

July 22, 1947.

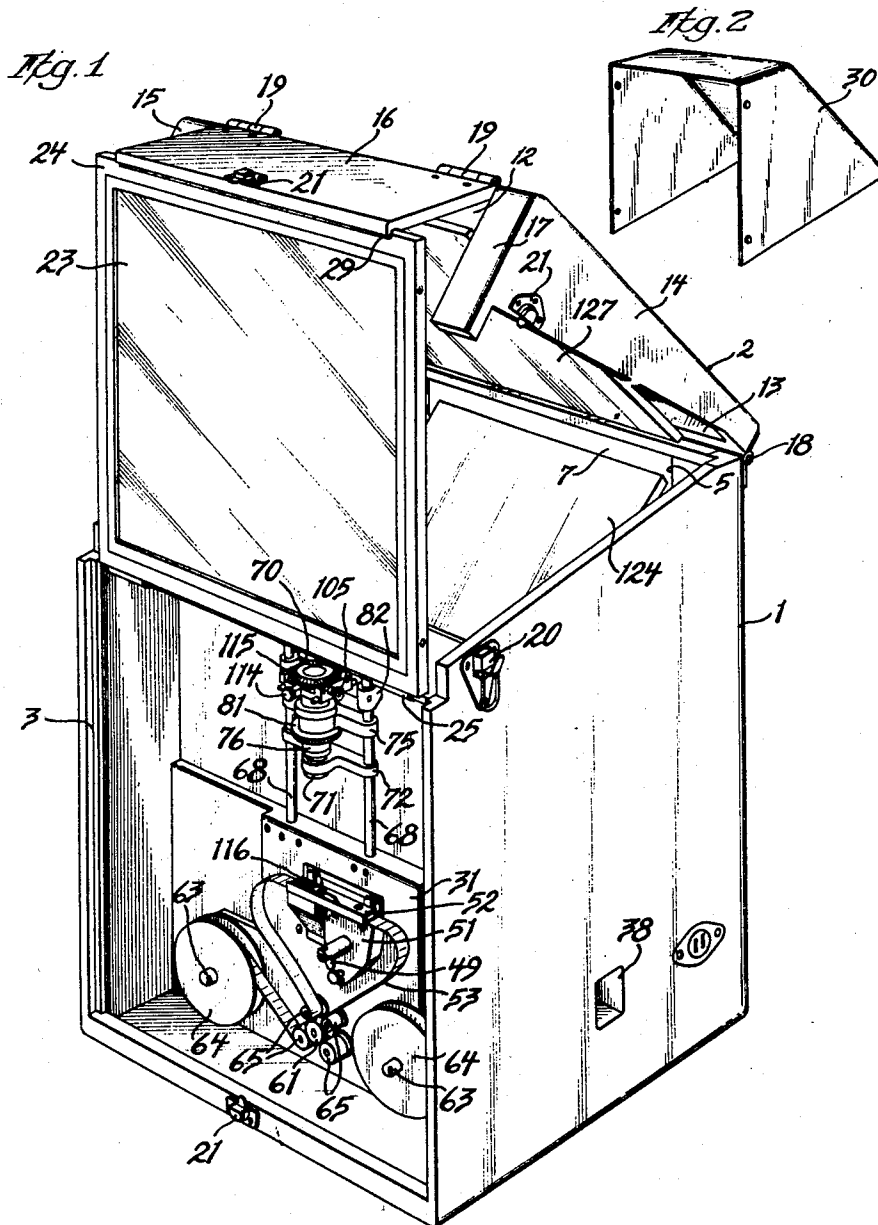
B. STECHBART ET AL

2,424,339

PICTURE PROJECTING APPARATUS AND PROJECTION SYSTEM THEREFOR

Filed May 1, 1944

8 Sheets-Sheet 1



INVENTORS
BRUNO STECHBART
PAUL C. FOOTE
By Robert F. Miedler
ATT'Y.

July 22, 1947.

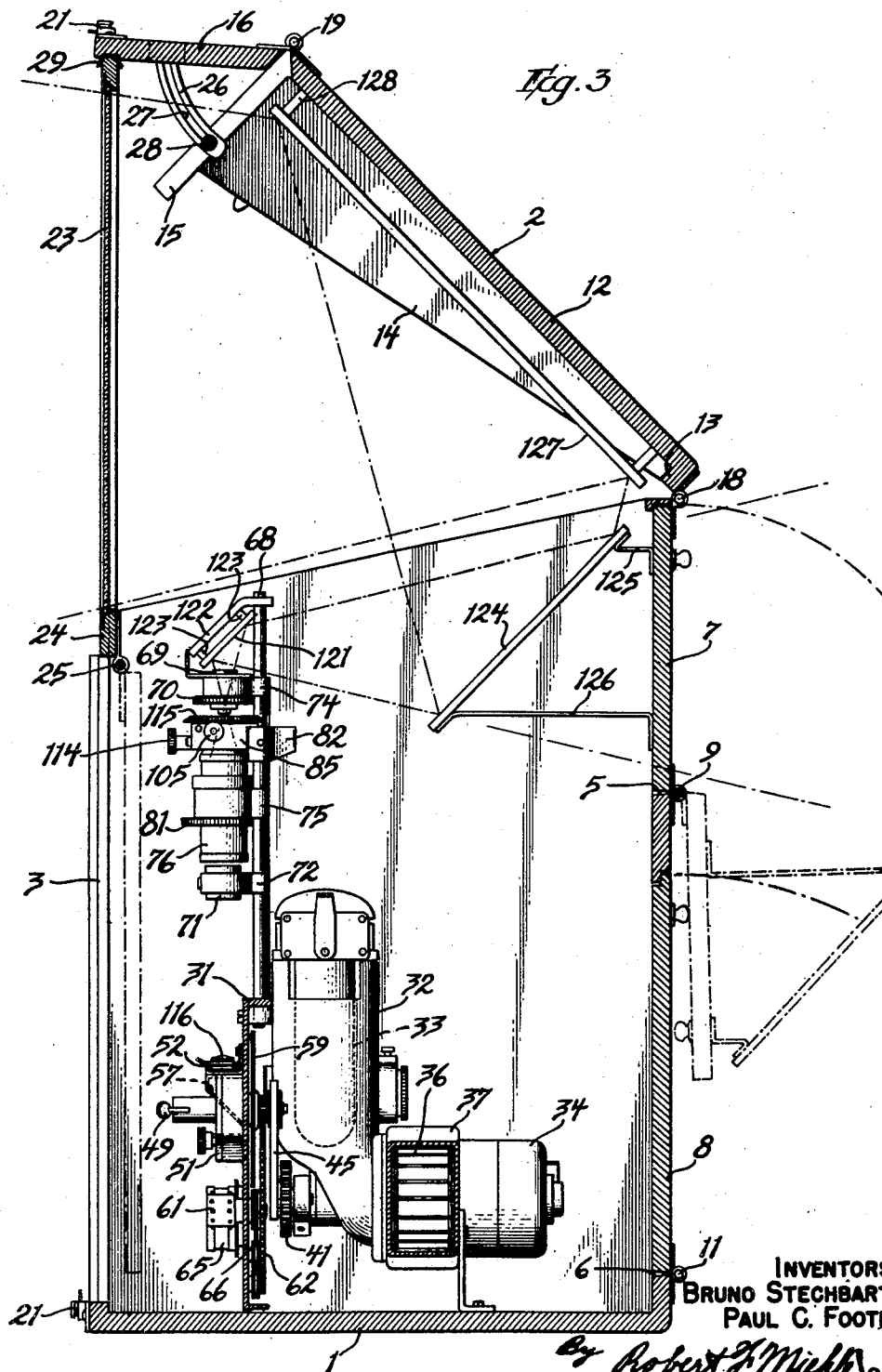
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Filed May 1, 1944

8 Sheets-Sheet 2



INVENTORS
BRUNO STECHBART
PAUL C. FOOTE

By Robert F. Miehle, Jr.
ATT'Y

July 22, 1947.

