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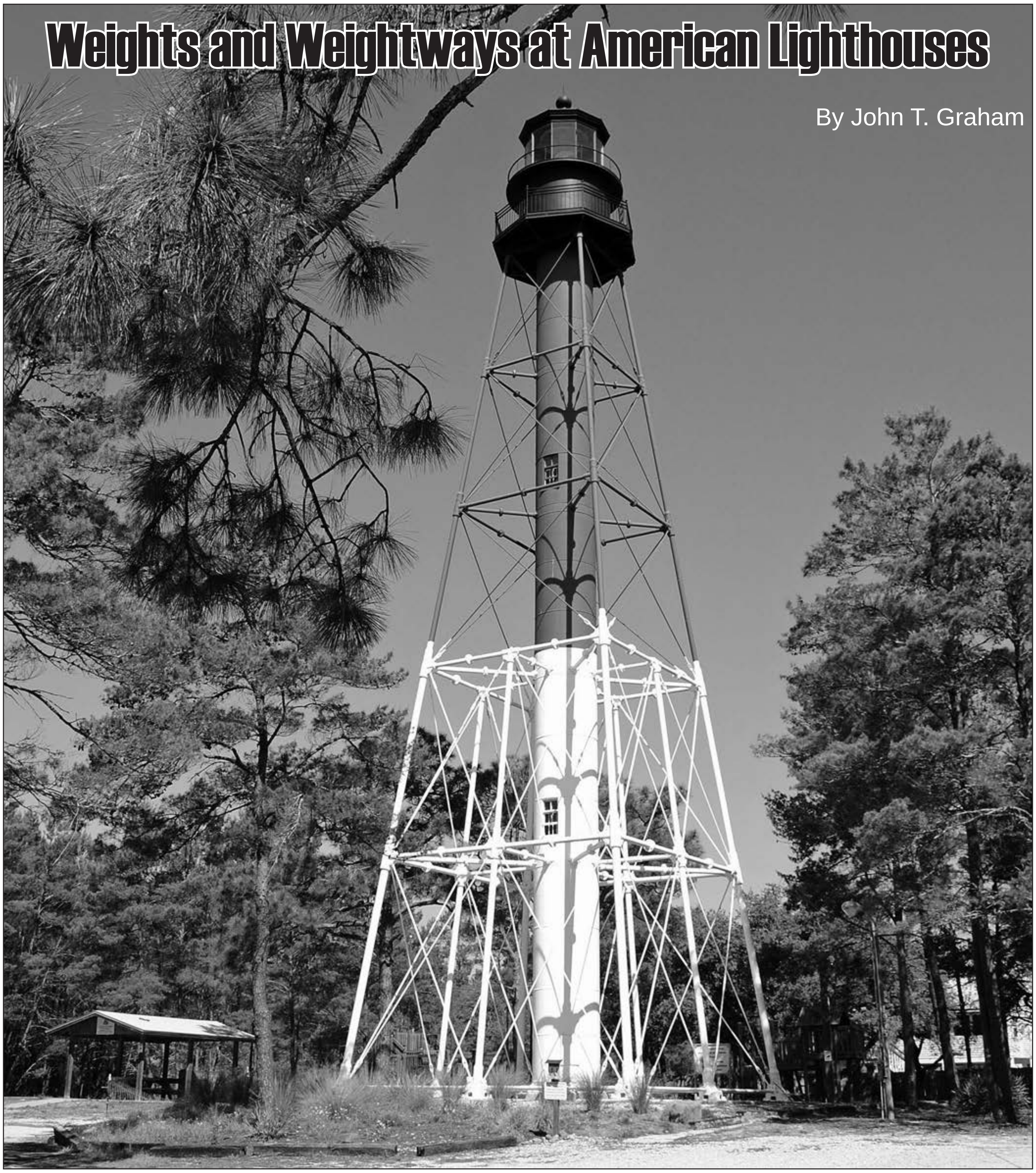
Weights and Weightways at American Lighthouses

By John T. Graham



Crooked River Lighthouse. USLHS archive photo.

It had been a long January 1927 night, and Keeper Thorwald Hansen at the Crooked River, Florida, Lighthouse was tired. His assistant was ill and so the nightly watch fell to him alone. The fourth-order Fresnel lens was rotated every 12.5 seconds by a clockwork driven by the 150 pounds of iron weights that hung on the end of a cable. Keeper Hansen had let these weights descend almost to the bottom of the tower, which took about 12 hours, so now he would have to wind them 80 feet back to the top before the lens came to a halt.

The bright light that beamed from the tower of a lighthouse, whether it was a tall one near the shore or a short one high on a headland, was a welcoming, comforting, and necessary beacon to the mariner navigating the often treacherous waters of the coastal United States. The single most important service that a lighthouse provided to that mariner was to confirm that "You are here" along those otherwise dark and foreboding shores.

It was not enough for that light to be only bright, as the ship master would then still be wondering which lighthouse he was viewing. This was especially true where the lights from several different lighthouses could be seen from a given location. Thus, from the earliest dates, lighthouse administrators sought to make the light from each tower somehow unique. Each light was to have its own "signature" or "characteristic" that set it apart from its neighbors. With the advent of the use of the highly efficient Fresnel lenses in the lantern rooms, one of the most common methods of achieving this was to make some lenses appear to flash.

The technical differences between lenses that exhibited a flashing characteristic and those that did not are explained well by many others in many other sources. For my purposes here, suffice it to say that most lenses that exhibited a light that appeared to flash had to turn, or rotate. It was the passing of each of the "bull's eye" sections of the lens between the lamp in the epicenter and the eye of the viewer, however far away he might be, that created the appearance of the flash.

Weight at Pigeon Point, California. Photo by Thomas Tag.

