Apr. 10, 1923. 1,451,325

D. F. COMSTOCK ET AL

CINEMATOGRAPHIC FILM

Filed Oct. 6, 1920

Fig. 1.

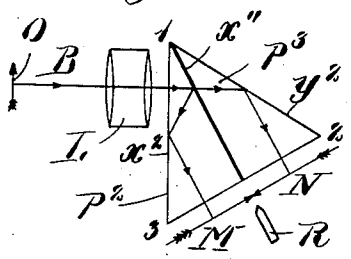


Fig. 2.

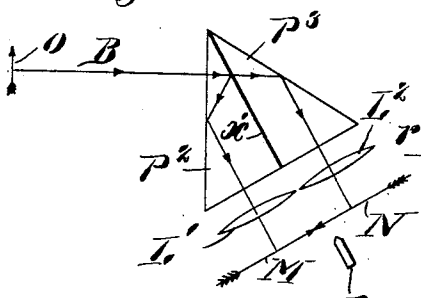


Fig. 3.

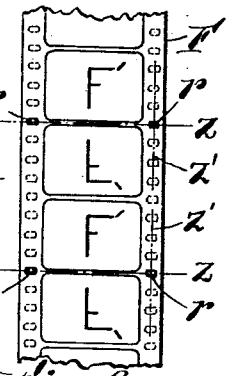


Fig. 4.

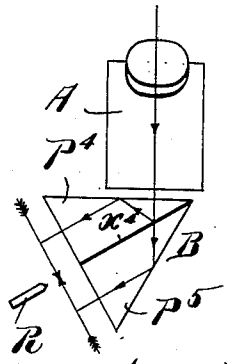


Fig. 5.

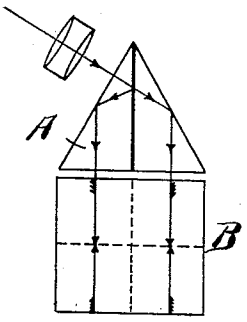


Fig. 6.

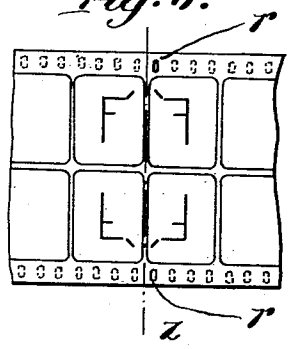


Fig. 8.

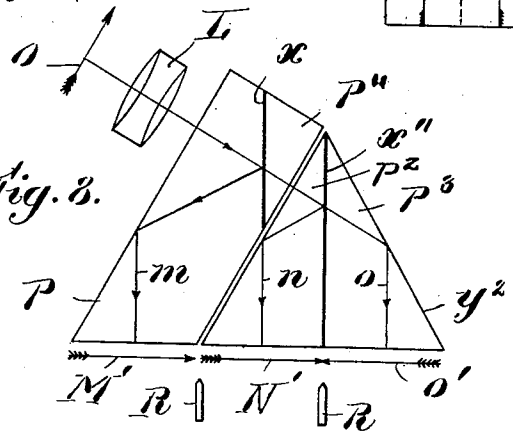


Fig. 7.

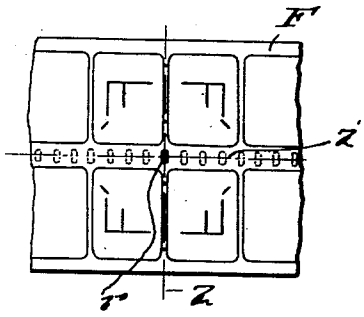
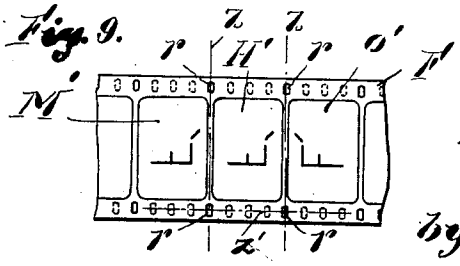


Fig. 9.



