[Second Edition.]

PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Cinematograph Films and a Method of Making the same.

We, DANIEL FROST COMSTOCK, a citizen of the United States of America, and TECHNICOLOR MOTION PICTURE CORPORATION, a corporation organised under the laws of the State of Maine, United States of America, both of 110, Brookline Avenue, Boston, Massachusetts, 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 the art of color cinematography and more particularly to those processes of color cinematography where two or more color records of an object field are taken simultaneously and where these several color records are later superimposed by additive or subtractive method to reproduce the original scene and its colors.

One of the chief obstacles to the advancement of this art is the difficulty of registering the complemental images so taken. If there is lack of register of the recombined picture on the screen, the effect, while different from that due to lack of sharp focus, is just as destructive of the fine drawing of the picture. Consequently the limits of register are much the same as those of focus, and for motion picture work this should be not over .0005 inch. The principal cause of registry difficulty is the shrinkage and expansion of the celluloid base of the film. Measurements show that motion picture film shrinks between one-tenth to one-quarter of one *per cent.* in the developing process and subsequent drying. It continues to shrink on exposure to air at a rate varying from one-twentieth to one-thirtieth of one *per cent.* per day. It is also affected by the humidity of the air and expands one-hundredth of one *per cent.* for each degree increase in humidity. These figures, viewed in the light of the limit in registration mentioned above, show that the possible condition of the film at the time of exposure, as well as subsequent shrinkages, must be provided for.

In the black-and-white art this shrinkage does not cause much trouble, because each picture is exposed printed and projected as a separate unit, and each picture space is individually positioned in the camera, in the printer, and in the projector by adjacent sprocket holes. Since the shrinkage of the film is recorded in these sprocket holes, it is eliminated and causes no trouble. At no time in the ordinary black-and-white process is the distance from one picture to the next determined by anything but the sprocket holes. But in systems of color cinematography where the two or more color records of the same scene are taken simultaneously, there is ordinarily an optical or mechanical factor which determines the distance between the two pictures. For example, if a camera with two lenses is used, there is the distance between the centers of the two lenses; or if a prism set is used behind one lens there is the displacement of the optical paths in the prisms, and while this displacement of the two pictures can be made to correspond accurately with the standard gauge of perforations as determined by the perforating machine, there can be no assurance that the film when exposed in the camera will be of this same length.

The aforesaid registry difficulty is not confined to camera operations but is met in printing positive films from negative films for either additive or subtractive use, in projecting additive images on a screen, in double-coated reproduction, in glueing films together with the complemental images in registry, in imbibition, printing, and indeed in practically every

branch of the color art at many stages subsequent to the exposure of the original negative.

It has been proposed to provide registering holes in the film adapted to be engaged by registering pins in the printer or projector, thereby accurately to position the images during printing or projection. However, as a film shrinks, (or expands) the distance between the registering holes and the corresponding images obviously changes, and where there are a plurality of complemental images for each registering hole or pair of holes, the respective images of each complemental set being distributed along the film at different distances from the holes, these different distances change different amounts and thereby destroy or seriously impair the registering relationship between the registering holes and the respective images of the corresponding complemental set.

The present invention comprises a cinematographic film having a plurality of series of complemental images taken from the same point of view at the same time in separate areas of the same side of the film, the images of one of the series being reversed with respect to the images of another of the series so that corresponding points of each pair of reversed images remain equidistant from the line of symmetry therebetween throughout shrinkage or expansion of the film, the images of respective series preferably being arranged in a row longitudinally of the film with the aforesaid lines of symmetry extending transversely of the film. The film is positioned by means of sprocket holes which are arranged symmetrically with respect to the aforesaid lines of symmetry, that is, with the lines disecting the holes themselves or the spaces between the holes, for a purpose hereinafter described.

According to the present invention the images of each complemental set are formed simultaneously in mutually reversed relationship on the same side of the cinematographic film, and preferably on adjacent areas of the film although not necessarily on juxtaposed or immediately adjacent areas. In exposing the film to successive sets of the complemental images the succeeding sections of the film upon which the successive sets of images are formed are recurrently positioned by engagement with openings spaced uniformly along the film and the reversed images of each set are formed on the film in such positions that the openings are symmetrically located relative to the midlines between the reversed images. The reversed complemental images are formed by a partially reflecting and partially transmitting surface disposed in a plane intersecting the film between said areas in symmetrical relationship to the paths of the divided beams and said areas, all portions of the film which are simultaneously exposed preferably lying in a plane perpendicular to said plane at the time of exposure. The light-dividing surface is enclosed between two prisms, a cross-section of each prism forming approximately a right-angle triangle and the two triangles together forming an outline having substantially equal sides, the prism surfaces through which the light enters and leaves the prisms being substantially normal to the light paths respectively. The divided beams may be reflected after leaving the partially transmitting and partially reflecting surface to form the reversed images in the same plane.

