Aug. 4, 1936. O. C. GILMORE 2,050,224

PROJECTOR FOR COLOR MOTION PICTURES

Filed Sept. 5, 1933 5 Sheets-Sheet 1

Fig. 1

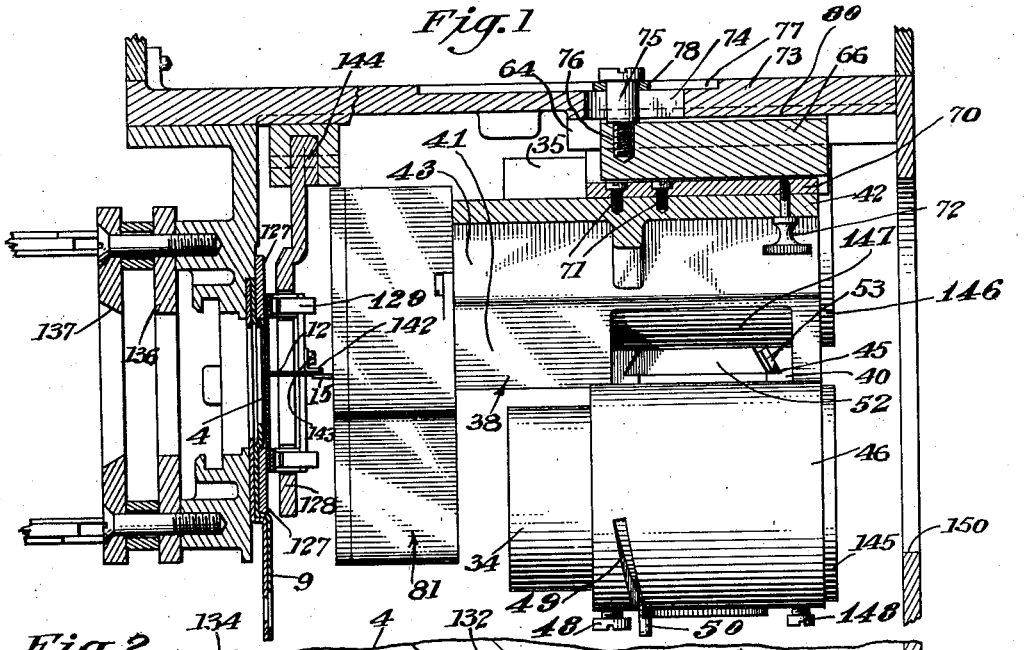
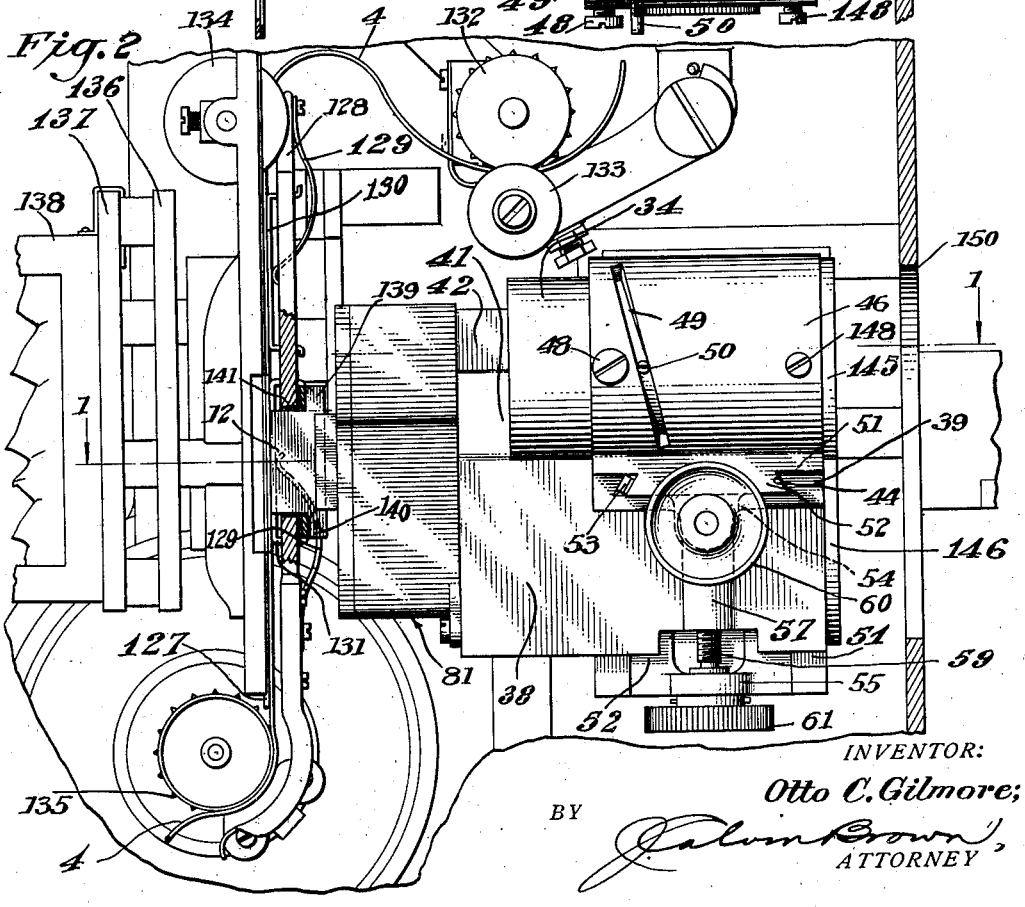


Fig. 2



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PROJECTOR FOR COLOR MOTION PICTURES