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Joseph A. Ball
by Roberts Roberts & Cushman
attys.

Patented Apr. 10, 1923. 1,451,325

UNITED STATES PATENT OFFICE.

DANIEL F. COMSTOCK, OF CAMBRIDGE, AND JOSEPH A. BALL, OF WOLLASTON, MASSACHUSETTS, ASSIGNORS, BY MESNE ASSIGNMENTS, TO TECHNICOLOR MOTION PICTURE CORPORATION, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

CINEMATOGRAPHIC FILM.

Application filed October 6, 1920. Serial No. 415,018.

To all whom it may concern:

Be it known that we, DANIEL F. COMSTOCK and JOSEPH A. BALL, citizens of the United States of America, and residents of Cambridge and Wollaston, respectively, in the counties of Middlesex and Norfolk and State of Massachusetts, have invented new and useful Improvements in Cinematographic Films, of which the following is a specification.

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 substractive 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 registery 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 registery 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 gluing films together with the complemental images in registery, 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 principal object of the present invention is to correlate the registering holes (or other registering means) and the complemental images so that the effect of shrinkage (or expansion) at any time during or after preparation is eliminated and so that after the images are once properly positioned with respect to the registering holes the subsequent registration of the images, whether for reproduction or projection, is automatically accomplished or at least readily and accurately effected by manual means.

The invention consists broadly in a cinematographic film having a plurality of series of complemental images (one series representing one color aspect of the object field, another series another color aspect, etc.), together with registering means arranged uniformly with respect to reference lines equidistant from the several images of each complemental set so that the distance from each point of each image of one series to the reference line thereof is the same as the distance between the corresponding points of the complemental images of the other series to the lines thereof. More specifically the invention is further characterized in that the images of two or more series are symmetrical to the same series of reference lines, whereby one series of registering means may be employed for two or more series of images. Other more specific characteristics of the invention will appear hereinafter.

In the accompanying drawings, which diagrammatically illustrate certain preferred embodiments of the invention;

Figures 1, 2, 4, 5 and 8 represent various optical systems for producing the subject matter of the present invention; and

Figures 3, 6, 7 and 9 represent various forms of my improved film.

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'', 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'' 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'', 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'' therefore constitutes a plane of symmetry.

It is desirable that prisms P^2 and P^3 be rightangled 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' and then the two parts pass through two lenses L' 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 symemtrical 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 view point. 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′ and F′ a pair of foot-to-foot, simultaneously made pictures of the same scene.

Should it be desired to obtain 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′ 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″ interposed between the lens L and the prisms P^2 and P^3, the prisms P and P″ corresponding to the similarly designated parts of Fig. 1 in former application Ser. No. 77,237, filed February 9, 1916. A light-dividing semi-transparent reflector x is placed between prisms P and P″, and a similar reflector x'' 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'', 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 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 coordinated (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 Reissue Patent No. 14,983 granted Nov. 16, 1920.

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 I have shown the ordinary sprocket holes (*r* in Fig. 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. An example of four motion pins adapted both to advance and to register the film is shown in application No. 119,377, filed Sept. 11, 1916. Consequently for the purpose of this disclosure I 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 line thereof is the same as the distance between the corresponding points of the complemental images to the lines therof. In Figs. 3, 6, 7 and 9 the character Z indicates transverse reference lines, and in Fig. 7, Z′ 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) betwen 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 Fig. 8 one set of registering pins are positioned in the plane of symmetry between images N′ and O′ and the other set of pins are positioned in the same relation with respect to the image M′.

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′ 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 4 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 we have shown the pins at

the right-hand side of the film as entirely filling the holes and the pins at the left-hand side of the film as having clearance on each side transversely of the film. With this arrangement the lines Z′ (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′, 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′. 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′, 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′, by making the registration 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 our improved film will be evident from the foregoing the following may be mentioned as examples.

