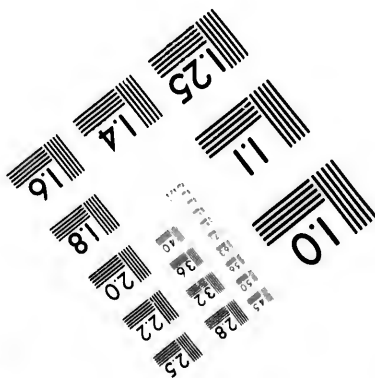
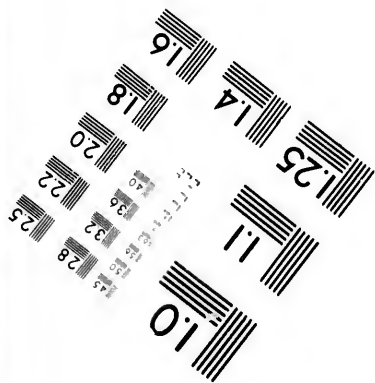
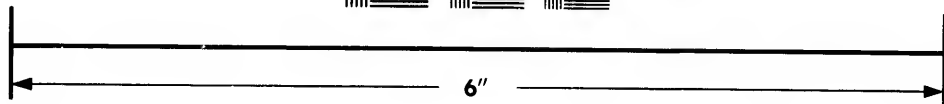
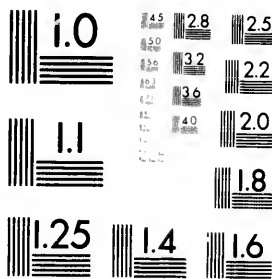


**IMAGE EVALUATION
TEST TARGET (MT-3)**



**Photographic
Sciences
Corporation**

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
100

**CIHM/ICMH
Microfiche
Series.**

**CIHM/ICMH
Collection de
microfiches.**



Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1981

01

The copy filmed here has been reproduced thanks to the generosity of:

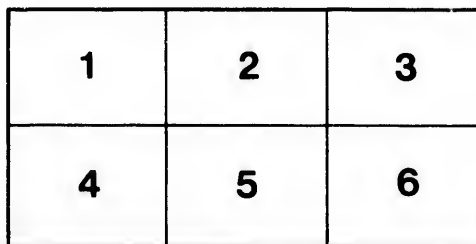
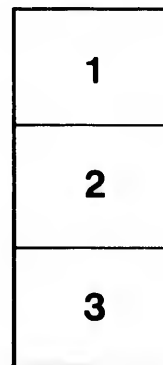
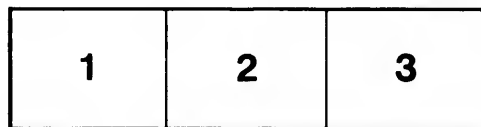
National Library of Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol \rightarrow (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L'exemplaire filmé fut reproduit grâce à la générosité de:

