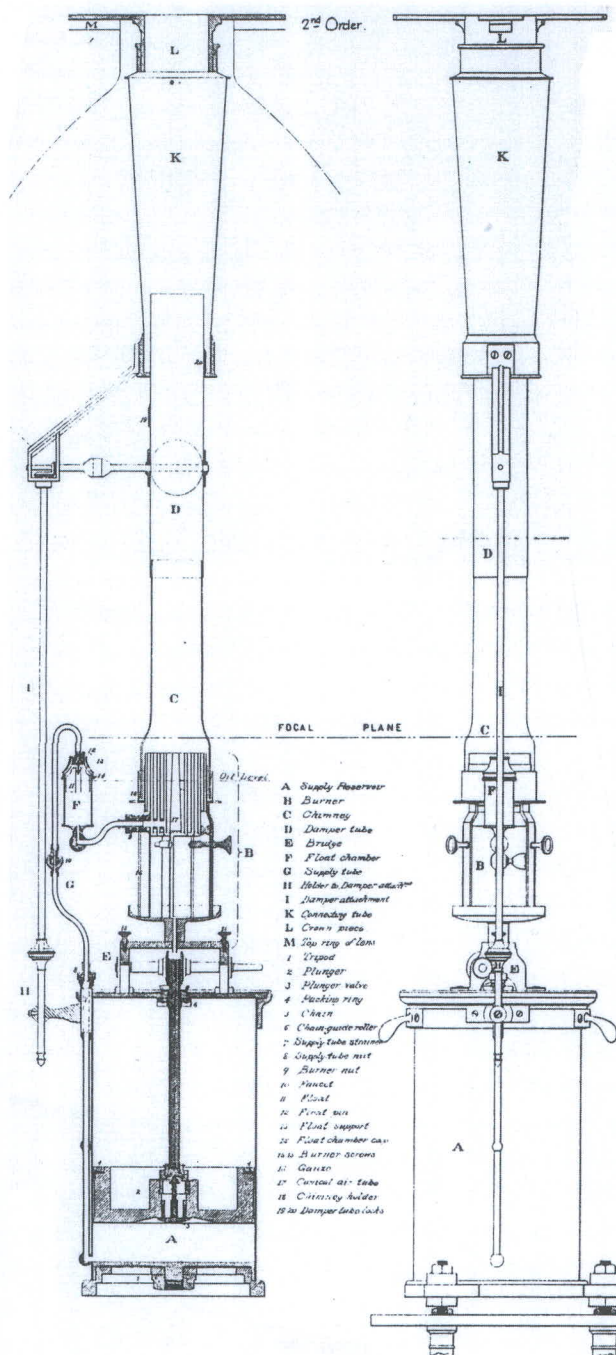


The Doty Dilemma

Technological Advancements in Lighthouse Lamps and Subsequent Patent Infringement

By Thomas A. Tag

U. S. Three-Wick
Mineral Oil Lamp
1880



Introduction

Most lighthouse research is drudgery. You go from item to item of mostly boring detail and slowly, very slowly, progress is made. But once in awhile, an unusual discovery is made and you run across a real gem buried in the musty details. That was the case with this story. In an obscure file box in the National Archives, I ran across information about Captain H. H. Doty that filled in many missing pieces of information about his struggles with our government some one hundred and thirty years ago. The information allowed the creation of this story about how Henry Harrison Doty was involved in converting the world's lighthouses to the use of kerosene as a lamp fuel and the dilemma that his patents raised for the United States Lighthouse Board.

Kerosene as a Lighthouse Fuel

Earth oil, Mineral oil, Paraffin, Schist oil and Coal oil are all petroleum oils and are alternate names for basically the same substance that we know as kerosene. Throughout this story the original oil name is used in any quoted information. However, regardless of the specific name used, kerosene is the fuel being described.

Kerosene was first distilled from coal, in 1846 by Dr. Abraham Gesner, a physician from Cornwallis, Nova Scotia. He called it coal oil and it was first used in the Canadian lighthouse at Meagher's Beach, Nova Scotia in 1852, and was later used in lighthouses on the St. Lawrence River in the early 1860s. Its popularity grew in Canada because most Canadian lighthouses of that period still used reflector lights with a single wick lamp and because the brighter flame produced by kerosene was more efficient.

