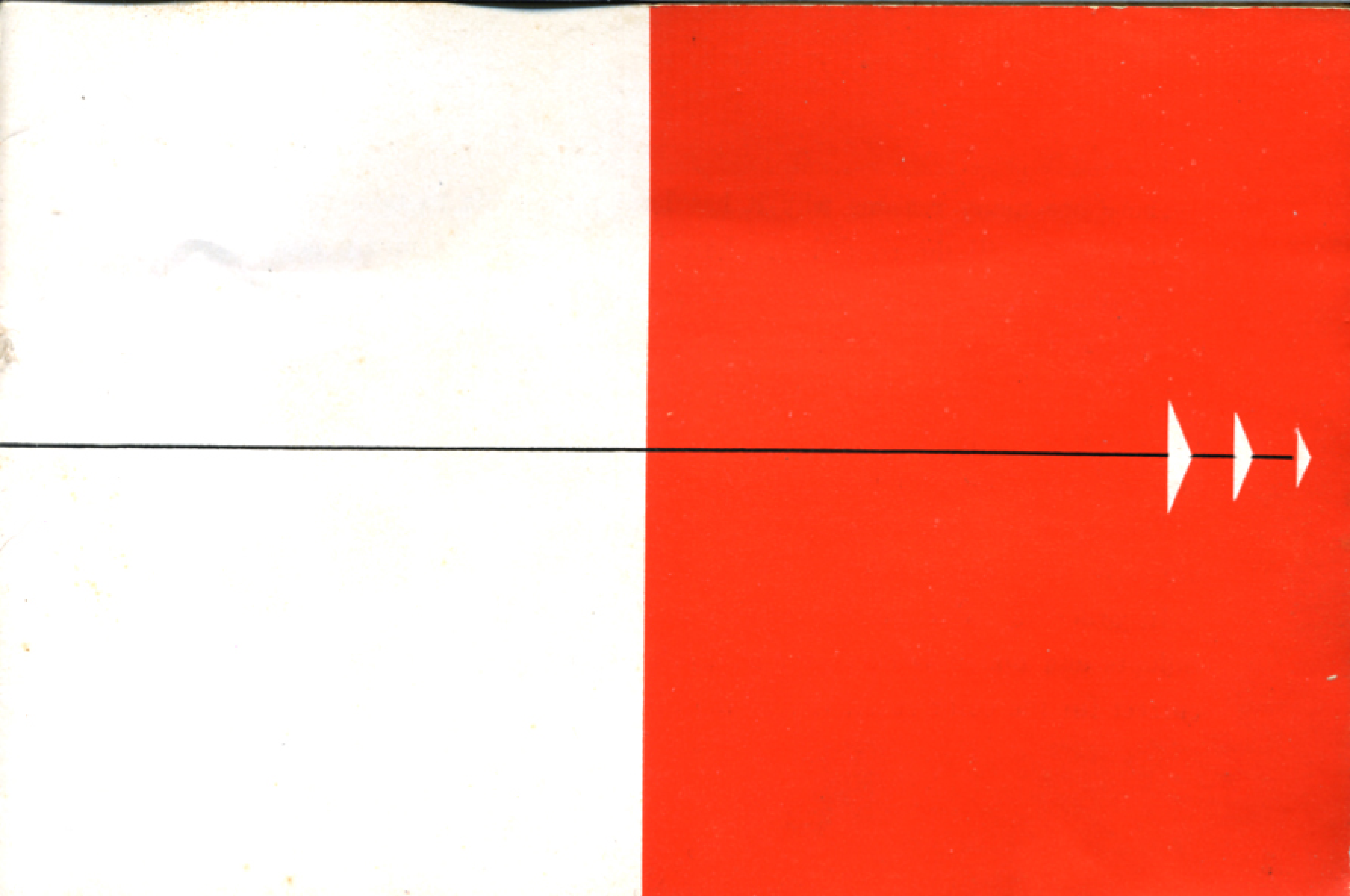
HARRISON'S COLOR CHARTS

of the Color Content of Light for Photographic Use



There are many reasons why it has been impossible to take natural color pictures under all the conditions where black-and-white film are now used.

In order to understand these reasons, it is necessary to have an understanding of light and the part it plays in color photography.

