REPORT OF THE OPTICS COMMITTEE

SINCE the last meeting of the Society the Optics Committee has repeated its former tests on the effect of color in projection, using a method not subject to some of the possible errors of the former one. When the film itself was dyed there was a chance of the dyeing material affecting the clear and opaque portions of the film to a different degree. Accordingly in the recent tests two uncolored loops from the same film were used, the picture being of a stationary object to insure equality. Each was then run through a machine—the machines being as nearly alike as possible—and the two pictures thus obtained were thrown side by side on the screen as before. A large piece of dyed gelatin was held just beyond one objective. The observers sat near the center of the room, so as to see both screens from the same angle, and recorded which picture seemed brighter, which clearer, and which of greater contrast—the colored or the black and white.

A metal mesh that intercepted half the light was next put over the objective used with the uncolored picture, and a second record was then made by the observers. A third and fourth record were made with the uncolored light reduced by meshes to ¼ and ⅛ of its initial value respectively. Before each comparison the screen was darkened and the room lights turned on to bring the eyes of the observers to approximately the same sensitivity each time.

Above is given a table of the results. Columns 1 and 2 give the number and name of the color, column 3 the percentage of the light falling upon the filter from a tungsten filament at 2880°K, that is transmitted. This percentage had been previously measured with a flicker photometer.

There are nine columns under each heading, Brightness, Clearness, and Contrast. The figures under columns *b* denote the number of observers that thought the brightness, clearness, or contrast of the colored picture to be equal to the uncolored one without intercepting mesh. Under columns, *d*, *f*, and *h*, is given the number who considered the colored picture equal to the uncolored picture when the latter was reduced by a mesh to ½, ¼, or ⅛ full brilliancy. Similarly columns *c*, *e* and *g* give the number of observers who recorded the point of equality as lying between the adjoining columns, and *a* and *i* beyond. For example, in color 1*a* three observers thought the contrast in the colored picture to have been less than in the black and white at full brightness, but greater than in the black and white reduced to one-half brightness.

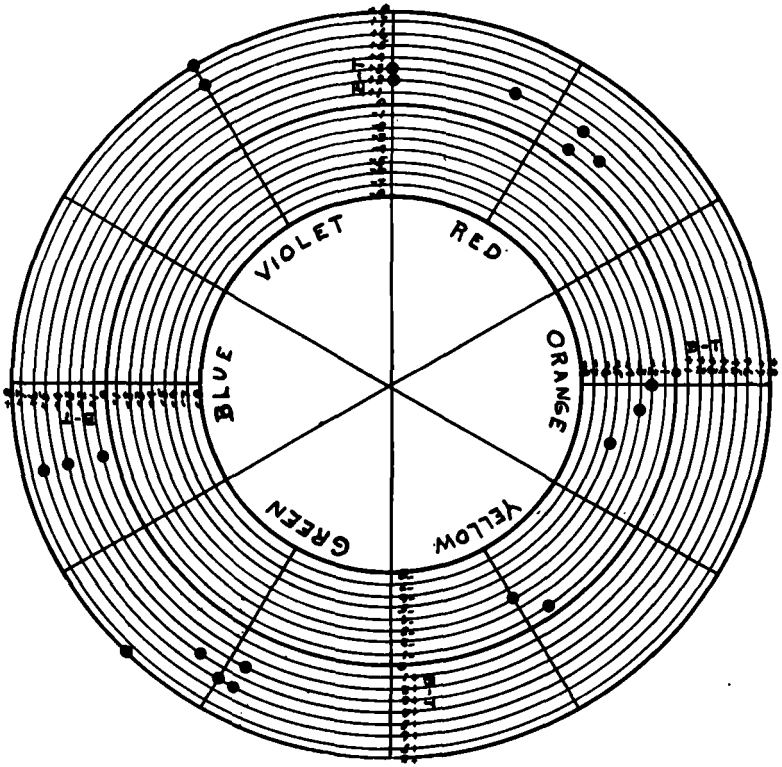
The colors were run through twice. The results of the first trial are given in the top half of each square and of the second in the lower half. In every case the readings indicate a gain by the colored picture in relative clearness and contrast, as well as brightness, each time the brightness of the uncolored light is reduced. This of course means that when any observer has decided that the