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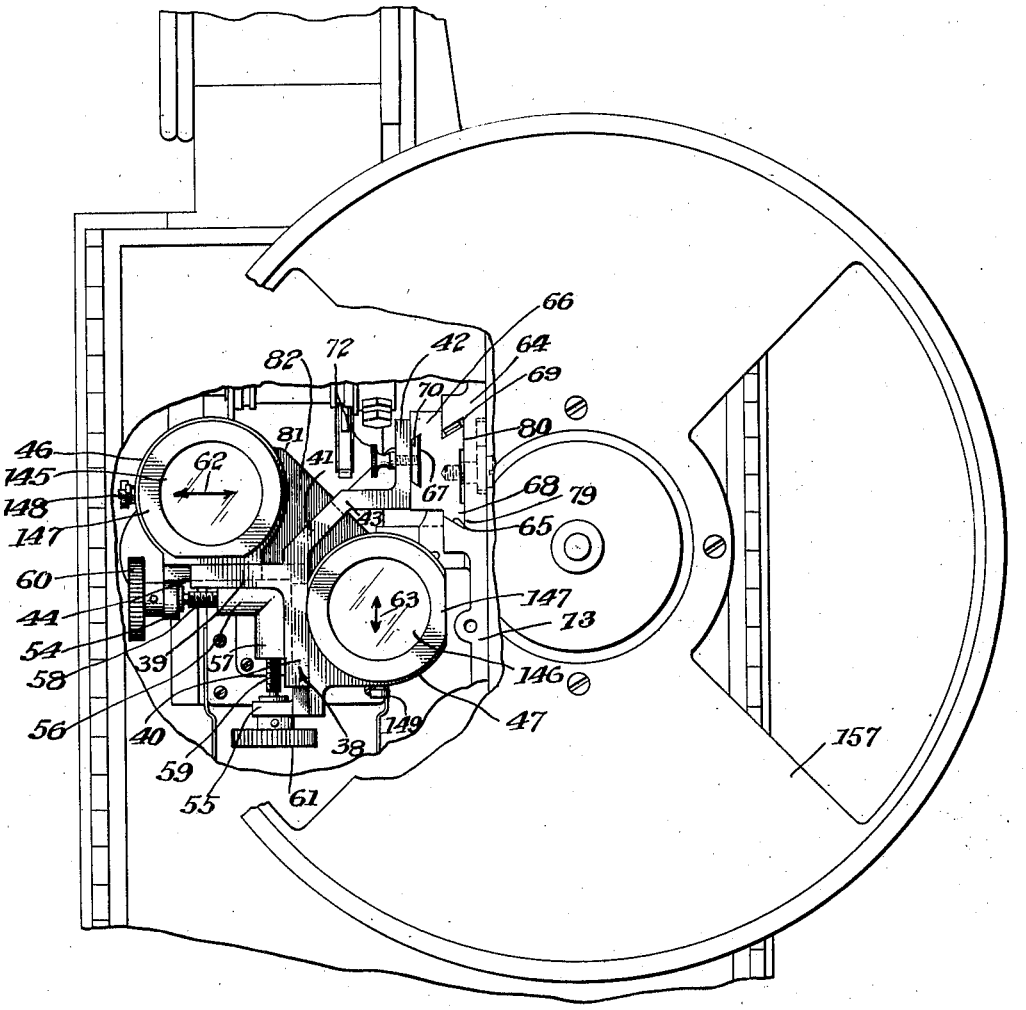

Fig. 3

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PROJECTOR FOR COLOR MOTION PICTURES

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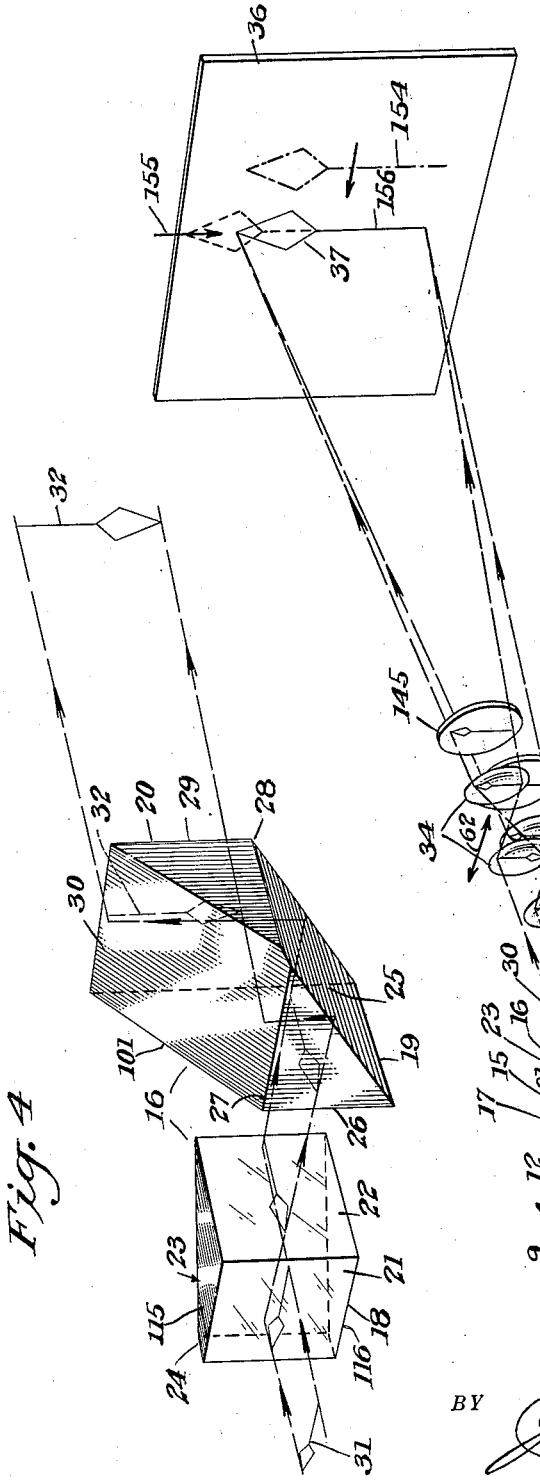

Fig. 4

Fig. 5

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PROJECTOR FOR COLOR MOTION PICTURES