In black-and-white photography we are concerned with the intensity of light. In natural color photography we are concerned with the intensity of light and also with the color content of light.

The exposure meter solves the exposure problem but the exposure meter does not solve the color problem.

In order to solve the color problem in natural color photography, both indoors and out, it is necessary always to have the color content of the light correct for the color sensitivity of the film.

The color content of light under all conditions consists of the three basic primary colors—blue, green and red—in varying and changing amounts. The color sensitivity of all natural color film is sensitive to the three basic primary colors—blue, green and red—in varying amounts.

Whenever we take color pictures under indoor or outdoor light and the color content of the light is correct for the color sensitivity of the film, the result can be a true natural color picture.

Because it is seldom that the color content of light is correct for the color sensitivity of the film, natural color photography is considerably limited. But since the development of the Harrison Light Corrector, it is now possible to correct the color content of the light to the color sensitivity of the film—under all conditions where black-and-white film are now used.

DEGREES OF KELVIN WHICH ARE THE COLOR TEMPERATURE OF THE LIGHT

Although we have outlined the color content of the light, and its importance to color photography—no mention has been made of how light is accurately measured for color content and what the scale of measurement is. As there is a scientific method of describing and measuring the color of light, the following is a simplified explanation of this scientific principle.

Since man first made a fire by rubbing two sticks together and observed that certain types of materials burned with different colored flames, some hotter than others, it has been obvious that there must be some connection between heat and color.

The color content of light is based on temperature—and for mathematical simplicity is actual temperature Centigrade plus 273°. The reason 273° is added to the Centigrade temperature, is that absolute Zero is 273° below Zero Centigrade—and when dealing with a critical medium such as light, absolute Zero must be used as a starting point.

As the temperature of any substance is raised from Zero, as for example, iron, steel, tungsten, etc., no visible change takes place until the temperature is 800° Kelvin at which temperature any of these materials gives off a dull red glow. As the temperature is raised, the color changes from a dull red to orange-red. If it were possible to keep increasing the heat of these materials, eventually they would appear to be white at 5400° Kelvin and then the color of a blue North sky, at 25,000° Kelvin.

This cycle of color change due to temperature runs through all types of light except fluorescent light so that by measuring the color, the temperature is known, or conversely, if the temperature is measured, the color is known. This system of measurement is called the Kelvin Scale or Kelvin Temperature in honor of Lord Kelvin, the great physicist, who established the relationship of color and temperature by placing every conceivable substance he could find, such as iron, gold, silver, crockery, etc., into an iron tube and heating the tube until it was a dull red. By looking into the tube he was not able to distinguish the various objects which were made of different materials. They all had one thing in common—they were all the same color. Even when the temperature was raised to the melting point of the tube, there appeared to be no difference in any of the colors of the objects showing that all substances are exactly the same color at the same temperature. Listed below are familiar recognizable color changes. Also listed from 2400° to 9000° Kelvin are the steps in color changes that are important photographically.

KELVIN SCALE FOR PHOTOGRAPHIC USE

Absolute Zero is 273° below Zero Centigrade

Kelvin temperature equals Centigrade Temperature plus 273°

Iron glowing dull red	800° Kelvin
Candle Flame	1850° Kelvin
Vacuum Tungsten Lamp	2400° Kelvin
Ordinary House Tungsten Lamp	2900° Kelvin
Projection Lamp	3200° Kelvin
Photoflood	3400° Kelvin
White Fluorescent Lamp	3500° Kelvin
Photo Flash	3600° Kelvin
Average Photo Flash	3800° Kelvin
Daylight Tungsten	4000° Kelvin
Early or Late Daylight	4300° Kelvin
Early or Late Daylight	4800° Kelvin
Daylight Photoflood	5000° Kelvin
Mean Noon Sunlight	5400° Kelvin
Sun and Sky	5900° Kelvin
Daylight Fluorescent	6500° Kelvin
Hazy Sky	8000° Kelvin
Blue Sky	9000° Kelvin

HARRISON'S COLOR CHART

In both black-and-white and natural color photography, correct exposure depends upon the accurate measurement of the light reflected from the object, and that the proper speed rating be applied to the film emulsion being used.

