PATENT SPECIFICATION

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Complete Specification Accepted: Oct. 5, 1943.

COMPLETE SPECIFICATION

Improvements in or relating to Optical Apparatus and Motion Picture Films for Three-Colour Photography

We, COSMOCOLOR CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 1, Wall Street, New York City, New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to motion picture films and to apparatus for recording colour-component images on said films.

According to the present invention a motion picture film has recorded thereon consecutive groups of three separate oblong colour-component images, two of said images being of substantially equal size and being arranged one above the other, and the third image being arranged beside the other two, turned on its side with respect to them and larger than either of them to an extent such that its long dimension approximates the sum of their short dimensions, and the three images cumulatively occupy an area substantially commensurate to the area of a normal motion picture frame, the ratio of short side to long side being equal in all of said images.

Further according to the invention there is provided apparatus for producing a motion picture film of the form set forth above, comprising an objective, means between the objective and the film dividing the light from the objective into three parts, two of the said parts being redirected and the other part passing directly to the film to form an image, means to further redirect one of the redirected parts of the light so that it forms an image on the film adjacent and substantially in vertical alignment with the aforementioned image, means to further redirect the second portion of redirected light so that it forms an image turned on its side and arranged beside the other two images, means to cause this third image to be larger than those formed by the other two portions of light, and filtering means in each light path intermediate the means for dividing the light into three parts and the film for removing predetermined colour components therefrom, the paths of all three portions of light being such that the images carried by the three portions all come to focus in the plane of the film.

The beam splitter methods have heretofore been considered undesirable due to the loss of light but by selecting the resultant divided beams as hereinafter described for recording certain spectral ranges very little effective light is absorbed or otherwise lost. Accordingly, by the use of a single optical device comprising an objective and a new-type of beam splitter, very excellent component images can readily be obtained and recorded within a single panchromatic emulsion layer. The new type of beam splitter is devised so as to produce three images having substantially equal intensities.

The invention will best be understood from the following description of the specific embodiments when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout.

Figure 1 is a view in perspective of optical apparatus for simultaneously producing three component images arranged in accordance with the invention, and the film having such an arrangement of images thereon;

Figure 2 is an exploded view of a three-way beam splitter;

Figures 3 and 4 are views in elevation of the sides of modified beam splitters; and

Figures 5 and 6 are views in perspective similar to Figure 1, and showing modifications of the apparatus.

Referring particularly to Figure 1 of the drawings, it will be seen that an image beam a of the object A, is received by an objective 1 and focussed upon a film 2. The objective 1 is preferably the type having a long back focus in order to mechanically accommodate a beam splitter 3 between the emergent

side of the objective 1 and the film 2. As objectives having a long back focus are inclined to also have a relatively narrow object field it may be desirable to combine a dispersive member, or so-called "wide angle" lens with the objective to obtain both the wide field and the long back focus. Satisfactory lenses of this type are shown in Patent Specification No. 355,452. The beam splitter 3 is provided with two partially transparent, partially reflecting faces 4 and 4^1, (Figure 2), so that an image beam is initially divided into two beams and one of the divided beams is again divided into two beams, whereby three beams are obtained, two being redirected by the faces 4, 4^1, and the third passing directly to the film. Blocks of glass are interposed in the paths of at least two of the divided beams to compensate for their longer light paths. The film 2 preferably comprises a standard type of panchromatic emulsion but, of course, two or more spectrally selectively sensitive emulsion layers may be used.

Colour filters are interposed in the paths of these three beams to thereby obtain three separate colour-component images. A blue filter 51, a yellow filter 52, and a red filter 53, may be interposed in the paths of the image beams, so as to remove from the beams the spectral complements of the colours of their respective filters, or other colours may be used, such as blue, green, and red, or blue-violet, yellow-green, and orange-red. As a matter of convenience, the colour filters may be mounted on the emergent faces of the beam splitter although of course they may likewise be separately mounted as a removable unit so that they may be replaced or other filters of slightly different absorption values may be substituted.