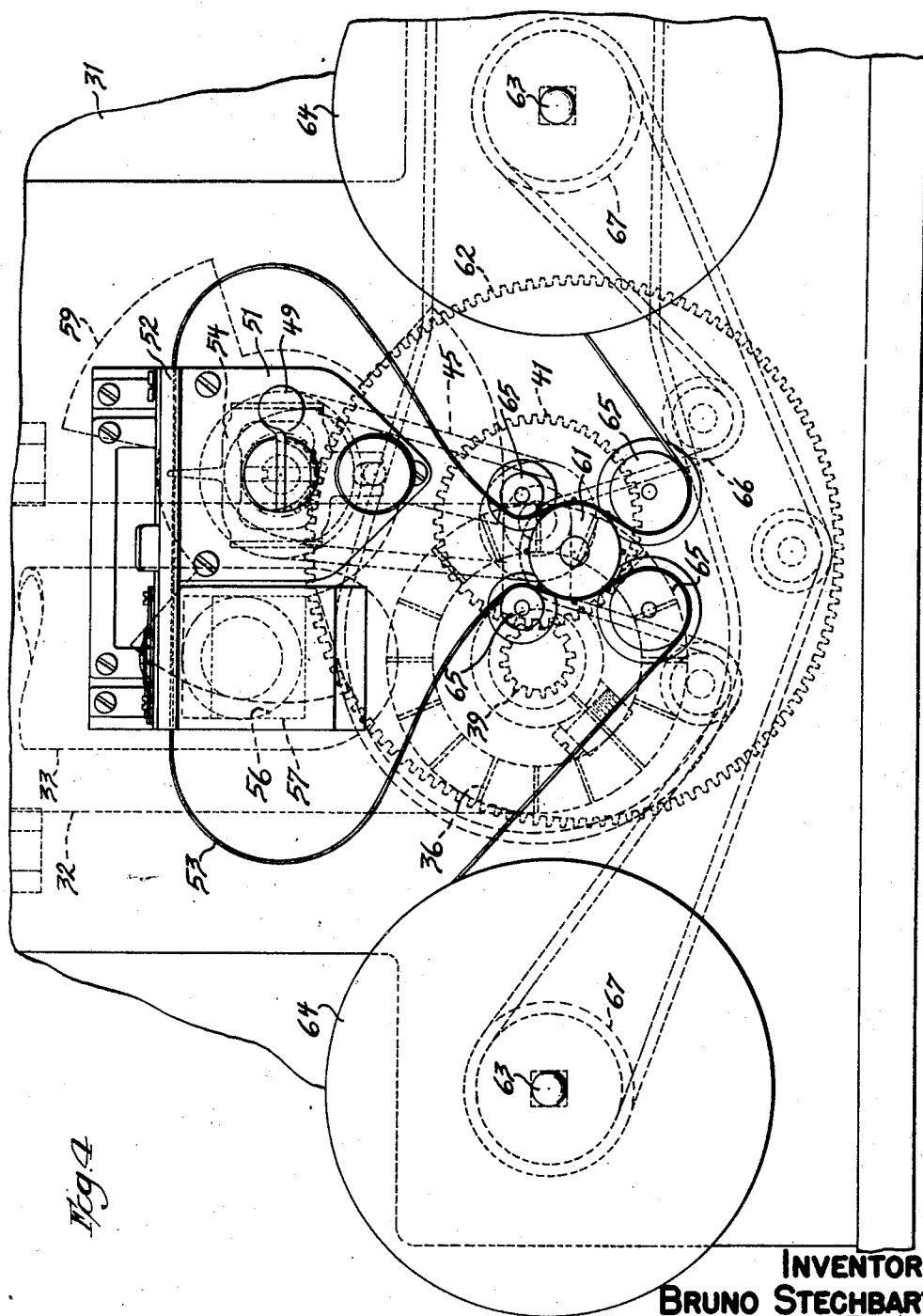
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2,424,339

PICTURE PROJECTING APPARATUS AND PROJECTION SYSTEM THEREFOR

Filed May 1, 1944

8 Sheets-Sheet 3



INVENTORS
BRUNO STECHBART
PAUL C. FOOTE
By *Robert F. Middley, Jr.*
ATT'Y.

July 22, 1947.

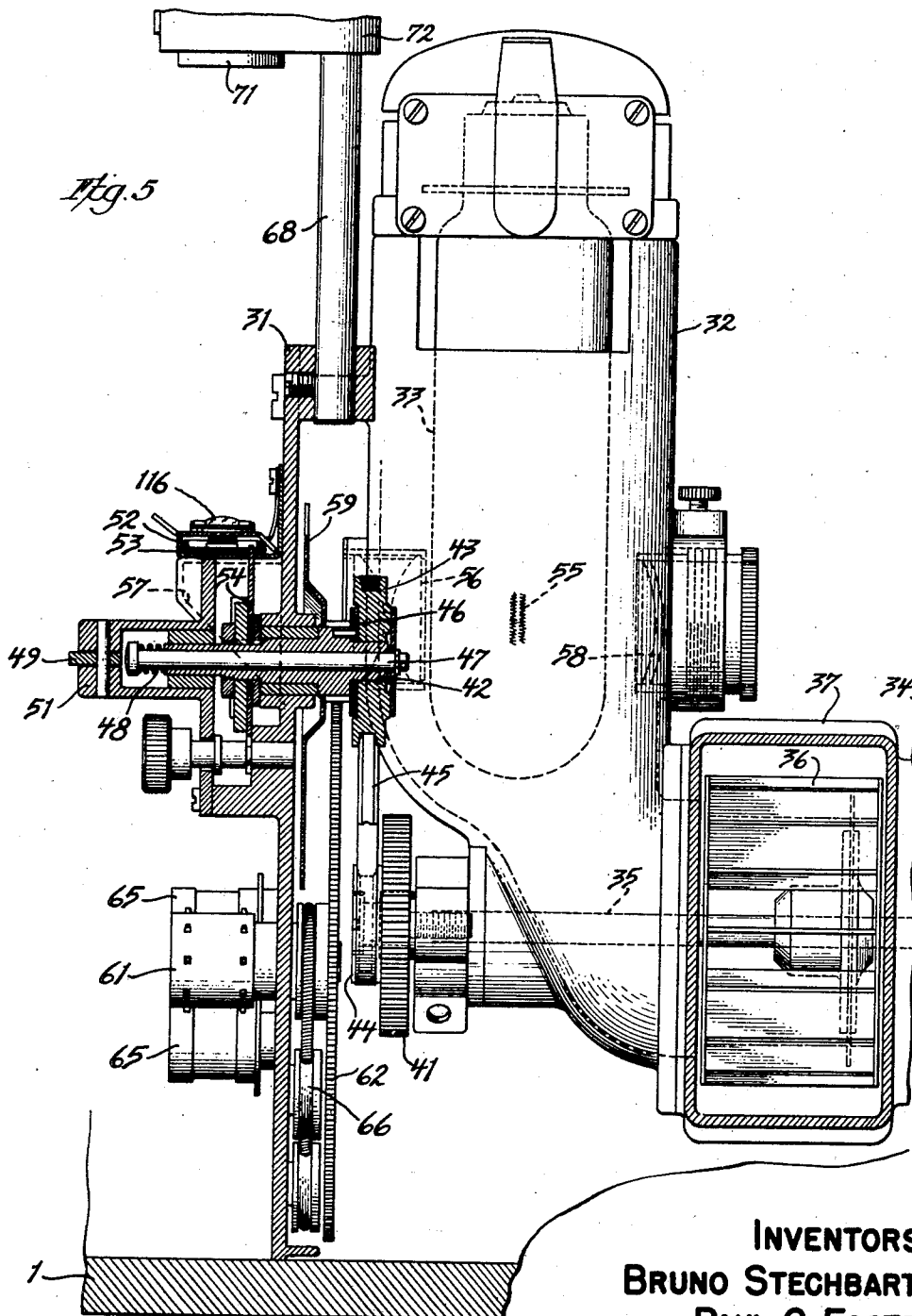
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Filed May 1, 1944

8 Sheets-Sheet 4



INVENTORS
BRUNO STECHBART
PAUL C. FOOTE
By Robert F. Muelly, Jr.
ATT'Y.

