deg. The ultramicroscopic examination of the red and blue solutions by polarized light revealed considerable differences in the form of the particles. With the red solution the diffraction disks were always circular, but with the blue solution they were often curiously deformed. In general, the phenomena exhibited by the blue solutions were far less uniform than those of the red solutions.

THE GUIDING LIGHTS OF OUR COASTS.

BY C. H. CLAUDY.

The goal toward which the Lighthouse Board of this country is striving, is a continuous chain of lights, completely encircling the United States and possessions, and, in the case of rivers and inland seas, bounding the waters on all sides, so that a ship may never leave the area of light thrown by one lighthouse, before entering the circle of light of another. As fast as Congress will appropriate the money, the gaps are being filled.

But what makes the light? When the curious inquirer is told "kerosene," he naturally wonders why his own student lamp does not give a better one, if the same oil in the lighthouse sends its beam from five to twenty-five miles.

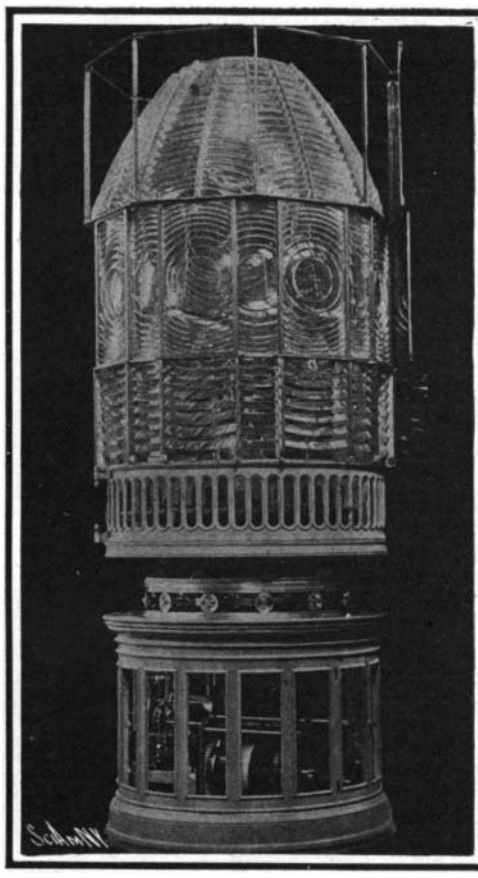
Various methods of lighting were in use until 1840, when a new system was introduced of employing nearly true paraboloid reflectors and better glass lenses. In some cases these reflectors gave a light which is not surpassed even to-day, except when handled with intelligent care. In 1852, when the present Lighthouse Board was instituted, the Fresnel system of lenticular glasses was introduced from France, and still remains. The first cost is great, but by the saving in oil over the reflector system this is soon reduced. With any reasonable care, a fine light always results; and it is impossible for a keeper to maintain a poor light with this apparatus without flagrant disobedience of instructions.

The accompanying illustration shows a first-order lenticular apparatus. It gives a flash every four seconds, alternate flashes being of slightly different duration. It will be seen that there are more or less complete lenses in the center of the apparatus, surrounded by more or less complete rings of prisms. Above and below are other sets of prisms, which catch the spreading rays of the central light and send it out straight toward the horizon.

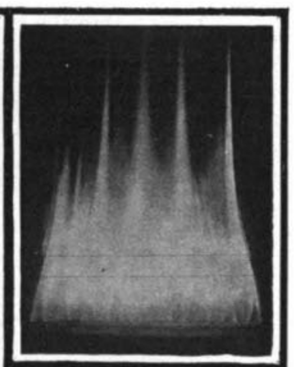
Even with such an apparatus, no common lamp can supply the light. First-order lamps have five wicks, one inside the other, and are fed with oil by a pump and pipe system. The oil is fed to the wicks so that it reaches the ends, where the flame is, in the right time and in the right quantity. It is difficult to look at it, so intense is the light. In the lenses rather than in the lamp is the secret, for they pick up and utilize nearly all the rays of light which ordinarily go astray. The Fresnel apparatus collects almost all of this waste light, and reflects and refracts it out in one great broad beam of light, parallel to the surface of the sea, where it is needed.

A diagram is reproduced with this article, showing the relative range of lights of the different orders and the relative intensities of a flash and a steady beam. All the light available is concentrated into the flash. In the steady beam, which has no intervals in it, the light covers a broader space, and so cannot cover it so far. That is one reason for making most first-order lights, which are to be seen at a great distance, very high, when they are fixed, and flashing whenever possible, so as not to interfere with near and similar lights.

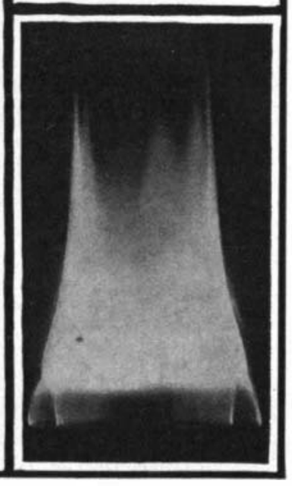
The flames which come from the lamps are largely transparent. So, of course, are all other similar flames. If flames were not transparent, there could be no advantage in having one flame inside another, and a third inside the first two, etc. The lights from the inner ones could not get out, and would do no good. Pictured with this article are flames of a first-order and a third-order lantern, to illustrate the transparency of the flames. These photographs were taken in a fraction of a second, and developed with great care, so as not to block up the delicate tracery of detail. As it is, the reproduction necessarily loses much of the fineness of the original.



First-order revolving Fresnel lamp.



First order flame.



Third-order flame.