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Fig. 6

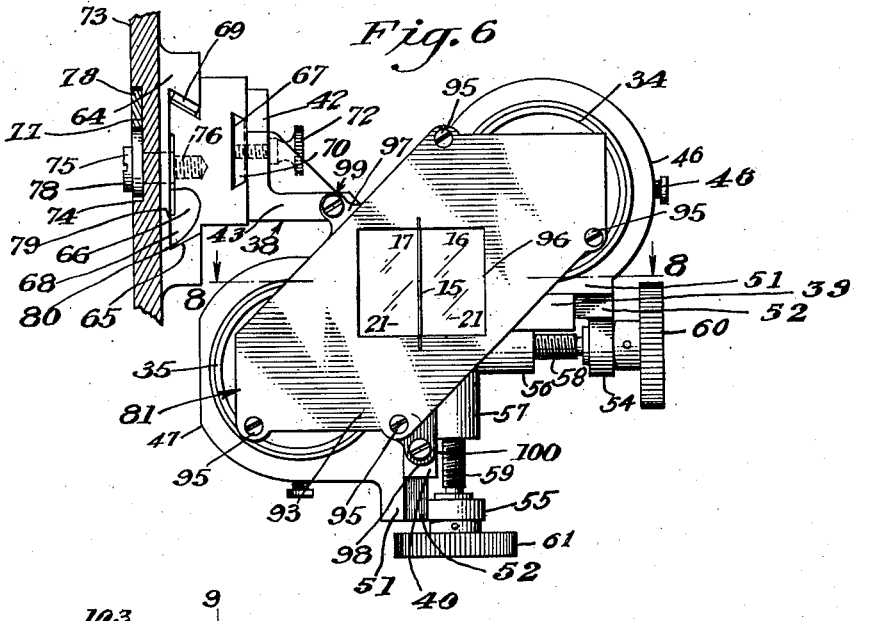


Fig. 7

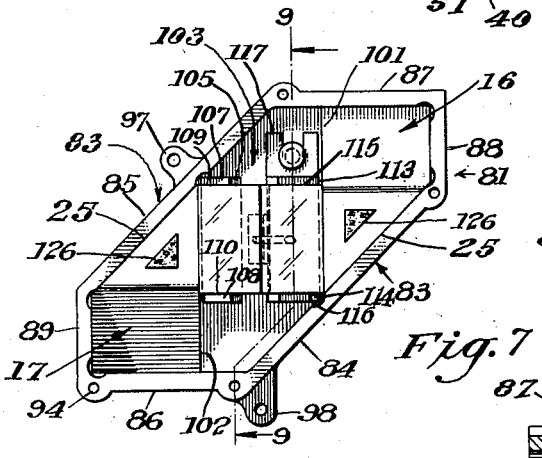


Fig. 10

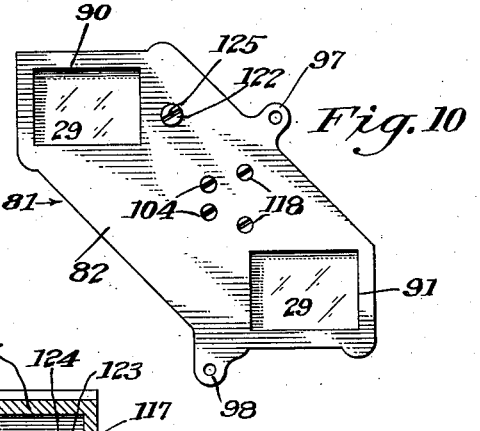


Fig. 8

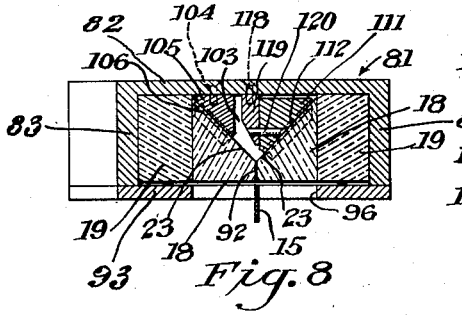
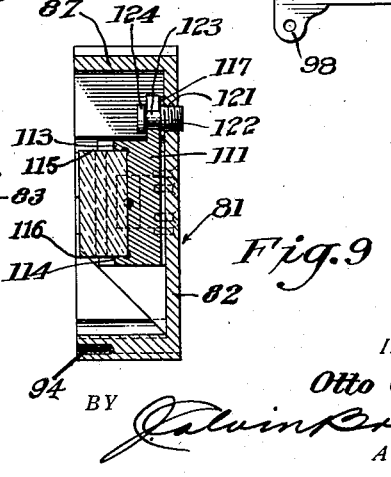


Fig. 9



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Aug. 4, 1936. O. C. GILMORE 2,050,224

PROJECTOR FOR COLOR MOTION PICTURES

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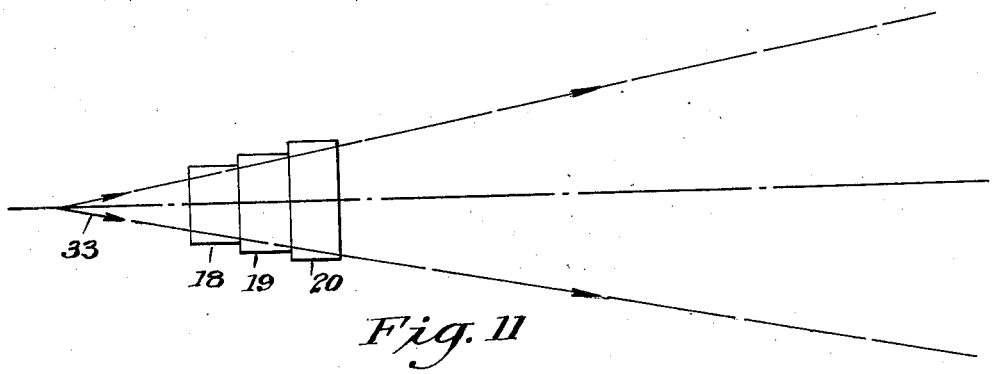

Fig. 11

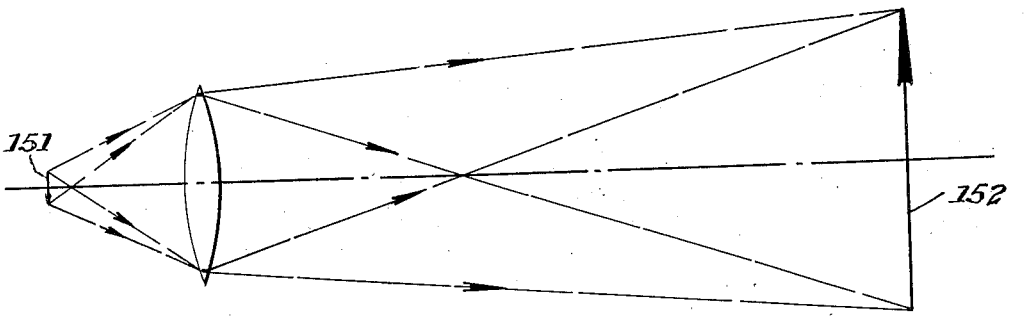

Fig. 12

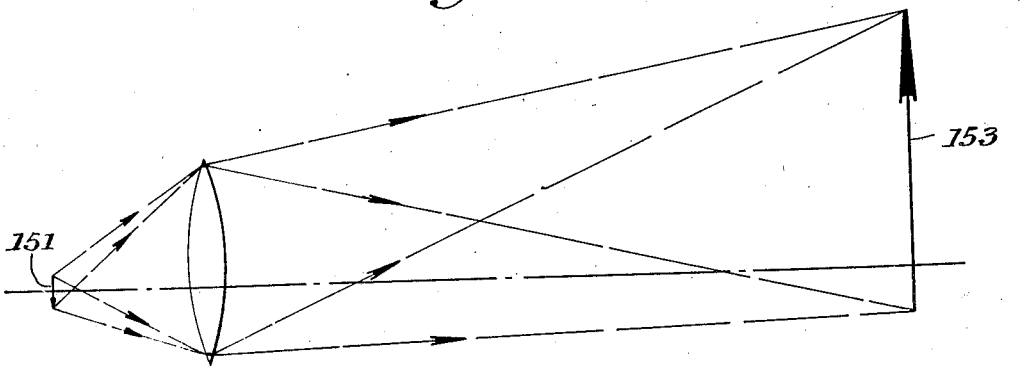

Fig. 13

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Patented Aug. 4, 1936

2,050,224

UNITED STATES PATENT OFFICE

2,050,224

PROJECTOR FOR COLOR MOTION PICTURES

Otto C. Gilmore, Los Angeles, Calif., assignor, by mesne assignments, to Cosmocolor Corporation, New York, N. Y., a corporation of Delaware

Application September 5, 1933, Serial No. 688,150

4 Claims. (Cl. 88—16.4)

This invention relates to projection devices of the type adapted to project pictures in color upon a suitable screen by the additive method.