In addition in natural color photography, in order to get consistently true natural color pictures, it is necessary that the color content of the light be correct for the color sensitivity of the film.

The Harrison Color Chart of the color content of light for photographic use, is a standard that shows graphically the color content of the light at every degree of color temperature, where the change in the color content of light is important in natural color photography.

This is the first time the natural color photographer has had a standard by which to measure the color content of light for photographic use.

The color of light changes at different degrees of Kelvin. All direct light is made up of the three basic primaries: blue, green and red. The differences in the color of light are determined by the varying quantities of each of the three primaries: blue, green and red, that are mixed together in any given light source.

At every change in degree of Kelvin temperature, the color of light will vary, and the color of light is determined by the individual amounts of the three primary colors.

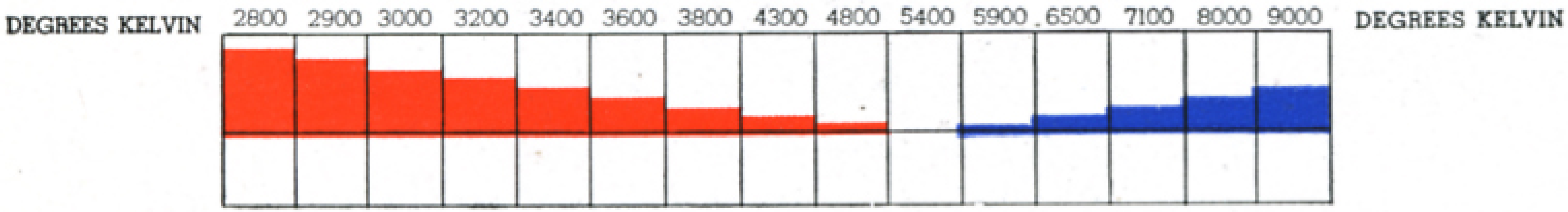
The color of light is always the same at any given degree of Kelvin temperature regardless of the light source. Because this is true, the color content of light at each photographic step of the Kelvin temperature scale is important in taking color pictures.

In natural color photography we are concerned with the color content of the light which is made up of the three primary colors: blue, green and red. The green primary can be treated as a constant as it is always in proportional relationship to the blue primary in the color content of the light.

Shown graphically on the Kelvin scale below, is the color content of the light that we are principally concerned with photographically.

HARRISON'S GRAPHIC CHART

of the Color Content of Light in direct relation to the Kelvin Scale for Photographic Use



At 5,400 degrees Kelvin the light is white and this is when the color content of the light consists of substantially equal amounts of the three primaries: blue, green and red.

As we go up the scale in Kelvin, the first important color photographic change is 5,900° Kelvin—here the blue primary in the light overbalances both the red and the green primaries. At 6,500° Kelvin, the blue increases in overbalance until we reach 9,000° Kelvin. We have not gone any further than 9,000° Kelvin because for practical photographic purposes in color photography above 9,000° Kelvin the blue content of the light is so overbalanced that the intensity of the light, if it were corrected, would be so low that it would be impractical photographically in relation to the color sensitivity of the film.

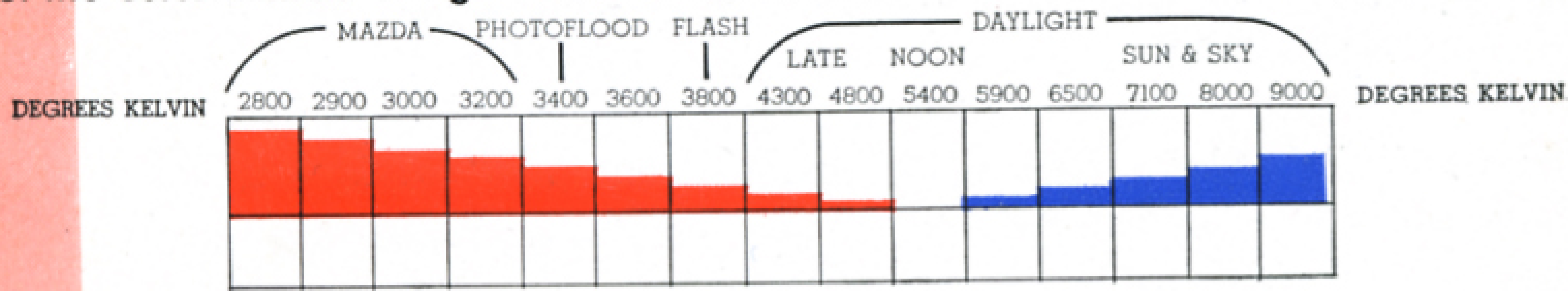
As we go down the scale, at 4,800° Kelvin, the red primary in the light over balances both the blue and green primaries. At 4,300° the red increases in overbalance until we reach 2,800° Kelvin. We have not gone any farther than 2,800°