July 22, 1947.

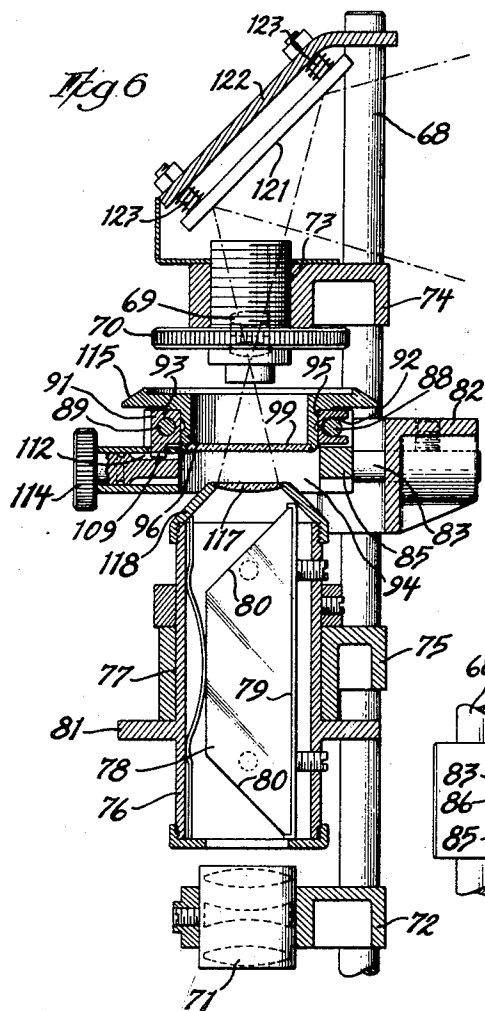
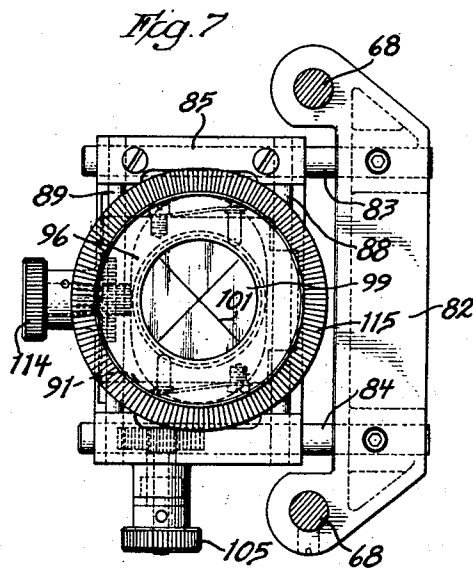
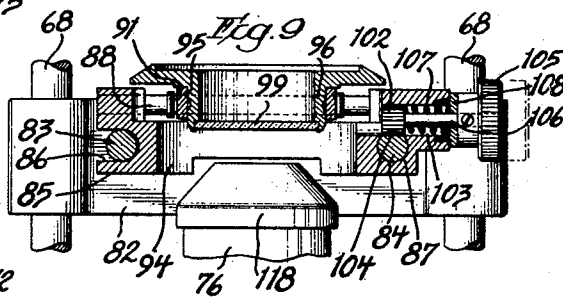
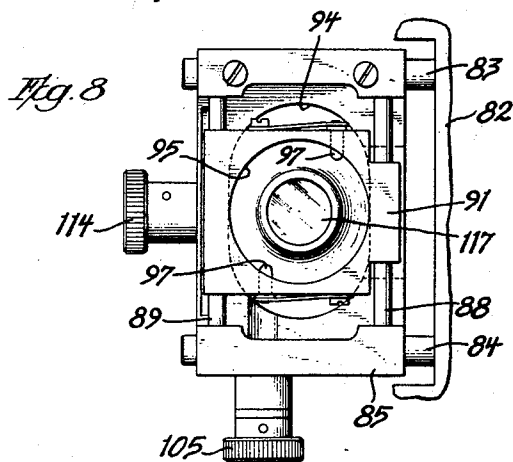
B. STECHBART ET AL

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Filed May 1, 1944

8 Sheets-Sheet 5



INVENTORS
BRUNO STECHBART
PAUL C. FOOTE

By Robert F. Muehlen
ATT'Y

July 22, 1947.

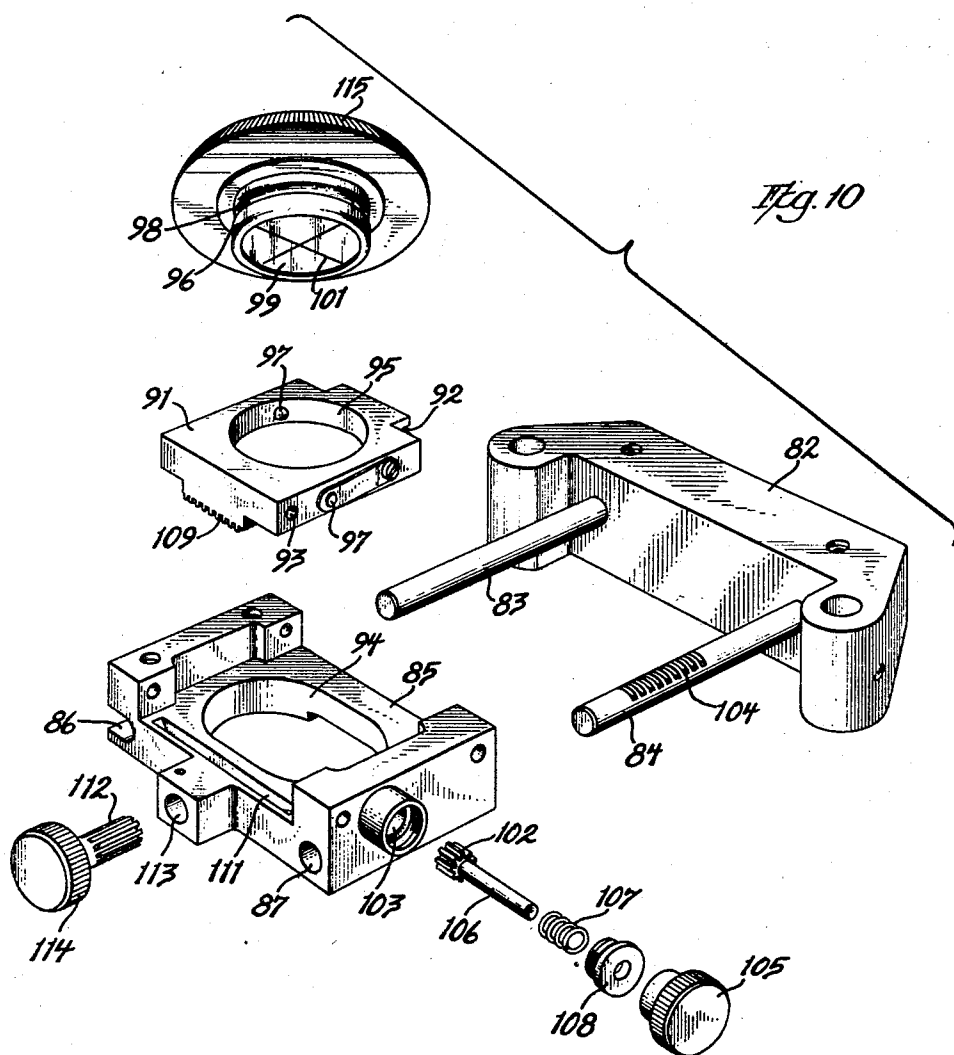
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Filed May 1, 1944

