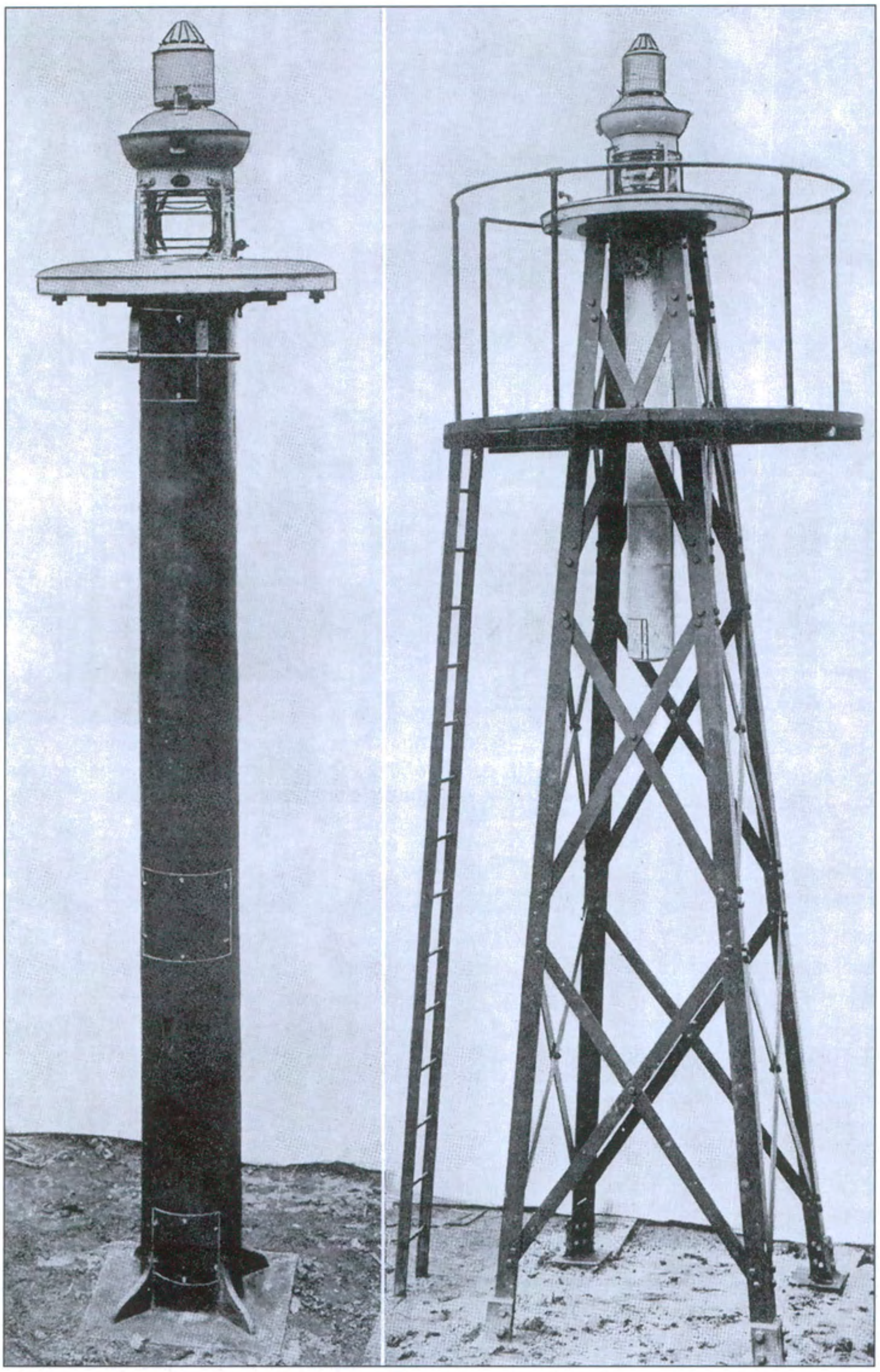
At the lower end of the float cylinder was a needle valve, which, when opened, permitted the float oil to drip away at a slow rate. This caused the float to fall with the oil in the float cylinder, and to drag the wick over the burner roller and down the float cylinder after it, so that a fresh surface of the wick was continuously at the top of the wick roller in the burner for combustion. The flame was actually on the side of the wick and not on the end as usual.

The lamps were of three styles, a single-wick version, a two-wick version, and a three-wick version. The oil in the float cylinder was usually caught in a storage container and could be filtered and reused. This design was widely used in areas of the Pacific Ocean, especially in the waters around Australia where over 60 were in use.

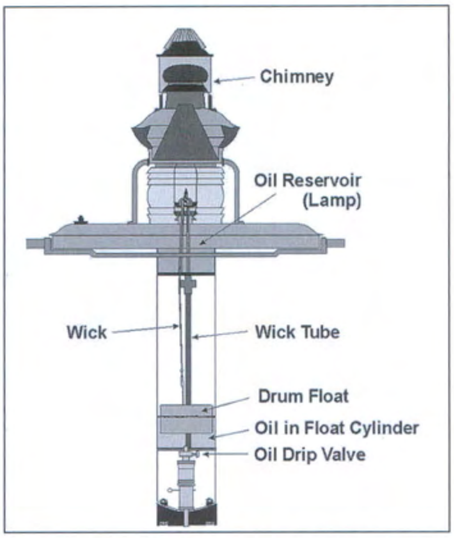
Wigham's Gas Gun for Fog Signals

Mr. Wigham also invented a gas gun, to be used as a fog signal at stations illuminated by gas. The gun was simply a tube of iron connected with the gas holder by a half-inch pipe. The charge of the gun was a mixture of oxygen, coal gas, and common air, one fourth of the mixture being common air and the remainder composed of equal volumes of oxygen and ordinary illuminating gas.

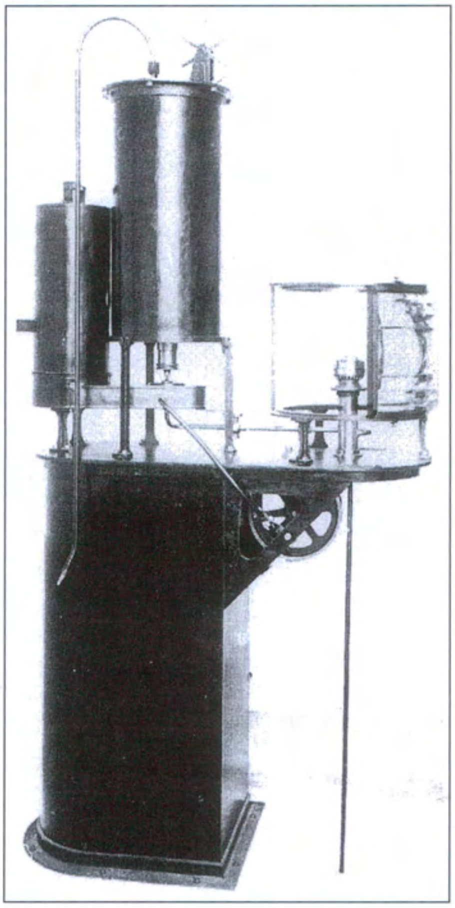
The proper quantities of the gases were allowed to flow from their respective reservoirs into a holder, and the mixture was then transferred to the closed end of the pipe, or breech of the 'gun,' the flow being regulated by a stop cock. The mixture was lighter than common air, and when it filled the feed pipe and gun, the latter being lower than the source of supply, it remained charged until



31-day petroleum lamp used in buoys and beacons. Photo from the author's collection.



Above – Inner Workings of the Wigham 31-Day Lamp. Drawing by the author
Below – The Wigham Pierhead Beacon Lamp. Photo from the author's collection.