The invention has for an object the provision of a suitable device so constructed and arranged as to render the same adaptable to any standard type of motion picture projection machine without necessitating change in the projection machine construction.

With respect to the above mentioned object, the average projection machine includes a projector head in addition to other adjuncts, such as the magazines, lamp house, sound equipment, and the like, and within the projector head is received the objective lens. This objective lens is carried upon a sliding block adapted to be fitted to a block in the projector head. Thus, it is possible to change the objective lenses, if desired. With my invention, the character of the projector is readily changed from one adapted to project a black and white picture to that adapted to project pictures in color by the additive method by merely releasing the standard lens from the block and replacing the lens with my attachment. This only requires a short duration of time and therefore makes the projection machine adaptable for two purposes, to-wit, black and white or color.

An object of the present invention is to provide a device suitably constructed to project pictures in color in such a manner that there is a minimum loss of light. When it is realized that the average projector is very wasteful of light, it becomes increasingly necessary when a picture is to be projected in color by the additive method that the device for permitting projection in color should be highly efficient; otherwise, the light loss is so great as to render color projection commercially unfeasible. It can easily be shown that the loss of light in passage through the condenser runs as high as 33% where a double lens is used. About 40% of the circular beam is cut off by the aperture rearward of the film with the result that only 40% of the original light reaches the film. The loss of light in passage through the film, of course, varies, and the density and photometric measurements have shown that as high as 25% of the light may be lost in transmission through the film. The objective usually includes two uncemented lenses, which involve a light loss of 25% or 30% and one cement doublet involving a further light drop to 22%. If the ordinary type of flicker shutter is utilized, the loss of light may amount to as much as 50%, with the result that if the light incident upon the first condenser lens is 12,000 lumens, only 11% passes the shutter; that is, 1300 lumens. Hence, if the light loss in passage through the atmosphere is included and the picture is to be projected upon a screen having an area of say 300 square feet, the light intensity on the screen would be 4.3 foot candles. In addition to his, the character of the screen must be considered. For instance, white cloth reflects from 70% to 75% of the light, and thin white plaster has an albedo value of about 80%. With the above under consideration, it may be readily seen that where the source of illumination must of necessity have the light appreciably reduced and then split as to direction into two paths, for passage through filters, that unless the device is accurately designed, it would be impossible to project upon a screen a picture in colors and still have the picture correct as to color rendering or the action distinct in outline.

With the present invention, I have so balanced and arranged the various elements thereof as to effect a saving in light, to the end that a picture may be projected upon a screen which will have a wealth of detail and recreate in color the original photographed object field.

Another object is to provide a construction whereby various optical elements adapted to split a beam of light may be accurately adjusted, to the end that the divided light pencils are parallel.

Another object is the provision of a device for the projection of pictures in color by the additive method so formed and constructed that the projected colored images may be accurately overlapped.

Another object is the provision of a device adapted to permit projection of pictures in color by the additive method in which there is no "stopping down" effect or side cutting of the light rays.

A further object of the invention consists in the utilization of prism elements so constructed as to permit passage of light therethrough, the minimum amount of glass being utilized.

With respect to the last mentioned object, it may be mentioned that the prism elements are adapted to give an image turning of 90°. Ordinarily, a prism adapted to accomplish this result would be of large size, resulting in great light loss, and further impractical because such a device would be so large as to prevent its placement within the ordinary type of projector head. I have, however, provided prism sets so constructed that a minimum amount of glass is utilized to turn the light pencil 90°.

Other objects of the invention will be set forth as the invention is described in detail, among which objects are simplicity and ruggedness of construction, and adaptability to various uses.

With the above and other objects in view, the invention consists in the novel and useful provision, formation, construction, association, and relative arrangement of parts, members, and

features, all as shown in certain embodiments in the accompanying drawings, described generally, and more particularly pointed out in the claims.

In the drawings:

Figure 1 is a sectional view on the line 1—1 of Figure 2, and shows the invention within a projector head,

Figure 2 is a side elevation of the showing of Figure 1,

Figure 3 is a fragmentary front elevation of the invention associated with a projection machine,

Figure 4 is a perspective view of certain of the optical elements of the invention, the direction of the path of light therethrough being indicated.

Figure 5 is a diagrammatic view showing the invention and general path of light through a film, the invention, and resultant projected picture upon a screen,

Figure 6 is a front elevation of the invention,

Figure 7 is a plan view showing certain of the optical elements within a casing, the cover being removed,

Figure 8 is a sectional view on the line 8—8 of Figure 6,

Figure 9 is a sectional view on the line 9—9 of Figure 7,

Figure 10 is a plan view of the base of the casing adapted to house the optical elements shown in Figure 7,

Figure 11 is illustrative of the passage of a light pencil through optical elements,

Figure 12 is illustrative of the passage of a light pencil through a lens when the lens axis is in one position, and—

Figure 13 illustrates the direction of the light pencil when the lens axis is moved to a second position relative to that shown by Figure 12.

Referring with particularity to the drawings, I shall first describe the optical system shown in Figures 4 and 5, after which I will describe the means for incorporating said optical system in a projection machine.

In Figure 5, I have shown at 1 a reflector and forward of the reflector is the usual arc 2. The point source of light from the arc would, of course, be passed through a condenser indicated by dotted lines at 3. This light is then passed through film 4 upon which film are parallel and aligned image areas 5 and 6. As indicated by the arrows 7 and 8, these image areas are in edge to edge relationship and geometrically identical, it being observed that the heads of the arrows indicate the top portions of the image areas in each instance. With respect to this particular character of film, and its method of production, attention is directed to my co-pending application for camera, filed in the United States Patent Office on September 5, 1933, Serial No. 688,149. 9 is an aperture plate, the aperture of which is adapted to register with the boundaries of the image areas, this aperture plate forming a part of the general projection machine construction, and particularly that portion which includes the film trap, including the shoes, gate, tension springs, and the like. As is customary, 10 indicates the emulsion or dull side of the film. The opposite side of the film, or the celluloid or bright side, at 11 has forward thereof a light shield 12. This light shield is substantially at right angles to the plane of the film face and divides the two image areas 5 and 6. It will be noted with respect to the image areas that I have outlined the image areas for the sake of clarity with transverse and longitudinal lines 13 and 14. The shield 12 would have one edge thereof adjacent the longitudinal line and would lie in a plane passed through the longitudinal line 14, which is transverse to the plane of the film. A second light shield is positioned at 15 in direct contact with the shield 12. So far, it will be seen that when the film and both image areas are illuminated that there are two distinct light pencils separated by the light shields 12 and 15. Furthermore, it will be observed that this construction is such as to prevent spread, relative to the axis, of light from each image area. I provide prism sets 16 and 17 which are substantially identical in construction, for which reason the set 16 will be described.