The irregularity of the flames is of less importance than the maintaining of a solid band of flame across the focal plane of the system, which is shown in the larger flame photograph, by black lines. It is from this point that the lenses take the light which they project out to the horizon, this part of the flame being the brightest and the steadiest. The relation of lamp and lens system is carefully adjusted, until all the light from the flame in the focal plane of the system is being sent to the place where it is most needed.

In some lighthouses, usually for range light purposes, the light is all to be concentrated in one beam. This is done by concentric rings of prisms and a central bull's eye and a reflector. Vessels getting such a light in range, either by itself or with another light, and running down the beam, are safe from obstructions which may be nearby the range lights, or beams of light, marking out the channel to be followed.

It is frequently asked of light keepers, why electricity is not used in place of mineral oil. An electric light is expensive to install, and difficult and expensive to maintain. There is always difficulty in keeping the arc exactly in the focal point of the lenses, the carbons never burning twice alike, and constant watching being necessary. Failure to have the light source exactly in the focal point of the lens results in sending the light rays up or down instead of straight out where they are wanted. Electricity, while superior in penetrative power in a fog, has no advantage over a powerful oil lantern in clear weather. Mineral oil, colza oil, or lard oil lights of the first order could be seen a hundred miles were it not for the curvature of the earth; and as long as the light is visible long before the coast is, all purposes are served.

It is only within recent years that mineral oil has been in use. Lard oil succeeded colza oil, and was used exclusively up to 1880, and with mineral oil up to 1889. Since the latter year, mineral oil has been used entirely, except where electricity has been experimented with, or coal or acetylene gas. So far, coal oil, for power, efficiency, cleanliness, ease of operation, and cheapness, holds its own against all other means of light making.

Electricity, if it can be successfully installed, is the best light; but through expense of maintenance, and in the inability to get skilled attendants for such a light for the price the law sets on keepers' services, it makes slow headway. The Lighthouse Board, however, keeps fully informed as to all improvements in such apparatus, and is anxious to experiment further whenever Congress will provide the funds.

The traveler who cruises up the coasts, and who sinks one light before picking up another, may know that somewhere in the dark circle is a spot picked for the foundation of a light which will be erected as soon as funds and time allow.

It is reported that from 2,500 to 3,000 tons of electrolytic copper will be required for the electrification of 1,310 miles of railroad in Sweden, the conversion of which from steam to electricity has been decided upon. The lines concerned are all to the north of Stockholm except the Charlottenburg and Laxa and the Gothenburg and Stramstad lines. The system will be fed from five power stations, and work will be commenced early next year.

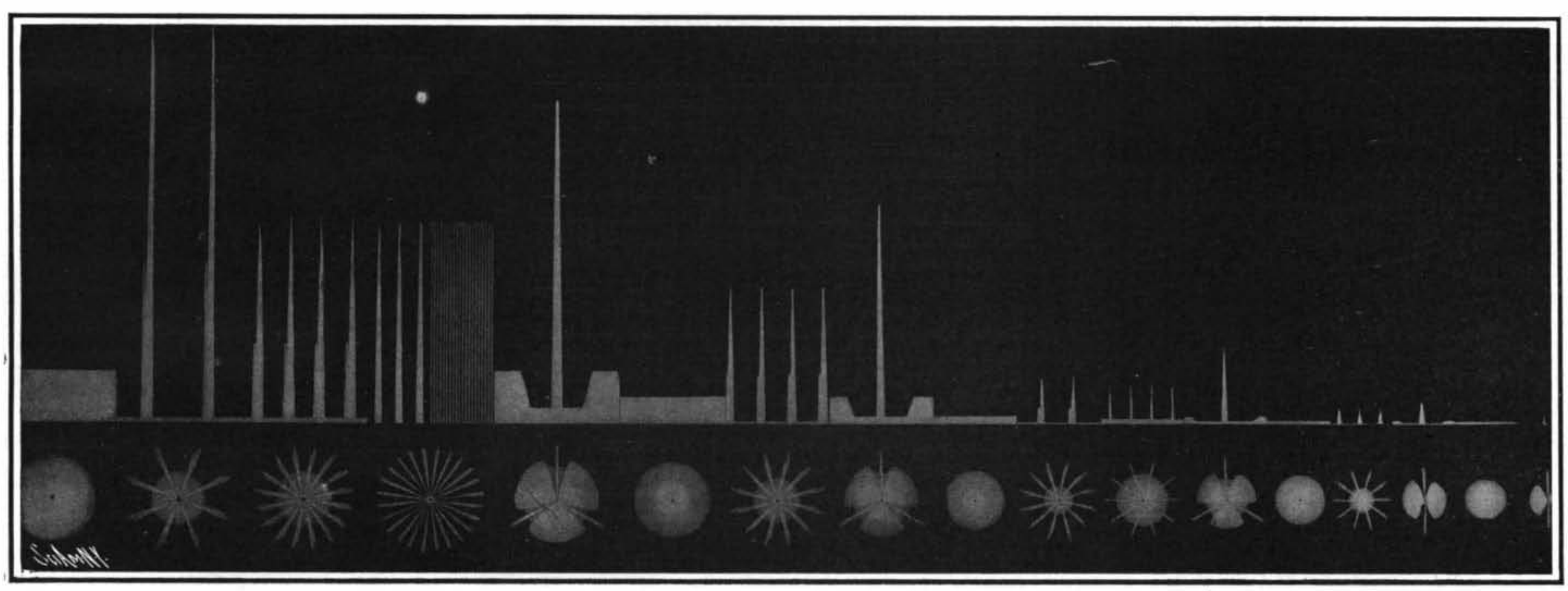


Diagram showing relative intensities of lights of different orders and different characters.

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