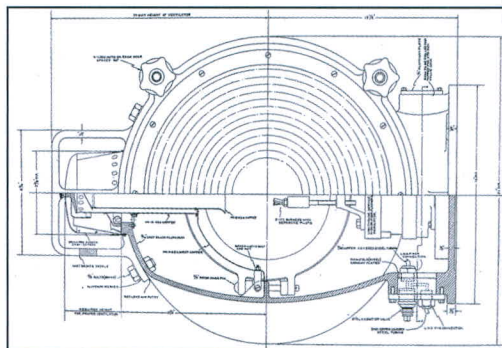


AIDS TO NAVIGATION FOR AIRPLANES - Part 2

Technology Developed by the Airways Division of the Lighthouse Service

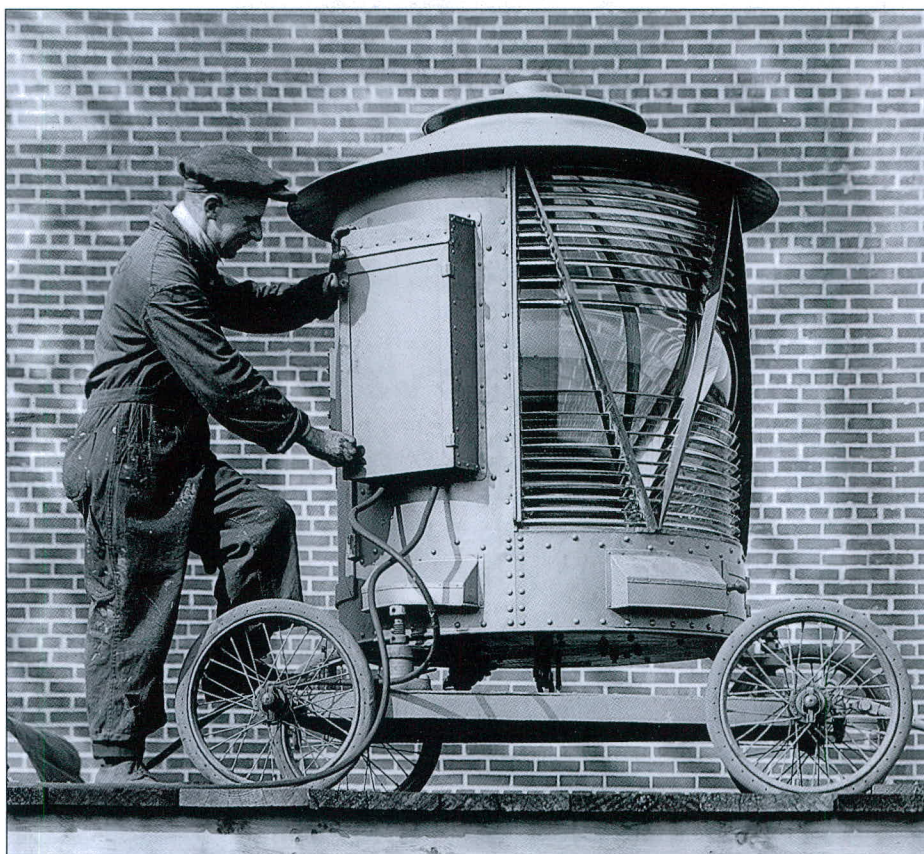
By Mary Louise Clifford and J. Candace Clifford



In 1927 the Airways Division issued the following Specification For Airway Flood Lights:

General Description – Each floodlight unit shall consist of a drum type housing mounted on a rigid pedestal, this drum to be fitted with a 14” or 16” commercial precision parabolic glass mirror, mogul screw socket, a spread light lens, and suitable provision for mounting a color screen.

Drum – The drum shall preferably be of cast aluminum non-corroding alloy, not less than 3/16” thick, or as an alternative, galvanized Armco iron of rigid construction will be considered. The drum shall be supported on a trunion mounting with a flange for fastening to a wooden deck, and shall be of sufficient strength and ruggedness to provide adequate support for outside mounting. The steel support shall be galvanized throughout. Provision shall be made to elevate the light, and hold the light firmly in position by a lever clamp. The lights will be subject to high winds and the design of the support shall be adequate to insure rigidity in the adjusted position. The design of the drum shall be adequate to carry off the heat. If ventilation is utilized to dissipate heat, the unit shall be rendered insect-proof by installation of suitable fine mesh bronze wire screen. Access to the floodlight unit shall be provided with a hinged door, front and rear, held in place with suitable swivel wing nuts, or the approved equivalent. The entire unit shall be ruggedly constructed, absolutely weather-proof, insect-proof, and designed to give adequate and long service exposed to the weather. A water-proof, rubber-bushed hole shall be provided in the bottom of the drum for the admission of electrical conductors. Diagonal peep sight holes shall be drilled in the drum for focusing the lamp, and the holes shall be threaded and provided with 6/32 brass, knurled head screws to close the



