A BIT UNUSUAL

The Search For Alternative Lighthouse Fuels

USLHE oil can.

By Thomas A. Tag

Mixed in with the standard lighthouse fuels used over the years were some very strange attempts to improve lighthouse illumination. This story will give the reader an insight into a few of the more exotic fuels and other unusual modes of illumination that were tried over the last 200 years. I think you will find these more than - A Bit Unusual.

First we need some definitions because many of the early names for various fuels bear little relationship to the modem names.

- Coal Gas, a mixture of hydrogen, methane and carbon monoxide = Town Gas, Coke-oven gas
- Kerosene, a major component of crude oil = Mineral oil, Coal oil, Schist oil, Paraffin, Earth oil
- Natural Gas, a mixture of methane and ethane = Oil Gas, Pintsch Gas, Marsh gas
- Peanut oil = Arachide oil, Earth-nut oil
- Wood Gas, very similar to Coal Gas = Rosin Gas, Blau Gas
- Camphene = Camphine, Pine oil, Chemical oil

There were two basic problems associated with the illumination of lighthouses. First, was the need to provide the brightest light possible for use each night under normal atmospheric conditions. Second, was the additional need to provide some form of still more powerful light for use in emergencies and when the atmosphere was poor due to storm or fog.

Improved Brightness Proposals

Bude Light – In 1835, Mr. Goldsworthy Gurney, of the town of Bude on the West Coast of England, began work on what he called the Bude Light. This lamp used jets of oxygen gas to combine with the usual oil flame. This design increased the combustion of the oil and greatly enhanced the brilliancy of the flame. In 1837, Mr. Gurney proposed that Trinity House adopt his Bude Light in their lighthouses. After preliminary experiments by Michael Faraday, then scientific advisor to the Trinity House, and a practical trial at the Orford Low Lighthouse in 1839, the Bude Light was found to be $2^1/_2$ times more intense than the usual lighthouse oil flame of the same dimensions. However, it charred the wick, the oxygen was difficult to produce at the lighthouse site, the increased cost was too great to justify its adoption, and so it never came into use.

Camphene – Camphene is a hydrocarbon obtained from a blend of turpentine and ethyl alcohol. In 1840, Stephen Pleasonton authorized Mr. B. F. Greenough to begin tests of what he called 'Chemical-Oil', at the Boston Lighthouse as a potential lighthouse fuel. Chemical-Oil was the name Mr. Greenough used for the substance Camphene. It was noted in the experiments at Boston Lighthouse that the Chemical-oil burned with intense brilliancy, greatly surpassing Sperm-Whale oil. Mr. Greenough patented his lamp, which had many advanced features, on April 10, 1841. Mr. Greenough also offered to fit his lamp, using Camphene as the fuel, in the tests of the first Fresnel lenses imported by the U.S. Government. Stephen Pleasonton later reported:

> "I have made a trial of Camphene, by Mr. Greenough, at Boston. The Camphene afforded a beautiful light, but after the lapse of a few months it became decomposed, and was not fit for use."

The storage containers used in those days were supplied by Winslow Lewis and while they did not leak, they did allow the more volatile fuels such as Camphene and Naphtha to easily evaporate.

Coal Gas – The first reported testing of Coal gas was made by the Trinity House in England in 1780. In America, David Melville built a Coal gas plant at the Beavertail Lighthouse at Newport, Rhode Island in 1817. This was the first Coal gas illuminated lighthouse in the world. Although a success, the trial of Coal gas at the Beavertail Lighthouse lasted just one year because of the strong opposition to the use of gas by Winslow Lewis and the Whale oil industry, and it was never used to any extent in America. In 1818, Coal gas was first used at the Salvore Lighthouse near Trieste, Italy by Giovanni Aldini. In 1837, Coal gas was used in the pier light at Troon, England. In 1847, Coal gas was used in the lighthouse at Hartlepool, England with a newly designed burner by Mr. McNeil. Coal gas was later made more effective by passing it through naphthaline, which nearly doubled its flame intensity. While Coal gas generated a bright flame and was relatively inexpensive, it was too difficult to produce because it required the erection of a complete gas production plant at each lighthouse. It was never popular and was used at few lighthouse locations.

