PATENT SPECIFICATION

Convention Date (United States): Jan. 16, 1936.

475,808

Application Date (in United Kingdom): May 25, 1936. No. 14723/36.

Complete Specification Accepted: Nov. 25, 1937.

COMPLETE SPECIFICATION

Light Dividing Device

We, TECHNICOLOR MOTION PICTURE CORPORATION, a Corporation of Maine, United States of America, of 823, North Seward Street, Hollywood, California, United States of America (Assignees of JOSEPH ARTHUR BALL and WADSWORTH EDMONT POHL), 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 apparatus for simultaneously forming a plurality of optical images which are for practical purposes identical and especially suited for purposes of color photography with three or more color separation records.

Light dividers of various types have been proposed for this purpose, but they all suffer from certain disadvantages, as for example complicated and unequal light paths involving much light absorption and necessitating difficult optical compensations, or, if the light dividing surface intersects an aperture through which the light enters, more or less parallax between the part images.

The present invention has the objects to provide an optical system forming a plurality of images of an object field, overcoming the disadvantages inherent in prior systems for this purpose, to provide a system of this type which maintains equal optical paths in both air and glass, which produces part images which are for practical purposes geometrically identical and at the same distance from the object, to provide a light dividing prism with a minimum of reflecting and transmitting surfaces and a minimum length of the optical paths, to provide a light dividing system which is very compact and therefore especially suited for use with short focus objectives, and permitting convenient use in still picture cameras as well as with film movements for purposes of motion picture photography, and generally, a light dividing system which is particularly suitable for multicolor photography for producing sill picture records as well as cinematographic films.

These objects are accomplished in accordance with the present invention by means of a prism system employing at least three prism elements contacting to form at least two partly reflecting surfaces inclined to each other, at least one of said elements having a totally reflecting surface inclined to said partly reflecting surfaces and arranged for deviating a component beam coming from a partly reflecting surface.

These and other objects and aspects will be apparent from the following explanation illustrating the invention by describing several typical embodiments which are also shown in the accompanying drawings which represent in:

Figs. 1, 2 and 3 diagrammatic views of light dividers for producing three similar images, and in

Figs. 4 and 5 similar views of devices for producing four similar images.

Fig. 1 shows a light dividing system according to the present invention which consists of three prisms 1, 2 and 3, preferably of right-angled triangle cross section and with angles of 30° at the common apex. While this shape is not essential, it is desirable for purposes of the invention in order to provide equal optical paths. The surfaces where prisms 1 and 2, and 2 and 3, respectively, are abutting are cemented together and partly reflecting.

Semi-transparent reflecting surfaces can be made in various ways, for example, by sputtering a thin deposit of metal on one of the abutting surfaces before cementing them together, or by removing, in the form of a regular or irregular grid, portions of a totally reflecting deposit applied to one of the two surfaces. The surfaces joined as above described form partly transparent reflecting surfaces 16 and 17. It will be understood that the ratio of transmitted and reflected light can be adjusted by varying the thickness of a sputtered metal layer or the ratio of reflecting and transmitting areas of a grid, and that the colour of the transmitted and reflected beams can to some extent be regulated by suitably selecting the reflecting material. Filters 21, 22, 23 may be

cemented to faces 11, 12 and 13 of the prisms.

A light beam bearing an image of object O is formed by an objective lens L of any suitable type and, as indicated by its axis R, enters prism 1 at surface 5, proceeding towards surface 16 where it is divided into two component beams A and B. Beam A again traverses prism 1 and, striking surface 5 at an angle of total reflection, is deviated parallel to surface 16 towards face 11 perpendicular thereto, where it emerges from the prism. Beam B, proceeding through prism 2, strikes surface 17 where it is divided into components C and D, component beam C continuing in prism 2 and emerging through face 12, and component beam D traversing prism 3 and emerging through face 13.

It will be noted that image *c* is reversed with respect to images *a* and *d*, since beam C is reflected once, beam A twice and beam D not at all.

The images may be recorded on photographic emulsions either on plates or films in suitable holders for still picture photography, or on film strips for motion picture photography. The former may be removably retained by conventional means, and the latter may be arranged in different ways, either parallel to, or crossing the line which forms the apex of the prism. In Fig. 1 a film W of double width is shown for recording images *a* and *c*, and a single width film F for receiving image *d*, both films moving in the direction of the apex line and parallel to surfaces 11, 12 and 13, respectively. The films are drawn as if turned 90° from their actual aperture plane into the paper plane in order to simplify the showing.