Portable airways Fresnel flood light.

holes against insects. An adjustable mounting of brass or galvanized steel with a porcelain mogul screw socket shall be installed for the reception of a G-40, 500-watt floodlight lamp. The adjustment shall be adequate to provide for the substitution of a 1000-watt floodlight lamp, should greater intensity be found necessary. Each drum shall be fitted with 15 ft. of extra flexible No. 12 duplex, “Okocord,” “Super-service,” or approved equal.

Mirror – Each floodlight unit shall be equipped with a 14” or 16” commercial, precision, parabolic optical glass reflector, properly annealed, and guaranteed not to crack from heat. The optical glass used shall be high transmission, tough and uniform, and

of quality that will not crack when subject to repeated heating and cooling. The reflector shall consist of a heavy, homogeneous coating of metallic silver, backed for protection in accordance with the Navy Department Specifications 17M3c.

The glass reflector shall be mounted in such a manner that there will be no breakage from shipment or rough handling while in transit.

Front Lens – The front lens shall be convex, heat resisting, spread light lens of approximately 40” horizontal spread. The front lens shall be made of clear high transmission glass free from imperfections, and suitable annealed, so as to insure freedom from



Installing an airways flood light.

cracks when operating under service conditions in rain or snow.

Color Screen – Each unit shall be furnished with a suitably red orange color screen of not less than 40% light transmission, made of heat resisting high transmission glass free from imperfections, suitable annealed to insure freedom from cracking. The color screens shall be installed so as to be easily removable.

Each bidder must furnish drawings and complete specifications of the equipment quoted on. Rights are reserved to accept equipment on manufacturer's specifications should it be deemed advantageous to the Government. The floodlight units will be inspected at the plant of the manufacturer before acceptance.

The units shall be adequately packed for freight shipment on Government Bill of Lading, and the prices quoted are to be F.O.B. manufacturer's plant.

Along with the specifications for the flood light was **Specification For 51 Ft., 62 Ft., and 75 Ft., Four Post Beacon Towers** on which the flood light was to be mounted:

Requirement – It is required that there be fabricated and delivered f.o.b. bidder's factory or warehouse, 51 ft., 62 ft., and 75 ft. galvanized steel skeleton towers in accordance with these specifications and attached drawings Nos. 502 (9-23-27) 503 (9-23-27) and 501 (6-16-27).

Corner Posts – The splices for the top 30 ft. shall be made with at least a 6" lap with three bolts in each leg of the angle (6 bolts). The splices on the remainder of the tower shall be made with at least an 8" lap and four bolts on each leg of the angle (8 bolts). The corner posts shall be securely fastened at the top with gusset plates as shown on drawings Nos. 501 and 502.

Girts – Girt "A" shall be placed with the back of the angle up and girt "B" with the back down in order to provide for attaching switch cabinet. Legs shall be punched so that girt "B" may be attached to any face of the tower.

Braces – All braces shall be flattened and punched for bolting to each other at intersections and also shall be flattened and punched for bolting to intermediate girts at crossing points. All braces shall be cut, flattened, and punched for bolting to corner posts with one bolt at each connec-

tion so as to form a rigid symmetrical structure from top to bottom. Braces shall be so arranged as to prevent so far as possible a pocketing of water.

Anchor Posts and Plates – Anchor plates shall be provided with two 1" diameter holes for use where it becomes necessary to anchor the tower legs to rock. All metal to be placed below ground level shall be given one coat of black asphalt paint.

Galvanizing – All steel parts, including bolts and nuts, shall be galvanized after fabricating, and shall meet the provisions specified by the National Electric Light Association, for galvanizing.

Bolts – All bolts shall be of the diameter shown on the drawings and shall be of the proper length to permit of peening after the nut has been tightened to prevent loosening. An excess of at least 10 per cent of bolts shall be supplied in order to provide for loss and replacements.

Ladder – The ladder rails shall extend below the ground level in order to fasten into the concrete foundation. The ladder rungs shall be of an oval pipe type and spaced 15" c/c. The ladder shall be assembled and shipped in convenient lengths for handling.