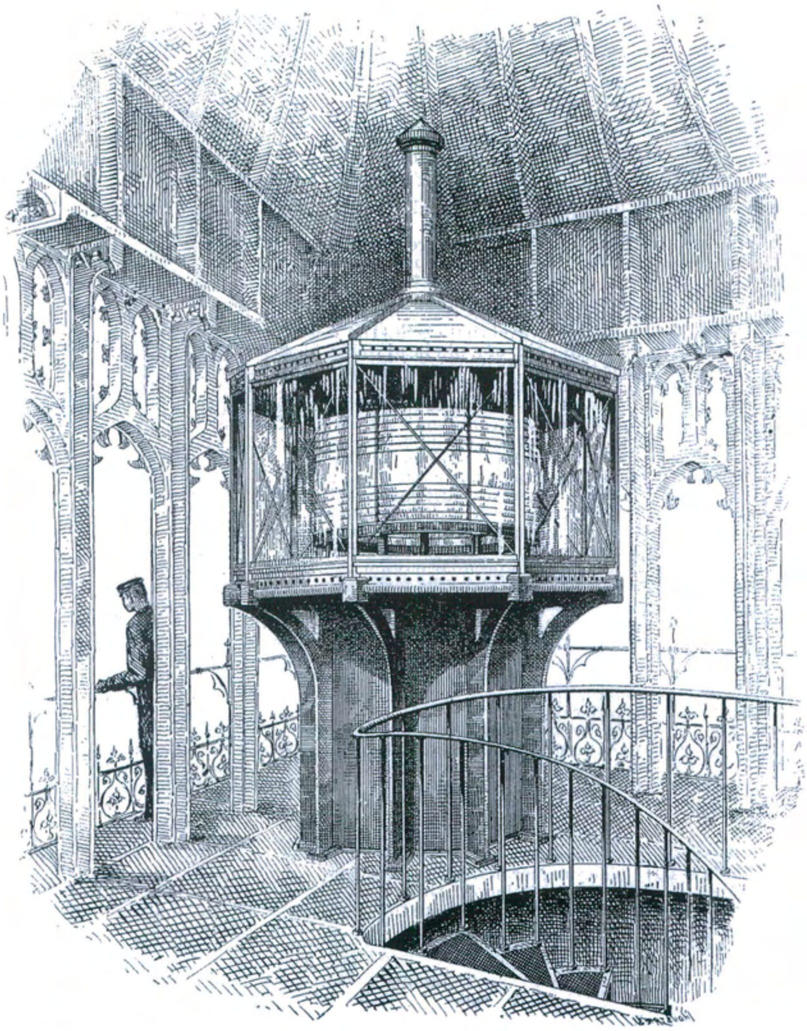
fired, which was done by touching a match to an orifice.

Wigham's Lamp for Pierheads and Beacons

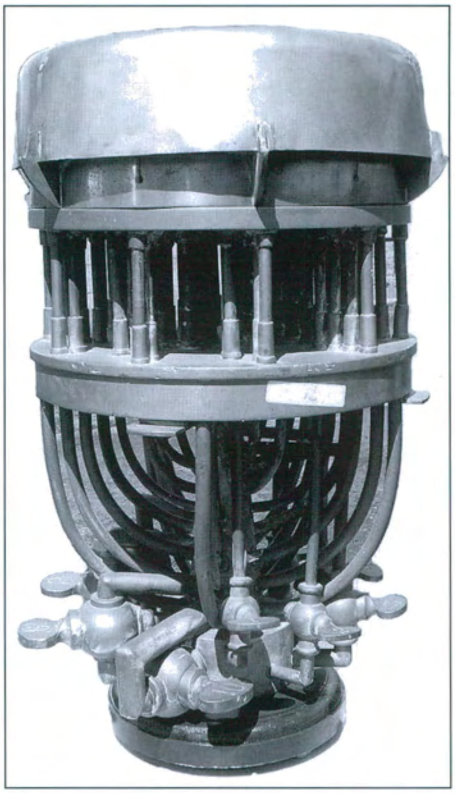
Wigham took his 31-day petroleum lamp design and modified it slightly for use on pierhead lighthouses and for beacon lights. He moved the float tank and the lamp fuel tank above and behind the lens and burner. He added a pressurized-oil overflow-collection tank below the other tanks and increased the size of the lens to provide for greater range.

Wigham's Hyper-radial Lens Proposal

In 1872, Wigham proposed a long focal length 'Hyper-radial' lens for use with his gas burners. The size of the gas flames had always been thought to be too ex-focal and Wigham determined that if a lens with a larger focal length were produced it would allow his large burner flames to produce more light that could be directed to the horizon. Some five years later in 1877 Wigham went to Barbier & Fenestre in France, and was shown the first drawings of his proposed 'Hyper-radial' lens. However, John Wigham did not have the political power to get his 'Hyper-radial' lens design actually produced. The Commissioners of Irish Lights were neither able nor



The 1893 2nd Order lantern and lens with Wigham gas burner at the House of Commons. Drawing from the author's collection.



Above –The Wigham 10-ring Gas Burner. Below – The 10-ring burner viewed from above. Photos Courtesy of the Commissioners of Irish Lights.

willing to fund this costly new lens design. Wigham ultimately gained approval for the 'Hyper-radial' lens and the first was installed in the Tory Island Lighthouse in 1887. In 1928, the optic was dismantled and reconstructed by Chance Brothers to make a new optic for the Mew Island Lighthouse. During this time, Chance Brothers constructed a new optic for Tory Island.

The House of Commons Signal Lens

In 1874, a Wigham 68-jet gas burner and bi-form lens was installed at the top of the British House of Commons in London. This lens and lamp were used to signal that a vote was in progress. The members of Parliament who were outside the building could check for this light and return to vote. (Ed: This was a rather expensive way to alert those on a coffee break!) The lens was replaced in 1893 when a more powerful design using a Wigham 68-jet burner was installed inside a second order drum-style lens and lantern in the bell tower of the House of Commons.

Wigham's 10-ring Gas Burner

After a trial of electricity, oil and gas held at the South Foreland Lighthouse site in 1885, John Wigham designed a 10-ring gas burner that was simpler and easier to maintain than his older 'composite' burner.

The 'Giant Lens'

In 1897, Wigham requested that Chance Brothers produce a 'giant' lens, which was described by James Kenward, the Chance Brothers plant manager in 1897, as follows: "There has also been constructed, at Mr. Wigham's suggestion, as an experiment, what he aptly calls a 'giant lens' of 2000 millimeters radius, but it is not yet adopted in practice." This 'giant lens' was over 13 feet in diameter or about one and one half times the size of the 'Hyper-radial' lens. Apparently, only one 'giant lens' was built and it was never actually installed in a lighthouse.

The End of Gas As a Lighthouse Illumiunant

Mew Island was the last Irish lighthouse to use gas as an illuminant. The gas system was removed in 1928, ending the era of coal gas usage.

Wigham also invented other fog signals, fog sirens, buoys and buoy lights, and later, acetylene lighting equipment. Edmundson & Co. later became known as F. Barrett & Co.

Brilliance & Prejudice – Part Two
The Inventive John R. Wigham

By Thomas A. Tag

In the last issue of *The Keeper's Log* [Volume XXIII, No 2] you read about the brilliant and innovative designs of John Wigham, and yet why is it that you probably have never heard of him before? Have you known of gas being used to illuminate lighthouses? Perhaps you didn't know gas was ever used in any significant way. Have you heard of the Wigham group-flashing lamp? Why did John Hopkinson get all the credit for its equivalent, the group-flashing lens? Have you heard of Wigham's bi-form, tri-form and quadri-form lenses? Why did James Douglass get all the credit for the design of the bi-form lens? Have you heard of Wigham's Hyper-radial lens? Why did Thomas Stevenson get all the credit for the Hyper-radial lens design? John Wigham's failure to receive proper and due credit for his inventions happened for a reason!