In the days before electricity and electric motors came to the shores, it was a weight-driven gearbox that provided the motive power to turn even immensely heavy Fresnel lenses to produce those flashes. For a technical look at these systems, refer to "The Clock Without Hands" by Thomas Tag, which can be found in the Spring 2008 issue of this journal. Another great source is the U.S. Lighthouse Society's website, specifically www.uslhs.org/clockworks. Information on the various types of clockworks and their operation can be found in these and many other sources. This article will focus on the weights that drove the gears and the paths they traveled from top to bottom of the light towers.

Weights visible in drop tube window, originally an access door. Split Rock, Minnesota. Photo by the author.

Keeper Hansen, noted in the introductory paragraph, was simply performing one of the many normal tasks of a lightkeeper, tasks that had not changed for decades. The arrival of electricity to the remote sites where most lighthouses are located brought an end to the "winding of the weights," just as it put an end to the nightly lighting of the lamp.

Today just a handful of lighthouses still have a Fresnel lens that rotates by use of a weighted clockwork; many others still display remnants of such a system, some with the weights rusting away in the weightway; but in the vast majority of cases, the weights themselves disappeared long ago when the electric motor relegated them to the junk pile. The following lighthouses still have an operational lens that is rotated by a weight-driven clockwork: Split Rock, Minnesota; Point Reyes, California; Elbow Reef, Abaco, Bahamas (the Elbow Reef light still uses a kerosene lamp, perhaps the last in the world to do so); Dixon Hill, San Salvador, Bahamas; La Martre, Quebec. There may, of course, be others.

In the typical system, it was a "rope" (in earlier days made of fiber, in later days made of iron/steel) that was wound onto the drum of the clockwork. This rope held the weights. The amount of weight needed was determined by the weight of the lens to be turned, the speed at which it needed to rotate to produce the specific characteristic assigned to that light, and the gearing ratios of the clockwork itself. This all went into determining how fast the weights would descend. Lighthouse engineers then had to determine how far down the tower they could or should descend and at what point the keeper on duty needed to wind them up again.

Although this article focuses on the weight systems used in the Fresnel lens era, lamp assemblies used before the advent of those revolutionary lenses often were rotated as well, using a similar, if simpler, system to attempt to produce a distinctive characteristic for particular lights.

The earlier lighthouses utilized wick lamps with a reflector to direct more of the light forward. There were often several to many of these lamps in a given lighthouse, usually mounted in a "chandelier" arrangement. Major seacoast lights might have had 20 or more individual lamps in the arrangement, which were arranged so that the chandelier was two-sided, three-sided, or even four-sided. To the mariner, these lights would show an "occulting" pattern of light followed by lesser light and/or darkness, the interval being determined by the arrangement of the lamps.

Little is known about the weights or weightways in the early towers, but as the Argand-type lamps used in those days weighed

Centered drop tube, Split Rock, Minnesota. Photo by Lee Radzak.

relatively little compared to even the smaller order Fresnel lenses, correspondingly less weight would have been required. When the first use of a clockwork to rotate a chandelier of lamps was put into use will be left to other historians. Most likely the weights simply hung down from the clockwork, but a reference to an actual weightway is found in the archives of the Cape San Blas, Florida, Lighthouse. In an 1848 letter to the district supervisor at Apalachicola, Light-House Establishment Superintendent Stephen Pleasonton requested that the plans for the staircase and lantern deck for the lighthouse then under design for this location be modified to allow for "clockwork and weights." Such systems had undoubtedly already been in use for decades if not longer.

What did the weights look like? There is no single answer to this question; as in almost all aspects of lighthouse design, there is a tremendous variety. However, the weights used with the Fresnel lenses can be generally grouped into three types.

Many of them were simply a single, solid piece of metal, or in some cases of stone, concrete, or other material, constructed around a metal rod with an eye for connecting to the supporting cable.

Many others were a similar solid piece but then had the addition of several smaller individual pieces. The ability to add or take away these additional, usually disc-shaped pieces, allowed for adjustment to the speed of descent. This would have been particularly necessary if the characteristic of a lighthouse was modified or if a new type/size lens was installed.

Still others are made up entirely of stackable, circular iron discs of various thickness and thus weight.

Much of the information for this article was obtained directly from staff at the various lighthouses noted. Unfortunately, since it has been decades since a clockwork system was used at most lighthouses, information about them is simply unknown or not remembered.

The other sources of information used are actual lighthouse inspection reports from the National Archives, as compiled into a database by volunteers of the U.S. Lighthouse Society. Although hundreds have thus far been transcribed, hundreds more remain to be so transcribed. Although there is great inconsistency in the work of the various inspectors over the years, these reports comprise an invaluable glimpse into lighthouse operation. [USLHS.org; Resources; Lighthouse Databases; then Enter the National Archives Database.] Data from these reports is shown on page 38.

Photo shows both the upper access door and the weight-resting shelf below. White River, Michigan. Photo by Matt Varnum, SPLKA.

Any blank space indicates that the inspecting officer did not complete that section of the report. For my purposes here, I was most interested in the following categories: how much weight was used and how frequently the weights were wound.

How Much Weight Was Used?

It was my naïve expectation that larger lenses would have required more weight, but this was clearly not the case. Seventy-five of the inspection reports reviewed noted the amount of weight in use. These ranged from a low of 30 pounds for a third-order lens at Ameila Island, Florida, to a high of 503 pounds for a second-order lens at Kilauea Point, Hawaii. Twenty-two of the reports noted weights of 200 pounds or more.

Although the radius of any given Fresnel lens is the measure of its "order," other dimensions, and thus the total weight, can vary significantly in lenses of the same order. Another factor is the rotational system in use. Some lenses used a chariot wheel system; some rotated on a ball-bearing plate; still others turned on a bed of mercury. There are likely other variables of which I am not aware.