Using a negative film formed as illustrated 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 gluing 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′ and the right-hand set of holes r would be used in printing each of the other two series N′ and O′.

Another advantage of our 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.

We claim:

1. A cinematographic film having a plurality of series of complemental images representing simultaneous aspects of an object field, the images of certain series being interposed between images of other series longitudinally of the film, the film having registering means arranged uniformly with respect to transverse lines equidistant from the several images of each complemental set so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof.

2. A cinematographic film having a plurality of series of complemental images representing simultaneous aspects of an object field from the same point of view, the images of respective series alternating longitudinally of the film, the film having registering means arranged uniformly with respect to transverse lines equidistant from the several images of each complemental set

so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof.

3. A cinematographic film having a plurality of series of complemental images the images of certain series being interposed between images of other series longitudinally of the film, the film having registering means arranged uniformly with respect to transverse lines equidistant from the several images of each complemental set so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof, the images of one series being reversed longitudinally of the film relatively to the images of another series so that the images of the two series are symmetrical to the same series of transverse lines, whereby one series of registering means may be employed for the two series of images.

4. A cinematographic film having a plurality of series of complemental images, certain of the series having the images of each of their complemental sets arranged in reversed relationship so that the images are symmetrical relatively to a reference line midway therebetween, the film having registering means for each of said sets, said registering means being uniformly positioned relatively to said reference lines throughout the length of the film.

5. A cinematographic film having a plurality of series of complemental images, two of the series having the images of each of their complemental sets arranged in juxtaposition and in reversed relationship longitudinally of the film, so that the images of each set of the two series are symmetrical relatively to a transverse line midway therebetween, the film having registering means for each of said sets, said registering means being uniformly positioned relatively to the corresponding transverse lines throughout the length of the film.

6. A cinematographic film having a plurality of series of non-superposed complemental images arranged so that images of each complemental set are symmetrically disposed relatively to a reference line pertaining thereto, the film having registering means for each of said lines, and the respective registering means being uniformly positioned relatively to their corresponding lines throughout the length of the film.

7. A cinematographic film having a plurality of series of non-superposed complemental images arranged so that images of each complemental set are symmetrically disposed relatively to a line transverse of the film, the film having registering means for each of said lines, and the respective registering means being uniformly positioned relatively to their corresponding lines throughout the length of the film.

8. A cinematographic film having a plurality of series of complemental images at least part of the images of each complemental set being so arranged in a row on the film that corresponding points of the images in the row are equidistant from a reference line transverse of the row, and the film having registering means for each of said lines, the respective registering means being uniformly positioned relatively to their corresponding lines throughout the length of the film.

9. A cinematographic film having a plurality of series of complemental images arranged so that each complemental set is symmetrically disposed relatively to a reference line, the film having registering means substantially centered on each of said lines.

10. A cinematographic film having a plurality of series of complemental images arranged so that each complemental set is symmetrically disposed relatively to a reference line, the film having registering means for each of said lines, the respective registering means being uniformly positioned relatively to their corresponding lines throughout the length of the film.

11. A cinematographic film having a plurality of non-superposed complemental images and registering means for each set disposed on a line equidistant from the corresponding points of the set.

12. A cinematographic film having a plurality of series of non-superposed complemental images, images of each complemental set being arranged relatively to a line transverse of the film so that each point of one image of the set is the same distance from the line as the corresponding point of another image of the set, and the film having registering means for each of said lines, the respective registering means being uniformly positioned relatively to their corresponding lines throughout the length of the film.

13. A cinematographic film having a series of sets of complemental images arranged so that each set is symmetrically disposed relatively to a line transverse of the film, the film having registering means substantially centered on each of said lines.

14. A cinematographic film having a plurality of series of non-superposed complemental images, images of each complemental set being arranged relatively to a line transverse of the film so that each point of one image of the set is the same distance from the line as the corresponding point of another image of the set, and the film having registering means substantially centered on each of said lines, whereby the registering means of each set is adapted to position said

images of each set identically notwithstanding variation in the dimensions of the film.