The essential characteristic of the optical system is the geometrical symmetry of the paths of the divided beams and the complemental images on the same side of the cinematographic film. This results in exact similarity between the images of each set and eliminates registration difficulties as aforesaid. It also results in a short distance between the lens and film which is highly desirable in cinematographic cameras.

In the accompanying drawings which illustrate the invention,

Figs. 1, 2, 4, 5 and 8 represent various optical systems for producing the cinematographic film of the present invention;

Figs. 3, 6, 7 and 9 represent various forms of the improved film; and

Figs. 10, 11 and 12 are views of apparatus for making the improved film, Figs. 11 and 12 being sections on lines 6—6 and 7—7 of Fig. 10 respectively.

Referring to Fig. 1, O represents the object, L the lens, and P^2 and P^3 glass prisms. The light beam B passes through the lens and the glass prisms P^2 to the semi-transparent reflecting surface x^{11}, whence one-half the light (or any other desired proportion) is reflected to the totally reflecting surface x^2, and thence out of the prism to the film, forming the image at M. The remainder of the light passes on through the surface x^{11} and the prism P^3 to the totally reflecting surface y^2, and thence out of the prism to the film, forming a second image at N, inverted with relation to the image M (one beam having been reflected twice and the other once), so that the pictures on the film appear head-to-head or foot-to-foot. Thus the images are symmetrically disposed relatively to the plane of surface x^{11}, with corresponding points of the

images disposed directly opposite each other equidistantly from the plane, so that the images would exactly register with each other if folded together about the intersection of said plane with the plane of the images. The plane of surface x^{11} therefore constitutes a plane of symmetry.

It is desirable that prisms P^2 and P^3 be right-angled and identical, in order that the optical paths to the two images may be equal. It is also desirable, though not essential, that they form in section an equilateral triangle, in other words, that the angles 1, 2 and 3 be each 60° so that the beam enters normally to the surface. If for any reason it is desired to use other angles a thin auxiliary prism may be interposed, presenting one face, normally to the incident light, and having the other separated by an air-film from surface x^2 of prism P^2. This avoids the dispersion due to obliquity; but no advantages are obtained by departing from the 60° form.

Instead of placing the plane of symmetry behind the lens, that is, between the lens and the film, in which case the beam first passes through the lens and is then split to form two images, it may be placed before two or more lenses, that is between the object and lenses, as shown in Fig. 2, in which case the beam B is first split at the semi-transparent surface x^1 and then the two parts pass through two lenses L^1 and L^2 to the two images M and N on the film. This arrangement makes the point of view of the two lenses the same, and avoids the stereoscopic effect which would result if the light passed directly from the object to the two lenses in two distinct beams. Since one beam has undergone one more reflection than the other, the images will be relatively inverted.

Thus, in order to obtain two pictures from accurately the same point of view at the same time, a plane of symmetry may be used, consisting of a transparent surface placed in a position either behind the lens and essentially symmetrical with respect to the images, or in a position in front of two lenses and essentially symmetrical with respect to them. The arrangement may be varied in several ways, but the essential condition in obtaining relatively inverted images is the presence of such plane of symmetry.

With the use of the plane of symmetry it is possible to get, in the case of one lens, two paths between the lens and the film, of essentially the same lengths; and in the case of two lenses in the two paths from the plane of symmetry to the film, the virtual images of the two lenses coincide, hence the two lenses have precisely the same view point regarding the scene to be photographed. In either case the two paths of the split light beyond the plane of symmetry where the light is split, are completely symmetrical to each other with respect to the plane of symmetry.

With the use of the plane of symmetry systems above described, two identical, or inverted and symmetrical images may be obtained on the film at the same time from precisely the same viewpoint. Such a film with relatively inverted or foot-to-foot pictures is illustrated in Fig. 3, wherein F represents a film of usual form, and F^1 and F^1 a pair of foot-to-foot, simultaneously made pictures of the same scene.

Should it be desired to obtained more than two such pictures, say three or four, this can be accomplished by adding a second symmetrical plane system to the system illustrated in Fig. 1, in the manner presently to be described. This will produce a film with four pictures of the same scene (or three by merely dropping out one picture) taken at the same time, from accurately the same point of view, and arranged symmetrically with relation to two axes, one transverse and one longitudinal of the film, as illustrated in Fig. 6. In this form each picture F^1 on the film F is symmetrically arranged and inverted with relation to the adjoining picture of the pair, whether considered lengthwise or crosswise of the film; and the four pictures are symmetrically and relatively inverted with relation to two axes.

To produce such a film as that shown in Fig. 6, having four pictures of the same scene from the same point of view taken at the same time, the system illustrated in Figs. 4 and 5 may be used, Fig. 5 being an elevation view from the right of Fig. 4. The upper part A represents the same system as Fig. 1, and will produce two images as already explained. In order to get four pictures in symmetrical positions another similar set of prisms, twice as wide, is placed at B in such a position that each ray is split again in a direction at right angles to the former split produced by A. Each of the two split beams from A is again split by the semi-transparent reflecting surface x^4, between prisms P^4 and P^5 (Fig. 4) in the same manner as already described with reference to Fig. 1, resulting in four symmetrical, relatively inverted images as shown in Fig. 6.

