PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Improvements in Optical Systems for the Projection of Erected Images.

We, ADAM HILGER, LIMITED, a Company organised under the laws of Great Britain, and JOHN HENDRI DOWELL, British subject, both of 98, Kings Road, Camden Road, London, N.W. 1, do hereby declare the nature of this invention to be as follows:—

The invention relates to optical systems adapted for erecting companion images, such as the systems used in projection apparatus for colour kinematography of the kind in which images are arranged side by side, the width of the pictures being along the length of the film. It is necessary in such apparatus to use means for erecting and superposing the images on the screen. The usual practice at present where two images are concerned is to use a pair of projection lenses side by side and to effect registration by relative adjustment of the lenses, an erector being arranged in front of the pair of lenses. In this case the beams of light from the two images remain adjacent and nearly parallel throughout the whole of their path through the erector and are in fact treated as if they appertained to a single image. Such an erector must be of considerable size to accommodate the whole of the beams of light passing through the projection lenses to the screen.

Another known form of apparatus is similarly arranged except that the lenses are not relatively movable and registration is effected by dividing the last reflecting surface of the erector so that the two images can be superimposed on the screen by relative adjustment of the two parts of this surface. The apparatus is usually then so constructed that erection takes place by three successive reflections in the erector; the light emerging in an axial horizontal direction from the lenses is reflected at right angles by the first reflecting surface of the erector to a horizontal transverse direction, then by the second reflecting surface to a vertical direction, and finally by the third reflecting surface to the axial direction again. Thus the first two reflecting surfaces are common to both images. It will be seen that the beams of light from the two images on the film remain adjacent with their optical axes substantially parallel and equidistant throughout the erector system, the pair of images being treated as a single image until the light from them impinges on the third reflecting surface, which, as stated above, is divided into two parts for effecting registration.

In a system of this kind it is difficult to prevent light coming from one image from falling on the reflector part belonging to the other image, unless the reflector parts are separated by such an amount as will ensure separation of the two beams. Separation of the reflector parts in this way entails a serious loss of light, as in practice the erector can seldom be placed in the most favourable position, i.e. so that the images of the condenser formed by the projection lenses fall upon the divided mirror. In this plane the beams of light coming from a pair of lenses overlap by the minimum amount. For example, in a projector as ordinarily used with a condenser of $4\frac{1}{2}$" diameter the condenser image formed by projection lenses of 3" focus would be approximately $\frac{3}{4}$" diameter and as the lenses would be separately by nearly $\frac{1}{2}$" the image would overlap approximately $\frac{3}{16}$".

The available space between the end of the projector lens jacket and the plane in which the condenser image is formed is, in practice, rarely more than 1 to $1\frac{1}{2}$ inches, and it is not possible to arrange an erector in this space with such a short optical path through it as to bring the condenser images into focus on the divided reflector when arranged with the position of the last reflector in known manner.

There is the added difficulty that such reflectors must be surface silvered and under the action of the intense light used they tarnish rapidly, nor can the divided mirror as arranged in known form be replaced by a pair of prisms, since serious reflections would take place along the dividing surface between the two components.

A further difficulty which is encountered with erectors of known form, particularly of the type in which a

divided reflector is used, is due to the pair of beams of light emerging from the system being displaced some distance from the optical axis of the projector so that light emerging from the erector is cut off when passing through the window of the projector room, and since it is necessary that the projector should be set up for showing films of ordinary type by removal of the erector, the machine would have to be shifted to suit an erector in which the light emerges on a different axis.

In an optical system adapted for erecting companion pictures, such as for colour kinematography, according to the present invention, the optical paths of the rays from the companion images are made to diverge before registration.

In such a system according to the invention registration is effected by relative movement of one of the component reflecting surfaces or of a group of them, and the beams of light from the companion images are completely separated prior to registration by reflecting surfaces so displaced out of co-planar setting that a dividing screen can be brought right up to the point where the optical paths of the beams diverge from one another.

This may be effected by arranging the registering reflecting surfaces approximately parallel but staggered. Alternatively a reflecting surface associated with one of the companion images is set at a considerable angle to the corresponding reflecting surface associated with another companion image. In many cases these will be the first reflecting surfaces of the erector on which the light impinges after leaving the projection lenses, but the first reflecting surfaces may be co-planar and the second set at a considerable angle.

In all of the prism systems according to this invention a single lens or pair of lenses can be used for projection, but preferably a pair of lenses, and in what follows it is assumed that a pair is used. The lenses may be mounted in one mount without registration adjustment other than that of rotating the pair together. The erectors according to the invention may be arranged so that all, or some of the following improvements are achieved:—

(a) Registration of the images by adjustment of a single unit of the erector, such adjustment consisting of either motions in two directions at right angles or alternatively a motion in one direction and means for rotating the pair of lenses (which is in effect equivalent to one of the adjustments on the erector).

(b) Incorporation of means whereby light coming from one picture cannot interfere at the registering reflector with light coming from the other picture, since the dividing plate can be brought right up to the point where the condenser images are formed.

(c) An erector entirely constructed with prisms as reflecting surfaces, thus dispensing with surface silvered glasses.

