PM003 XR 3,929,487

United States Patent [19]

Singh

[11] **3,929,487**

[45] **Dec. 30, 1975**

[54] **SPECTRAL BALANCING MEANS FOR COLOR PHOTOGRAPHY**

[76] Inventor: **Harbans Singh**, Box 37, Rte. 1, Odessa, Fla. 33556

[22] Filed: **Dec. 7, 1970**

[21] Appl. No.: **95,901**

Related U.S. Application Data

[62] Division of Ser. No. 583,789, Oct. 3, 1966, Pat. No. 3,588,215.

[52] **U.S. Cl.** ..... **96/84 R**; 96/2; 96/87 R

[51] **Int. Cl.²** **G03C 1/84**

[58] **Field of Search** ..... 96/84, 82, 87 R

[56] **References Cited**

UNITED STATES PATENTS

2,219,304	10/1940	Gaspar	96/84 R
2,219,305	10/1940	Gaspar	96/84 R
2,219,306	10/1940	Gaspar	96/84 R
3,234,023	2/1966	De Remaix	96/84 R

OTHER PUBLICATIONS

Kirk–Othmer Encyclopedia of Chemical Technology 2nd Edition, Vol. 5, pp. 838 and 839 and Vol. 9, pp 254 to 258 (1965).

Primary Examiner—Ronald H. Smith
Attorney, Agent, or Firm—Buell, Blenko, and Ziesenheim

[57] **ABSTRACT**

A photographic material comprising a spectral balanc ing means for color photography consisting essentiall of a layer of magenta dye and yellow dye.

2 Claims, 13 Drawing Figures

Fig. 1.

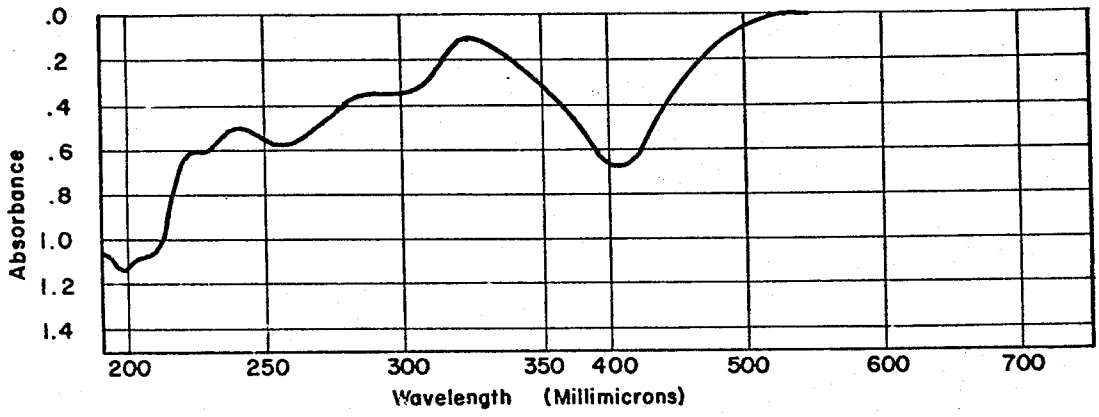


Fig. 2.

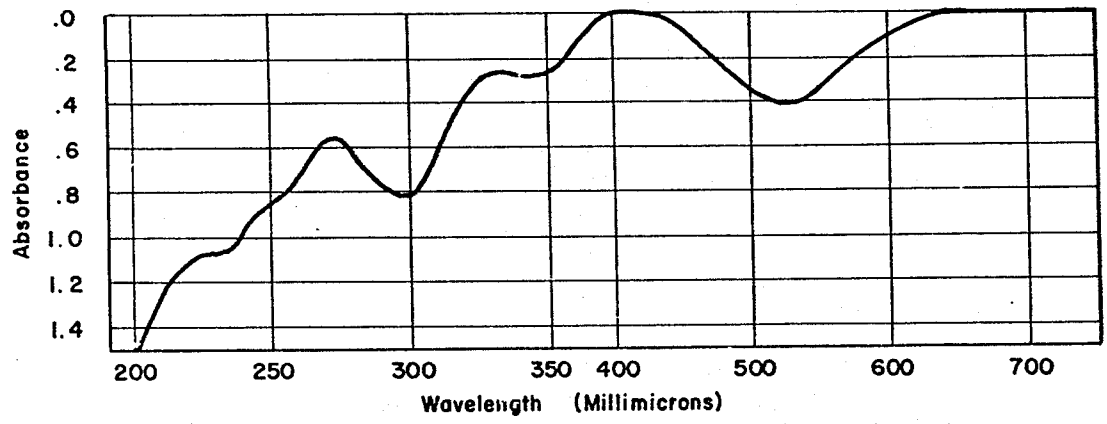


Fig. 3.