The following is a summary of the individual weight amounts noted for various orders of lenses:

Hyper-radial lens:
Makapuu, Hawaii, 121 pounds

First-order lens:
low at Pensacola, Florida, 80 pounds; high at Cape Fear North Carolina, 500 pounds

Second-order lens:
low at Minot's Ledge, Massachusetts, 100 pounds; high at Kilauea, Hawaii, 503 pounds

Third-order lens:
low at Amelia Island, Florida, 30 pounds; high at Cape Spencer, Alaska, 270 pounds

Three-and-a-half-order lens:
low at Chandeleur, Louisiana, 60 pounds; high at Brazos River, Texas, 165 pounds

Fourth-order lens:
low at Hendricks Head, Maine, 40 pounds; high at Barbers Point, Hawaii, 278 pounds

Fifth-order lens:
low at Butler Flats, Massachusetts, 100 pounds; high at Port Ferro, Puerto Rico, 200 pounds

Reports from the earlier years of the Fresnel era seldom noted any data about weights, rotation times, or drop tubes. In a few later instances, reports noting weight data from the same lighthouse were found for more than one year. In some of these the information was identical in all years noted, but in others changes in the amount of weight used were documented from one point in time to another.

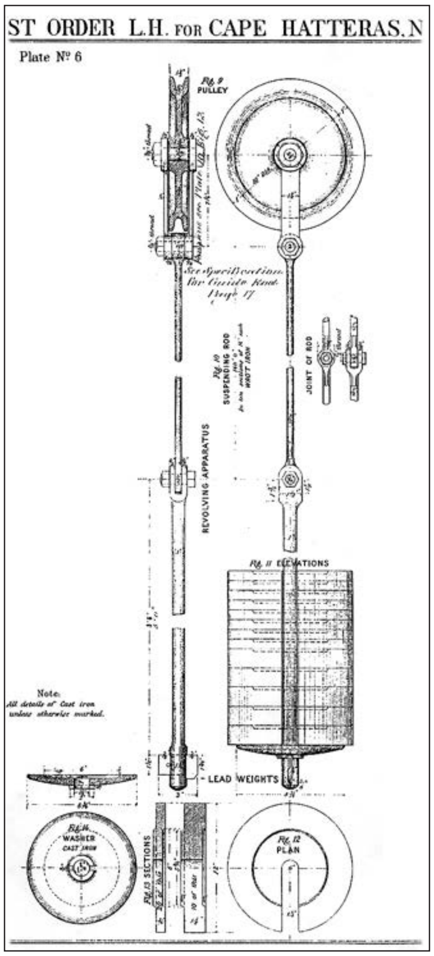
The Barbers Point, Hawaii, Lighthouse is such an instance. Reports for 1912, 1916, and 1927 show weights of 182, 278, and 110 pounds respectively, all rotating a fourth-order lens every five seconds. A history of this lighthouse notes that the fourth-order lens was installed in 1912 with a five-second rotation, but notes no changes until a new tower was constructed in 1933, so I can not explain the need for different amounts of weight.

Two of the reports are for the Molokai, Hawaii, Lighthouse. In 1910, 272 pounds of weight turned the lens once every 40 seconds; in 1927 only 166 pounds of weight are noted, yet the lens turned once every 20 seconds. This author can only speculate about these seemingly drastic changes in the amount of weights in use and their effect on lens operation.

It is important to note that the reports reviewed represent only a fraction of those that are available in the archives and that only a relatively few of those that were reviewed noted the actual amount of weight in use, so the ranges of weights referenced here may well have been exceeded at both the low and high ends at other locations.

In one instance obtained from other than the inspection reports, current staff at Elbow Reef, Bahamas, which still turns its first-order Chance Brothers lens with a clockwork, 700 pounds of weight are reportedly in use. This is by far the largest amount of weight encountered anywhere.

How much weight was needed to turn a lens was also impacted by if, or how many, pulleys were employed in the rigging of the cable between the clockwork and the weights themselves. Sizable adjustments to the rotational speed of the lens could be made by adding or subtracting various poundage of weights. Commonly these were iron disks, but an 1894 letter to the district engineer from the keeper of the Heceta Head, Oregon, Lighthouse noted that "about 50 pounds of chain has been added to the revolving apparatus." Finer adjustment of the speed was by means of the "vanes" that were a part of the clockwork regulator. Temperature and humidity changes could require that the angles of these vanes be modified as needed. This was a job that only experienced and practiced keepers of a specific lens/clockwork could accomplish satisfactorily.



Plan of original rod system, Cape Hatteras North Carolina. Courtesy of John Havel.

In spite of the best engineering and top quality equipment, sometimes the keepers just couldn't get things to work correctly. In a 1913 letter to Bureau of Lighthouses Commissioner George Putnam, Horatio B. Bowerman, the chief constructing engineer then engaged in reworking the weight system at Cape Hatteras wrote in regard to the existent system:

> The keeper tells me that it has borne a reputation for irregularity in the past… The first night I was there it ran 15 seconds fast and required a reduction in driving weight. The next night it ran as much as 25 seconds slow and required additional weight. The third evening it stopped twice on us without apparent cause and it required two hours close attention before it braced up. After that it ran all right, all night.

Such irregularity was undoubtedly an occasional situation at all sites with a clockwork and was one more reason why diligent watchfulness was required of the keepers

The time of lens rotation was critical to producing the characteristic flash published in mariners' light lists, so much so that keepers were issued precision watches by which to monitor these times. Even a second of variation could confuse a ship captain as to his location.