In any engineering organization, even today, there is a premise known as "Not Invented Here." Not invented here, is the natural tendency of one engineer or inventor to find fault with the designs of his rivals. Some engineers carry this desire to extremes. They will never accept the designs of a rival no matter how innovative or useful they may be. This type of engineer will spend months or years trying to find reasons why his rival's design is poor. If this doesn't work, because the invention is, in fact, valuable, he will work on designs with slight or major variations of the rival's and proclaim that the invention will only work properly with his added variation. If the rival's invention cannot be discredited on its own, it will be attacked based on cost of usage, or safety of use, or some other outside variable. Finally, in rare cases, the rival is attacked personally. It could be based on education, social status, nationality, or personal trait. The personal disparagement of a rival is a significant step and can be dangerous to the perpetrator's reputation as well. It is therefore usually done only in extreme cases of jealousy and by methods that can be mostly hidden. In the case of John Wigham, nearly all of his inventions were attacked by every method mentioned. Attempts were made to show that the inventions were not really needed, did not work any better than designs in current use, cost too much, were not safe, and that Wigham was undeserving of credit. The remainder of our story will look at some of these evaluations of Wigham and his designs. Much of this analysis has been taken nearly verbatim from a series of articles written by Dr. John Tyndall, Scientific Advisor to the Trinity House.

Dr. John Tyndall began work as scientific advisor to Trinity House on May 9, 1866. He became deeply involved with John R. Wigham in the experimentation with the gas illumination system for lighthouses. Dr. Tyndall always remained impartial in the disputes over the gas system between John Wigham and the Trinity House, James Douglass, and others. He commented on Mr. Wigham by stating: "Mr. Wigham was Honorary Secretary to the Dublin Chamber of Commerce, a justice of the peace, a member of the Society of Friends, and an uncompromising Unionist. The national press of Ireland always loyally backed him in his contentions with the Trinity House. Though a man of culture and position, he was occasionally sneered down as a mere trader."

David Stevenson. Author photo.

During the exhibition of the comparatively imperfect 'crocus' burner in 1868, Mr. David Stevenson, engineer of the Northern Lighthouse Board, paid a visit to Howth Baily. It was his opinion that Howth Baily was an excellent first-class fixed light. He learned that the lamp chimney, so essential to an oil flame, was no longer needed. This was considered to be a great advantage in the application of gas to lighthouse illumination because it eliminated any delay in exhibiting a light caused by the breaking of the lamp chimney by the heat of the oil flame. It also eliminated the loss by reflection at the two surfaces of the lamp chimney, and the loss by absorption in the glass itself. The oil flame had always required half-an-hour's 'nursing' by the keeper before it attained its maximum brilliance, while the power of gas was obtained at the moment of ignition. After his visit to the Howth Baily light, David Stevenson reported what he had seen to his brother Thomas. At this point, the eminent engineers of the Northern Lighthouse Board in Scotland appeared very interested in the gas light.

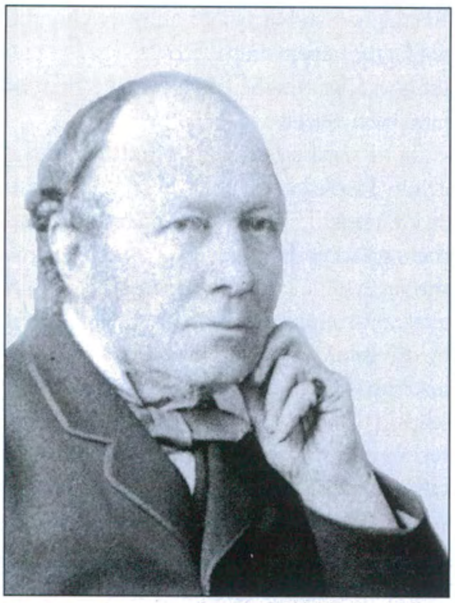
In early 1869, Mr. Wigham was invited by the Stevenson brothers to try his gas light in Scotland and to exhibit the light from the temporary tower at Granton, using Edinburgh town gas while making the investigation. The invitation was accepted, with the reported results decidedly unfavorable to gas. The conclusion drawn by the Stevensons in regard to the luminous power of gas was that the 6 ¾ inch diameter gas light, as compared with the oil light, which was only 4 inches in diameter, did not match the results that appeared to have been obtained in Ireland. The experiments were repeated with gas manufactured under Mr. Wigham's superintendence, but the results were again reported to be unfavorable. The Stevensons stated: "On the whole we are of the opinion that the results of the experiments made with burners prepared by Mr. Wigham, and with gas manufactured by him especially for these experiments, do not warrant us in recommending the adoption of the gas light as a substitute for the present mode of illumination."

The Stevensons then compared the expense of gas with that of oil for various lighthouses, determining in all cases that gas was more costly. The estimates of cost difference reached their climax in the case of the Auskerry Lighthouse in the far north of Scotland, where the annual cost of oil was measured at 114 while the cost of gas was estimated at 712! The Stevenson's report was utterly in conflict with the costs estimated by Wigham and the Irish authorities. It was difficult to imagine that two men of the trained intelligence of Captain Roberts, Inspector of Irish Lights, and Mr. Wigham who had been experimenting for more than four years on this question of cost, and who had proclaimed gas to be the cheaper illuminant, would have done so if the facts were those as stated in the Stevenson report. Something was wrong with the analysis of either the Stevensons or Wigham and the Irish Board.

Dr. Tyndall stated: "Here the point is reached where it became my privilege, or doom, to be called upon by the Board of Trade to strike into this Irish inquiry. My first care was to secure the services of an assistant – able, practical, accomplished as a photometrist, and of great experience in both gas and oil. This was the late Mr. Valentin, a fellow of the Chemical Societies of London and Berlin, and principal demonstrator in the Royal College of Chemistry. Furnished with proper instructions he reached Dublin a little in advance of me; and on Saturday, the 5th of June 1869, his first series of experiments were executed at Howth Baily. They were quite in harmony with those previously executed in Ireland."

"I reached Dublin on the evening of the 5th, and, without giving the lightkeeper any warning of my visit, went straight to the lighthouse. The experimenters had departed, and I was alone with the keeper. Him I put through his facings, and he proved himself a perfect master of his work."

"The flame alight at Howth Baily when I arrived was produced by a group of 28 fishtail jets (Ed: the 'composite' burner), specially constructed for the purpose which they served, and so closely compacted as to be of the same diameter as the 4-wick oil burner. The flame was a very fine one – in fact, a first-rate fair-weather flame. But the inventor of the new gas system had the straits of the sailor in foul weather mainly in view; and he had made arrangements to vastly enhance his power in rain, snow, mist, and fog. He was able, as the



Thomas Stevenson. Author photo.

atmosphere thickened, to rise from the 28-jet flame to a 48-jet flame; from a 48-jet to a 68-jet; from a 68-jet to an 88-jet; finally, from an 88-jet to a 108-jet flame. With rapidity and certainty all these changes were made in my presence, on the night of my arrival, by the unwarned lightkeeper. He obviously put forth a power that he was able at any moment to exercise, which he habitually did exercise, and not a power got up especially for my surprise and delectation."

"Nothing of this kind had been previously dreamt of by our lighthouse authorities, and it is only by a comparison with the best lighthouse lamps then in vogue that the magnitude of the step taken in Ireland can be estimated. I was immensely pleased with the ready skill of the keeper and with the efficiency of the apparatus. Nevertheless, when I witnessed the burst of flame – tremendous for a lighthouse – that accompanied the ignition of the 108-jet burner, I felt the reasonableness of a remark made to me by Captain Arrow before I came away, that 'the gas system of illumination was a harking back to the old beacon fires employed when dioptric lenses were unknown.' The heat-radiation of this large flame was so powerful as to render me anxious for the safety of the apparatus. The Messrs. Chance had, however, certified the goodness of the glass, and had replied to a question bearing on the subject in these words: 'We should not expect any injury to arise from the utmost heat that a large gas flame could generate.' Direct experiments executed by Captain Roberts confirmed this opinion; and the experience of years has long since extinguished all thought of danger on this score."