Petroleum oil had also been found in 1847 in a coal mine in England. Its discoverer was James Young who found that this oil was a valuable lubricant. Young then began experiments in distilling kerosene (called Paraffin in Scotland) from the shale found in and near coal deposits. By 1850, Young was producing kerosene and other forms of petroleum oil from the shale and had begun the oil industry in Scotland.

The Lighthouse Board first began to experiment with the use of kerosene in 1855. However, they found that the available kerosene was highly volatile and potentially very dangerous, especially in the hands of an untrained lighthouse keeper, and stopped further testing.

In 1856, a Frenchman named Monsieur Maris invented one of the first single wick lamps that could efficiently burn kerosene. However, it was not until 1859, when Colonel E. L. Drake discovered oil in Pennsylvania and began the American petroleum industry that kerosene became a readily available, low cost potential for a lighthouse fuel.

By the early 1860s, whale oil had become very expensive and the American authorities began looking for a cheaper alternative. The Lighthouse Board tested many oils and tried, with little success, to persuade American companies to produce colza oil. At this time, kerosene was again under test by the

Lighthouse Board, but during the trial, the keeper of a lighthouse on Lake Michigan substituted a kerosene lamp he had purchased on his own, for the usual lighthouse lamp. The kerosene lamp gave a good light and required no trimming during the night. It burned well for several nights, and the keeper congratulated himself on the success of what he considered a very important experiment. Unfortunately, one morning he attempted to extinguish the flame by blowing down the chimney, when an explosion took place. The explosion scattered burning kerosene over the deck of the tower and also on the keeper's clothes. The keeper ran down the stairs of the tower, and had just reached the ground when he heard a violent explosion, which blew off the whole lighthouse lantern and broke the lens apparatus. The Lighthouse Board again found that the available kerosene vaporized at too low of a temperature causing it to be highly volatile, and was thus subject to explosion if not handled very carefully. The keeper recovered, but the accident caused the Board to abandon its attempts to use kerosene.

Starting in 1864, the Lighthouse Board devoted its efforts to the perfection of high-grade lard oil. This proved highly satisfactory having only one drawback. In winter the oil congealed at low temperature to a greater degree than whale oil and it had to be pre-heated before it could be placed in the lamp. Once the lamp was lit, the heat radiating from the burner served to keep the oil sufficiently fluid. Lard oil was introduced in the U. S. lighthouses during the years 1865-1867.

The French were also experimenting with the use of kerosene and found success with its use in their single-wick Maris lamp for use in the fourth, fifth and sixth-order lenses. However, Monsieur Reynaud, the Chief Engineer of the French Lighthouse Service, stated in 1864:

"All attempts made up to the present date to apply mineral oils for lighting the three superior orders of lighthouse apparatus have been fruitless."

An American ship captain, Henry Harrison Doty, thought he could solve the problems related to the use of kerosene in lighthouse burners. He described his efforts as follows:

"In 1866, the idea occurred to me

that if paraffin as now manufactured, with a large specific gravity and safety standard, could be employed in Lighthouse Illumination, a great reform in the economy and intensity of coast lights would be attained. I accordingly set myself resolutely to the solution of the problem, how this could be effected, not only for the one wick burner, but for lamps having concentric wicks. After more than two years unremitting study and experiment, I was successful in discovering the means of doing this for all the different orders of burners, and that too, without causing any structural re-arrangement of the apparatus or lamp at present in use."

Trinity House, the English Lighthouse Authority, experimentally converted a few of its single-wick lamps in their fourth, fifth and sixth-order lenses to the use of kerosene in 1866. James T. Chance, a major manufacturer of lighthouse equipment and lamps in England, stated on May 7, 1867:

"In the lamp with a single wick, colza is being superseded by petroleum which is cheaper, and gives a more intense light than colza."