Bibliothèque nationale du Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

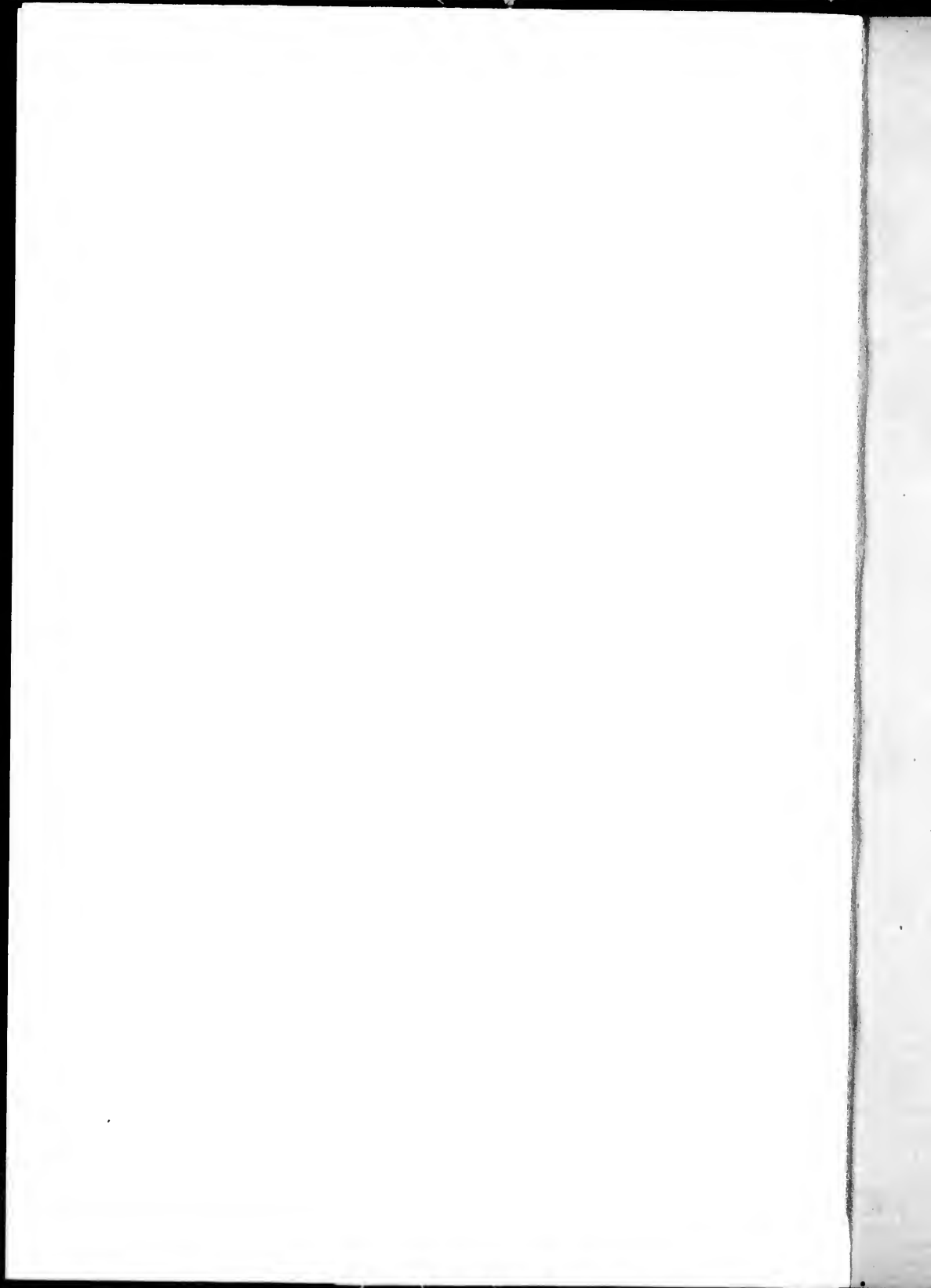
Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole \rightarrow signifie "A SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