Kelvin because for practical photographic purposes in color photography—past the 2,800° Kelvin, the red content in the light is so overbalanced that the intensity of this light, if it were corrected would be so low that it would be photographically impractical in relation to the color sensitivity of the film.

Shown graphically below is the Kelvin reading of the different sources of light showing the range of color content of the different types of light used photographically.

HARRISON'S GRAPHIC CHART

of the Color Content of Light in direct relation to the Kelvin Scale for Photographic Use



Mazda bulbs for photographic use are made with a definite Kelvin reading of 3,200° Kelvin—but because of voltage variations and age of bulbs, the degrees of Kelvin of any rated Mazda bulb may vary between 2,800° and 3,200° Kelvin; and these variations in the color content are shown graphically.

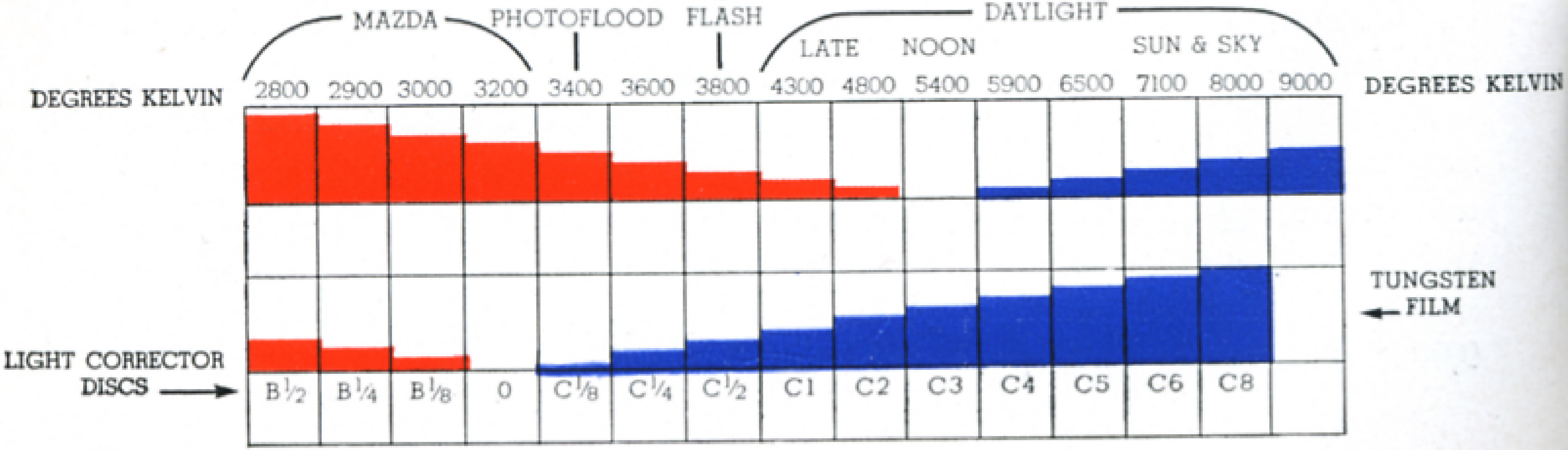
The photoflood bulb for photographic use has a Kelvin rating of 3,400° but because of voltage variation and age, the photoflood bulbs may vary from 3,600° to 2,800° Kelvin and these variations in the color content are shown graphically.

Flash bulbs have a Kelvin reading of 3,800° Kelvin, but these flash bulbs may vary, and there is no way to know because we cannot check the color content of the light before taking the picture. In the main, however, the Kelvin rating on these bulbs is very closely maintained.

