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(54) **Method for exposing a lightsensitive color photographic material.**

(57) A method for exposing a light-sensitive photographic material comprising at least two spectrally different but partly overapping light-sensitive phases which is advantageous for obtaining a color photographic image with color purity, said method comprising a step of exposing said photographic material to light through a filter which absorbs at least a part of said spectrally overapped region.

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METHOD FOR EXPOSING A LIGHT-SENSITIVE COLOR PHOTOGRAPHIC MATERIAL

FIELD OF THE INVENTION

The present invention relates to an exposing method suitable for obtaining an image with a light-sensitive color photographic material.

BACKGROUND OF THE INVENTION

A simple technique suitable for forming a color image usually employs a silver halide color photographic light-sensitive material comprising multi-layers having spectrally sensitized with a cyanine dye, meroyanine dye or the like so that specific layers may be sensitive to blue, green or red light, wherein silver halide serves as light-sensitive member. The typical examples of such a simple technique include photographs with a color negative film or color reversal film, instant photography employing diffusion transfer process, and photography using so-called silver dye-bleach process.

These photographic light-sensitive materials have light-sensitive layers are sensitive to different wavelength regions as a silver halide particles in these layers have been spectrally sensitized, for example, with a cyanine dye or merocyanine dye. Generally, most of these light-sensitive materials are also sensitive to a spectral wavelength region which is not required for color reproduction. For this reason, sensitiveness to the unnecessary spectral wavelength region needs to be eliminated by some measures; for example, by disposing a yellow filter layer above green-sensitive and red-sensitive silver halide layers, i.e., on the side of a photographic object or a light source, in order to prevent a blue light from reaching the green-sensitive and red-sensitive silver halide layers. Further examples of such measures are by selecting a spectral sensitizing dye, which has lowest possible green-sensitivity, to be added to the red-sensitive silver halide layer; or by using a dye, which is capable of absorbing a green spectrum and is usually capable of being eluted in the course of photographic process, or decolorized, and thus the dye does not remain in the final image.

Even with commercially available color photographic light-sensitive materials incorporating such measures, it is still difficult for the light-sensitive materials to provide photographs with satisfactorily high color purity as it is difficult to completely eliminate such overlaps in color sensitivities thus definitely separate overlap pad spectral regions into clear-cut independent blue, green and red spectral sensitivities. The negative film have been improved to some extent using techniques such as a colored coupler, DIR (Development Inhibitor Releasing) compound or the like. However, the improvement is not satisfactory to satisfy the increasingly demanding requirements on the part of users.

On the other hand, as the means for duplicating a color image, such processes as electrophotographic process, thermosublimation dye transfer process, and a means using a color photographic light-sensitive material are conventionally known in the art.

Among the techniques using these means, the techniques using silver halide color photographic light-sensitive materials include a technique to print an image onto a positive light-sensitive material using a negative film as a medium; and a technique using reversal type, direct positive type or silver dye bleaching type light-sensitive materials, where each type of materials being capable of directly forming a positive image.

To duplicate an original image, each of these materials is used with certain advantages. However, in view of eliminating an extra procedure for providing a negative film as an intermediate medium, silver halide light-sensitive materials which are capable of directly forming a positive image are advantageous since they do not require such an extra procedure.

As previously described, the light-sensitive materials for directly forming a positive image are advantageous as they do not require a negative film as a medium. However, this type of light-sensitive materials are not completely satisfactory in terms of both color purity and color reproduction in spite of various attempts. One of the reasons is that color positive photographic light-sensitive materials, when compared to color sensitive photographic light-sensitive materials, do not allow masking technique which is for compensating the absorption in the unnecessary spectral region in the spectrally sensitive regions of a photographic material. As a technique for enhancing color separation, inter image effect is also available, but is not still satisfactory.

In terms of color purity, color images obtainable from color positive photographic light-sensitive

materials tend to be inferior to those obtainable from color negative photographic light-sensitive materials.

On the other hand, the current status of exposing method for duplicating is as follows.

A color photographic light-sensitive material usually comprises layers respectively sensitive to lights of primary colors, normally, blue, green and red colors. According to one method for exposing such a light-sensitive material, the material is exposed sequentially to blue, green and red lights. This method, however, requires a longer operational time because of three steps of exposing. Also, another method, in which exposure is performed in a single step by using three light sources, respectively provided with a color separation filter generating independent blue, green and red lights may be used. The disadvantage of this technique is, as mentioned above, necessity for three light sources. In this case it is possible to select filters depending on the degree of overlapping spectral sensitivity of a silver halide photographic light-sensitive material, and this can improve color purity. However, this method incurs another disadvantage; since a blue filter absorbs green and red lights, there arises a significant loss in light intensity.

Still another exposing method is as follows; yellow, magenta and cyan filters are used with a light source having continuous spectral ranging from blue to red regions in order to expose a light-sensitive material in compliance with the relative sensitivities of three light-sensitive layers. This method has a unique advantage; the loss in light-intensity is smaller compared with that with the method using color separation filters. However, by this method it is difficult to improve color purity because of inability to control the overlapped spectral regions of a silver halide photographic light-sensitive material.

When considering another criterion i.e. exposure time, regulating light intensity by means of three shutters or by changing an operating voltage of the light source requires, disadvantageously, complicated mechanism.

Apart from an apparatus for forming a small duplicate such as a cabinet size photograph, an exposing apparatus for duplication which is capable of duplicating a large size photograph such as an A3 sized photograph inevitably needs larger dimensions. To solve this disadvantage, the applicant proposed, in Japanese Patent Application Nos. 73010/1985, 73011/1985, 73012/1985 and 73017/1985, a color photographic copying apparatus capable of being miniaturized by exposing a light-sensitive material while scanning an original image. In such exposure-by-scanning technique, it is desirable single step of scanning be capable of duplicating a whole image, since exposing several times readily causes a misaligned image. This requirements prompts the need for a technique which is capable of correctly reproducing an original image simply with single step of scanning.

SUMMARY OF THE INVENTION

One object of the present invention is to provide an exposing method which, with an arbitrary color photographic light-sensitive material, more specifically, even with a conventional commercially available color photographic light-sensitive material, is capable of readily forming a color image having excellent color purity.

Another object of the invention is to provide an exposing method which is capable of forming a color image having excellent color purity, more specifically, an exposing method which, even using a direct positive photographic light-sensitive material, or even when exposing such a material only once using an exposing apparatus having a miniaturized structure by virtue of scanning exposure system, is capable of positively ensuring improved color purity.

Still another object of the invention is to provide an image forming method, by the use of a silver halide color photographic light-sensitive material, which is capable of forming images having excellent color purity, with good tone reproduction.

More specifically, the present invention relates to a method for exposing a photographic light-sensitive material comprising at least two spectrally different but partly overlapping light-sensitive phases, comprising a step of exposing the photographic material to light through a filter which absorbs at least a part of the spectrally overlapped region.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 to 4 are spectrogram charts for explaining of the present invention.

Fig. 5 is a spectral sensitivity chart of the light-sensitive material used in Example-1.

Fig. 6 is a synthesized spectrogram of a system using the light-sensitive material of Example-1 and a filter.

Fig. 7 is a chromaticity chart for Example-1.

Fig. 8 is a chromaticity chart for Example-2.

Figs. 9 and 10 are spectral transmittance curves of the filters used in Example-3 and Example-6.

Fig. 11 is a schematic diagram explaining the structure of the color copying machine used in Example-3.

Fig. 12 is a chromaticity chart Example-3.

Fig. 13(a) is a spectral sensitivity chart of the light-sensitive material used in Example-4.

Fig. 13(b) is a spectrogram chart for Example-4, when the filter member according to the present invention was used.

Fig. 13(c) is a spectrogram chart for Example-4, when the tri-color-divided filter was used.

Fig. 14 is a schematic diagram of the copying machine used in Example-4.

Fig. 15(a) is a structural sectional view of a lens unit used in Example-4.

Fig. 15(b) is a structural view of tri-color-divided filter used in Example-4.

Fig. 16 is chromaticity chart for Example-4.

Fig. 17 is a chromaticity chart for Example-5.

Fig. 18 is a chromaticity chart for Example-6.

Fig. 19 is a spectral transmittance curve of the filter used in Example-7.

Fig. 20 is a chromaticity chart for Example-7.

Figs. 21(a), 21(b), 22(a), 22(b), 23(a) and 23(b) are drawings for explaining the preferable embodiment of the present invention.

Figs. 24, 25 and 26 are chromaticity charts for Examples 8 and 9.

DETAILED DESCRIPTION OF THE INVENTION

According to the invention, a color photographic light-sensitive material is imagewise exposed to light through a filter which is incorporated into a light source or inserted into a photographing system, wherein the filter is capable of absorbing a spectrally overlapped region of the light to which a blue-sensitive layer and a green-sensitive layer of the light-sensitive material commonly have sensitivity and/or a spectrally overlapped region of the light to which a green-sensitive layer and a red-sensitive layer have sensitivity in common.

The exposing method and effects thereof according to the invention are schematically explained below, using Figs. 1 through 4.

Fig. 1 illustrates one example of a spectral sensitivity diagram, where the respective spectral sensitivities of the color sensitive layers in a light-sensitive material constitute clear-cut ideal blocks. However, a color light-sensitive material having such spectral sensitivities is currently non-existent.

Fig. 2 illustrates typical examples of spectral sensitivities available from a typical conventional light-sensitive material.

Fig. 3 shows one example of a spectral transmittance curve obtainable from a filter according to the invention.

Fig. 4 illustrates the spectral sensitivity diagram obtained by exposing the color light-sensitive material of Fig. 2 to a light of which energies in specific spectral regions have been eliminated by this filter. As demonstrated here, the light-sensitive material no longer has sensitivities in 500 nm and 600 nm spectral regions, whereby the spectral sensitivities constitute clear-cut blocks, indicating improved color separation.

As can be understood from the examples above, the invention is capable of remarkably improve the color purity using simple means of absorbing specific spectral regions with a filter.

According to the preferred embodiments of the present invention, a color photographic light-sensitive material is subjected to imagewise exposing using a light transmitted through a filter which is capable of absorbing at least light of the 490 to 510 nm spectral range and/or 580 to 620 nm spectral range, whereby the filter is incorporated into a light source or inserted into an image acquisition system. The 490-510 nm spectral range corresponds with the region where in an ordinary light-sensitive material the light-sensitivity of both blue-sensitive layer and green-sensitive layer overlap; similarly, the 580-620 nm spectral range corresponds with the region where the light-sensitivity of both green-sensitive layer and red-sensitive layer overlap. Simultaneously, incorporating such a filter positively prevents the blue-sensitive, green-sensitive and red-sensitive layers from being sensitive to an unnecessary spectral range. In essence, this arrangement ensures the respective spectral sensitivity ranges to be clear-cut independent blocks, thus positively providing an image with excellent color purity.

The preferred spectral absorption properties of a filter used in embodying the invention are as follows.

In terms of spectral absorption is relation to the overlapped region between blue spectrum and green spectrum, the preferred property is at least for absorbing of the 580-620 nm spectral range, in particular, the 570-630 nm spectral range.

Preferably the filter advantageously used for the present invention has the following optical transmitting characteristics; that is, the average transmittance within wavelength from 490 nm to 510 nm is at least 50% less, preferably less than 20%, and most preferably less than 10% than the transmittance at a wavelength from 450 nm to 550 nm, whereabout the light-absorptions of most blue-sensitive phases and green-sensitive phases overlap.

Also, in the case of longer wavelength region, the average transmittance of the filter within wavelength from 580 nm to 600 nm is at least 50% less, preferably less than 20%, and most preferably less than 10% than the transmittance of the filter at a wavelength from 550 nm to 650 nm, whereabout the light-absorptions of most green-sensitive phases and red-sensitivity phases overlap. This arrangement ensures exposing with radiation which is emitted and allowed to have spectral energy distribution comprising respective, clear-cut blue, green and red spectral ranges.

A filter according to the invention is used for an apparatus which makes a color photographic light-sensitive material to be subjected to imagewise exposing. Such a filter absorbs at least one of spectrally overlapped regions formed between spectrally different light-sensitive phases which were previously described using Figs. 2 and 4. Using the filter according to the invention readily achieves the exposing method of the invention.

According to the invention, the filter may be incorporated into an arbitrary location as far as it is on the optical path; the filter may be directly incorporated into the light source or placed near the light-sensitive material.

The exposing apparatus according to the invention is an apparatus for subjecting a color photographic light-sensitive material to imagewise exposing. The apparatus incorporates a filter which is capable of absorbing at least one of overlapped regions of a light-sensitive material which comprises a plurality of spectrally different but partly cverlapping light-sensitive phases.

In embodying the invention, at least a specific part of at least one spectrally overlapped region selected from several spectrally overlapped light-sensitive phases of the light-sensitive material, wherein the spectral region being absorbed is arbitrarily selected in compliance with the degree of the intended color purity.

In other words, any filter which is capable of absorbing at least part of spectrally overlapped region may be used in the invention. A narrower absorption range limits the effects of the invention; in contrast, a wider absorption range enhances the effects. However, too wide an absorption range may cause excessive sensitivity loss in the light-sensitive material and therefore may not be practical.

The description above refers to a light-sensitive material comprising blue-sensitive, green-sensitive and red-sensitive phases. However, the applicable light-sensitive material is not limited only to such light-sensitive material but the invention may be applied to an arbitrarily selected light-sensitive material comprising a plurality of light-sensitive phases of which spectral sensitivities are different from each other but partly overlapping by various spectral sensitization methods.

The filter useful in embodying the invention is prepared, for example, in the following manner; the filter is prepared by applying a dye, being capable of absorbing an intended spectral region, on a transparent or a glass substrate; or by deliberately evaporation-depositing a thin film onto a substrate. In using a dye as a light-absorbing member, applying the mixture of several types of dyes respectively having specific absorption ranges and applying the resultant dye mixture onto a substrate may prepare a single filter member.

According to a thin-film deposition process, a filter member which has more than two absorption ranges may be formed by evaporation-depositing a thin filtering respectively on both faces of a substrate so that each film should have an intended specific absorption range. A thin-film deposition process may be also applicable to evaporation-deposition for forming a filtering film on a part of photographing lens, or on a transparent, sheet pressing plate which is located in front of the image forming plane.

A filter in compliance with a thin film is advantageous, because of arbitrarily selective spectral absorption ranges and smaller loss in light-intensity.

Such filter member may comprise a plurality of filter elements. However, as far as the spectral sensitivities of a color photographic light-sensitive material are always unchanged, a single filter member is advantageous, since a filter member incurs a smaller light-sensitivity loss which is induced by flare, reflection by a surface phase, or the like.

The present invention is applicable to an arbitrary type of a color photographic light-sensitive material and capable of improving the color purity of an image formed by such a material.

The invention is advantageously applicable to light-sensitive silver halide color photographic materials

such as a color negative film, color print paper, direct positive color light-sensitive material, reversal color light-sensitive material and the like.

The invention is especially advantageous when applied to positive color light-sensitive materials such as a direct positive color light-sensitive material, reversal light-sensitive material and silver dye bleaching light-sensitive material.

In the case of a negative color film it is possible to incorporate a colored coupler in order to correct an undesirable spectral absorption of a dye image-forming coupler which is used both in the film and a negative color paper for printing. This is because coloring a negative color film does not cause any problems as it is a mere intermediate medium for obtaining a positive image. In this way, there is other means for color correction for a negative type light-sensitive material. Additionally, an arrangement is available for improving color purity by using a DIR (development inhibitor releasing) compound and in compliance with the inter-image effect for enhancing monochromatic colors. Application of this arrangement to both negative and positive light-sensitive materials has been studied, but has failed to attain a satisfactory level especially for a positive type color light-sensitive material. Accordingly, the present invention is especially beneficial when applied to positive color light-sensitive material. It is not much to say that there is no effective means for improving the color purity of the positive color light-sensitive material without the use of the present invention.

Incidentally, incorporating a filter may change the sensitivities of the respective color-sensitive layers and deteriorate color balance. However, such deterioration may be corrected during the course of final printing, when the invention is applied to a negative film or to exposure for a printing paper.

If the invention is applied to a direct positive photo graphic light-sensitive material, the color balance may be ensured light-sensitive material, the color balance may be ensured by incorporating another independent filter.

According to a preferable embodiment of the invention, the exposing method of the invention is advantageously applicable for exposing a color photographic light-sensitive material by scanning.

With the exposing apparatus used for performing image exposure by scanning, a color photographic light-sensitive material is exposed while the scanning is performed by sinchronizing the image on the photographic subject with the finally formed image, wherein that apparatus incorporates the filter member in the optical path.

According to another embodiment of the invention, the present invention relates to an image forming method for forming an image on a silver halide color photographic light-sensitive material which has a color-sensitive silver halide emulsion layer being capable of forming a positive image.

In particular, this method is characterized in that the light-sensitive color photographic material, which comprises a silver halide emulsion layer, and the first order differences taken on any point of the optical density range from D = 0.5 to 1.2 on the D-logE characteristic curve are larger than the 70% of the maximum first order difference value taken on the range of optical density D = 0.5 to 1.2, is subjected to imagewise exposure through a filter which is located on the optical path and has the absorption maximum in the 480 to 520 nm range and the absorption values at 450 nm and 540 nm are respectively smaller than 70% of the absorption value in the maximum absorption range, and/or the absorption maximum in the 540 to 630 nm range and the absorption values at 540 nm and 650 nm are respectively smaller than 70% of the absorption value in the maximum absorption range.

It is possible to provide an image forming method for a light-sensitive material, whereby reproduction of a pure color and excellent tone reproduction becomes possible, and whereby an original having various spectral properties can be reproduced as an image having excellent original colors.

To be more specific the preferred embodiment of the invention can be mentioned as follows.

The photographic light-sensitive material to which the image forming method of the invention is preferably applied comprises a silver halide emulsion layer containing the mixture of high sensitive and low sensitive silver halide particles. Or the silver halide emulsion layer preferable comprises at least two layers including a high-sensitive layer and a low-sensitive layer. In this case, silver halide particles contained in the low-sensitive particles, or in the low-sensitivity layer, are preferably monodispersed particles.

More preferably, an emulsion having low-sensitive particles contain multivalent metal ions such as rhodium and/or iridium.

The invention is applicable to any type of silver halide color photographic light-sensitive material as far as the material has a light-sensitive layer which is capable of forming a positive image when developed after imagewise exposure. The invention is also advantageous in a method for forming a duplicate image by using a positive silver halide color photographic light-sensitive material. The invention is also advantageously used as an image forming method of a reversal type light-sensitive material and a silver dye bleaching type light-sensitive material.

The characteristic curve of the light-sensitive silver halide emulsion layer in the light-sensitive material of the invention which is capable of forming a positive image when developed after imagewise exposure has the following features: the first order difference taken on any point within optical density range D = 0.5 to 1.2 of the D-logE characteristic curve is larger than 70% of the maximum first order difference value taken in the same optical density range.

These features are described in detail referring to the attached Fig. 21

Figs. 21(a) and 21(b) show typical characteristic curves according to the invention, wherein the plotted solid line indicates a curve obtained by the logarithm logE of exposure E expressed horizontally and the density D expressed vertically, and additionally, the first order difference dD/dlog (sometimes simply referred to as "gradient", in this specification) taken on the same characteristic curve is expressed vertically. In other words, the solid characteristic curve in the logE-D curve, while that broken line represents the logE-dD/dlogE curve. Fig. 21(a) indicates a case where the first order difference in the range of D = 0.5 to 1.2 on the characteristic curve simply increases, while in Fig. 21(b) indicates a case where there is a maximum value in the same range.

The case in Fig. 21(a) is first described. In this example, the first order difference increases from a first order difference G(0.5) at D = 0.5 to a first order difference G(1.2) at D = 1.2, and, accordingly, the first order difference G(CM) in the section is equal to G(1.2). As shown in the figure, the first order differences G(0.5) through G(1.2) (indicated by a thick broken line) are larger than 70% of the maximum value G(M) = G(1.2) (this value is assumed to be 100%).

Next, in the case shown in Fig. 21(b), there is the maximum value present in the range from G(0.5) to G(1.2), where the maximum value G(M) is the maximum value in this section. As shown in the figure, the first order differences G(0.5) through G(1.2) are larger than 70% of the maximum value G(M).

The preferred area of the gradient is above the 80% of the maximum value G(M).

According to the invention, an image is formed on a light-sensitive material which features the characteristic curve described above.