The major successful use of Coal gas occurred in Ireland, where John R. Wigham began its use in 1865. Wigham not only proposed its use, but developed many inventions useful in the production and burning of this fuel. A major drawback in burning Coal gas was that the gas burners developed heat as high as 370 degrees within a Fresnel lens, often causing cracks to develop. This was accentuated because one of Wigham's burner designs included 108 individual gas jets in its burner.

Coconut Oil – Coconut oil was tried in many locations. It is a yellowish white solid, found to have a very bright flame that was superior to all of the early oils used. Its major drawback was the fact that Coconut oil remains a solid until it reaches approximately 74 degrees. This forced the keepers to heat the solid mass of Coconut oil before it could be used, even in the summer months. Coconut oil was used at the Cape St. Jaques lighthouse in China, but was not used to any extent in Europe or America.

Cottonseed Oil – Stephen Pleasonton tried to use Cottonseed Oil as a lighthouse illuminant. He stated:

> "I was in hopes at one time to have found a suitable and cheap substitute for Sperm-Whale oil in that from Cottonseed; for, having tried it in my family, I found it to bum very well when new. But, like all oils from vegetable substances, after a few months it became thick and unfit to burn."

Fluorescent Electric Bulbs – The fluorescent light bulb, which came into use just before World War II, was tested as a possible lamp for lighthouse use. However, the Coast Guard tests showed that it did not have the candlepower for lighthouse use. The light was too diffuse and would not work well in the focus of a lens.

Lime Light – The Drummond Lime Light is produced by two jets of gas, the one of oxygen and the other of hydrogen, ignited upon a ball of lime measuring only three-eighths of an inch in diameter, and placed in the focus of a parabolic reflector or lens. (See the section on 'emergency lighting proposals' for further details.)

Linseed Oil – Linseed oil was tried by the French in 1861 - 1862. The oil was consumed very quickly by the Argand Lamp. The flame was found to be inferior to most other oils, and it had a major problem because it is known as a drying oil. A drying oil thickens and becomes hard on exposure to the air, potentially clogging the lamp and storage tanks.

Magnesium – Several lighthouse authorities also tried the light from the combustion of magnesium. From the results obtained, it appeared that if this metal could have been procured in sufficient quantities, and at a reasonable cost, it could have superseded all other materials which were proposed for lighthouse illumination. A flattened wire, weighing 3½ grams to the foot, gave a light while burning in the air, equivalent to 206 candles. In 1868, magnesium lights were tried in America. The Magnesium light worked well, but the problem was the availability of a consistent supply of high purity Magnesium and in developing a reliable method of burning it over long periods of time with little attention by the keeper. It was therefore found unsuitable for lighthouse purposes.

Naphtha – Naphtha is a volatile and highly flammable hydrocarbon from petroleum. In 1845, Alan Stevenson, of Scotland's Northern Lighthouse Board, stated that he had tried the vapor of naphtha in a lighthouse lamp.

> "I heard by accident from one of the elder brethren of the Trinity House of experiments having been made under the superintendence of that body as to the substituting of Naphtha for oil in lighthouses. On mentioning this circumstance at the next meeting of the Bell Rock committee, our Board made an application requesting to have the details of those experiments communicated. This request was favorably received by the elder brethren."
>
> "In my experiments I found that there is a risk involved in the use of gaseous substances like Naphtha, and I have found nothing in its illumination abilities that I conceive warrants the running of such risk in regard to the regular exhibition of the lights."

Both of the experiments at Trinity House and at the Northern Lighthouse Board found Naphtha too dangerous to use as a lighthouse fuel, and its use was abandoned.