Other film arrangements are possible and will be shown in combination with other modifications of the light divider, it being understood that any of the latter can be used with any of the film arrangements or combinations thereof.

Referring now to Fig. 2, instead of dividing component beam B at surface 17, it is, according to this arrangement, totally reflected at the corresponding surface 36 of prism 32 corresponding to prism 2 of Fig. 1 towards semi-transparent surface 37 between prism 32 and prism 33, prisms 32 and 33 having together the same shape as prism 2 of Fig. 1, and surface 37 bisecting the angle formed by faces 36 of prism 32 and 14 of prism 33. Beam B is therefore partly reflected and partly transmitted at 37 and thus divided into component beams E and F. Image *e* is reversed with respect to images *a* and *f* for apparent reasons.

In this instance, film gates which guide two film strips 41 and 42 perpendicularly to the apex line of the prism are shown by way of example. Film strip 43 in film gate 41 will record two corresponding records which may be separated by any suitable method, for example according to that disclosed in United States patent No. 1,738,095 of December 3, 1929. Film 44 in film gate 42 receives a series of records of the third corresponding image, in the customary manner. Any suitable type of film movement can be employed for shifting the films, whereby it will be understood that strip 43 must move two steps for each step of film 44.

The embodiment of Fig. 2 requires even less space than that of Fig. 1, whereas the light paths in glass are somewhat simpler in Fig. 1, there being an added total reflection at 36 of Fig. 2.

Instead of subdividing component beam B, beam A can be split as shown in Fig. 3. This embodiment is essentially similar to that of Fig. 2 concerning its optical function, with the only difference that the reflection of beams is less evenly divided, direct beam B of Fig. 3 being only once reflected at 56, beam H twice at 16 and 55, and beam G three times at 16, 55 and 57. In Fig. 2, beam A is reflected twice at 16 and 5, beam E once at 36, and beam F twice at 36 and 37. For certain purposes, the embodiment according to Fig. 3 may be somewhat more compact than that of Fig. 2.

By properly selecting the reflection-transmission ratio of the semi-transparent surfaces and the number of reflections in relation to the filter transmissions and emulsion sensitivities it is easily possible to obtain an illumination of optimum usefulness under the circumstances at hand, selections of this kind being familiar to those skilled in the art.

In Fig. 3, the films are shown as progressing in the direction of the apex lines of the prism, as in Fig. 1.

Filters may be arranged in any suitable way, for example as shown in the drawings.

It should be noted in this connection that filters may be cemented to the respective surface if that surface only transmits, but does not reflect light. On the other hand, filters arranged in front of surfaces which transmit as well as reflect light (as for example surface 55 of Fig. 3) must be spaced from their respective prism faces by air gaps since, without this provision, these faces would not

act as reflectors, but transmit all light impinging thereon.

By combining the embodiments of Figs. 2 and 3, as shown in Fig. 4, beam R can be divided into four component beams K, M, N, and P. In this embodiment, three similar prisms 61, 62, 63 of obtuse isosceles triangular section are cemented together along their shorter sides, the cemented surfaces 64, 65, 66 being rendered partly reflecting as above discussed. It will now be evident that beam K is reflected three times at 64, 67 and 66, beam M twice at 64 and 67, beam N once at 68, and beam P twice at 68 and 65. In accordance with the number of reflections, images *k* and *n* are reversed with respect to images *m* and *p*.

Fig. 5 shows diagrammatically a combination of the embodiments according to Figs. 1 and 3 and is numbered accordingly. In this modification, beam R is divided into four component beams S, T, U and V in a manner which will now be understood without further explanation. The images *s* and *u* are reversed with respect to images *t* and *v*, as indicated. Filters may be associated with faces 12, 13, 18 and 19, and the images may be recorded on films arranged in suitable manner, as for example indicated in Figs. 1 or 2.

The arrangement according to Fig. 4 is more compact than that of Fig. 5, but the latter has one total reflection less, namely that at 68 of Fig. 4.

The prism units of triangular cross section according to Figs. 2, 3 and 4 have the further advantage of permitting the addition of a finder for viewing a composite image even during the use of the apparatus in which the light divider is incorporated. In the case of a camera for color photography, the various color aspect images as recorded on the separate films can be superimposed and viewed in full color. As indicated in Fig. 4 in dotted lines, the rays coming from image *p* are reflected at 65 and then together with those from *n*, reflected at 68 and 64, emerging through face 68; the rays from *k* are reflected at 66 and then, together with those from *m*, reflected at 67 emerging through 64 and, together with rays *p* and *n*, through face 68. By arranging a viewing lens system Q adjacent to face 68, the superposed images can be continuously observed. It will be noted that, in this manner, every surface and surface portion of the prism unit according to Fig. 4, is put to use, the whole arrangement forming a device of optimum compactness and shortness and uniformity of light paths.