According to the image forming method of the invention, when subjecting the color photographic light-sensitive material described previously is subjected to imagewise exposing through a filter which is located on the optical path, more specifically, in the light source itself or in the photographing system, and which has the absorption maximum in the 480 to 520 nm range and the absorption values at 450 nm and 540 nm are respectively smaller than 70% of the absorption value in the maximum absorption range and/or through a filter which is similarly located and has the absorption maximum in the 540 to 630 nm range and the absorption values at 540 nm and 650 nm are respectively smaller than 70% of the absorption value in the maximum absorption range. This exposing method may, especially for the imagewise exposing, have an arrangement wherein the color photographic light-sensitive material is subjected to imagewise exposing through a filter which is incorporated into the light-source or photographing system and capable of selectively absorbing a spectrally overlapped region which a blue-sensitive layer and a green-sensitive layer of the light-sensitive material commonly have and/or a spectrally overlapped region which a green-sensitive layer and a red-sensitive layer commonly have.

The exposing method of the invention and the effects thereof are hereinunder schematically described referring to Figs. 22 and 23.

Fig. 22(a) shows the typical spectral sensitivity of a conventional light-sensitive material.

Fig. 23(a) shows one example of the spectral transmittance curve available from the filter used in the invention. Fig. 23(b) is a spectral sensitivity distribution diagram obtained by exposing the color light-sensitive material of Fig. 22(a) with a light from which an energy of a specific wavelength range has been absorbed by the filter of Fig. 23(a). As shown here, the light-sensitive material has lost sensitivity around the 500 nm and 600 nm, and is provided with sharper spectral sensitivity and features improved color definition.

Fig. 23(b) is a spectral sensitivity distribution diagram obtained by exposing the color light-sensitive material of Fig. 22(a) with a blended light of the light from which an energy of a specific wavelength range has been absorbed by the filter of Fig. 23(b) and a light not passed through the filter. The color definition characteristic here is somewhat intermediate nature between in Fig. 22(a) and that in Fig. 22(b).

According to the invention, a simple means using absorption by a filter which absorbs only a specific wavelength range remarkably improves color purity. Thus, this simple means is, by changing the property and location of the filter, capable of ensuring excellent color reproduction even with originals having various spectral characteristics, for example, the dyed good, natural materials, prints and photographs.

According to the invention, as described above, the absorption property of a filter relative to a specific wavelength is arbitrarily controlled, and, originals having various spectral characteristics are provided with excellent color reproduction.

The filter used in the invention is described in detail below.

According to the invention, the filter to be used is a filter having the absorption maximum in the spectral range of 480 to 520 nm, wherein the absorption values at 450 nm and 540 nm are respectively smaller than 70% of the maximum absorption wavelength range. The more favorably used filter has the absorption maximum in the range of 490 to 510 nm, wherein the absorption values at 450 nm and 540 nm are respectively smaller than 50% of the maximum absorption range.

Another useful filter according to the invention is a filter having the absorption maximum in the spectral range of 570 to 630 nm, wherein the absorption values at 540 nm and 650 nm are respectively smaller than 70% of the maximum absorption wavelength range. The more favorably used filter of this type has the absorption maximum in the range of 580 to 620 nm, wherein the absorption values at 540 nm and 650 nm are respectively smaller than 50% of the maximum absorption range.

Exposing through a filter of the invention prevents each of the blue-sensitive, green-sensitive and red-sensitive layers from sensitive to a light of undesirable spectral range. This arrangement ensures clear-cut sensitivity for each of the color-sensitive layers, and thus provides an image with excellent color purity. Additionally, arbitrarily incorporating such a filter into an optical path controls the degree of separating the intended sensitive spectral range from another, and ensures original images having various spectral characteristics to be duplicated with excellent color reproduction.

Next, the silver halide color photographic light-sensitive material to which the image forming method of the invention is applied is hereinunder described.

With a light-sensitive material used in embodying the present invention, the silver halide emulsion layer for forming the silver halide emulsion layers of the similar material may incorporate any silver halide possibly used for an ordinary silver halide emulsion, for example, silver bromide, silver iodo-bromide, silver iodo-chloride, silver chloro-bromide, and silver chloride. The silver halide particles included in such a silver halide emulsion may be any of those prepared in compliance with an acid process, neutral process or ammonium process. The silver halide particles may be grown at once, or may be grown after forming seed grains. The method for forming seed grains may be identical with or different from that of growing these grains. A silver halide emulsion containing such silver halide particles may be prepared either by mixing together halide ions and silver ions, or by blending either one type of ions into a solution containing the other type of ions. Additionally, the silver halide particles may be generated by simultaneously adding halide ions and silver ions into a reaction vessel step by step while monitoring the critical growing rate of silver halide crystals and controlling the pH and pAg in the vessel; this method prepares regular-configured silver halide particles having near-uniform particle size. Also, it is possible to modify the halide composition of the silver halide particles by using the conversion method once the particles have satisfactorily grown. Any silver halide emulsion thus prepared and having any particle size distribution may be used. Accordingly, the useful emulsion may be an emulsion having either larger particle size distribution (known as a multidispersed emulsion) or smaller particle size distribution (known as a monodispersed emulsion); or, the useful emulsion may be a mixture of several types of emulsions; or, the mixture of a multidispersed emulsion and a monodispersed emulsion. The concept an emulsion of "monodispersiveness" refers to an emulsion the deviation coefficient relative to the size distribution of particle contained in the emulsion is less than 22%, or, preferably, less than 15%.

As described earlier, it is preferable in embodying the present invention that the respective silver halide emulsion layers of a light-sensitive material comprise mixture of high-sensitivity and low-sensitivity particles; or, the material comprises at least two layers including high-sensitivity and low-sensitivity layers. Under such conditions, however, the low-sensitivity particles, or the low-sensitivity layers contained within a low-sensitivity layer should preferably be monodispersed silver halide particle as described above.

Additionally, such a low-sensitivity emulsion should preferably contain multi-valent metal ions, in particular, rhodium ions, and iridium ions, and, especially advantageously, rhodium ions. Incorporating these types of ions may be achieved by an arbitrary emulsion preparation technique.

The deviation coefficient is a coefficient indicating the width of particle size and defined by the following expressions.

$$\text{Deviation coefficient} = \frac{\text{Standard deviation of particle size distribution}}{\text{Average particle size}} \times 100\%$$

$$\text{Average deviation of particle size distribution} = \sqrt{\frac{\Sigma(\bar{r} - ri)^2 ni}{\Sigma ni}}$$

$$\text{Average particle size} = \frac{\Sigma niri}{\Sigma ni} = \bar{r}$$

where $\bar{r}i$ represents an average particle size of independent particles; ni, the number of the particles. Average particle size is, in the case of cubic silver halide particles, the average length of individual edges; or in the case of spherical particles or the like, the average value of individual edges, with individual particles converted to imaginary cubic particles. The expressions above hold when the individual particle sizes are represented by ri, while the number of the particles is ni.

The particle size mentioned above is determined using various methods usually used for this purpose in the photographic art.

A silver halide emulsion used to prepare the light-sensitive material of the invention may be prepared by mixing silver halide particles of several types of different average of particles. Using different average particle sizes of emulsions, in this manner, enables the resultant emulsion to be either low-sensitivity emulsions or high-sensitivity emulsions.

Additionally, in embodying the present invention the so-called core-shell type particles may be used.

In an image forming method with a direct positive silver halide photographic light-sensitive material, the light-sensitive material may incorporate internal-image type silver halide particles, wherein the surface of individual particles is not pre-fogged. The concept "the surface of individual internal-image type silver halide particles is not pre-fogged" means that the density obtained by developing, using the following surface developer A as 20°C for ten minutes, an unexposed sample having on a transparent film support an emulsion layer containing such silver halide particles at a rate of 35 mgAg/cm^2, does not exceed 0.6, or preferably, 0.4.

Surface developer A

Metal	2.5 g
ℓ-ascorbic acid	10 g
$NaBO_2 \cdot 4H_2O$	35 g
KBr	1 g

Water for preparing one liter solution

A direct positive image is, according to the invention, readily formed by subjecting a direct positive silver halide color photographic light-sensitive material to imagewise exposing (image acquisition) in compliance with a conventional method, and then, to surface developing. More specifically, the principal procedure for forming a direct positive image are as follows: first, the light-sensitive material of the invention comprising non-fogged internal-image type silver halide emulsion layers is subjected to imagewise exposing, and then, to surface developing after and/or during a fogging process for forming fogged cores by a chemical or optical operation. In this course, the fogging process may be performed by subjecting the light-sensitive material to the overall exposing or by using a compound, for example, a fogging agent, being capable of forming fogged cores. More specifically, the overall exposing may be performed by immersing a light-sensitive material, which has undergone imagewise exposing, in developer or another aqueous

solution, or moistening the material with the developer or another aqueous solution, and then, subjecting the material to the overall, uniform exposing. A light source used for this purpose is an arbitrary light as far its spectral range is contained in a light-sensitive range of a photographic light-sensitive material. The light source may be a short-duration, high-intensity light such as a flash light, or, otherwise, a week light being irradiated for an extended period. Additionally, the range of duration for overall exposing may be varied in order to ensure optimum, final positive image, depending on the type of photographic light-sensitive material, conditions of developing, type of the light source being used, and other criteria. The optimum exposure for overall exposing is preferably selected from a specific range in compliance with the light-sensitive material being used.

When subjecting a photographic light-sensitive material to the fogging process, a fogging agent being used may be selected from a wide variety of compounds. Such a fogging agent serves its intended purpose as far as being present in the course of developing. Therefore, this agent may be incorporated into a photographic structural layers (preferably, silver halide emulsion layers) in a photographic light-sensitive material other than a support, or in a developer, or in a photographic processing solution which is used prior to the developing. The amount fogging agent being used may be varied in accordance with a specific requirement.

The silver halide color photographic light-sensitive material of the invention comprises at least one light-sensitive silver halide emulsion layer. This type of light-sensitive emulsion layer may be embodied as a layer having an arbitrary light-sensitive phase. Additionally, such at least one light-sensitive emulsion layer may be incorporated into a full-cooler light-sensitive material. Accordingly, a photo graphic light-sensitive material for full color application usually comprises a blue-sensitive silver halide emulsion layer containing a yellow coupler, a green-sensitive silver halide emulsion layer containing a magenta coupler, and a red-sensitive silver halide emulsion layer containing cyan coupler.

The preferred yellow coupler, for the purpose mentioned above, is selected from known acylacetanilide couplers; a benzoylacetanilide or pivaoylacetanilide compound is advantageous.

The preferred magenta coupler, for the purpose mentioned above, is selected from known 5-pyrazolone couplers, pyrazolobenzimidazole couplers, pyrazolotriazole couplers, and open-chained acylacetanitrile couplers.

The preferred cyan coupler, for the purpose mentioned above, is selected from naphthol couplers, and phenol couplers.

The photographic light-sensitive material of the invention comprises a support provided thereof at least one light-sensitive silver halide emulsion layer, and may have a plurality of various photographic structural layers such as a filter layer, intermediate layer, protective layer, subbing layer, backing layer and anti-halation layer. The applicable coating method for these layers include a dip coating method, air-doctor coating method, extrusion coating method, slide hopper coating method and curtain flow coating method.

The support in the light-sensitive material may be either opaque or transparent depending on the application of the material.

In embodying the invention, the silver halide emulsions may, depending on the application, incorporate various photographic additives such as a wetting agent, layer-property improving agent, and coating auxiliary. Other useful photographic additives include a gelatin plasticizer, surfactant, ultraviolet absorbent, pH adjuster, anti-oxidant, anti-static agent, thickener, graininess improver, dye, mordant, whitening agent, developing velocity adjuster, and matting agent.

In corporating an ultraviolet adsorbent into the light-sensitive material is advantageous in preventing a dye image from fading due to a short-wavelength active ray; the examples of such an agent are thiazolidone, benzotriazole, acrylonitrile and benzophenone compounds.

The silver halide emulsion layers in the light-sensitive material of the invention may incorporate, protective colloid, or, gelatin, or, in compliance with a specific requirement, an appropriate gelatin derivative serving as a binder. These layers may also contain another type of hydrophilic binder. The emulsion layer and other photographic layers such as intermediate layer, protective layer, filter layer and backing layer may, in compliance with a specific requirement, contain an appropriate binder. Furthermore, the hydrophilic binder may contain an appropriate plasticizer, wetting agent or the like in compliance with a specific requirement.

The structural layers in the photographic light-sensitive material of the invention may be hardened using an appropriate hardener.

In embodying the invention, an AS (anti-stain) agent may be used. Additionally, the developing process of the invention may use an inhibitor.

EXAMPLES

The preferred examples of the present invention are hereinunder described in detail. However, it should be understood that the following examples are mere embodiments of the invention and do not limit the scope of the invention only of these examples.

Example 1

In this example Sakura Color SR Film, Professional-type S (Konica Corporation) was used as a color light-sensitive material. First, a color chart was photographed using a conventional method, and, then the original image was printed onto Sakura Solor PC Paper, Professional-type, so as to attain good neutral-color balance, thereby the chromaticity of the color chart reproduced on the print was measured. This example constituted a comparative example.

Fig. 5 shows the spectral sensitivity diagram of the light-sensitive material (film) used in this examples.

Additionally, a print was prepared in a manner identical with the mentioned above, except that in the course of image acquisition, an interference filter having a evaporation-deposited thin metal film and capable adsorbing wavelength ranges of 480 - 510 nm and 570 - 610 nm was incorporated in the front of the image acquisition lens. This technique was in compliance with the invention. The chromaticity of the color chart reproduced by this technique was measured. Fig. 7 illustrates the chromaticity of the color chart of the comparative example, above, and chromaticity measurements of the reproduced color chart.

Fig. 6 illustrates the actual spectral sensitivity distribution of an original color chart as well as the similar distribution obtained by using a filter in accordance with the technique of the invention, mentioned above.

As can be understood by referring to Fig. 7 which illustrates the results of printing, the example using exposure through a filter provides more faithful reproduction of original chromaticity, and, thus, excels in color reproduction. In Fig. 7, the symbols "x", together with broken lines, indicate the spectral characteristics of the original; solid black dots and broken lines indicated the example without a filter (comparative example); and, the circles and solid lines indicate the example with a filter (invention). It is apparent from this diagram that the chart reproduced using a filter has near-original characteristics, while the characteristics of the chart reproduced without using a filter significantly deviate from those of the original. In essence, the results obtainable from the invention are higher color purity, and excellent color reproduction.

Example 2

In this example, the technique of the invention was applied to the exposing of a color.paper, whereby the negative film of Example 1 was used for image acquisition without using the filter in Example 1. Instead, the similar filter was used when making a color print based on this negative film. Adjusting sensitivity using each of cyan, magenta and yellow color correction filters, color printing was performed for comparison of each result. Fig. 8 illustrates the results. A color paper inherently has a less significant overlap in spectral sensitivity, and allows less significant effect by the filter according to the invention; the effect is less significant when compared to that of a filter used in the course of image acquisition with a negative film. However, in spite of this limitation, the use of filter during printing, when compared with the case using no filter at all, apparently, improves color purity, resulting in improved color reproduction.

Example 3

In this example using a Gretag 3114 Color Printer (Gretag Corporation), and using a color formed on a color reversal film as an original, the original image was printed on an Ektachrome 22 Paper (Eastmen Kodak Co.), whereby the paper was exposed and subjected to a specified reversal developing process (Ektaprint R-3), thus a positive image was obtained (Sample 10, comparative example).

The filter member of the invention, prepared by evaporation-depositing thin film being capable of absorbing spectra of 476 - 518 range and 574 - 616 range, was inserted between an original and a diffusion plate, whereby printing and exposing were performed in order to obtain a positive image (Sample 11).

Instead of the filter mentioned above, a filter member according to the invention, capable of absorbing spectra of 490 - 500 range and 574 - 600 range, was used for printing and exposing to obtain a positive image (Sample 12).

Fig. 9 illustrate the spectral transmittance curve of a filter which is capable of absorbing 476 - 512 nm spectral range; Fig. 10 illustrates the spectral transmittance curve of a filter which is capable of absorbing 574 - 616 nm spectral range.

Fig. 11 illustrates a schematic diagram (retaining members for individual parts are known illustrated) of a color printer used in this example.

In Fig. 11, the light emitted from a halogen lamp is converted into a diffused light by a mirror box 3 and a diffusion plate 4, and an original is irradiated with this light. The image on the original 6 is projected on a light-sensitive material 12 by a lens and 7 and a total reflection mirror 10. The quantity of light is controlled by shutters 8, 9. Fig. 12 is the a*b* diagram illustrating the color reproducibility of the images formed in the manner mentioned above.

As can be understood from Fig. 12, when compared to sample 10 obtained without using a filter, samples 11 and 12 of the invention more faithfully comply with the coordinates of the original image. This indicates the samples of the invention attained improved color purity. Also apparent is that sample 11 having a wider absorption wavelength range is more advantageous than sample 12 having a narrower absorption wavelength range.

Example 4

In this example, a Sakura Color Chrome PC Paper (reversal paper, manufactured by Konica Corporation) was used as a color light-sensitive material, and this material was exposed using a color copying apparatus. Fig. 13(a) illustrates the spectral sensitivity distribution curve of this material.

The copying apparatus used in embodying this example has a configuration shown in Fig. 14 wherein exposing is performed by scanning. The detail of this copying apparatus is described layer.

When this copying apparatus and the light-sensitive material mentioned above, a color chart was duplicated by adjusting sensitivity using each of yellow and magenta filters. The obtained sample was designated sample A.

Additionally, another color chart was duplicated by further adjusting sensitivity by means of incorporating a filter member of the invention being capable of absorbing the spectral ranges of 476 to 510 and 574 to 516 nm, in front of the lens member within the lens unit U on the copying apparatus of Fig. 14. The duplicated color chart was designated sample B. Unlike sample A mentioned above which being a comparative sample prepared without using a filter, sample B is a sample of the invention prepared in accordance with the invention.

Additionally, using the similar copying apparatus, a color chart was duplicated. However, in this example, the apparatus incorporated a lens having a built-in three-component filter member comprising, as shown in Fig. 15(b), three filter elements L12, L13 and L14 respectively serving as yellow, magenta and cyan filters. The prepared sample was designated sample C. For the preparation, a filter according to the invention was not used. Correspondingly sample C is a comparative sample.

Fig. 13(b) illustrates the spectral sensitivity distribution curve obtainable from the filter member mentioned above according to the invention; Fig. 13(c) illustrates the spectral sensitivity distribution curve obtainable from the three-component filter member mentioned above, wherein exposure time was three times as long as normal, because exposure was performed each of the three colored light.

When preparing samples A, B and C, the aperture of the lens was kept unchanged, whereby the adjustment for exposure was ensured by synchronizing the image-scanning velocity and the relative traveling speed of the light-sensitive material, so that the gray density was maintained constant. Under this arrangement, the ratio among the scanning velocities required for preparing the respective samples A, B and C were examined based on sample A as a standard. The results are listed in the following Table 1.

Table 1

Sample	Scanning velocity
Sample A	1.0
Sample B	0.82
Sample C	0.17

Fig. 16 illustrates color charts corresponding with samples A, B and C. In Fig. 16, color chart a plotted with solid black dots and solid lines indicate the characteristics of sample A prepared without using a filter member, color chart b plotted with blank circles and solid lines indicate the characteristics of sample B prepared using a filter member, color chart c plotted with triangles and dashed lines indicate the characteristics of sample C prepared using a three component filter member comprising blue, green and red filter elements. Additionally, the chart p is the color for the original. The smaller the deviation from the color chart p of the original, the better the reproducibility.

As can be understood from Fig. 16 the color purity in the color chart a of sample A is poorer than that of the color chart p of the original. In contrast, the color purity in the color chart a of sample B, which was prepared by using a filter member of the invention, is better than that of the color chart a of sample A. The color purity in the color chart c of sample B, Which was prepared by using blue, green and red filters, is better than that of the color chart b of sample B and, however, the scanning velocity is significantly low, as apparent from Table 1. In essence, it is apparent from the results from the exposing technique incorporating the filter member of the invention is excellent in not significantly decreasing the scanning velocity (exposing speed).

The copying apparatus used in this example is hereunder described.