In Fig. 7 the heads of the images are directed longitudinally of the film as in

Fig. 3 instead of transversely of the film as in Fig. 6.

Fig. 8 illustrates an optical system to produce a film having one image reversed relatively to two other images of the complemental set as illustrated in Fig. 9. This system comprises a lens L and a pair of prisms P^2 and P^3 corresponding to the similarly designated parts of Fig. 1 and in addition two prisms P and P^{11} interposed between the lens L and the prisms P^2 and P^3. A light-dividing semi-transparent reflector x is placed between prisms P and P^{11}, and a similar reflector x^{11} is placed between prisms P^2 and P^3. Reflector x may transmit substantially two-thirds of the light, half of which is reflected and half transmitted at x^{11}, or the light may be otherwise proportioned between the component beams m, n and o if desired.

A feature in all of the above arrangements is substantial equality between the two or more optical paths from lens to images. This is attained either by complete geometrical symmetry with respect to the surface which splits the beam, or (as in the form shown in Fig. 8) by the optical equivalent of such symmetry, in that the lengths of the paths of the split beams in glass and in air are the same. This is highly advantageous as only in this way can the objective and prism unit be co-ordinated (where a single objective is placed in the path of the main beam in contradistinction to a separate objective in the path of each divided beam) substantially to eliminate the aberrations, *viz.*, curvature of field, chromatic aberration, and spherical aberration, as disclosed in Patent No. 131,422 of 1918.

From the foregoing, it will be evident that the complement images of films as herein disclosed are geometrically identical owing to the identity between the light paths; they are superior with respect to definition owing to the relatively short glass paths; and by virtue of their reverse arrangement they afford many unique advantages among which may be mentioned the following.

With the ordinary multiplex film on which the images are all directed in the same direction, it is impossible to automatically register, with a single set of registering holes for each set of images, the respective images of each complemental set of images, for projection, for printing or for any other purpose, owing to the fact that when the film shrinks or expands (as it inevitably does) the distance between the registering holes and the respective images of the set change different amounts. However, with a film as herein disclosed, the registering holes may be positioned in the lines of symmetry between the images (or bearing a uniform relation to these lines), whereby shrinkage or expansion of the film is rendered harmless inasmuch as the position of the complemental images relative to the corresponding registering holes change uniformly during shrinkage or expansion owing to the symmetrical arrangement of the images of each complemental set. This unique combination between the arrangement of images and the arrangement of registering holes is the principal feature of the present invention and will now be described in detail.

The principal construction of the film whereby it may be engaged by suitable registering means may be varied widely, but for the purpose of this disclosure we have shown the ordinary sprocket holes (r in Figs. 3, 6, 7 and 9) adapted to receive the registering means. Likewise the registering means may take any one of many forms. For example, the registering means may comprise pins having purely a rectilinear motion, the film being advanced to approximate position by the ordinary sprocket wheels and then accurately positioned by the pins reciprocating into the registering holes of the film; or the registering pins may have four motions, *viz.*, first into the film holes, secondly in the direction of the film travel, thirdly out of the film hole, and fourthly back to the starting point, *etc.* The registering pins may be employed both to advance and to register the film or merely to register the film. For the purpose of this disclosure we have merely shown diagrammatically registering pins (R in Figs. 1, 2, 4 and 8) which may be actuated by any suitable means.

The cardinal feature of the invention consists in arranging the registering holes (or other means) uniformly with respect to reference lines (real or imaginary) equidistant from the several images of each complemental set so that the distance from each point of each image to the reference link thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof. In Figs. 3, 6, 7 and 9 the character Z indicates transverse reference lines, and in Fig. 7 Z^1 indicates a longitudinal reference line. The holes r adapted to receive the registering pins may be placed either on the reference lines as shown in Figs. 3, 7 and 9, or they may be spaced from the reference lines a uniform distance throughout the length of the film as shown in Fig. 6, but if the film is to be used under such conditions that there is a substantial shrinkage (or expansion) between the time of

perforating and the time of exposing the registering holes should be approximately on said lines. It is to be understood that each set of complemental images would have at least one reference line and one set of registering holes. By forming the images on one side of the reference line in reversed relationship to the images on the other side, a single set of registering holes serves for a plurality of complemental images.

In Figs. 1 and 4 the registering pins are shown in the plane of symmetry between the symmetrical images for use with a film having its registering holes on said transverse lines as illustrated in Figs. 3 and 7. In Fig. 2 the registering pins are shown displaced from the plane of symmetry for use with a film having its registering holes displaced from said reference lines as illustrated in Fig. 6. In Figs. 8 one set of registering pins are positioned in the plane of symmetry between images N^1 and O^1 and the other set of pins are positioned in the same relation with respect to the image M^1.