The prism set in the present instance includes prisms 18, 19 and 20. Each prism is of the right-angled isosceles triangular type, and the prisms are adapted to be cemented together in any suitable manner, such as through the use of balsam, to the end that there is no air gap therebetween. The prism 18 is provided with two face portions 21 and 22 at right angles, and with an oblique face portion 23 which would normally extend between the faces 21 and 22 were it not for the fact that the prism is truncated at 24 to provide a truncated face at right angles to the plane of the face 21. The face 21 constitutes the plane incident beam receiving face for the said prism; the face 22, the plane emergent beam face; and the oblique face 23, normally the hypotenuse of the triangular prism, the reflecting face. The second prism 19 has an oblique face 25 extending between two plane faces 26 and 27, the faces 26 and 27 being at right angles. 26 and 27 constitute the beam receiving and beam emergent faces. respectively, and 25 the reflecting face. The prism 20 is provided with faces 28 and 29 in right angular relationship and an oblique face 30. As before, 28 and 29 constitute the beam receiving and beam emergent faces, and 30 the reflecting face. As a matter of fact, when the several prisms are joined together, for instance, the face 22 of prism 18 secured to face 26 of prism 19, and face 27 of prism 19 secured to face 28 of prism 30 through the use of Canadian balsam, the prism becomes as a single piece of glass without reference to beam receiving and beam emergent faces, save and except for the faces 21 of prism 18 and 29 of prism 20. It will be observed that when the several prisms are cemented together that the light pencil is turned 90° in the passage through the said set from incident beam receiving face to emergent beam face. For instance, the image as to position, and as illustrated at 31, is turned to the position illustrated in dotted lines at 32. This is true for the reason that when the light pencil strikes the incident beam receiving face 21 of prism 18, it is reflected by face 23 at right angles and strikes the reflecting face 25 of prism 19. It will be observed that this right angular reflection turns the image so that it lies in the same plane as the image shown at 31. The light pencil bearing an image is then reflected by the face 25 onto the reflecting face 30, the position being such that the image is then turned 90° or at right angles to the plane of the light pencil image shown at 31. It will be seen that the plane incident beam receiving face 21 and the plane emergent beam face 29 of prisms 18 and 20 are in parallel relationship.

Considering each prism separately, it may be remarked that the areas of the light receiving and light emergent faces are the same and that,

as between contiguous light emergent faces and the light receiving faces of the different prisms, there is a difference in the face areas. By way of example, the emergent face 22 of the prism 18 is of lesser area than the beam receiving face 26 of prism 19 and the beam receiving face of prism 20 is of greater area than the beam emergent face of prism 19. Hence, there is a progressive increase in size of the faces from the plane incident receiving face 21 of prism 18 to the plane emergent beam face 29 of prism 20. This construction is one of the features of the present invention and the relative sizes of the prisms are so selected that the cone of light, as it increases in size, is not side cut or "stopped down" in its passage through the prism set. The principle is illustrated in Figure 11, wherein I have illustrated the three prisms 18, 19 and 20, constituting mere rectangular blocks, the light pencil being designated as 33, and it will be seen that the cone of rays gradually increases as to diameter in passage through the prism, and that the construction is such that there is no side cutting of the light rays.

As stated, the prism set 17 is a duplicate of the prism set 16 and if the prism set 16 were revolved 180° from the position shown in Figure 5, the exact position of the prism set 17 would result. In other words, the truncated faces 24 of the prisms 18 for both sets would be in juxtaposition and abutting. The oblique faces 25 of the prisms 19 for both sets would be substantially parallel, and whereas the prism 20 is above or supported upon the prism 19 for prism set 16, for prism set 17 the prism 20 depends from the prism 19. However, the oblique faces 30 are parallel as are likewise the plane emergent beam faces.

There are two objective lens sets 34 and 35. The objective lens set 34 has the objective axis thereof lying in the axis of the light pencil passed through the prism set 16 and the objective lens set 35 has the lens axis thereof lying in the axis of the light pencil emerging from the prism set 17. However, in order to cause a complete overlap of the light pencils passed through both objective lens sets, both objective lens sets may be shifted as to position, as will be hereinafter detailed. However, for the present, it may be remarked that when both image bearing light pencils are finally projected upon the screen 36, both image bearing light pencils overlap in perfect registry, as illustrated at 37. The light pencils, after passing through the objectives, pass through color filters 145 and 146.

Figure 6 illustrates, in rear elevation, the prism casing adapted to hold the prism sets 16 and 17 and likewise shows the objective lenses 34 and 35 forward of the prism casing. The general view of the construction is further detailed in Figures 1 and 2, wherein it will be seen that I have provided a casting designated generally as 38 (see also Figure 3) this casting including two lens carrier members 39 and 40 in right angular relationship, and an offset bracket 41 integral with the lens carrier members. This bracket 41 includes a part 42 which may be termed the mounting plate for the casting, and which is substantially parallel to the lens carrier member 40. This bracket has an interconnecting piece 43 between the lens carrier members and the mounting plate 42. Both lens carrier members 39 and 40 are provided with transverse dove-tailed slots 44 and 45, respectively (see Figures 1 and 2).

The objectives in each instance are contained within suitable focusing mounts or sleeves. This construction is not detailed for the reason that it is common practice to provide some focusing arrangement for the lenses. In this connection, I provide for each lens mount a jacket or housing 46 and 47, respectively. Each jacket is adapted to enclose a focusing lens mount, being secured within said jacket by means of screws or the like 48, with both said jackets provided with a spiral slot 49 through which a focusing lever 50 secured to the lens mount, is passed. Thus, movement of the focusing lever within the slot will cause approach or separation of a component of the objective lens. Both said jackets are provided with carrier blocks 51 provided with dove-tailed tongues 52. Both dove-tailed slots 44 and 45 in the lens carrier members 39 and 40 have greater transverse dimensions than the transverse dimension of the dove-tailed tongues 52, and to prevent any side play when the tongues are within said dove-tailed slots, strip type compression springs 53 are interposed between a wall bounding the dove-tailed slot and a side wall of the dove-tailed tongue, as clearly illustrated in Figures 1 and 2. As previously stated, this same structure obtains for the jacket 47. Both dove-tailed tongues of the jackets 46 and 47 are provided with depending lugs 54 and 55, respectively, (see Figures 2 and 3). Secured to the under side of both of the lens carrier members 39 and 40 and in alignment with the lugs 54 and 55 are enlargements 56 and 57, each provided with a screw-threaded bore. Screws 58 and 59 are received within the screw-threaded bores in the members 56 and 57, and both screws are secured to suitable heads 60 and 61, carried by the lugs 54 and 55. It is, therefore, evident that a turning of the heads in one of two directions will cause movement of the lens jacket to the right or left, in one instance, to-wit, for the objective 34, and up and down or vertically for the objective 35, see the arrows, Figure 3, at 62 and 63.