The range of times it took for a given lens to make one complete turn is another interesting category of information found in the reports. Rotation times varied from five seconds for a fourth-order lens at Barber's Point, Hawaii, to nine minutes at both St. Augustine, Florida, and Cape San Juan, Puerto Rico. Two hundred and fifty pounds of weight turned a first-order lens every 18 seconds at the Graves, Massachusetts, Lighthouse. The same amount of weight turned a second-order lens every six minutes at the Petit Manan, Maine, Lighthouse.

There must be a direct correlation between the size/weight of lens, the mechanical system in use, and the desired rotational time that went into the determination of how much weight was used, but I will leave that explanation to others.

Post 1913 rail system for guiding weights – no longer in use – Cape Hatteras, North Carolina. Photo by Jami Lanier, National Park Service.

How Frequently Were Weights Wound?

Just as lighthouse folklore often had the keeper lugging unbelievably unnecessary amounts of fuel up the stairs to the lantern, so too do today's tour guides like to talk of the unending labor by the keeper to wind those heavy weights back up to the top of the lighthouse.

The amount of physical labor required undoubtedly varied with the particulars of the equipment at any given site. Francis Jacker, 1880s keeper at the Raspberry Island, Wisconsin, Lighthouse, noted in his log, "Proper surveillance of the revolving apparatus during the long nights of the fall, when frequent windings are required, is exhausting."

In most instances, however, the job of winding even the heaviest weights was made relatively easy by the mechanical advantage of the gearing in the clockwork. It was seldom a hard job and in most cases did not have to be done that often.

The inspection reports that were reviewed frequently but not consistently noted a time interval between windings. What is unclear is whether these times are how long it would have taken for the weights at that individual lighthouse to go from the uppermost position after winding to the lowest possible point in the tower, or whether they represent the usually shorter interval at which the keeper arbitrarily decided to rewind them. Even with the efficient gearing, it made sense to wind them a shorter distance more often than "all the way up" less often.

The opening paragraph says that Keeper Hansen had to wind the weights 80 feet up from the bottom of the tower. In practice he likely didn't let them get down so far.

Open top of weight tube, Cap Madeliene, Quebec, Canada. Photo by the author.

A few reports include comments that make it clear that at some sites the weights were arbitrarily rewound sooner than absolutely necessary. The 1913 report for North Manitou, Michigan, notes that the wind time was "5 hours, machinery wound every 2.5 hrs." A similar note in the 1912 report for Sanibel, Florida, notes that the weights "can run for 12 hours" but that they were usually rewound every four.

The winding interval was also affected by the simple fact of how tall the tower was and how far up and down that tower the weights were actually allowed to travel.

At the Cape Meares, Oregon, Lighthouse, it is only about 10 feet from the underside of the pedestal deck to the floor below. Subtract the length of the weight unit itself and there were only a few feet that the weights could travel before they had to be wound. It would appear the winding interval was quite short here, yet the inspection report from 1910 notes a 2½ hour wind time. The weights here obviously descended very slowly.

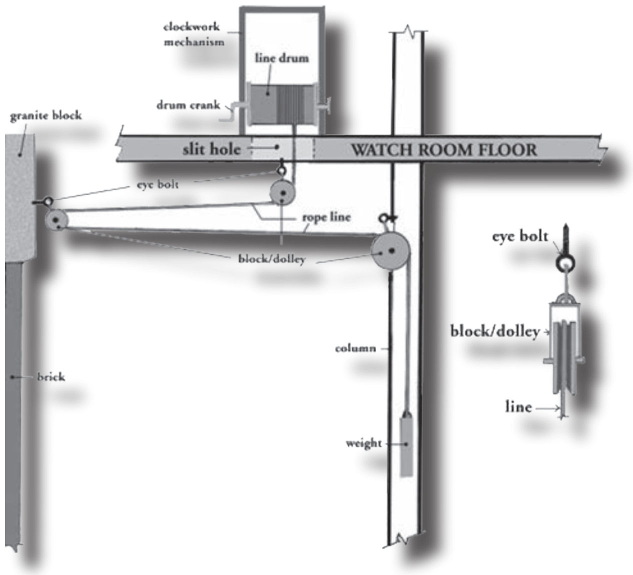
The tower at Cape Hatteras, North Carolina, is the tallest in the U.S., thus one would think that once wound up the weights here could descend a long way over a long period of time. This is not the case. The weights here could descend all the way to the bottom. They were not wound all the way to the top, however, but rather only a short distance up from the bottom. (See more information on this system in a section below.)

As originally installed, the weights at the Heceta Head, Oregon, Lighthouse could only descend a portion of the tower height. The keeper complained in an 1894 letter to the district engineer that "if the tower had been arranged to permit the weights to come down to the ground floor, it would run two or three hours without rewinding." At some later date, holes were cut into the landings to allow a greater drop distance.

The inspection reports from the National Archives show a range of wind times, the shortest being 1.2 hours and the longest

LIGHTHOUSE	YEAR	ORDER	POUNDS	ROTATION TIME	DROP TUBE FT.	WIND TIME HR.	BB, CW, MF
Barnegat, New Jersey	1910	1		4 M	only part used	2	CW
Cape Cod, Massachusetts	1927	1	200	20 s		2.25	MF
Cape Fear, North Carolina	1918	1	500	4 M		2	CW
Cape Hatteras, North Carolina	1927	1	150	2' 24"	130	15	CW
Cape May, New Jersey	1907	1		8 M		8	CW
Cape Meares, Oregon	1910	1		4 M	10	2.5	CW
Cape Mendocino, California	1907	1		8 M		3	CW
Carysfort Reef, Florida	1912	1		5.33 M	11	3.5	BB
Destruction Island, Washington	1910	1		4 M	no tube 64' drop	5	CW

Partial table shows, for a sampling of first-order lenses, the reporting year; weight; rotation time; length of the drop tube, if any; hours between winding; and whether the mechanism is ball bearings (BB), chariot wheels (CW), or mercury float (MW). The full table can be found on the U.S. Lighthouse Society's website at https://uslhs.org/history/lens-rotation/weights-and-measurements.