errata
to

pelure,
n à



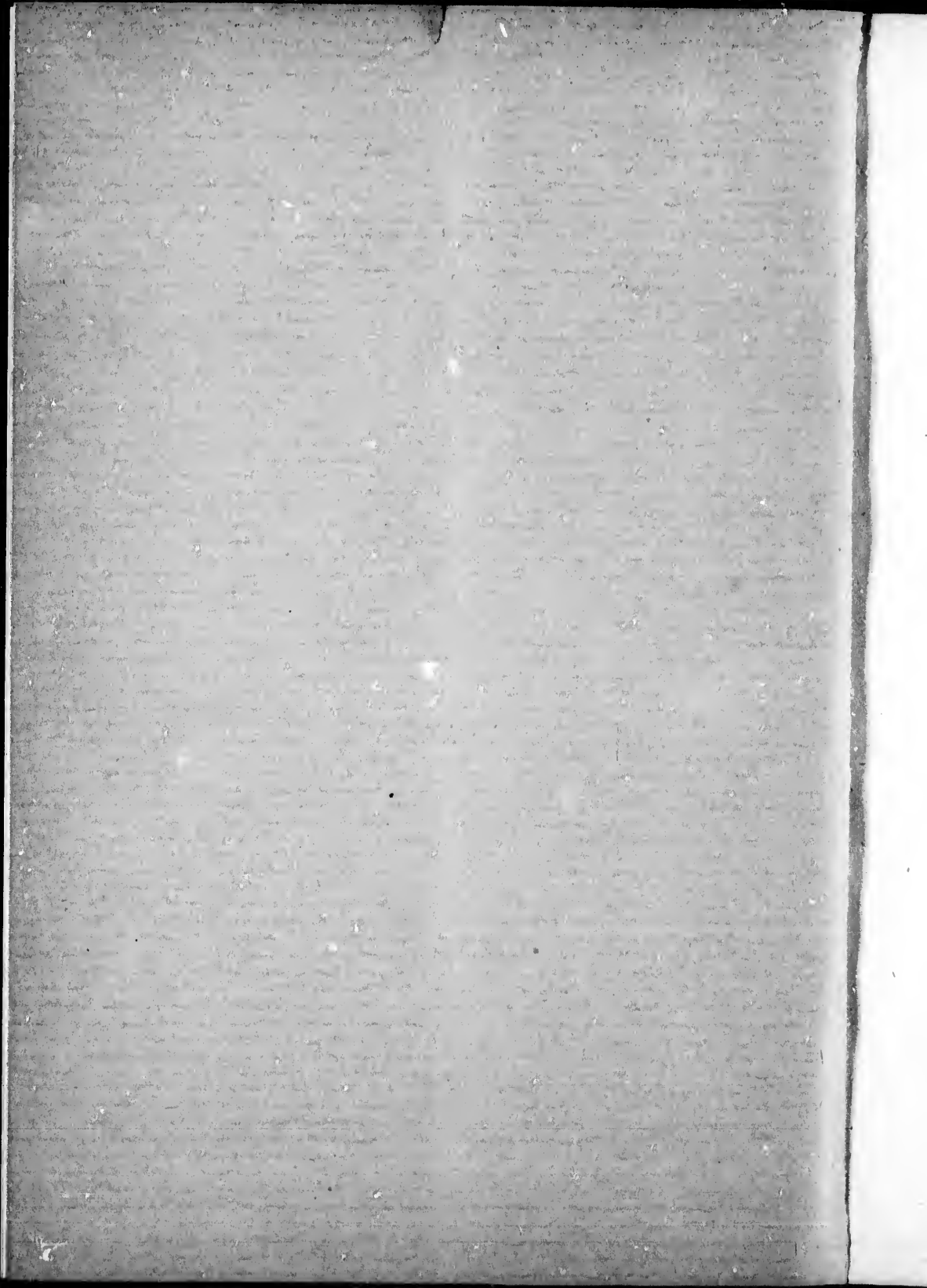


Color Blindness in its Relation
to Railroad Employees and
the Public.

With the Compliments of the Author.

Cassell's American Encyclopedia

1889



7

COLOR BLINDNESS

IN ITS RELATION TO

RAILWAY EMPLOYEES AND THE PUBLIC.

BY

G. STERLING RYERSON, M.D., C.M., L.R.C.S. EDIN.,

Professor of Ophthalmology in Trinity Medical College, Toronto.