As best shown in Figure 2, the beam splitter comprises a right angle prism 5, one face 6 of which is positioned normal to the image beam *a*. The face 4 of this member 5 lies at 45° to the image beam *a* and may be treated as by sputtering silver, gold, aluminium or the like, thereon so that, when it is in contact with a face 14 of a prism 13 hereinafter described, it forms a partially reflecting, partially transmitting surface. This face 4 is prepared so that approximately one-third of the light which strikes said face is reflected while two-thirds of the light incident to said face is transmitted. The reflected light beam *x* is directed to a six-sided prism 7 which comprises two prisms similar to the prism 5 in one unit and has an incident face 8, two full reflecting surfaces 9 and 10 and an emergent surface 11. By means of this prism combination the reflected image is not only set off to one side of the original image beam *a*, but is also turned through an angle of 90° so that the image X, which is recorded on the film, lies upon its side.

After the image beam *x* emerges from the face 11 it then passes through a compensating block 12 to equalize the paths of the reflected beam *w* and the transmitted beam y^1. Upon passing through the compensatting block 12, the beam *x* then passes through the red filter 53 so that the resulting image X comprises the red component. The light beam y^1 that is transmitted by the face 4, which comprises two-thirds of the light incident thereto, then passes into a rhomboid prism 13 through its incident face 14 lying in contact with the face 4. The prism 13 has a face 4^1 serving, when in contact with the face 19 of a prism 18, as a partially reflecting, partially transmitting face. This surface 4^1 is adapted to reflect as beam *z* one-half of the light comprising beam y^1 and to transmit as beam *y* one-half of the said light so that two like images are formed, each of which comprises approximately one-third of the total light of the original image and is substantially equal to the power of the first reflected image.

The image beam *z* reflected by the surfaces 4^1 is directed into a prism 15 surface 4^1 is directed into a prism 15 which lies at an angles of 45° to the direction of the image beam *z* and parallel to the surfaces 4 and 4^1. The image beam *z* is thereby reflected through the extended portion 17 of the prism 15 which constitutes a compensating element to equalize the length of image beam *z* with respect to the paths of the other divided images. The image beam *z* emerging from the prism 15 is passed through the yellow filter 52 so as to record the yellow-green component image Z upon the film. The image beam *y* which is transmitted by the surface 4^1 passes into a right angle prism 18 through its surface 19 lying in contact with the surface 4^1 emerges through an upright surface 20 that lies normal to the beam *y* and from which the beam passes through the blue filter 51 to the film 2 to record thereon a blue component image Y.

The principal objection to the use of beam splitters has heretofore resided in the fact that there has been a considerable loss of the light as it passes through the various optical elements. It is now known that loss by surface reflection may be reduced to a minimum by providing

optical surfaces with thin films, and the surfaces of the elements in the objective 1 and various transmitting surfaces of the elements of the beam splitter may be so treated. Loss of light is also decreased by providing the full reflecting surfaces of the beam splitter, namely surfaces 9, 10 and 16, with coatings which render the highest possible value of reflection.

According to present-day methods, it has been found that the best reflection is obtained by evaporating aluminium upon the totally reflecting surfaces. It has also been found that the light dividing surfaces of the beam splitter, that is, those surfaces which partially transmit and partially reflect the light, are the most efficient when they are formed by sputtering silver on the surfaces. In the present instance the surfaces 4 and 4¹ would have the silver sputtered thereon in accordance with the amount of light that each of these surfaces is supposed to reflect.

Another feature which has been incorporated in this system arises from the fact that the light reflected by the light dividing surfaces is relatively high in the red values of the spectrum, whereas the transmitted or direct beam of light is relatively high in the blue values of the spectrum. Accordingly, the first reflected image which is relatively high in the red values, is filtered with a red filter, whereas the directly transmitted beam of light is filtered with a blue filter. This principle is further borne out by the fact that the second reflected image is filtered with a yellow filter to record the yellows and greens. By this arrangement the maximum amount of the respective light values is obtained for recording each of the component images on the film.

It has been found that in projection it is preferable to have the best possible definition in the green component image on the positive film, and therefore to have the best possible definition in the red component image X, that is originally recorded. An additional advantage in recording the red component image with the first reflected beam which contains a predominant proportion of red light resides in the fact that the red component image X may be considerably enlarged. A very slight reduction in the normal size of the blue and yellow-green component images Y and Z will provide film area for such an enlarged red component in a normal picture area, or preferably it may occupy the film area which is normally allotted to the sound record as well as the normal picture area.