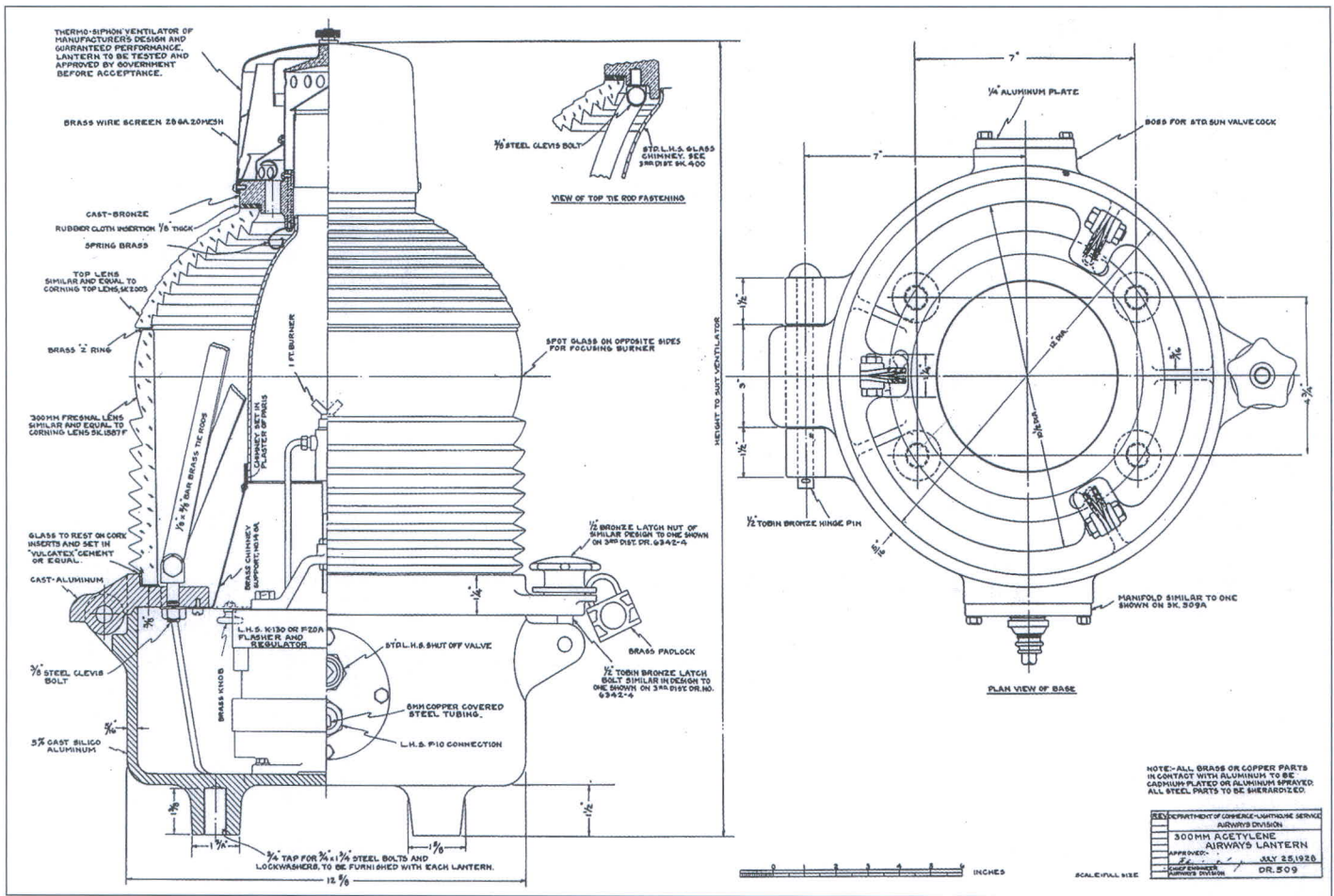
Platform – A platform 6 ft. square shall be provided 2 ft. below the top of the tower with galvanized 2" angle supports, railing and braces as shown. The platform shall be of 1 1/2" x 6" Louisiana Gulf red cypress No. 1, common S 4 S, not less than 1/4 finished thickness, planks laid with 1/2" space between adjacent planks and shall be bolted to the angle iron frame with 1/4" galvanized bolts. The platform shall be provided with a trap door about 18" by 22" furnished with extra heavy galvanized 5" T hinges and galvanized 4 1/2" safety hasps. Both hinges and hasps shall be provided with brass pins. All woodwork shall be given one coat of chrome yellow paint equal in color to No. 4 specifications 3-1, Q.M.C., U.S.A.