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INVENTORS
BRUNO STECHBART
PAUL C. FOOTE
By Robert F. Miehle, Jr.
ATT'Y.

July 22, 1947.

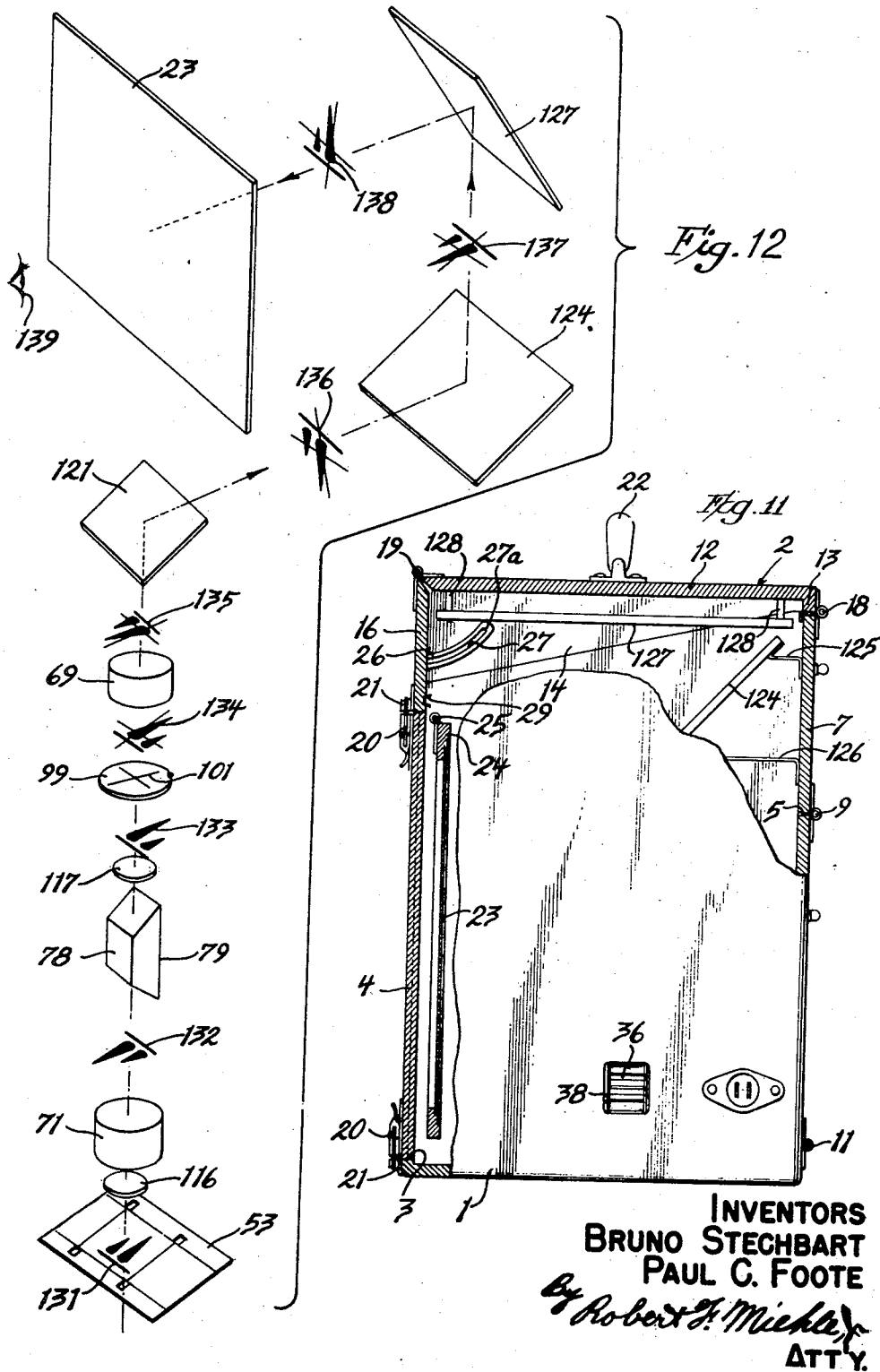
B. STECHBART ET AL

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PICTURE PROJECTING APPARATUS AND PROJECTION SYSTEM THEREFOR

Filed May 1, 1944

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July 22, 1947.

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PICTURE PROJECTING APPARATUS AND PROJECTION SYSTEM THEREFOR

Filed May 1, 1944

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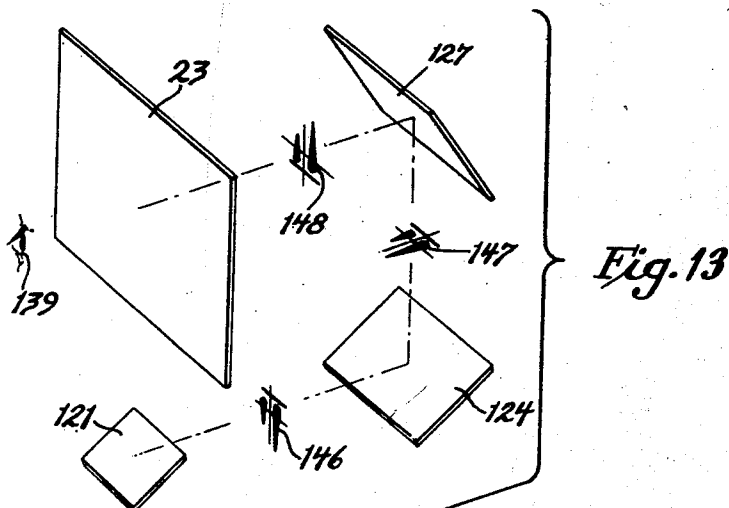