In early 1868, Captain Doty had what he thought was a workable lamp design for the use of kerosene and went to the Trinity House to try to interest them in his invention. The Trinity House scientific advisor, Dr. Tyndall, tried Doty's burner on May 30, 1868, and stated:

"I have this day examined Captain Doty's Paraffin Lamp, and compared its performance with that of the oil lamp usually employed in first class dioptric apparatus. The ratio of the one light to the other was in the first experiment 5 to 7, the larger number representing the emission from the oil (Ed: colza) flame. By nursing his flame, Captain Doty raised it so as to make the ratio 6 to 7; I even rendered it a little nearer to equality. I do not doubt that improvements on his lamp might enable Captain Doty to render his flame fully equal to the oil flame. I will not say that the difficulties to which I refer cannot be overcome to anything like the extent which would justify me in recommending to the Elder Brethren the displacement of oil by paraffin."

Captain Doty later produced a further improved burner with four concentric wicks for a second trial, but was told that the Trinity House was decidedly adverse to the use of kerosene and would not allow any further trials. The Trinity House Chief Engineer stated on November 17, 1868:

"Much remains to be done in the application of petroleum, as at present only burners with one circular wick have succeeded."

The French Lighthouse Service had long been considered the leader in technical innovation and quality. Captain Doty took samples of his latest burners and went to Emperor Napoleon III in November 1868, convincing him of their advantage and requesting that France put them on trial. Doty's request was granted and a trial within the French Lighthouse Service was begun in December 1868 and completed successfully in January 1869. A number of French lighthouses were then converted to kerosene as a fuel, with the Doty burner modifications. The French did not use the Doty burner directly. Instead, they bought the rights to use Doty's design principals in their own burner designs. In 1873, Monsieur Reynaud, the Chief Engineer of the French Lighthouse Service, stated:

"The numerous attempts by Engineers and manufacturers to use Mineral Oil in lamps of the superior orders, (which have, as is well known, several concentric wicks) did not succeed; the combustion was incomplete, brilliancy feeble, smoke sometimes abundant. While we were still experimenting, Captain Doty, an American, succeeded in solving the problem, which until then had baffled all."

In early 1870, Captain Doty went to Messrs. David and Thomas Stevenson, Engineers of the Northern Lighthouse Board in Scotland. The Stevensons were already at work on a kerosene burner of their own, but stopped when they saw the Doty burner in action. The Stevensons and Dr. Macadam, the chemist of the Northern Lighthouse Board, put the Doty burner into rigorous and impartial trials at the Girdleness lighthouse where it proved highly successful. After the trials the Doty burner was quickly put into use in two Scottish lights. By the end of 1870, kerosene began to replace colza

and sperm oil as the fuel used in Scottish lamps.

After the trials in Scotland, Captain Doty submitted his burner to the other lighthouse services around the world. He suggested that his burner modifications solved the following concerns:

- Kerosene can be used in lighthouses without danger.
- Kerosene is not affected by extreme cold.
- The Doty burner can be easily used in all existing lamps.
- The Doty burner will work with the existing wicks and chimneys currently used with colza and animal oils.
- With kerosene, the burners are more easily maintained.
- Kerosene produces a purer and more intense light.
- The cost of maintenance with kerosene is about one-half that of other oils.

Captain Henry Harrison Doty received a United States Patent no. 109,303 for his invention "Improvement in Apparatus for Burning Paraffin and Other Hydrocarbon-oils," on November 15, 1870.

The Trinity House heard that the French Lighthouse Service and the Scottish Northern Lighthouse Board were deploying kerosene lamps in their single wick burners and were about to make major deployments of Doty's kerosene multi-wick lamps. Trinity House began another series of experiments with kerosene. By November 1870, Trinity House had arrived at an efficient method of burning kerosene in single-wick lamps and began full-scale deployment. Trinity House was also starting experiments with multi-wick lamps at this time.

The Trinity House Chief Engineer, James Douglass, was able to design a multi-wick kerosene burner by March 1871. Although Captain Doty said:

"Mr. Douglass was able, after I had shown him the way, and by adopting parts of my invention to produce a concentric wick burner. Immediately when it was seen what a great revolution my invention was destined to make in lighthouse illumination, lamp makers, in addition to the engineers of the Trinity House, by spurious variation of parts of my burners, have attempted to defraud

me of the fruit of my labors."