"The gentlemen amid whom I found myself were all strangers to me. I did not know one of them. Their authority was nothing to me, and the facts disclosed during the first three days of my visit were eminently calculated to enforce circumspection. One of them has been just cited; another, discovered immediately after our arrival, was a most serious error that had been committed in the record of the gas consumed in the lighthouse. The good faith of those who committed it was proved by the fact that the error told against themselves. If I might dare to say so in these present days of rampant 'nationality' I feared at the time that, however admirable the proofs of genius and of originality, which lay before me might be, I had still to reckon with the inaccurate Irish mind. Further, the out-of-door observations enabled me to qualify, or correct, the photometric measurements made in the shed. There, the light of the 28-jet burner was more than twice that of the 4-wick lamp; but kept clear of the lantern sashes, and nursed to its utmost brilliancy in the well-ventilated lighthouse, the flame of the 4-wick oil lamp rose to practical equality with that of the 28-jet burner. Seen from Poolbeg, it was hardly possible to say which light was best. Thus my first official visit to Ireland was a discipline in caution from beginning to end."

"The inaccuracy-of-the-Irish-mind hypothesis had soon to disappear, being dissipated by the able and accomplished men with whom I came into contact. I had often previously admired the cleanliness, neatness, and good order of the lighthouses of England. They were rivaled in all these particulars by the lighthouses of Ireland. Here, moreover, was an Irish invention, which, in regard to the soul and spirit of the lighthouse system - the light itself - threw everything that had been done in England or elsewhere into the shade. In addition to the direct and immediate benefit conferred by it upon the sailor, it would moreover be sure to act as a stimulus to the lighthouse authorities of the United Kingdom. This it has done to an unsuspected extent."

"I examined John Wigham's work, and found it trustworthy; corrected his errors, and found him willing to be corrected."

It appears after this careful re-trial by Dr. Tyndall and Mr. Valentin that the Stevensons had been biased in their review of gas and had exaggerated the costs of gas as compared to oil (apparently another case of not invented here).

It would be appropriate to stop here for a moment to recap the state of lighthouse illumination in the late 1860s and early 1870s. Nearly all lighthouses used whale oil or colza oil as a fuel, although lard oil was also used in America. In first-order lenses, 4-wick lamps were in general use and no lamp with more than five wicks had ever been used.

The Elder Brethren of the Trinity House resolved to institute an inquiry into the comparative merits of gas and oil in 1871, and because Haisbro', on the coast of Norfolk, possessed two lighthouse towers, this station was chosen for the trial. In 1872 gas works were erected, and gas usage was initiated in the Haisbro' High Lighthouse. Soon afterwards Dr. Tyndall met with Captain Nisbet, at that time one of the most experienced of the Elder Brethren in the matter of lights. He had been to Haisbro', and had seen the gas in action. "It is," he said to Dr. Tyndall, "perfectly beautiful." At the request of the Trinity House, two of the Gas Referees of that period, Mr. John Sampson Pierce and Mr. F. A. Patterson, went to Haisbro' and inspected the gas works, "we found them," say these gentlemen in their report of June, 1872, "in a most satisfactory condition, and constructed in accordance with the specification submitted to us by you last year."

It is interesting to note that this test at Haisbro' was not conducted solely between the Trinity House standard 4-wick lamp and the Wigham gas system. Instead, the Trinity House substituted a new, unproven, 6-wick lamp in some of the trials. They were comparing 'apples and oranges' to show what an experimental larger oil lamp might be capable of against the current gas system.

The new 6-wick oil lamp had been constructed so that the three inner wicks could be suppressed, with only the three outer wicks to be used during good weather. In fog the three inner wicks were added; the power of the lamp being nearly doubled by their addition. Unfortunately, it required a quarter of an hour's attention before the lamp recovered its full power after this change. Note that, prior to the labors of Mr. Wigham, the idea of strengthening a light in foggy weather had never been tried other than through the use of chemical powders similar to fireworks, which failed. The Engineer of the Trinity House decided that greater power during fog was desirable, only after it had been realized and practiced, with a seven-fold effect, at Howth Baily and elsewhere for seven years. Dr. Tyndall stated: "I have the very highest authority for stating that, were it not for the impetus imparted by the gas system, the 6-wick lamp of the Trinity House would not have been invented."

From the first, the Elder Brethren of the Trinity House looked unfavorably on the Irish innovations. This seems to have predisposed them to accept too readily evidence against the gas system. For example: in March 1873, a committee of four of the Brethren, assisted by two gentlemen not named in their report, made an expedition to Haisbro', satisfied themselves of the utter failure of gas, and immediately reported this result to the Board of Trade, in England. They reported the 4-wick oil burner to be about 35 per cent better than the 28-jet gas. They reported the same 4-wick oil burner to be from 10 to 15 per cent better than the 48-jet gas. Dr. Tyndall stated: "Had I known anything of this expedition, more as their friend than as their "Adviser," I should have urged them to pause before publishing such observations. But I knew nothing either of the expedition or of its results. Hence it came to pass that, while on the night of Thursday, 13th of March, 1873, a committee of the Elder Brethren had, to their own satisfaction, and, I believe, with perfect honesty of conviction, given its quietus to the gas system; on the 1st of April, 1874, another committee, including two of the Brethren present on the previous occasion – now in complete accord with their Scientific Adviser and the

Haisbro' Lighthouse. Photo courtesy of the Peter Williams Collection.

commander of their yacht – irretrievably overthrew the conclusions of their predecessors."

Some real reason must have existed to mislead these four principal members of the Trinity House in March, 1873. What was this cause? On Good Friday of 1873, Mr. Wigham visited Haisbro', carefully compared the two lights on the evening of his arrival, and found the oil light was actually inferior to the gas light. He expected this, knowing that orders had been given to use the 48-jet gas burner as the ordinary light, which should have been more powerful than the 4-wick oil lamp. Still the superiority of gas was not as great as previous experiments had shown it should be. "The reason," said Mr. Wigham, "was soon apparent; for, on being admitted into the lighthouse, I found that the tap of the 48-jet gas burner was only turned quarter on. On pointing this out to the light-keeper he informed me that he had orders not to turn on the tap to any greater extent. On inquiry I was informed that during the recent experiments ... the same quarter-power was maintained in all the various sizes of gas flames that were experimented upon. When the gas was turned fully on, the flame was greatly increased back to the expected values." If orders had been given to cut back the gas flow, was that the reason that oil appeared to be better than gas?

To resolve this issue completely, a carefully constructed triple photometer was created by Mr. Wigham, for ascertaining the illuminating power of various sizes of his gas burners and another trial was made under the direction of the Trinity House. The triple photometer was used, under the superintendence of Professor Valentin, of the Royal College of Science, to arrive at correct and verifiable results. The whole of the experiments were put under the charge of Dr. Tyndall. Mr. James Douglass, Trinity House Engineer, was present, and Mr. Wigham and his nephew, a civil engineer, were also in constant attendance. The results, as agreed to by all parties, were as follows:

Burner Type	Equivalent number of candles (clear weather)
28-jet gas burners =	429
48-jet gas burners =	832
68-jet gas burners =	1,253
88-jet gas burners =	2,408
108-jet gas burners =	2,923
Douglass 4-wick oil burner =	28
Douglass 6-wick oil burner =	722

So we can see that a properly controlled trial again showed gas to be superior to oil. Even with this conclusive evidence, James N. Douglass, the Engineer to the Trinity House, wrote a report in which he contended that much of the light, especially from the large gas burners, was ex-focal, and therefore that it was totally useless and wasted.

The Douglass 6-wick lamp. Author photo.