Wind Cone Bracket – A galvanized wind cone bracket as shown on the blueprint No. 501 shall be furnished with each tower. Horizontal brace arms shall be connected to the tower by a hinge joint. The upper end of the suspension iron shall be detachable from the tower. The 1" pipe flange shall be furnished. (The wind cone will not be furnished under this contract.)

75 Ft. Extension – The 51 ft. towers shall provide for an extension to 75 ft. by adding



Tower holding flood light.



Drawing of 300-mm acetylene route beacon.

two lower panels, anchors and anchor posts, as show on drawing No. 503. Where the extension for 75 ft. tower is required the anchors and anchor posts shown on Drawing No. 502 will be omitted. Bidders will quote a unit price for furnishing the complete material required to extend the tower to 75 ft. and the Government reserves the right to order not less than five nor more than fifteen such extensions at the unit price quoted.

62 Ft. Extension – The 51 ft. towers shall provide for an extension to 62 ft. by adding the upper or 11 ft. panel together with girt “B”, anchor posts, and anchors shown on Drawing No. 503. Where the extension for 62 ft. tower is required the anchors and anchor posts shown on Drawing No. 502 will be omitted. Bidders will quote a unit price for furnishing the complete material required to extend the tower to 62 ft. and the Government reserves the right to order not exceeding five 62 ft. such extensions at the unit price quoted.

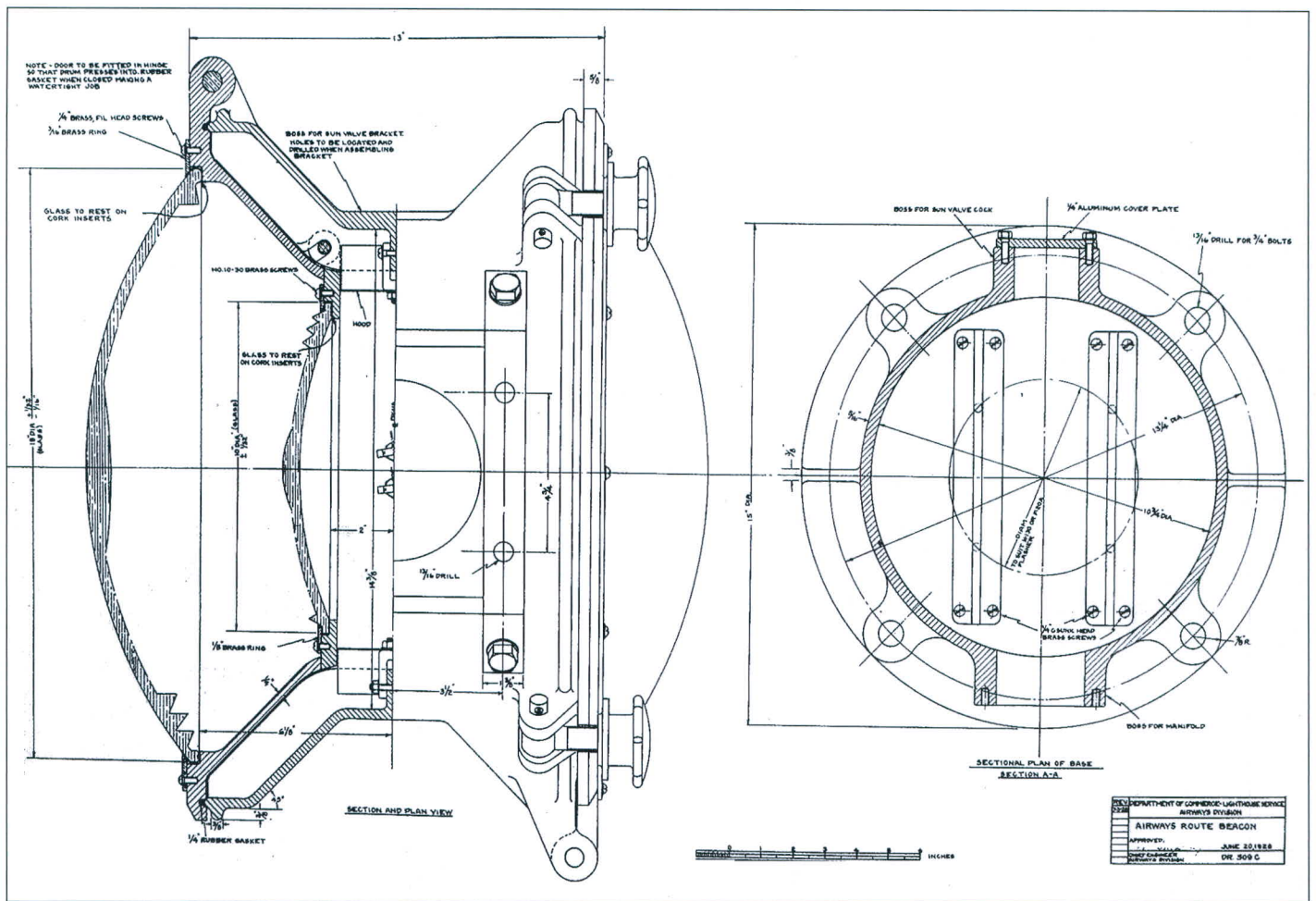
Inspection and Payments – Inspection will be made by a representative of the Bureau of Lighthouses. Towers will be inspected at the contractors works and the contractor, if so