According to the preferred arrangement, the blue and yellow-green component images may remain at the same size of .495 inches by .360 inches and the red component image may be enlarged to .660 inches by .480 inches. This arrangement obtains a highly desirable result without producing any difficulty, because in taking the original records the picture images and the sound records are usually recorded separately. The differences in size of the image does not matter as the picture records obtained by the present system are all enlarged during printing to the normal size for a motion picture image, which is .825 inches by .600 inches, or during the intermediate steps of producing the commercial projection films.

The enlargement of the red component image may be readily effected by interposing a lens 25 in the path of the reflected beam x that emerges from the block 12. This effect may likewise be obtained by the use of a modified structure as shown in Figure 3, wherein the block 12 is provided with one or more lens segments 26 on the entrance or emergent faces of said block 12 or on both of said faces. It will also be seen by Figures 1 and 3 that the red filter 53 may be positioned between the emergent face of the block 12 and the lens 25 or between the emergent face of the lens and the film.

The centre of the red component image X normally lies in sustantially the same horizontal plane as the centre of the yellow-green component image Z, and, due to the turning of the red component image X, the ends thereof extend beyond one of the horizontal boundaries of its companion images Y and Z. While this offsetting of the images works no particular hardship in the average case, it is sometimes desirable for all three of the images to be positioned completely within the area normally occupied by a single standard sized image. The position of the red component image X may be readily adjusted by various means. For instance, as shown in Figure 5, a very thin wedge prism 28 may be interposed in the red image beam x, along with the lens 25, not shown. By this means the red image beam x will be refracted so that its image x' will lie completely within the normal image area.

In Figure 5 the red component image X has been shifted to a position where its centre lies in the horizontal plane that runs between the adjacent horizontal edges of the companion images Y and Z, although it will be understood that it need not be shifted as much. Instead of employing a separate wedge prism 28, the emergent face of the com-

pensating block 12 may be arranged at an angle as shown in Figure 4, so as to cause the red component image X to be refracted to the desired position. Of course, the shifting of the image can also be obtained by tilting the magnifying lens 25 shown in Figure 1 although some slight distortion might result by so doing. Likewise, the magnifying lens 25 might be formed in more or less of a wedge which would cause the necessary refraction of the image.

Still another modification of the invention is shown in Fig. 6, wherein the optical image beam *a* is received and divided by the beam splitter 3 into three like image beams and filtered by the color filters 51, 52 and 53 as hereinbefore described. The principal difference in this modification resides in the fact that a separate lens is used for each of the image beams after they have been divided in lieu of the objective 1 for receiving the original image beam. It will be understood that the separate lenses may be employed in combination with the principal objective 1 if it is desired to control the separate image beams in any manner. It will be seen in Fig. 6 that a lens 54 may be placed in the image beam *x*, a lens 55 may be placed in the image beam *y* and a lens 56 may be placed in the image beam *z*. By such an arrangement, the original image beam may be received by the beam splitter and divided into three like beams, colored by complementary color filters to form complementary color images, the color filtered complementary images may then be focused upon the plane of the film and thereby recorded in a single light sensitive silver halide emulsion.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A motion picture film having recorded thereon consecutive groups of three separate oblong colour-component images, two of said images being of substantially equal size and being arranged one above the other, and the third image being arranged beside the other two, turned on its side with respect to them, and larger than either of them to an extent such that its long dimension approximates the sum of their short dimensions and the three images cumulatively occupy an area substantially commensurate to the area of a normal motion picture frame, the ratio of short side to long side being equal in all of said images.

2. A motion picture film as claimed in Claim 1, wherein the larger image is a red component image.

3. Apparatus for producing a motion picture film of the form set forth in Claim 1, comprising an objective, means between the objective and the film dividing the light from the objective into three parts, two of the said parts being redirected and the other part passing directly to the film to form an image, means to further redirect one of the redirected parts of the light so that it forms an image on the film adjacent and substantially in vertical alignment with the aforementioned image, means to further redirect the second portion of redirected light so that it forms an image turned on its side and arranged beside the other two images, means to cause this third image to be larger than those formed by the other two portions of light, and filtering means in each light path intermediate the means for dividing the light into three parts and the film for removing predetermined colour components therefrom, the paths of all three portions of light being such that the images carried by the three portions all come to focus in the plane of the film.