(d) The displacement of the emergent optical axis, i.e. the axis midway between the axes of the two emergent beams, in relation to that of the entering beams reduced to zero or approximately so.

(e) The use in the projector in its normal position, i.e. emulsion towards the condenser, of film taken by a camera without an erecting system

(f) No rotation of the projected images caused by rotation of the erector.

Some typical embodiments of the invention will now be described, and it will be understood that where separate prisms are mentioned in the description two or more such prisms may in suitable cases be constructed as a single block of glass. For the sake of clarity in the description it will be assumed that the apparatus is viewed from the projection screen.

A simple form of erector which achieves the advantages enumerated under (a), (b) and (c) above is made up of four right angled prisms reflecting at the cathetus surfaces. Three of the prisms are cemented together and are adapted to erect one image. The first of these three prisms is set to reflect the axial ray from the left hand projector lens horizontally to the left; the second prism is cemented to the left hand face of the first and reflects this ray vertically upwards; the third prism is cemented to the top face of the second and reflects the ray again into the axial direction. The image is thus rotated through 90° by means of the three reflections. The fourth prism is parallel to the first at the same vertical height, but staggered in relation to it, being further to the right and axially further from the lens. It thus reflects the axial ray from the right hand projector lens horizontally towards the left. This ray then impinges on the second prism, which for this purpose is extended forward beyond the part in contact with the first prism. The entrance face for the ray in question is thus a continuation of the contact face between the first and second prisms. The third prism is correspondingly extended forward to accommodate this ray.

To provide for registration the fourth prism is made adjustable in one or preferably in two directions. One movement should be about a vertical axis and the

other about a horizontal axis preferably parallel to the optical axis of the lens. It will be seen that the two images are rotated through 90° in passing through the erector, but if the reflecting surface of the fourth prism were strictly parallel to that of the first, without the registration adjustment just mentioned, it would be found that the two edges of the images previously in contact now form the outer edges, and the previous outer edges are now in contact, the light from the two images having been caused to diverge before registration and then having their relative disposition changed.

Since the optical path length is different for each of the images, a compensating lens is employed in one of the paths, or preferably a spherical surface is worked on one of the prism surfaces of either the first or the fourth prism as convenient, so as to bring both images into focus in one plane.

Another form of erector which achieves the advantages enumerated under (a), (b) and (c) above, comprises six prisms, three for each image. Five of the prisms are cemented together and the remaining one is movable relatively to the others to provide for registration. The prisms are all set to reflect from the cathetus faces. The first prism for the left hand image reflects the axial ray coming from the left hand projector lens vertically downwards, the second then reflects it horizontally towards the right and the third reflects it into the axial direction again. The optical axis of this image is thus displaced downwards by approximately the distance separating the optical axes of the two images, and to the right by about the same amount.

The first prism for the right hand image is mounted on the same horizontal level as that for the left hand image, and immediately to the right of it. It is set to reflect the axial ray vertically upwards. The second prism reflects this ray horizontally to the left and the third prism reflects it again into the axial direction. Thus the right hand picture is brought out above the left hand picture, the two being transposed with reference to the vertical axial plane and both being rotated through 90°. The prism which is movable in relation to the other five is one of the third prisms; it is adjustable about two axes at right angles to register the images on the screen, while the other five are stationary. Interference between the two images is prevented by continuing the dividing screen from between the lenses to pass between the two first prisms.

Owing to the small size of the prisms used and their arrangement in relation to the lens, the displacement of the emerging light symmetrically arranged is small enough to allow the light to pass through an ordinary projection room window.

A third form of erector achieves all the six advantages enumerated under (a) to (f) above. In this form there are two separate units, one for each image, each unit having three right-angled prisms, but the second prism of each unit is arranged so that the cathetus surface is used for entrance and exit of the light, reflection taking place from the other two faces through a total angle of 180°. The first and third prisms reflect the light as before from their cathetus faces.

Referring first to the set of prisms for the left hand image, the second prism is mounted with its cathetus face horizontal and its opposite or 90° edge at 45° to the optical axis of the lens system and below the cathetus face. The direction of this edge is away from the lens from right to left. The other two prisms are mounted on the cathetus face of the second, the entrance face of the first and the exit face of the third being perpendicular to the optical axis of the lens system. The first prism reflects the axial ray downwards into the second prism in which it is reflected horizontally across to the right at an angle of 45° to the axial direction, then up into the third prism, which reflects it again into an axial direction nearly in line with the entrant ray from the right hand image.

The set of prisms for the right hand image is arranged similarly, but the second prism is on top of the first and third with its 90° edge above the cathetus face in a direction at right angles to the corresponding edge of the other second prism. It will be seen that the first and third prisms will fit in between those for the left hand image since each third prism is located further from the lens system than the first prism of the other set.

One of the units is preferably stationary in its mount, and the other provided with one or with two adjustments at right angles, said adjustments being arranged to produce rotation each about an axis lying in a vertical plane inclined at 45° to the optical axis, and inclined on either side of the vertical by 45°, a fixed common pivot point being arranged at the intersection of the two axes. Preferably the adjustment is applied to the lower unit.

Interference of light from the images is prevented by extending the lens dividing plate between the two first prisms.