It will be evident from the foregoing that the corresponding points of the complemental images are equidistant from said reference lines. For example, in each of Figs. 3, 6, 7 and 9 the primes of the letters F^1 are equidistant from the lines Z. Consequently if the film shrinks (or expands) the distances between said corresponding points and the reference lines of the images will change equally and will therefore remain equal. If the registering holes are positioned on the reference lines they will obviously remain on the lines after shrinkage (or expansion). Likewise if the registering holes are spaced uniformly from said lines before shrinkage they will remain uniformly positioned relatively to the lines after shrinkage.

In the foregoing description the invention has been described more particularly as applied to registering the complemental images longitudinally of the film, but it is also adapted to register the images transversely of the film as will now be illustrated by one example selected from a number of possibilities.

Where the images of each complemental set are distributed along the film longitudinally of the film, as shown in Figs. 3 and 9 for example, the images may be registered transversely of the film by shaping and positioning the registering pins *r* of each set so that one pin fills the holes into which it is inserted, or at least extends the full dimension of each hole transversely of the film, and the other pin, at the other side of the film, does not fill the holes into which it extends but has clearance at least transversely of the film. Thus when the film shrinks (or expands) the smaller pin will still register with its holes by virtue of the lateral clearance which is made adequate to take care of maximum change in size of the film. After shrinkage the full-size pin may fit into its holes more snugly but the changes of dimension of the holes are so slight owing to their small size that the pins will always fit into the holes.

Thus in Fig. 3 for example, the pins at the right-hand side of the film would entirely fill the holes and the pins at the left-hand side of the film would have clearance on each side transversely of the film. With this arrangement the lines Z^1 (one line for each complemental set) extending longitudinally of the film through the centers of the right-hand holes constitute the longitudinal reference lines relative to which the images are transversely registered.

Where the images of each complemental set are distributed along the film transversely of the film, as shown in Figs. 6 and 7, the images may be transversely registered according to the present invention as illustrated in Fig. 7. This method involves registering holes which are uniformly positioned with respect to reference lines longitudinal of the film equidistant from corresponding points of each of the four images of the complemental sets shown, the primes of the four letters F^1, for example, being equidistant from the line. The registering holes of the other complemental sets (not shown) bear the same relation to their corresponding lines Z^1. By placing the registering holes on these lines (or bearing a uniform relation thereto) the images may be exactly registered transversely of the film. In Fig. 7 the registering hole *r* is centered on both the transverse reference line Z and also on the longitudinal reference line Z^1, thereby registering both transversely and longitudinally. A registering hole is, of course, similarly placed with respect to each set of complemental images.

A film as shown in Fig. 9 may be transversely registered as described in connection with Fig. 3, with respect to a longitudinal reference line Z^1, by making the registering pins to fill the holes on this line and making the registering pins on the other side with clearance transversely of the film.

While the many unique capabilities of the improved film will be evident from the foregoing the following may be mentioned as examples.

Using a negative film formed as illus-

trated in Fig. 3 and using a positive film coated on both sides, a subtractive positive may be formed by running the two films through a contact printer, advancing the negative film two image spaces and the positive one image space between each printing operation, and using registering pins in said registering holes of the negative and in similar holes in the positive, the same pins passing through the holes of both films; and then reversing the positive face to face and running the two films through a contact printer in opposite directions, advancing the negative two spaces at a time in one direction and advancing the positive one space at a time in the opposite direction, taking care of course to start the films so that the complemental images will be printed opposite each other on the positive. By using the same registering holes in both printing operations the complemental images are automatically registered with each other.

To produce a three color positive from a negative such as illustrated in Fig. 9, first print one series of negatives on a positive strip, advancing the negative three spaces to one of the positive, secondly print a second positive from a second series of the three negatives, and thirdly print a third positive from the third series of negatives; then develop and dye the respective films; and finally glue them together with the complemental images in registry. By using the registering holes *r* in each of the printing operations and also in the glueing operations the images will be automatically registered in accurate superposition, it being understood that in the printing operations the left-hand set of holes *r* (Fig. 9) would be used in printing series M^1 and the right-hand set of holes *r* would be used in printing each of the other two series N^1 and O^1.

Another advantage of the improved film is afforded in additive projection of the images. With the ordinary multiplex film where the images are directed in the same direction, the images can be framed and registered only by separate sets of mechanism, a set of mechanism for registering being required in addition to the framing mechanism owing to variations in the film due to shrinkage or expansion. With the present film on the other hand, wherein the complemental images are symmetrical with respect to a reference line therebetween, only a single set of mechanism is required, the images being automatically registered when properly framed.