Fig. 13

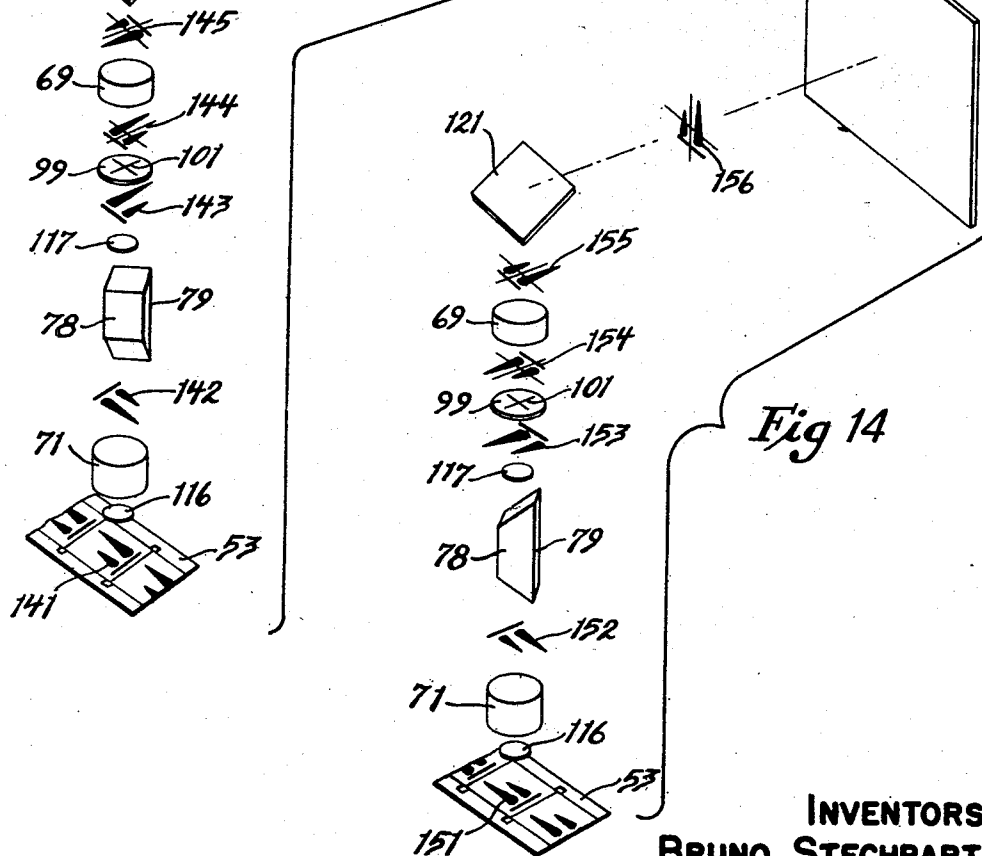


Fig 14

INVENTORS
BRUNO STECHBART
PAUL C. FOOTE

By *Robert G. Miedley*
ATT'Y.

UNITED STATES PATENT OFFICE

2,424,339

PICTURE PROJECTING APPARATUS AND
PROJECTION SYSTEM THEREFORBruno Stechbart, Park Ridge, and Paul C. Foote,
Chicago, Ill., assignors to The Bell & Howell
Company, Chicago, Ill., a corporation of Illinois

Application May 1, 1944, Serial No. 533,460

6 Claims. (Cl. 88-24)

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Our invention relates particularly to motion picture projecting machines and more particularly to such as are especially adapted for displaying motion pictures taken from military aircraft to portray the manoeuvres of the aircraft particularly with reference to objectives or targets which the aircraft may have encountered in flight.

Objects of the invention reside in the provision of a novel and effective picture projecting apparatus and projection system therefor which is particularly adapted for the above purpose; which is adapted to project pictures on a projection screen in the desired erected position and which is preferably adjustable in this respect to provide the desired erected position of the pictures on the projection screen under different conditions such as where the different films used in projection have the images thereon differently positioned angularly of the film faces or where different projection conditions are involved as will be hereinafter described; which is provided with a sighting image forming means or reticle which superimposes a sighting image on the projected pictures, thus providing composite projected picture and sighting image pictures particularly for accurately illustrating the movements of military aircraft with reference to objectives or targets, from which aircraft pictures being projected have been photographed, and which sighting image forming means or reticle is preferably adjustable with reference to the projection path to adjust the superimposed sighting image with reference to the projected pictures; which embodies a projection system particularly adapted for providing the aforesaid composite projected picture and sighting image pictures; which is conveniently compact and portable; which is provided with an enclosing case which when closed is of conveniently compact and portable form and which when open affords convenient operation of the machine; which includes as a part thereof a projection screen which, when the case is closed, is compactly arranged therewith and preferably therein and which, when the case is open, is positioned as a part of the machine for convenient viewing; and which, while including a projection screen as a part thereof, is adapted to project pictures on a separate screen considerably spaced from the projection machine for the projection of relatively large pictures.

The invention will be better understood by reference to the accompanying drawing in which—

Figure 1 is a perspective view of a motion picture projecting machine embodying my inven-

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tion and showing it in open condition for the projection of pictures;

Figure 2 is a similar perspective view, in reduced scale relative to Figure 1, of a light enclosing hood which may be applied to the machine when it is in open condition as hereinafter described;

Figure 3 is a side elevational sectional view of the projecting machine and showing it in open condition for the projection of pictures;

Figure 4 is a partial front elevational view showing the motion picture mechanism of the projecting machine;

Figure 5 is a partial side elevational sectional view showing the motion picture mechanism of the projecting machine;

Figure 6 is a partial side elevational sectional view of the major portion of the optical system of the machine;

Figure 7 is a top plan view of the adjustable sighting image or reticle forming device of the machine;

Figure 8 is a view similar to Figure 7 with the sighting image forming or reticle element removed;

Figure 9 is a partial front elevational sectional view of the adjustable sighting image or reticle forming device of the machine;

Figure 10 is an exploded perspective view showing the parts of the sighting image or reticle forming device of the machine;

Figure 11 is a side elevational view partially in section of the projecting machine and showing it in closed condition for carrying; and

Figures 12, 13 and 14 are similar diagrammatic views of the optical system of the machine illustrating different conditions of operation.

Referring to the drawing, an enclosing casing of rectangular form comprises a main lower casing portion, generally designated at 1, and an upper casing portion, generally designated at 2, forming the top of the casing. See Figures 1, 3 and 11. The lower casing portion is provided with an opening 3 at the front side thereof which is substantially coextensive with said front side, and is provided with a door 4 for closing said front opening as shown in Figure 11, this door being releasably secured in closed position as hereinafter described to provide access through the front opening into the lower casing portion, as shown in Figures 1 and 3. The lower casing portion is provided with upper and lower openings, respectively designated at 5 and 6, at the rear side thereof, and is provided with doors 7 and 8 for respectively closing these rear open-

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ings, as shown in Figure 3. The doors 7 and 8 are hingedly mounted at the lower sides thereof on the rear side of the lower casing portion, as respectively designated at 9 and 11, for movement in a vertical plane to respectively open and close the rear openings 5 and 6, usual releasable means, not shown, being provided for releasably maintaining these doors in closed position.

The upper casing portion 2 comprises a top part 12 of rectangular form conforming with the horizontal cross section of the lower casing portion and side parts depending from the margin of the top part to form continuations of the sides of the lower casing portion when the upper casing portion is in closed position as shown in Figure 11. These side parts of the upper casing portion consist of a rear side part 13, forwardly and rearwardly extending side parts 14, and three front side parts 15, 16 and 17, of which the end front side parts 15 and 17 are fixed with the top part and of which the middle and most extensive front side part 16 is movable with respect to the top part as hereinafter described.

The top part 12, and with it the side parts thereof, is hingedly mounted, as designated at 18, at the rear side thereof upwardly on and at the rear side of the lower casing portion for movement relative thereto in a vertical plane downwardly into closed position as shown in Figure 11, and upwardly out of closed position as shown in Figures 1 and 3. The middle front side part 16 is hingedly mounted on the front side of the top part 12, as designated at 19, for movement therewith and relative thereto in said vertical plane and forms with the end front side parts 15 and 17, when the middle front side part is alined with the end front side parts and the top part is in closed position, the upper portion above the door 4 and front opening 3 of the front side of the casing as shown in Figure 11, the middle front side part being movable outwardly from its position alining with the end front side parts as shown in Figures 1 and 3. When the upper casing portion 2 and the door 4 are inclosed position, conventional releasable latches, comprising cooperating latch parts 20 and 21, are operative between the lower portion of the door 4 and the bottom of the lower casing portion 1, between the upper portion of the door 4 and the middle front side part 16, and between the side parts 14 and the corresponding sides of the lower casing portion to releasably secure the upper casing portion and the door 4 in closed position on the lower casing portion as shown in Figure 11. A carrying handle 22 is secured centrally on the top part 12 for conveniently carrying the device compactly enclosed within the casing.