Natural Gas – Oil gas was first used at the Holyhead Lighthouse in Wales in 1820, and in 1823, Pintsch gas was tried at the South Foreland Lighthouse in England.

A lighthouse built in 1829, known as the Barcelona Lighthouse, and sometimes called the Portland Lighthouse, located on Lake Erie, was unique because of its fuel source. The nearby town of Fredonia, New York 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. The Lighthouse Service was obliged to keep standard Sperm-Whale oil lamps in the tower as a backup light source, because water frequently collected in the gas pipes, over which the gas would not pass. While the pipes were removed and freed of water, the oil lamps had to be used. Unfortunately, the Natural gas gave out in 1838, and the gas lamps were removed.

Natural gas was used in lighthouses in a number of countries. However, its production, delivery, and excessive heat restricted its use to a relatively small number of lighthouse locations.

Neon Electric Bulbs – When new types of light such as neon were invented, they were tested for lighthouse use. Neon was tried in 1928, but was a rather poor illuminant.

Nuclear Powered Electric Generator – On May 20, 1964, a 4,600-pound SNAP-7B radioisotope Strontium-90 Nuclear generator was placed in operation at the Baltimore Light Station. However, it was not a success and was removed two years later.

Olive Oil – Among other forms of oil used for lighthouse illumination was refined Olive oil, used in the Liverpool, England lighthouse burners between 1847 and about 1887. Olive oil was also used extensively in the Spanish, Italian and Austrian lighthouses, and was burnt in a number of other countries where it was locally produced.

Peanut Oil – Peanut oil was tried by the French in 1861 and 1862 and later by several other lighthouse authorities. It was one of the longest burning oils tried and had a bright flame in a one-wick lamp. Its flame was less bright in a two or more wick lamp. It was more expensive than Colza oil, and not easy to obtain in Europe. It was never used in lighthouses to any extent.

Porpoise Oil – The United States Light House Service tried an interesting experiment in 1803-1804, when the commissioner of revenue instructed the keeper of the Cape Hatteras Lighthouse to test Porpoise oil. The test showed that the Porpoise oil flame was rather poor. The supply of Porpoise oil was small and further usage of this fuel was abandoned.

Sheep's Tail Oil – One of the most peculiar illuminants was that used about 1849 in the Cape Green Point, Cape Mouille and Cape Agulhas Lighthouses near the Cape of Good Hope in South Africa. This oil was procured from the tips of the tails of the cape sheep, and was said to be far superior to any other oil for brilliancy of light, but the quantity of oil consumed, and the expense of procuring the oil, was great. It cost significantly more per gallon than Colza oil, and each first order lighthouse consumed about 730 gallons yearly, whereas 482 gallons of Colza oil would have been sufficient.

Wood Gas – Monsieur Le Bon was given a French patent for producing illuminating gas from wood in 1799, which was made by carbonizing wood in a closed retort. Wood gas was first used in the Porkkala Lighthouse in Finland in 1800.

U.S. Coast Guard Cutter *White Pine* at the Baltimore Lighthouse installing the Nuclear Generator. Photo courtesy of the Coast Guard historian's office.

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 an enclosed retort. After about a year of trial, the effort at Christina Creek was abandoned as impractical.

In total there were four of these Rosin gas lights in the Delaware Bay: Christina Creek, Reedy Island, Cohanzey, and Egg Island. These lights all required the building of a gas production facility next to each lighthouse. In addition, standard Sperm-Whale oil lamps were used for three to six months each year because the keepers often allowed the furnaces and retorts, used to produce the Rosin Gas, to burn out before they gave notice to the district superintendent of the necessity of supplying new ones. The provision and installation of the replacements often required several months.