According to the invention, as mentioned previously, a filter is located in an arbitrary position of the optical pat within the apparatus were exposing is performed by scan-exposing. When using a mirror as a reflective system, the mirror having an evaporation-deposited filter layer may advantageously serve as a filter member. Of course, a filter member may be positioned in adjacency of a mirror, for example, in front of the mirror, or, an independent filter member may be located between a mirror and the neighboring optical member. Additionally, when incorporating a lens into an optical system, a filter member may be positioned in front or rear of the lens, or; filter member may be positioned both in front and rear of the lens; or, a filter member may be formed on the lens by means of evaporation-deposition. A filter may be inserted between a lens and another type of optical component. In short, positioning a filter on the optical path ensures the effect of the invention.

According to this example, an independent filter member was disposed in the close vicinity of a lens. Because of filter layers evaporation-deposited on the front and rear surfaces of a substrate, a single filter member of the invention is capable of absorbing the two spectral ranges previously mentioned.

The copying apparatus used in this example has a constitution which enables, by incorporating a filter member described above, this apparatus to be an exposing apparatus of the invention. As suggested previously, this apparatus has an arrangement for easy attaching/removal of each filter, and, therefore allowed to record data both of the invention and comparative example, depending on the presence/absence of the filter of the invention, or by the deployment of blue, green and red filters.

Now, by referring to Fig. 14, the general constitution of the copying apparatus is hereinunder described.

In Fig. 14 the copying apparatus 1 used in this example has an original-draft deck 2 comprising a transparent member (unshown) made of, for example, glass, for placing a subject on the upper surface thereof. The original-draft deck 2, together with a subject, may be covered, as illustrated in Fig. 14, with a cover 3. Under the original-draft deck 2 and toward one end thereof is disposed a light source 4. The light source is capable of scanning horizontally. In summary, these components as a whole constitute a scan-exposing apparatus. The light-source according to this example employs a bar-shaped halogen lamp (200 mm) with a slit width of 10 mm for allowing slit-exposing. The exit plane for light is provided with a frost glass which eliminates uneven light distribution. Under the light source 4 is disposed a first reflection mirror

5 in the oblique position, wherein the mirror 5 is capable of scanning horizontally in conjunction with the light source 4. Accordingly, being synchronous with the scanning of the light source 4, the first reflection mirror 5 and directs the light reflected by the subject to a second reflection mirror 6 disposed horizontally as opposed to the first reflection mirror 5. Under the second reflection mirror 6 is disposed a third reflection mirror 7 which inclines tin the direction exactly opposite to the second reflection mirror 6. The third reflection mirror 7 reflects, in the horizontal direction, the light reflected by the second reflection mirror 6, allowing the light to travel through a lens in a lens unit L to an exposure opening 9 disposed as opposed to the third reflection mirror 7.

The reflected light from the third reflection mirror 7 is fed into the exposure opening 9 which is formed above a transportation portion 8 for a photographic light-sensitive material F disposed, as opposed horizontally to the mirror 7, toward the other end of the apparatus. The transportation portion 8 is energized as synchronized with the light-source 4, and pressed onto the roll-shaped light-sensitive material F loaded in a magazine which is attached to the middle of one end of the apparatus, so as to move the material F and allowing it to face the exposing opening 9. The outlet of the exposure opening 9 is provided with a presser plate 9A, which together with a light-sensitive material guide plate 8A in the transportation portion 8 ensures the focul plane to be free from fluctuation, whereby the light-sensitive material F travels along the focul plane. By this arrangement, the light-sensitive material F drawn out of the magazine is directed by pairs of rollers 10, 10′ through 14, 14′, along the transportation portion. A severing blade 15 is disposed between the first pair of rollers 10, 10′ and the second pair of rollers 11, 11′. This blade 15 severs the light-sensitive material into a prescribed dimensions. Various severing methods are available; for example, while traveling in the breadthwise, the blade severs the light-sensitive material F; or, being depressed onto the surface of light-sensitive material F, the blade severs the material at once. However, the type of member does not matter, as far as it severs the light-sensitive material F. As a matter of course, the light-sensitive material F may be a plurality of independent sheets; in this case, the blade is not required.

In a photographic processing portion 16, the light-sensitive material F undergone exposing is subjected to photographic processing, whereby a positive image corresponding with the subject is formed. According to this example, the photographic processing portion 16 comprises, toward the downstream side, four processing baths i.e. a developing bath 17, bleach-fixing bath 18, and stabilizing baths 19, 20. The stabilizing baths 19 and 20 combinedly constitute a two-bath counterflow system. A light source 21 incorporated provides for exposing during developing when an internal image type silver halide light-sensitive material is used as the photographic light-sensitive material F.

The photographic light-sensitive material F undergone exposing is treated in the respective baths on the photographic processing portion 16 for specific periods, and then, transferred to a drying portion 22, where being dried, and then, ejected outside the apparatus 1.

In the figure, numeral 30 represents & shutter.

The description for this example was limited only to that has three reflection mirrors. However, the quantity of mirrors may be varied in compliance with a specific requirement. Increasing mirrors may miniaturize the exposing system.

Using a duplicate image forming apparatus having such a constitution, a color original image was duplicated.

With using such a constitution, a filter member may be formed on the mirrors 5 through 7 by evaporation-deposition. Also, a filter member may be incorporated into a lens within a lens unit. However, according to this example, as mentioned previously, the filter unit is disposed in front of the lens constituting the lens unit.

Fig. 15(a) illustrates a lens unit.

In Fig. 15(a), a front group of lenses L2, L3 are secured onto a bracket L1, by a spacer L4 and fastening ring L5, whereby these components constitute the front group lens unit. A rear group lenses, being secured by a fastening ring L8, constitute a rear group lens barrel. In Fig. 15(a), an area indicated by L9 is a room for disposing a filter member. Within the room L9 is disposed a filter member of the invention. This room also allows, for comparison, the insertion of the respective blue, green, and red filters.

Having a size readily fitting into this room L9, a filter member according to the invention is readily inserted into this room L9 without requiring any modification. On the other hand, the room L9 is provided with a slide guide L10 which enables a three component filter for comparison, which allows toning toward blue, green and red colorimetric characteristics, to take a specified position within it.

As shown in Fig. 15(b), the three component filter L11 comprises three filters respectively having a common filter factor, they are a filter L12 allowing optimum transmission of cyan, a filter L13 allowing optimum transmission of magenta, and a filter L14 allowing optimum transmission of yellow, wherein the respective filters having an equal center angle are disposed on the center of a near-square glass plate.

When aligning the division center o of the three component filter L11 with the center of the opening, the filter areas of the cyan, magenta, and yellow filters become identical with each other, allowing a resultant image to have an ordinary neutral tone. On the other hand, when enhancing cyan and yellow, while weakening magenta, the purpose is attained by shifting the division center o of the filter L11 by x horizontally and by y vertically to o'. Using the three component filter L11 in the manner mentioned above my achieve that balanced toning regarding blue, green, and red in compliance with a specific requirement. However, the effect obtainable from the filter member of the invention is more favorable than that of such a toning filter.

Example 5

In this example, Ciba Chrome II (Ilford Corporation) was used as a color light-sensitive material. Using the copying apparatus also used in Example 4, the material was exposed in a manner identical with Example 4, thereby the material was treated under its specified conditions, so as to prepare color charts. In this example, like in preceding examples, three types of color charts were prepared with the three types of samples, i.e. sample D, without using a filter member; sample E, using a filter member of the invention; and sample F, using a blue-green-red filter. Fig. 17 illustrates the results. In Fig. 17, the symbols d, e and f indicate color charts which respectively correspond with samples E, F and G. The color chart indicated by symbol p is that of an original image. The ratio among the scanning velocities required for preparing the respective samples E, F and G were examined based on sample D as a standard. The results are listed in the following Table 2.

Table 2

Sample	Scanning velocity
Sample D	1.0
Sample E	0.85
Sample F	0.23

As can be understood from the results of this example illustrated in Fig. 17, sample e of the invention is superior, in color purity, to comparative sample d which was prepared without using a filter of the invention. Comparative sample f prepared by using a blue-green-red filter, though excellent in color purity, is disadvantageous because the scanning velocity is significantly low as listed in Table 2. In essence, it is apparent the technique of the invention is outstandingly excellent, because of excellent color purity and limited loss in scanning velocity.

Example 6

This is an example where a direct positive light-sensitive material is used as a color light-sensitive material. More specifically, using a color copying apparatus Konica Color 7, and a direct positive color photographic light-sensitive material Konica Color Paper 7KC7-11P, the effect of the invention was examined. Figs. 9 and 10 illustrate the spectral transmittance curve of an absorption filter member used in this example. More specifically, this absorption filter has a spectral absorption transmittance property according to which the filter absorbs two wavelength ranges i. e. A and B in Figs. 9 and 10. In this example, two types of prints were prepared one type of sample was prepared using the filter located in front of a lens of Konica Color 7, and, for the other type, the filter was not used at all. In both cases, color correction was performed in order to allow the prints to have neutral tone.

Fig. 18 lists the results. As can be understood from the charts in Fig. 18, when compared to color chart

h (indicated by solid black dots and solid lines) prepared without using the filter obtainable by using the filter, color chart g (indicated by blank circles and solid lines) shows much higher color purity in the B, G and R (pure blue, pure green and pure red) ranges, relative to color chart of the original indicated by the symbol "x"s and broken lines.

According to this example, the loss in light intensity resulting from the insertion of the filter member corresponded with two steps with a density correction button, and did not impose the problem for practical operation of this color copying apparatus.

The results obtained by mounting the filter member onto the presser plate 9A were similar to the results mentioned above.

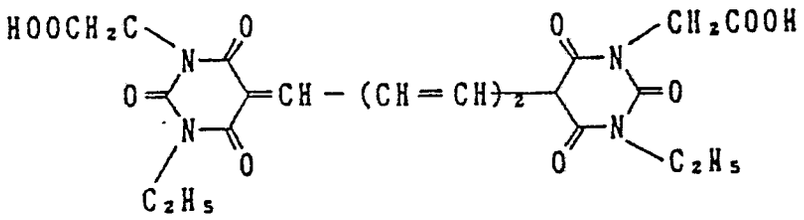
Example 7

This example was performed in a manner identical with Example 6, except that the filter in Example 6 was replaced with a filter having absorption characteristics of the invention, of which spectral transmittance curve illustrated in Fig. 19. In other words, for this example, the filter having the spectral transmittance curve B in Figs. 9 and 10 was replaced with a filter having the spectral transmittance curve C in Fig. 19. The filter having the absorption characteristic C was prepared by applying and drying gelatin, to which the following compound Q was added, onto a glass plate.

Fig. 20 illustrates color charts of the samples prepared in this example. As can be understood from the results in Fig. 20, like the preceding examples, color chart i prepared by using a filter more resembles chart p of the original, when compared to color chart j prepared without using a filter. This means the sample using the filter of the invention has wider range of the color reproducibility, whereby the effect of the invention is apparent.

The correction of exposure was effected in this example, with three steps of a density correction button, and did not cause problems in practical operation.

Compound Q



Example 8

(1) Preparation of emulsion (EM-1)

A monodispersed silver chloro-bromide emulsion (EM-1) was prepared by a method hereinafter described.

First, a silver bromide emulsion containing silver bromide particles with a mean particle diameter of 0.45 μ was obtained by simultaneously adding, in compliance with a controlled double-jet precipitation method, and aqueous solution containing ammonia and silver nitrate together with an aqueous potassium bromide solution into an aqueous solution containing ossein gelatin; during this course, the temperature of the gelatin solution was maintained at 40°C, wherein the rate of addition was controlled to 75% of the maximum rate of addition which is the threshold rate where further generation of silver halide core particles does not occur. to obtain cubic particles, the pH and the pAg of the silver bromide emulsion were controlled by adding an aqueous potassium bromide solution and an aqueous acetic acid solution. Into the obtained silver bromide emulsion containing bromide cores with mean diameter of 0.45 μ were further added, simultaneously, in compliance with a controlled double-jet precipitation method, an aqueous silver nitrate solution and an aqueous solution containing sodium chloride and potassium bromide (NaCℓ : KBr = 50 :

50, by mole ratio) in order to grow the shells onto individual cores to a mean diameter of 0.6 μ, wherein the addition rate was varied so as to be controlled to 75% of the maximum addition rate which is the threshold rate of which further generation of silver halide core particles does not occur. In the course of shell formation, the pAg of the emulsion was controlled by adding an aqueous solution containing both sodium chloride and potassium bromide into the emulsion. The obtained emulsion was washed to remove water soluble salts, thereby gelatin was added to the emulsion in order to prepare emulsion EM-1. Emulsion EM-1 was found to be a monodispersed emulsion with particles of a uniform cubic configuration and uniform size.

(2) Preparation of emulsion (EM-2)

A silver bromide emulsion containing silver bromide particles with a mean particle diameter of 0.2 μ was obtained by simultaneously adding, by means of a controlled double-jet predicipitation method, an aqueous solution containing ammonia and silver nitrate together with an aqueous solution containing potassium bromide into an aqueous solution containing ossein gelatin, while the temperature of the ossein gelatin solution was maintained at 40°C during the addition, wherein a rate of addition was varied so as be controlled to 75% of the maximum precipitation rate which is the threshold rate where further generation of silver halide core particles does not occur. The pH and pAg of the emulsion were controlled to obtain cubic particles. To grow shells to a mean diameter of 0.32 μ onto the core particles in the obtained emulsion having 0.2 μ silver bromide particles, an aqueous silver nitrate solution and an aqueous solution containing sodium chloride and potassium bromide (NaCℓ : KBr = 40 : 60, by mole ratio) were further added to the emulsion by means of a controlled double-jet precipitation method, wherein the precipitation rate was controllingly varied to be 50% of the maximum rate of the addition which is the threshold rate where further generation of silver halide core particles does not occur. The pAg of the emulsion was controlled by addition of an aqueous solution containing sodium chloride and potassium bromide. The obtained emulsion was subjected to washing with water to remove water soluble salts, whereby gelatin was added to the emulsion to complete emulsion EM-2. Emulsion EM-2 was found to be a monodispersed emulsion with particles of a uniform cubic configuration and uniform size.

(3) Preparation of emulsion (EM-3)

A silver bromide emulsion containing silver bromide particles with a mean particle of 0.22 μ was obtained by adding at a constant rate, an aqueous silver nitrate solution into an aqueous solution containing ossein gelatin and potassium bromide, while the temperature of the later solution was maintained at 50°C during the process. The configurations of the resultant particles were not uniform and the particles at a rather high proportion included twin crystals while the particles sizes were far from uniformity. Using a double-jet precipitation method, into this emulsion was simultaneously added a silver nitrate solution and a solution containing sodium chloride and potassium bromide (NaCℓ : KBr = 40 : 60, by mole ratio) in order to form shells. The amount of silver used for the shell formation accounted for 75 mole% of the total amount of silver in the emulsion. Neither configurations not sizes of the obtained particle were uniform. The obtained emulsion was washed with water to remove water soluble salts, thereby gelatin was added to the emulsion to complete Emulsion EM-3.

By using the emulsions EM-1 through EM-3 thus prepared, a sample of the present invention and a comparative sample were prepared as follows.

Sample No. 1 was prepared by sequentially forming the layers specified below, on a paper support having lamination of polyethylene on both sides.

First layer: The layer contains emulsion (EM-1), with dissolved red-spectral sensitizing dyes (D-1) and (D-2), at a rate of 0.2g/m^2, were the rate being indicated as converted into an amount of silver, emulsion (EM-2), with dissolved sensitizing dyes (D-1) and (D-2), at a rate of 0.12 g/m^2, where the rate being indicated as converted into an amount of silver, gelatin at a rate of 1.1 g/m^2. The layer also contains the following cyan coupler (C-1) at a rate of 0.35 g/m^2, the following (C-2) at a rate of 0.30 g/m^2, and dibutyl phthalate at a rate of 0.5 g/m^2.

Second layer: The layer contains at a rate of 0.8 g/m^2, 2,5-di-tert-octylhydroquinone at a rate of 0.05 g/m^2, and dioctyl phthalate at a rate of 0.07 g/m^2.

Third layer: The layer contains emulsion (EM-1), with dissolved green-spectral sensitizing dye (D-3), at a rate of 0.2 g/m^2, where the rate being indicated as converted into an amount of silver: emulsion (EM-2), with dissolved sensitizing dye (D-3), at a rate of 1.0 g/m^2, where the rate being indicated as converted into

an amount of silver; gelatin at a rate of 1.0 g/m^2. The layer also contains a magenta coupler (M-1) specified below at a rate of 0.35 g/m^2, and dioctyl phthalate at a rate of 0.35 g/m^2.

Fourth layer: The layer contains gelatin at a rate of 0.5 g/m^2, 2,5-di-tert-octylhydroquinone at a rate of 0.03 g/m^2, and dioctyl phthalate at a rate of 0.04 g/m^2.

Fifth layer: The layer contains yellow colloidal silver at a rate of 0.1 g/m^2, gelatin at a rate of 0.07 g/m^2, 2,5-di-tert-octylhydroquinone at a rate of 0.03 g/m^2, and dioctyl phthalate at a rate of 0.04 g/m^2.

Sixth layer: The layer contains gelatin at a rate of 0.5 g/m^2, 2,5-di-tert-octylhydroquinone at a rate of 0.03 g/m^2, and dioctyl phthalate at a rate of 0.4 g/m^2.

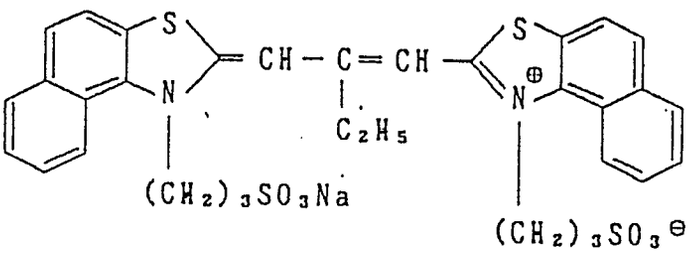
Seventh layer: The layer contains emulsion (EM-1), with dissolved blue spectral sensitizing dye (D-4), at a rate of 0.4 g/m^2, where the rate being indicated as converted into an amount of silver; emulsion (EM-2) dissolving the same sensitizing dye (D-4), at a rate of 0.2 g/m^2, where the rate being indicated as converted into an amount of silver; gelatin at a rate of 0.5 g/m^2. The layer also contains a yellow coupler (Y-1) specified below at a rate of 0.75 g/m^2; and dibutyl phthalate at a rate of 0.45 g/m^2.

Eighth layer: The layer contains gelatin at a rate of 1.5 g/m^2, an ultraviolet absorbent (UV-1) at a rate of 0.9 g/m^2, and dioctyl phthalate at a rate of 0.5 g/m^2.

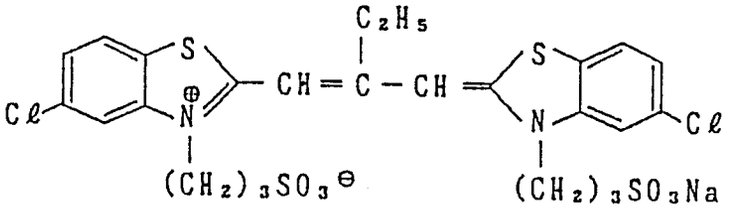
Ninth layer; The layer contains gelatin at a rate of 0.8 g/m^2.

The structure of the compounds used are as follows.