directed, shall assemble and erect one tower at his works for inspection. A progress report of 75 per cent based on the unit prices quoted will be paid upon completion, inspection and acceptance of each lot of twenty-five towers. Final payment will be made upon receipt in the Office of the Bureau of Lighthouses of Government bills of lading duly received by common carrier, showing complete shipment.

Shipping – Towers will be shipped on Government bills of lading which will be furnished from time to time together with shipping instruction. Platform shall be assembled and the trap doors secured by wooden cleats nailed to the under sides of the platform; ladders shall be assembled and shipped in convenient lengths for handling; anchor plates shall also be assembled but otherwise the towers shall be shipped disassembled. All bundles shall be made up in such a manner as to assure the number of pieces in each bundle. As a rule only one tower will be shipped to one destination. All members shall be appropriately numbered or otherwise marked for convenience of erection and twenty-five copies of erection diagram furnished.

A year later, in April 1928, the Chief Engineer of the Airways Division, F. C. Hingsburg, issued a memo:

“A hearing was held by the Assistant Secretary of Commerce for Aeronautics on April 10, 1926, in connection with bids covering acetylene routing beacons, Proposal No. 19310, which were opened on March 30, 1926. It was decided that all bids be rejected owing to imperfect specifications and the possibility of obtaining superior equipment based on manufacturer’s design. It was arranged that tests of acetylene lighting equipment meeting the general requirements for airways lighting, be submitted to the Department for test at the General Lighthouse Depot, Staten Island, N.Y. A committee consisting of Superintendent of Lighthouses J. T. Yates, and Chief Engineer of the Airways Division, F. C. Hingsburg, was appointed by the Assistant Secretary to test out the equipment and report to the Assistant Secretary the results of the tests and the suitability of the apparatus submitted for airways lighting. Upon this report, revised specifications and detailed drawings would be prepared cov-



Detail of the 300-mm acetylene airway route beacon.

ering the apparatus serving the best interests of the Government.”

In August 1928 the Airways Division sent new specifications to the American Gas Accumulator Company and Interflash Signal Corporation (both long-time suppliers of acetylene beacons, flashers, buoy, canisters, etc., to the lighthouse service), asking them to supply an acetylene Airway Route Beacon for testing.

Airways Division, Bureau of Lighthouses, Department of Commerce, August 2, 1928 - *Specifications For 300 M/m Acetylene Airways Lantern:* [Drawing attached]

1. General Description: The lantern shall consist of a 300 M/M half Fresnel lens and conical top lens section, mounted in a lantern housing, fitted with an acetylene regulator and flasher, one foot burner and dual pilot and ventilating system as shown on drawing number 509, and as specified hereinafter. It is intended that the lantern shall be mounted on the double-ended range lantern, shown on Airways Division Drawing Nos. 509-A, B and C, the combination forming the standard acet-

ylene airways route beacon. The lantern shall be a self-contained unit designed for exposure to the weather and shall be absolutely wind-proof, storm-tight and insect-proof. Provision shall be made for the future attachment of a sun valve by providing the necessary bosses for the attachment of a sun valve cock manifold. The characteristics shall be flashing, 40 flashes per minute with a luminous period of 1/8. Complete piping, fittings, manifold, gauges, valves, etc. shall be furnished for installation on 20 foot tower and to connect up with three commercial 300 cc. ft. cylinders.