Daylight, for all practical photographic purposes, varies from 2,800° to 9,000° Kelvin.

Shown graphically below is the relationship between the color sensitivity of the tungsten film and the color content of the light at different degrees of Kelvin that are important steps in the color temperature change photographically.

HARRISON'S COLOR CHART
OF THE
Color Content of Light for Photographic Use



At 3,200° Kelvin, because the color content of the light is correct for the color sensitivity of the film, our color pictures should have true colors—but if tungsten film (Ansco tungsten, Eastman Kodachrome type B) is used with light at any other degree Kelvin, the chart shows the overall degree of the bluish or reddish cast that will be had photographically dependent upon the variance of the color content of the light with which this film is being used.

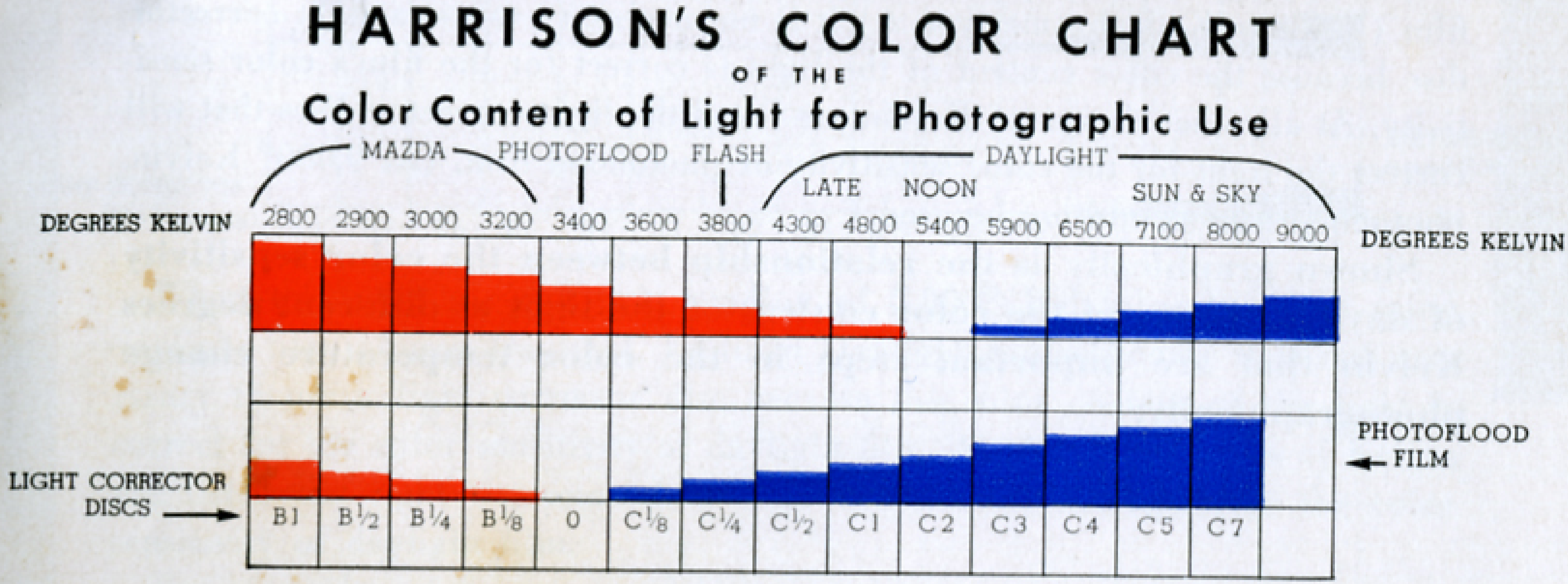
From the chart it can be seen that the color content of light at 3,200° Kelvin is correct for the tungsten film and for this reason it is not necessary to use a light corrector disc in order to get a true color picture. At the other degrees

Kelvin, because the color content of the light is not correct for the color sensitivity of the film, below are listed the light corrector discs that will correct the color sensitivity of the light for the color sensitivity of tungsten film.