Rotation of either unit about an axis parallel to the optical axis or parallel movement in any direction will not cause rotation of the image, the system being the optical equivalent of a thick glass plate from this point of view.

Since four reflecting surfaces are used in each unit, the erector is particularly suitable for the projection of film taken by a camera not fitted with an erecting device, i.e. operating on its side, since such films can be used in the projector the normal way round, that is, emulsion side towards the condenser. Film taken by an erecting camera can, of course, be used, but the projected film must then be reversed, i.e. emulsion side towards the screen.

A fourth possible arrangement may be considered as being derived from the last named. In this the first prism reflects the light horizontally to the left in the case of the set for the left hand picture, and the second prism has its cathetus face in a vertical plane parallel to the optical axis of the lens system. The set for the right hand picture is similarly arranged on the other side. In this case the emergent beam from the left hand image is vertically below the entrant beam therefrom, and that from the right hand picture vertically above the entrant beam therefrom. The exit apertures are thus displaced symmetrically about the optical axis, but only by a small amount which would not interfere with projection through the average projection box window. Registration adjustment may be carried out as in the arrangement just previously described.

A further modification of the last described arrangement makes it suitable for use with film in which the companion images are oppositely oriented. All that is necessary is to rotate one of the second prisms by 90° in the plane of its cathetus face, keeping the associated first and third prisms parallel to their original position, but placing the third prism adjacent to the other third prism. The particular prism to rotate will be governed by the relative orientation of the images on the film, i.e. top to top or bottom to bottom and this will also determine whether the adjacent emergent faces will be above or below the entrant faces.

The specific description has been given in every case in relation to two companion images. It is clear that with comparatively simple modification the erectors described can be used for registering more than two companion images.

Dated this 24th day of December, 1931.

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COMPLETE SPECIFICATION.

Improvements in Optical Systems for the Projection of Erected Images.

We, ADAM HILGER, LIMITED, a Company organised under the laws of Great Britain, and JOHN HENDRI DOWELL, British subject, both of 98, Kings Road, Camden Road, London, N.W. 1, 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:—

The invention relates to optical systems adapted for erecting companion images, such as the systems used in projection apparatus for colour kinematography of the kind in which images are arranged side by side, the width of the pictures being along the length of the film. It is necessary in such apparatus to use means for erecting and superposing the images on the screen. The usual practice at present where two images are concerned is to use a pair of projection lenses side by side and to effect registration by relative adjustment of the lenses, an erector being arranged in front of the pair of lenses. In this case the beams of light from the two images remain adjacent and nearly parallel throughout the whole of their path through the erector and are in fact treated as if they appertained to a single image. Such an erector must be of considerable size to accommodate the whole of the beams of light passing through the projection lenses to the screen.

Figures 1 to 6 of the accompanying drawings illustrate the problem to be solved by the invention. In these

Figure 1 is a diagram of rectified light paths through the projection apparatus,

Figures 2, 3 and 4 are plan, side view and front view respectively of a known optical system for the purpose mentioned and slightly different from that already referred to, and

Figures 5 and 6 are diagrams showing

the effect of a modification of such a system.

Referring to figure 1, N represents the condenser, M the film, L_1 L_2 the pair of lenses, and rays are drawn in to indicate the path of light through the lens L_1.

In the form of apparatus shown in figures 2, 3 and 4, the erector is combined with a pair of lenses not relatively movable. In this case registration is effected by dividing the last reflecting surface of the erector so that the two images can be superimposed by relative adjustment of the two parts of this surface. The apparatus is usually then so constructed that erection takes place by three successive reflections in the erector; the light emerging in an axial horizontal direction from the lenses is reflected at right angles by the first reflecting surface A of the erector to a horizontal transverse direction, then by the second reflecting surface B to a vertical direction and finally by the third reflecting surface C to the axial direction as shown by the arrow-head lines. Thus the first two reflecting surfaces A and B are common to both images. It will be seen that the beams of light from the two images on the film remain adjacent with their optical axes substantially parallel and equidistant throughout the erector system, the pair of images being treated as a single image until the light from them impinges on the third reflecting surface C, which, as stated above, is divided into two parts for effecting registration.

In a system of this kind it is difficult to prevent light coming from one image from falling on the reflector part belonging to the other image, unless the reflector parts are separated by such an amount as will ensure separation of the two beams. Separation of the reflector parts in this way entails a serious loss of light, as in practice the erector can seldom be placed in the most favourable position, i.e. so that the images of the condenser formed by the projection lenses at the plane R of figure 1 fall upon the divided mirror C. In this plane the beams of light coming from a pair of lenses overlap by the minimum amount. For example, in a projector as ordinarily used with a condenser of $4\frac{1}{2}$" diameter the condenser image formed by projection lenses of 3" focus would be approximately $\frac{3}{4}$" diameter and as the lenses would be separated by nearly $\frac{1}{2}$" the image would overlap approximately 3/16".

The available space between the end of the projector lens jacket and the plane R in which the condenser image is formed is, in practice, rarely more than 1 to $1\frac{1}{2}$ inches, and it is not possible to arrange an erector in this space with such a short optical path through it as to bring the condenser images into focus on the divided reflector when the position of this reflector is as shown in the known arrangement already described.