2. Lenses: The lenses shall be approximately 300 M/M in diameter, lower lens being 360° Fresnel, cut at the upper part of the central drum. The upper section shall be 3 5/8" high, 4 3/8" internal diameter at the top with inside prisms as shown, and shall be fitted to the lower lens section by means of a brass "Z" ring. The optical glass shall be clear, hard, high transmission, pressed and polished lenses of proper optical design. The maximum candlepower from the lower section using a one-foot acetylene burner shall be not less than 180 B.

cp [candlepower] with a distribution of light from 0° to +8°. The light distribution of the upper section shall be from +4° to +30°. The lenses shall be similar and equal to the Corning lenses held as the standard of comparison.

3. Lantern: The base castings shall be 5% silico-aluminum, properly proportioned to conform to the dimensions shown on the drawings... (complete text can be found at <www.marylouiseclifford.con>).

The successful bidder will be required to fabricate one complete beacon in advance of quantity production, this sample to be inspected by the Chief Engineer of the Airways Division or an authorized representative, and final approval given by him prior to further manufacture of the beacons.

4. Patents: If any article, device or arrangement used is subject to a patent right, the cost of royalty for its use is to be paid by the contractor. All parts must be guaranteed for a period of one year against defective and inferior parts and workmanship. The proper performance and reliability of apparatus shall be guaranteed for one year.

5. Painting: The metal parts of the lantern shall be neatly painted with a heat resisting primer coat and enamel of approved brand, color to be similar to yellow No. 4 U.S. Army Color Chart supplement to specification No. 3-1.

6. General: The successful bidder will be required to fabricate one complete beacon in advance of quantity production, this sample to be inspected by the Chief Engineer of the Airways Division or an authorized representative, and final approval given by him prior to further manufacture of the beacons.

7. Shipping: The lanterns shall be carefully and adequately boxed and packed for shipment on Government bills of lading. Payment will be made for each lot of lanterns or individual units upon shipment. Each lot of lanterns will be inspected by the Government before shipment.

In a memo dated April 12, 1928, author unknown, a further explanation of the beacon needed for air routes was given:

"The acetylene beacon shall be the most effective apparatus designed by manufacturers for approximately 3 1/3 mile spacing of lights along airways. This apparatus will be installed generally on 20-foot towers furnished by the Government, but where required, 30, 50, 75, and 80-foot towers will be used. The maximum brightness shall be shown to the pilot flying at 1000 feet elevation along the course. The horizontal divergence of the range light shall be sufficient to permit the airplane to drift 1/2 mile either side of the axis of the course without losing its effectiveness.

"The vertical divergence shall be sufficient to see the light from the adjacent beacon to cover flying at lower elevations and also when flying at 1000 feet elevation the pilot shall see the light with the same brightness to a point above the light as he approaches from the adjacent beacon. . . .

"The lanterns shall be all bronze castings, ruggedly constructed for long life and shall have a proper ventilating system rendering the apparatus storm-proof. The apparatus shall be insect-proof. The flasher shall be of marine type, K 130 or equal, with piping, valves, and connections interchangeable with Lighthouse Service apparatus. The design of the range light shall provide for change of elevation and course within reasonable limits."

Testing and modifying the beacon

Between June 1928 and March 1929, Superintendent J. T. Yates at the Staten Island General Depot tested airway route beacons submitted by the American Gas Accumulator Company and Interflash Signal Company. Lengthy correspondence with the two companies and within the Airway Division of the Light House Bureau discussed every aspect of the beacons—ventilators, filter valves, cork spacers, dowel pins, gaskets, sun valves, etc.

Mr. Yates connected the beacons with a gas supply on the south bulkhead dock at the General Depot on Staten Island and lit them, leaving them exposed to the weather. He daily subjected them to water from a hose held some 20 or 30 feet above the lantern so that the water struck the lantern in form of drops resembling heavy rain. At the same time a jet of air from a 3/8" nozzle 100 pounds pressure, was directed against each lantern

from a distance of about 5 feet, to test the weather proofness [sic] of lantern. It was then subjected to the jet of air as above held at all distances from 6 feet to directly into all ventilation openings. If in this test the pilot was extinguished or flame caused to flicker, the lantern was rejected. If any moisture leaked into the beacon either during the test or during the next 24 hours, suggestions were made for correcting the problem and the lantern was returned to its manufacturer. Another test placed the lantern inside a tankhouse with a steam hose to ascertain whether the lantern would function properly under conditions up to 130°.