Weight system plan, Fire Island, New York. Plan courtesy of Dave Griese.

being 15 hours. The majority of the noted intervals are between two and six hours, with the average of the 91 times noted in the reports I reviewed being 5.4 hours. Ten of the 91 entries show a wind time of 10 hours or more. Even on the longest winter night, it would seem that not many keepers exhausted themselves winding the weights.

The Weightway

Weightway is the proper term for the path by which the weights descended the towers. Whatever their appearance, weights all hung on the end of a cable (often referred to as a "rope" or a "cord") that was wound around a drum within the clockwork located at the base of the pedestal that held the lens. This cable then went through an opening in the pedestal deck, and gravity was the motive force that caused the weights to descend. The unwinding of the cable turned the drum on which it was wound, turning a gear that turned yet other gears, until the mechanical advantage of the gearbox ultimately turned the lens itself.

Sometimes the weights were enclosed within a tube, a box, or a channel in the wall, or sometimes they just hung down the center of the tower openly from the clockwork.

The most accurate and informative information about the various weightways came from staff at the individual lighthouses noted, but some information was gained from the inspection reports that were reviewed. The heading for the inspection item regarding the weightways was "Drop Tube Ft." The fact that the column is so headed leads me to believe that an enclosed "tube" of some kind was the normal situation rather than an exception.

Many of the entries simply give a number (130, 45, 54, 80 as examples), which I believe indicates the length of an actual enclosure for the weights. Several entries (all text is quoted verbatim) state such things as "full len. of tower" or "stairwell" or "whole height," which I also interpret to refer to an enclosure. Several say "none" or "no tube," which I interpret to mean the weights here hung openly down the tower.

The earliest weights were suspended on hemp or other fiber ropes, and wear and strain probably caused their breakage far more often than we know. Fiber ropes were replaced by "wire rope" cables when this innovation came along in the later 1800s, and these likely parted less often. A few of many documented instances of the cable breaking are noted below.

An 1865 letter from the Third District Engineer to the Light-House Board notes damage caused by the "break of the clock cord" at the Fire Island Lighthouse. "The clockweight which runs within the iron newell [center column] is stopped by means of two iron bars running crossways through the newell. In consequence of the parting of the clockcord the falling weight broke the two bars and also knocked pieces out of the newell, which is a main support of the iron stairway." In a creative bit of engineering, it was recommended that, in addition to repairing the damage, a "spring sufficiently strong to counteract the force of the falling weight" be installed on top of the iron bars to prevent similar damage should the cord break again. There is no record of such a spring being installed.

New England and lighthouse historian Edward Rowe Snow, in his book *Famous Lighthouses of New England*, references an 1869 event at the Petit Manan, Maine, Lighthouse. "The heavy weights of the clock fell from the top of the tower, snapping off eighteen of the steps before crashing to the floor of the lighthouse. Fortunately no one was climbing the stairs at the time."

In an incident at Jupiter Inlet, Florida, the weights were once wound too far up, causing them to break free and plummet downward, damaging five of the stairs as they fell.

Keepers likely kept a close eye on the condition of the cables and replaced them as necessary, but a fascinating glimpse into this is provided by the log books from the Point Sur, California, Lighthouse. The log notes the April 1875 receipt from the lighthouse inspector of "one coil of rope for our revolving light." The entry for September 5 of that year notes, "Put new cord on clock work." Between that date and September 1895, a span of 20 years, the log documents that a new cord was installed no less than 17 times, sometimes only a month apart, at other times several years between replacement. Most often the word "cord" is used, but sometimes the word is "rope." Only the December 1889 entry notes the words "steel wire clock cord."

Types of Weightways

This section notes different types of weightways as they once functioned and/or still survive at individual lighthouses across the country. I am appreciative of and indebted to staff at the various lighthouses noted. This is by no means a comprehensive list, but represents a sampling.

Weight pit, Keldsnor Lighthouse, Denmark. Photo from the Egbert Koch collection, courtesy of Thomas Tag.

Weights Hung Down the Center of the Tower

This arrangement, in which the weight assembly simply hung openly right down the center of the tower is the simplest and was quite common in towers short and tall. This was most easily accomplished in towers where the winding staircase was attached to the outside wall of the tower, thus leaving a large open space in which the weights could hang.

A 1911 inspection report for Hillsboro Inlet, Florida, states that no "drop tube" existed but that the weights simply "drop thru center of columnar stairs."

A 1910 report from the Thunder Bay Island, Michigan, Lighthouse says similarly, "No drop tube, weights drop down center of tower."

These are only a few of the many reports that note "none" regarding a drop tube.

In several lights there are guiding devices to keep the cable hanging truly in the center of the tower. These are particularly important in the taller towers where a long cable with heavy weights on the end could easily begin to act like a pendulum.

In some instances (Cape Hatteras, for example, as its weight system was changed in 1913), there were two rails that extended down the center on which the weight assembly traveled.

In some cases other cables were used to guide the weights. Such was the case at the Detroit River Lighthouse. A 1909 inspection report noted "weights are held in place by two guide lines secured top and bottom by eye bolt."

Above: Weight pit, St. Augustine Lighthouse, Florida.
Below: Guide "eye" on landing for the weight cable, centered over the weight pit at St. Augustine. Photos by Kathleen McCormick.