Dr. Tyndall stated: "In a letter dated 21st January 1875, I dealt pretty fully with these 'views.' I will here content myself with stating their essence. Mr. Douglass took exception to the shape of the gas flames, asserting that, because of their height, a considerable portion of their light was out of focus. This objection was not raised while the flames were burning before us at Haisbro', where it would have been easy to cut off the ex-focal light and determine its exact numerical value. Mr. Douglass' criticism was purely inferential, not the result of actual observation. Had he made the experiment, he would have discovered his error. The point was one easily decided; but in its decision I thought it wise to invoke the aid of a gentleman whose word would carry weight, and whose fame, as a scientific optician was then growing towards the magnitude that it has since attained. The best means open to me was to ask the celebrated optician, Mr. Grubb, of Dublin, to determine the photometric value of that portion of the 28-jet flame that rises above the height of 4 inches, this being the height hitherto aimed at in the case of the four-wick Trinity lamp. Mr. Grubb has done this, and he certifies the photometric value of the part of the flame referred to, to be under 4 per cent, of the whole illumination. Mr. Douglass makes the amount 31 per cent." Dr. Tyndall goes on to say; "In the larger powers of the Wigham burner, while showing in clear weather lights of the utmost splendor, a great part of the light is necessarily more or less ex-focal. The focus is fixed for the horizon, and every addition to the power of the burner strengthens the beam in this direction. The large powers are not required for the horizon; they are intended for thick and foggy weather, when the horizon is utterly unattainable, and when the object is to make the light strong nearer shore. The glare of these powerful flames upon a fog, more especially if the system of flashing be introduced, cannot fail to be of the utmost service as a guide to the mariner."

Dr. Tyndall later stated: "From my first visit to Ireland I had striven hard to blend and harmonize, for the public good, the respective talents of Mr. Douglass and Mr. Wigham. But they proved immiscible. This was the rift in my relation to the elder Brethren – their Engineer could bear no rival nigh him. Mr. Wigham was a comparative stranger to me; but I saw his personal merit, and his value to the State. I could by no means stand by and see him wrongfully borne down by mere authority. For six years I had fought a perfectly constitutional battle; and in my reports throughout those years, and for many years afterwards, no breath of temper, or even of complaint, is to be discerned. Facts and reasonings are there in abundance, but no anger. The struggle with Mr. Douglass in regard to this Irish question took up, however, too much of my time, and I accordingly sent in my written resignation." Dr. Tyndall's resignation was not accepted and for a time the controversy diminished.

In 1872, Wigham proposed the superimposed lens (bi-form) and he soon introduced the tri-form and quadri-form as well. The Commissioners of Irish Lights decided to establish a beacon on the promontory of Galley Head in 1877. It was decided that the new light would be a group-flashing quadri-form gas light. Four tiers of lenses were superposed, and a 68-jet burner was placed in the focus of each tier.

Dr. Tyndall stated: "Nothing approaching in grandeur and beneficent power to this proposed "pharos" of Galley Head had previously entered the official lighthouse mind. It was the offspring of individual genius, untrammeled by routine, coming first-hand into contact with a question that required for its expansion both energy and originality. Accurate photometric measurements had made the light of a single 68-jet burner equal to 1,253 candles. Four such burners, when called upon to fight for the sailor against imperiling fog, were able to shine with a light of 5,012 candles. Such was the power to be disposed of at Galley Head."

As usual, attacks and misstatements followed this innovation as well. Dr. Tyndall reported: "Not long after its completion in 1878, and when it had already won the applause of seafaring men, the Elder Brethren resolved to visit the new lighthouse. As seamen they emphatically claimed competence, and as a corporation jurisdiction, to pronounce judgment on the lighthouses of Ireland. Believing implicitly in the fairness of the Elder Brethren when judging for themselves, I hoped, when first informed of their intention, that they would forego tutelage, and found on their own inspection and observation an independent opinion of the light of Galley Head. I regarded it as of doubtful omen when informed that they were to be accompanied by their Engineer Mr. Douglass. On the return of the Elder Brethren I had a friendly note from Sir Richard Collinson, the Deputy Master, asking me to call and see him. This I promptly did. Our relations had always been most cordial, and speaking as friend to friend he told me about the visit to Galley Head. Mr. Douglass, he informed me, had written a report of his personal observations. This document he held in his hand, and, with his honest, kindly smile, he placed it in mine, uttering as he did so the single word "Hostile." His colleagues, strange to say, discovered afterwards that the report was not hostile, but appreciative. In the Admiral's presence I silently read the report, and found it as skilful as I expected it to be."

"I do not know a more skilful advocate than Sir James Douglass. The dexterity with which he manages, by the introduction of outlying points, to 'o'er inform' the reader, and damage his opponent's case, has often excited my admiration."

"Bit by bit the system of superposed lenses was analyzed, and its failings exposed, the principal faults being the 'positive waste' of light, consequent on the abandonment of the top and bottom prisms, and the use of large burners. The spirit of the report was plain enough to me as I read. It was obvious that, if Mr. Douglass had his way, we should have no more Galley Heads. In handing back the document I confined myself to remarking that when the report was printed, in the usual way, there would be time to consider it, and to answer it if necessary. The rejoinder of the Deputy Master staggered me. It had been decided, he said, not to print the report. It was only to be 'circulated.' Copies of it were to be, or had been, sent to the other lighthouse boards, and to the Board of Trade; but the document was not to be printed. I thought it strange that a paper of such gravity should be dealt with in this way. It seemed to me a document that specially needed the light of publicity. I did not, however, press this point, but, on handing the document back to Sir Richard Collinson, remarked that if the Commissioners of Irish Lights wished for my opinion on the subject they would, in due time, let me know. That a body of men who had so long and so wisely fostered the inventions of their fellow-citizen, and who numbered among them a leader of the competence and the courage of Lord Meath, would accept this report of Mr. Douglass as final, I thought unlikely; and that they would call on me either to verify it or to refute it I thought probable."

"My surmise proved correct; I was called upon by the Irish Commissioners and I responded to the call. On the 8th of May, 1879, I journeyed from London to Milford Haven, and went on board the *Princess Alexandra*, then, as now, commanded by the able and efficient Captain A. K. Galwey. Mr. William Douglass, brother of the Trinity House Engineer, had been just appointed Engineer to the Board of Irish Lights; and with the view of comparing opinions with him in the actual presence of the light, I had requested the pleasure of his company. I was gratified to find him at Milford on my arrival. We steamed immediately to Queenstown, and arrived next day at Galley Head."

"At 8:50 p.m. The experiments began, a single 68-jet burner having been alight from sunset to that time. We were 12½ miles distant from Galley Head and the same distance from the lighthouse on the Old Head of Kinsale. This latter light could not be distinguished from some of the boat lights near us. It resembled, if I may so speak, a weak continuous whisper, while Galley Head, to continue the metaphor, sent forth, at intervals, a succession of luminous yells to warn the mariner. The night was dark, but the air under the heavy cloud-canopy above us was free from fog. We went through a long series of burners, beginning with a bunch of 12 jets, and ending with our old friend 108. The light flashed automatically. The 12-jet beam yielded two bright flashes; the 28-jet three; the 48-jet four; the 68-jet five, which were very powerful; and the 108-jet seven, more powerful still. No beacon flame existing at that time in the world could compete for an instant with this flashing light of Galley Head."

"The flashing was suspended, and the apparatus caused to act as an ordinary revolving light. No such noble beams had ever been seen from any other lighthouse. The increase of luminous intensity derived from the enhanced depth of the flame was remarkable. Resuming our observations of the 68-jet flashing light, we steamed out till it dipped beneath the horizon. We were then twenty-one miles from Galley Head, and in the cloudy air above the lighthouse every pulse of the flame was distinctly visible. From the deck, and even from the bridge of the steamer, the flame itself was hidden behind the rotundity of the earth. But the small difference of level between the bridge and the top of the deckhouse lifted us above the terrestrial curvature, and enabled the blaze of the gas to smite the eye as if the lighthouse were close at hand. The sudden emergence, on ascending the ladder, of these powerful flashes from the darkness of a starless night, was in the highest degree impressive. Turning towards Mr. William Douglass, and addressing myself specially and distinctly to him, I inquired whether his experience had made him acquainted with any light that, in point of power, and distinctiveness, came up to Galley Head. His reply was that he knew of none. In my report this answer was recorded."