Stephen Pleasonton later ordered a double set of furnaces and retorts at each lighthouse, in order that one set might be used while the other was undergoing repairs. However, this produced no improvement, as both sets were burnt out before the keepers gave the necessary notice for new ones. The keepers were opposed to making and burning gas, and preferred the Sperm-Whale oil lamps. The district superintendent consequently was given orders to notify the respective keepers that if appropriate notice was not given by them to keep the gas-works in repair, it would be cause for their removal. Even this action failed to correct the problem.

Stephen Pleasonton finally abandoned the project. Although the gas from rosin was very inexpensive, it was not advisable, in his opinion, to continue the attempt to use gas in lighthouses. The average keeper could not handle the production of the gas and to employ more qualified men in the gas production facilities at each lighthouse, would occasion an expense out of all proportion to the benefits to be derived.

In Germany, Blau gas, a product of the burning of charcoal with a mixture of air and steam, was tested in lighthouses and buoys. The advantage of Blau gas was that it could be stored in rather small steel tanks, and that it was not considered to be very explosive. However, Blau gas did not become generally used in lighthouses and only found an application, in later years, as the fuel for the motors on Zeppelins.

Emergency Lighting Proposals

Sir David Brewster suggested in 1826, the necessity of providing a means of exhibiting powerful lights in cases of severe fog or other emergency. He proposed three possible emergency lighting methods:

1. The use of chemical signal lights
2. The use of the Drummond Lime-Light
3. The use of any extra lamps which may be available in the lighthouse

Colored Light from Chemical Powders – The Blue, or Bengal, Light was produced by a chemical powder made from potash, sulfur, carbonate of copper, and alum. It was called a Bengal light because Bengal, in India, was the chief source of its chemical components. The Red, or Crimson, Light was produced from a chemical powder made of Nitrate of Strontia, sulfur, and potash. The Green Light was produced from a chemical powder made from Nitrate of Baryta, sulfur and potash. These chemical lights were a type of firework, designed to burn steadily for a short time. They were normally used for signaling and only needed to burn long enough to send a message or to obtain bearings for direction fixing. Sir David Brewster's recommendation was reviewed, and eventually Scotland's Northern Lighthouse Board conducted experiments as follows:

"*First night's experiment* – On Tuesday, the 12th February 1833, the experiment first suggested by John Robison, esq., secretary to the Royal Society of Edinburgh, with the blue or Bengal light, was exhibited; first at eight o'clock, but it was not then visible from Carlton Hill. It was shown again at nine and ten o'clock, when it was faintly seen.

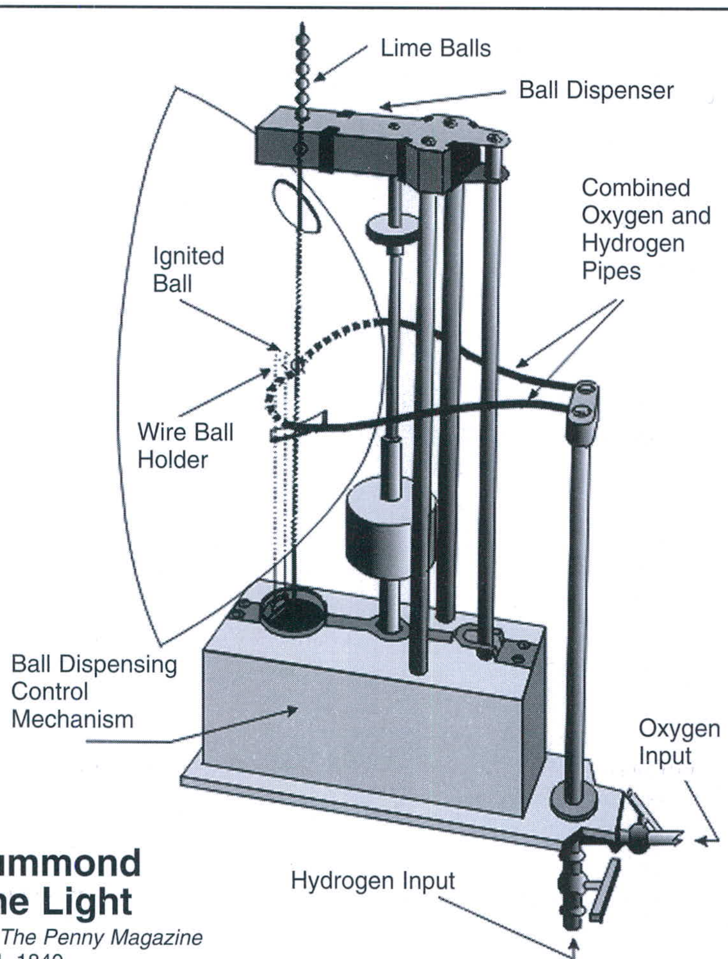
"*Second night's experiment* – At ten o'clock, when the lens and reflected lights were extinguished, the Bengal, and also what are called red or crimson lights, were exhibited. The former was hardly visible, but the latter produced a bright flash of red colored light, which was distinctly recognized by the party.