A rigid translucent projection screen 23, carried within a suitable frame 24, is hingedly mounted, as designated at 25, on the lower casing portion 1 in the region of the top of the front side thereof for movement relative thereto in a vertical plane from a lower position within the casing adjacent the front side thereof, as shown in Figure 11, through the front opening 3 into an upper position extending upwardly from the lower casing portion at the front side thereof as shown in Figures 1 and 3.

Releasable positioning means is operative to position the projection screen 23 in its position extending upwardly from the lower casing portion 1 and to position the upper casing portion 2 upwardly out of closed position with the top part 12 inclining upwardly and toward the projection screen and with the front side part 16

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extending in a horizontal direction toward the projection screen as shown in Figures 1 and 3. This releasable positioning means, in addition to the hinge mountings 18, 19 and 25, comprises an arcuate arm 26 secured on the front side part 16 and provided with an arcuate slot 27 coaxial with the hinge mounting 19 and a stud structure 28 on the front side part 16 and slidably engaged in the slot 27 and which stud structure engages the outer end 27a of this slot, see Figure 11, to limit outward movement of the front side part 16 with respect to the top part 12, and a channel member 29 secured on the inside face of the front side part 16 and releasably engageable over the uppermost side of the projection screen frame 24 when the screen is in its upwardly extending position, as shown in Figures 1 and 3. A light enclosing hood 30 of suitable shape, as shown in Figure 2, may be fitted over the upper casing portion 2 when the casing is in open condition, as shown in Figures 1 and 3, to prevent stray light from passing out of the casing during operation of the machine. The casing is closed with the projection screen 23 enclosed therein by lifting the front side part 16 to disengage the channel member 29 from the projection screen frame 24, swinging the projection screen downwardly through the front opening 3 into the lower casing portion, lowering the upper casing portion, swinging the front side part 16 inwardly, and placing the door 4 in the front opening 3.

A motion picture projecting machine is mounted within the lower casing portion 1 and is spaced inwardly from the front opening 3 to accommodate the projection screen within the lower casing portion. The projecting machine, which will now be described, is accessible for the operation thereof through the front opening 3 and is operative to project images upwardly.

The main frame 31 of the projecting machine is of flat form and is secured in vertically transversely extending position within the lower casing portion 1, and a lamp house 32 is disposed at the rear of the main frame and houses an incandescent electric lamp 33 which provides the projection light for the machine. See Figures 3, 4 and 5. An electric motor 34 is also disposed at the rear of the main frame for driving the projection mechanism of the machine, and the forwardly projecting shaft 35 thereof has a fan 36 mounted thereon which is enclosed in a housing 37 communicating with the lamp house for ventilating the same, air from the lamp house being exhausted by the fan from the lower casing portion through an opening 38 in a side of the lower casing portion as shown in Figure 11.

A gear 39, see Figure 4, is secured on the forward end of the motor shaft 35 and meshes with a rotatably mounted gear 41 for driving the same. A forwardly and rearwardly extending axially bored shaft 42, see Figure 5, extends through and is rotatably mounted on the main frame 31 and has a pulley 43 rotatably mounted on the rear end thereof, and this pulley is driven from the gear 41 by means of a pulley 44 secured with this gear and an endless belt 45 engaged on the pulleys 43 and 44.

A friction driving clutch, generally designated at 46 in Figure 5, is operative between the pulley 43 and the shaft 42 to drive this shaft from this pulley, and is controlled by a rod 47 slidably engaged in the bore of this shaft and yieldably urged forwardly by a spring 48 to engage the clutch. The driving clutch is released and engaged by means of a manually actuable cam lever

49 pivotally mounted on a subframe member 51 secured with the main frame and operable on the rod 47, it being observed that the lever 49 is accessible through the front opening 3 of the lower casing portion 1. The shaft 42 serves to drive the intermittent film feeding mechanism and the light shutter of the motion picture mechanism of the projector as will hereinafter appear, so that the projection of pictures is controlled by the cam lever 49.

A transversely extending horizontally disposed projection apertured intermittent film feed guide 52 is mounted on the main frame 31 at the front thereof and above the shaft 42, it being thus accessible through the front opening 3 of the lower casing portion 1 for the placing of a usual motion picture film 53 therein and the removal of the film therefrom. See Figures 1, 3, 4 and 5. An intermittent film feeding mechanism, generally designated at 54, is driven from the shaft 42 and cooperates with usual feed perforations of the film to intermittently feed the same in the guide.

Light from the filament 55 of the lamp passes horizontally through a condensing lens 56 and is reflected upwardly through the projection aperture of the guide by means of a reflecting prism 57 to illuminate the film for the projection of pictures thereon, the lamp house being provided with a usual reflector 58 for reflecting light to the condensing lens. See particularly Figure 5. A segmental light shutter 59 is secured on the shaft 42 at the rear of the main frame 1 and intermittently interrupts the light between the condensing lens 56 and the reflecting prism 57 in timed relation with the intermittent feed of the film as is usual in the projection of motion pictures.

A constant feed film sprocket 61 is rotatably mounted on the main frame 31 and is disposed at the front thereof below the guide 52 and is driven from the shaft 42 by gearing, generally designated at 62, disposed at the rear of the main frame. Horizontally spaced film reel spindles 63 are rotatably mounted on the main frame and are adapted to have film reels 64 detachably mounted thereon forwardly of the main frame 31. See particularly Figures 1 and 4.

The film 53 is fed from one reel 64 to the sprocket 61, from the sprocket to one end of the guide 52, from the other end of the guide to the sprocket 61, and from the sprocket to the other reel to be taken up thereon in the manner usual to motion picture projectors, guide rollers 65 rotatably mounted on the main frame 31 and disposed at the front thereof serving to releasably maintain the film in engagement with the sprocket. As will be observed, the front opening 3 of the lower casing portion 1 serves to provide access to the machine for the installation and removal of the film and film reels.

For the purpose of taking up the film 53 alternately on the reels 64 depending upon the direction in which the mechanism is operated, driving means is operative between the sprocket 61 and the reel spindles 63 and comprises a yieldable belt and pulley drive, generally designated at 66, which embodies rotatable pulleys 67 respectively coaxial with the reel spindles 63 and usual automatic one way clutches, not shown, operative respectively between the pulleys and the reel spindles to alternately drive the reel spindles to take up the film depending upon the direction in which the mechanism is operated in the manner usual to motion picture projectors.

A pair of vertical transversely spaced parallel support rods 68 are secured on the main frame 31 and carry the major portion of the optical system of the projecting machine, which is operative to project images upwardly and which will now be described.

For the purpose of superimposing a sighting or reticle image upon the picture images projected from the film 53 at the projection aperture of the guide 52, a relay projection lens system is preferably employed which embodies an objective lens 69 and a cooperating erector lens 71 disposed between and spaced from the objective lens and the plane of the film in the guide, the objective and erector lenses being disposed on a common vertical optical axis. The erector lens is carried in adjusted focusing relation with the image plane of the film in the guide on a bracket 72 secured on the support rods 68, see particularly Figure 6, and the objective lens is axially screwthreaded, as designated at 73, through a bracket 74 considerably spaced upwardly from the bracket 72 and secured on the support rods 68, the objective lens being thus axially adjustable for focusing with reference to a projection screen and being provided with a knurled manipulating flange 70 which is accessible through the front opening 3 of the lower casing portion 1.

