

suppose scientific knowledge had sooner led us to recognize the close relation of electricity and light. Surely the mode of division would be quite different. The definition of Zoology before and after Darwin would have been different. A classification which then appeared to be scientific would now be recognized as inadequate. The very first thing we must recognize is that our scientific knowledge is imperfect and growing, and we must adopt a system capable of easy modification as our knowledge increases. Another point which Chevalier Descamps made was that we adopt different methods with regard to different sciences; in some cases the numbers are followed by symbols; in some cases the numbers are separated by a hyphen, and so on. We have gone into this question as scientific men, and, although perfectly ready to submit the result of our work to the criticism of other scientific men, we do believe that the plan that suits best one science will not suit another. Take one example. Take, for instance, Zoology. There is the question of arrangement of the subject in accordance with the species of animals, and the question of arrangement with regard to the geographical distribution. Here are two ideas to which there is nothing similar in physics or chemistry. It would be disastrous if we attempt to force all these sciences to adopt the same method. If two things are essentially different, we do not apply the same principles to both. In the last place, Chevalier Descamps says the main object of classification is to tell us where to find a particular object with which we are dealing. I do not much believe in the average memory of scientific men being able to grasp a large number of numbers. I believe it is much easier to find the place by using symbols, which are more distinct than a large number is from a small one. Significant words which are for temporary use have their own meaning. You find them

alphabetically. I do think, on the question of general principle, that it is very desirable that the Conference should express an opinion as to whether or not they think the symbols are to be devised in such a way as to help the memory or to find the place; secondly, whether they do or do not hold the view that the plan good for one science is good for all, and whether it is desirable to attempt to plan a scheme in the belief that it will hold good for all time."

Dr. Bernoulli said that after hearing the statements in favor of the two systems he wished to add that the decimal system was in actual working order in Switzerland, and that its practical utility had been demonstrated there. He considered it superior to the system proposed by the Royal Society, although originally he had been an opponent of the decimal system.

M. Deniker replied that it was necessary to consult an alphabetic index to use the decimal-system catalogue. He favored a methodical or subject catalogue alphabetically arranged.

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(*To be Concluded.*)

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#### COLOR-WEAKNESS AND COLOR-BLINDNESS.

It is generally accepted as a well established fact that the traveling public is fully protected by the present tests for color-blindness to which railway employees and pilots are subjected. Yet several of the mysterious accidents that have occurred during the last two years might be explained on the supposition of color-blindness on the part of responsible lookouts. In fact, I believe myself in position to prove that persons of dangerously defective color-vision actually do pass the regular tests and obtain positions where their defects are continual dangers to public welfare.

In the first place, I have at the present time among my students one who is abso-

lutely perfect at the wool-test. He can match wools with incredible precision at any distance away; he is, nevertheless, color-blind. This case is typical of a class of persons with eyes abnormally acute for differences in color, but yet with only two fundamental sensations instead of three.

In the second place, I have had among my students those who possessed perfect color-vision for near objects or bright objects, but who were practically color-blind for weakly illuminated or distant objects. These persons possess the typical three fundamental color sensations, but have one of them weaker than the normal. A person of this kind may pass the wool-test with the utmost perfection if the test is performed close by, but will fail if the wools are removed to a distance of 20 or 30 feet. This peculiar defect I take the liberty of terming 'color-weakness.' The first student of this kind that I examined passed the wool-test close at hand and yet was unable to distinguish red and green lanterns a few hundred yards away. Cases similar to this have been reported by the British Marine Examiner, Edridge-Green. Among other cases he quotes a letter from an engineer containing the following statement: "I have been on the railway for thirty years and I can tell you the card-tests and wool-tests are not a bit of good. Why, sir, I had a mate that passed them all, but we had to pitch into another train over it. He couldn't tell a red from a green light at night in a bit of a fog."

To eliminate both these classes of persons we must have a method of testing on quite different principles from the usual ones.

In the first place, the sorting of delicate shades of colors, according to likeness, must be replaced by *naming certain fundamental and familiar colors*. The sorting of wools is a quite unusual and perplexing task to a man brought up in a railway yard and on shipboard. It puts a nervous man at quite

a disadvantage; it furnishes the unsuccessful candidate with the excuse that the judgment required was so unlike any he had made before that he failed from nervousness; and, finally, it is not a guarantee that all who pass are not color-blind. The naming of colors should—as Donders proposed—be rigidly required. The engineer or the pilot in his daily routine is not called upon to match colors, but to decide whether a light is red, green or white; he should be tested on just this point. The color-blind student referred to above who can pass the wool-test to perfection fails at once when called upon to name the wools. The naming of delicate and perhaps unusual shades should, however, not be required; the colors to be named should be the three familiar ones: red, green and white, so manipulated that every possible chance for confusion is presented.

The second necessity for eliminating danger is that of an absolutely certain test which shall detect both the color-blind and the color-weak. Acting on the basis of suggestions from the work of Donders and of Edridge-Green, I have devised a test that meets this requirement as well as the first one.