"*Third night's experiment* – On Thursday the 14th, the same experiments as on the 13th, were exhibited in a similar state of the atmosphere, and with nearly similar results. The experiments with the Bengal and red crimson lights were again exhibited. The former was hardly visible, but the latter, though of momentary duration, was distinctly seen.

"*Additional experiments* – On Wednesday the 20th, the blue light was tried in the focus of the lens. It was exhibited at half-past 8, and the red light in the focus of the lens was shown at a quarter before 9 o'clock. These lights were to be kept in view for 10 minutes each, but this was not accomplished."

Alan Stevenson, Engineer of the Northern Lighthouse Board, reported on the experiments as follows:

> "We tried the lights produced by the nitrate of strontia, the nitrate of baryta, and the Bengal light. The substances were burned in pans at Gullanness, and observed from the Carlton Hill of Edinburgh, a distance of about 14 miles. They were very well seen, and the effect was splendid; but we found them completely inapplicable to lighthouses, from the impossibility of burning them for any length of time. Each of the three substances was tried and each was found to produce sulphurous fumes in great quantity, so as to render it impossible to burn them in a close[d] chamber."



Drummond Lime Light
From *The Penny Magazine* April 4, 1840

Drawing by Thomas A. Tag.

Sir David Brewster's views of the experiments were at considerable odds with those of Alan Stevenson. He stated:

> "In introducing the blue and red lights for occasional purposes, we have only to bum them on an iron plate or dish, placed either beside the usual burner, or occupying its position. From the power of the red light to penetrate fogs I consider it as an invaluable resource in lighthouses. In the experiment, which the Commissioners witnessed, its brilliancy was fully equal to that of the usual lamp within the lens apparatus."

Alan Stevenson's view prevailed and the chemical lights were abandoned as emergency lighthouse illuminants. However, I am sure that most of us recognize their eventual use in flares, star shells and in our annual Fourth of July celebrations.

The Drummond Lime Light

The Drummond Lime Light is produced by two jets of gas, the one of oxygen and the other of hydrogen, ignited upon a ball of lime (Calcium Oxide) measuring only three-eighths of an inch in diameter, and placed in the focus of a parabolic reflector or lens. Its light is equal to about 284 flames of an ordinary Argand lamp used with the best Sperm-Whale oil. It bears the name of Lieutenant Thomas Drummond, Royal Engineers, who first applied it in the focus of a parabolic reflector for geodetic purposes, and afterwards proposed it for lighthouses. So intensely brilliant was this light, that in good atmospheric conditions, observers could see their shadows at about 13 miles from the lamp.

Lieutenant Thomas Drummond described the development of the Lime light as follows:

> "I had been working with signal lights in 1816, in consequence of being employed on the trigonometrical survey of England. Great difficulty was being experienced in seeing the distant stations, such as the observation of Leith Hill in Surrey from Berkhampsted Tower in Herfordshire. These circumstances combined to show how desirable it would be to procure a very brilliant light capable of penetrating the almost constant haze, which in some cases impedes the progress of such survey operations.