"For many years I had been able to congratulate myself on the courteous attention of the officials of the Board of Trade, who never failed to send me copies of all documents in which my name was mentioned or my work discussed. Months, however, elapsed before I heard anything of my Galley Head report, and when I did hear of it, it was through what might be called the accidental courtesy of a friend. I applied for it, and found appended to it some 'Observations' by Mr. William Douglass, which I read with profound concern and surprise. One of them in particular arrested my attention. It ran thus: 'Dr. Tyndall, in quoting my testimony to the excellence of the light, has stated that which I fear may mislead the Board as to my real opinion respecting it. I understood Dr. Tyndall's question to refer only to its distinctive character, and I answered his question with reference to the character of the light and not to its power.' I make no charge against Mr. Douglass, but limit myself to saying that my question and his answer were both distinctly heard by two gentlemen close at hand."

"The reader will remember that three-fourths of the full luminous energy at Galley Head is instantly and totally suppressed when fog is supplanted by fair weather. A single 68-jet burner is then alight. But even then Mr. William Douglass objected to the waste of gas; for, he urged, a 28-jet burner would be quite sufficient in clear weather. It must here be borne in mind, though Mr. Douglass made no mention of it, that the periodic extinction of the gas practically diminished the consumption to that of 45 jets, burning continuously. But even this would be 17 jets in excess of what is needed. What do we gain by this over-consumption? The reply is, a light of greater strength in thick weather; and, in all weathers, a light of unrivalled individuality. We incur the trifling loss, in hours of clearness, for the sake of securing greater power in fog. If Mr. Douglass' objection to the 68-jet burner, on the score of waste, be valid, how overwhelming must be its force when applied to the electric light, not the smallest fraction of which is suppressed in clear weather! The lights at the South Foreland and at the Lizard, for example, are not only lavishly but harmfully wasted; they dazzle and bewilder the mariner. In clear weather a light of 300 candles is sufficient; but the light of the Lizard is said to be 3,600 candles. While, therefore, the fair-weather light at Galley Head is little more than one-and-a-half times what would suffice, the light at the Lizard is twelve times what is necessary. But neither of the Messrs. Douglass have ever urged that, because of this enormous waste on clear nights, the electric light ought to be suppressed. The benefits derived from the strength of the electric light in thick weather are rightly or wrongly, held by them to outweigh its waste in clear weather. Justice demands that the same reasoning should be applied to the Galley Head gas light."

Dr. Tyndall stated: "A couple of years after the 'hostile' report above referred to had been 'circulated,' I found myself standing beside the engineer of the Trinity House on the platform of Westcombe Park Railway Station. We had often worked hard and happily together, and were then engaged in making observations. He spontaneously broached the subject of superposed lenses; admitted not only with frankness, but with warmth, that it was the proper system, and that he intended to adopt it. I confess myself permeable to that joy, which in higher spheres is said to accompany a sinner's repentance, and I was here delighted. But my joy was not long-lived. During the years referred to, Mr. Douglass, brooding over his report, and finding its texture weak, had resolved to abandon it. Searching through the records of the Patent Office, he had convinced himself that he had found a means by which he might concede the excellence of the 'Multiform' system, without conceding much to Mr. Wigham. Some time after our conversation on the railway platform, I had referred to me, for my observations, a letter addressed to the Elder Brethren by their Engineer, wherein he advised them to take counsel's opinion as to the validity of Mr. Wigham's patent. The course recommended seemed as harsh as it was unnecessary: for it was open to the Elder Brethren at the time to make an arrangement, honorable to all parties, costing the public nothing, and effectually preventing all future litigation. But Mr. Douglass was not to be shaken in his purpose. Despite a remonstrance from me, the opinion of counsel and a load of other matters were afterwards shot down upon me by the Secretary of the Trinity House. It was admitted that Mr. Wigham had been the first to use superposed lenses. It was also admitted, now for the first time, that the light at Galley Head was 'powerfully effective.' And because it was so, and because Mr. Wigham had made it so, the Elder Brethren, brushing him rudely aside, proclaimed their intention to "use superimposed lenses wherever the necessities of the service required them.'"

"This high-handed decision, contrasting strangely with the more generous instincts of the Elder Brethren, and for which the public had afterwards to pay, was soon translated into fact. Smeaton's grand old tower at the Eddystone had been undermined, and a new tower had been erected on an adjacent rock, under the superintendence of Mr. James Douglass. It is, I believe, a very fine piece of work. In this tower, with historic associations beyond those of any other lighthouse in the world, the most powerful available light was to be introduced. Gas was out of the question in such a position. How then was the oil light to be raised to an intensity worthy of the genius of the place? By adopting there the very system, which, in his report on Galley Head, the Trinity House Engineer had so emphatically condemned. Sir James Douglass, moreover, is at the present moment adopting the system of superposed lenses in the remodeled light on the Bishop's Rock, and in the new lighthouse at Round Island."

A few years later, in late 1881, the controversy over the use by Sir James Douglass of a first-order bi-form lens in the new Eddystone Lighthouse continued when William T. Douglass stated: "In 1859 Mr. J. D. Brown, of Lewisham, proposed superposed lenses for signal and lighthouse lanterns, with a separate light for each tier of lenses. In 1872, Mr. John Wigham, of Dublin, proposed superposed lenses for lighthouses, and the first application of these, in conjunction with gas-flames, was made by him in 1877, at the Galley Head Lighthouse, on the coast of County Cork. In 1876 Messrs. Lepaute and Sons, of Paris, appear to have made successful experiments with superposed lenses and the mineral oil flames of one to five-wick lamps, the results of which were given by Mr. Henry Lepaute, Jr., in a paper contributed to the Congress at Havre in 1877, of the French Association for the Advancement of Science. Messrs. Lepaute and Sons also exhibited an apparatus of this kind at the Paris International Exhibition of 1878. The Eddystone represents the first practical application of superposed lenses of the first order with oil as the illuminating material."

R. H. Brunton reviewed the claims of William T. Douglass and stated: "Engineers might, without great impropriety, adopt the ideas of other people, if they were ideas only, but they could not very well, without proper arrangement, adopt ideas, which possibly at the expenditure of much time and labor, had been reduced to practice by other persons. Many persons might have thought of using superimposed lenses in lighthouses, but Mr. Wigham was the first to show the practical utility and advantage of the method." He could only say that in his opinion: "The Trinity House mineral-oil burner, the superimposed lenses in the

Eddystone Lighthouse, and the gas-lamp on the table are standing examples of an infraction of that salutary rule."

William T. Douglass replied that: "With reference to the employment of superposed lenses, the idea was not that of Mr. Wigham, neither was their first application due to him, for he should have stated that this was due to Professor Holmes, who introduced superposed lenses for the electric light at Dungeness Lighthouse in 1862, and they were afterwards adopted by Mr. E. Allard, director general of the lighthouses of France at La Heve Lighthouse in 1863. He had clearly shown by the diagrams that the method followed at the Eddystone differed entirely from Mr. Wigham's. Further he had shown by the diagrams and models that the burners of Sir James Douglass, both for coal gas and mineral oil, differed entirely from those referred to by Mr. Brunton."

John Wigham replied: "Various combinations of superposed optical apparatus have been employed in lighthouses since the application by Faraday in 1843 of ventilating tubes to each lamp, for conveying to the cowl of the lantern the products of their combustion. Inasmuch as Faraday's tubes had reference to dioptric apparatus, he thought William Douglass was here mistaken; only one central oil light was ever used in dioptric apparatus, and he was not aware that there had been any application of superposed lenses, till in 1877 the quadri-form gas apparatus at Galley Head was lighted; and this was borne out by a statement of William Douglass that at Galley Head was the first application of superposed lenses with gas flames, and that at the Eddystone was the first with oil as the illuminating material. William Douglass observed that Mr. J. W. D. Brown proposed superposed lenses so far back as 1859; but that gentleman never gave any description of his plan, nor was it ever put into operation. Douglass further stated that Messrs. Lepaute and Son, a year previous to the introduction of superposed lenses at Galley Head, made successful experiments with this method of placing lenses, but as Mr. Wigham's patent, under which Galley Head was lighted, was dated 1872, he had evidently preceded them in this invention. He only mentioned this fact because, unfortunately, he was at present engaged in a controversy with the Elder Brethren of the Trinity House on this very subject, claiming that they had infringed his patent in fixing the superposed oil lights at the new Eddystone. He would not go any further into the question than to say that in his patent specification oil was specially mentioned as one of the sources of illumination referred to in the invention. The lamps, burners, and flues at the new Eddystone Lighthouse were most ingeniously constructed, but to his mind they were defective in one important particular; the flues for conveying the products of combustion from the lower lamp obstructed the light from the upper lamp in three places, so that, as the lenses revolved, the light from the lamp to the best portion of each lens, as well as every other portion of it in its turn, was obstructed by these flues."