TABLE

No.	Transmission	Color	BRIGHTNESS a b c d e f g h i 1 ½ ¼ ⅛	CLEARNESS a b c d e f g h i 1 ½ ¼ ⅛	CONTRAST a b c d e f g h i 1 ½ ¼ ⅛	AVERAGE B. Cl. Co.	Transmission	B-T
1a	35	Purple	4 1 4 1 3 3	1 1 6 1 1 3 2	3 1 4 1 2 2 2	d- e e	e	2
1b	24	Purple	1 1 5 1 2	2 3 1 1 1 1	2 4 1 2 2 1	e e e-	f	3
2a	28	Scarlet	1 5 2 1 3 1	1 4 2 2 2 1	5 2 1 2 2	e e e-	f	2
2b	45	Scarlet	5 3 1 2 3	4 4 1 1 1	4 3 1 1 4 1	d d- e	d-	1
3a	70	Orange	3 4 1 2 3 1	1 4 3 2 3 1	3 3 2 2 3 1	d d- d	e	-2
3b	62	Orange	2 4 2 2 1 1	1 3 1 1 3 1 1 1	1 3 2 1 2 2 1 1	d- d- d	e-	-3
4a	88	Yellow	1 4 2 4 1 1	1 3 3 3 2 1	1 2 4 2 2 2	e- d d	b-	-3
4b	87	Yellow	4 3 1 4 2	5 2 2 3	6 2 1 2	e e e	b-	-1
5a	28	Green	1 2 2 2 1 4	1 3 2 1 1 1 4	1 1 4 1 1 1 1 3	d- d e-	f	4
5b	47	Green	1 5 3 1 2 3	1 3 2 1 1 1 3	1 4 2 1 1 1 3	e- e- e-	d-	3
5c	52	Green	2 3 3 2 2 1	1 4 3 2 2 1	4 2 2 2 2 1	b- e e	d	5
6a	21	Blue-green	1 4 1 1 1 2 1 1	2 2 1 2 1 2 1 1	1 1 3 1 1 1 3 1	e e e	g	5
6b	28	Blue-green	3 3 1 1 1 3 2	2 2 1 2 1 2 3 1	1 1 3 1 2 3 1	d- d e-	f	4
7a	10	Blue	1 3 3 1 1 4	1 1 2 3 1 1 3	1 2 2 3 3 1	g f- e-	i	6
7b	38	Blue	1 1 5 1 3 2 1	2 1 3 2 1 1 3 1	2 2 3 1 3 2 1	e- e- e	e	4
8a	19	Violet	2 4 1 1 4 1	2 3 1 1 1 4	1 2 3 1 1 5	d- e d-	g	8
8b	11	Violet	1 4 3 1 4	1 3 3 1 1 4	1 2 4 1 1 4	f- f- f	h-	6
9	30	Red	2 2 3 1 3 1	2 2 3 1 1 1 2 1	3 2 2 1 1 1 2	d- e d	e-	3
10	35	Green	2 2 3 2 1 3 1 1	3 1 1 4 4 1 1	3 2 1 1 4 1 1	e- e- e-	e	-1
11	1	Blue	9 6	9 6	8 6	i i i	i-	1
12	68	Orange-yellow	2 1 1 4 1 2 1 1	1 3 1 1 2 3 1 1	1 4 1 2 3 1 1	e e e	e	-5
13	13	Blue-green	1 6 1 1 3 2	2 5 1 2 1 2 2	2 1 4 1 2 2 3	e- e e-	h	8
14	22	Purple	2 6 3 1 1	2 6 1 1 3	1 2 3 1 1 1 1 3	e- e- e-	f-	3

contrast or clearness of the colored and uncolored pictures are equal for any given brightness of the uncolored light, for all values of brightness of the uncolored light less than this, the colored picture will seem to have greater contrast or clearness.

The columns under "Average" in the Table give the average brightness, clearness and contrast of all the observers for both trials, the two trials being weighed equally though there were more observers at the first than at the second. The second trial, as may be seen, indicates a value of brightness, clearness and contrast lower than the first by approximately 20%, 15% and 30%. Part at least



Units of B-T arranged in a circular spectrum.

of this difference can be accounted for by a difference in the two machines (which were interchanged for the second trial) so small as to be detectable only by the averaging of a number of readings such as those described.

As far as can be seen clearness and contrast follow brightness quite closely, instead of contrast being considerably greater in the colored picture, as reported in the last Transactions. This would lend some strength to the belief that dye does not act uniformly on

a photographic film having different quantities of silver at different points, but that the dye collects around the silver particles.

In the column headed "Transmission" are given the values graded by letter of the transmission fraction given in the second column, and under B-T the difference between the average brightness, as judged by the picture on the screen, and the transmission—i. e., the brightness as measured by the flicker photometer. The units are approximately 10% of the larger value (one-third the difference between any letter and the next in order). These values of the differences are shown very roughly in the accompanying figure. The spectrum is arranged in a circle, the ends being brought together so that the violet fades into the red as the red fades into the orange.

Though far from perfect in their agreement, the points indicate a fourfold difference of brightness as compared on the screen between yellow and violet of equal brightness as measured by the flicker photometer. Also there seems to be a suggestive symmetry about the orange-yellow, blue-violet diameter.

In conclusion, the Committee wishes to show a few representative slides to indicate not only the method of the experiments, but also the difficulty an observer experiences in determining the effect of color on brightness, as well as clearness and contrast. Though in some instances the preference is quite marked it does not necessarily follow, as is shown in the Table, that a second trial of the same slide will produce the same impression.

The Committee does not regard the conclusions indicated above as in any sense final, but the problem is one of such complexity, and the time available for the tests so short, that progress must necessarily be slow.

W. E. STORY, *Acting Chairman.*