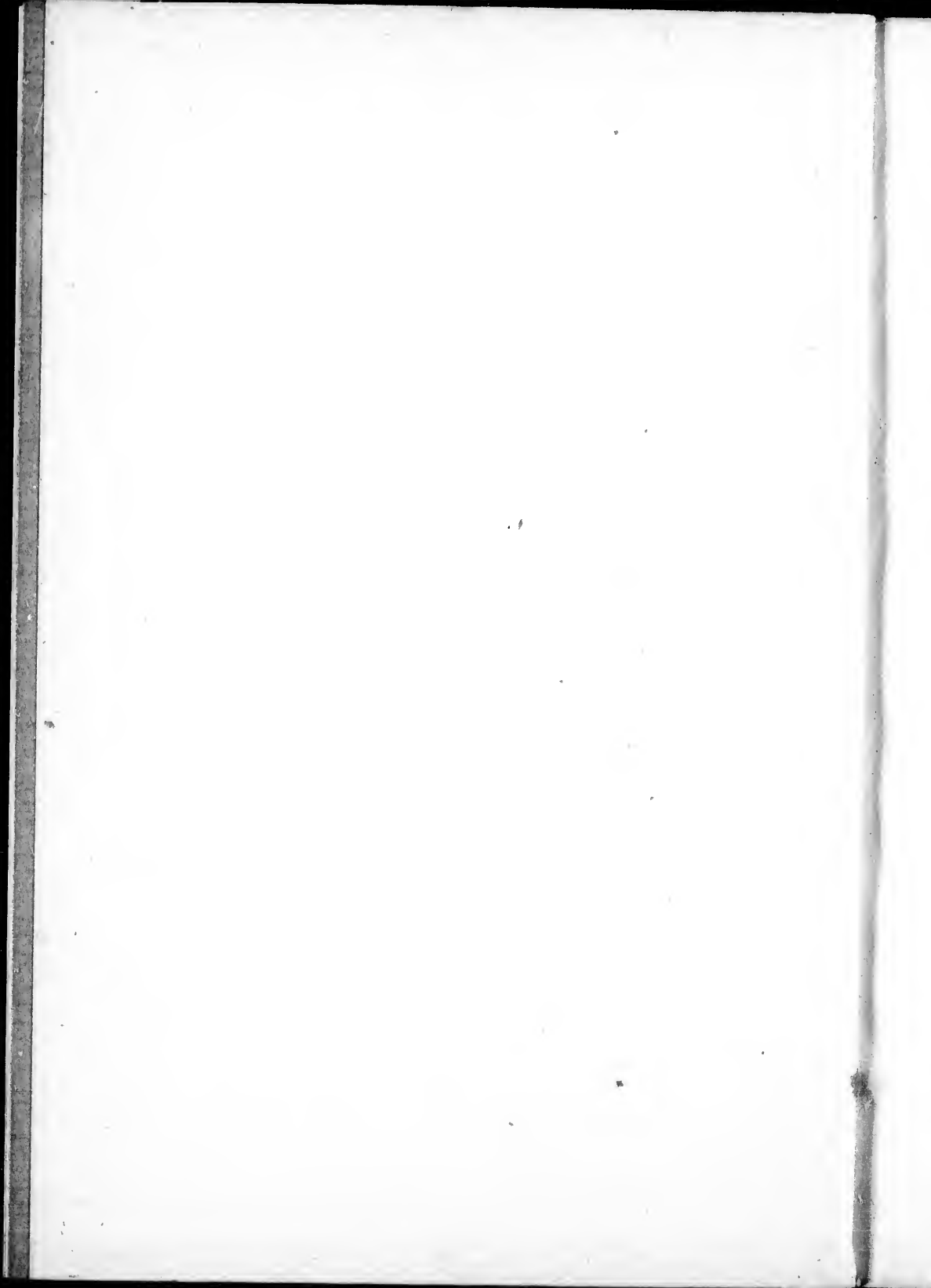
*A Paper read at the Canadian Institute, Toronto, at the
regular Meeting, Saturday, Feb. 9th, 1889.*

~~~~~

TORONTO:

J. E. BRYANT & CO., MEDICAL PUBLISHERS.





. . . 64 BAY STREET . . .

OFFICE OF

J. E. Bryant & Co.,

Medical Publishers.

DEAR SIR,

TORONTO, March 23rd, 1889.

We have much pleasure in presenting you, with the compliments of the distinguished author, the enclosed monograph on "Color Blindness, in its relation to Railway Employees and the Public." This subject is so important in itself, and so certain to arouse public interest when once thoroughly understood, that we feel quite sure you will not regret our bringing under your notice the succinct and lucid exposition of it which the author has here presented. And should you be induced to assist, so far as lies in your power, in the formation of an enlightened public opinion in regard to the matter, Dr. Ryerson, we are confident in saying, will feel that he has been largely rewarded for the pains he has taken and the expense he has incurred in making known to the public the latest results of scientific enquiry in respect to it.

Yours, very sincerely,

J. E. BRYANT & Co.

1870

1870

*Mr. President and Gentlemen :*

For our knowledge of this most important subject we are largely indebted to the labors of Profs. Seebeck and Stilling, of Germany ; Prof. Wilson, of Edinburgh ; Prof. Holmgren, of Sweden ; Prof. Donders, of Holland, and, on this continent, to Dr. Joy Jeffries, of Boston, and Prof. Wm. Thompson, of Philadelphia, to both of whom I am much indebted for advice and information, and from whose writings I will frequently quote.

As in other scientific matters—practical tests must have some THEORETICAL BASIS. In this matter it is fortunate that both theory and practice agree. The theory of color which students of Color Blindness have adopted is that of Young, revived after nearly a hundred years of oblivion, by Helmholtz.\*

As regards the different VARIETIES OF COLOR BLINDNESS, Dr. Joy Jeffries, in his book on "Color Blindness," thus quotes Holmgren's work :—

"We classify the different kinds of color blindness under especial heads, to be able the better to grasp the whole. We might, indeed, divide this blindness into congenital and acquired ; but as such a division has reference alone to the mode of origin, and not to the nature of this blindness, and affects in no wise the manner of its discovery, it has no practical importance in the case now occupying our attention. Besides, our division relates, as does our entire memoir on this subject, essentially to congenital color blindness. The division is as follows :—

"I. Total color blindness, in which the faculty of perceiving colors is absolutely wanting, and where the visual sense consequently can only perceive the difference between darkness and light, as well as the different degrees of intensity of light.

---

\* The well-known Young-Helmholtz theory, and its application to Color Blindness, was here explained in full.

"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."

The various METHODS OF TESTING for color blindness are those of simultaneous contrast, complementary after images, Stilling's method, Maxwell's disc, Woinow's discs, Donder's, Chibret's and Holmgren's tests. Testing by lanterns and flags is tedious and uncertain. The best general method is that of Holmgren.\*

THE CAUSES OF COLOR BLINDNESS are congenital defect, heredity, severe illness or injury, particularly to the spine and head, excessive smoking and drinking.

So far as tests have been made, all nations have shown a certain percentage of color blind persons, even the North American Indians. From two to thirteen per centum of the population are color blind. So that, on an average, one in every twenty-five (25) is so affected.

---

\* These tests were fully explained and in some instances demonstrated.