There is the added difficulty that such reflectors must be surface silvered and under the action of the intense light used they tarnish rapidly, nor can the divided mirror as arranged in known form be replaced by a pair of prisms, since serious reflections would take place along the dividing surface between the two components as shown by the arrow-head lines in figures 5 and 6 which are diagrammatic representations of prism systems equivalent to the divided mirror C of figures 2, 3 and 4.

A further difficulty which is encountered with erectors of known form, particularly of the type in which a divided reflector is used, is due to the pair of beams of light emerging from the system being displaced some distance from the optical axis of the projector so that light emerging from the erector is cut off when passing through the window of the projector room, and since it is necessary that the projector should be set up for showing films of ordinary type by removal of the erector, the machine would have to be shifted to suit an erector in which the light emerges on a different axis.

In an optical system adapted for erecting companion pictures, such as for colour kinematography, according to the present invention, registration is effected by relative movement of one of the component reflecting surfaces or of a group of them, and the beams of light from the companion images are completely separated prior to registration by reflecting surfaces so displaced out of co-planar setting that a dividing screen can be brought right up to the point where the optical paths of the beams diverge from one another.

This may be effected by arranging the registering reflecting surfaces associated with the separate images and relatively movable for registration to be approximately parallel but staggered. Alternatively corresponding reflecting surfaces associated with the separate companion images and relatively movable for registration are set at a considerable angle to each other. In many cases these will include the first reflecting surfaces of the erector on which the light impinges after leaving the projection lenses, but the first reflecting surfaces may be co-planar and the second set at a considerable angle.

In all of the prism systems according

to this invention a single lens or a pair of lenses can be used for projection, but preferably a pair of lenses, and in what follows it is assumed that a pair is used. The lenses may be mounted in one mount without registration adjustment other than that of rotating the pair together. The erectors according to the invention may be arranged so that all, or some of the following improvements are achieved:—

(a) Registration of the images by adjustment of a single unit of the erector, such adjustment consisting of either motions in two directions at right angles or alternatively a motion in one direction and means for rotating the pair of lenses (which is in effect equivalent to one of the adjustments on the erector).

(b) Incorporation of means whereby light coming from one picture cannot interfere at the registering reflector with light coming from the other picture, since the dividing plate can be brought right up to the point where the condenser images are formed.

(c) An erector entirely constructed with prisms as reflecting surfaces, thus dispensing with surface silvered glasses.

(d) The displacement of the emerging optical axis, i.e. the axis midway between the axes of the two beams, in relation to that of the entering beams reduced to zero or approximately so.

(e) The use in the projector in its normal position, i.e. emulsion towards the condenser, of film taken by a camera without an erecting system.

(f) No rotation of the projected images caused by rotation of the erector.

In the accompanying drawings figures 1 to 6 have already been referred to. The remaining figures show some embodiments of the invention.

Figures 7, 8 and 9 are plan, side view and front view respectively of one form of erector, the front view being considered in this and all other cases as a view from the projection screen.

Figures 10, 11 and 12 are plan, side view and front view respectively of another embodiment.

Figures 13, 14 and 15 are half plan, side view and front view respectively of a third form of construction.

Figures 16, 17 and 18 are plan, side view and front view respectively of a fourth arrangement according to the invention.

Figure 19 is a plan partly in section on the line X—X of figure 21 showing a method of mounting the prism system of figures 10, 11 and 12.

Figure 20 is a sectional elevation corresponding to figure 19.

Figure 21 is a front elevation corresponding to the same with the cover removed, and

Figure 22 is a view similar to figure 21 with the cover in place.

It will be understood that where separate prisms are mentioned in the description two or more such prisms may in suitable cases be constructed as a single block of glass.

Referring to the drawings, figures 7, 8 and 9 show a simple form of erector which achieves the advantages enumerated under (a), (b) and (c) above. It is made up of four right angled prisms reflecting at the cathetus surfaces. The first three prisms A_1, B and C are cemented together and are adapted to erect one image. The prism A_1 is set to reflect the axial ray from the left hand projector lens L_1 as viewed from the screen horizontally to the left, the prism B, cemented to the left hand face of the prism A_1, reflects this ray vertically upwards and the prism C cemented to the top face of the prism B reflects the ray again into the axial direction. The image is thus rotated through 90° by means of the three reflections. The fourth prism A_2 is parallel to A_1 at the same vertical height, but staggered in relation to it, being further to the right and axially further from the lens. It thus reflects the axial ray from the right hand projector lens L_2 horizontally towards the left. This ray then impinges on the second prism B which for this purpose is extended forward beyond the part in contact with the prism A_1. The entrance face for the ray from lens L_2 is thus a continuation of the contact face between the prisms A_1 and B. The prism C is correspondingly extended forward to accommodate this ray. The dividing plate S between the lenses L_1 and L_2 is extended right up to the prism A_1 so that light cannot pass from either lens into that part of the erector system associated with the other.