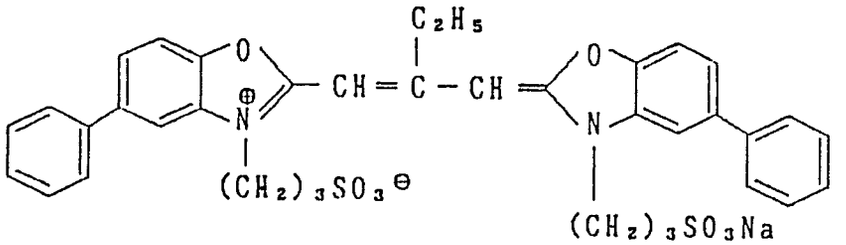
(D − 1)



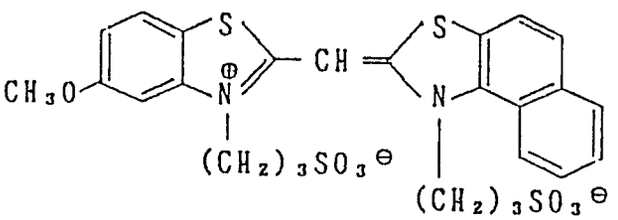
(D − 2)



(D − 3)

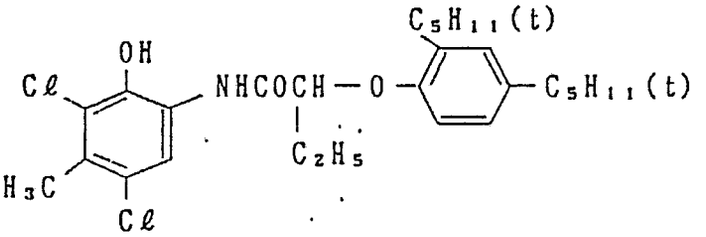


(D − 4)

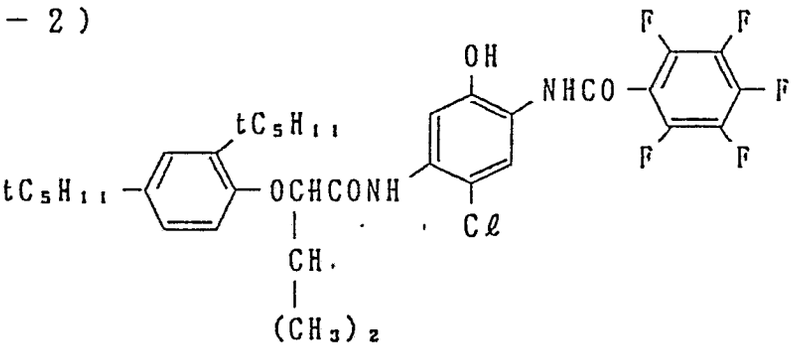


$(C_2H_5)_3N^+H$

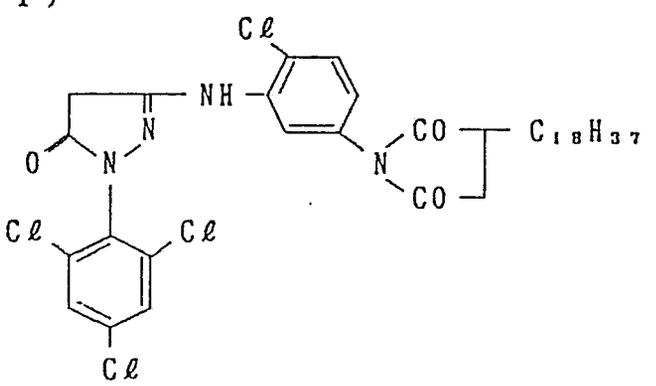
(C－1)



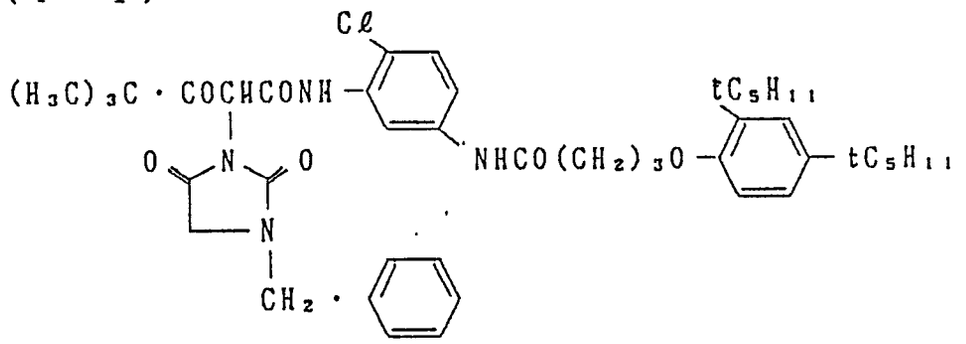
(C－2)



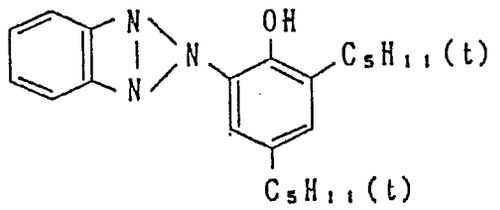
(M－1)



(Y − 1)



(UV − 1)



Sample No. 2 was prepared in a manner identical with Sample No.1 except that emulsion EM-3 was used in place of emulsion EM-3.

The obtained Sample Nos. 1 and 2 were exposed respectively through an optical wedge, thereby treated with the following processing steps.

Processing temperature	38°c
Color developing	2 min. 30 sec.
Bleach-fixing	1 min.
Stabilizing	1 min.

The minutes after the commencement of color developing, the overall surface of each sample was exposed with one lux white light for ten seconds.

The compositions of processing solutions used in the respective processing steps are as follows. The attached figures concentration of each ingredient in terms of grams/liter.

(Composition of color developer)

Potassium carbonate	28.9
Potassium sulfite	2.6
Sodium bromide	0.26
Benzyl alcohol	12.8
Ethylene glycol	3.4
Hydroxylamine sulfate	2.1
1,8-dihydroxy-3,6-dithiaoctane	0.1
Diaminopropanol tetraacetic acid	0.09
Sodium chloride	3.2
Nitrilotriacetic acid	0.4
3-methyl-4-amino-N-ethyl-N-(β-methanesulfonamithyl)-aniline sulfate	4.45
pH (adjusted by potassium hydroxide)	10.20

(Composition of bleach-fixer)

Ammonium thiosulfate	110
Sodium hydrogen sulfite	10
Ferric ammonium ethylenediaminetetraacetate	60
Diammonium ethylenediaminetertraacetate	5
Bisthiourea	2
pH (adjusted by aqueous ammonium)	6.5

(Composition of stabilizer)

Glacial acetic acid	20
Sodium acetate anhydride	5

Characteristics values obtained from each sample are listed in Table 3.

Table 3

Sample	Color-sensitive layer	Dmin	Dmax	Gmax (Density)	Gmin 0.5-1.2	Remarks
Sample No. 1	Y	0.24	2.12	1.38 (D=1.03)	1.06	Invention
	M	0.18	2.20	1.42 (D=0.85)	1.14	
	C	0.15	2.25	1.44 (D=0.96)	1.27	
Sample No. 2	Y	0.24	2.17	1.42 (D=1.10)	0.87	Comparative
	M	0.17	2.26	1.45 (D=0.97)	0.74	
	C	0.15	2.20	1.24 (D=1.01)	0.90	

In the table Dmin and Dmax represent the minimum density and the maximum density respectively; Gmax represents the maximum absolute value of a gradient, whereby (Density) represents a density to provide the maximum absolute value. $Gmin_{0.5 - 1.2}$ represents the minimum absolute value of the gradient taken on the range of image density coordination 0.5 to 1.2.

As apparent from Table 3, Sample No. 1 satisfies the criteria of the present invention; with this sample, the absolute value of gradient (hereinafter simply referred to as "gradient", which is the first order difference taken on each point) reaches the maximum (hereinafter referred to as "maximum gradient") within the range of from density 0.5 to density 1.2. On every point within the range from 0.5 to 1.2, the gradient is always greater than 70% of the maximum value. In contrast, with Sample No 2. the gradient at a density of 0.5 is smaller than 70% of the maximum gradient value; this is a comparative sample not in compliance with the invention.

Next, using Sample Nos. 1 and 2, printing was performed, then color reproduction with these samples was examined. The original used was a portrait bearing the image of Macbeth Color Checker and prepared

by using both Sakura Color SR-V100 and Sakura Color Print (both manufactured by Konica Corporation).

In performing printing, the method of imagewise exposing was varied as described below, in order to prepare both the comparative print and the print in compliance with the image forming method of the invention.

For printing, imagewise exposing was performed using irradiation of a tungsten light with a color temperature of 5200K via a lens and a total reflection mirror, whereby a yellow magenta or cyan color correction filter was used and an exposure time was deliberately selected, in order to reproduce neutral gray with a light-sensitive material of Sample No. 1. The sample was then subjected to the photographic process specified previously. The prints obtained by treating Sample Nos. 1 and 2 were designated Print A and Print B respectively.

Next, other type of prints were prepared in a manner identical with Print A and Print B, except that Sample Nos. 1 and 2 were subjected to imagewise exposing by employing an interference filter (a) having transmittance characteristics in Fig. 9, whereby the filter was disposed in front of the lens portion. This interference filter (a) has the absorption maximum around the 490 nm range and is capable of absorbing the overlapped spectral region which the blue-sensitive and green-sensitive phases of a light-sensitive material commonly have. Using such an interface filter (a), printing was performed by deliberately selecting a combination of color correction filter and exposure time in order to reproduce neutral gray. The print prepared in this manner with Sample No. 1 was designated Print C, the print similarly prepared with Sample No.2 was designated Print D.

Additionally, other types of prints were prepared in manner identical with Print C and Print D, except than an interference filter (b) having transmittance characteristics in Fig. 10 was disposed in place of interference filter (a), wherein the interference filter (b) has the absorption maximum around the 590 nm range and is capable of absorbing the overlapped spectral region which the green-sensitive and red-sensitive phases of a light-sensitive material commonly have. Using such an interference filter (b), printing was performed, whereby the print prepared in this manner with Sample No. 1 was designated Print E, the print similarly prepared based on Sample No. 2 was designated Print F.

Using L*a*b* color chips, the portions on a Macbeth checker i.e. (a) blue, (b) green, (c) red, (d) yellow, (e) magenta, and (f) cyan portions were examined respectively for each of these prepared prints i.e. Print A through Print F. The measurement results are illustrated in Figs. 24 and 25. Fig. 24 illustrates color chart p representing the original, and color charts a, c and e representing, correspondingly, Prints A, C and E obtained by using Sample No. 1. Fig. 25 illustrates color chart p representing the original, and color charts b, d and f representing, correspondingly, Prints B, D and F obtained by using Sample No. 2.

Figs. 24 and 25 demonstrate the following. As can be understood from the results in Fig. 24, where each print was based on Sample No. 1 i. e. the light-sensitive material of the invention, both color charts c and e correspondingly obtained from Print C prepared using interference filter (a) and Print E prepared using interference filter (b) more faithfully reproduce color chart p of the original. Accordingly, it is apparent that by exposing a sample of the invention using an exposing means of the invention, an excellent image representing the original image more faithfully is available, and favorable color reproducibility is attained. In contrast, as can be understood from the results in Fig. 25, where each print was based on Sample No. 2 i.e. the light-sensitive material not in compliance with the invention, either color chart b obtainable from Print B prepared without using an interference filter or color chart d obtainable from Print D prepared using interference filter (a) or color chart f obtainable from Print F prepared using interference filter (b) rather poorly reproduces color chart p of the original. In essence Prints B, D and F fail to attain significant improvement in color reproducibility.

As can be understood from the results above, especially from the results in Fig. 24, the image forming method of the invention attains excellent color reproducibility, in particular, color reproducibility relative to pure colors.

Example 9

(1) Preparation of emulsion (EM-4)

A monodispersed silver iodo-bromide emulsion (EM-4) was prepared by a method hereinafter described.

A silver iodo-bromide emulsion containing silver bromide particles with a mean particle diameter of 0.7 μ was obtained by simultaneously adding, in compliance with a controlled double-jet precipitation method, an aqueous solution containing ammonia and silver nitrate together with an solution containing potassium

bromide and potassium iodide (KBr : KJ = 96 : 4, by mole ratio) into an aqueous solution containing ossein gelatin, while the temperature of the gelatin solution was maintained at 40°C during the addition. In the course of addition, the pH and pAg of the emulsion was controlled in order to positively obtain octahedral particles. Once water soluble salts were washed out with water, gelatin was added to the emulsion. The emulsion thus prepared was designated EM-4.

(2) Preparation of emulsion (EM-5)

A silver iodo-bromide emulsion containing silver iodo-bromode particles with a mean particle diameter of 0.3 μ was obtained by simultaneously adding, in compliance with a controlled double-jet precipitation method, an aqueous solution containing ammonia and silver nitrate together with an solution containing potassium bromide and potassium iodide (KBr : KI = 96 : 4, by mole ratio) into an aqueous gelatin solution, while the temperature of the gelatin solution was maintained at 40°C during the addition. Once 1.3 amount of total silver was added to the emulsion, potassium hexachloroiridate was added at a rate of 2×10^{7} mol/molAg relative to the total amount of silver being added. During the course of addition, the pH and pAg of the emulsion were controlled in order to positively obtain octahedral particles. Once water soluble salts were washed out with water, gelatin was added to the emulsion. The emulsion thus prepared was designated EM-4. This emulsion (EM-4) was a monodispersed emulsion having particles of a uniform configuration and size.

The prepared emulsions EM-4 and EM-5 were subjected to both sulfur sensitization and gold sensitization.

Using emulsions EM-4 and EM-5 thus prepared, Sample No. 3 was prepared by sequentially forming the layers specified below, on a paper support having lamination of polyethylene on both sides.

First layer: The layer contains emulsion (EM-5), with dissolved red-spectral sensitizing dyes (D-1) and (D-2), at a rate of 0.14 g/m^2, were the rate being indicated as converted into an amount of silver, and gelatin at a rate of 0.55 g/m^2. The layer also contains the previously specified cyan coupler (C-1) at a rate of 0.18 g/m^2, the previously specified cyan coupler (C-2) at a rate of 0.15 g/m^2, and dibutyl phthalate at a rate of 0.25 g/m^2.

Second layer: The layer contains emulsion (EM-4), with dissolved red-spectral sensitizing dyes (D-1) and (D-2), at a rate of 0.24 g/m^2, where the rate being indicated as converted into an amount of silver, and gelatin at a rate of 0.55 g/m^2. The layer also contains the previously specified cyan coupler (C-1) at a rate of 0.18 g/m^2, the previously specified cyan coupler (C-2) at a rate of 0.15 g/m^2, and dibutyl phthalate at a rate of 0.25 g/m^2.

Third layer: The layer contains gelatin at a rate of 0.8 g/m^2, 2,5-di-tert-octylhydroquinone at a rate of 0.05 g/m^2, and dioctyl phthalate at a rate of 0.07 g/m^2.

Fourth layer: The layer contains emulsion (EM-5), with dissolved green-spectral sensitizing dye (D-3) at a rate of 0.12 g/m^2, where the rate being indicated as converted into an amount of silver and gelatin at a rate of 0.5 g/m^2. The layer contains the previously specified magenta coupler (M-1) at a also rate of 0.18 g/m^2, and dioctyl phthalate at a rate of 0.18 g/m^2.

Fifth layer: The layer contains emulsion (EM-4), with dissolved a green-spectral sensitizing dye (D-3), at a rate of 0.24 g/m^2, where the rate being indicated as converted into an amount of silver, and gelatin at a rate of 0.5 g/m^2. The layer also contains the previously specified magenta coupler (M-1) at a rate of 0.18 g/m^2, and dioctyl phthalate at a rate of 0.18 g/m^2.

Sixth layer: The layer contains yellow colloidal silver at a rate of 0.1 g/m^2, gelatin at a rate of 0.07 g/m^2. The layer further contains 2,5-di-tert-octylhydroquinone at a rate of 0.03 g/m^2, and dioctyl phthalate at a rate of 0.04 g/m^2.

Seventh layer: The layer contains emulsion (EM-5), with dissolved green-spectral sensitizing dye (D-4) at a rate of 0.24 g/m^2, where the rate being indicated as converted into an amount of silver, and gelatin at a rate of 0.75 g/m^2. The layer also contains the previously specified yellow coupler (Y-1) at a rate of 0.38 g/m^2, and dibutyl phthalate at a rate of 0.23 g/m^2.

Eighth layer: The layer contains emulsion (EM-4), with dissolved a green-spectral sensitizing dye (D-4), at a rate of 0.4 g/m^2, where the rate being indicated as converted into an amount of silver, and gelatin at a rate of 0.75 g/m^2. The layer also contains the previously specified yellow coupler (Y-1) at a rate of 0.38 g/m^2, and dibutyl phthalate at a rate of 0.23 g/m^2.

Ninth layer: The layer contains gelatin at a rate of 1.5 g/m^2, an ultraviolet absorbent (UV-1) at a rate of

0.9 g/m², and dioctyl phthalate at a rate of 0.5 g/m².

Tenth layer: The layer contains gelatin at a rate of 0.8 g/m².

Sample No.3 thus prepared was exposed through an optical wedge, thereby treated with the following processing steps.

Processing

(1) Primary developing	38°C	1 min 15 sec
(2) Washing	38°C	
(3) Secondary developing	Higher than 200 CMS	
(4) Color developing	38°C	1 min 30 sec
(5) Washing	38°C	
(6) Bleach-fixing	38°C	2 min
(7) Washing	38°C	1 min 45 sec
(8) Drying	75°C	1 min

[Composition of primary developer]

Sodium hexametaphosphate	2.0 g
1-phenyl-3-pyrazolidone	0.5 g
Sodium sulfite anhydride	50.0 g
Hydroquinone	6.0 g
Sodium carbonate anhydride	30.0 g
Potassium bromide	0.7 g
Sodium thiocyanate	1.5 g
6-nitrobenzimidazole nitrate	0.8 g
Potassium iodide	0.01 g

Water was added to complete 1.0 liter solution.

[Composition of color developer]

Benzyl alcohol	6.0 mℓ
Sodium hexametaphosphate	2.0 g
Sodium sulfate anhydride	5.0 g
Sodium secondary phosphate	40.0 g
Potassium bromide	0.25 g
Potassium iodide	0.01 g
Sodium hydroxide	6.5 g
Ethylenediamine sulfate	7.8 g
Hydroxylamine sulfate	2.2 g
3-methyl-4-amino-N-ethyl-N-(β-methanesulfonamidethyl)-aniline sulfate	5.0 g

Water was added to complete 1.0 liter solution

[Composition of bleach-fixer]

Ammonium thiosulfate	100 g
Ferric ammonium ethylenediaminetetraacetate	60.0 g
Diammonium ethylenediaminetetraacetate	5.0 g
Sodium sulfite anhydride	2.7 g
Thiourea	1.0 g

Water was added to complete one liter solution.

Table 4 lists the characteristic values obtainable from Sample No. 3.

Table 4

	Dmin	Dmax	Gmax (Density)	Gmin 0.5-1.2	Remarks
Y	0.24	2.24	1.25 (1.24)	0.91	Invention
M	0.19	2.24	1.31 (1.01)	1.02	
O	0.15	2.27	1.41 (0.84)	1.15	

As can be understood from Table 4, Sample 3 satisfies the criteria for a light-sensitive material of the invention; at any point, the gradient in a density range from 0.5 to 1.5 is greater than 70% of the maximum gradient value.

Next, using Sample No. 3, printing was performed, and then, color reproduction and tone reproduction were examined. The original used was identical with that of Example 1. a print of the original was subjected to imagewise exposing using irradiation of a tungsten light with a color temperature of 5200K via a lens and a total reflection mirror, whereby a yellow, magenta or cyan color correction filter was used and an exposure time was deliberately selected, in order to reproduce neutral gray with a light-sensitive material of Sample No.3. This material was then subjected to the photographic process specified previously. The print obtained by treating Sample No.3 was designated Print G.

Next, another type of the print was prepared in a manner identical with Print G above, except that light-sensitive material of Sample No. 3 was subjected to imagewise explosing by disposing both a dye filter (c) having transmittance characteristics in Fig. 19 (center of absorption maximum is around 600 nm) and the previously specified interference filter (a), whereby printing was performed by deliberately selecting a combination of color correction filter and exposure time in order to reproduce neutral gray. Using L*a*b* color chips, the portions on a reproduced Macbeth checker i.e. (a) blue, (b) green, (c) red, (d) yellow (e) magenta, and (f) cyan portions were examined respectively for each of prepared prints i.e. Print G and Print H. The measurement results are illustrated in Fig. 26.

Fig. 26 demonstrates that when compared to Print G prepared without using a filter of the invention, Print H prepared both interference filter (a) and dye filter (c) shows more faithful color reproduction of the original.

Claims

1. A method for exposing a light-sensitive photographic material comprising at least two spectrally different but partly overlapping light-sensitive phases, comprising a step of exposing said photographic material to light through a filter which absorbs at least a part of said spectrally overlapped region.

2. The method of claim 1, wherein said light-sensitive material comprises blue-sensitive, green-sensitive and red-sensitive phases wherein the spectrally sensitive region of either one of blue-sensitive and green-sensitive phases or green-sensitive and red-sensitive phases overlaps.