THE INFLUENCE OF FOG, MIST, SNOW AND STEAM ON SIGNAL LIGHTS is very 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 and darker green glass or thinner and brighter red glass, the difference in the intensity of the light may be destroyed, and hence arise all the conditions for the occurrence of dangerous mistakes. Steam also affects the color of the light. As seen through different degrees of pressure, it may appear red, green, or violet. The importance of this fact is self-evident.

Experience and experiment show that we are forced to use red and green lights on vessels, and at least red lights on railroads. Some roads have discarded green and use only red. Form cannot be substituted for color at night, as the rapid movement of the train alters the appearance of the lights, and thus mistakes may arise.

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 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 the safety signal (white) into a danger signal, completely alter the color of the lantern signal (green), and so darken the danger signal (red) as to render it invisible." Dr. Joy Jeffries, of Boston, further remarks: "In the even slightly color blind these changes will be intensified, and to the completely color blind, his only means of distinguishing the signals will be gone, viz., the difference in the intensity of the light."

Dr. Joy Jeffries elsewhere says: "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 especial cases, he knows how to discriminate, his judgment is simply guided by the intensity of the light.

"If, then, a red-blind individual finds that a red and a green tint are exactly alike, it is necessary that the green be to the normal eye much less intense than the red."

This corresponds with what has already been stated. It cannot be too often repeated and insisted on, that it is the *intensity* of the light, and not the color, that the color blind judge by, and hence the great danger of employing even partially color blinds as engine drivers, etc.

I would like to emphasize the fact that injuries to the head, severe illness, and the excessive use of alcohol and tobacco, especially the latter, are causes of color blindness.

Now, the reason that ACCIDENTS directly traceable to color blindness are not more heard of is, that the public are not informed of any minor accident which occurs, and, even in more serious ones, reporters have difficulty in getting at *all the facts*. Also, because familiarity with the road teaches engine drivers when to expect certain signals, and that it rarely happens that both engine driver and fireman are color blind, though such an unfortunate event has occurred.

Having thus, as far as limited time will permit, discussed nature, cause, peculiarities and mode of detection of color blindness, I invite your attention to the remedy for this condition. Color blindness is, when congenital, incurable. When caused by disease or injury, it may be cured. Exercising the ears with the names of the colors, and the eyes with sensations of color, help the color blind to supplement their eyes, but do not increase their color perception. They are often quite unconscious of their defect, and are greatly surprised when informed of it. Others know the fact and seek various ways of escaping detection. Color blindness, due to alcohol and tobacco poisoning, is easily recognized by the oculist, by means of an instrument called the perimeter.

There is no reason why railroad officials should escape their percentage of color blindness. The remedy here is the *elimination of railroad employees who are color blind*. These employees comprise the engine drivers and firemen, pointsmen, conductors, signal men and station masters. I mean, that men of these particular classes found to be color blind should be removed to positions where the color sense is not essential to the performance of their duties. This is equally in the interest of the travelling public, the railroad authorities and shareholders, and of the men themselves. The public demands that rail-

road travel shall be made as safe as is possible, and by the proper elimination of the color blind, a great source of danger is removed.