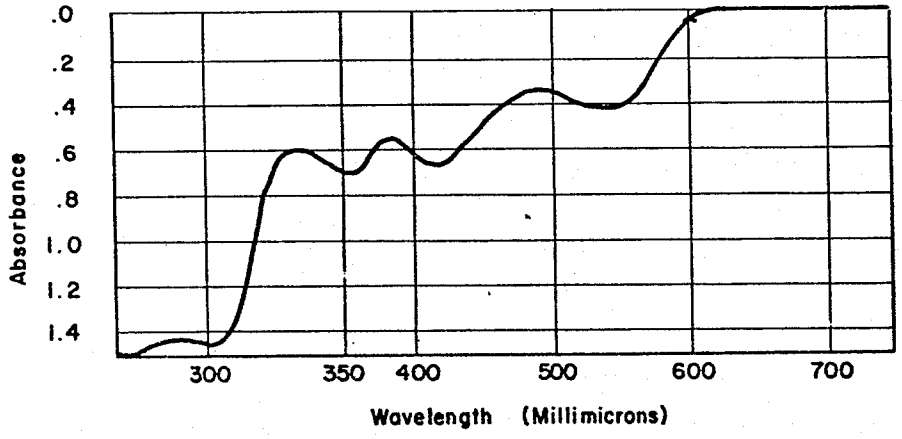


Fig. 6.

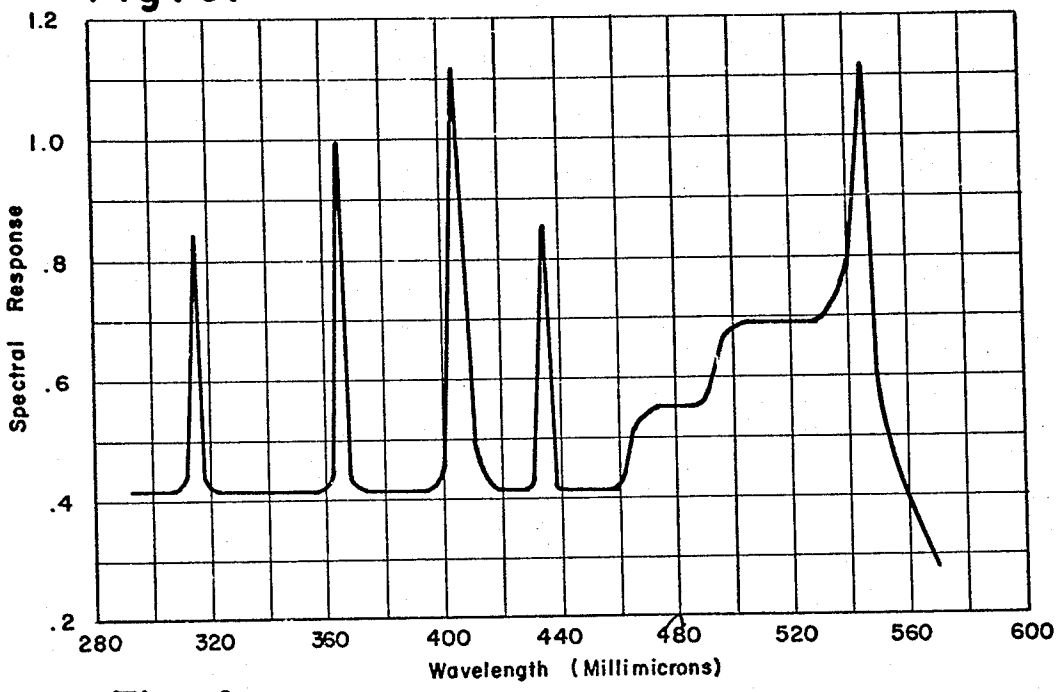


Fig. 4.

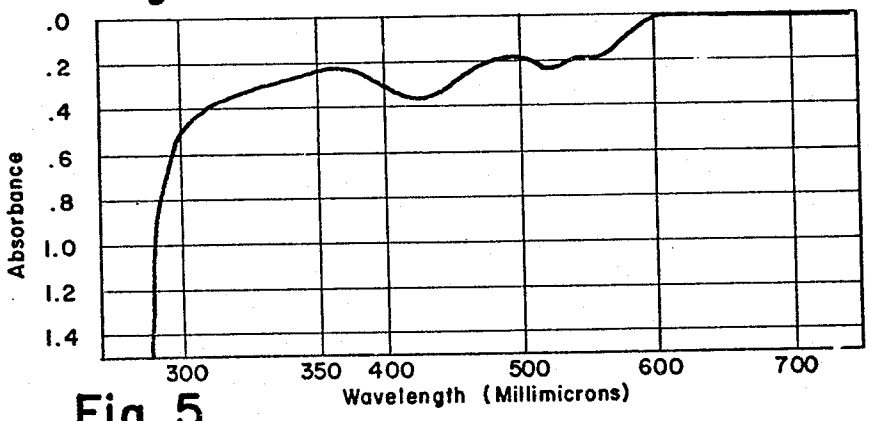


Fig. 5.

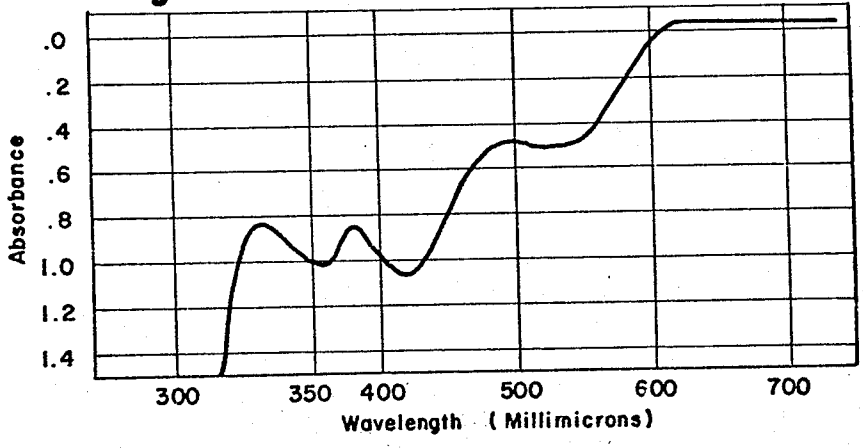


Fig. 7.