The apparatus shown in Figs. 10, 11 and 12 comprises a film gate 1 mounted on the casing 2 of a camera, a prism set 3 adjustably mounted on the front of the film gate, a pressure plate 4 movable forwardly and rearwardly to press the film against the forward plate 5 of the film gate, the latter having exposure openings 6 and 7 therein, registering pins 8 movable into and out of engagement with the sprocket holes of the film accurately to position the film, together with mechanism for actuating the positioning pins and for advancing the film through the film gate. The means for advancing the film may be of any suitable type, the type shown in the drawings comprising a pin wheel 9, a star wheel 10, and a sprocket wheel 11 arranged intermittently to advance the film two picture spaces at a time.

The mechanism for accurately positioning the film in the film gate comprises a yoke 41 which carries the registering pins 8, an oscillatory arm 12 for moving the yoke 41 to and fro, the arm 12 being fast on shaft 13 upon which is also fastened an arm 14 carrying at its free end a cam roll 15 engaging a cam 16. The movable pressure plate 4 is normally held out of engagement with the film by means of springs 17, surrounding pins 18, and bearing at their opposite ends against a stationary plate 19 and the heads of the pins 18. After the film has been advanced and positioned the pressure plate 4 is advanced into the position shown in Fig. 11 by means of a spring 20 on arm 12 operating upon the pressure plate through a pin 21 sliding in sleeve 22 on the stationary part of the film gate. The cam for actuating the registering pins is driven in synchronism with the film advancing mechanism by any suitable power means (not shown) so that after the film is advanced two picture spaces the registering pins 8 are advanced accurately to position the film in the film gate, and the pressure plate 4 is advanced to hold the film against the forward pressure plate 5. After the exposure has been made, the registering pins 8 and pressure plate 4 are first withdrawn and the intermitting pin and star wheels then advance the film two picture spaces.

When using positioning pins other than the film advancing pins or teeth and when using advancing means which are always in positive engagement with the film, the advancing means should be adjusted to advance the film only to a position slightly in the rear of its exposure position so that the positioning pins always move the film forwardly, thereby avoiding the injury to the film which might result if the positioning pins moved the film backwardly against the holding action of the advancing means.

As shown in Figs. 1, 2 and 11 the light-

dividing surface 33 is positioned in a plane intersecting the film perpendicularly midway between the images formed on the film in the film gate. The positioning pins are preferably located either in this plane as shown in Fig. 1 or at a distance from this plane equal to half the distance between adjacent sprocket holes as shown in Figs. 2, 10, 11 and 12, the aforesaid effect of film shrinkage (or expansion) being more completely eliminated by locating the pins near said plane. With the positioning pins located as shown in Fig. 1 the lines of symmetry Z of the film bisect the sprocket holes as shown in Fig. 3, whereas with the positioning pins located as shown in Figs. 2 10, 11 and 12 said lines bisect the spaces between the sprocket holes as shown in Fig. 6.

By making one of the registering pins 8 substantially to fit the sprocket holes on one side of the film, and by making the registering pin on the other side narrower than the sprocket transversely of the film, slight changes in the transverse dimension of the film when the film shrinks or expands are accommodated so that the images may be accurately registered both transversely and longitudinally of the film in manipulating the film after it has been initially exposed, pins similar to those shown at 8 being suitable for use in the printer or projector or any other machine in which the film is subsequently to be employed.

In forming the images in reversed relationship a unique advantage results from positioning the images so that the aforesaid positioning openings are symmetrically disposed relative to the transverse lines midway between the reversed images, that is, so that the mid-lines either bisect certain of the openings or bisect the spaces between adjacent openings (in either case of which the openings would register if the film be folded about the mid-lines). This advantage consists in that when the respective series of reversed images are printed on positive films in non-reversed relationship but in the same relation to the sprocket holes or other openings of the positives as the negative images bear to their sprocket holes, the sprocket holes of the positive films register when the films are superposed with their images in registry notwithstanding the positives are printed in non-reversed relation from reversed negatives. This is of particular significance in contact printing where the positives must bear the same relation to their sprocket holes as the negatives bear to their sprocket holes and will be evident from the following.

Considering the superposed positive films to have superposed transverse lines corresponding to each mid-line of the negatives, the sprocket holes adjacent the respective positives of each complemental set lie on the same side of the transverse lines of the set while the sprocket holes adjacent the respective negatives of each set lie on opposite sides of the mid-line of the set. Thus, in contact printing where the relationship between the images and the openings must be the same in the positive films as in the negative film, it is essential that the sprocket holes of the negative be symmetrical relative to the mid-lines in order for the openings of the superposed positive films to register, the registration requirements for the images and openings of the positives being the same as for the images and openings of the negatives if folded about their mid-lines.

Furthermore, the negative may be advanced in the same direction as the positive in printing one positive but in the direction opposite to the direction of positive feed in printing the other positive; and if the positioning openings are symmetrically located relatively to the aforesaid mid-lines the corresponding positioning openings of the respective positives will register when the positives are superposed in such relative position that the complemental images register.

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 cinematographic film having a plurality of series of complemental images taken from the same point of view at the same time in separate areas of the same side of the film, the images of one of the series being reversed with respect to the images of another of the series so that corresponding points of each pair of reversed images remain equidistant from the line of symmetry therebetween throughout shrinkage or expansion of the film.