Many excuses were made for Trinity House not paying Captain Doty for his patent rights. Alexander G. Findlay reported about the introduction of kerosene in his book, *The Lighthouses of the World* as follows:

"Another form of burner was devised about 1868 by Captain H. H. Doty, on the introduction of Mineral Oil, with excellent effect, and was adopted by the Northern Lighthouse Board, and the French Lighthouse Department. At this time, the Trinity House officials found, by a series of experiments, that no principles were involved in the construction of lamps for combustion of Paraffin Oil for lighthouse purposes other than those already in use in lamps for burning Colza Oil."

It is strange that all of the lighthouse services of the world found that their standard lamps required significant modification to use kerosene, but somehow, the lamps in use in England required no new principals. Chief Engineer Douglass was a brilliant engineer, but was the design he used totally his? Captain Doty's response was a legal case against the Trinity House for patent infringement.

Late in 1871, Captain Doty first made the American Lighthouse Board aware of his invention and presented a model to them for review and testing. At the same time, the Barbier & Fenestre Co., in France, purchased Captain Doty's patent for mineral-oil burners. They had the right to produce and sell Doty burners worldwide except for Great Britain and America, where Doty maintained his rights, and for the French government, with which Doty had made a special arrangement. The Barbier & Fenestre stated that mineral oil had been adopted in most countries of Europe, as well as in South America and Canada by 1873. During 1872-73, all of the other manufacturers of lighthouse lamps, in France, were also busy modifying their colza oil lamps for the use of mineral oil, using Doty's principals.

Back in America in 1873, the Lighthouse Board requested bids for 95,000 gallons of oil, Sperm-Whale, Colza or Lard oil. They would buy whichever came in at the lowest bid. The oil was to be delivered in well made casks, hooped with iron, each having a capacity not exceeding 50 gallons. Lard oil won the competition based on its lower cost.

News of the conversion to kerosene by many of the world's lighthouse services prompted the Lighthouse Board to begin a third study of the use of kerosene late in 1873. The Lighthouse Board advertised for samples of kerosene early in 1874. Joseph Funck, the foreman of the Lamp Shop at the Tompkinsville New York Depot, was assigned to begin analyzing any changes necessary in the design of lamps for the use of kerosene. This time, the trials were a success and kerosene was found to have a brighter flame and to be far less expensive than lard oil. Later that year, Funck's single-wick lamp design had been perfected and the Board began to use kerosene in some small single-wick lamps on the inland rivers.

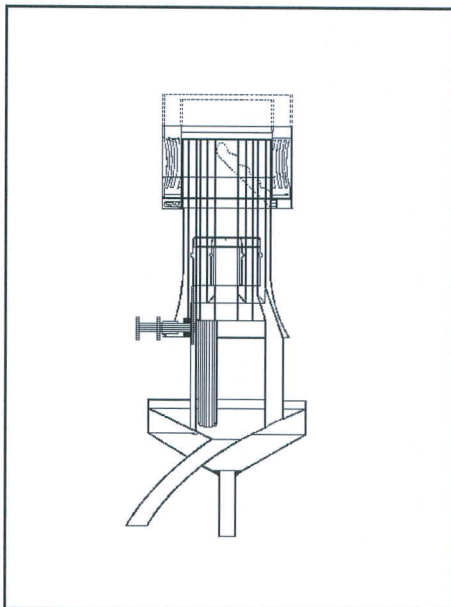
One problem with the use of kerosene was that it did not overflow the lamp burner and cool it as the lard oil did, leading to over heating of the burner and melting of the solder used to connect the various burner parts. This required the solder to be replaced in kerosene lamps with Spelter a much harder soldering compound that melted at a higher temperature. A second problem was still the tendency for kerosene to explode if not of the proper grade or if not handled properly. In order to resolve this problem, the kerosene selected for use by the Lighthouse Board had a flash point of at least 140°F and had to pass a fire test of at least 154°F without catching fire.

By 1874, Captain Doty's kerosene lamp burners were being installed throughout Europe, with the exception of England, and also by the governments of Japan and New Zealand and others. However, Captain Doty could not convince Trinity House or the American Lighthouse Board to use his design, and on December 18, 1874, Captain Doty first warned the Lighthouse Board that he might file a lawsuit if they continued to deploy Funck's version of a kerosene lamp.