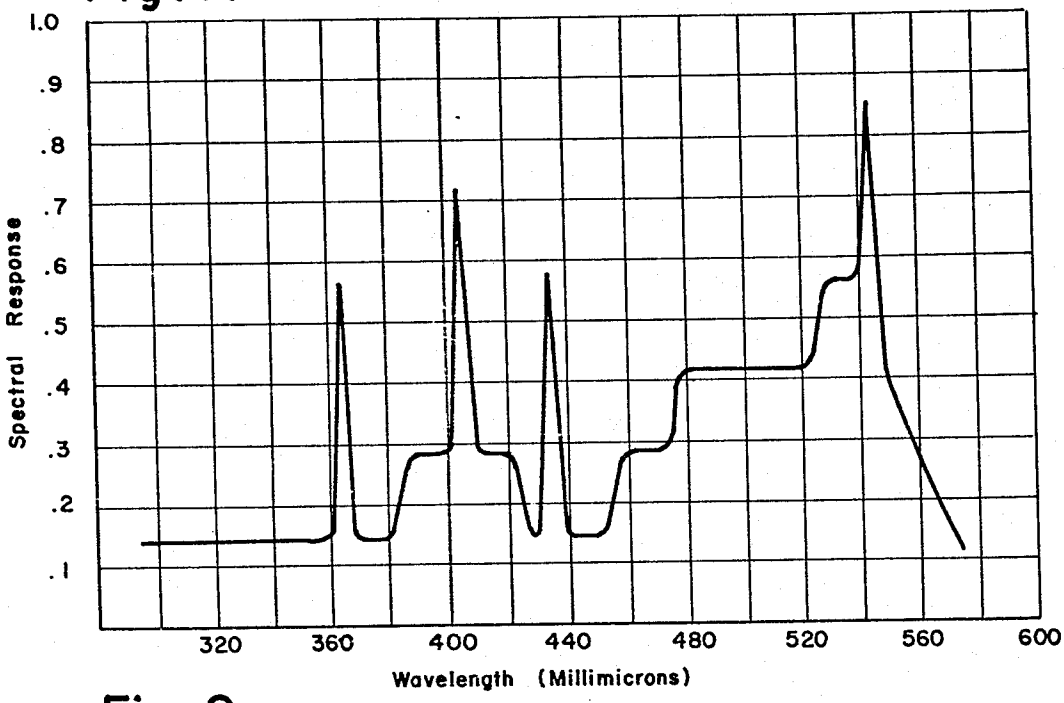

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Spectral Response
320
360
400
440
480
520
560
600
Wavelength (Millimicrons)

Fig. 8.

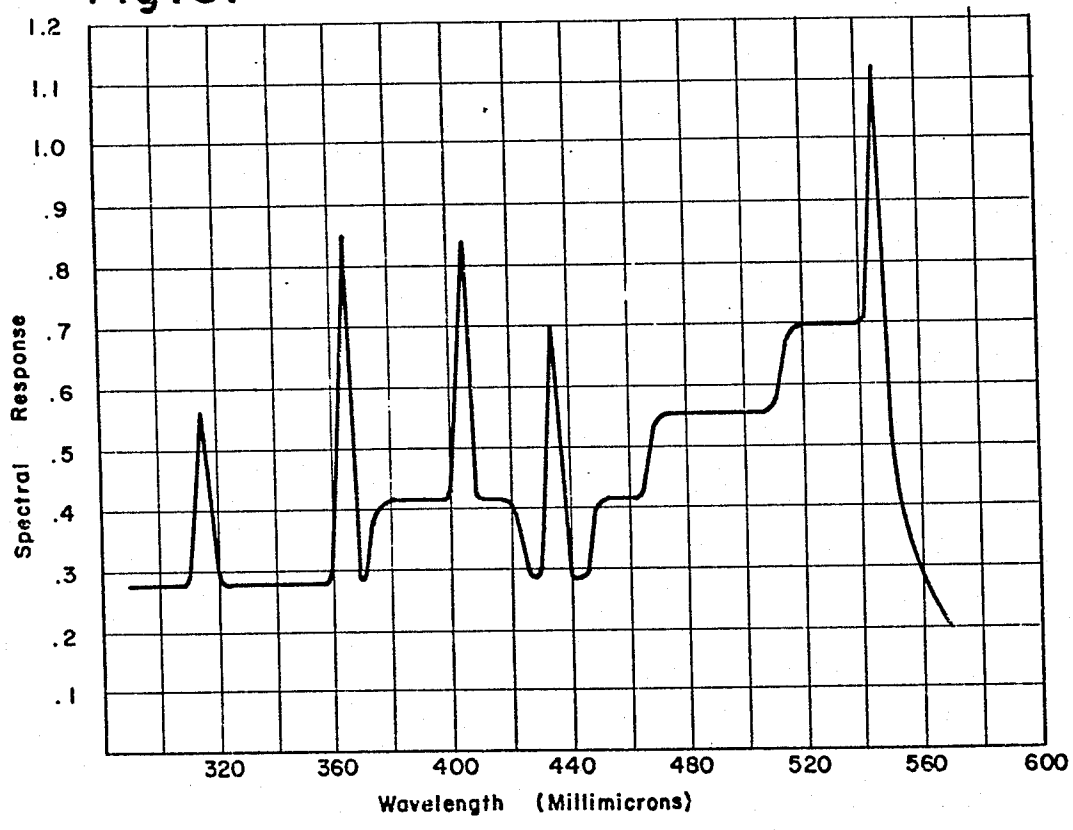

1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Spectral Response
320
360
400
440
480
520
560
600
Wavelength (Millimicrons)