About the same time I began to repeat some experiments of Jöns Jacob Berzelius, on the distinctive qualities of different substances heated in the flame of a blowpipe. The property assigned by Berzelius to lime, was that of emitting, when heated by the blowpipe, of a peculiarly bright light. The effect of this light was very distinct, even when the particle of lime was so minute, that it could barely be seen by the naked eye. It occurred to me, that if an apparatus could be constructed whereby a ball sufficiently large could be kept in a state of intense ignition, its effect, when placed in the focus of a reflector, would far exceed that of any light hitherto used. I commenced a series of experiments with this view.

"I designed the basic Lime light over the next few years and its operation was gradually perfected to the point where it could be put into actual trials of its operation and usefulness.

"One of the early successful trials occurred during the survey of Ireland in 1826. There was a hill called Slievesnaght, in Innishowen, so constantly enveloped in haze that it had been invisible to us for two months. I then determined to put the Lime light on it. In the line of direction with this hill, but very much nearer, there was a church tower, in which a common reflector with an Argand lamp was placed. The church with the Argand lamp was 12 miles distant while the hill with the Lime light was nearly 70 miles distant. When the lights were lit, the Lime light at the distance of 70 miles appeared larger and brighter to the eye than the Argand lamp at 12 miles. Anyone who did not know their actual positions would have said that the more distant one was the nearer one, judging by the appearance.

"The result of the experiments in Ireland were such as to induce me to bring this mode of illumination to the notice of the Trinity House for potential use in lighthouses, and a series of experiments were instituted in 1829 by the direction of that corporation.

"There are, it must be admitted, circumstances of some difficulty to be removed before the use of this method can be safely recommended for lighthouses. The circumstances to which I allude are, first, the rapid diminution of the ball, by the lime becoming fused and volatilized, and the difficulty therefore of replacing the lime. It requires some apparatus that shall keep up a constant supply, and renovate that portion which has become useless. If the lime ball cracks or breaks, which it is sometimes liable to do, the heat of the mixed gases is so great that it will melt any part of the apparatus which might be exposed by the removal of the lime, and the light would of course be extinguished. These, I think, are the chief circumstances of difficulty attending its management in the lantern. The other circumstances relate to the question of economy. The preparation of the gases is easy enough, but the materials from which they are prepared are bulky, and the situation of a lighthouse is very often such as to render the transport of materials of this description expensive.

"The lighthouses as now erected, are seen at as great a distance as the curvature of the earth will allow in a clear atmosphere. If clear nights were the ordinary state of the atmosphere in this country, then of course there would be much less occasion for having a very bright light. But, as haze is the general state of the atmosphere, more or less intense, then it becomes an object of great consequence to get a light, which shall be distinctly visible in such nights. In hazy or thick weather there would be a chance of my light being seen when the present light would not be discernible."

Trials of the Drummond Lime light were also held in Scotland by the Northern Lighthouse Board in 1833. The results of the trials were described by Alan Stevenson, the engineer of the Northern Lighthouse Board, as follows:

"We established that the Drummond light is visible in certain states of the atmosphere in which the reflector and the lens lights are not to be seen. We proved this by showing all three lights, the French Fresnel lens, the Drummond Lime light and the reflector lights, at one time, and observing them at the distance of 15 miles, as well as at the distance of 12 miles and about six miles. We found that the Drummond light was quite visible when the others were so completely eclipsed as not to be seen at all.

We also tried the Drummond light in the focus of the lens, and compared it with the reflector, but we found the lens to give an inferior light to the reflector when both were illuminated by the Drummond light.

In its present state, the Drummond Lime Light is quite inapplicable to a lighthouse. I believe a cylinder of lime might be more convenient than a ball, if future trials are made."