In other cases, some lighthouses had guide "eyes" built into each landing to keep the cable straight down the center. Yaquina Head, Oregon, and St. Augustine, Florida, are examples of towers with such guide eyes. These guide eyes at stations such as Yaquina Head kept the cable straight but restricted the weight assembly itself from being raised beyond the lowermost of the guides. Thus when "wound" these weights were only a relatively short distance up from the bottom of the tower; they could not be wound all the way to the top.

In an even more unusual variation of a guide device, an early letter regarding the Cape Hatteras tower noted that a black walnut board with a hole in it was used to "keep the rope centered."

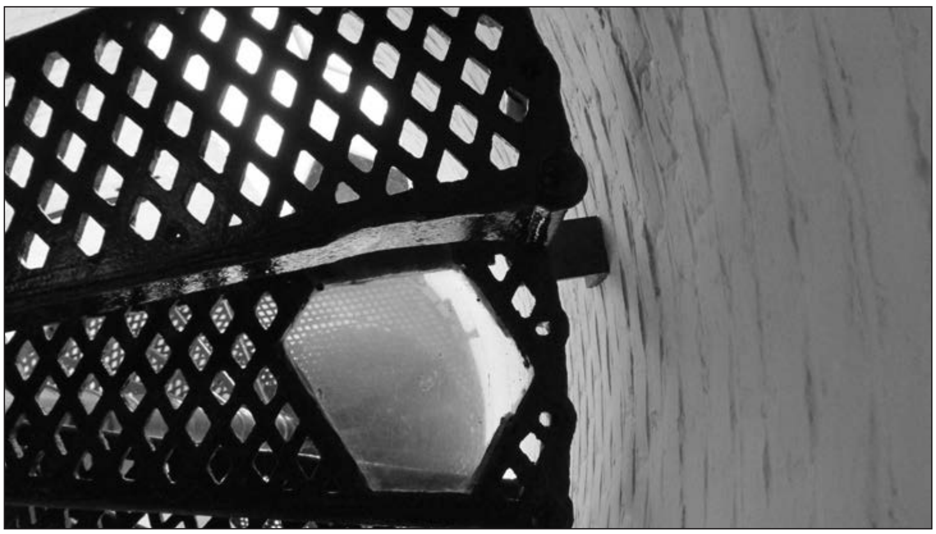
A common feature of the towers in which the weights hung down the center was a well-like pit, approximately four feet in diameter and several feet deep. This was in the center of the floor and usually surrounded by a railing. These pits are usually found where a first-order lens, which required many pounds of weights to turn it, was in a very tall tower. If the cable on which the weights hung should break, the weights could plummet a long way down and potentially do great damage to people or objects in the way or to the tower floor itself. This pit, which was filled with sand, provided a "cushion" onto which the falling weights and cable could land.

Ponce Inlet is one example of a tower with such an enclosed pit on the bottom floor into which the weights would descend. The tower at Yaquina Head, Oregon, once had such a weight pit, but it has been filled in. The photo of the Keldsnor Lighthouse in Denmark that accompanies this article shows the pit filled with sand. Pigeon Point, California; St. Augustine, Florida; and Cape Hatteras, North Carolina, are other lighthouses that have such a pit.

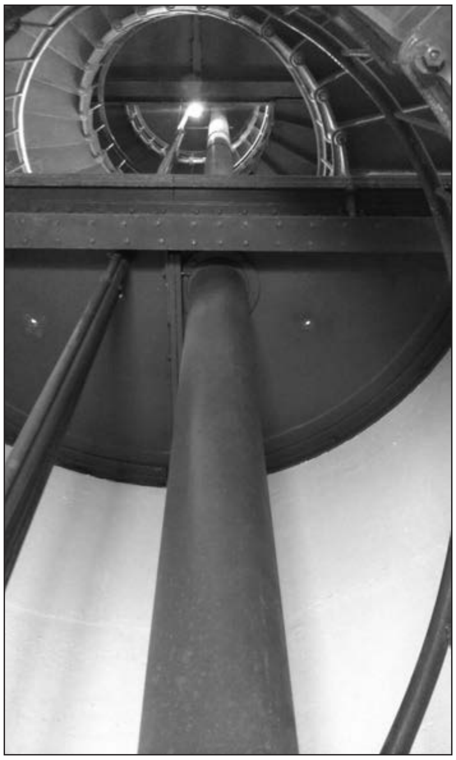
Shorter towers generally did not have a well pit; if the cable broke, the weights would simply hit the floor below. Undocumented lore at the Cape Meares, Oregon, Lighthouse, where the distance the weights could fall is less than 10 feet, tell of a crack in the stone floor caused by falling weights. Today's guardians of that lighthouse deny such a crack, but it had to have happened someplace.

Off Center but Still Hanging Openly

A variation of the "down the center" system sometimes found the weights descending not exactly in the center of the tower, but slightly offset. An example of this can be found



Hole in stairs for weights, Jupiter Inlet, Forida. Photo by Josh Liller.



Off-center drop tube, Point Arena, California. Photo by Ty Moore.

at the Pensacola, Florida, Lighthouse. Holes cut in the pedestal deck and in one of the decks below allowed the weights to descend approximately 38 feet before they would have settled onto the next deck level below.

A most unusual variation on this was once in use at the Cape Hatteras Lighthouse, well known as the tallest lighthouse in the U.S. The distance from the floor on which the clockwork, and the cable drum, was located all the way to the sand pit at the ground level is approximately 160 feet. That number of feet of the typical wire rope cable in use in the early days at Hatteras would have required a cable drum much larger than could have been incorporated into the clockwork there, so a very unique system was created. Only about 50 feet of cable was actually wound onto the cable drum. Below the cable was an iron rod composed of 10 14-foot-long smaller rods that were linked together—in effect a 140-foot-long solid rod—on the end of which a series of the common stackable weight discs were installed. The rod system, of course, could not be wound up onto the drum, only that approximately 50 feet of cable unwound as the weights descended and was rewound by the keepers. It is not known how much weight was used in this system; the rods themselves would have contributed many pounds. In 1913 the system was converted to weights guided by L-shaped rails and reconfigured so that the weights descended over a much greater distance in the tower.