15. A cinematographic film having a plurality of series of complemental images, the images of certain series being interposed between images of other series longitudinally of the film, the film having registering means arranged uniformly with respect to transverse lines equidistant from several images of each complemental set so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof, the images of two of the series having their heads directed in a different direction from those of another of the series.

16. A cinematographic film having at least three series of complemental images, the images of certain series being interposed between images of other series longitudinally of the film, the film having registering means arranged uniformly with respect to transverse lines equidistant from the several images of each complemental set so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof, the images of one series being reversed longitudinally of the film relatively to the images of another series so that the images of the two series are symmetrical to the same series of transverse lines, whereby one series of registering means may be employed for the two series of images.

17. A photographic picture for projection characterized by symmetrically opposite geometrically like simultaneous impressions of an image viewed from the same point of view and arranged on a film having support-engaging means substantially at the place of the line of symmetry, and a registering device adapted to engage said support-engaging means for the purpose of positioning either or both of said impressions.

18. A cinematographic film having a plurality of sets of complemental images, the images of each set being taken simultaneously from the same point of view, the film having registering means arranged uniformly with respect to transverse lines equidistant from the several images of each complemental set so that the distance from each point of each image to the transverse line thereof is the same as the distance between the corresponding points of the complemental images to the lines thereof.

19. A cinematographic film having a plurality of sets of complemental images, the images of each set being taken simultaneously from the same point of view and certain images of each set being arranged in a row, the film having registering means arranged uniformly with respect to reference lines extending transversely of said rows equidistant from the several images of the rows so that the distance from each point of each image of each row to the transverse line thereof is the same as the distance between the corresponding points of the other images of the rows to the lines thereof.

20. A cinematographic film having a plurality of sets of complemental images, the images of each set being taken simultaneously from the same point of view and certain images of each set being arranged in a row transverse of the film, the film having registering means arranged uniformly with respect to reference lines extending longitudinally of the film equidistant from the several images of the rows so that the distance from each point of each image of each row to the transverse line thereof is the same as the distance between the corresponding points of the other images of the rows to the lines thereof.

21. A cinematographic film having a plurality of sets of complemental images, the images of each set being taken simultaneously from the same point of view and being positioned on the film in non-superposed relationship, the film having registering means arranged uniformly with respect to both transverse and longitudinal reference lines equidistant from the several images of each complemental set so that the distances from each point of each image to the transverse and longitudinal lines thereof respectively are the same as the distances between the corresponding points of the complemental images to the transverse and longitudinal lines thereof respectively.

22. A cinematographic film having a plurality of sets of complemental images, the images of each set being taken simultaneously from the same point of view and being positioned on the film in non-superposed relationship, the film having registering means arranged uniformly with respect to both transverse and longitudinal reference lines equidistant from the several images of each complemental set so that the distances from each point of each image to the transverse and longitudinal lines thereof respectively are the same as the distances between the corresponding points of the complimental images to the transverse and longitudinal lines thereof respectively, said registering means being at least in part disposed substantially at the intersections of said transverse and longitudinal lines.

23. A cinematographic film having a plurality of sets of non-superposed complemental images, the images of each set being arranged relatively to a pair of mutually perpendicular reference lines so that the corresponding points of the images are equidistant from said lines respectively, and registering means uniformly positioned rel-

atively to said lines respectively throughout the length of the film.

24. A cinematographic film having a plurality of sets of non-superposed complemental images, the images of each set being arranged relatively to a pair of mutually perpendicular reference lines so that the corresponding points of the images are equidistant from said lines respectively, and registering means disposed at least in part substantially at the intersections of said transverse and longitudinal lines respectively.

Signed by us at Boston, Massachusetts, this fourth day of October, 1920.

DANIEL F. COMSTOCK.
JOSEPH A. BALL.