A bracket 75 is secured on the support rods 68 between the brackets 72 and 74, and a tubular carrier 76 is mounted on the bracket 75, as generally designated at 77, in axial coincidence with the optical axis of the objective and erector lenses and for angular adjustment on such axis. A truncated isosceles image turning or Dove prism 78, disposed between the objective and erector lenses, is secured within the carrier 76 with its reflecting face 79 parallel to the optical axis of the projection system and facing the same and with the refracting faces 80 thereof extending across said axis at oppositely disposed acute angles thereto and operative to deflect the projection light respectively from said axis to the reflecting surface 79 and from said reflecting surface onto said axis for effecting reflection of the projection light by this reflecting surface, so that angular adjustment of the prism incident to angular adjustment of the carrier 76 effects the turning of images projected from the film 53 in the guide at twice the angular velocity of the prism, the images being refracted by the refracting faces 80 to and from the reflecting face 79 and being internally reflected by the reflecting face with resultant handing of an image by the turning prism. The carrier 76 is provided with a knurled manipulating flange 81 by means of which this carrier and with it the image turning prism 78 may be conveniently adjusted angularly of the optical axis of the projection system, it being observed that the flange is accessible through the front opening 3 of the lower casing portion 1.

A bracket 82 is secured on the support rods 68 between the brackets 74 and 75 and is provided with forwardly extending parallel rods 83 and 84 disposed in a horizontal plane and respectively on opposite sides of the optical axis of the projection system. See Figures 6 to 10 inclusive. A carrier 85 extends horizontally across between the rods 83 and 84 and is slidably mounted thereon for forward and rearward adjustment by means of a slot 86 on this carrier and a bore 87 on this carrier and parallel to the slot 86 which are respectively slidably engaged on the rods 83 and 84. The carrier 85 is pro-

vided with parallel rods 88 and 89 disposed in a horizontal plane and at right angles to the slot 86 and bore 87 thereof, and a carrier 91 extends horizontally across between the rods 88 and 89 and is slidably mounted thereon for horizontal adjustment at a right angle to horizontal adjustment of the carrier 85 on the rods 83 and 84 by means of a slot 92 on the carrier 91 and a bore 93 on the carrier 91 and parallel to the slot 92 which are respectively slidably engaged on the rods 88 and 89.

The carrier 85 is provided with a vertical opening 94 therethrough through which the projection light passes, and the carrier 91 is provided with a vertical circular bore 95 therethrough through which the projection light also passes. An annular externally shouldered carrier 96 is engaged for rotation on a vertical axis downwardly into the bore 95 of the carrier 91 and is releasably secured therein by means of spring pressed detents 97 engaging a circumferential groove 98 on the carrier 96.

A light transmitting sighting image or reticle element 99, disposed between the turning prism 78 and the objective lens 69 and extending across the optical axis of the projection system, is secured on and extends across the bore of the carrier 96, and is provided with a sighting or reticle design 101, see particularly Figure 7, the image of which is superimposed upon the images projected upwardly from the film 53 as hereinafter described.

The carrier 85 is conveniently adjusted on the rods 83 and 84 by means of a gear pinion 102 rotatably mounted in a bore 103 of the carrier 85 and meshing with a rack 104 on the rod 84 and a manipulating knob 105 secured on the shaft 106 of the pinion for rotating the same, a spring 107, encircling the pinion shaft and operative between the pinion and a bushing 108 screwthreaded into the bore 103, normally maintaining the pinion in engagement with the rack. See Figures 9 and 10.

The carrier 91 is conveniently adjusted on the rods 88 and 89 by means of a rack 109 on the carrier 91 and disposed in parallelism with the slot 92 and bore 93 and engaging downwardly into a slot 111 in the carrier 85, and a gear pinion 112 rotatably mounted in a bore 113 of the carrier 85 and meshing with the rack 109 and provided with a manipulating knob 114. See Figures 6 and 10.

The carrier 96 is conveniently adjusted angularly by means of a knurled manipulating flange 115, it being observed that the knobs 105 and 114 and the flange 115 are all accessible for adjustment through the front opening 3 of the lower casing portion 1.

A field lens 116 is mounted on the guide 52 and as so mounted is disposed across the optical axis of the projection system between the plane of the film 53 in the guide and the erector lens 71, see particularly Figure 5, and a second field lens 117 is mounted in the bore of an annular carrier 118 secured concentrically on the upper end of the tubular carrier 76 and as so mounted is disposed across the optical axis of the projection system between the turning prism 78 and the sighting image or reticle element 99 and consequently between the erector lens 71 and the objective lens 69. See particularly Figure 6.

These field lenses serve to constrict the projection light so that vignetting is prevented despite small apertures of the objective and erector lenses.

The plane of the film 53 as positioned in the guide 52 and the plane of the sighting or reticle design 101 are disposed respectively at conjugate foci of the erector lens 71, so that an image of the picture on the film at the projection aperture of the guide is formed at the plane of the sighting image or reticle design 101, and the plane of the sighting image or reticle design forms the back focal plane of the objective lens 69 which is focused to project the picture image formed at the plane of the sighting image or reticle design by the erector lens with the image of the sighting image or reticle design superimposed thereon upon a projection screen, the resulting image projected upon the projection screen being a composite image of the picture and the sighting image or reticle design.

For the purpose of projecting the aforesaid composite image of the picture and the sighting image or reticle design upon the projection screen 23 when this screen is positioned in its upwardly extending position and the upper casing portion 2 is positioned upwardly out of closed position as hereinbefore described and as shown in Figures 1 and 3, a series of reflecting elements are provided which together with their mountings will now be described.

A reflecting element 121 of the front surface reflecting type is mounted within the lower casing portion 1 above the objective lens 69 by means of a bracket 122 secured on the support rods 83 and adjustable mounting stud structures generally designated at 123. The reflecting element 121 as so mounted is directed downwardly and rearwardly, and is operative to reflect the projection light horizontally and rearwardly. See Figures 3 and 6. A second reflecting element 124 of the front surface reflecting type is mounted within the lower casing portion and on the inside of the door 7 by means of brackets 125 and 126, and as so mounted is directed forwardly and upwardly when the door 7 is in closed position, and is operative when this door is in closed position to reflect the projection light, as reflected from the reflecting element 121, upwardly. See particularly Figure 3. A third reflecting element 127 of the front surface reflecting type is mounted on the under side of the top part 12 of the upper casing portion 2 in parallelism with the top part by means of stud structures 128. See Figures 1 and 3. The reflecting element 127 is directed downwardly with respect to the top part 12, and, when the upper casing portion 2 is positioned upwardly out of closed position as hereinbefore described and as shown in Figures 1 and 3, is directed downwardly and forwardly and is operative to reflect the projection light, as reflected by the reflecting element 124, horizontally and forwardly onto the projection screen 23 when the screen is in its upwardly extending position, as hereinbefore described and as shown in Figures 1 and 3, from the front of which screen the aforesaid composite image of the picture of the film 53 and of the sighting image or reticle design 101 may be observed.