3. The method of claim 1, wherein said light-sensitive phases are silver halide light-sensitive layers.

4. The method of claim 2, wherein said light-sensitive phases are silver halide light-sensitive layers.

5. The method of claim 4, wherein said filter has light absorption in the spectral range of 490 through 510 nm and/or 580 to 620 nm.

6. The method of claim 4, wherein said filter has light absorption in the spectral range of 480 through 520 nm and/or 570 to 630 nm.

7. The method of claim 4, wherein the exposure is carried out by scanning of a light beam.

8. The method of claim 4, wherein said light-sensitive material is a silver halide photographic material comprising a direct positive emulsion, a silver halide photographic material for reversal process and a silver halide photographic material for silver dye bleaching process.

9. The method of claim 5, wherein said filter has a absorption maximum within the spectral wavelength range between 490 nm and 510 nm and/or between 580 and 620 nm.

10. The method of claim 9, wherein the absorbance of said filter at 450 nm and 540 nm is not more than 70 % as much as that at the maximum absorption wavelength within 480 to 520 nm, and/or the absorbance of said filter at 540 nm and 650 nm is not more than 70 % as much as that at the maximum absorption wavelength within 570 to 630 nm.

11. The method of claim 10, wherein said light-sensitive material is a silver halide photographic material comprising a direct positive emulsion, a silver halide photographic material for reversal process and a silver halide photographic material for silver dye bleaching process.

12. The method of claim 11, wherein the exposure is carried out by scanning of a light beam.

13. The method of claim 11, wherein said light-sensitive material comprises a light-sensitive silver halide emulsion layer of which differential coefficient value in a D-logE characteristic curve of said emulsion layer at a density of 0.5 through 1.2 is not less than 70 % as much as the maximum differential coefficient value thereof within the same density range.

14. The method of claim 6, wherein said filter has absorption maximum within the spectral wavelength range of 480 to 520 nm and/or 570 to 630 nm.

15. The method of claim 14, wherein the absorbance of said filter at 450 nm and 540 nm is not more than 70 % as much as that at the maximum absorption wavelength within 480 to 520 nm, and/or the absorbance of said filter at 540 nm and 650 nm is not more than 70 % as much as that at the maximum absorption wavelength within 570 to 630 nm.

16. The method of claim 15, wherein said light-sensitive material is a silver halide photographic material comprising a direct positive emulsion, a silver halide photographic material for reversal process and a silver halide photographic material for silver dye bleaching process.

17. The method of claim 16, wherein the exposure is carried out by scanning of a light beam.

18. The method of claim 16, wherein said light-sensitive material comprises a light-sensitive silver halide emulsion layer of which differential coefficient value in a D-logE characteristic curve of said emulsion layer at a density of 0.5 through 1.2 is not less than 70 % as much as the maximum differential coefficient value thereof within the same density range.

19. A filter for light exposure of a light-sensitive photographic material comprising at least two spectrally different but partly overrapping light-sensitive phases, characterized in that said fiter absorbs at least a part of said spectrally overlapped region of said light-sensitive phases.

20. A photographic apparatus for carrying out imagewise exposure to a light-sensitive photographic material having at least two spectrally different but partly overlapping light-sensitive phases, comprising a filter which absorbs at least a part of said spectrally overlapped region.

FIG. 1

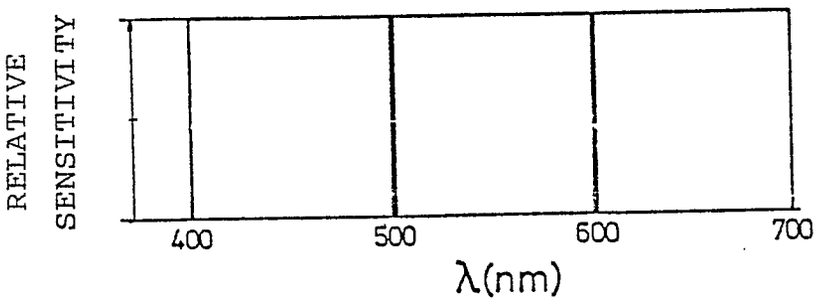


FIG. 2

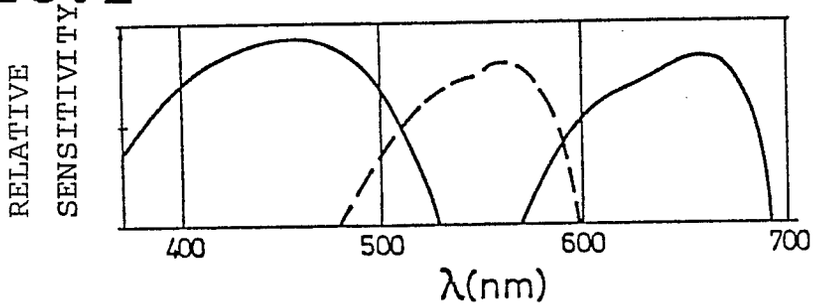


FIG. 3

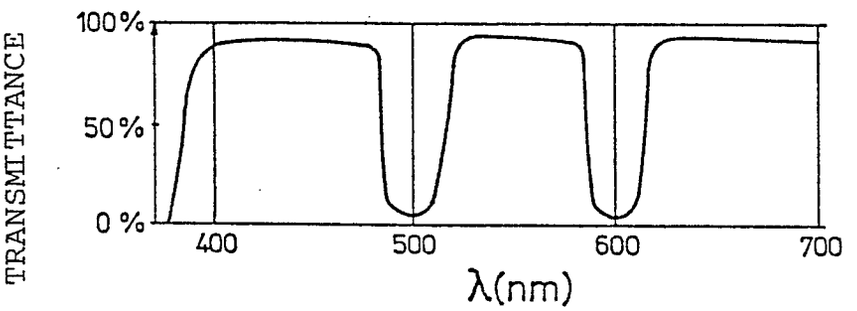


FIG. 4

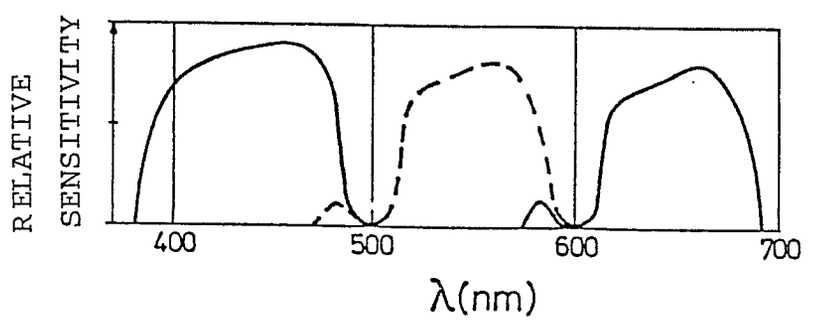


FIG.5

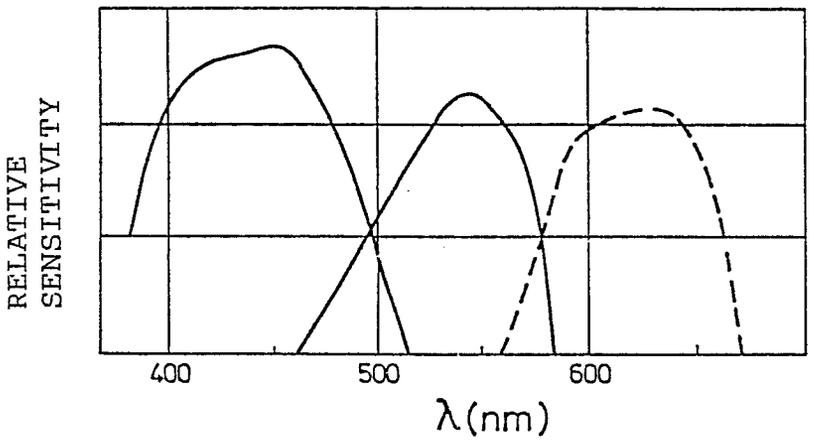

RELATIVE SENSITIVITY
400
500
600
λ(nm)

FIG.6

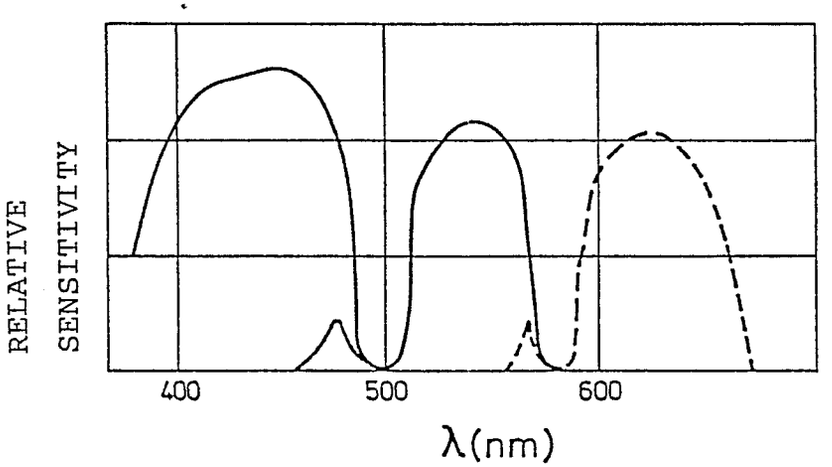

RELATIVE SENSITIVITY
400
500
600
λ(nm)

FIG.7

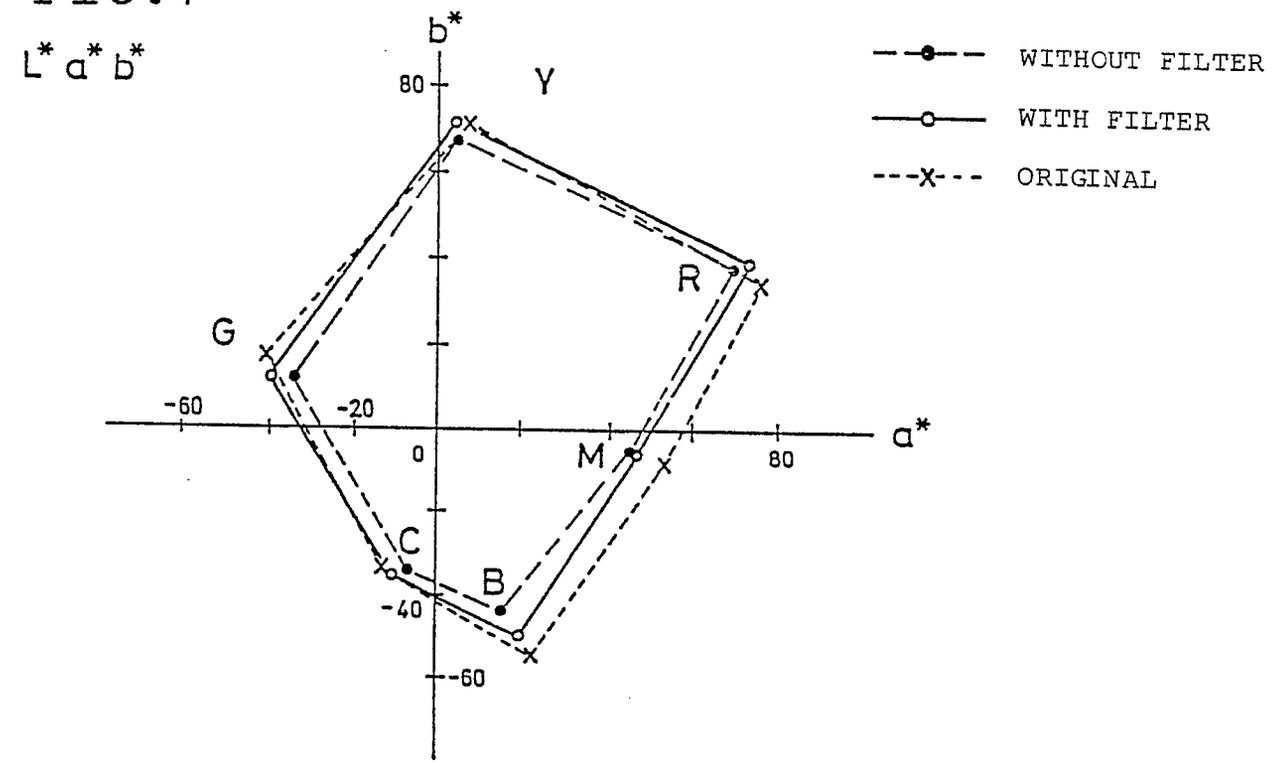

L* a* b*
b*
80
Y
R
G
-60
-20
0
M
80
a*
C
B
-40
-60
WITHOUT FILTER
WITH FILTER
ORIGINAL

FIG.8

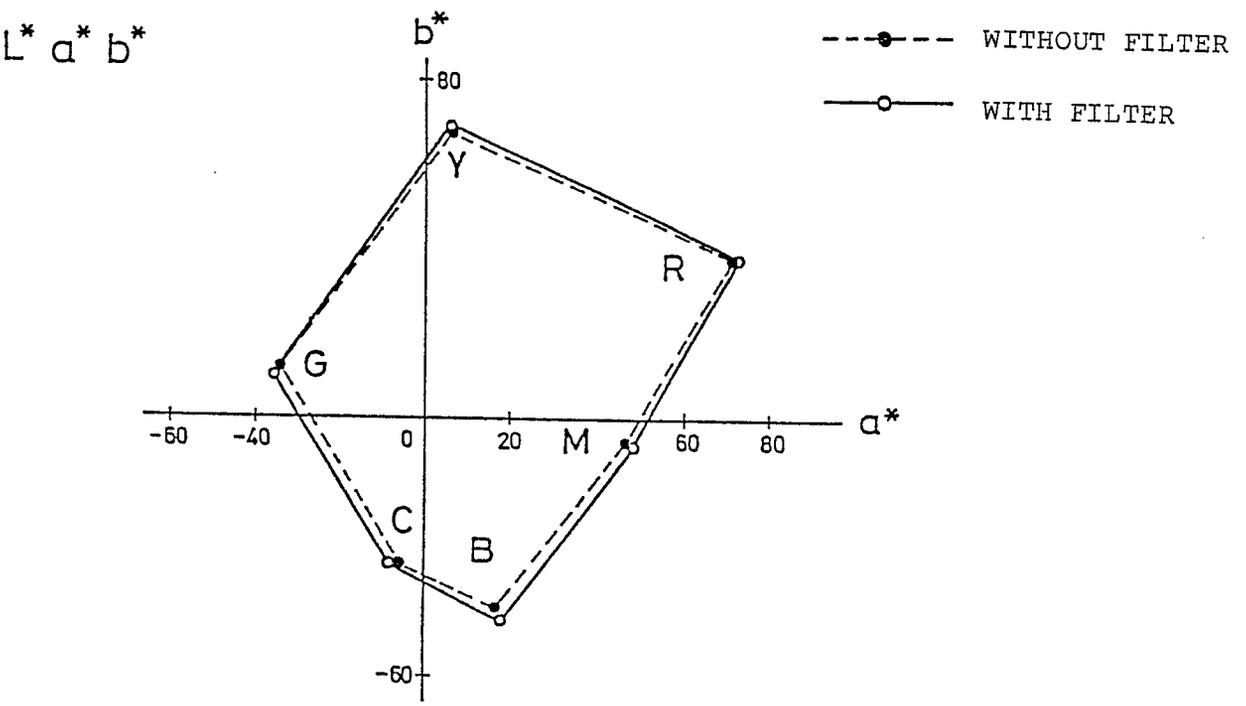

L* a* b*
b*
80
Y
R
G
-60
-40
0
20
M
60
80
a*
C
B
-60
WITHOUT FILTER
WITH FILTER

FIG.9

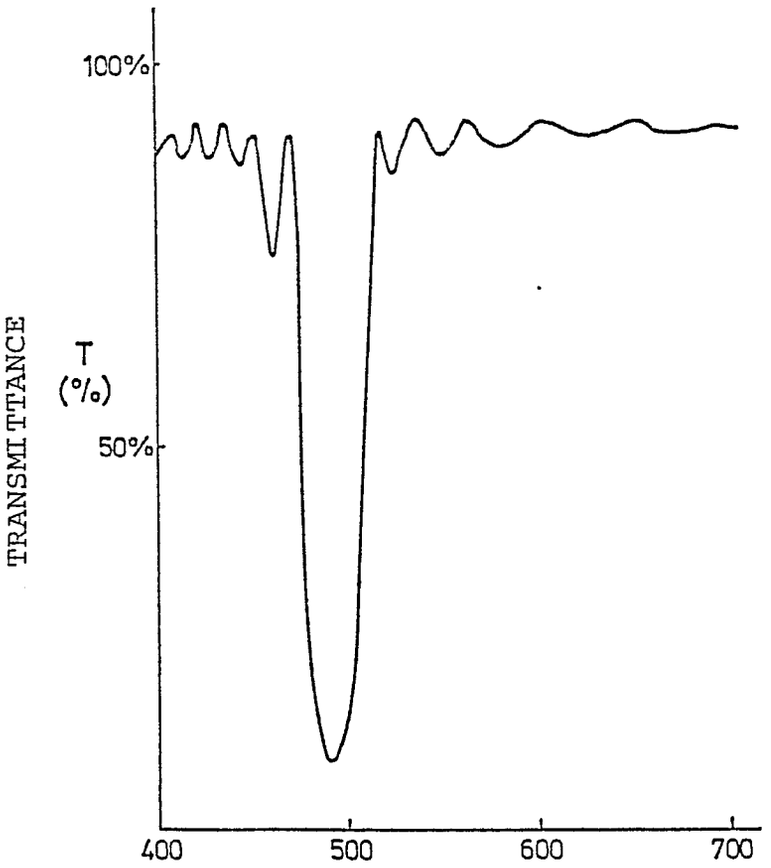

100%
T
(%)
50%
TRANSMITTANCE
400
500
600
700
λ(nm)

FIG.10

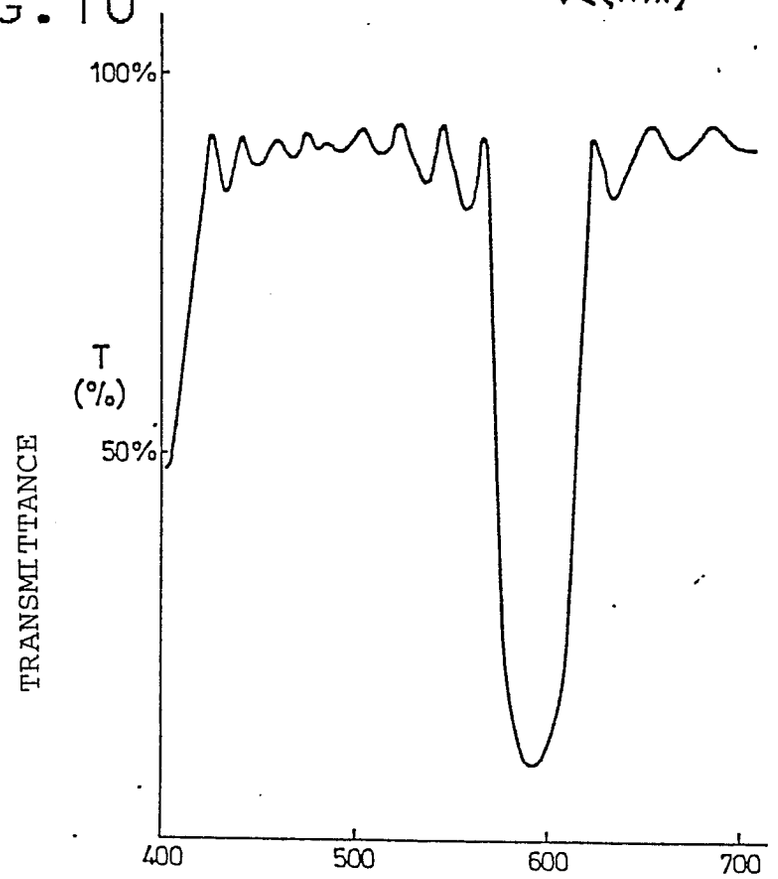

100%
T
(%)
50%
TRANSMITTANCE
400
500
600
700
WAVE LENGTH λ (nm)