As each test revealed problems, the beacons were sent back to the manufacturer for modification. The Interflash Signal Corporation was eliminated during the testing, for failure to meet required deadlines.

The following requisitions indicate that air routes were being developed at the time in the Rocky Mountains:

Special Requisition, DEPARTMENT OF COMMERCE, LIGHTHOUSE SERVICE
December 11, 1928, by F. C. Hingsburg, Acting Commissioner of Lighthouses to Superintendent of Lighthouses, Staten Island, NY.

It is requested that the articles specified below be shipped from Staten Island, NY.

Estimated Quantity	Purpose and description of articles or services	Cost
Acetylene lantern, 300 m.m. (Acetylene blinkers)		
Ship to Assistant Secretary of Commerce for Aeronautics, % Harrison-Wright Company as follows:		
1	Dry Lake, Nevada – for installation on 20' tower	300.00
1	Moapa, Nevada – "	300.00
2	Nada, Utah – 1 for 20' tower & 1 for 51' tower	600.00
1	Bloom, Utah – for installation on 20' tower	300.00
2	Ship to Assistant Secretary of Commerce for Aeronautics % Muhleman and Kayhoe, Inc., Birmingham, Ala., for 51' towers	600.00
Acetylene Route Beacons		
Ship to Assistant Secretary of Commerce for Aero. %Harrison-Wright Co. as follows:		
2	Dry Lake, Nev. – for installation on 20' towers	771.00
2	Moapa, Nev. – "	771.00
1	Little Field, Ariz. – "	385.00
2	Bloomington, Utah – "	771.00
2	Leeds, Utah – "	771.00
2	Pinture, Utah – "	771.00
6	Cedar City, Utah – "	2313.00
6	Nada, Nev. – "	2313.00
6	Milford, Utah – "	2313.00
3	Black Rock, Utah – "	1156.00
10	Ship to Bloom, Utah - for installation on 20' tower	3855.00
4	Toplift, Utah – "	1542.00
3	Tooele, Utah – "	1156.00

Aircraft radio

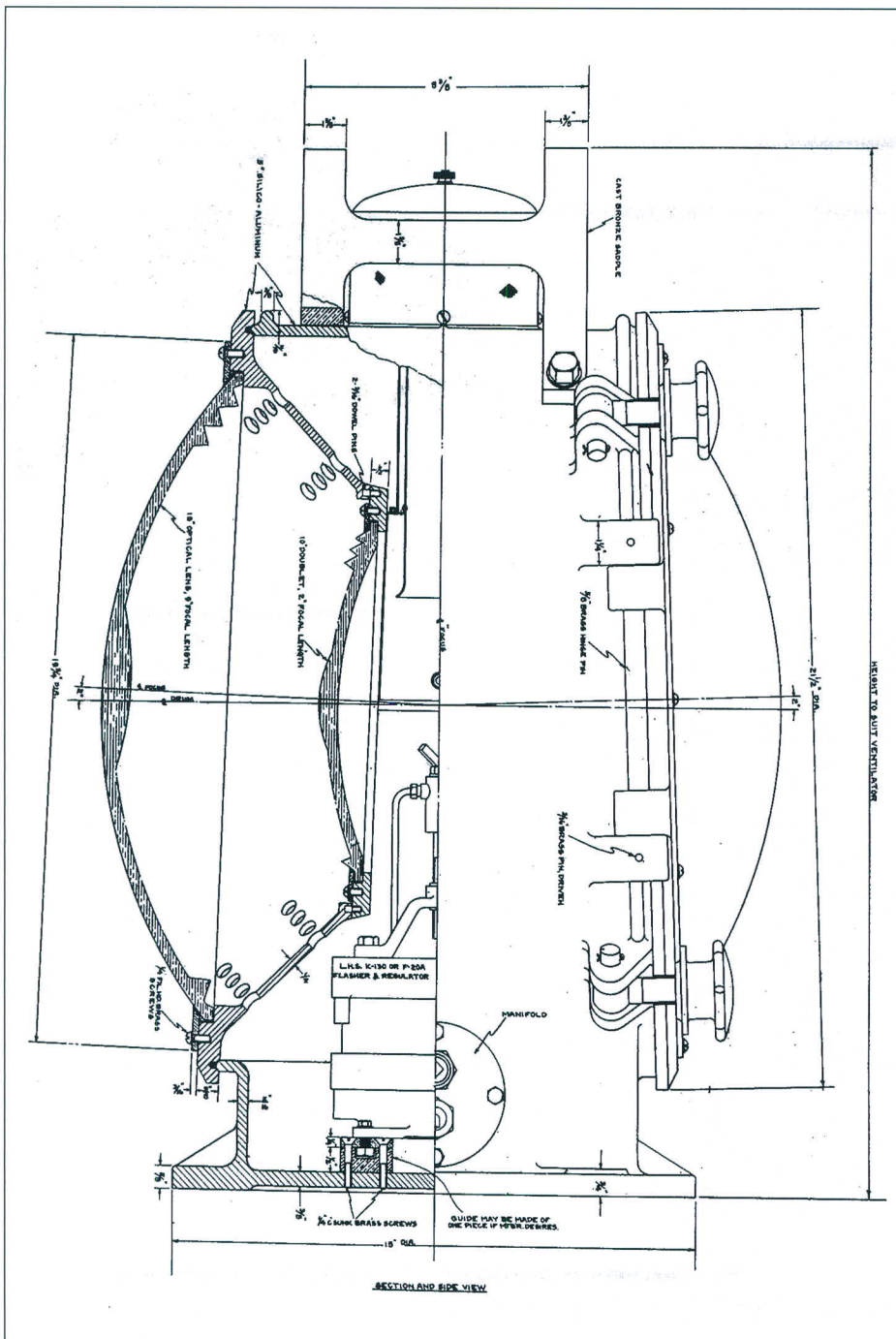
By the time the Airways Division took over the Transcontinental Airway System, there were 45 radio operators working at the renamed Airway Radio Stations.