*The officials of a road that, through carelessness or other cause, allow a color blind engine driver to run an engine, should, in the event of a fatal accident, be held guilty of manslaughter.* Should injury or death to a passenger resulting from an accident be proved to have arisen from color blindness of an official of the train, heavy damages could be obtained from the company on whose road the accident occurred, because the accident would be recognized as PREVENTABLE. When one has occurred amongst us, as has been proved to have happened elsewhere, the community will awaken to a sense of the danger. I need hardly point out how serious is the risk of financial loss to the stockholders. The destruction of rolling-stock and the liability for damage to freight in course of transportation, and for actions for damages by injured passengers, might easily cause a loss of thousands of dollars.

Now, it will be said by railway officials, that the men of their respective companies are tested for color blindness. I may reply, by anticipation, that I have made it my business to enquire of all engineers, firemen and other railway employees, with whom I have come in contact, for the past three years, as to the tests made, and I have come to the conclusion that they are imperfectly carried out. Not from any under-estimation of their importance, by the officials, but because the tests are not properly and scientifically conducted. Men with good color sense may be, and probably are, refused promotion as being color blind, and men with imperfect color sense are passed as being normal-eyed.

This state of affairs is as unfair for the men as it is unsafe for the public. I feel sure that an examination of five hundred to one thousand employees would show a certain percentage of color blindness. The tests I have shown to-night seem very simple, but in the case of men who are constantly exercised with signals, their power of discrimination of color-tone (not of color itself, that is never changed) becomes remarkably increased, so that considerable experience and knowledge of the science of colors are required to detect them.



It may be argued by the companies, that I desire to put them under the rule of an army of doctors and involve them in great expense. I desire nothing of the kind. I see no reason why the Divisional Superintendents should not carry out the tests *when they have been properly instructed in them by an expert*. I think also, that it is not right that a man should be refused employment, dismissed from the road or refused promotion, on the ground of alleged color blindness, except upon the certificate of an expert.

Furthermore, I insist that it is imperatively necessary, in the interests of all parties, that every man should be *re-examined periodically*, and more especially after an illness or severe accident.

The process of examination and elimination of the color blind on railroads, has, in most continental European countries, been controlled and directed by their respective Governments. In the United States various plans have been followed. In Massachusetts, Connecticut, Alabama, and other States, the examination has been controlled by law. In others, as in Pennsylvania, it has been left in the hands of the Railroad Companies. The Companies have not been slow to recognize the importance of the proper tests being made, and great numbers of men have been examined and a varying percentage of color blinds has been found.

In this country these examinations have been, and are entirely in the hands of the Companies. If the Companies will have the tests conducted in such a way as to secure absolute elimination of the color blind, the matter might be left in their hands. But if they show carelessness or indifference about it, legislation must be sought that will place a supervisory power in the hands of the Department of Railways and Canals. Just as sailors desiring masters' certificates are required to pass an examination in color-sense before a Government Inspector, so must engine drivers, etc., be called upon to prove their color-sense and visual acuity.