FIG.11

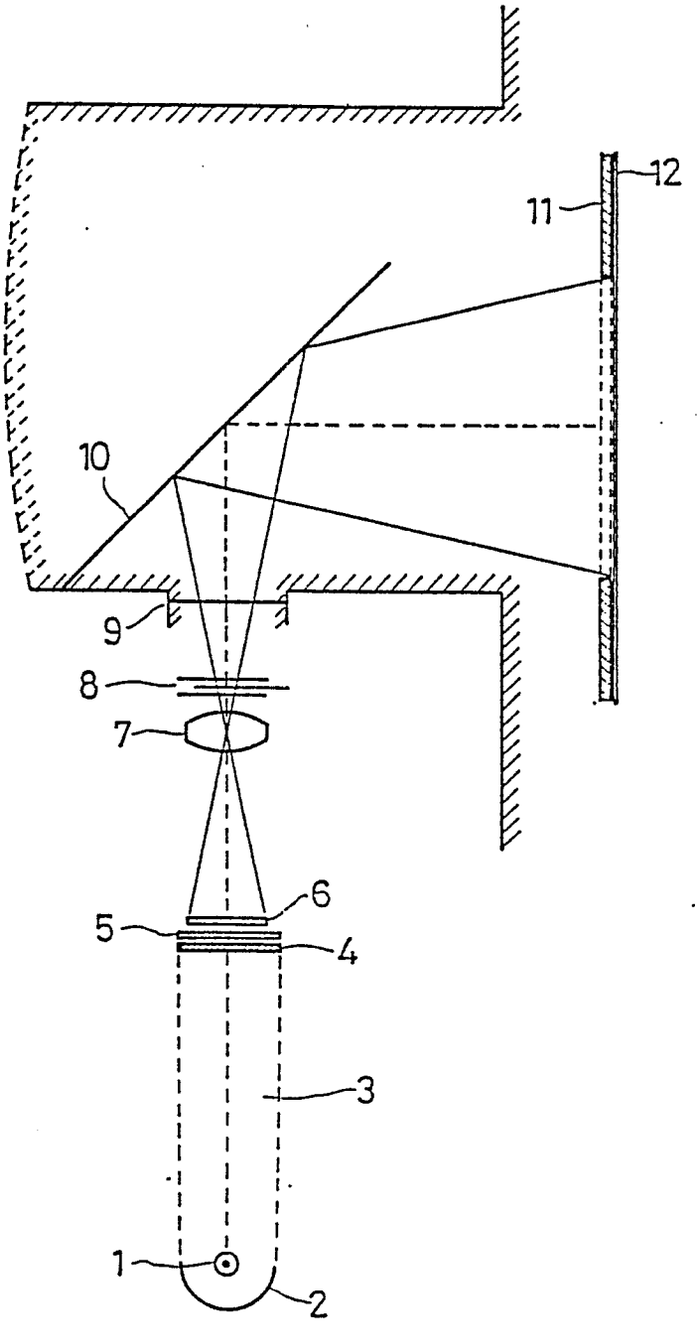


FIG.12

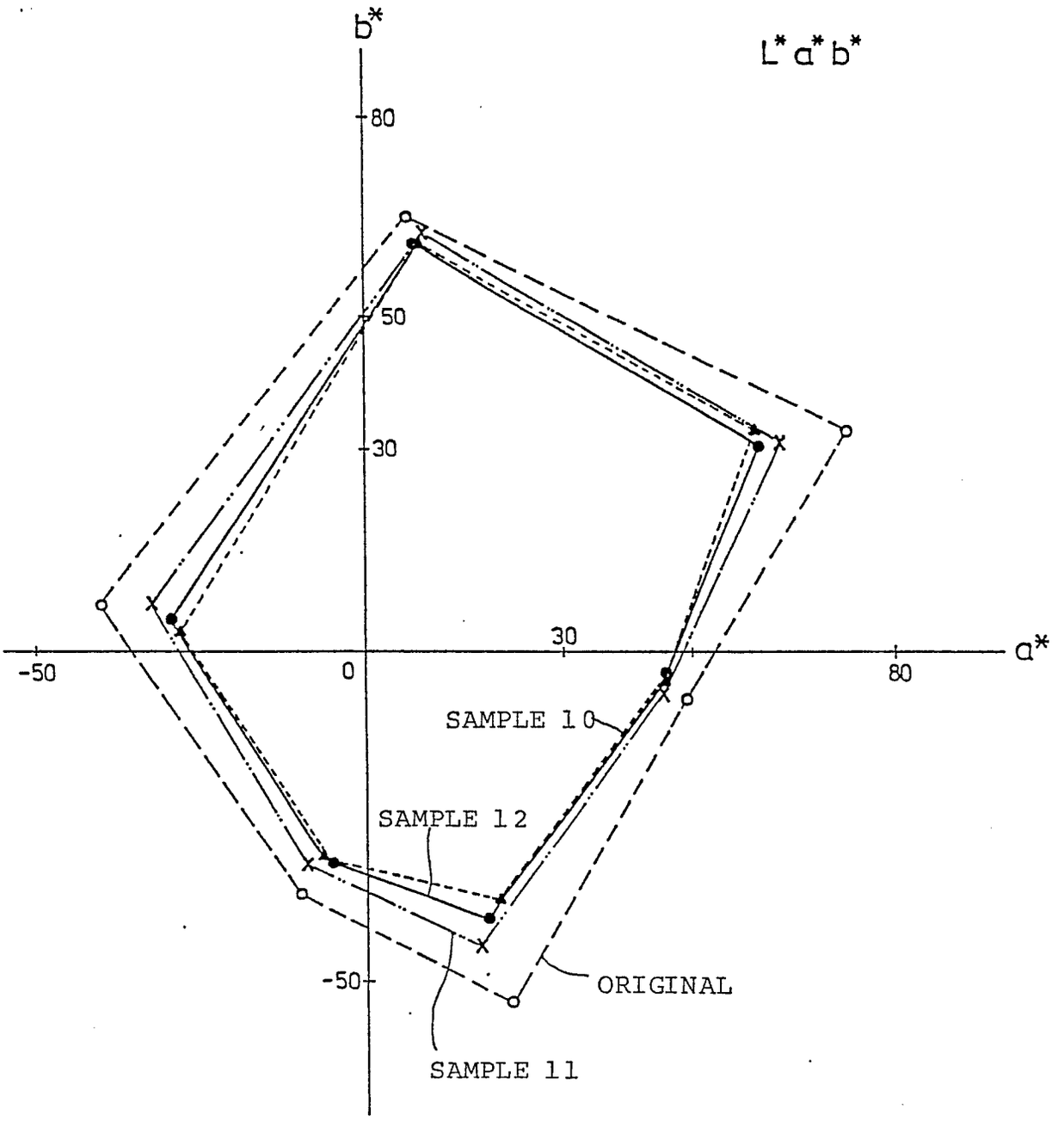

b*
L*a*b*
80
50
30
-50
0
30
80
a*
SAMPLE 10
SAMPLE 12
-50
ORIGINAL
SAMPLE 11

FIG.13(a) WITOUT FILTER

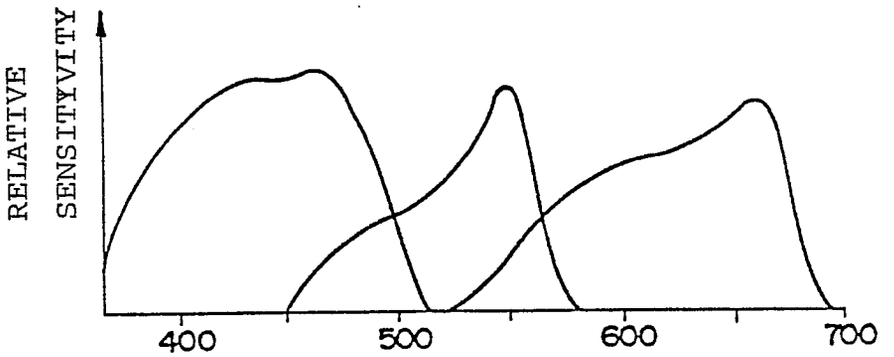


FIG.13(b)

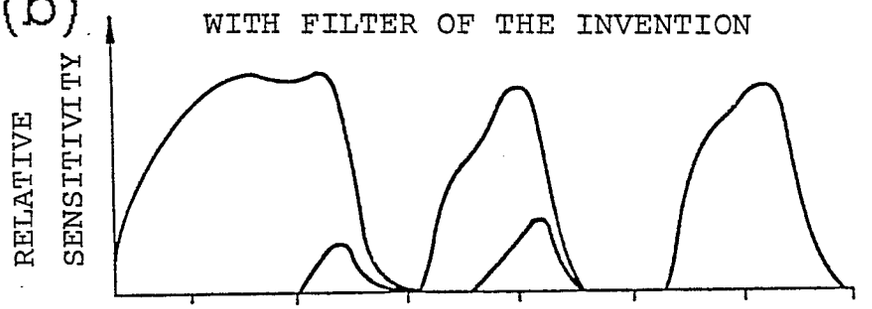


FIG.13(c)

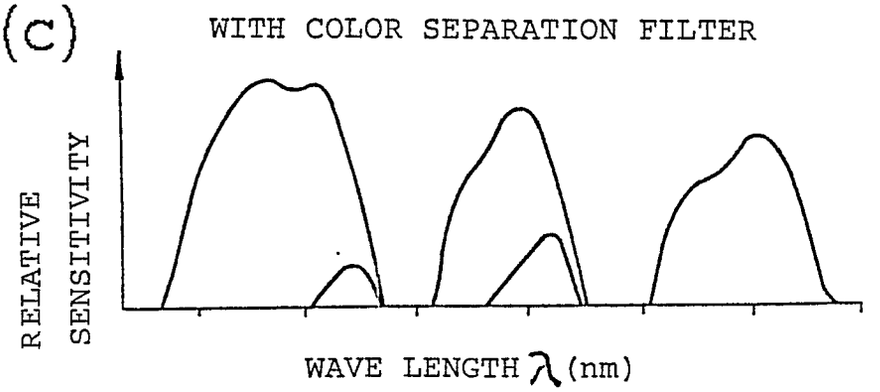


FIG. 14

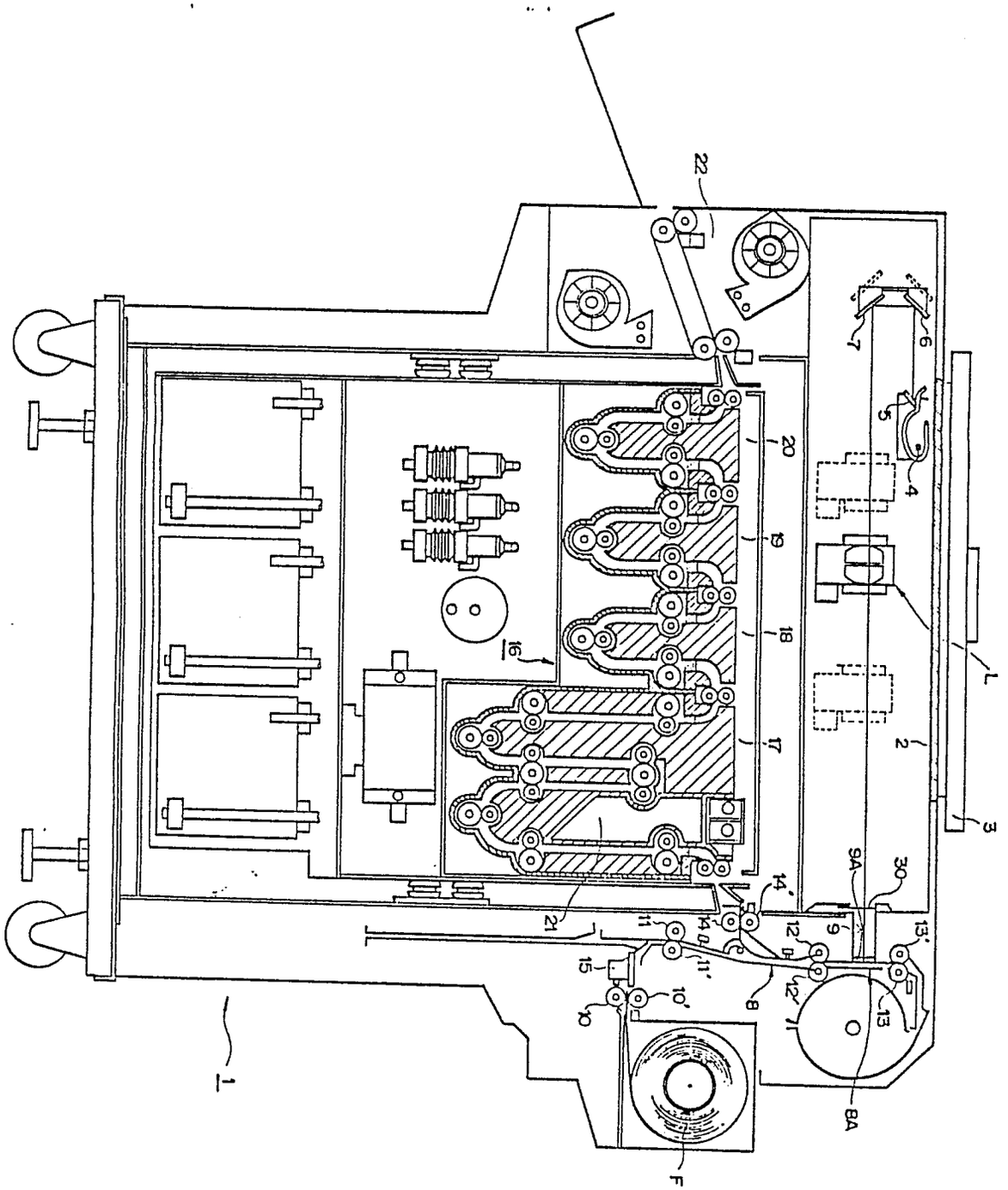

22
7
6
5
4
20
19
18
17
16
L
2
3
21
11
14
12
9
9A
30
13'
15
11'
10'
10
8
12'
13
8A
1
F

FIG.15(a)

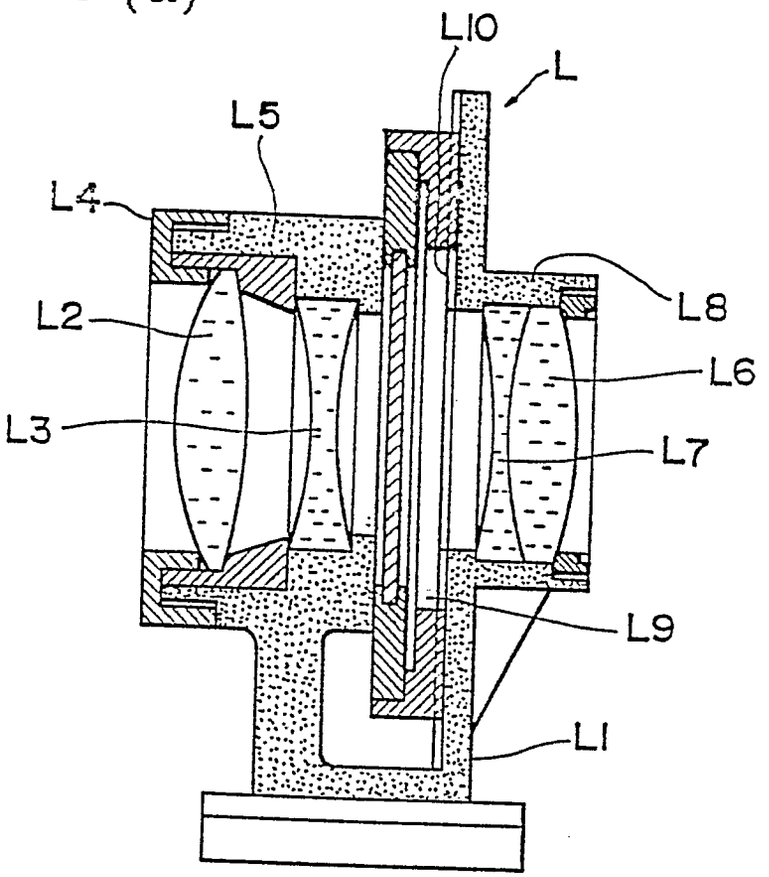


FIG.15(b)

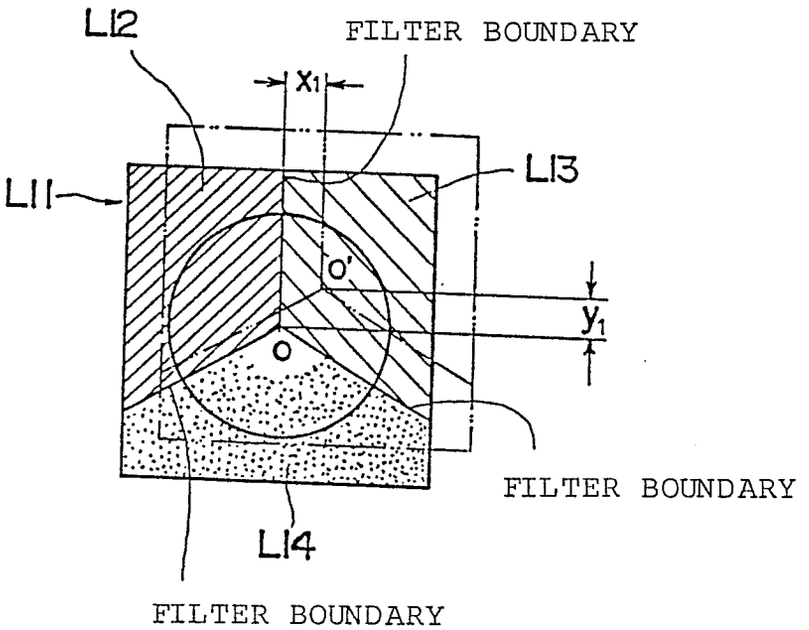


FIG.16

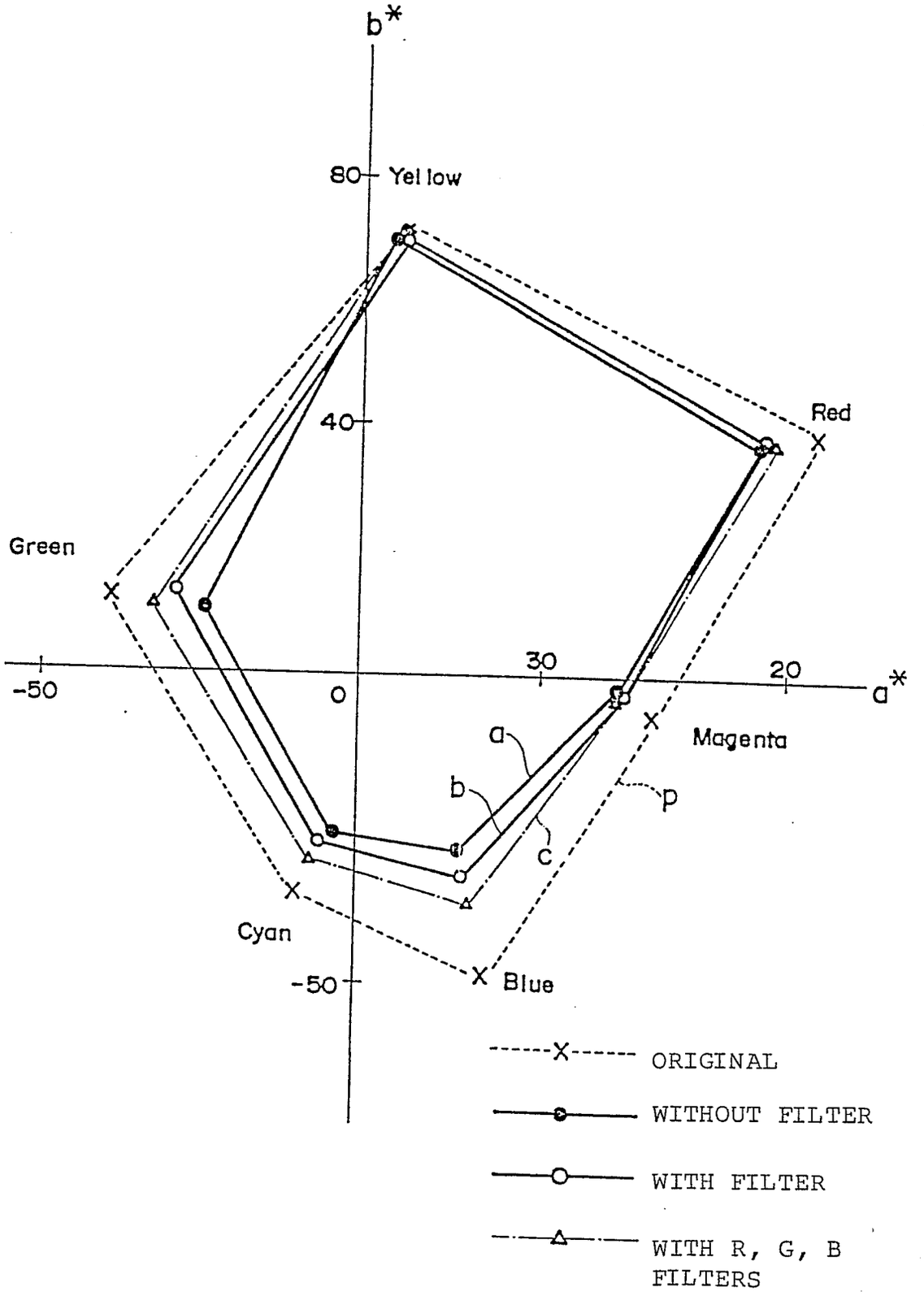

b*
80
Yellow
40
Red
Green
-50
0
30
20
a*
Magenta
a
b
c
p
Cyan
-50
Blue
ORIGINAL
WITHOUT FILTER
WITH FILTER
WITH R, G, B FILTERS