4. Apparatus as claimed in Claim 3, wherein a separate lens is provided in each beam between the beam splitter and the film, either in conjunction with an objective in front of the beam splitter or in substitution for it.

5. Apparatus as claimed in Claim 3 or 4, in which the filtering means remove the spectral complement of blue from the portion of the light forming one of the smaller images, the spectral complement of yellow-green from the portion of the light forming the other of the smaller images, and the spectral complement of red from the portion of the light forming the larger image.

6. A motion picture film substantially as described with reference to the accompanying drawings.

7. Apparatus for producing a motion picture film substantially as described with reference to the accompanying drawings.

Dated this 30th day of December, 1941.

For the Applicants:

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[This Drawing is a reproduction of the Original on a reduced scale.]

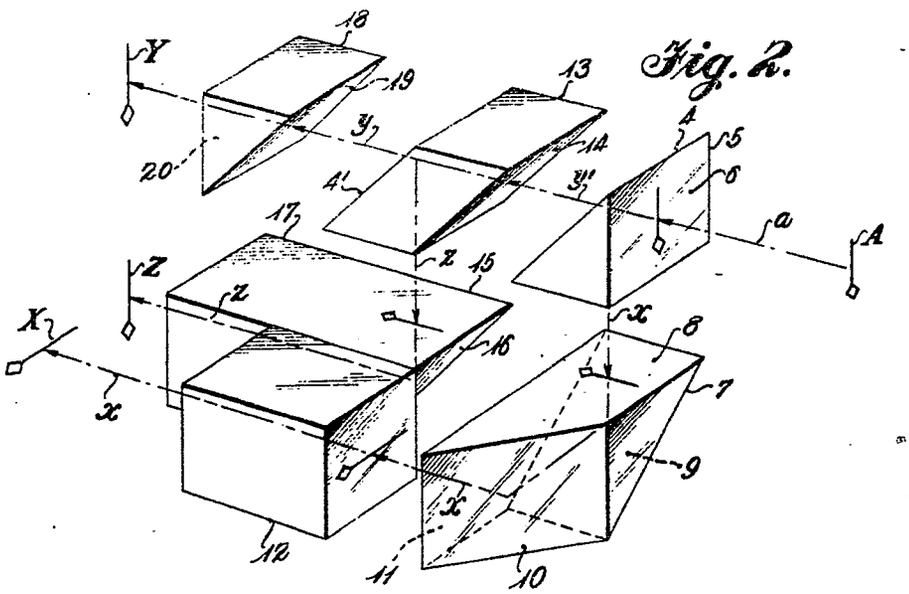


Fig. 2.

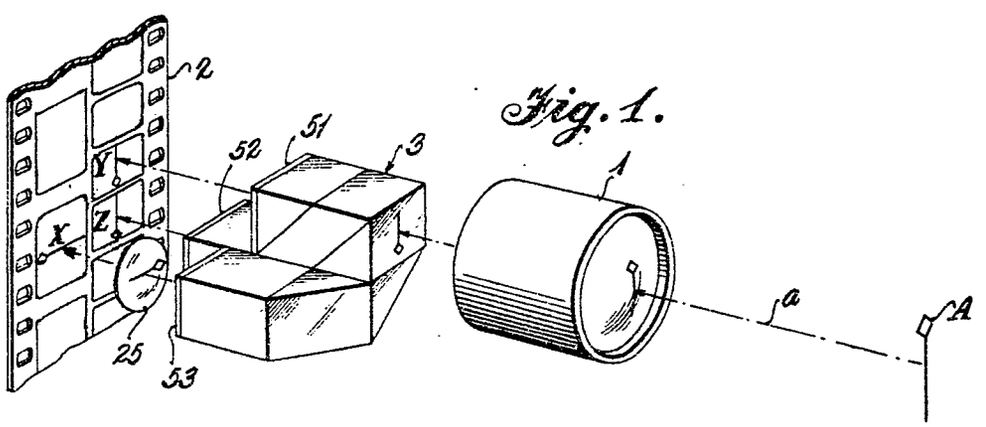
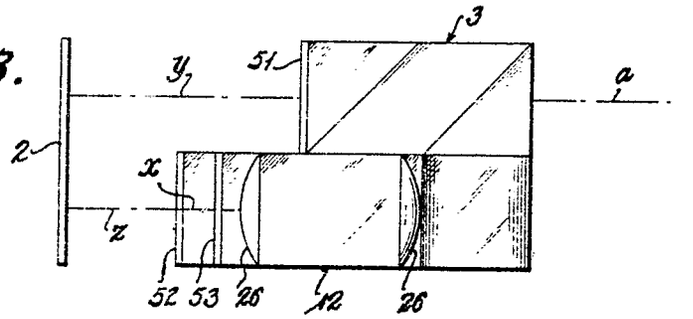