Fig. 9.

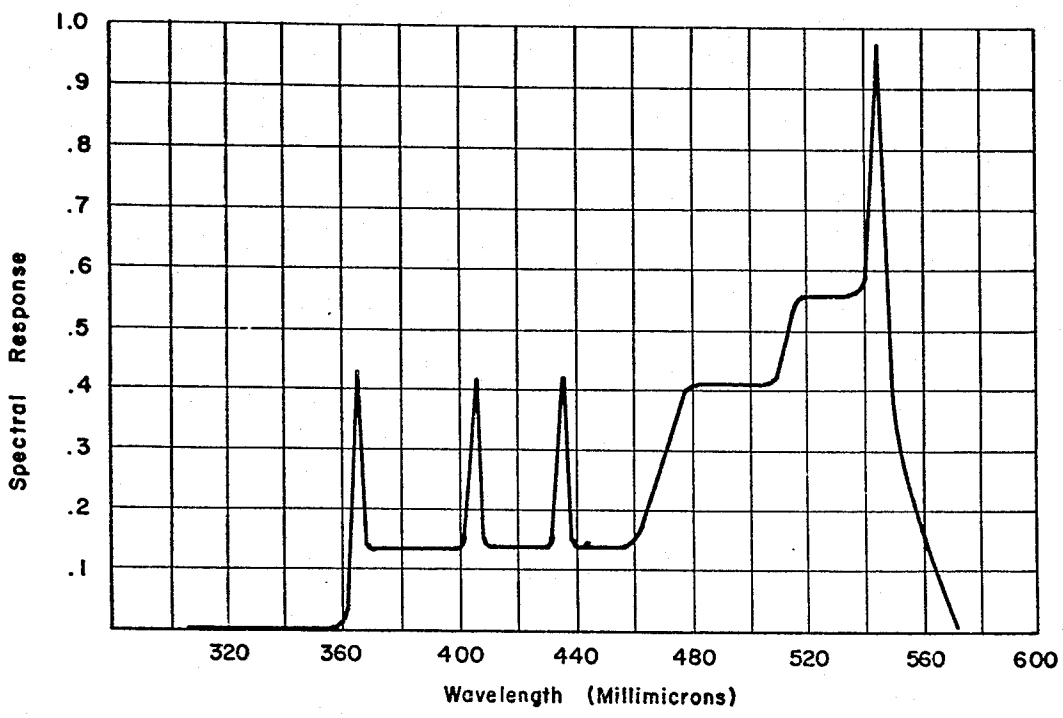

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Spectral Response
320
360
400
440
480
520
560
600
Wavelength (Millimicrons)

Fig. 10.

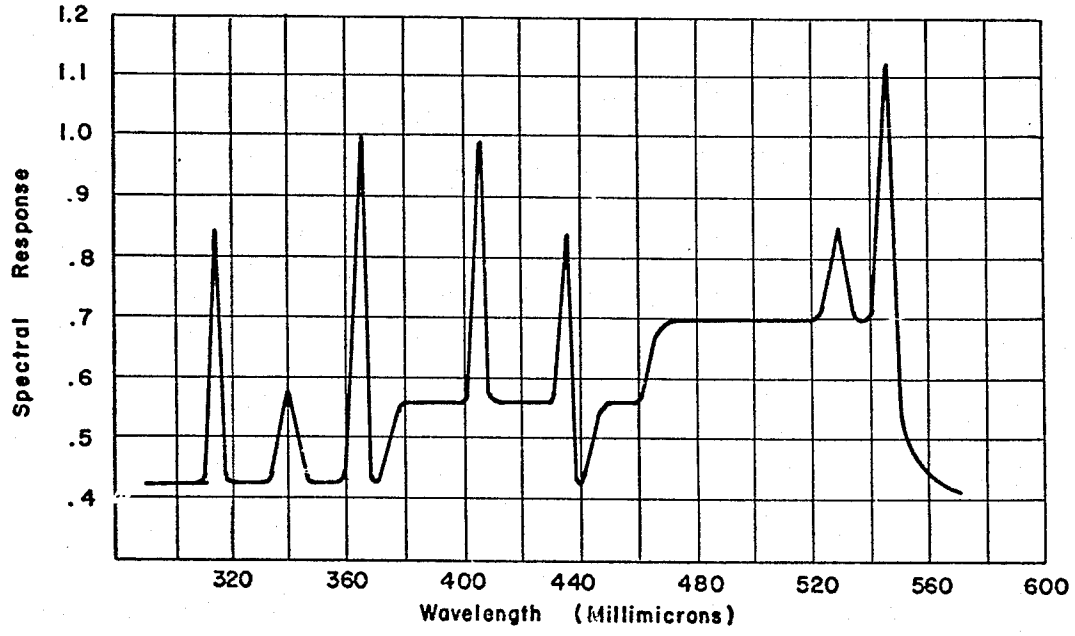

1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
Spectral Response
320
360
400
440
480
520
560
600
Wavelength (Millimicrons)

Fig. 11.