The Lighthouse Board began converting its fourth, fifth and sixth-order lamps to kerosene in 1875, but in June 1876, Captain Doty was given a reissue, no. 7165, of his patent giving him credit for most of the items in the Funck design and all further deployment was stopped. At nearly the same time, the Trinity House finally gave up and recognized Doty's claims and patents, paying him an undefined fee.

Trinity House was now free to use their Douglass burner design with its features, some of which may have been Doty inspired.

Joseph Funck was given a patent for his version of the kerosene lamp for lighthouses on November 28, 1876, and immediately filed a patent interference against Doty. The patent interference had not been resolved, but the Board was confident, with Funck's patent in hand that they would win, at least for the single-wick lamp, and therefore reinitiated the deployment of that lamp in early 1877.



The Lepaute lamp of 1845 with two concentric wicks. Drawing from Report of the Claim of H. H. Doty.

In the Annual Report of the Lighthouse Board for 1877, the Board, for the first time, stated that it was their intent to convert all lamps being used in American lighthouses to kerosene as a fuel. In order to save face for not having chosen to convert earlier, as the rest of the world had, they stated that lard oil was not inferior to kerosene, just more expensive.

Captain Doty was continuing to further describe his design and on March 28, 1877, he asked for a second reissue of his patent to describe some additional features of his original design that he felt Funck was infringing upon. Funck and the Lighthouse Board were incensed and Funck filed a patent interference on April 3, 1877 to stop the reissue. But, the Lighthouse Board had a trick up its sleeve. During the first interference proceeding, it was found that a lamp made

by, Frenchman, Henry Lepaute in 1845 had almost all of the features in Captain Doty's patent and that the Lepaute lamp had been installed and used at the Brandywine Shoals lighthouse from 1861 through 1863, burning Sperm-Whale oil. However, during the first interference proceeding the Commissioner of Patents had refused to hear the testimony about this lamp. Now, the Lighthouse Board made the sworn testimony about the Lepaute lamp available to the judge reviewing Funck's latest interference case. It was found that the Lepaute lamp of 1845 would burn kerosene nearly as well as the Funck and Doty lamps and therefore Doty's claims had been anticipated by the Lepaute lamp and could not be patented. The Board's lawyer fought Doty on every issue that was raised. Doty's lawyer had to revise the request for reissue many times and when it was finally approved, as reissue no. 7867, on August 28, 1877, it no longer covered any feature of the single wick lamp and few of the features of multi-wick lamps. The government now had the complete right to use the Funck single-wick lamp, and the deployment of these lamps was further accelerated.

By June 1878, the Board reported significant progress in converting single-wick lamps for use with kerosene in the fourth, fifth and sixth-order lenses. They also requested a new storage facility at the main depot at Tompkinsville, New York due to the hazardous character of the kerosene fuel being stored.

The multi-wick issue still remained to be fully resolved. On May 27, 1878, the Acting Commissioner of Patents dissolved Funck's interference related to the multi-wick lamp. Funck and the Government lawyers again appealed the decision on July 25, 1878. The legal wrangling continued over the next few months with additional decisions and appeals until on December 5, 1878 there was a final decision of the Supreme Court of the District of Columbia. In this decision Funck and the Government won every point and Funck's multi-wick design was declared to be free of any patent infringement related to H. H. Doty or anyone else. The Lighthouse Board now had the right to deploy Funck's multi-wick kerosene lamps throughout the system.

In June 1879, the Board reported that all of the smaller lamps had not yet been converted to kerosene because they found that the kerosene was evaporating from the

storage containers. The Board decided they would have to produce smaller airtight storage cans for use in shipping and storing the kerosene at the lighthouses. This also started the nearly twenty-five year effort to build separate oil storage houses at each lighthouse.

Once the storage problems were resolved, kerosene single-wick lamps were installed in nearly all the fourth, fifth and sixth-order Fresnel lenses and for most post lights and beacons. This was completed by the end of 1880. The Lighthouse Board began to install Funck's new kerosene multi-wick lamps into the second and third-order lamps in 1880 and 1881. The first use of a kerosene lamp in a first order lens in America was at the Navesink, New Jersey lighthouse in 1883. By 1885, kerosene was the principal illuminant used in America.