It will be understood that many other modifications and applications of the above-described embodiments of our invention are feasible; for example, the prism angles may be changed to some extent; the prism units may be used for superposing light beams instead of dividing them, as indicated in Fig. 4, for a view finder but also possible and useful for other purposes, as for example additive projection of color separation records; that objectives may be arranged in each component emergent beam instead of using a single lens system in the entrant beam; and that the prism unit can be used with equal advantage for still picture photography as well as cinematography.

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 system for dividing a light beam into at least three component beams, of the type employing contacting prism elements with partly reflecting as well as totally reflecting surfaces, comprising a prism element forming with at least two additional prism elements at least two partly reflecting surfaces inclined to each other, at least one of said elements having a totally reflecting surface inclined to said partly reflecting surfaces and arranged for deviating a component beam coming from a partly reflecting surface.

2. Light dividing system according to claim 1, further characterized in that the prism surfaces form angles directing two component beams to emerge from the system in substantially parallel directions.

3. Light dividing system according to claim 1, further characterized by a cross section composed of three substantially congruent right angled triangles, two of which are contacting at the longest sides whereas the third triangle contacts with one of the said two triangles at corresponding shorter sides, the contacting sides constituting partly reflecting surfaces and a free side constituting a totally reflecting surface.

4. Light dividing system according to claim 3, further characterized by an additional partly reflecting surface in the path of the component beam coming from said totally reflecting surface.

5. Light dividing system according to claim 1, further characterized by partly reflecting surfaces forming an obtuse angle and by two totally reflecting surfaces in the component beams coming from one of said partly transmitting surfaces and deviating said component beams in substantially parallel direc-

tions, one of said component beams being further divided by said second partly reflecting surface.

6. Light dividing system according to claim 1, further characterized by a cross-section composed of three 120° isosceles triangles contacting at their equal sides constituting three partly reflecting surfaces, the longer sides of two of said triangles constituting totally reflecting surfaces directing the two component beams coming from the partly reflecting surface therebetween towards the two other partly reflecting surfaces where they are further divided.

Dated the 25th day of May, 1936.

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Chancery Lane, London, W.C.2,
Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1937.