At 9,000° Kelvin there is no light corrector disc listed under the tungsten film because tungsten film should not be used when the light has a temperature of 9,000° Kelvin.

Because it is impossible to visually determine the degree Kelvin of light except under laboratory conditions, it is necessary to use the Light Corrector Meter so as to determine the proper light corrector disc to use.

Shown graphically below is the relationship between the color sensitivity of photoflood film and the color content of the light at different degrees of Kelvin that are important steps in the color temperature change photographically.



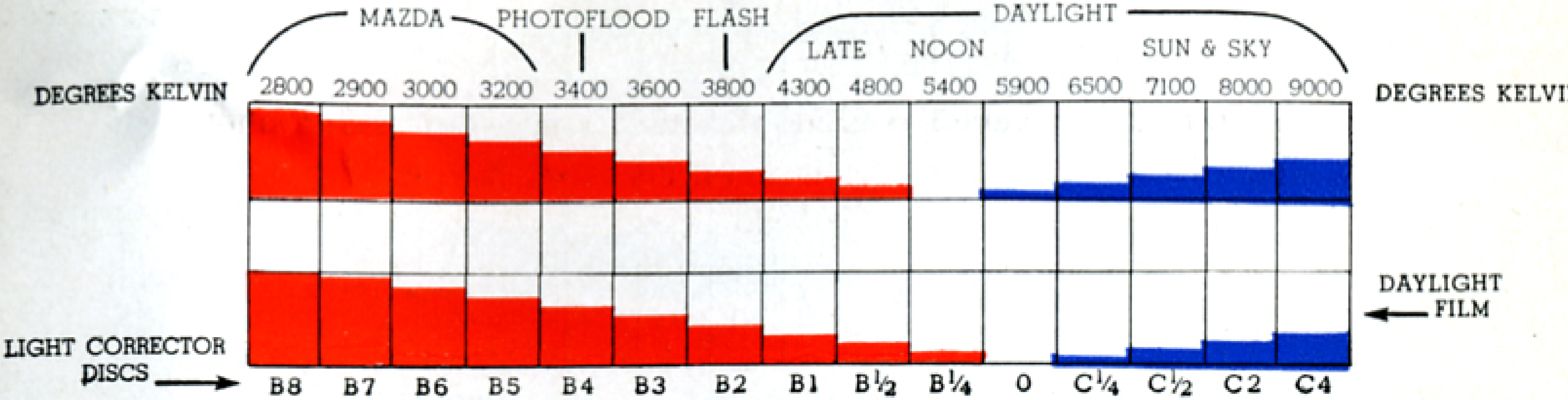
When the light has a Kelvin reading of 3,400° and we are using photoflood film (Eastman Kodachrome type A) it is not necessary to use a light corrector disc because the color content of the light is correct for the film's color sensitivity. At all other degees of Kelvin are listed the light corrector discs that will correct the light for the color sensitivity of photoflood film. (At 9,000° Kelvin, photoflood film should not be used.)

Shown graphically is the relationship between the color sensitivity of daylight film and the color content of the light at different degrees Kelvin that are important steps in the color temperature change photographically.