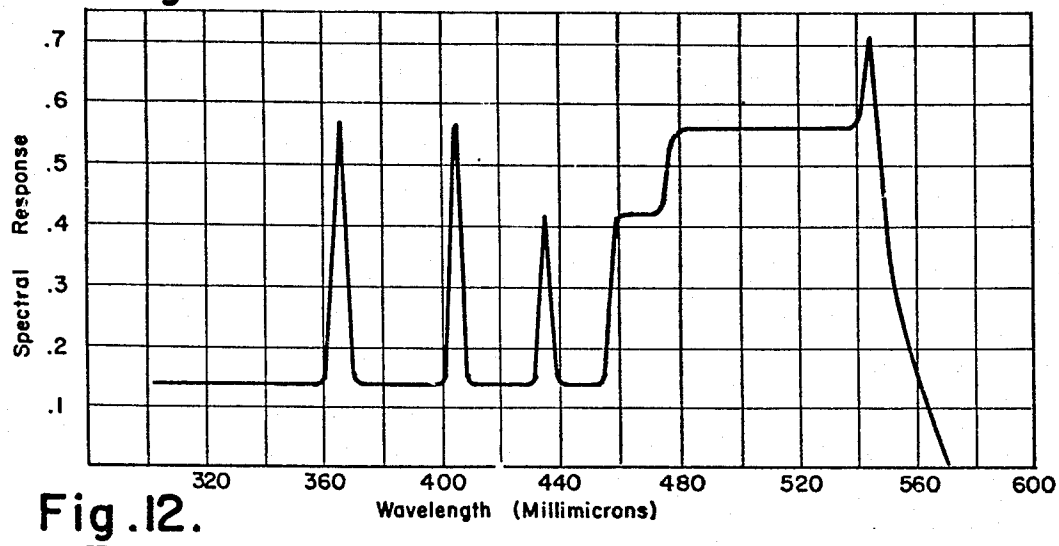


Fig. 12.

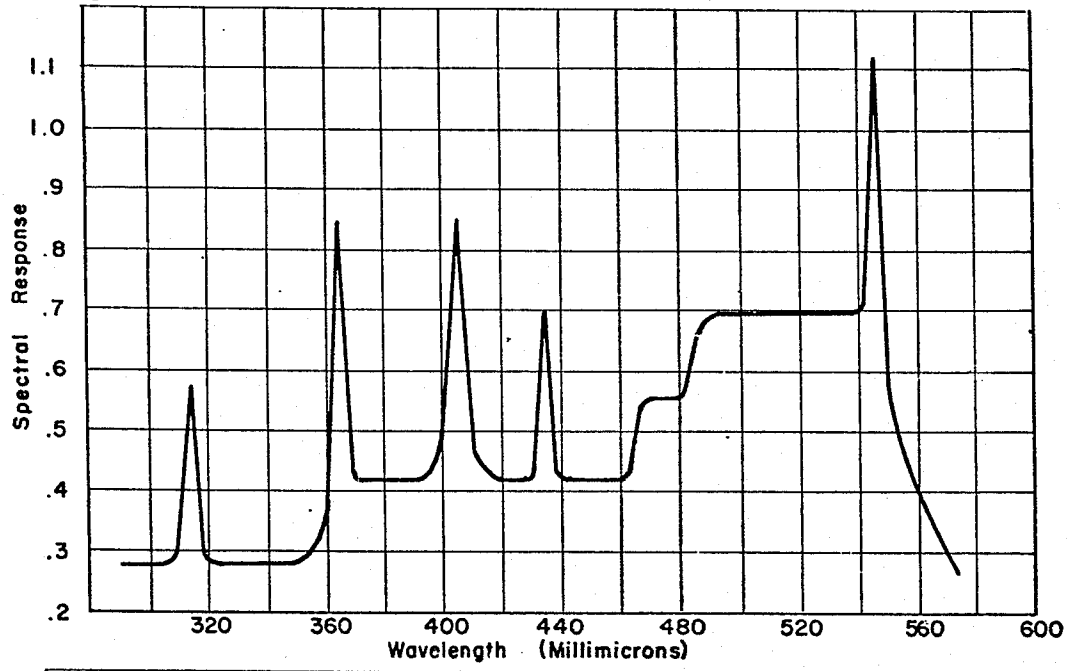
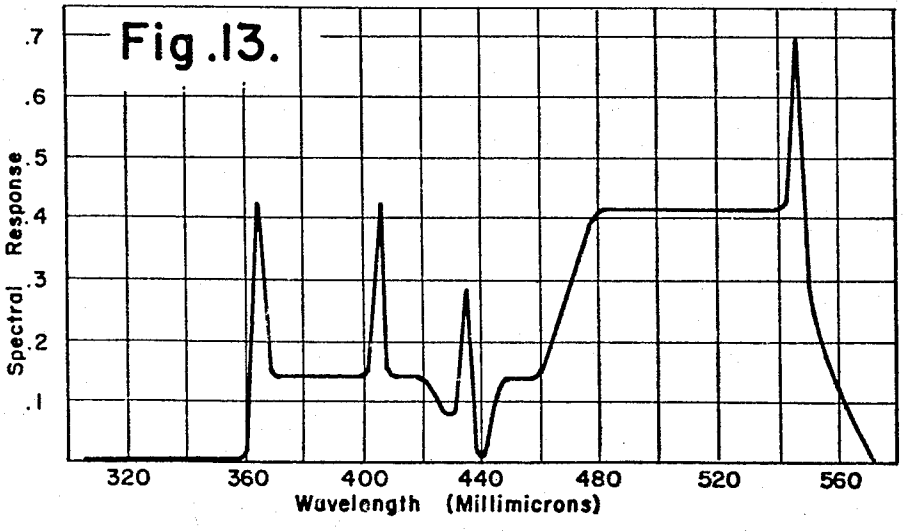