Fig. 1

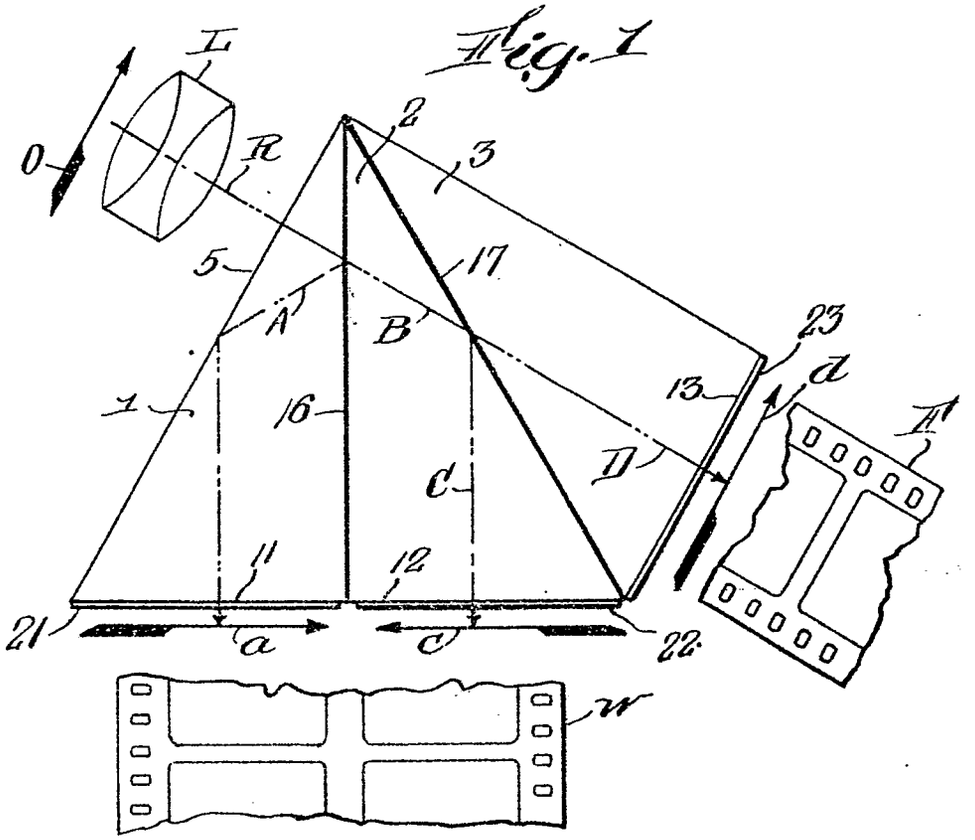


Fig. 2

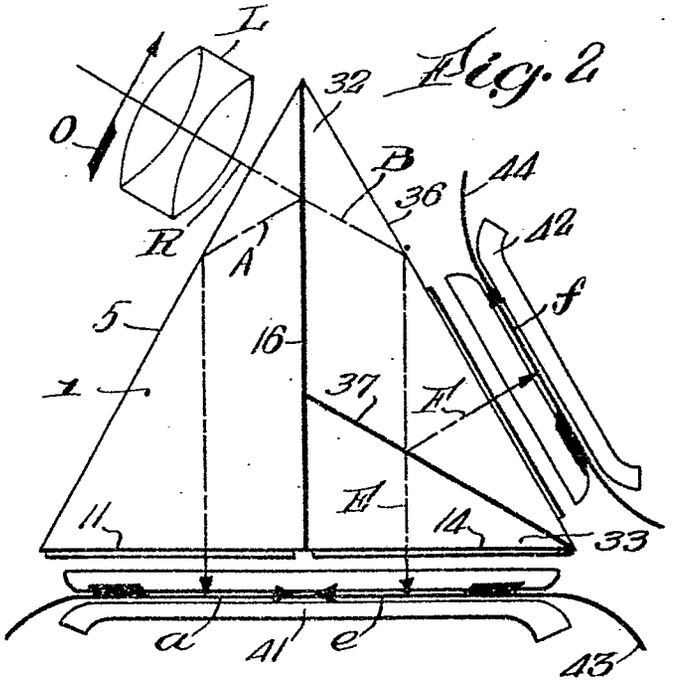


Fig. 3

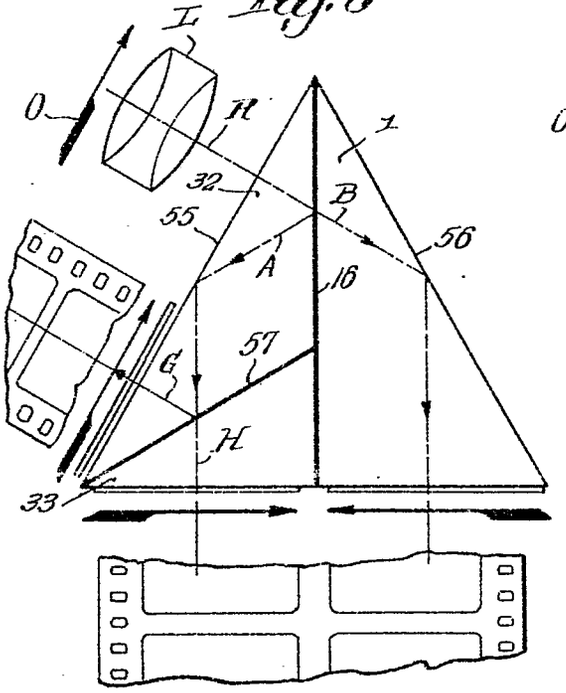


Fig. 4

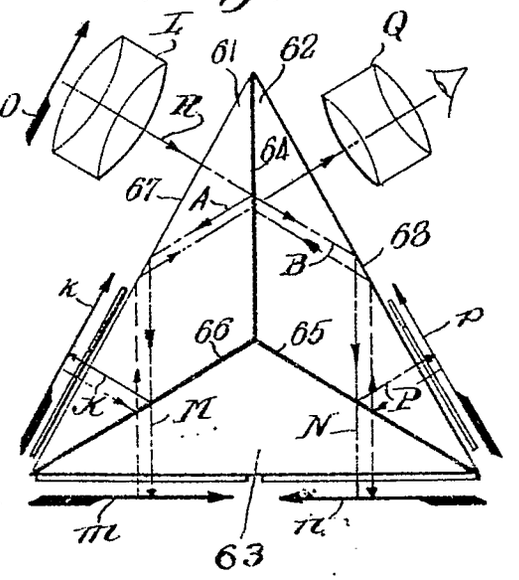
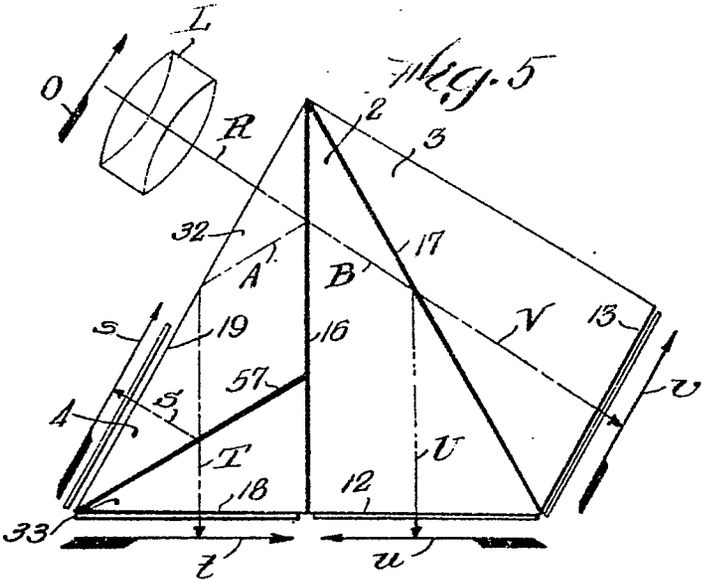


Fig. 5



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