Trials were also made in France. Monsieur Reynaud, the engineer of the French Lighthouse Service, stated:

"The oxy-hydrogen or Drummond light has many times been suggested, the expense, the danger attending its use, and the irregularity of its flame have prevented, up to the present time, its practical use in lighthouses."

By 1858, improved Lime lights had been designed by James Copcutt. The light was on the same principle as Drummond's, but varied in the shape of the prepared lime on which the oxy-hydrogen flame played. The prepared lime, in the form of a thin block, was pushed slowly upwards as it was worn away by the heat, and was prevented from falling outward by a series of wires. The Lime block design was a significant improvement over the use of Lime balls sliding down a Platinum wire, but it was still not reliable.

Copcutt's design was further improved by Major W. E. Fitzmaurice, who designed what he called the Oxy-olefiant Lime light using Oxygen gas. Olefiant gas, which we know as Ethylene, was used in place of the normal Hydrogen gas. With the aid of a reflector, the Oxy-olefiant Lime light could allow someone to clearly see the hands of a watch a mile distant from the lamp. This design also used a prepared Lime wick. A trial of this light was made at the Trinity House Blackwell test facility in December 1858. However, it also failed.

In 1860, Mr. Prosser, later affiliated with the Universal Lime Light Company of London, invented a still further improved Lime light that was brought to the attention of Michael Faraday, scientific advisor to Trinity House. A practical trial of this light was made at the South Foreland High Lighthouse in 1861-62, but the results were not satisfactory enough to lead the Trinity House to adopt it. The Electric light was also being developed and tested at this time and looked more promising.

In 1868, the American Lighthouse Board tried using the Lime light and reported on its usefulness as follows:

"The Lime light required much labor, there was danger associated with the production of the gases used, it required expensive apparatus, and the liability of the lime to become deranged far outweighed any advantages in the way of superior illumination which could be derived from it."

Within a few years the Electric light was placed in further trials and early usage of the Electric Arc light was begun. At this time, Thomas Drummond's Lime light was abandoned as a potential lighthouse illuminant.