To provide for registration the prism A_2 is made adjustable in one or preferably in two directions. One movement should be about a vertical axis and the other about a horizontal axis preferably parallel to the optical axis of the lens. It will be seen that the two images are rotated through 90° in passing through the erector, but if the reflecting surface of prism A_2 were strictly parallel to that of prism A_1 without the registration adjustment just mentioned it would be found that the two edges of the images previously in contact now form the outer edges and the previous outer edges are now in contact, so that the relative dis-

position of the companion images is changed.

Since the optical path length is different for each of the images a compensating lens is employed in one of the paths, or preferably a spherical surface is worked on one of the surfaces of either prism A_1 or prism A_2 as convenient, so as to bring both images into focus in one plane.

Another form of erector which achieves the advantages enumerated under (a), (b) and (c) above is shown in Figures 10, 11 and 12. This erector comprises six prisms, three for each image. Five of the prisms are cemented together and the remaining one is movable relatively to the others to provide for registration. The prisms are all set to reflect from the cathetus faces. The first prism A_1 for the left hand image reflects the axial ray from the left hand lens vertically downwards, the second prism B_1 reflects it horizontally towards the right and the third prism C_1 reflects it into the axial direction again. The optical axis of this image is thus displaced downwards by approximately the distance separating the optical axes of the two images and to the right by about the same amount.

The first prism A_2 for the right hand image is mounted on the same horizontal level as the prism A_1 and immediately to the right of it. It is set to reflect the axial ray vertically upwards. The second prism B_2 reflects the ray horizontally to the left and the third prism C_2 reflects it again into the axial direction. Thus the right hand picture is brought out above the left hand picture, the two being transposed with reference to the vertical axial plane and both being rotated through 90°. The prism C_2 is made separate from the other five and adjustable about two axes at right angles to register the images on the screen. Interference between the two images is prevented by continuing the dividing screen S from between the lenses (not shown) to pass between the two prisms A_1 and A_2.

Owing to the small size of the prisms used and their arrangement in relation to the lens, the displacement of the emerging light symmetrically arranged is small enough to allow the light to pass through an ordinary projection room window.

A third form of erector shown in figures 13, 14 and 15 achieves all the six advantages enumerated under (a) to (f) above. In this form there are two separate units, one for each image, each unit having three right-angled prisms, but the second prism of each unit is arranged so that the cathetus surface is used for entrance and exit of the light, reflection taking place from the other two faces through a total angle of 180°. The first and third prisms reflect the light as before from their cathetus faces.

Referring first to the set of prisms A_1 B_1 C_1 for the left hand image, the second prism B_1 is mounted with its cathetus face horizontal and its opposite or 90° edge at 45° to the optical axis of the lens system and below the cathetus face. The direction of this edge is away from the lens from right to left. The other two prisms A_1 and C_1 are mounted on the cathetus face of B_1, the entrance face of the prism A_1 and the exit face of the prism C_1 being perpendicular to the optical axis of the lens system. The prism a_1 reflects the axial ray downwards into the prism B_1 in which it is reflected horizontally across to the right at an angle of 45° to the axial direction, then up into the prism C_1 which reflects it again into an axial direction nearly in line with the entrant ray from the right hand image.

The set of prisms A_2 B_2 C_2 for the right hand image is arranged similarly, but the prism B_2 is on top of the prisms A_2 and C_2 with its 90° edge above the cathetus face in a direction at right angles to the corresponding edge of the prism B_1. It will be seen that the prisms A_2 and C_2 will fit in between the prisms A_1 and C_1 as will be clear from figures 13 and 14.

One of the units is preferably stationary in its mount, and the other provided with one or with two adjustments at right angles, said adjustments being arranged to produce rotation each about an axis lying in a vertical plane inclined at 45° to the optical axis, and inclined on either side of the vertical by 45°, a fixed common pivot point being arranged at the intersection of the two axes. Preferably the adjustment is applied to the lower unit A_1 B_1 C_1; it is indicated diagrammatically by the screws D E and the pivoting axes shown by chain dotted lines intersecting at the point F and each passing through the point of the screw associated with the other axis.

Interference of light from the images is prevented by extending the lens dividing plate S between the two prisms A_1 and A_2 as shown in figure 13.

Rotation of either unit about an axis parallel to the optical axis or parallel movement in any direction will not cause rotation of the image, the system being the optical equivalent of a thick glass plate from this point of view.

Since four reflecting surfaces are used in each unit the erector is particularly

suitable for the projection of film taken by a camera not fitted with an erecting device, i.e. operating on its side, since such film can be used in the projector the normal way round, that is, emulsion side towards the condenser. Films taken by an erecting camera can of course be used, but the projected film must then be reversed, i.e. emulsion side towards the screen.

A fourth possible arrangement is shown in figures 16, 17 and 18 and has some similarity with the one just described. In this the prism A_1 reflects the light from the left hand picture horizontally to the left, and the prism B_1 has its cathetus face to which the prisms A_1 and C_1 are cemented in a vertical plane parallel to the optical axis of the lens system. The set of prisms A_2 B_2 C_2 for the right hand picture is similarly arranged on the other side as will be clear from the drawing and from the description of figures 13, 14 and 15. In this case the emergent beam from the left hand image is vertically below the entrant beam therefrom and that from the right hand picture vertically above the entrant beam therefrom. The exit apertures are thus displaced symmetrically about the optical axis, but only by a small amount such as would not interfere with projection through the average projection box window. Adjustment may be carried out as in the case of the system shown in figures 13, 14 and 15.

