

where the visual sense consequently can only perceive the difference between darkness and light, as well as the different degrees of intensity of light.

"II. Partial color blindness, in which the faculty of certain perceptions of color, but not of all, is wanting. It is subdivided into—

"1. Complete color blindness, in which one of the three fundamental sensations, one of the three perceptive organs of color in the retina, is wanting, and in which, consequently, the colored visual field has but two ranges. This group includes three kinds, namely—

"(a) Red-blindness.

"(b) Green-blindness.

"(c) Violet-blindness.

"2. Incomplete color blindness, where one of the three kinds of elements, or perhaps all, are inferior in excitability or in numbers to those of the normal chromatic sense. Incomplete color blindness exhibits, like the normal sense, three zones in the visual field, but is distinguished from it by an unusually small central field. This group includes the whole of a series of different forms and degrees, a part of which—the superior degrees, which might be called *incomplete red-blindness* and *incomplete green-blindness* (and *incomplete violet-blindness*)—constitutes the transitions to the corresponding kinds of complete color blindness; and another part of which—the inferior degrees, which we call a feeble *chromatic sense*—constitutes the transition to the normal sense of colors."

Of the various tests, the most important are Stilling's, Donder's, Chibret's and Holmgren's. Testing by lanterns and flags is tedious, but may have to be resorted to occasionally.

The causes of color blindness are congenital defect, heredity, severe illness, or injury, particularly to the spine and head, and excessive use of alcohol and tobacco.

The influence of fog, mist, snow, rain and steam, on signal lights is important. A white lantern exposed to snow and rain, by absorption of light from the dimmed glass, may appear green to the color blind, who depends on the intensity of the light to guide him. So also may a green light appear red. By the accidental use of thicker or thinner glass (red or green) the difference in the intensity of the light may be destroyed, and hence arise all the conditions for the occurrence of dan-

gerous mistakes. Steam also effects the colors of the light. As seen through different pressures it may appear red, green or violet. The importance of this fact is self evident. It should always be borne in mind that the color blind, judge of color by the *intensity of the light alone*, and that turning a white light up or down represents to him the different colors. With regard to this, Dr. Wilson, of Edinburgh, writes, "How often it must fall to the lot of engine drivers to watch lamps through an atmosphere which will convert a safety signal (white) into a danger signal, completely alter the color of the green signal, and so darken the danger signal (red) as to render it invisible." Dr. Jeffries further remarks: "In the even slightly color blind, his only means of distinguishing the signals will be gone, viz., the difference in the intensity of the light."

Dr. Jeffries elsewhere writes: "A red and a green light appears to excite one and the same element in the retina of the red-blind. A ray, red and green, must seem fundamentally to the red-blind to be one and the same color, and if, in special cases, he knows how to discriminate, his judgment is simply guided by the intensity of the light.

The reason that *accidents traceable to color blindness* are not more frequently heard of is, that the public are not informed of many minor accidents which occur, and, even in more serious ones, the reporters have great difficulty in getting at the facts. Also familiarity with the road teaches engine drivers to expect certain signals at certain places, and it rarely happens that both engine driver and firemen are color blind, though such a misfortune has happened. As might be expected from the uncertain conditions of water travel, accidents due to color blindness are more common on the water than on the land. A collision took place in 1875, between the steamers *Lumberman* and *Isaac Bell*, near Norfolk, Va., which was distinctly proved to have been due to color blindness of the pilot of the former vessel.\* Ten lives were lost. Another case was the loss of the steamer *City of Austria*, in the Harbor of Fernandina, Florida, in 1881.†

Mr. Bickerton, of Liverpool, gives also details

\*Annual Report for 1880 U. S. Inspector-General of steam vessels.

†*Shipping and Mercantile Gazette* and *Lloyd's List*.