Douglass fired back: "Reference had been made by Mr. Wigham to a patent granted to him on the 5th of April 1872, No. 1015, 'Improvements in illuminating lighthouses, beacons, harbor-lights, and light-ships.' This patent was not for the invention of superposed lenses, which had been in use for many years previous to that date; but it was for a special arrangement of two or more gas-burners, one burner above the other, together with their chimneys and flues, so as to form a source of light for dioptric lighthouses or beacon apparatus. No drawing or description of either a lens, oil burner, or the necessary ventilating flue for the latter was to be found in the patent referred to."

When John Wigham became aware that the Trinity House was about to use his bi-form lens design he had approached the Trinity House with an offer allowing them to purchase the rights to his design for a symbolic price of only one shilling a year (the equivalent of one dollar). The Trinity House refused to pay the requested royalty and later the English Courts reviewed Wigham's 1872 patent No. 1015 and found it had been infringed by James Douglass. They then awarded Wigham the much greater sum of £2,500. However, if Wigham wanted the money he would have to give up his lens design patents to the ownership of the British Government.

In 1884, the French had stated that they planned to convert many lighthouses to electricity and were then moving rapidly to modify these lighthouses for electricity. At the same time England and Scotland were in the process of drastically reducing their fixed lens installations and substituting flashing lenses, usually the "group-flashing" design of John Hopkinson. They were also converting from the 4-wick Douglass lamp to the newer 6-wick model.

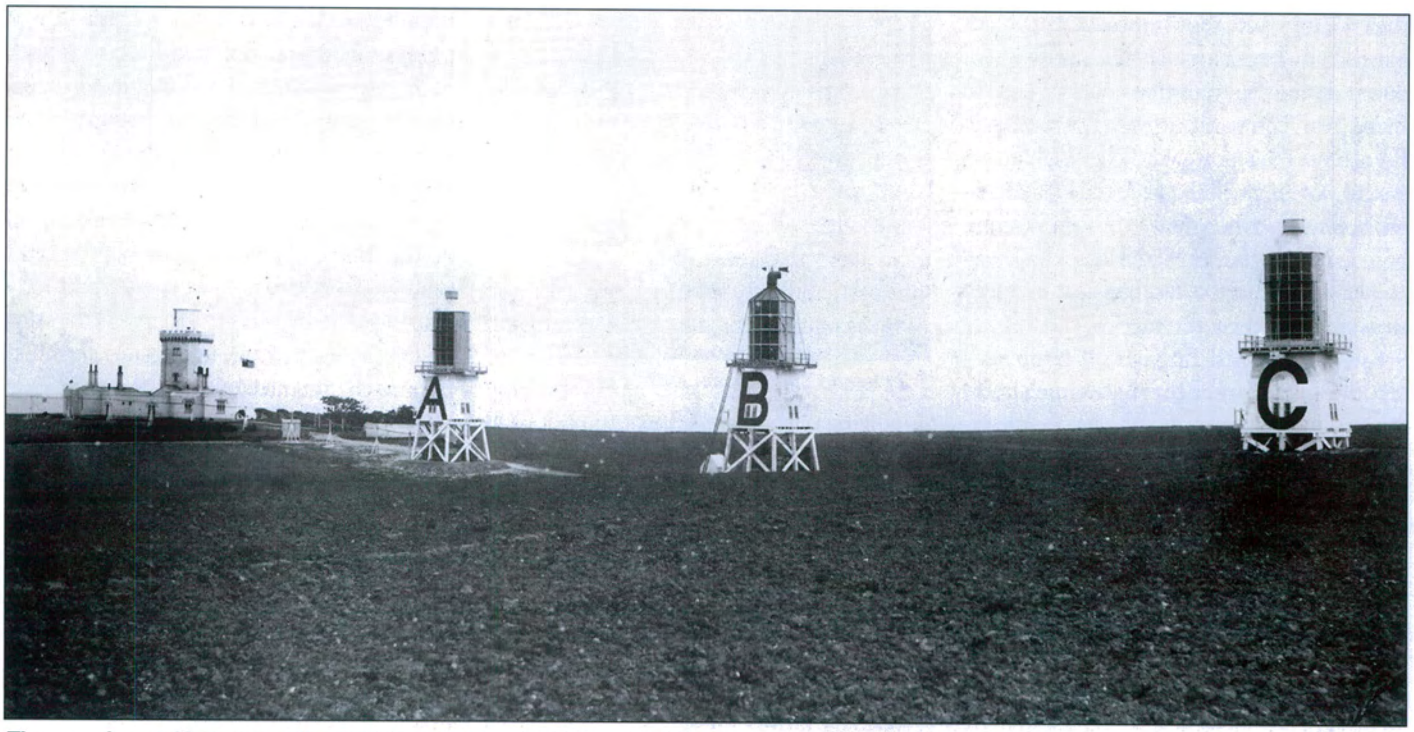
In 1885, a great new trial designed to resolve the lighthouse illumination controversy once and for all was being developed. Electricity, oil and gas were to be extensively tested at the South Foreland Lighthouse site. As the trial was being organized, controversy again arose between James Douglass and John Wigham.

Dr. Tyndall stated: "Sir James Douglass had become the patentee of an oil lamp; and that he should, under the circumstances, accept a seat on a committee in which he, aided by his equally hostile brother, would have to pronounce judgment not only on his rival's lamp but on his own, appeared to me unbecoming to the last degree. I urged – and here again I submit my conduct to the judgment of practical men – that if a committee were formed embracing Sir James Douglass, it ought in fairness to embrace Mr. Wigham also. I contended that either both or neither should be included in the committee."

The committee that would control the experiments replied: "Resolving therefore upon the methods of proceeding, your committee had first to consider how far they might avail themselves of the services of Sir James N. Douglass, the Corporation's Engineer-in Chief, so as to obtain, as they must so greatly need, the full benefit of his practical and scientific knowledge, and yet leave no room for reflections upon his integrity such as have been recently, and your Committee need not say how unjustly, cast upon it."

As the controversy continued, Dr. Tyndall stated: "Mr. Inglis, Secretary of the Trinity House, had previously paid me a visit, and had taken pains to impress upon me the intrinsic difference between Sir James Douglass and Mr. Wigham, and how inadmissible it was that Mr. Wigham should sit upon a committee as the equal of the Trinity House Engineer. On the 8th of November, moreover, 1882, Mr. Inglis, in a letter to the Board of Trade, had urged that, 'whatever may be the part that Sir James Douglass is invited to take in these matters, the Elder Brethren have no doubt that the Board of Trade will concur with them in desiring that he should not be called upon to accept a position derogatory to his standing among civil engineers.'"

A proposal was then made to change Dr. Tyndall's function on the review committee. Tyndall could take no more and wrote to Mr.



The experimental lanterns at the 1885 trials held at South Foreland. Photo courtesy Wigham Collection.

Chamberlin at the British Board of Trade as follows: "These wranglings must now cease. I might have ended them earlier, had not the lives of our sailors, and of those in their charge, been in a measure implicated in the discussion. The messenger who carries this to you will also convey to Mr. Farrer my resignation of the position, which, for so many years, it has been my privilege to hold under the Board of Trade. My resignation of the post of Scientific Adviser to the Trinity House shall also be dispatched to-day." And thus, a great scientific and impartial man was lost to the Trinity House and to the improvement of lighthouses.