Centered but Inside the Steel Column That Supports the Circular Staircase

In towers where the stairs were attached to a central column, this column often served as the weightway as well. This central steel column that supports the stairs is called a "newel post" or simply a "newel." The Burnt Island, Maine, Lighthouse is one such example. An opening at the bottom of the stair column allowed inspection of the weights as well as retrieval should the cable break. The Fire Island, New York, Lighthouse had another example of this type of weightway, as did that at Sanibel, Florida.

Central stair column that also serves as weight tube, Burnt Island, Maine. U.S. Coast Guard photo.

Inside a Dedicated Tube or Channel

Another type of weightway was an enclosed metal or wooden column, referred to as a "drop tube," that went straight down the center of the tower from the pedestal deck level to or even to below the lower floor. This was often the case where the spiral stairs were connected to the exterior wall of the tower rather than to a central post, and this drop tube served exclusively to contain the clockwork weights. As noted earlier, I believe that some kind of such enclosure was the norm, although exactly where in the tower such tube was located varied greatly. These tubes were sometimes not in the exact center of the tower but were offset or, perhaps, located just inside the exterior wall.

Drop tube, Point Sur, California. Photo by Carol O'Neil.

The drop tube at the Amelia Island, Florida, Lighthouse, is described by staff as a "wooden box on the inside of the wall."

Some were built partially within the outside wall of the tower.

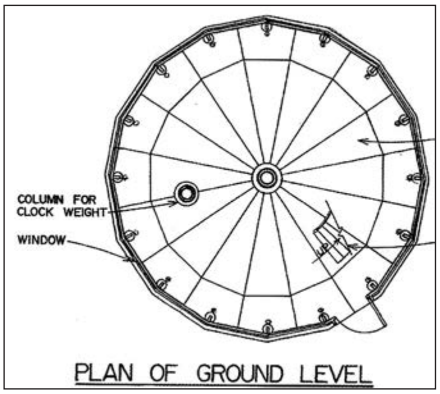
An inspection report for Fenwick Island, Delaware, describes drop tube as " wrought iron, about 8" in diameter, and projects from wall of tower about ½ its diameter."

Spectacle Reef has a square such tube built against the outer wall.

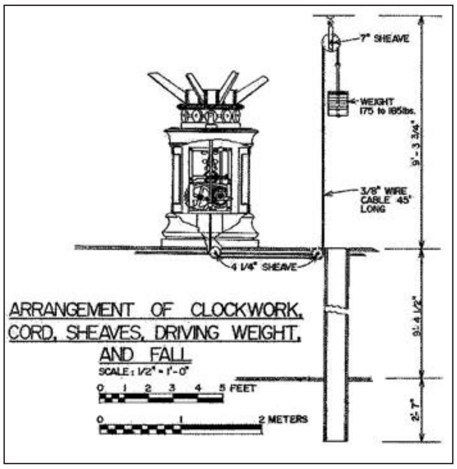
The tube in the Point Reyes, California, Lighthouse is located about halfway between the outside wall and the center of the tower. The weight cable here took an unusual route—passing beneath the floor on which the clockwork sat, then coming up into the watch room to a pulley above, and then entering the tube.

Such tubes can also be found at Split Rock, Minnesota; Rock of Ages, Michigan; Point Sur, California; Elbow Reef, Bahamas; and Devils Island and Raspberry Island, Wisconsin, to name a few others.

A classic example of a dedicated drop tube is still in use at the Split Rock, Minnesota, Lighthouse; the huge bi-valve lens here is still being turned by the weights and clockwork. The tube is separate and distinct from the spiral stairs, which are against and connected to the outside wall of the tower. It actually descends several feet below floor level and has a door at the bottom, accessed via a hatch in the floor. The 180 pounds of weights in use today can be inspected or adjusted via this door or retrieved in the case of a cable break. A second door is several feet above the floor



Plans of the Point Reyes Lighthouse, California, show (above) location of column (drop tube) for weights and (below) the cable routing. National Park Service photos courtesy of Carola Derooy.



level. This door was replaced with a glass window to allow visitors to see the weights as they descend. The window also alerts staff that it will be another 45 minutes before the weights bottom out and the lens will stop turning. The weights are intentionally allowed to settle on the bottom of the tube when staff wants to stop the lens rotation.

Typically the cable, with the weights hung on the end, would pass through an opening in the pedestal deck right below the clockwork and enter the tube directly, but there were variations. In one variation, the cable on which the weights at the Fire Island, New York, Lighthouse were suspended did not go directly from the drum on the clockwork into the central tube, but rather first went to a pulley mounted on the outside wall and then back to the central column. As in many things regarding lighthouses, one would think there would be more uniformity, but the variety of creativity shown by the engineers and builders is surprisingly extensive.

An early example of a drop tube is described in the same 1848 letter from Stephen Pleasonton referenced earlier in regard to the weights at the Cape San Blas Lighthouse. The weightway which was to be constructed there was described as a "box ten inches square in the center of the staircase."

In an External Tube—Skeletal Towers

These "erector set" style lighthouses are characterized by a relatively small diameter central cylinder, which houses the staircase, surrounded by a grid of iron/steel beams and rods, all surmounted by the lantern assembly which itself looks little different than the one on other lighthouses. The diameter of the central column provided little room for anything other than the stairway.