HARRISON'S COLOR CHART

OF THE

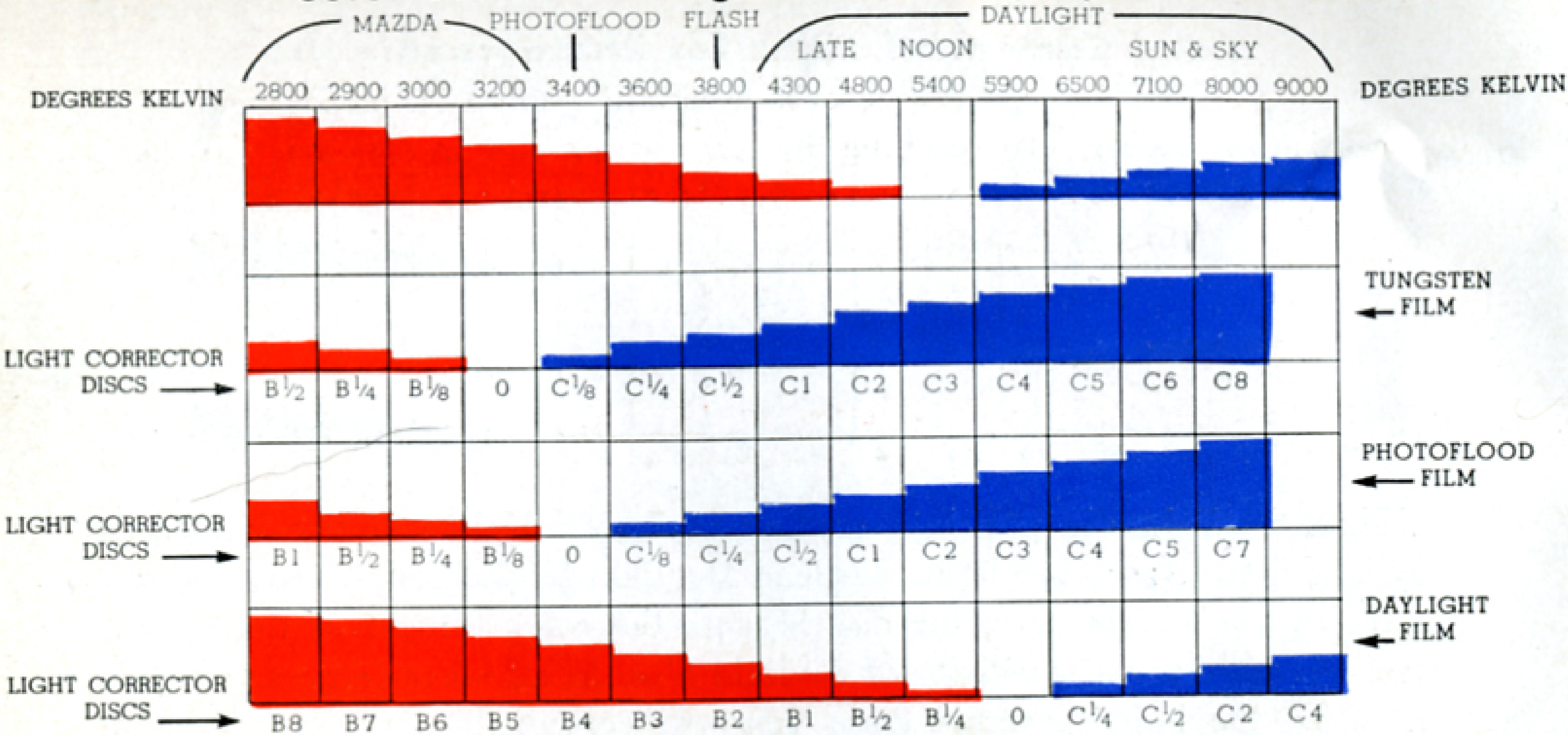
Color Content of Light for Photographic Use



When the light has a Kelvin reading of 5,900° Kelvin and we are using daylight film (Ansco Daylight, Eastman Daylight Kodachrome) it is not necessary to use a light corrector disc because the color content of the light is correct for the color sensitivity of daylight film. At all other degrees of Kelvin are listed the light corrector discs that will correct the light for the color sensitivity of daylight film.

For convenience and easy readability, we have combined the graphic charts.

HARRISON'S COLOR CHART
OF THE
Color Content of Light for Photographic Use



LIGHT CORRECTOR DISC CHART

LIGHT CORRECTOR DISCS →	B⅛	B¼	B½	B1	B2	B3	B4	B5	B6	B7	B8	C⅛	C¼	C½	C1	C2	C3	C4	C5	C6	C7	C8
CORRECTOR DISC FACTOR →	1.4	1.5	1.7	1.8	2	4	6	8	10	12	15	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2
LENS INCREASED FROM NORMAL →	½	½	¾	¾	1	2	2½	3	3¼	3½	3¾	0	¼	¼	¼	¼	½	½	¾	¾	1	1

ILLUSTRATED BELOW THE HARRISON COLOR CHART IS THE LIGHT CORRECTOR DISC CHART

As each light corrector disc absorbs a certain proportion of the light, it reduces the amount of light reaching the film. An increase in exposure will therefore be required to compensate for the light absorbed by the light corrector disc. This is illustrated below.

