NATIONAL BUREAU OF STANDARDS REPORT

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IMPROVEMENT OF NAVIGATIONAL LIGHTS

By

Ray P. Teele

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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This report describes the optical components for two types of navigational lights designed to give improved optical performance while decreasing the physical size compared to currently used navigational lights. Consideration was given to features that would permit retracting the navigational lights when used on submarine vessels. It is understood that the mechanical design will be carried out by the Bureau of Ships. However, models were made up to serve as possible prototypes.

1. CYLINDRICAL MODEL

The cylindrical shape would lend itself to retraction. The bottom could be equipped with rings and operate as a piston inside of a tube extending through the fairing or into the hull of the vessel. The top of the unit could be shaped so as to be flush with the fairing or hull when the unit was retracted.

1.1 Mast Head Light

The optical unit for the mast head light is shown in Section B-B of Figure I. The optical unit is essentially a channel and in production could be made from channel brass (or other metal) and serve as the mechanical support between the top and bottom of the complete light unit. The forward edges should be bevelled and made as thin as possible while having adequate mechanical strength.

The optically important dimensions, a and b, are related by the relation $a/b = \tan 22.5°$. The dimension, a, is the distance of the filament from the plane containing the forward edges of the channel. The dimension, b, is half the width of the channel measured outside at the forward edges.

An alternate construction is shown in Figure II. In this case the section of the metal cylinder at the back of the unit must serve as the support for the top and bottom of the unit and would need to be quite thick to maintain the top and bottom parallel to each other and to exert adequate pressure on gasket material to seal the glass cylinder against entrance of water.

1.2 Side Lights

The optical unit for the side lights is shown in Section A-A of Figure I. This optical unit is symmetrical about the horizontal center line, A-A. One unit serves for both port and starboard lights, being installed with the opposite end up in one light as compared with the other light. This interchangeability would simplify stocking and storing problems.

The optically important dimensions are, as for the clear unit, a and b, for the side cut-off and on the forward axis through the filament for the forward cut-off. The arched shield for the forward cut-off has sufficient length to permit relamping; its shape need not be held to close tolerances.

1.3 Lamp Bulbs

Lamp bulbs were designed for these units. They are characterized by having spherical bulbs with medium prefocus bases. The filament is a single coil at the center of the spherical bulb and at right angles to the axis through the base. The bulbs are especially selected to be free of striae, stones, bubbles and other imperfections. Although made up specifically for this project by one of the large lamp manufacturers, they would not be too costly in production in quantities A description of the lamp would be: bulb, G-16 1/2; base, medium prefocus; rated volts, 19; amperes, 2.6; filament, C-6; light center length, 2 3/32 inches; maximum overall length 3 1/16 inches. The criteria for selection of the bulbs for quality are the same as now commercially used for lamps for medical instruments, for example, as used for the trade number 981 lamps. The life can be specified as desired between 100 and 1000 hours.

1.4 General

Each unit is equipped with a standby lamp. The optical performance is the same with either the regular or standby lamp in operation.

All surfaces of the optical units are painted with flat (matte) finish black paint.

In production an opaque coating should be applied to the outer glass cylinder over all portions through which light does not pass. (Paint was used on the models but would not be durable in actual service.) The opaque coating on the models has been omitted at the back of the side units to permit examination of socket arrangement and wiring. In all units the #3 terminal of the plug is the common lead.

2. SEALED-BEAM UNIT

A sealed-beam unit was designed. The principal advantage of this unit would be ruggedness and small size. It could be used in a housing similar to a traffic-signal standard with a regular unit and a standby unit in the same housing. A red coating has been developed by the Westinghouse Lamp Division which is suitable for use on these lamps. However, a durable green coating has not yet been perfected. While the coated red or green bulb is preferable it is possible to use a clear bulb and external colored glass disk. At a demonstration of an early model of this sealed-beam unit it was decided by the Bureau of Ships representatives to concentrate on the cylindrical model. However, an improved sealed-beam lamp was already on order at that time.

The improved sealed-beam lamps were delivered subsequently and their performance is such that, in view of their ruggedness and small size, they might be used in some service applications. A fog lamp housing was obtained to house this unit and it is suggested that it be considered along with the other models. The cut-off is not adjusted to be exactly 112.5 degrees in this sample. This adjustment would need to be made for the exact dimensions of the final housing decided upon if the unit seems to have sufficient merit.