FIG.17

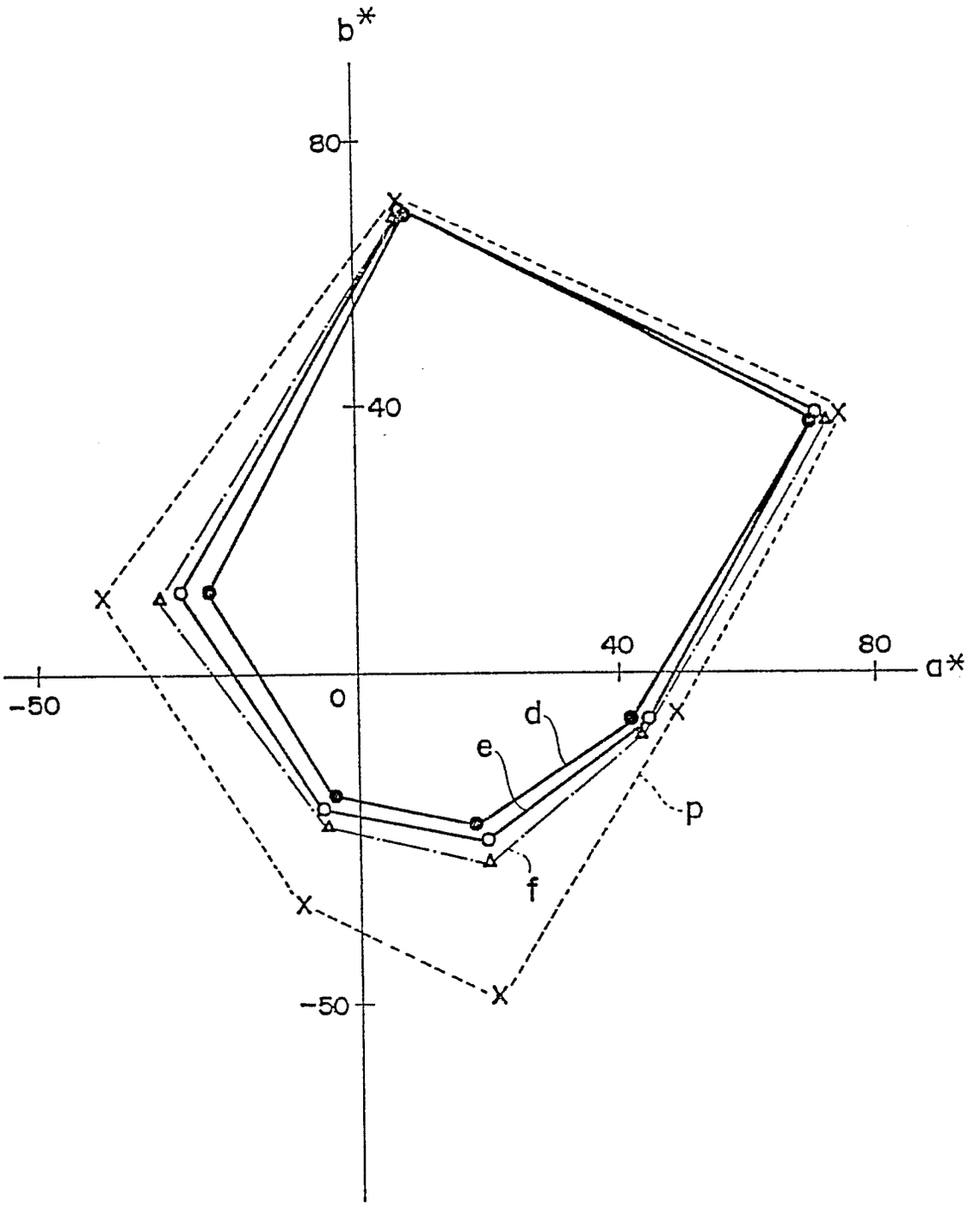


FIG.18

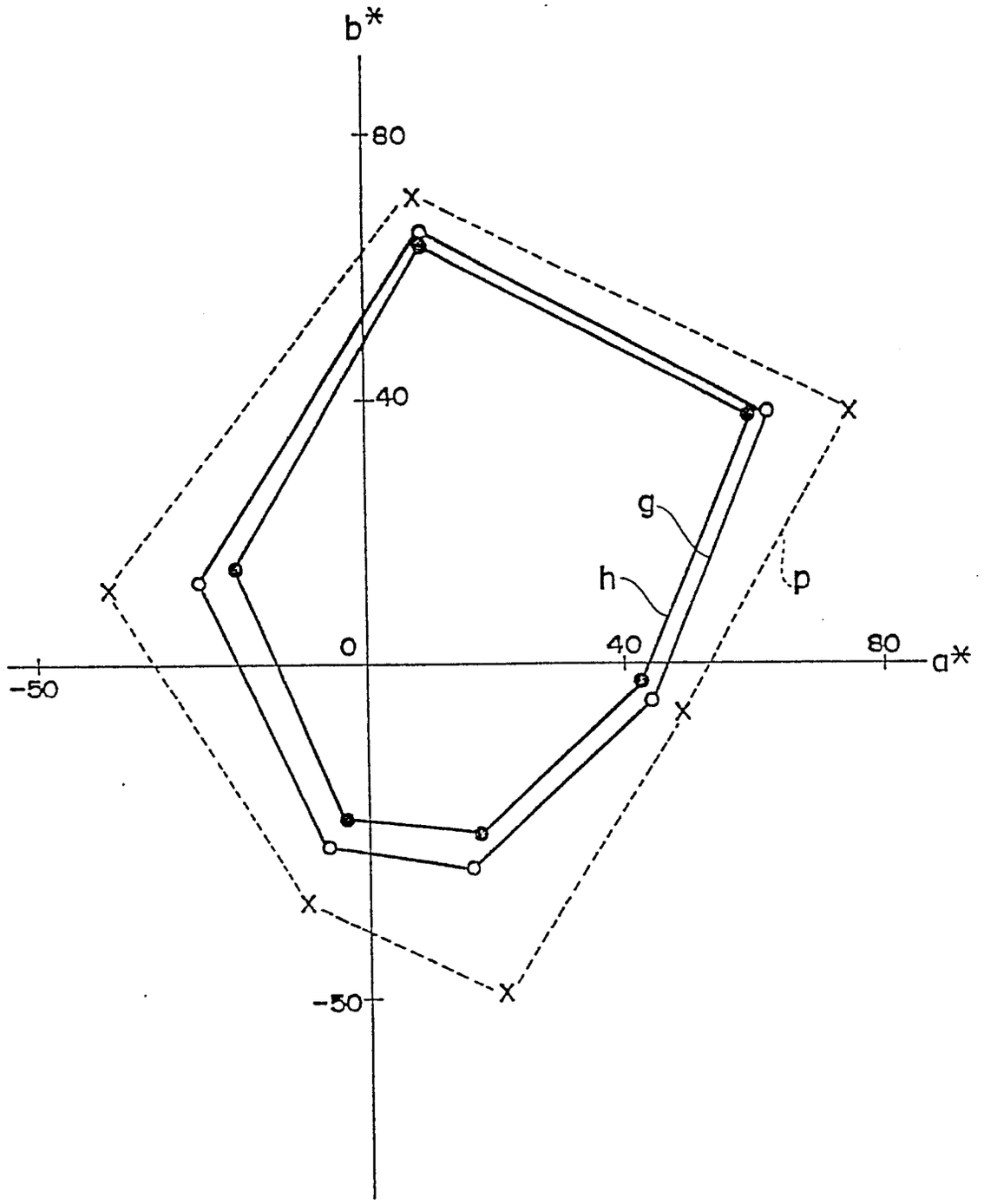


FIG.19

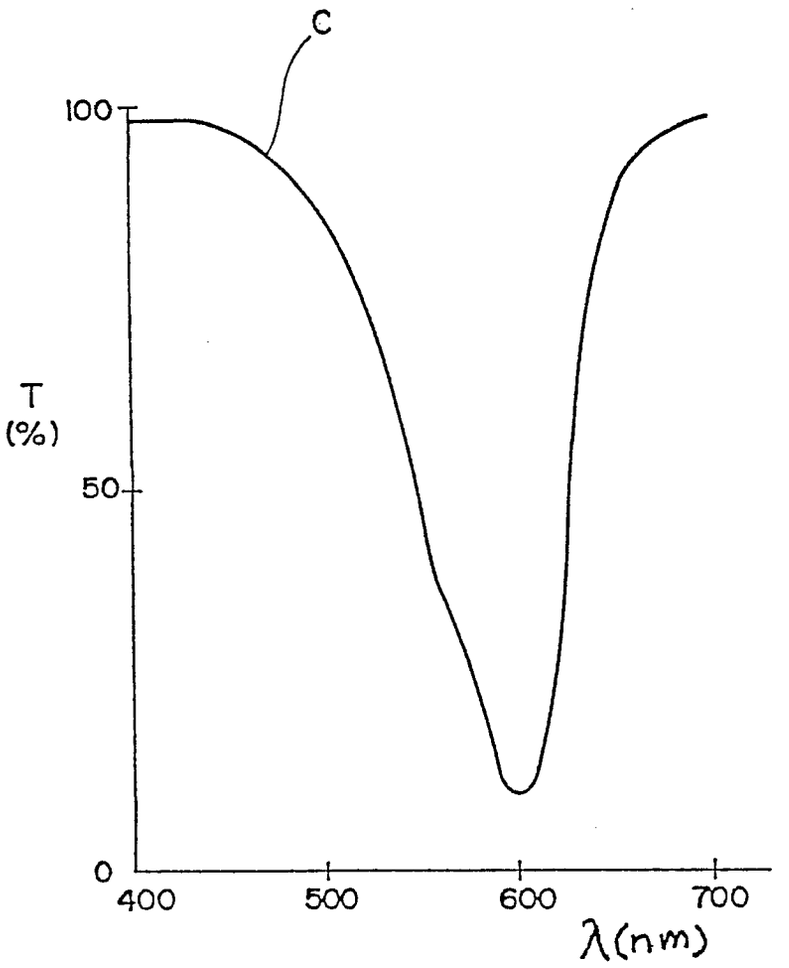
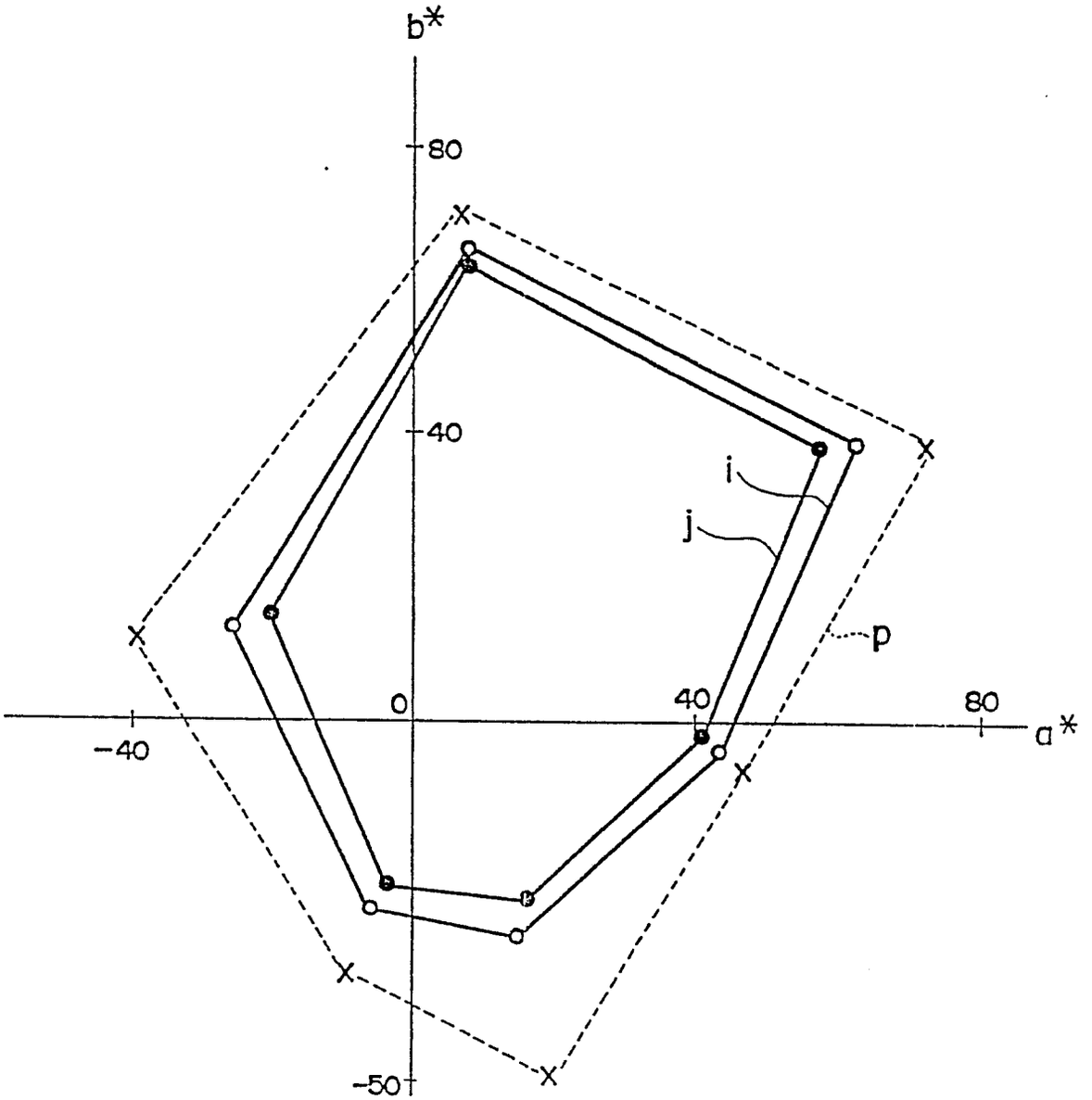


FIG.20



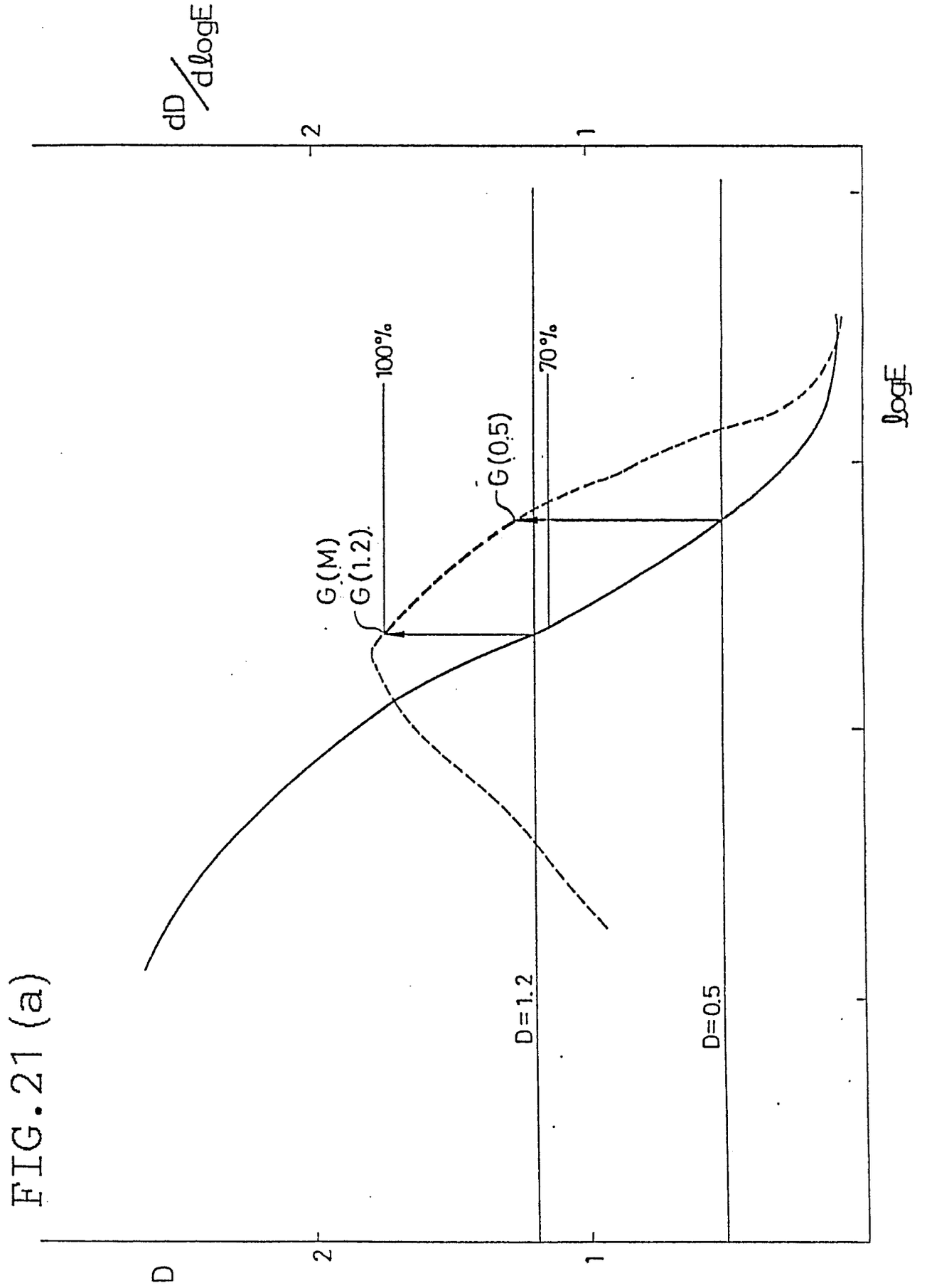


FIG. 21 (a)