2. A cinematographic film according to Claim 1 further characterized in that the images of respective series are arranged in a row longitudinally of the film with the aforesaid lines of symmetry extending transversely of the film.

3. A cinematographic film according to Claim 1 or Claim 2 further characterized by sprocket holes (or other registry means) arranged symmetrically with respect to said lines of symmetry so that the lines bisect the holes or the spaces between adjacent holes.

4. The method of making a cinematographic film such as defined in Claim 1 characterized by dividing a beam of light with a partially reflecting and a partially transmitting surface and acting upon the light to bring images of the object-field into focus in the respective divisions of the beam in mutually reversed relationship in adjacent areas on the same side of the film.

5. The method of making a cinematographic film such as defined in Claim 3 characterized by recurrently positioning succeeding sections of the film by engagement with said holes and forming the reversed images on the film in such positions that the openings are symmetrically located relative to the mid-lines between the reversed images.

6. The subject matter of Claim 4 further characterized in that the partially reflecting and partially transmitting surface is disposed in a plane intersecting the film between said areas in symmetrical relationship to the paths of the divided beams and said areas.

7. The subject matter of Claim 4 further characterized in that the partially reflecting and partially transmitting surface is enclosed between two prisms, a cross-section of each prism forming approximately a right-angle triangle and the two triangles together forming an outline having substantially equal sides, the prism surfaces through which the light enters and leaves the prisms being substantially normal to the light paths respectively.

8. The subject matter of Claim 7 further characterized in that the divided beams are each reflected after leaving the partially transmitting and partially reflecting surface to form the reversed images in the same plane.

Dated the 2nd day of May, 1922.

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2nd Edition

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

Fig. 1

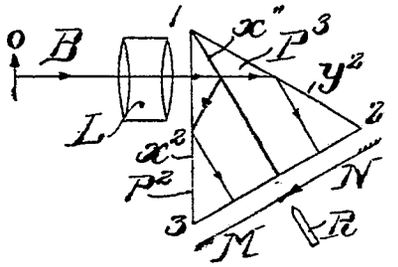


Fig. 2

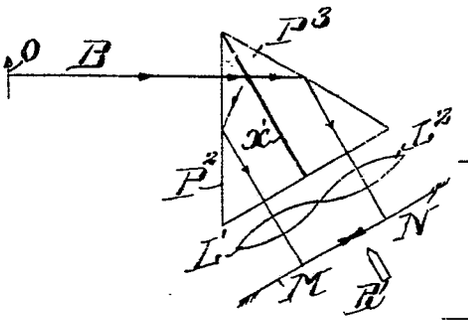


Fig. 3

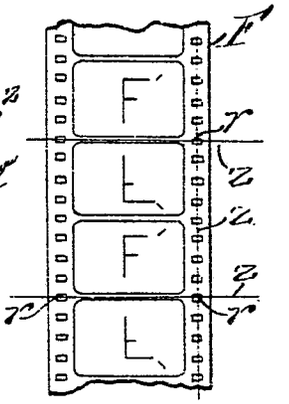


Fig. 4

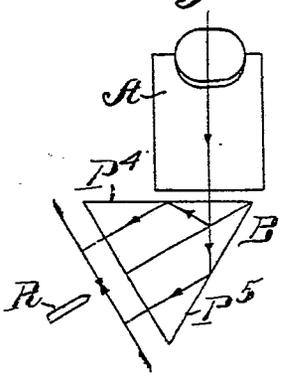


Fig. 5

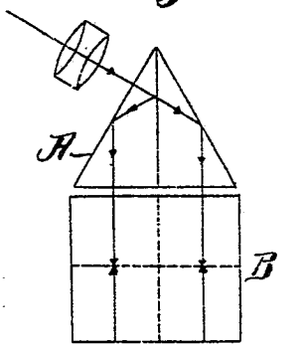


Fig. 6

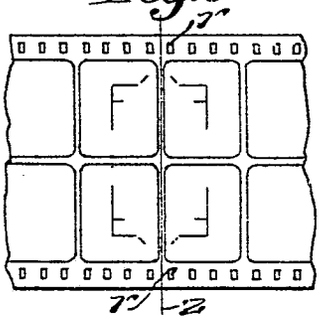


Fig. 8

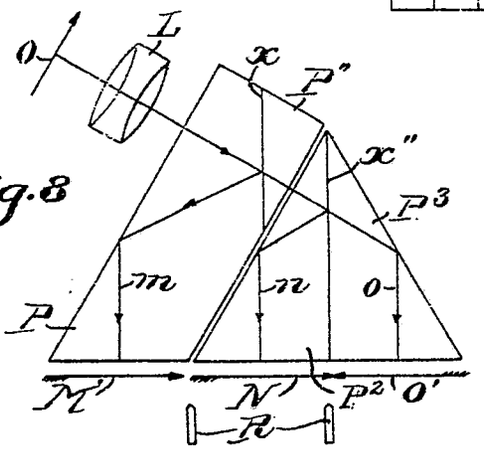
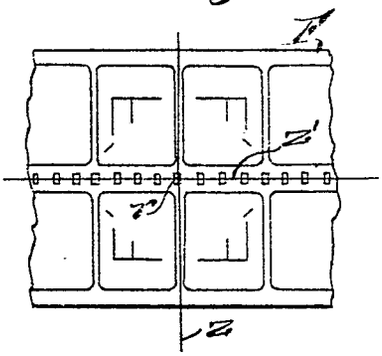