It is believed that the sealed-beam unit would prove to be the most rugged in actual service as well as the easiest to maintain in first class working condition.

3. MEASUREMENT OF CUT-OFF OF UNITS

The various models and one of the present masthead lights were measured on a semi-automatic recording

goniophotometer to determine the cut-off characteristics. The present mast-head light delivered to the Bureau together with the lamp currently used in this model were found to have either an incorrect socket position or an incorrect light center length for the lamp. We were assured by telephone that both unit and lamp were those currently used. The difference between the filament location for a horizontal beam and the actual location of the filament in the unit delivered to this Bureau is approximately 1/4 inch.

The angles in the vicinity of the cut-off are determined with an expanded angle scale as marked on each graph sheet. The major portion of the horizontal traverses was run with an angle scale of 5 degrees per line on the graph; the expanded angle scale is 0.5 degree per line on the graph.

3.1 Present Mast-Head Light

The cut-off of this unit, as can be seen from Graph I, is accomplished in approximately 5 degrees.

3.2 Improved Mast-Head Light

The cut-off of this unit. shown on Graph II, occurs in 1 1/2 degrees.

3.3 Improved Port Light

The side cut-off of this unit, shown on Graph III, occurs in 1 1/2 degrees. The forward cut-off occurs in 2 degrees.

3.4 Improved Starboard Light

The side cut-off of this unit, shown in Graph IV, occurs in 1 1/2 degrees. The forward cut-off occurs in 2 degrees.

3.5 Larger Improved Mast-Head Light

The cut-off of this unit, shown in Graph V, occurs in less than 1 degree.

3.6 Sealed-Beam Side Light

The entire beam is shown in Graph VI, together with expanded angle-scale of cut-off region at each end. The entire range of the cut-off is about 8 degrees but the

effective cut-off is about 1/2 of this value (from zero to about 60 percent of the side increase in intensity).

4. REDUCTION IN SIZE

The present mast-head light is 10 1/2 inches high and 29 inches wide. The side boards are "swept back" and the overall depth is about 1 foot (the central body is 9 inches deep).

The small size improved mast-head light is 7 1/2 inches in diameter by 12 inches high. The larger size improved mast-head light would be about 9 inches in diameter by 12 inches high in complete unit form. The optical unit is 7 1/4 inches in diameter; a surrounding glass cylinder and top and bottom plates would increase the diameter to about 9 inches in a completed unit. The improved side lights are the same size as the improved mast-head light. Two photographs showing comparative size are appended to this report.

The sealed-beam lamp is 4 3/8 inches in diameter by 2 1/2 inches deep. When this is mounted in an automotive fog light housing with the light baffle on the front the complete unit is 5 inches in diameter and 3 1/2 inches deep.

5. SUMMARY

An improved cylindrical navigational light with internal control of the cut-off angle has been developed. The smallest practical size has a cut-off of about 1 1/2 degrees as compared to about 5 degrees for the current lights. A slightly larger unit (about 1 1/2 inches greater diameter) would result in a cut-off of less than 1 degree. Either cylindrical model is approximately the same size as the central body of the current lights. No side "boards" are used with the new lights.

A sealed-beam unit was developed which would have optical characteristics comparable with those of the current navigational lights. The advantages of this unit would be its small size, ruggedness, and ease of maintenance in service.

This report covers the optical units in prototype housings. Details of mechanical design are to be worked out by the Bureau of Ships.

Photographs showing the comparative size of the current and improved mast-head lights and the optical components (from left to right) for a side light, the large mast-head light, and the small mast-head light are appended to this report.

One fault that exists in the current model is the presence of reflections in the edges of the prisms of the Fresnel lens. These reflections cause difficulty at close ranges. The improved units all use smooth outer or cover glasses and such reflections are avoided. The smooth outer glass is, of course, much easier to clean than are the Fresnel lenses now in use.

Photograph 1

Present mast-head unit on the left and improved mast-head unit on the right

Photograph 2

Optical units of improved navigational lights. Side-light unit on left, large mast-head unit in center, and smallest practical mast-head unit on right.

Photograph 3

Sealed-beam unit for side lights compared with present mast-head light. Ruggedness and small size are the principal advantages of the sealed-beam unit, which has cut-off characteristics comparable to those of present lights.

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports. and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.


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