Light Corrector Disc Chart

LIGHT CORRECTOR DISC	B⅛	B¼	B½	B1	B2	B3	B4	B5	B6	B7	B8
LIGHT CORRECTOR DISC FACTOR	1.4	1.5	1.7	1.8	2	4	6	8	10	12	15
LENS STOP INCREASED FROM NORMAL	½	½	¾	¾	1	2	2½	3	3¼	3½	3¾
LIGHT CORRECTOR DISC	C⅛	C¼	C½	C1	C2	C3	C4	C5	C6	C7	C8
LIGHT CORRECTOR DISC FACTOR	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2	2.2
LENS STOP INCREASED FROM NORMAL	0	¼	¼	¼	¼	½	½	¾	¾	1	1

The light corrector disc factor shows the number by which the exposure must be multiplied for each light corrector disc to compensate for the amount of light absorbed by the light corrector disc.

As exposure can be easily increased from normal by increasing the diaphragm opening of the lens, shown below each light corrector disc is the increase in lens diaphragm opening necessary to compensate for the increase in exposure.

Light Corrector Disc Chart

LIGHT CORRECTOR DISC										
B⅛	B¼	B½	B1	B2	B3	B4	B5	B6	B7	B8
LENS STOP INCREASED FROM NORMAL										
½	½	¾	¾	1	2	2½	3	3¼	3½	3¾
LIGHT CORRECTOR DISC										
C⅛	C¼	C½	C1	C2	C3	C4	C5	C6	C7	C8
LENS STOP INCREASED FROM NORMAL										
0	¼	¼	¼	¼	½	½	¾	¾	1	1

The lens diaphragm readings are as follows:

Full f stop—1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 45, 64

Half f stops— 1.7, 2.5, 3.5, 4.5, 6.3, 9, 12, 18, 25, 36

If the lens diaphragm is marked with the stop f 1.4, 2, 2.8, etc., then those from f 1.4 to f 2 etc., each are a full stop opening, and f 1.7 is a half stop opening between f 1.4 and f 2 etc., as illustrated above.

The ½ stops are not usually indicated on the diaphragm but by merely moving the indicator to the ½-way position between the f stops we will get ½ stop change.

Full	Stop f	1.7,	2.5,	3.5,	4.5,	6.3,	9,	12,	18,	25,	36,
Half	Stop f		2	2.8	4	5.6	8	11	16	22	32 45

If the lens diaphragm is marked with the stops f 1.7, 2.5 etc., each is a full stop opening and the f 2 is a half stop opening between the f 1.7 and f 2.5 etc., as illustrated above.

(Each full stop opening doubles the amount of light reaching the film. Conversely, each half stop opening decreases the amount of light reaching the film by ½).

If the exposure meter called for a shutter setting of 1/50th part of a second and a diaphragm opening of f5.6 and the light corrector meter called for the use of the light corrector disc B-⅛, the diaphragm setting would be changed to f4.5. This would increase the lens opening from normal by ½ stop and thus would increase the exposure by ½ and compensate for the light absorbed by the light corrector disc B-⅛.

The exposure could also be compensated for in another way, and that would be by decreasing the shutter speed. This would be done by changing the shutter from 1/50th of a second to 1/37½th of a second. So that the light that is absorbed by the light corrector disc can be compensated for either by increasing the diaphragm opening or by decreasing the shutter speed.

If the exposure meter called for a setting of 1/100 at f 16 and the light corrector meter called for the B-3 light corrector disc (the light corrector disc factor is 4) the exposure could be compensated for the light absorbed by the light corrector disc either by changing the diaphragm setting to stop f 8, or by leaving the diaphragm setting at stop f 16 and decreasing the shutter speed from 1/100 to 1/25 of a second. Because of the latitude of the natural color film, even though there is a slight change in the corrector disc factor between B-1/8 and B-1/4, 1/2 stop is correct because of the latitude of natural color film. The same is true of B-1/2 and B-1. The other factors of the light corrector discs are shown accordingly on the chart.

In Conclusion

This is the first time the natural color photographer has had a standard by which to measure the color content of light for photographic use.

If a light corrector is not used then the manufacturer's instructions for color film should be followed and natural color pictures should only be taken as their instructions indicate.