Captain H. H. Doty was still not finished. On May 10, 1888 Doty again filed a Patent Infringement Appeal, this time with the United States Court of Claims. But, it was too late. The Lighthouse Board had already fully deployed its kerosene lamps and had the proof it needed to defend the lawsuit. After several years of additional court testimony and legal argument, the Court made its decision on January 13, 1896 declaring "No Infringement Exists."

The Doty dilemma was finally resolved and kerosene became the major fuel in use for the next twenty years. The use of kerosene solved many problems and improved the light output while reducing costs for the world's lighthouses. Now a major lamp improvement was about to affect the light output still further.

Incandescent Oil Vapor Lamp

One of the first lamps burning gasified oil was developed by Nyberg and Lyth in Sweden in 1881. It worked by vaporizing colza oil and burning it without a mantle as a Bunsen burner does. However, this type of lamp was not efficient at producing additional light output. The next step was the addition of the incandescent gas mantle invented by Carl Auer von Welsbach, in Vienna, in 1885. This led to the first crude kerosene Incandescent Oil Vapor (I.O.V.) lamp, which was installed at the Lille Penfret lighthouse, by the French, in 1898. It used air pressure and



The Funck first-order kerosene lamp. Photo from the author's collection.

a fuel vaporizer tube where the kerosene was preheated into a fine vapor before it was ignited as a flame. This dramatically increased the oxygen at the flame and provided a brighter flame using less fuel. In 1901, Arthur Kitson, an American, invented an improved burner in which the oil was converted into vapor under pressure in a retort and then mixed with air in a mixing chamber to form a gas for heating a mantle made of platinum gauze. The platinum gauze quickly carbonized and within a short time Kitson abandoned it in favor of a Welsbach style incandescent mantle made of silk impregnated with zirconia. This lamp produced at least three times the light output of the Argand style lamps previously used. The I.O.V. lamp was first used in America at the Sandy Hook lighthouse in 1904. Finally in 1921, David Hood further improved and simplified the Kitson burner.

Incandescent Oil Vapor Burner Operation

In the photo, the kerosene comes in under 60 psi in the pipe on the lower right. It goes up the pipe on the right under the copper heat-retaining cap and then comes down the pipe on the left. You can see the inverted "U" pipe better in the drawing. Note: the drawing

does not show the copper heat-retainer cap. The kerosene continues down the pipe on the left and into the burner at the bottom and is turned up again inside the burner. It then enters the bottom of the mantle as an incandescent gas and burns on the outside of the mantle.

There are a number of other points to note. On the left, in the photo, is a brass cylinder with a pipe sticking down. At the top of the cylinder is a small knob. If you lift up on the knob the cap comes off and inside are two wicks sticking upwards out of the lower cylinder. This is called the 'Torch' or 'Spirit Lamp'. When the keeper wanted to light the I.O.V. he first pumped up the air pressure in the kerosene pressure tank. There was a gauge that he could read to see if he had reached 60 psi. Next, the keeper removed the cap of the spirit lamp uncovering its wicks. He lit the spirit lamp, which burned alcohol or Methyl Hydrate, a chemical that burned with intense heat. He then temporarily removed the mantle and its holder and set it aside. Then he held the spirit lamp and twisted it to the right. The whole assembly moved allowing the burner to move out from under the copper heat retainer to the position where the spirit lamp had been, and the spirit lamp to move to the position where the burner had been. The spirit lamp heated the inverted "U" pipe, under the copper heat-retainer cap, which would later vaporize the kerosene.

After about 8 to 10 minutes the inverted "U" pipe would be hot enough. The keeper then had to turn on a valve at the pressure tank to release a small amount of kerosene. This had to be done very slowly or kerosene, in liquid form, would come out of the oblong hole in the pipe on the left next to the spirit lamp in the photo. Note: this oblong hole is the air inlet hole to allow a large amount of air to mix with the kerosene vapor. He then lit the, now vaporized, fuel at the top of the burner using a long candle. Once the fuel was lit, the keeper placed the mantle holder over the burner and then quickly had to pull the spirit lamp from under the inverted "U" pipe and back to its original position. At nearly the same time, he had to open the pressure valve and let a greater amount of vaporized kerosene pass through the pipes, gather air from the oblong hole and come up inside the mantle. If all went well, the kerosene ignited and as the mantle got hot it