Fig. 13.



SPECTRAL BALANCING MEANS FOR COLOR PHOTOGRAPHY

This is a division of application Ser. No. 583,789, filed Oct. 3, 1966, now U.S. Pat. No. 3,588,215.

This invention relates to spectral balancing means and methods of spectral balancing and particularly to spectral balancing means for use in order to properly balance the spectral emission of carbon arc and mercury discharge spectral energy sources.

I shall particularly describe the invention in connection with a typical mercury discharge spectral energy source, fluorescent lighting. Fluorescent lighting is very much used for illumination in offices, public buildings and homes. It has many advantages for general illumination, being soft and very efficient. However, it is well known that fluorescent lighting is unbalanced in its spectral emission characteristics and cannot be satisfactorily used for many purposes where a balanced spectrum is required. Many attempts have been made in the past to find a satisfactory method for balancing the spectral emission of fluorescent sources or to correct the inherent difficulties by modifying the spectral distribution characteristics of fluorescent sources, but without success. I have invented a means and method of spectrally balancing fluorescent sources which may be used wherever a balanced fluorescent source is desired.

I shall particularly describe the invention in connection with photography using color film. It is well known that fluorescent lighting cannot be used satisfactorily for color photography. Consequently, when television or motion picture cameras are being used for color reproduction under artificial light, special lighting sources must be used. If the objects to be photographed are also illuminated by fluorescent artificial light sources, the special lighting sources must overpower them; if such special lighting sources are not permanently installed at the area, they must be carried there and installed and used. This is expensive and inconvenient, but is necessary because no satisfactory method for balancing the spectral emission of fluorescent sources has been found prior to the present invention.

I have discovered a means and a method of balancing the spectral emission of fluorescent sources which makes it possible to use conventional fluorescent light sources for color reproduction. I have successfully produced photographic results under fluorescent lighting which are completely free from the "washed out" appearance characteristic of color reproduction by fluorescent lighting in the past and which are comparable to color reproduction by daylight illumination.

In a preferred embodiment of my invention, I provide a spectral balancing means absorbing ultra violet radiation without distortion of violet and deep blues and with a relative strengthening of blue green and green wavelengths of light. A device of my invention preferably selectively reduces the peaks at ± 3650 angstroms, ± 4050 angstroms and ± 4360 angstroms and substantially absorbs the ± 3130 angstroms peak characteristic of all white fluorescent light sources (cool and warm whites) presently in use. The device of my invention is preferably prepared by combining known color filter materials to produce the peculiar advantages here set out. Preferably, I combine dyes on a suitable carrier to selectively reduce the emission peaks which are characteristic of all white fluorescent light sources. Preferably, dyes are combined to get an absorbance cur similar to curves hereafter described. Preferably, I u gelatin as the carrier although any other suitable op cal transmission carrier may be used to carry the dy

In the foregoing general statement of my invention have set out certain objects, purposes and advantag of my invention. Other objects, purposes and adva tages will be apparent from the following descripti and the accompanying drawings in which,

FIG. 1 is a curve of absorbance characteristics of o of the dyes combined according to my invention;

FIG. 2 is a curve of absorbance characteristics of second dye to be combined with the dye of FIG. 1 produce a spectral balancing means according to m invention;

FIG. 3 is a curve of absorbance of spectral emissi in a preferred embodiment of my invention;

FIG. 4 is a curve of absorbance of spectral emissi in a second embodiment of my invention;

FIG. 5 is a curve of absorbance of spectral emissi in a third embodiment of my invention;

FIG. 6 is a spectral response curve of an orth chromatic film exposed to the spectral emission of typical cool-white fluorescent light source without b ancing its spectral emission;

FIG. 7 is a spectral response curve of an orth chromatic film exposed to the spectral emission of typical cool-white fluorescent light source using t embodiment of my invention of FIG. 3;

FIG. 8 is a curve as in FIG. 7 using the embodime of my invention of FIG. 4;

FIG. 9 is a curve as in FIG. 7 using the embodime of my invention of FIG. 5;

FIG. 10 is a spectral response curve of an orth chromatic film exposed to the spectral emission of typical warm-white fluroescent light source witho balancing its spectral emission;

FIG. 11 is a curve as in FIG. 10 using the embo ment of my invention which was also used in FIG. 3

FIG. 12 is a curve as in FIG. 10 using the embo ment of my invention which was used in FIG. 4; an

FIG. 13 is a curve as in FIG. 10 using the embo ment of my invention which was also used in FIG. 5

Referring to the drawings, I have illustrated in FIG an absorbance curve of one preferred dye compone for combining to form the balancing means of my vention and in FIG. 2 an absorbance curve of a seco preferred dye component for combining with the dye FIG. 1 to form the balancing means of my inventio

In order to illustrate the effectiveness of the spect balancing means, I prepared three gelatin carriers w dye combinations which would effectively balance t spectral emission of fluorescent sources. The abs bance curve values of each device were determin using a spectrophotometer and appear in Table I l low.