Fig. 1

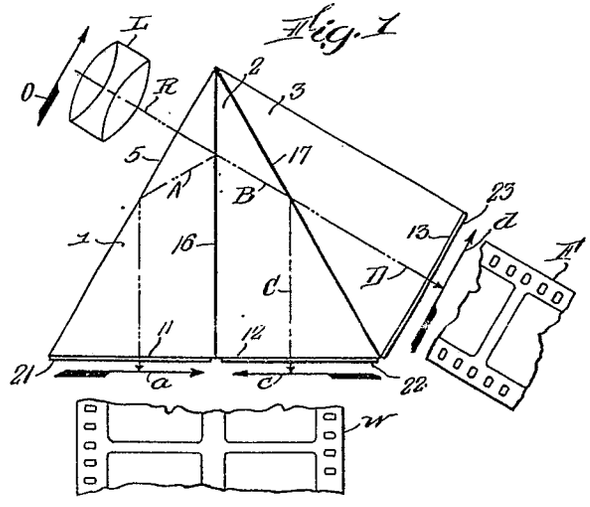


Fig. 2

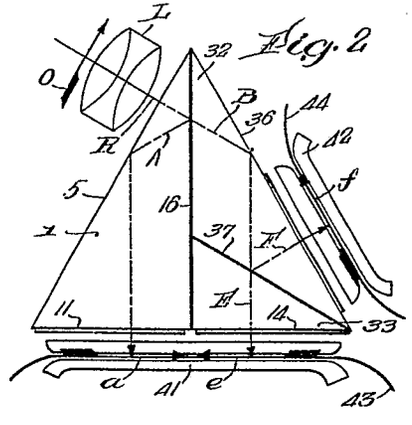


Fig. 3

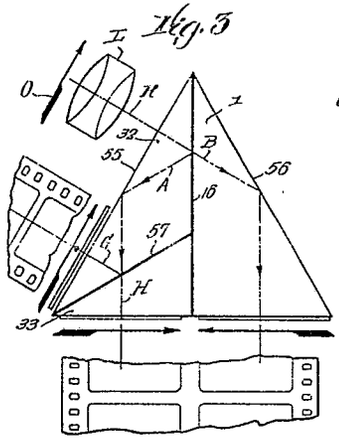


Fig. 4

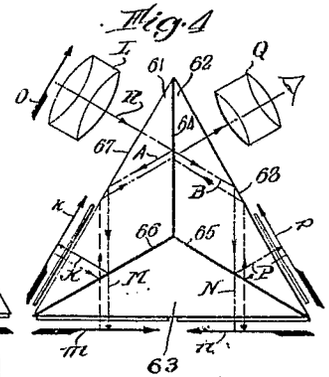
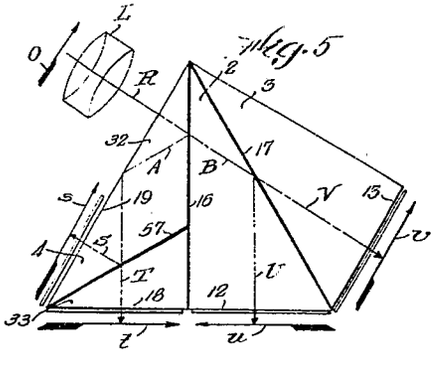


Fig. 5



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