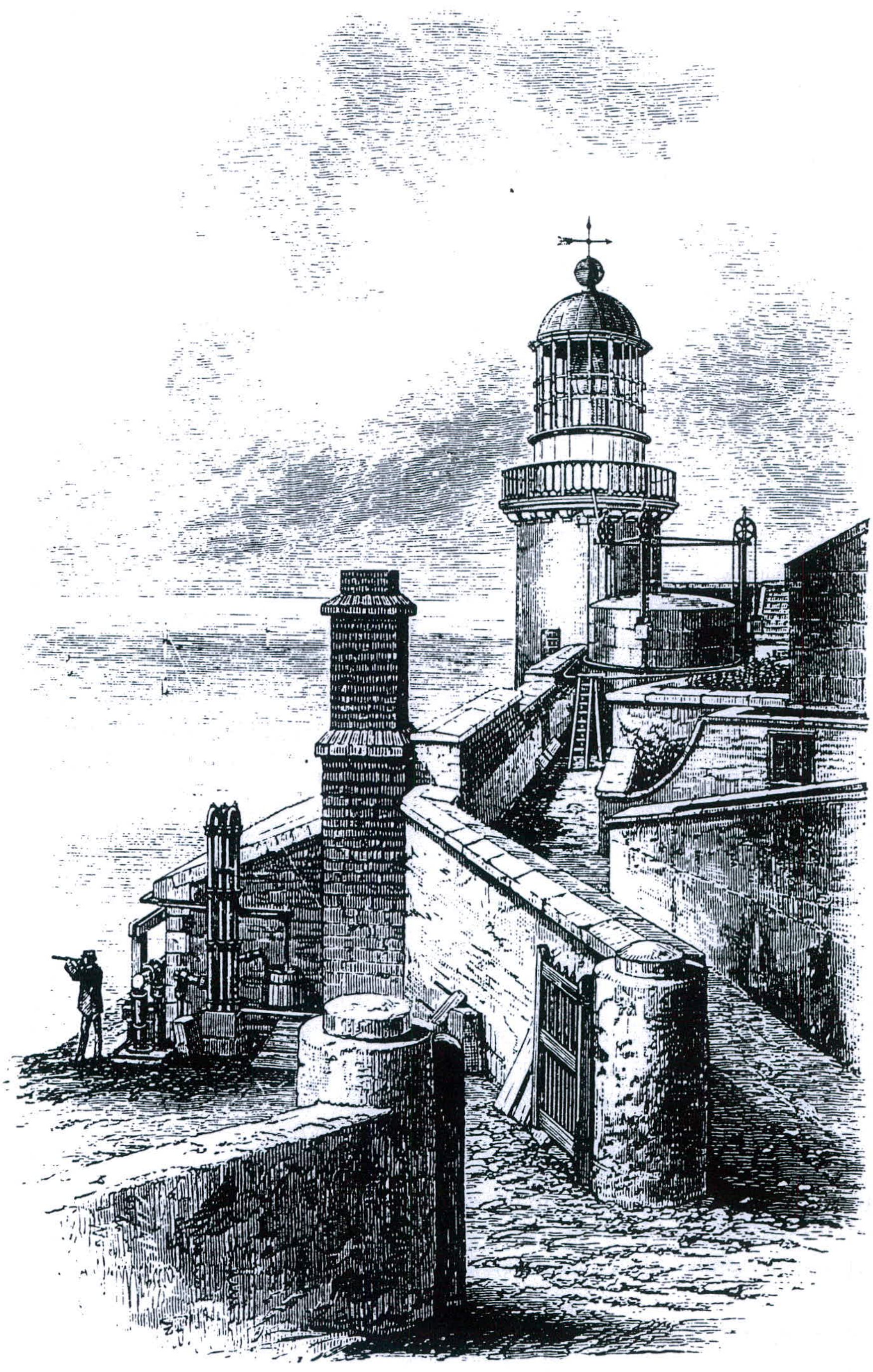
The Use Of Extra Lamps Within A Lens

Sir David Brewster suggested the following as a last resort for an emergency light:

> "If the lighthouse keeper is provided neither with the Drummond light, nor the blue and red signal fires, he can at present do nothing to add a ray to his reflectors, even if he knew that in a dark and stormy night human life is exposed to danger; with the lens apparatus, on the contrary, he can surround the main burner with all the spare Argand burners in his possession, and thus convey a great quantity of additional light into the refracted beam."

While this suggestion might sound useful, adding additional lamps within a Fresnel lens accomplishes almost nothing, because the lamps cannot be located within the focus of the lens, which is already occupied by the standard lamp. This proposal was also quickly abandoned.

As you have seen, the lighthouse authorities around the world constantly looked at potential new lighthouse illuminants. Some worked, while most did not, and some were just – **A Bit Unusual**.



Gas Lighthouse at Wicklow Head, Ireland. Buiding at left is the gas manufacturing house. Gas storage tank next to the light tower.

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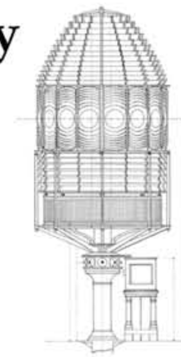

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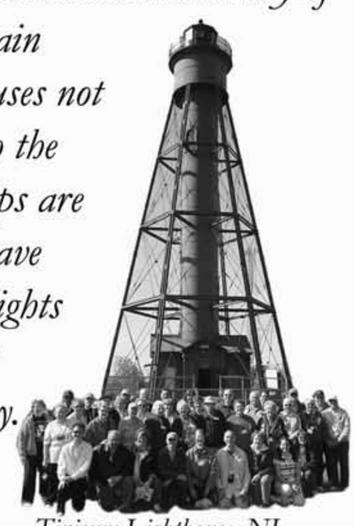

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