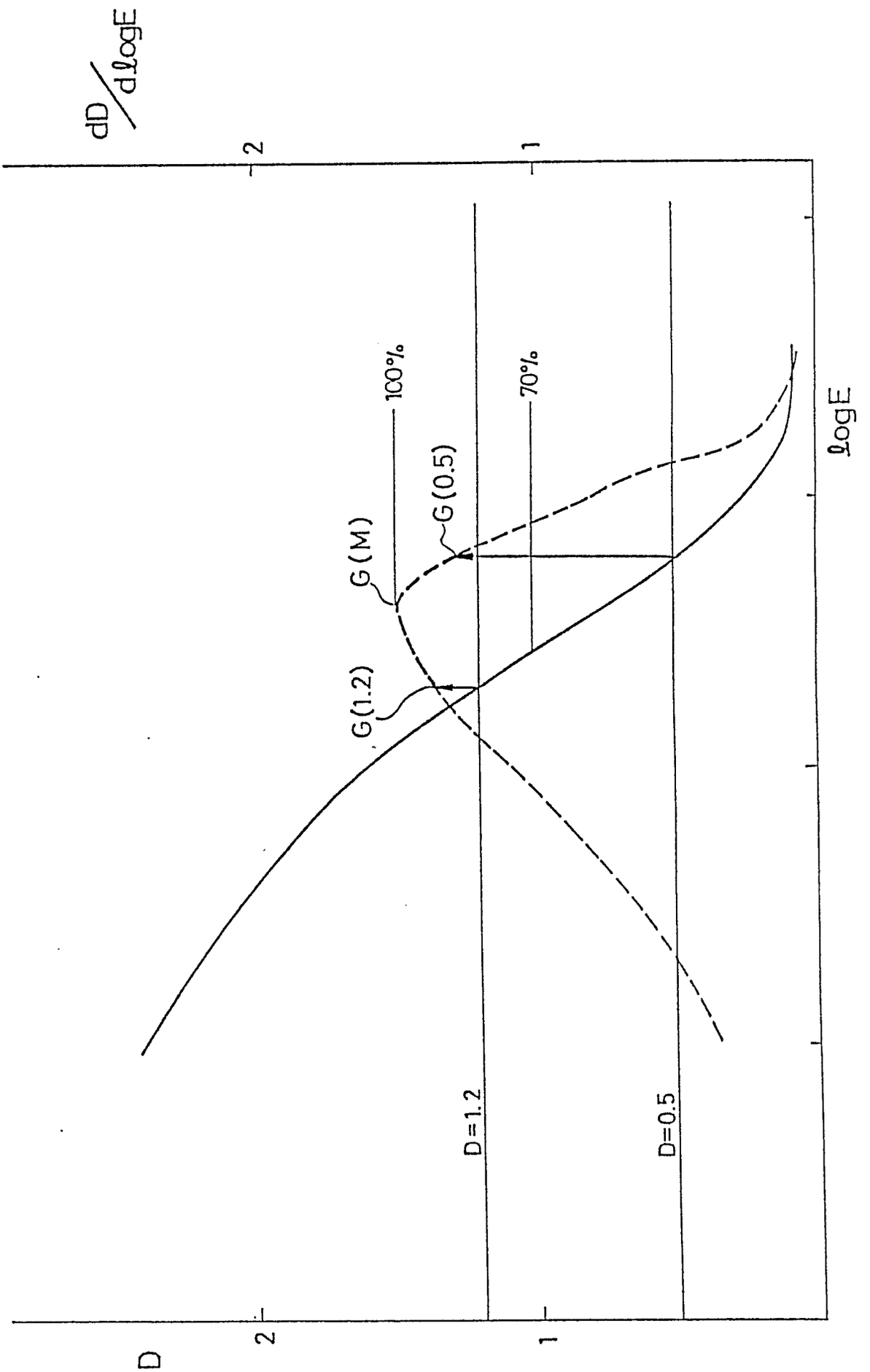


FIG. 21 (b)

FIG. 22 (a)

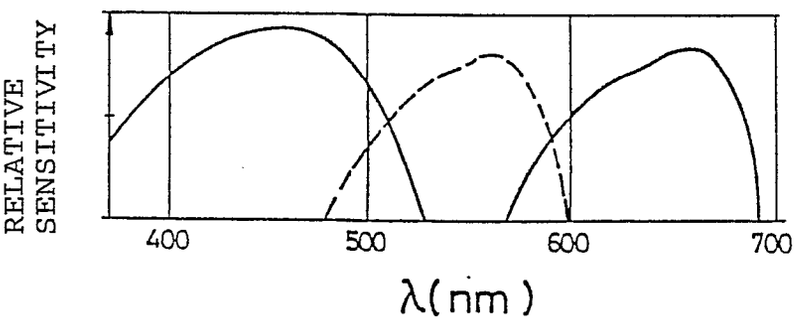


FIG. 22 (b)

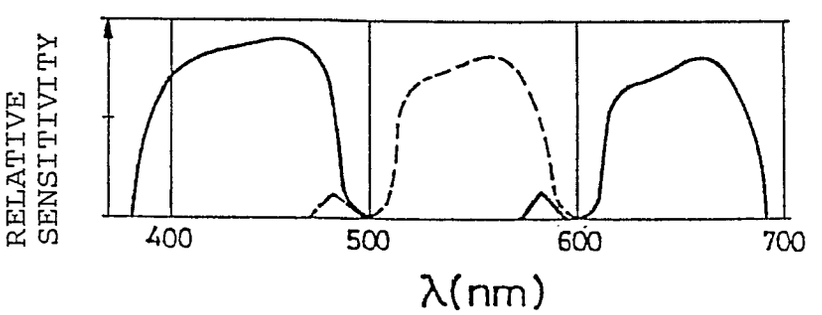


FIG.23 (a)

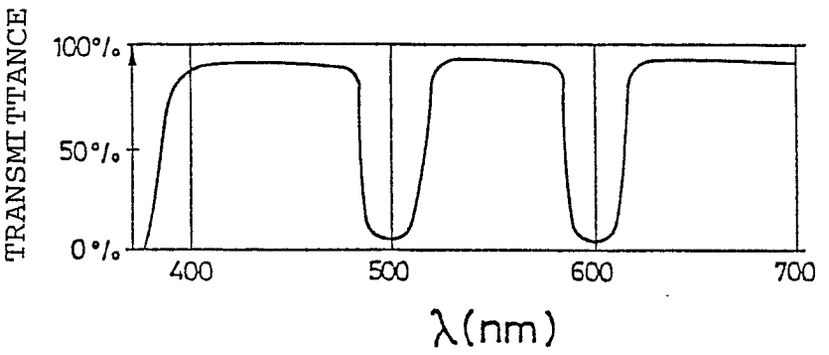


FIG.23 (b)

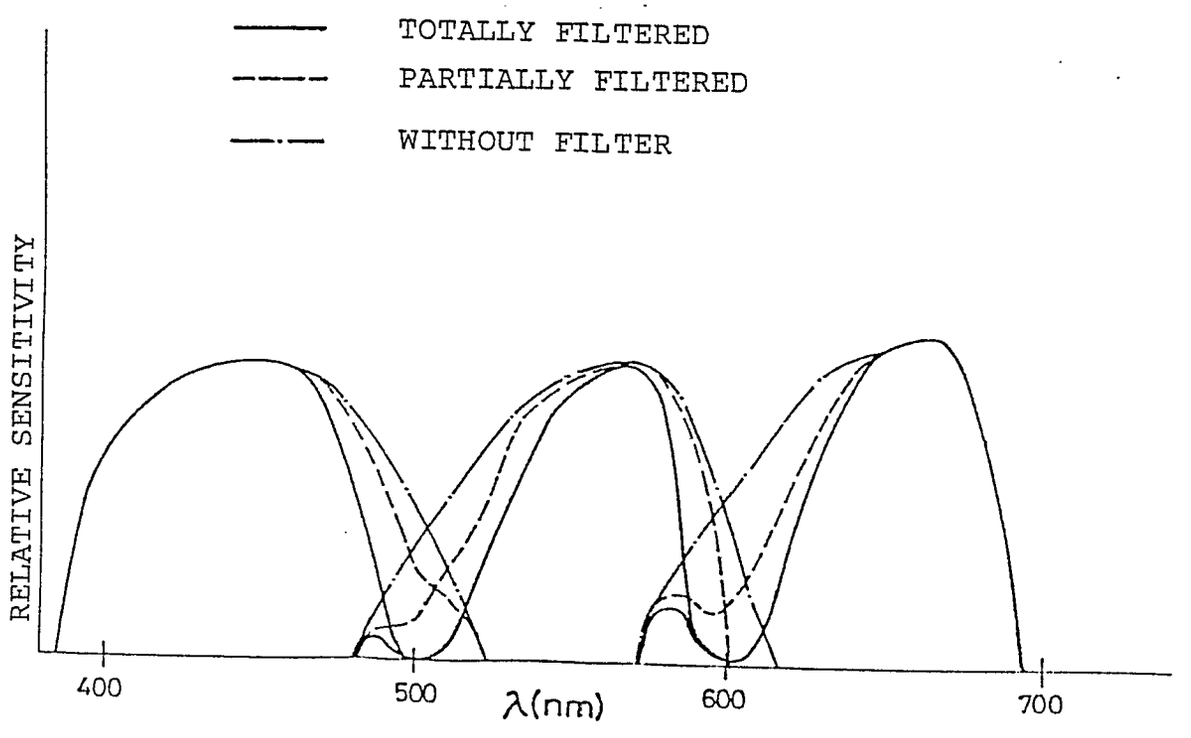


FIG.24

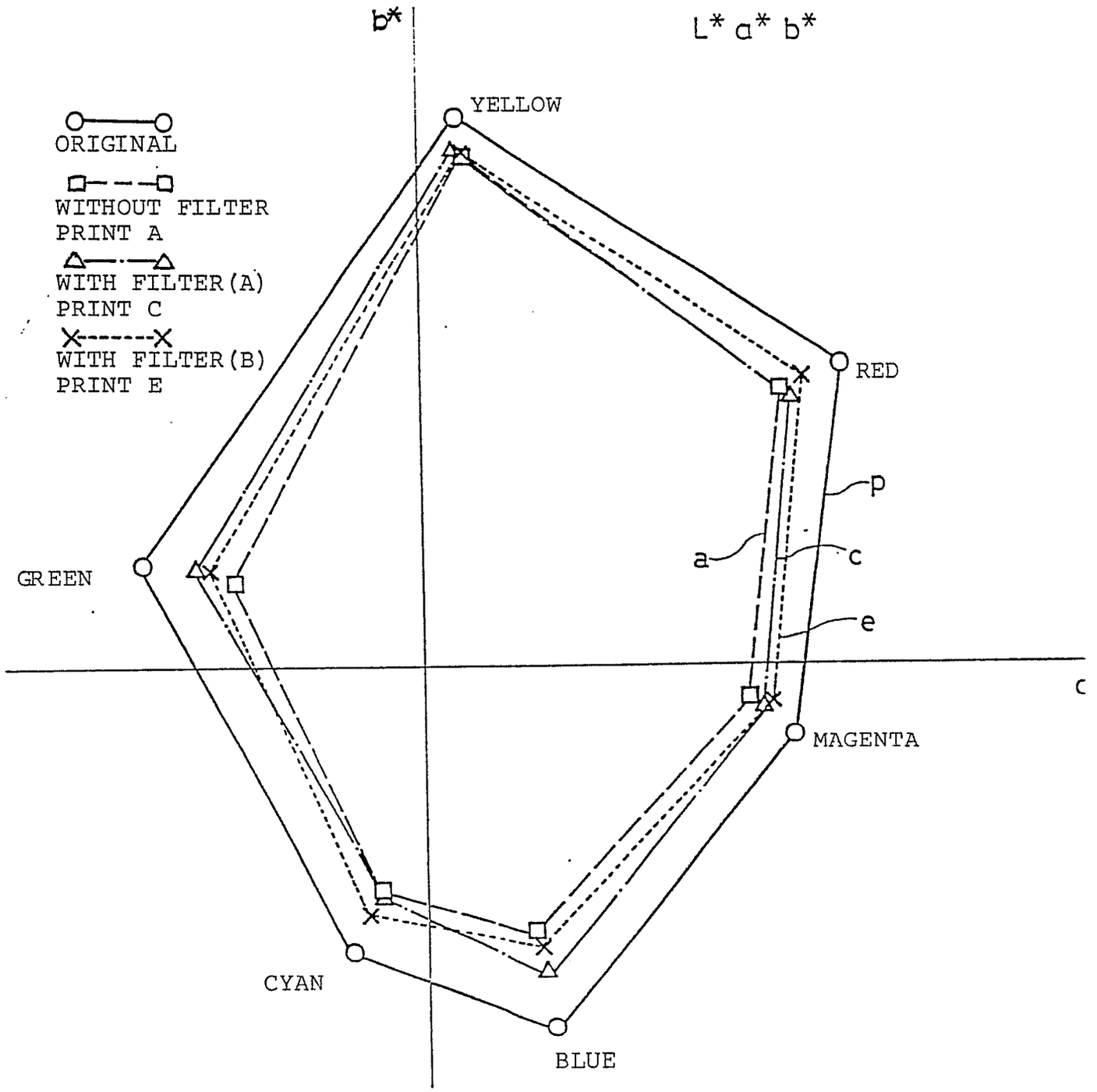

b*
L* a* b*
YELLOW
ORIGINAL
WITHOUT FILTER
PRINT A
WITH FILTER(A)
PRINT C
WITH FILTER(B)
PRINT E
RED
p
a
c
e
GREEN
MAGENTA
CYAN
BLUE

FIG.25

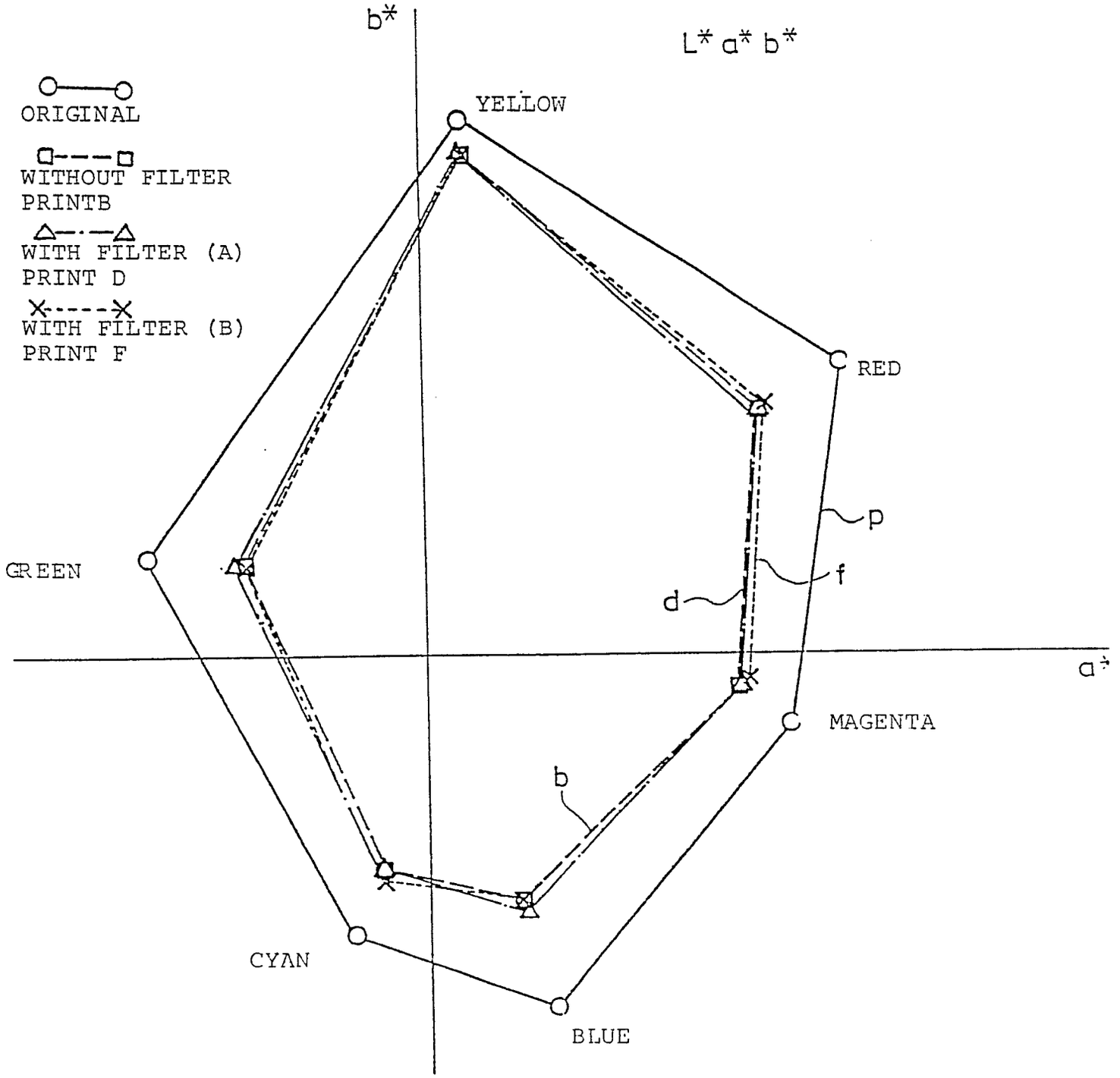
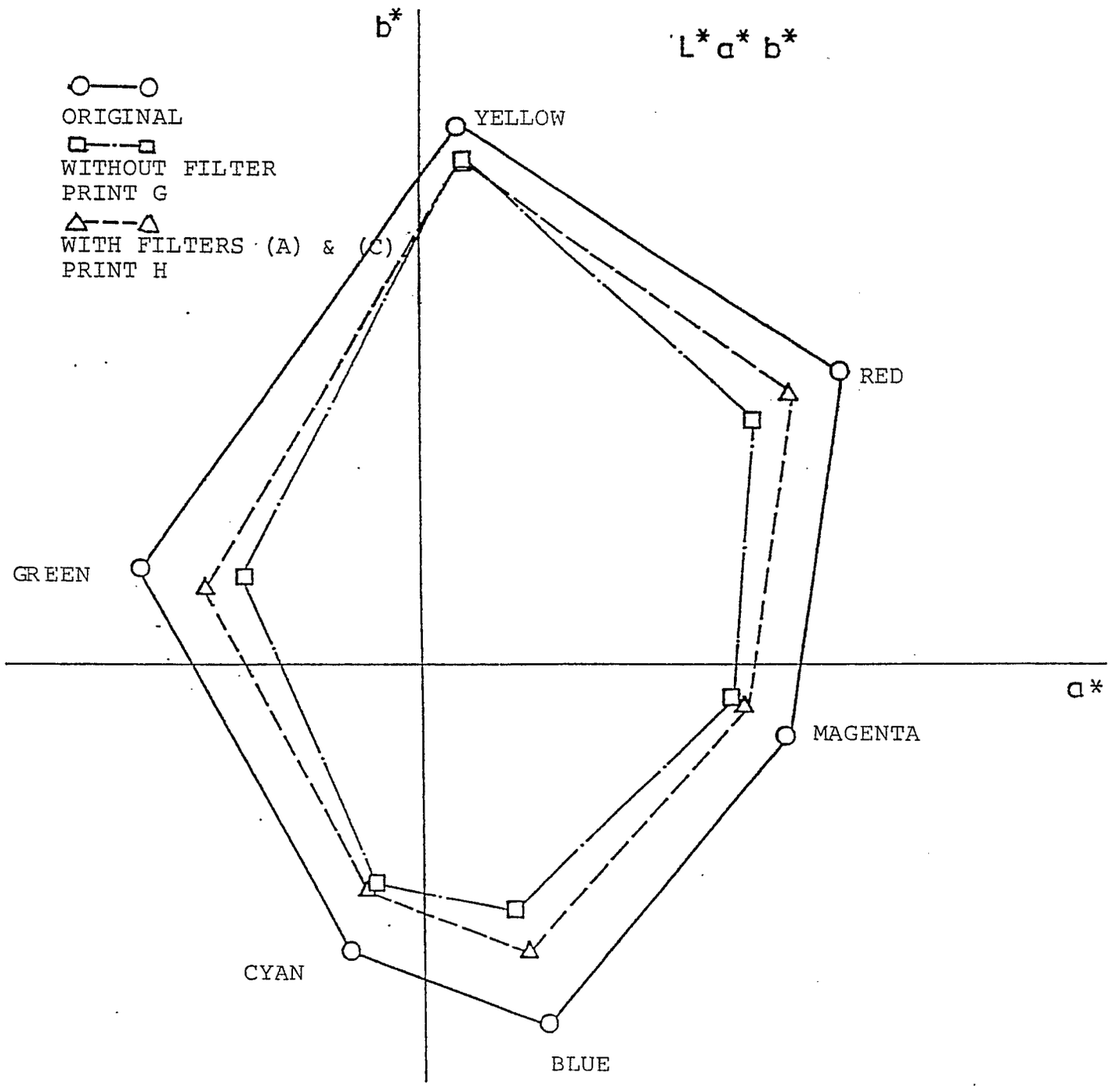

b*
L* a* b*
ORIGINAL
WITHOUT FILTER
PRINTB
WITH FILTER (A)
PRINT D
WITH FILTER (B)
PRINT F
YELLOW
RED
GREEN
MAGENTA
CYAN
BLUE
a*
p
f
d
b

FIG.26


b*
L* a* b*
ORIGINAL
WITHOUT FILTER
PRINT G
WITH FILTERS (A) & (C)
PRINT H
YELLOW
RED
GREEN
a*
MAGENTA
CYAN
BLUE