Table I

Wavelengths in Angstroms	Spectral Absorbance* Embodiment No. 1	Embodiment No. 2	Embodim No. 3
3000	1.46	0.55	1.50
3100	1.35	0.40	1.50
3200	0.90	0.35	1.30
3300	0.60	0.30	0.83
3400	0.65	0.27	0.90
3500	0.70	0.24	0.95
3600	0.70	0.22	1.00
3700	0.64	0.23	0.94
3800	0.55	0.25	0.85

Table I-continued

Wavelengths in Angstroms	Spectral Absorbance* Embodiment No. 1	Embodiment No. 2	Embodiment No. 3
3900	0.56	0.27	0.90
4000	0.62	0.30	1.00
4100	0.66	0.34	1.05
4200	0.68	0.36	1.06
4300	0.64	0.37	1.02
4400	0.58	0.35	0.95
4500	0.50	0.32	0.83
4600	0.44	0.28	0.72
4700	0.38	0.24	0.62
4800	0.34	0.20	0.54
4900	0.33	0.19	0.48
5000	0.34	0.19	0.47
5100	0.38	0.20	0.49
5200	0.40	0.22	0.51
5300	0.42	0.22	0.50
5400	0.42	0.20	0.50
5500	0.40	0.18	0.48
5600	0.38	0.18	0.44
5700	0.30	0.16	0.35
5800	0.19	0.10	0.22
5900	0.10	0.05	0.12
6000	0.07	0.02	0.04
6100	0.02	0.01	0.00
6200	0.00	0.00	0.00

*At any given wavelength, the spectral absorbance value relates the amount of spectral energy (of that specific wavelength) entering the spectral balancing means to the amount of spectral energy transmitted.

The absorbance curve of Embodiment No. 1 is plotted in FIG. 3, that of Embodiment No. 2 in FIG. 4 and that of Embodiment No. 3 in FIG. 5. Known color balancing filters for color photograph become opaque below ± 4000 A. To the contrary absorbance curves of my invention disclose transmittance of spectral energy in the near ultraviolet range.

To illustrate the effect of my invention on the response of photographic emulsions and materials to spectral emission from fluorescent sources I had spectrographic negatives prepared exposing photographic material to fluorescent sources through a spectral balancing means of my invention and with none at all. Orthochromatic film was used rather than panchromatic film because the described spectral balancing means exhibit little transmission difference above approximately 5800 angstroms.

When the orthochromatic film was exposed to the fluorescent source, a step-density wedge of fine-grain silver was interposed. Each step of the wedge had an incremental density of 0.14. Thus, for example, two increments totaled 0.28, which for practical purposes represents a 2X difference in transmission or, in other terms, a one *f*-stop difference in lens aperture. These density increments are directly equivalent to absorption values of 0.14, 0.28, etc.

After the orthochromatic film was exposed, it was developed in a high-contrast, catalytic, paraformaldehydehydroquinone developer to a gamma above 3.0 and a "toe" density less than 0.30. Low-contrast continuous tone spectrographic negatives were also produced, in order to verify the results of this high-contrast procedure.

To determine the spectral response curves of the orthochromatic film, positive prints were made from the spectrographic negatives onto high gamma paper and developed to high contrast. The printing exposures were timed to print maximum possible density for all densities in the original negatives of 0.40 or less. The resulting positive prints thus show directly a contour of the photographic response from all wavelengths between 3000 and 5800 angstroms. From the prints data were tabulated into the following Table II and Table III and spectral response curves were plotted, which are FIGS. 6 through 13.

Table II

SPECTRAL RESPONSE OF AN ORTHOCHROMATIC FILM TO THE SPECTRAL EMISSION OF A COOL WHITE FLUORESCENT LIGHT SOURCE

Wavelengths in Angstroms	Without Balancing Effects of My Invention	Balanced by Embodiment No. 1	Balanced by Embodiment No. 2	Balanced by Embodiment No. 3
3000	.42	.14	.28	Base*
3100	.42	.14	.28	Base*
3130**	.84	.14	.56	Base*
3200	.42	.14	.28	Base*
3300	.42	.14	.28	Base*
3400	.42	.14	.28	Base*
3500	.42	.14	.28	Base*
3600	.42	.14	.28	Base*
3650**	.98	.56	.84	.42
3700	.42	.14	.28	.14
3800	.42	.14	.42	.14
3900	.42	.28	.42	.14
4000	.46	.28	.42	.14
4050**	1.12	.70	.84	.42
4100	.56	.28	.42	.14
4200	.42	.28	.42	.14
4300	.42	.14	.28	.14
4360**	84	.56	.70	.42
4400	.42	.14	.28	.14
4500	.42	.14	.42	.14
4600	.42	.28	.42	.14
4700	.56	.28	.56	.28
4800	.56	.42	.56	.42
4900	.56	.42	.56	.42
5000	.70	.42	.56	.42
5100	.70	.42	.56	.42
5200	.70	.42	.70	.42
5300	.70	.56	.70	.56
5400	.78	.56	.70	.56
5460**	1.12	.84	1.12	.98
5500	.56	.42	.56	.42
5600	.42	.14	.28	Base*