A further modification of the last described arrangement makes it suitable for use with film in which the companion images are oppositely oriented. All that is necessary is to rotate one of the second prisms, say B_2 by 90° in the plane of its cathetus face, keeping the associated prisms A_2 and C_2 parallel to their original position, but placing the prism C_2 adjacent to the prism C_1. The particular prism B_1 or B_2 to rotate will be governed by the relative orientation of the images on the film, i.e. top to top or bottom to bottom, and this will also determine whether the adjacent emergent faces will be above or below the entrant faces. In this case the width of prisms A_1 A_2 C_1 C_2 in figure 18 will preferably be made equal.

The specific description has been given in every case in relation to two companion pictures. It is clear that with comparatively simple modification the erectors described can be used for registering more than two companion pictures.

The various embodiments of the invention which have been described are shown in a more or less diagrammatic way. A more detailed construction will now be described with reference to figures 19 to 22 showing how the erector of figures 10 to 12 may be carried out in practice. It will then be clear how other forms can be built up into instruments of this kind.

Referring to figures 19 to 22 the optical elements consist of three prisms 1, 2 and 3. Prism 1 consists of a prism having three reflecting faces equivalent to the three cemented separate prisms A_1, B_1, and C_1 illustrated in figure 12. Prism 2 corresponds to the two cemented separate prisms A_2 and B_2, and prism 3 corresponds to the prism C_2. The prism 1 is mounted on a plate 4 which may be rotated through a small amount by means of the screw and spring plunger adjustment 5. The prism is retained on the plate 4 by means of the clamp screw 6 on the bracket 7 which presses the prism up against the edges 8 and 9.

The prism 2 is clamped in a similar manner by the screw 10 on the bracket 11 against edges 12 and 13 on the fixed base plate 14. Prism 3 is mounted in a container 15 and is held against two adjustable screws 16 and 17 and one fixed point 18 by means of the spring 19. A clamping screw 20 is also provided so that when correct adjustment is obtained the mount may be securely clamped. The optical parts are protected by the box 21 and cover plate 22. A slot 23 is arranged to take a frame carrying the two colour filters, and a tube 24 to fit the projector jacket on its outside diameter and fit the projection lens in its inside diameter. The adjustment of the erector is carried out as follows:—

The two images are first brought approximately into registration by means of adjusting screws 16 and 17, screw 16 moving the picture as seen on the screen in a horizontal direction, and screw 17 moving the picture in a vertical direction. The one image is then rotated by adjustment 5 until both images are exactly parallel in all directions, for instance, base and sides of both pictures exactly parallel. The pictures are then adjusted into exact registration by adjusting screws 16 and 17 and then the container 15 is clamped by screw 20.

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. An optical system adapted for erecting companion images and projecting them on to a screen in enlarged dimensions, such as for colour kinematography, in which registration is effected by relative movement of one of the component reflecting surfaces or of a group of them,

and the beams of light from the companion images are completely separated prior to registration by reflecting surfaces so displaced out of co-planar setting that a dividing screen can be brought right up to the point where the optical paths of the beams diverge from one another.

2. An optical system adapted for erecting companion images, such as for colour kinematography, in which the registering reflecting surfaces associated with the separate images and relatively movable for registration are approximately parallel but staggered.

3. An optical system adapted for erecting companion images, such as for colour kinematography, in which corresponding reflecting surfaces associated with the separate companion images and relatively movable for registration are set at a considerable angle to each other.

4. An optical system as claimed in claim 1 or 2, for two companion images, comprising three united prisms adapted to reflect the light from one image three times and a separate prism with registration adjustment and approximately parallel to the first of the three united prisms, adapted to reflect the light from the other image into the second of the three united prisms, the second and third of the united prisms being dimensioned to accommodate the light from both images.

5. An optical system as claimed in claim 1 or 3, for two companion images, comprising three united prisms adapted to reflect the light from one companion image three times and three prisms symmetrically situated to the first three, having the first two united and the third provided with registration adjustment and adapted to reflect the light from the other companion image three times.

6. An optical system as claimed in claim 1 or 3, for two companion images comprising two symmetrically situated sets each of three united prisms, one set being provided with registration adjustment, in which each set is adapted to reflect the light from one image four times by constituting the second prism to reflect the light twice, the first and third prisms being united to its cathetus face.

7. An optical system as claimed in claim 6, in which the exit face of one set of prisms is in approximately the same axial location as the entrance face of the other and in front of it, so that the companion images are transposed left and right by the system.

8. An optical system as claimed in claim 6, in which the exit face of one set of prisms is almost vertically above the entrance face when viewed along the optical axis of the projector and that of the other almost vertically below.

9. An optical system as claimed in claim 6, in which the exit faces of both sets of prisms are almost vertically both above or both below the corresponding entrance faces when viewed along the optical axis of the projector.

10. Optical systems adapted for erecting companion images, such as for colour kinematography, substantially as shown in figures 7 to 22 of the accompanying drawings and as described with reference thereto.

Dated the 26th day of September, 1932.