Fig. 1.

Fig. 3.



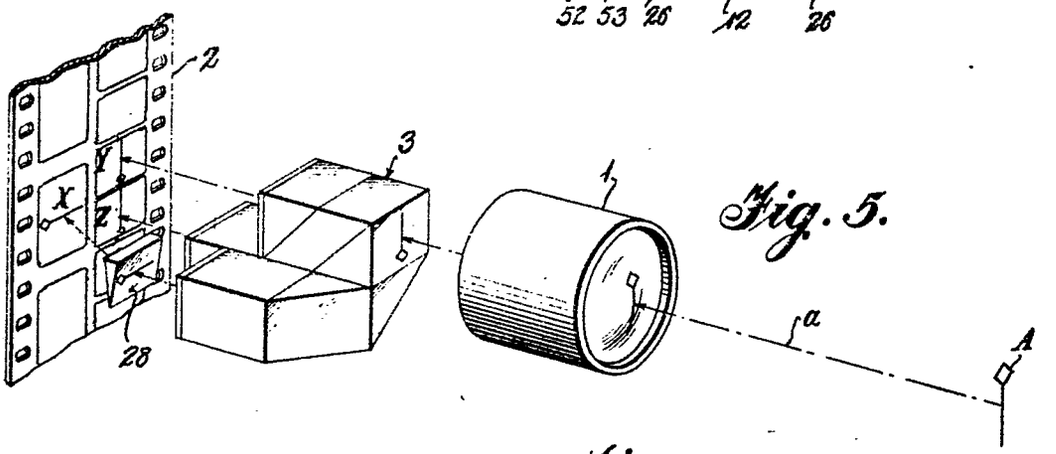


Fig. 5.

Fig. 4.

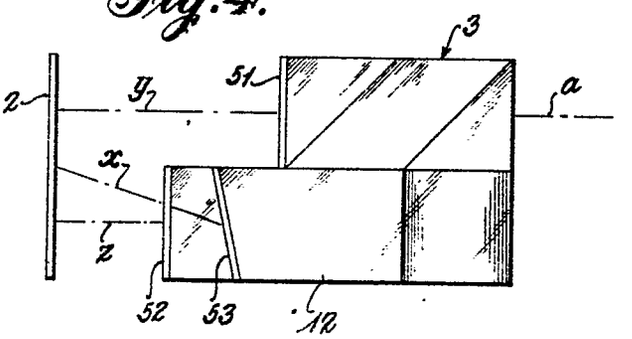
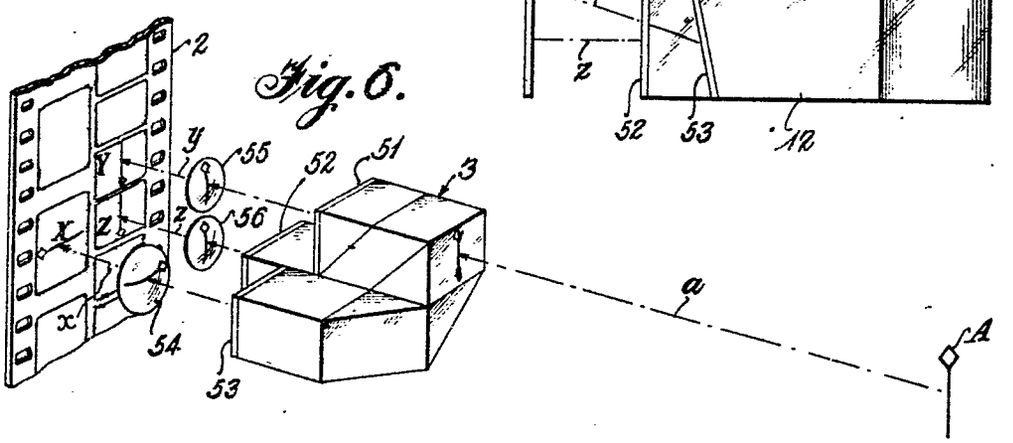