In conclusion I would say that it is my belief—

1. That the color tests, as made on railroads in Canada at present, are imperfect.

2. That danger arises to the public from this cause.

3. That it is urgently necessary that this danger be obviated by the proper elimination of the color blind from among the employees.

4. And that the men should be re-examined periodically, and more particularly after severe illness or injury.

I am so convinced of the correctness of my opinion, that I am willing to examine here from five hundred to one thousand engine drivers, firemen, brakemen and signal or pointsmen, free of all cost, provided that they are not specially selected, and on this condition: that if I find one per cent. or upwards of color blinds, I shall be paid by the Company for my services at a rate to be agreed upon beforehand. If I do not find this percentage of color blindness, I am to receive nothing. The color blindness will be proved to be such to the officers of the Company.

I do not put a higher percentage than one per centum, because the proportion of color blinds to the normal-eyed community has never been determined in this country; and while it may prove to be higher than in other lands, yet, results might show it to be lower. I am now engaged in testing the school children of this city with a view of determining this question.

## APPENDIX.

The following table, from Joy Jeffries' work, gives some idea of the numbers tested and the percentage of color blindness found, in Europe and the United States:—

| OBSERVERS.          | Place.            | Number. | No. Color Blind. | Percentage | Position in Life.    |
|---------------------|-------------------|---------|------------------|------------|----------------------|
| Dr. Fontenoy .....  | Copenhagen .....  | 1,084   | 31               | 2.87       | Railroad employés.   |
| Prof. Donders.....  | Utrecht.....      | 2,300   | 152              | 6.60       | " "                  |
| Dr. Krohn .....     | Finland.....      | 1,200   | 60               | 5.00       | " "                  |
| Dr. Minder.....     | Berne.....        | 1,429   | 95               | 6.58       | Schools and various. |
| Dr. Daae.....       | Norway.....       | 205     | ..               | 4.88       | School boys.         |
| Dr. Cohn .....      | Breslau.....      | 2,429   | 95               | 4.00       | "                    |
| Dr. Magnus .....    | ".....            | 3,273   | ..               | 3.50       | "                    |
| Dr. Stilling .....  | Cassel.....       | 400     | ..               | 6.00       | Railroad employés.   |
| Dr. von Reuss.....  | Vienna.....       | 800     | ..               | 3.50       | " "                  |
| Prof. Holmgren..... | Sweden.....       | 3,654   | 166              | 4.54       | Scholars.            |
| " .....             | ".....            | 8,682   | 300              | 3.45       | "                    |
| " .....             | ".....            | 1,523   | 47               | 3.08       | Students.            |
| " .....             | ".....            | 2,752   | 105              | 3.81       | Orphan children.     |
| " .....             | ".....            | 555     | 43               | 4.50       | Young people.        |
| " .....             | ".....            | 7,953   | 171              | 2.15       | Railroad employés.   |
| " .....             | ".....            | 4,225   | 94               | 2.22       | Sailors.             |
| " .....             | ".....            | 1,851   | 62               | 3.34       | Soldiers.            |
| " .....             | ".....            | 649     | 31               | 4.77       | Mill-hands.          |
| " .....             | ".....            | 321     | 18               | 5.60       | Prisoners and g'rds. |
| Dr. Jeffries.....   | New England ..... | 10,387  | 431              | 4.149      | Teachers and sch'rs. |

of the  
Europe

---

---

Life.

---

mployés.  
"  
" various.

mployés.  
"

ren.  
e.  
mployés.

l g'nds.  
sch'rs.

---