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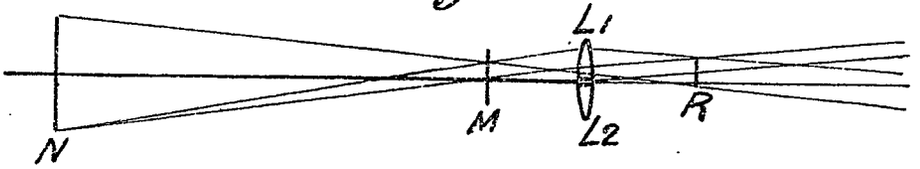
24, Southampton Buildings, London,
W.C. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1933.

Fig. 1.



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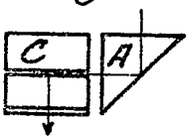

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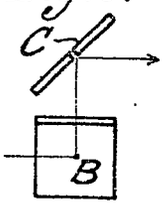

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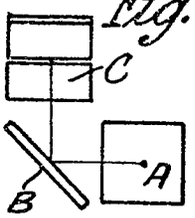

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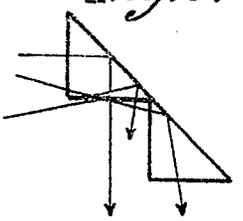

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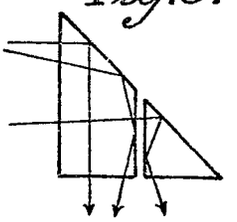

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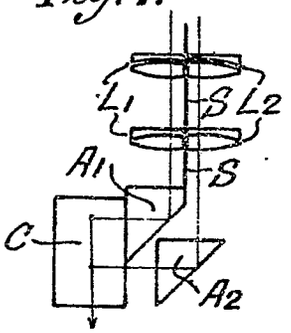

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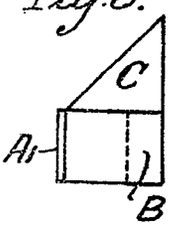

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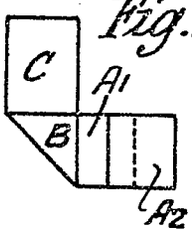

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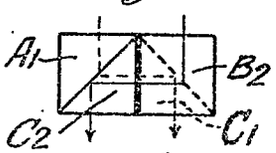

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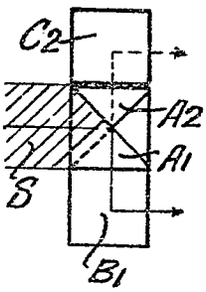

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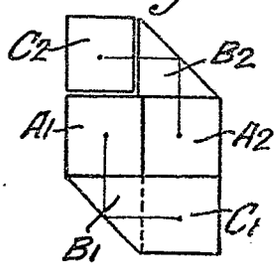

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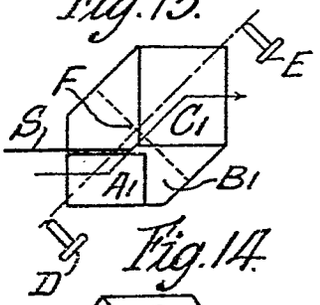

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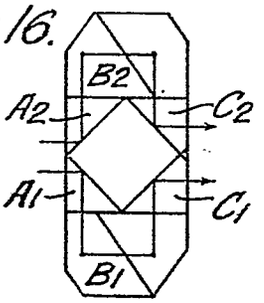

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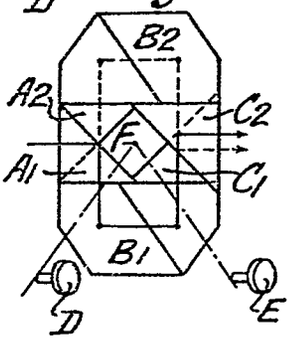

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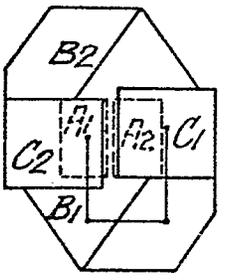

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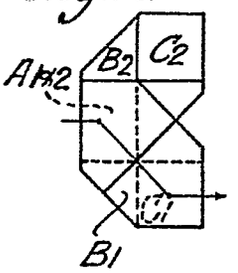

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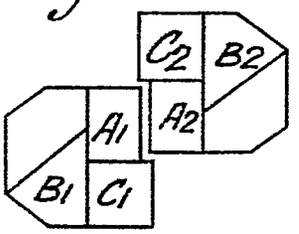

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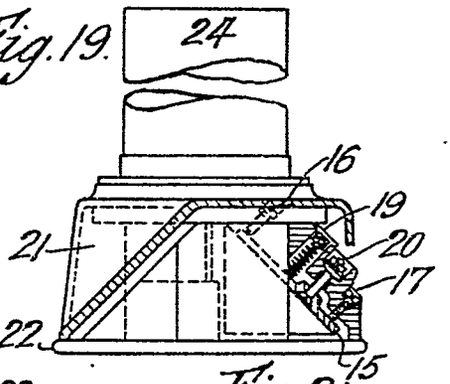