Fig. 7



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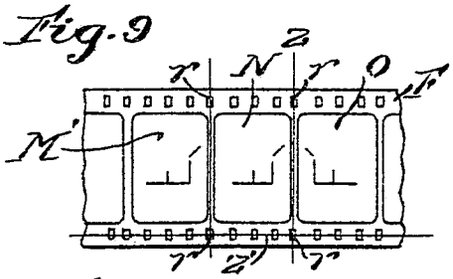
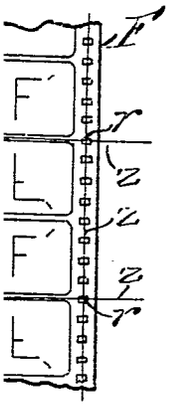


g.3



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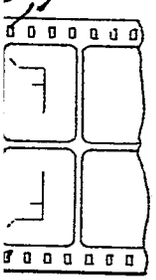

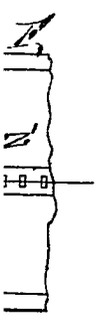

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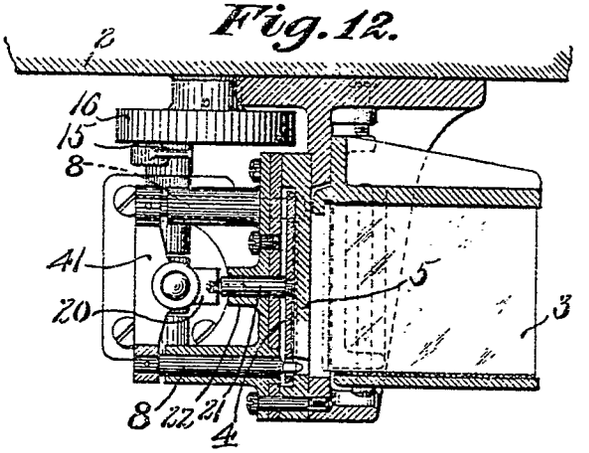

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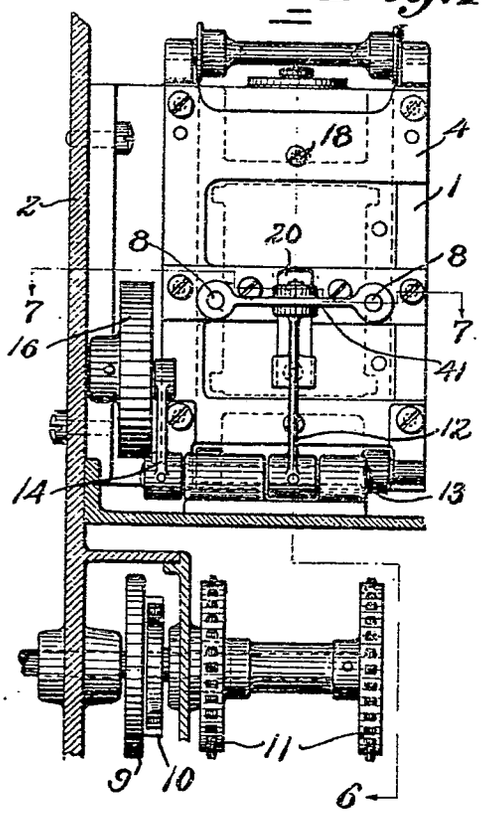
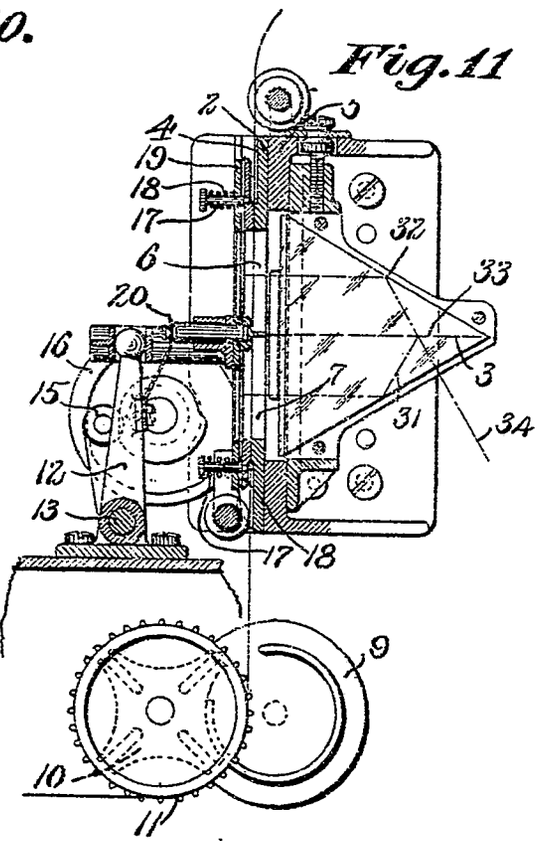