Fig. 6.



Malby & Sons, Photo-Lith

556,426 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

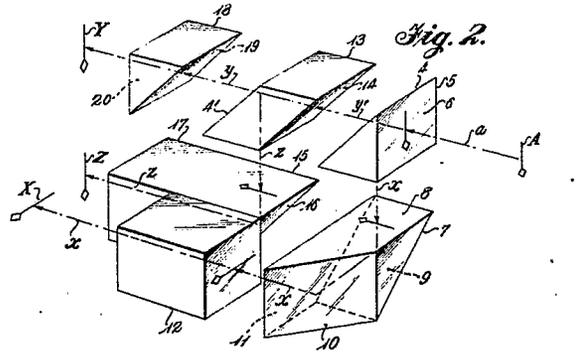


Fig. 2.

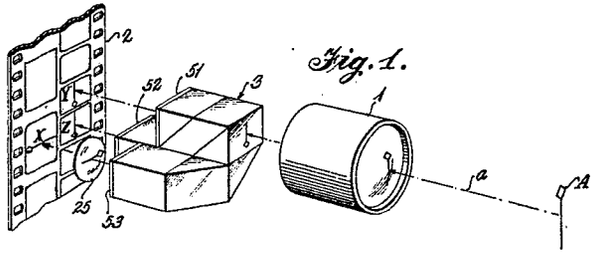


Fig. 1.

[This Drawing is a reproduction of the Original on a reduced scale.]

SHEET 2

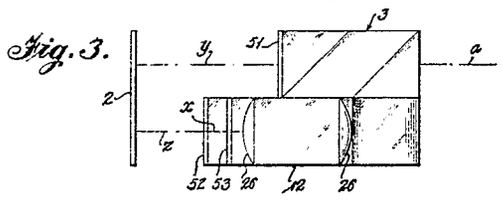


Fig. 3.

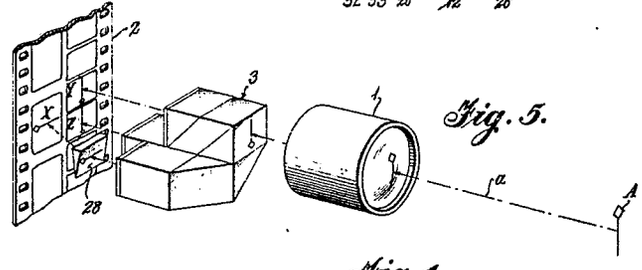


Fig. 5.

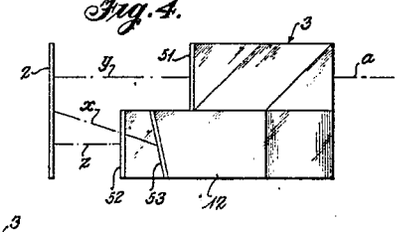


Fig. 4.

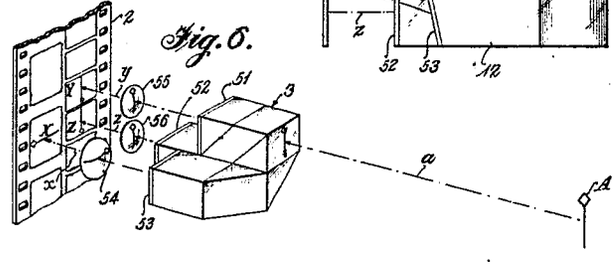


Fig. 6.

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