The projector head is provided with a block 64 having a dove-tailed slot 65. Ordinarily, the objective is provided with a slide block formed with a dove-tailed tongue, and in the present instance, I do not change this structure other than to provide an intermediate block 66 provided on one face with a dove-tailed slot 67, and on the opposite face with a dove-tailed tongue 68. The dove-tailed tongue 68 of the block is received within the dove-tailed groove 65 of the block 64, and a compression spring 69 is within the dove-tailed slot and bears against the dove-tailed tongue 68 to take up side play. The mounting plate 42 has secured thereto a dove-tailed tongue 70 through the medium of screws 71. A lock screw 72 is also secured to the dove-tailed tongue in such a manner that the dove-tailed tongue may be moved in part away from or toward the mounting plate 42. This tongue is received within the dove-tailed slot 67 and through the medium of the lock screw 72, it is possible to move the tongue into clamping engagement with the side walls bounding the dove-tailed slot 67, and thereby lock the mounting plate 42 against movement relative to the intermediate block 66. The wall 73 forming one wall of the projection head is formed with a longitudinal slot 74, and movable within this slot is a screw 75, which screw is received within a screw-threaded opening 76 of the intermediate block 66. The outer face of the wall 73 is provided with an elongated channel 77 and received within said channel and surrounding the shank of the screw 75, is a slide 78. Thus, when the screw is tightened, a clamping

relationship exists between the slide, bearing against the bottom wall bounding the channel, and the intermediate block 66, the intermediate block having the bottom face 79 of the dove-tailed tongue 68 pressed against the face 80 bounding the dove-tailed slot 65. The casing 38 is of extended length and in addition to spacing apart the said objective lenses, carries a prism box or casing 81.

The prism box or casing is detailed as to construction in Figures 6 to 9, inclusive, wherein it will be observed that from a configuration standpoint, it is in the form of a truncated hollow parallelepiped, and wherein 82 is the base and 83 the side walls of the casing. It will be observed that the portions 84 and 85 of the side walls are substantially parallel, as are likewise portions 86 and 87, 88 and 89, the walls 88 and 89 forming the truncation. The form of the casing is arbitrary but lends itself to housing the prism sets 16 and 17 in a compact manner. It will be noted that the base 82 which constitutes the front wall when viewing the casing relative to the objectives, is provided with two spaced apart and substantially parallel apertures 90 and 91. It is intended that he faces 29 of the prisms 20 of both prism sets 16 and 17 should be adjacent these apertures. For instance, the face 29 of the prism set 16 would appear at the aperture 90 and the same face of the prism set 17 at the aperture 91. The oblique faces 25 of the prisms 19 bear against the inner surfaces of the side wall and particularly the portions 84 and 85, as best illustrated in Figure 7, and the truncated edges of the prisms 18 are in abutting relationship, as shown in Figure 8, at 92. The casing is provided with a cover 93 conforming in outline to the configuration of the side wall 83, and the casing side wall is provided with screw-threaded bores 94, and the said cover is provided with openings adapted to align with the screw-threaded bores aforesaid whereby suitable securing means, such as screws 95, may fasten the cover 93 to the casing side wall. This cover is provided with an aperture 96, and reference to Figures 6 and 10 will show that this aperture is substantially midway between the apertures 90 and 91. The aperture 96 is in alignment with the faces 21 of the prisms 18 of the prism sets 16 and 17.

Dividing the aperture 96 into two portions and in the plane of the abutting truncated faces 24 of the prisms 18 of the prism sets 16 and 17, is the light blind or shield 15. The base of the said prism casing is provided with one or more perforated ears or lugs 97 and 98, and the casting 38 is provided with screw-threaded bores whereby suitable securing means passed through the openings of said ears may engage said screw-threaded bores of the casting, as illustrated in Figure 6, at 99 and 100, to secure said casing to the casting and in a defined relationship to the axes of the objectives.

A feature of the present invention resides in the means whereby the plane emergent beam faces, together with the incident beam receiving faces of both prism sets considered as entireties may be brought into substantial parallelism at any time desired. This means is best illustrated in Figures 7, 8 and 9. Referring to these figures, it will be observed that the arrangement of the prism sets is such that when they are confined within the prism casing, there is a space between the base and the inner side walls 101 and 102 of the prisms 20 and likewise there is a space included between the said base of the casing and the oblique faces 23 of the prisms 18. For convenience, this space will be designated as 103 (see Figure 8). Secured to the base by means of screws or the like 104, and within the space 103, is an elongated block 105 having an oblique face 106 corresponding to the angularity of the oblique face 23 of the prism 18 of the prism set 17, and said block is provided with end portions 107 and 108 adapted to overlap sides 109 and 110 of the said prism, and to securely hold the prism to the block. The prism 18 of the prism set 16 is held by a block 111. This block has an oblique face 112 corresponding to the angularity of the oblique face of the said prism and provided with end portions 113 and 114 adapted to overlap sides 115 and 116 of the prism for the purpose of holding said prism to said block. The block is provided with a furcated extension 117. Within the space 103 and secured to the base by suitable screws, or the like, 118, is a standard 119. A pivot pin 120 is interposed between the standard and the block 111 substantially intermediate the length of said block. The base of the casing is provided with a screw-threaded opening 121 and an adjusting screw 122 is threaded thereto, the said adjusting screw having a reduced diameter shank 123 and a head 124. The shank 123 is received between the furcations 117, the head 124 overlying said furcations, as best illustrated in Figure 7. The outer end of the screw 122 is formed with a kerf 125. Thus, a turning of the screw 122 through the medium of any suitable implement will rock the prism block 111 to in turn rock the entire prism set 16, and in this manner it is possible to adjust the two prism sets in such a manner that the emergent faces,, to-wit, the faces 29, are in substantial parallelism. There are several methods whereby this parallelism may be gauged, one being to pass the light pencil through the prisms and observing the relative position for the light pencil upon a screen. It is also possible to take one prism set and position it accurately within the prism casing and to so arrange the second prism set that, before the balsam between two faces of the two contiguous prisms has hardened, to-wit, prisms 18 and 19, to rock the block through the adjusting screw to bring the incident and emergent beam faces of the prism sets into optical parallelism. As before, this may be done by observing some image passed through the prism sets projected upon a screen, and irrespective of the presence of the objective lenses 34 and 35.