The tower at Whitefish Point, Michigan, includes a separate drop tube, external to and parallel to the central stair column, in which the weights that once turned a lens there descended. The cable passed out through the wall of the watchroom, where the clockwork unit was located, and entered the tube at the gallery deck level. This system is no longer in use, but the tube remains. A July 1909 letter from lighthouse engineer Ralph Tinkham describes this drop tube at Whitefish as "60' 5" long, is cylindrical sheet iron shaft 12" x 15" leading down outside of stair cylinder from lantern deck to ground."

Photos of the skeletal towers at Detour Point, Michigan, and Manitou Island, Michigan, show that such separate exterior tubes were at these lights at one time also, but I have turned up no evidence of others.

Staff at several other skeletal towers whom I was able to contact report no such exterior tubes present, but whether or not such a tube once existed is no longer recalled. Many of these present-day caretakers suspect that the weights in any that had a rotating lens must simply have hung down the center, in spite of the relatively tight quarters these central columns provided. The 1912 inspection report for the Sanibel Island, Florida, Lighthouse, notes that the drop tube is a "newel post, 65 ft." This is the center post to which the stairs are attached; it served also to house the weights, so this was indeed the situation there.

External drop tube of a skeletal tower. Manitou Island, Michigan. U.S. Coast Guard photo.

I suspect that in at least some other instances there once was an external weight tube but that it was removed as a no-longer-needed and unnecessary maintenance headache when an electric motor relegated the weights to the scrap heap, but documentation of this is lacking.

Inside the walls

The stately tall brick towers that are found in many locations along the shores of Lake Michigan and Lake Superior are often referred to as "Poe Towers," as their elegant design is attributed at least in part to early lighthouse District Engineer Orlando Metcalfe Poe. These lighthouses are double-walled, with the outer tapering cone of brick surrounding an inner perfectly cylindrical wall. The inner and outer walls are connected, not separately free-standing, but this construction results in an air space between the two which itself tapers from several feet at the bottom to several inches at the top. It is in this space between the walls that the weights in those towers that had a rotating lens were hung, and the construction of them provided for that potentiality. Towers at Au Sable, Michigan; Big Sable Point, Michigan; Little Sable Point, Michigan; Outer Island, Wisconsin; and Cana Island, Wisconsin, are a few of the many examples of these.

Special access doors into the between-the-wall space were installed in most of these towers when they were built, even though some of them never displayed a rotating lens. The upper door was located just below the pedestal deck and had a vertical slot through which the cable entered the wall. The cable then went around a pulley inside that upper door and the weights hung down from there. A lower door, without the need for the slot, was located some distance below. Should the cable break, the weights could be retrieved for reinstallation via this lower door.

With the exception of overall height,

Upper doors into inter-wall space at (above) Cana Island, Wisconsin (photo by Lee Radzak) and (below) Outer Island, Wisconsin (National Park Service photo by David Cooper.)

these towers are in most other respects almost identical, yet there is variance as to the distance between the upper and lower doors, and thus the distance the weights could descend before they would have to be wound back up. The upper and lower doors at the South Manitou Island, Michigan, Lighthouse are about 40 feet apart. In the tower at Au Sable Point, Michigan, the two doors are about 61 feet apart. In yet another very similar tower at Little Sable Point, Michigan, the two doors are 78 feet apart. These distances represent the maximum distance the weights could have descended, and I have no explanation for the differences.

A unique additional feature of several of these towers is a horizontal slot in the wall, a few feet below the upper door. A wooden or metal "shelf" could be inserted into this slot. During the day, or when work had to be done on the clockwork, this shelf would be inserted and the weights would be lowered on to it, thus taking the strain off the cable drum of the clockwork.

The lighthouse at Outer Island, Wisconsin, exhibits a unique feature not found in any of the other similar towers—a third access door into the weight channel. This one is located just below the upper door where the cable entered the chamber and is significantly longer than the upper one. When the weights were wound to the uppermost position, they would have been hanging right inside this door and easily accessible for either inspection or for adjustment. If this was the reason for this third larger door, I have no explanation as to why it is not found in any of the other similar towers as well.

Double-walled towers exist at many other locations besides the Great Lakes. Montauk, New York; Cape May, New Jersey; and Pensacola and Jupiter Inlet, Florida, are some examples.

Upper door opening into inner-wall space (door removed), showing cable going around the pulley inside. Little Sable Point, Michigan. Photo by Matt Varnum, SPLKA.

An unusual variation of the cable routing once existed at the Jupiter Inlet Lighthouse. When first put into service, the weights of the clockwork did descend in an inner-wall space, but this channel ended at the third landing of the tower, at the 75th step. In 1928 the system was changed, and the weights were rehung just inside the inner wall. An opening for them to pass through was cut into the 92nd step. The hole, now with a plexiglass cover, is still there, intriguing today's visitors. In a variation of "within-the-wall," the relatively short "schoolhouse" tower at White River, Michigan, has the weightway built into an otherwise solid masonry wall.

Summary

Although it has been decades since electrification led to the mechinization of lighthouses, and soon spelled the death-knell of the keepers themselves, many remnants of the weight-driven clockwork systems that once turned the rotating lenses survive in lighthouses worldwide, and more and more of today's caretakers of these icons of our maritime history are working to save if not utilize these remnants. A precious few sites still use this technology, and they provide a valuable glimpse into "what was" for a century-plus.

Among the many nightly tasks of Keeper Hansen at Crooked River, and all of his peers at lighthouses from coast to coast, "winding the weights" was but one job, albeit among the most critical. As is true in almost every aspect of lighthouses, the variety and creativity of the engineers in designing weightways, through which up to hundreds of pounds of driving weights descended the towers, is astonishing.

It is my hope that this article will bring new interest to this almost forgotten part of lighthouse history.

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