Table II-continued

SPECTRAL RESPONSE OF AN ORTHOCHROMATIC FILM TO THE SPECTRAL EMISSION OF A COOL WHITE FLUORESCENT LIGHT SOURCE				
Wavelengths in Angstroms	Without Balancing Effects of My Invention	Balanced by Embodiment No. 1	Balanced by Embodiment No. 2	Balanced by Embodiment No. 3
5700	.28	.07	.20	Base*

*The printing exposures for making positive prints were timed to print maximum possible density for all densities in the original negatives of 0.40 or less.
**This wavelength designates an average of those wavelengths which comprise this "peak", which is characteristic of the spectral emission of a typical fluorescent light source.

Table III

SPECTRAL RESPONSE OF AN ORTHOCHROMATIC FILM TO THE SPECTRAL EMISSION OF A WARM WHITE FLUORESCENT LIGHT SOURCE				
Wavelengths in Angstroms	Without Balancing Effects of My Invention	Balanced by Embodiment No. 1	Balanced by Embodiment No. 2	Balanced by Embodiment No. 3
3000	.42	.14	.28	Base*
3100	.42	.14	.28	Base*
3130**	.84	.20	.70	.14
3200	.42	.14	.28	Base*
3300	.42	.14	.28	Base*
3400	.56	.14	.28	Base*
3500	.42	.14	.28	Base*
3600	.42	.14	.35	Base*
3650**	.98	.56	.84	.42
3700	.42	.14	.42	.14
3800	.56	.14	.42	.14
3900	.56	.14	.42	.14
4000	.56	.14	.56	.14
4050**	.98	.56	.84	.42
4100	.56	.14	.56	.14
4200	.56	.14	.42	.14
4300	.56	.14	.42	.07
4360**	.84	.42	.70	.28
4400	.42	.14	.42	Base*
4500	.56	.14	.42	.14
4600	.56	.42	.42	.14
4700	.70	.42	.56	.28
4800	.70	.56	.56	.42
4900	.70	.56	.70	.42
5000	.70	.56	.70	.42
5100	.70	.56	.70	.42
5200	.70	.56	.70	.42
5300	.84	.56	.70	.42
5400	.70	.56	.70	.42
5460**	1.12	.70	1.12	.70
5500	.56	.42	.56	.28
5600	.42	.14	.42	.14
5700	.42	Base*	.28	Base*

*The printing exposures for making positive prints were timed to print maximum possible density for all densities in the original negatives of 0.40 or less.
**This wavelength designates an average of those wavelengths which comprise this "peak", which is characteristic of the spectral emission of a typical fluorescent light source.

The devices used in the foregoing tests were made of gelatin containing the following dye transfer (imbibition) dyes:

Embodiment No. 1 5 parts ASA magenta + 5 parts ASA yellow

Embodiment No. 2 2 parts ASA magenta + 5 parts ASA yellow

Embodiment No. 3 9 parts ASA magenta + 12 parts ASA yellow.

In order to compare the results of using the foregoing Embodiments Nos. 1, 2, and 3 and the results of using the filters and combinations of filters presently known and the results of not using any of them, color motion pictures for television transmission and for conventional projection were produced under both cool white and warm white fluorescent light sources. All the films exposed without use of my invention revealed the color imbalance characteristic of color film exposed to the spectral emission of fluorescent light sources. On the other hand, the films exposed using my inventions h excellent color balance.

It will be apparent from the foregoing tables a curves that my invention has a very selective abso tion characteristic for peak emissions of fluoresc light sources and at the same time changes the relat transmission of wavelengths in the band ± 3000 a stroms to ± 6300 angstroms. Accordingly, broa stated, my invention has a selective absorption for p emissions of fluorescent light sources and adjusts relative transmission of wavelengths in the band ± 3(A to ± 6300 A. Preferably, the spectral balancing vice of my invention has a spectral absorbance cu lying between the curves of FIG. 4 and FIG. 5 a particularly similar to that of FIG. 3.

The spectral balancing means of my invention n be applied to a fluorescent source envelope or t separate carrier member as described herein, or it n be applied directly to the photographic film base a

emulsion or material or as a modification of the fluorescent source phosphors.

While I have set out certain preferred embodiments and practices of my invention in the foregoing specification, it will be understood that this invention may be otherwise broadly practiced within the scope of the following claims.

I claim:

1. A spectral balancing means for color photography under a fluorescent light source consisting essentially of in combination in a single transfer dye layer a magenta dye and a yellow dye in the ratio of 1:1 to 2:5 coated and applied as one of a single layer and a pellicle onto one of a photographic film base, a photographic emulsion and a photographic material.

2. A spectral balancing means for color photography under a fluorescent light source consisting essentially of in combination in a single layer a magenta dye and a yellow dye in the ratio of 1:1 to 2:5 incorporated into one of a photographic film base, a photographic emulsion and a photographic material.

* * * * *