Small compression members, such as cork, indicated at 126, may be laid on the sides of the prism members adapted to face the cover 93. When the cover is secured to the casing, as shown in Figure 6, the prism sets are held tightly against movement within said casing.

Referring now to Figures 1 and 2 specifically, the projection head, in addition to housing the invention just described, also houses the film trap. The film trap includes spaced shoes 127, a gate 128, the usual tension springs 129, together with top and bottom tension spring shoes 130 and 131. The strip film 4 has the perforations thereof engaged by the top sprocket wheel 132 and held in engagement with the teeth of said sprocket wheel through the medium of a guide roller 133. The film is held in position by guide spools designated generally as 134, after which a length of film is interposed between the gate and the shoes. A further length of the strip film is engaged by the teeth of an intermittent feed sprocket 135. It is to be realized that this constitutes only a por-

tion of the projection mechanism, the magazines not being included. The aperture plate 9 is positioned rearwardly of the film, as are likewise two other spaced apart light aperture plates 136 and 137. The lamp house 138 faces these aperture plates. A suitable source of light is provided within this lamp house. The blind or shield 12 is provided with two wings 139 and 140 and a portion of said shield is passed through the aperture 141 of the gate. The wings in turn are secured by small angle brackets designated generally as 142, to the gate. These angle brackets, as well as the wings, are so positioned as to be above and below the marginal confines of the aperture 141. Any suitable medium may be employed for securing the angle brackets to the gate, such as by employing screws or the like 143 (see Figure 1).

In the type of projector shown, the gate may be entirely removed from the projector head, the head to this end having top and bottom bifurcated lugs 144 and the gate is provided with an offset extension adapted to be received between the bifurcations of said lugs. By pressing upwardly on the bottom of the gate, the gate is easily removed from the projection head. Figures 1 and 2 of the drawings are illustrative of certain mechanism of a standard type of projector.

The invention also includes the provision of suitable filters forward of the objectives. These filters, of course, vary as to color but for convenience, it may be assumed that one of the filters is red—orange and the other blue—green. There are two filters having different color components, as shown at 145 and 146. Each filter is suitably secured within a ring 147. The ring for each filter component is telescopically received within the mounting jackets for the objectives. For instance, the filter component at 145 is telescopically received within the jacket 46 while the filter component 146 is received within the jacket 47. Suitable locking screws 148 and 149 hold the filter rings within the respective jackets.

The usual shutter 157 is provided forward of the aperture 150 in the projection head.

The operation, uses and advantages of the invention are as follows:

When it is desired to project pictures in color using a standard type projector, such as illustrated in part in Figures 1 to 3, inclusive, it is necessary to remove the ordinary form of objective lens and place the blind or shield 12 in position, followed by placing the tongue 68 of the intermediate block 66 in position within the dovetailed slot 65 of the block 64. The mounting plate 42 with its dove-tailed tongue member 70 may then be locked within the dove-tailed slot 67 of the intermediate block. This slide block construction permits proper placement of the color device within the projection head. When correctly positioned, the shields 12 and 15 will be in slightly overlapped relationship, normally, because of the condensing lens between the light source and the film, as shown in Figures 1 and 5. The adjustment given the dove-tailed blocks through the medium of the lock screw 72 and the screw 75 permits the proper spacing between the film and the plane incident beam receiving faces of the prism sets 16 and 17. It is apparent that there will always be a certain position at which best focusing results are obtained. The objectives may be properly focused through the medium of the focusing mounts and this is accomplished by moving the focusing mount levers 50. There is an air gap between the objectives and the emergent beam faces of each prism set, to-wit, the faces 29.

Assuming a source of light in the lamp house, this source of light passes through the apertures 137, 136, thence through the aperture of the plate 9. If a film has its image areas, to-wit, the areas 5 and 6, positioned within said aperture, light passed through said film will be divided by the light shield so that the image areas may be kept separated. Each image will be received upon the plane incident beam receiving face 21 of the prisms 18 for each prism set 15 and 16. As the light pencils pass through each prism set, the light pencil increases in diameter; in other words, diverges to provide what may be termed a cone of rays. As previously explained, the relative size of the different prisms of each set progressively increases to the end that there is no side cutting of the divergent light cone. The image bearing light pencils are then passed through the objectives and thence through the filters 145 and 146. It will be observed that both emergent beam faces 29 of the prism sets are disposed at substantially the same angularity and the same distance from the incident beam receiving faces 21 of said sets. The axis of each objective may be shifted relative to the image bearing axial rays passed through each prism set. This is accomplished by means of the screws 58 and 59. These screws, as before mentioned, carry heads, and the heads are secured to lugs depending from the tongue members of the objective mounting jackets. These screws are received within the threaded openings in the members 56 and 57, to the end that when the head 60 is rotated in one of two directions, the lens mount jacket 46 may be moved in accordance with the double-headed arrow 62 shown in Figure 3, while the lens mount jacket 47 may be moved at right angles to the movement of the lens jacket 46, or in a direction indicated by the double-headed arrow 63. The effect of this shifting of the axis of each objective is illustrated in Figures 12 and 13. In Figure 12, the axis of the light pencil and the axis of the lens coincide and there is no shifting of the projected image. In other words, the axis of the image to be projected, 151, and the projected image, 152, are in the same relative positions relative to the lens axis. However, if the axis of the lens is shifted relative to the axis of the light pencil from the image 151, the projected image will be shifted from the position shown at 152 to that shown at 153. The principle here explained and illustrated is that used for causing two projected images to overlap upon the screen 36. It is evident that a small degree of shift of either objective relative to the projected image bearing light beam, considering the throw thereof from projection machine to screen, results in large movement of the projected picture on the screen. This is illustrated in Figure 5 by the enlarged arrows shown in dotted lines at 154 and 155. By shifting the objective 34, the image 154 may be moved to the full line position at 156. In the same manner, shifting of the objective 35 may move the image 155 to the full line position 156. In actual practice, a perfect overlap results by shifting, if necessary, the axis of each objective. The image areas indicated at 7 and 8 on the film are reversed as to position in passage through the prism sets, to the end that the images appear as shown at 156 on the projection screen. This has been previously detailed in describing the passage of the image gearing light pencils through the prism

sets (see Figure 4). Both images are rotated 180° or to upright position when passed through the objectives in the well understood manner.