There was a great difference of opinion as to the relative merits of electric and gas lights in a misty or foggy atmosphere. It was strongly asserted on one side that the electric light had a greater power than any other luminary of penetrating fog, while the opponents of that theory stated that in foggy weather the electric beam was more readily absorbed than the beam from a gas or oil light. It was not a question of intensity or actual candle power that was involved, because in this respect there was no doubt whatever as to the superiority of the electric light. There was a question connected with the color of the light produced. It was well known that red and orange rays were not as easily absorbed in their passage through a thick atmosphere as were violet rays, and it was asserted that in gas and oil lights the red rays were proportionally more abundant than in the electric light, in which there was an equality of all colors.

The trials in 1885 attempted to determine, which type of illumination was preferable by setting up three experimental lanterns located near the South Foreland Lighthouse. Lantern "A" was used for the electric-arc lamp, lantern "B" was used for the Wigham and Douglass gas systems and lantern "C" was used for the Douglass oil system.

The Trinity House stated: "The lanterns for "A" and "C" were made in the workshops of the Trinity House; that for "B" was constructed by Messrs. Edmundson and Co., a firm in Dublin, of which Mr. Wigham, the inventor of the multi-form Gas System, is understood to be a member." It was as though they were unsure what position Wigham held in Edmundson and Co., when, in fact, he owned it.

Again in this trial the Wigham system was tested as it currently stood while the Douglass trials consisted of current equipment along with the new 7-wick oil burner and several new experimental models of Douglass gas burners (apples and oranges again). In addition, the oil and gas lamps were shown through different sized lenses in a number of trials (still more apples and oranges).

As the great trial went on Sir James Douglass was indeed allowed to pronounce judgment on his own designs as well as those of his rival Mr. Wigham. With the views of the Trinity House already well known and the stacked deck of judges it was hardly unexpected that the results of the trial confirmed that gas was of little use, and even when gas was used, the Douglass gas burners were better than Wigham's anyway.

The committee summed its opinion with regard to the relative merits of electricity, gas and oil as lighthouse illuminants in five points as follows:

- The electric light exhibited in the 'A' experimental lantern had the most penetrative power through fog.
- The Wigham gas system was essentially equal to the Douglass 6-wick oil system when shown through superimposed revolving lenses, and the quadri-form gas light was little better than tri-form oil.
- The gas system was superior to oil when shown through superimposed fixed lenses.
- The new Douglass patent gas burners were much more efficient and economical than the Wigham gas burners.
- For the ordinary necessities of lighthouse illumination, mineral oil was the most suitable and economical illuminant. For places where a powerful light was required, electricity offered the greatest advantage.

A modern evaluation of the data actually shows different results because in most cases the oil lamps were shown through larger lens panels, 68% larger, and the tables of data produced during the trials that could be used to make 'real' comparisons were not averaged. Remember the report said: "The Wigham gas system was essentially equal to the Douglass 6-wick oil system when shown through superimposed revolving lenses." If the lenses had been of equal size and if the data had been averaged we would find the following:

4-wick standard English oil lamp vs. 108-jet gas burner through same sized revolving lens panel: Average for clear weather - oil would produce 29.5 percent less light than the gas burner.

6-wick oil burners vs. 108-jet gas burner through same sized revolving lens panel: Average for clear weather - oil would produce 17.9% percent less light than the gas burner.

It appears that gas probably had an 18 to 29 percent advantage over oil if the same size lens panels had been used.

The big trial was now complete and the results were generally accepted, Tyndall was gone, and Wigham just continued on with his work in Ireland. The next major event happened in 1887 at Tory Island Lighthouse. At that time the lights on Mew Island and Tory Island were revolving tri-form in design, with a burner of 108 jets in each focus of their triple tiers. Still, though the two lights were similar, the Tory beacon was reported by sailors to be by far the better of the two. We need to review how this came to be. The superiority was due to the greater focal length (Hyper-radial) of the annular lenses employed at Tory Island. The evidence shows without question that Mr. Wigham was the first to propose such lenses. On various public occasions he proposed their use and showed that they were necessary to allow the full development of his larger flames. His proposals had not been accepted. In 1872, he brought the subject before the Royal Dublin Society, and again six years later before the British Association. In 1877, Mr. Wigham was in communication with the French lens-making firm, Barbier and Fenestre, and had obtained from it drawings and descriptions of a "Hyper-radial" lens, and an estimate of the amount by which the light of his 108-jet gas burners would be enhanced by its use. These documents and drawings were shown to Dr. Tyndall in 1879. In that same year, Mr. Wigham introduced the subject at

Tory Island Lighthouse. Author photo.

a meeting of the British Institution of Civil Engineers, where Sir James Douglass promptly pronounced judgment on it. "The 'Hyper-radial' lenses," he asserted, "would be too large for lighthouse purposes, and their cost would be prohibitory."

With James Douglass firmly against the Hyper-radial lens, how was it that they were actually used at Tory Island? According to Dr. Tyndall the answer was simple: "As long as the advocacy of these great lenses was confined to Mr. Wigham, the notion of introducing them was not tolerated. But, during the experiments at the South Foreland in 1885, the same conception entered the fruitful mind of Mr. Thomas Stevenson, and to this lighthouse veteran the Board of Trade granted, with alacrity, the necessary sanction for the construction of a hyper-radiant lens. It was made by the self-same firm, Barbier and Fenestre, with whom Mr. Wigham had worked out the subject, and from whom he had obtained the requisite drawings seven years previously. To Mr. Stevenson we are indebted for the expressive name, 'hyper-radiant.' When tried at the South Foreland, its performance was found to be all that Mr. Wigham had predicted it would be. The Commissioners of Irish Lights thereupon took courage to recommend, and indeed gallantly to fight for, the introduction of such lenses at Tory. And though lenses similar to those at Mew had been actually purchased for Tory, they were set aside, and a Tri-form of Hyper-radiant lenses took their place in 1887."

The new light on Tory Island, when full on in fog mode, had a total of three hundred and twenty-four jets, equal nearly to nine thousand candles; in conjunction with the 'Hyper-radial' long-focus lenses used, it was capable of making the light from the three burners equal to about seven million candles, according to Mr. Allard's formula.

Of course, Sir James N. Douglass thought the design was of little use, stating: "The optical apparatus for gas described at Tory Island, is of the same dimension as that at the 'Bishop Rock Lighthouse,' namely, 1,330 millimeters focal distance; but it has three tiers of burners and lenses, instead of two as at the 'Bishop,' where it would not have been prudent to have risked an apparatus of greater height. The system adopted at Tory Island of producing a 'group-flashing' light has two serious defects, especially for a coast light where two or three lights of the same description are required in the same neighborhood, first, the uncertainty in the number of flashes in each group, and secondly, the want of uniformity in the intensity of the flashes. At the 'Bishop,' the system of Dr. John Hopkinson has been adopted, as is usual with all similar apparatus of the Corporation of Trinity House. With these apparatus, the number of flashes in each group is identical, because a separate lens is devoted to each, as shown; and the flashes from each are also always identical in their intensity."

Time after time Wigham's designs solved significant lighthouse illumination problems with the result that they were immediately attacked as useless or nearly so. Then supposedly impartial trials would be held to prove which design was best. In almost all cases the trials were not between the current Trinity House design and the current Wigham design. Instead, new experimental Douglass designs were brought forth in an attempt to compete with the gas system. Wigham's design principles were copied (multiple powers for use in fog), designs were copied (bi-form and hyper-radial lenses), designs were copied in another form (group-flashing lens), all while Wigham was talked of as a mere trader.

Dr. Tyndall stated: "I have reason to know that before his lamented death, Thomas Stevenson this highly distinguished man became fully convinced of the merit of Mr. Wigham, and of the demerit of the attempt made afterwards to deprive him of his righteous due."

In 1887, John Wigham was offered a knighthood, which he refused, stating: "I have always believed that to hold the position of knighthood is not consistent with the principles of the Religious Society of Friends (Quakers) of which I am a member – in this view my family concur." He was invited a second time, and again, refused.

As we have seen, John Richardson Wigham was a brilliant engineer and an honest and modest man, while his opponents appear to have shown little other than prejudice for him and his ideas.