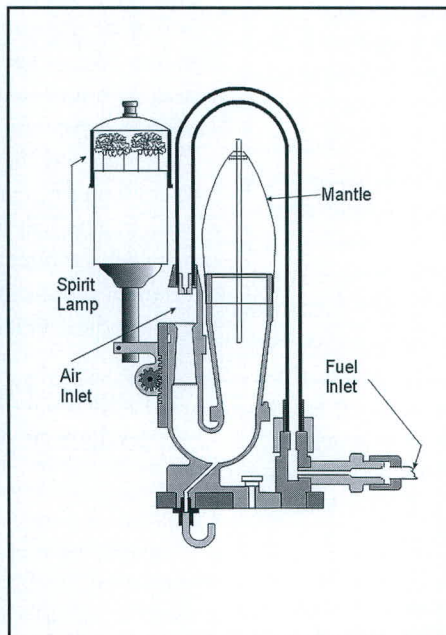
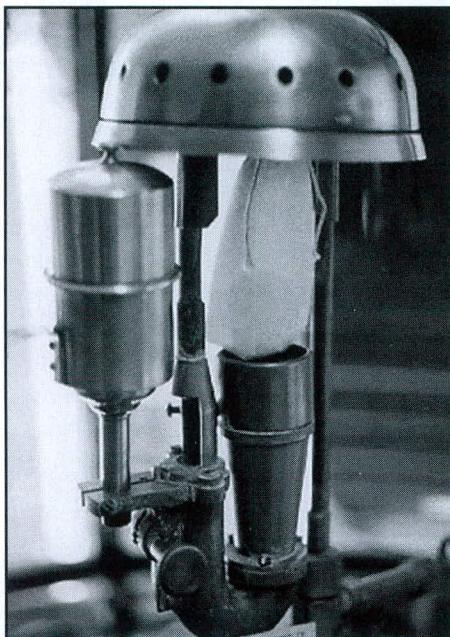
began to incandesce. If everything was not right, liquid kerosene would explode out of the burner and destroy the mantle and the keeper would have to start over. The heat from the mantle supplied the heat to vaporize the kerosene that was formerly heated by the spirit lamp. The copper heat-retainer cap maintained the high heat necessary to vaporize the fuel around the inverted "U" pipe while the spirit lamp was in use, but was removed when the lamp was in full operation.

Additional Kerosene Lamp Developments

By about 1913, the Aladdin kerosene mantle lamp began to replace the single-wick Funck-Heap lamp in the smaller lens orders, and the Incandescent Oil Vapor (I.O.V.) lamp had been deployed in most of the first through third-order lenses. At this time, the electric light also began to be used in a number of American lighthouses. Some kerosene lamps would remain in service into the 1950s, until completely replaced by the electric light.

Captain H. H. Doty had assisted with the design, development, and deployment of the kerosene lamp throughout the lighthouse services of the world. He was compensated well, except for the American Lighthouse Service, where he was only responsible for 'The Doty Dilemma.'

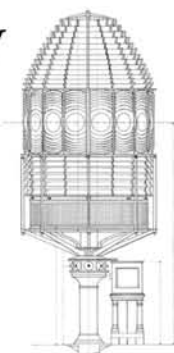
Incandescent oil vapor (IOV) lamp with spirit lamp shown on at right. Photo from the author's collection.



IOV lamp burner cut-away view. Drawing by the author from official drawing.



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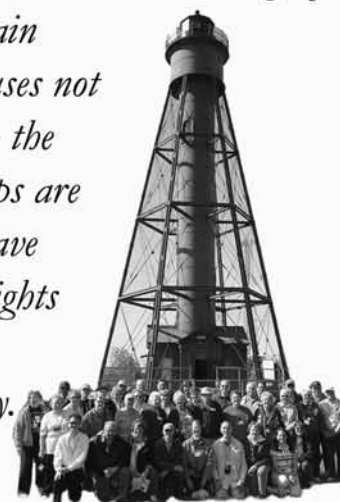
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