The focusing of the objectives as well as the correct positioning of the prism sets relative to the film is simple in operation and has been previously described in detail.

When one image bearing light pencil is projected through a filter, say an orange—red, and onto a screen, the second image bearing light pencil is projected through a blue—green filter and caused to overlap the orange—red image, and substantially a correct color rendering will be obtained in the resultant projected picture. This color rendering will be substantially in accordance with the original photographed object field.

In the preliminary statement of the invention detailing loss of light, mention was made of the fact that the present invention was saving in light, and great loss of light was not entailed through use of the invention. Roughly speaking, it is possible to calculate mathematically the actual loss of light in its passage through a prism set. This loss depends upon the areas of the various plane incident beam receiving and emergent faces, and upon such factors as air to glass losses. Each oblique reflecting face of the several prisms forming each prism set is full silvered and silver entails a certain loss of light. In an actual device as used in a standard projection machine, it can be shown mathematically that the loss of light in passing through one of the prism sets may be as high as 45%. This does not take into consideration the air to glass loss in passage of the light from the film to a prism set. This may amount, in the present instance, considering the glass to air of the emergent beam from the prism, to 6.8% or more. Hence, considering the beam as divided by the two image bearing light pencils, the transmitted light for each pencil is approximately 22.5%. These figures are arrived at mathematically, as before stated, for an actual device. However, a measurement of light loss through a prism set shows that the present device is saving in light. Using a Weston photrome foot-candle meter, model 614, No. 20, and positioning the said meter eleven feet from the projection shutter for all tests, the following results were obtained:

Table #1

Black and white—shutter in motion—no prisms		
Rectifier setting	Amperes	Foot candles
2	15	85
4	17	105
6	21	120
8	25	135

Table #2

Black and white—shutter stopped—no prisms		
Rectifier setting	Amperes	Foot candles
2	15	170
4	17	215
6	21	250
8	25	280

Table #3

Prisms—no filters—shutter stopped		
Rectifier setting	Amperes	Foot candles
2	15	180
4	17	200
6	21	245
8	25	270

Table #4

Prisms—with filters—shutter in motion		
Rectifier setting	Amperes	Foot candles
2	15	45
4	17	52
6	21	55
8	25	60

Table #5

Prisms—no filters—shutter in motion		
Rectifier setting	Amperes	Foot candles
2	15	85
4	17	105
6	21	110
8	25	120

Table #6

Prisms—with filters—shutter stopped		
Rectifier setting	Amperes	Foot candles
2	15	72
4	17	98
6	21	122
8	25	135

Table #7

Prisms—no shutter—with filters		
Rectifier setting	Amperes	Foot candles
8	25	67 Blue—green
8	25	62 Orange—red
8	25	128 Sum of both filters
Prisms—no shutter—no filters		
8	25	130 Blue—Green
8	25	135 Orange—red
8	25	265 Total

These tables show that the prisms are more efficient in actual practice than the mathematical calculations for determining the amount of light loss would indicate. It is believed that the efficiency of the prisms resides in the fact that they are of small size and correctly balanced and positioned in such a manner as to not side cut the light cone passed therethrough. Furthermore, it is to be remembered that the light images

passed through the two prism sets, the objectives and filters, are again merged on the projection screen.

It will be seen by comparison of Tables #2 and #3 that the light loss through use of the prisms is practically negligible. A comparison between Tables #1 and #5 shows that there is practically no light loss through the prisms. The light loss principally results when filters are interposed as shown by Table #6, and this light loss increases when the shutter is in motion, as shown by Table #4.

In actual use, the resultant projected picture in colors has been found to be sharp in detail and comparable to a black and white picture. There is no apparent flicker and where the object field was originally photographed with care, the lights and shadows in the colored projected picture are pleasing as to details and quite faithfully recreate the object field in color.

Reference is made to Figures 1 and 2 wherein it will be observed that the prism sets are comparatively close to the film, and further that the spacing between the emergent beam faces of the prism sets and the objectives is not large. This feature of the invention is important when air to glass losses in illumination are considered. So far as the inventor is aware, prior investigators have been unsuccessful in placing prisms between the objective and the film due first to the large size of the prisms used, and the fact that a reconstruction of the projection machine was necessary. By placing the prism sets comparatively close to the film, the image bearing light beam therethrough directly contacts with the incident beam receiving faces of the prism sets and is passed through the prism sets without the pencils of light diverging to any appreciable extent. Where there is considerable gap between the film and the prism sets, the prisms must be enlarged as to size. If the light pencils are allowed to diverge to any extent, the size of the prisms becomes such as to prevent their use unless the prisms are cut in such a way as to induce a "stopping down" effect in the light pencils. Ordinarily a reflector is placed behind the source of light and a condenser forward of the source of light for the purpose of concentrating the light. As a rule, the film aperture is placed at or near the point where the converging rays of light from the condenser cross, to the end that the greatest amount of light may pass through the aperture. From this point, the rays diverge toward the projection objective. Hence, it is essential and likewise a feature of the present invention, that the prism sets be placed quite close to the film gate and its aperture, and likewise that the prism sets be in close proximity to the projection objectives in order that the projected image be sharply defined upon the screen and the illumination not materially reduced.

I claim:

1. An optical device for a multi-color picture projector that comprises a frame, a plurality of prism sets mounted in the frame, each set comprising a series of prisms for turning a light beam through approximately 90°, means on which one of the sets is mounted, said means being pivoted to the frame at right angles to the general axis of the prism set, means to adjust the mounting means on the pivot and objectives in the light beams for projecting the transmitted beams in registry.

2. The device of claim 1 in connection with a film gate, means to support the device before the film gate, and a septum extending from the middle of the film gate to the plane of the incident faces of the prism sets.

3. An optical device for a multi-color picture projector that comprises a frame, a plurality of prism sets mounted in the frame, each set comprising a series of prisms for turning a light beam through approximately 90°, means on which one of the sets is mounted, said means being pivoted to the frame at right angles to the general axis of the prism set, means to adjust the mounting means on the pivot, objectives in the light beam for projecting the transmitted beams in registry, means for mounting one of said objectives for transverse movement with respect to the frame and means for mounting the other objective also for transverse movement with respect to the frame, but at right angles to the direction of movement of the first objective.

4. An optical device for a multi-color picture projector that comprises a frame, a film gate, means to support the frame closely adjacent the film gate, a septum extending from the middle of the film gate in the direction of the light beam, a plurality of prism sets mounted in the frame at the end of the septum, each set comprising a series of prisms of increasing size for turning a light beam through approximately 90°, objectives for projecting the transmitted beams in registry, means for mounting one of said objectives for transverse movement with respect to the frame and means for mounting the other objective also for transverse movement with respect to the frame but at right angles to the direction of movement of the first objective.

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