“Early specialists were primarily former maritime radio operators. They were all experienced in building, maintaining, and operating radios for long periods with little or no assistance. These radios used point-to-point telegraphy using Morse Code-known as CW (Continuous Wave) to communicate with other ground stations. CW was used for air ground communication until voice radios were developed. CW was not phased out of the air traffic system until 1948. Weather and aeronautical information was passed along the routes from one station to the next. The standard Morse Code gave way to shorthand methods as radio traffic increased.”

The October 1932 issue of the *Lighthouse Service Bulletin* stated that:

“H. J. Walls, radio engineer, attached to the airways division, Lighthouse Service, was appointed a technical adviser representing the Department of Commerce at the International Radio Conference now being held in Madrid. The last conference was held in Washington in 1927; at this conference the present frequency band for radiobeacons was adopted.”

All photos and drawings in this article are from The National Archives. The reference material on which this article is based can be found at <www.marylouiseclifford.com>.



Airways route beacon

Airways route beacon useful in lighthouses as well

The June 1931 *Lighthouse Service Bulletin* reported that the acetylene Airways Route Beacon developed by the airways division would be useful as well in lighthouses:

“A new type of revolving beacon, having two 36-inch lenses, is now available for marine work, having been developed in the airways division. Among the advantages which this beacon offers over previous types is that of

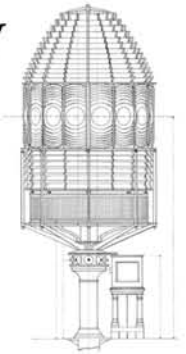
two lenses. This amounts to a doubling of the light period, and makes it possible to double the number of flashes without speeding up the beacon.

“Another important feature of the new beacon is the inner lens doublet which considerably shortens the focus and permits the mounting of two lenses with a single light source in a housing not excessively large. The inner doublet also facilitates changes in the color of the light, as either or both of the doublets may be of colored glass.”

Mary Louise and J. Candace Clifford are the authors of five lighthouse books, the most recent being *Lighthouses Short and Tall*, for readers age 11 and up. For more information see <www.lighthouse-history.info>



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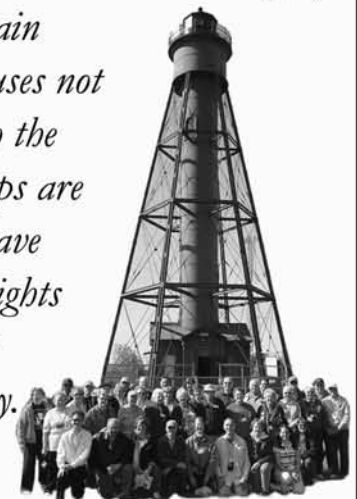
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Tincum Lighthouse, NJ