Fig. 11



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194,971 COMPLETE SPECIFICATION

2nd Edition

SHEET 1

2 SHEETS
SHEET 2.

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

Fig.1

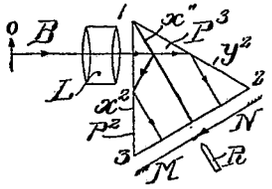
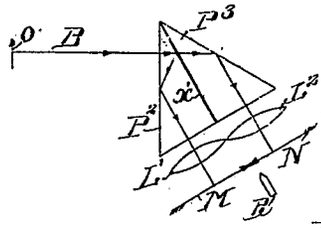


Fig.2



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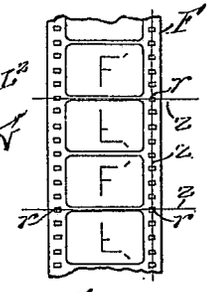
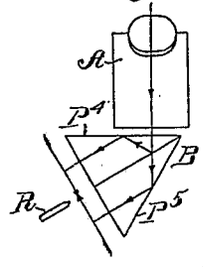


Fig.4



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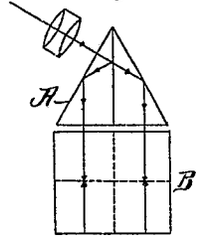

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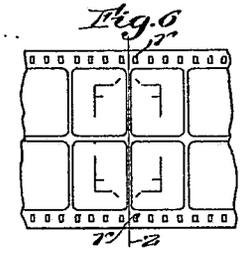

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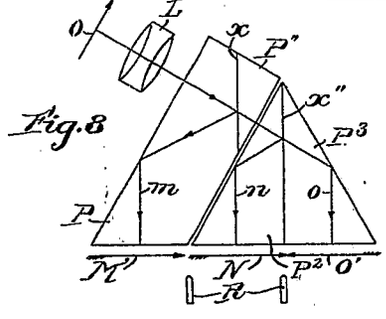


Fig.7

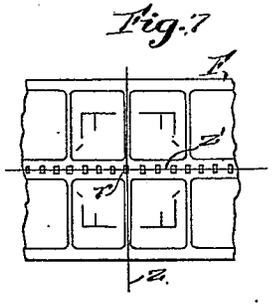
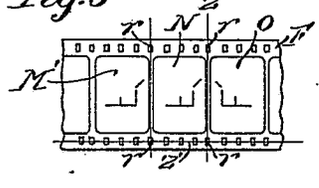


Fig.9



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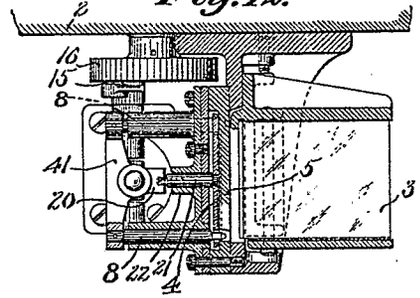

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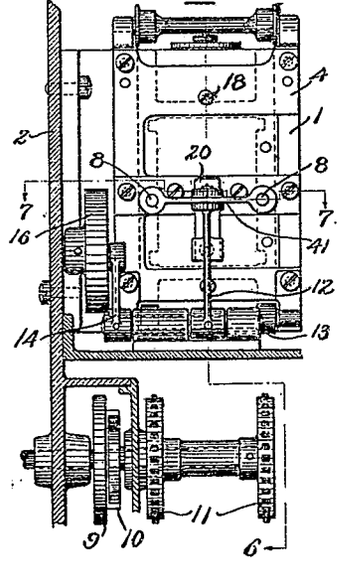
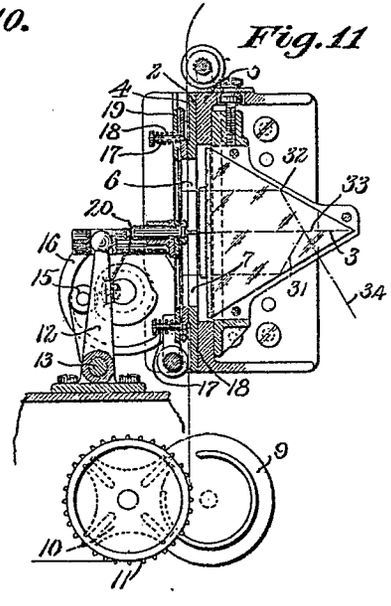


Fig.11



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