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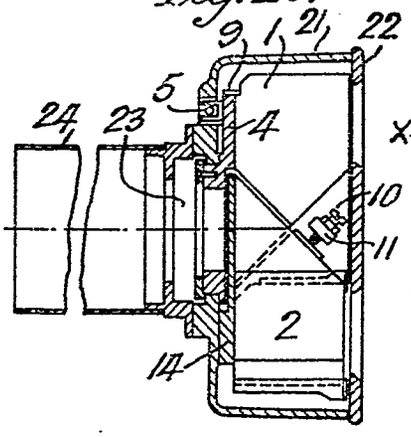

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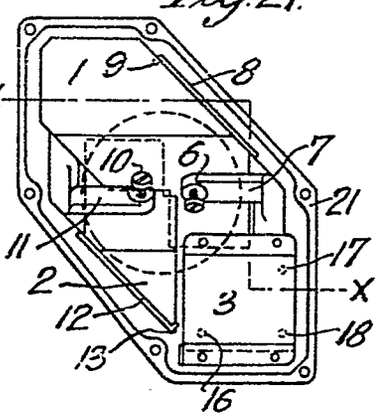

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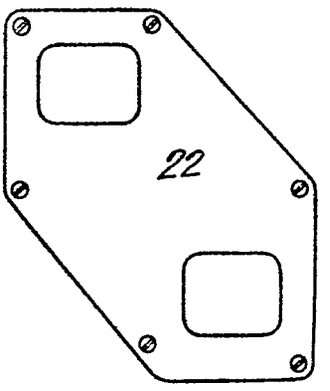

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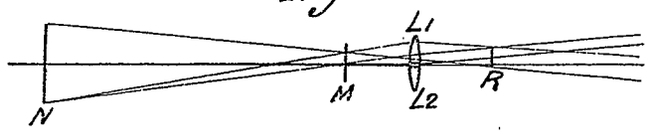

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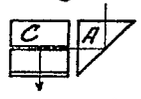

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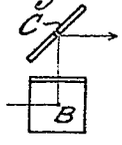

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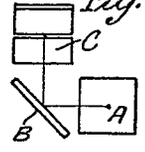

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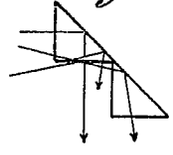

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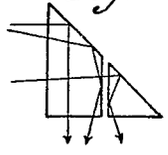

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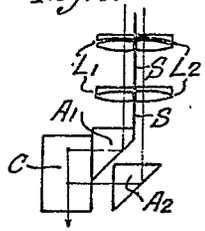

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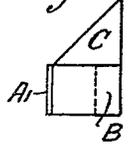

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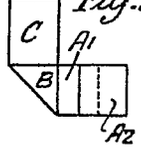

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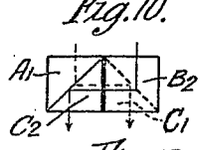

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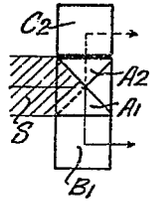

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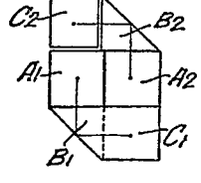

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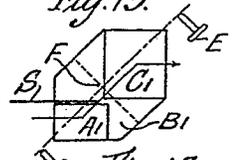

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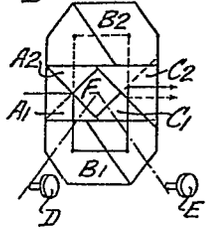

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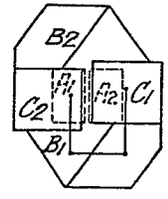

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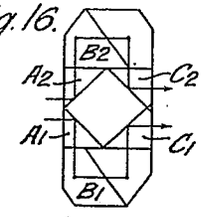

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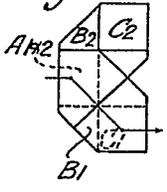

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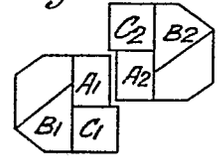

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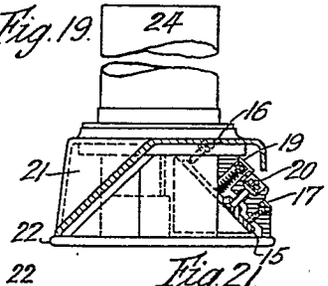

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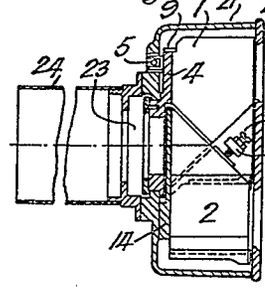

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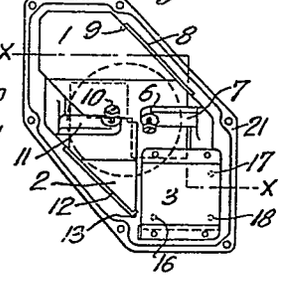

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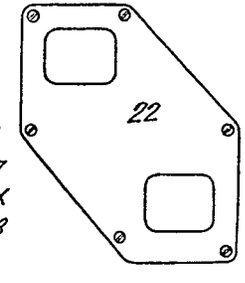

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