The instrument\* which I have invented may be termed the 'color sight tester' or the 'color sense tester.' In general appearance it resembles an ophthalmoscope. On the side toward the person tested, Fig. 1, there are three windows of glass, numbered 1, 2 and 3, respectively. The opposite side of the tester, Fig. 2, consists of a movable disk carrying twelve glasses of different colors. As this disk is turned by the finger of the operator the various colors appear behind the three windows. At each movement of the disk the subject calls off the colors seen

\* For those interested in obtaining the Color-Sight Tester I will say that I have made arrangements to have it made by the Chicago Laboratory Supply and Scale Co., Chicago.

at the windows. The windows, 1, 2 and 3, are, however, fitted with gray glasses. No. 1 carries a very dark smoked glass; all colors seen through it will be dark. No. 2 carries a piece of ground glass, showing all colors in full brightness. No. 3 carries a light smoked glass. There are thus thirty-six possible combinations of the colors. The twelve glasses are, however, mainly reds, greens and grays.

A suitable arrangement of the colors

reds, greens and grays simultaneously in a large number of different shades of intensity. The light of a green lantern, at different distances or in a fog, is simulated by the green behind the different grays; at the same time a white light is also changed. The color-weak person to whom weak green is the same as gray (white at a distance) is utterly confused and thinks that the weakened green is gray (white) and the dark gray is green.



FIG. 1.



FIG. 2.

gives direct simultaneous comparisons of reds, greens and grays of different shades. The well-known confusion by color-blind persons of dark greens with reds, greens with gray, etc., are exactly imitated, and the instrument gives a decisive test for color-blindness. Its peculiar advantage, however, lies in the fact that it presents

The actual test is performed in the following manner. The tester is held toward a window, at about  $2\frac{1}{2}$  feet from the person tested. The operator begins with any chance position of the glasses, and asks the person tested to tell the colors seen through the three glasses, Nos. 1, 2 and 3. He answers, for example: "No. 1 is dark red; No.

2 is gray ; No. 3 is green." The operator records from the back of the tester the letters indicating what glasses were actually used. If he finds that A, D and G were opposite the glasses Nos. 1, 2 and 3 he records: A 1, dark red ; D 2, gray ; G 3, green. The disk is then turned to some other position ; the colors are again named, and the operator records the names used. For example, the result might be: "No. 1 is dark green ; No. 2 is white ; No. 3 is red ;" and the record would read: G 1, dark green ; J 2, white ; A 3, red. Still another record might give: J 1, dark gray ; A 2, red ; D 3, medium gray. Similar records are made for all combinations. Of course, the person tested knows nothing concerning the records made. A comparison with a list of the true colors for each position determines whether the test has been passed or not.

The three records just cited were all obtained from the red glass, A ; the gray glass, D ; the green glass, G, and the ground glass, J, in combination with the dark gray, No. 1 ; the ground glass, No. 2, and the medium gray, No. 3. Those familiar with color-blindness will notice that these combinations place side by side the colors most confused.

The records can be taken by any one, and, on the supposition that the record has been honestly obtained and that the instrument has not been tampered with after leaving the central office, the comparison is mechanical. There is none of the skillful manipulation required in the wool-test and none of the uncertainty attaching to its results. The only instruction given to the subject is: "Name the colors;" the results render the decision with mechanical certainty.

One of the testers is in use on one of the English railways, another on the central division of the New York Central Railroad. From the former I have not yet heard, but

the examiner on the latter reports that since using the tester he has found men who get through the wool-test, but are caught by the tester. On the other hand, he states that "the men examined say that this test is more like the signals they are used to seeing every day on the road, and is, therefore, fairer than to ask them to pick out a lot of delicately tinted pieces of yarn."

An experience of several years seems to justify the following claims for the color-sense tester:

1. It detects with unerring precision both the color-blind and the color-weak.
2. It is a perfectly fair test for the men concerned and injures no man by requiring an unfamiliar judgment.
3. It requires but a very small fraction of the time used on the wool-test.
4. Its decisions are self-evident and unquestionable.

E. W. SCRIPTURE.

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#### AMERICAN CLIMATOLOGICAL ASSOCIATION.

THE sixteenth annual meeting of the American Climatological Association was held in New York City on May 9th and 10th at the hall of the New York Academy of Medicine. About fifty members were in attendance from all portions of the United States. Twenty-five papers were read upon subjects pertaining to climatology, hydrology and diseases of the respiratory and circulatory organs. These papers, which will appear in the annual volume of the Transactions, were as follows:

'Presidential Address,' by Dr. Beverley Robinson, of New York.

'Treatment of Consumption by Air and Light in Colorado,' by Dr. Charles F. Gardiner, of Colorado Springs.

'Intermediate Altitude for the Consumptive,' by Dr. B. P. Anderson, of Colorado Springs.