When the door 7 is in open position as shown in dot and dash lines in Figure 3, the reflecting element 124 is positioned with it on the exterior of the lower casing portion 1 and out of line with the projection light as reflected rearwardly by the reflecting element 121, so that the reflecting element 121 is then operative to reflect the projection light horizontally and rearwardly through the rear opening 5 for the projection of the aforesaid composite image upon a relatively large sep-

arate projection screen considerably spaced from the projection machine for the projection of relatively large pictures, such a separate screen being designated at 129 in Figure 14 hereinafter referred to.

Figures 12 and 13 illustrate the functioning of the optical system of the device under different conditions while utilizing the projection screen 23.

Referring to Figure 12, the motion picture film 53, positioned in the projection guide 52, has on a frame thereof a picture 131 which has its horizontal extending longitudinally of the film. After passing through the lens 71, the picture image is erected as designated at 132 and after passing through the image turning prism 78 the picture image is handed vertically thereof as designated at 133. In the position of the turning prism angularly of the optical axis of the objective and erector lenses as shown in Figure 12, the reflecting face 79 of the image turning prism is parallel to the horizontal of the picture on the film so that in this case the picture image 133 is not turned but is merely handed vertically thereof with respect to the picture image 132. As a picture image is formed at the plane of the sighting image or reticle design 101 by the erector lens, the sighting image or reticle design is superimposed upon the picture image to form a composite picture and sighting image or reticle design image as designated at 134. After passing through the objective lens 69, the composite image is erected as designated at 135, and as the composite image is reflected rearwardly by the reflecting element 121, it is handed vertically of the picture image as designated at 136. As the composite image is reflected vertically by the reflecting element 124, it is again handed vertically of the picture image as designated at 137 so that it is disposed correspondingly with the composite image 135. Finally, as the composite image is reflected forwardly by the reflecting element 127, it is again handed vertically of the picture image as designated at 138, so that the composite image projected upon the screen 23 is disposed with the picture image thereof upright and naturally handed for the observance thereof in a natural position by an observer's eye 139 spaced forwardly of and directed toward the screen.

Referring to Figure 13, the motion picture film 53, positioned in the projection guide 52, has on a frame thereof a picture 141 which has its horizontal extending transversely of the film. Figure 13 has designated thereon at 142-143-144-145-146-147-148 images of the picture 141 or composite images of the picture 141 and the sighting image or reticle design 101, which correspond, with respect to their sequential positions relative to the projection system, respectively with the images 132 to 138 inclusive of Figure 12, so that a detailed description thereof is unnecessary.

As will be noted, the picture 141 on the film 53 of Figure 13 has its horizontal extending transversely of the film, whereas the picture 131 on the film 53 of Figure 12 has its horizontal extending longitudinally of the film, and the final composite image 148 of Figure 13, which is projected upon the screen 23, is disposed with the picture image thereof upright and naturally handed, just as is the picture image of the final composite image 138 of Figure 12, which is projected upon the screen 23, disposed upright and naturally handed.

This upright position of the picture image of

the final composite image 148 of Figure 13 is accomplished by angularly adjusting the image turning prism 78 on the optical axis of the objective and erector lenses in the counter clockwise direction from its position as shown in Figure 12 to the position as shown in Figure 13 where the reflecting face 79 of the image turning prism is disposed at an angle of forty-five degrees to the horizontal of the picture 141 on the films.

As a result of this angular positioning of the turning prism as shown in Figure 13, the picture image erected by the erector lens 71 as designated at 142 is not only handed horizontally thereof in passing through the image turning prism but is turned through an angle of ninety degrees in the counter clockwise direction as designated at 143, with the result that the picture image of the final composite image 148, which is projected upon the screen 23, is disposed upright and naturally handed.

Thus, pictures variously positioned on the film may be projected upon the screen in upright naturally handed position.

As hereinbefore described, when the door 7 is in open position, the reflecting element 124 is positioned out of line with the projection light as reflected rearwardly by the reflecting element 121, so that the reflecting element 121 is then operative to reflect the projection light rearwardly through the rear opening 5 of the lower casing portion 1 for the projection of the composite image upon a separate reflecting projection screen 129 spaced rearwardly from the projecting machine as shown in Figure 14.

Referring to Figure 14, inasmuch as the projection screen 129, as shown, is a reflecting screen and in order that the picture image of the final composite image projected on the screen be naturally handed as well as disposed upright, the film 53 in the projection guide is reversed facewise on an axis extending longitudinally of the film with respect to the films of Figures 12 and 13. To illustrate, the film 53 of Figure 14 is shown as having on a frame thereof the same picture, designated at 151 in Figure 14, as the picture 141 of the film 53 of Figure 13. However, the picture 151 of the film of Figure 14 is handed horizontally thereof with respect to the picture 141 of the film of Figure 13 because the film of Figure 14 is reversed facewise on an axis extending longitudinally of the film with respect to the film of Figure 13. While this facewise reversal of the film causes a slight change of the picture plane of the film, a sufficiently sharp projection is obtained in either film position for usual purposes, though, if desired, the erector lens 71 may be axially adjusted for the slightly different film picture positions.

Figure 14 has designated thereon at 152-153-154-155-156 images of the picture 151 or composite images of the picture 151 and the sighting image or reticle design 101, which correspond, with respect to their sequential positions relative to the projection system, respectively with the images 132 to 136 inclusive of Figure 12 and with the images 142 to 146 inclusive of Figure 13, so that a detailed description thereof is unnecessary.

As will be noted, the picture 151 on the film 53 of Figure 14 is handed horizontally thereof with respect to the picture 141 on the film 53 of Figure 13, and the final composite image 156 of Figure 14, which is projected upon the screen 129 is disposed upright and is naturally handed.

The upright position of the final composite image 156 of Figure 14 is accomplished by angularly adjusting the image turning prism 78 on the

optical axis of the objective and erector lenses in the clockwise direction from its position as shown in Figure 12 to the position as shown in Figure 14 where the reflecting face 79 of the image turning prism is disposed at an angle of forty-five degrees to the horizontal of the picture 151 on the film. As a result of this angular positioning of the turning prism as shown in Figure 14, the picture image erected by the erector lens 71 as designated at 152 is not only handed horizontally thereof in passing through the turning prism 78 but is turned through an angle of ninety degrees in the clockwise direction as designated at 153, with the final result that the picture image of the final composite image 156 of Figure 14, which is projected upon the screen 129, is disposed upright and naturally handed as the image on the screen is viewed from a position forwardly thereof.

By reason of the carrier 85 being mounted for horizontal bodily adjustment, of the carrier 91 being mounted on the carrier 85 for bodily adjustment therewith and for bodily adjustment relative thereto at a right angle to the adjustment path of the carrier 85, and of the carrier 96 being mounted on the carrier 91 for rotation on a vertical axis, the sighting image or reticle bearing element 99 and its sighting or reticle design 101 may be adjusted angularly or bodily transversely of the optical axis of the system, with the result that the sighting or reticle image may be correspondingly adjusted with respect to the picture images for the purpose of alining or desirably disposing the sighting or reticle image relative to objects or targets depicted in pictures projected from the film, particularly with respect to accurately illustrating the movements of military aircraft with reference to objects or targets, from which aircraft pictures being projected have been photographed.

While we have thus described our invention, we do not wish to be limited to the precise details described, as changes may be readily made without departing from the spirit of our invention, but having thus described our invention, we claim as new and desire to secure by Letters Patent the following:

1. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting element spaced along the optical axis of the system from a picture bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci thereof respectively thereat to form an image of said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, and adjustable mounting means carrying said sighting element for adjustment transversely of said axis.

2. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting element spaced along the optical axis of the system from a picture bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci

thereof respectively thereat to form an image of said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, and projection light constricting first and second field lenses disposed across said axis respectively between said picture bearing element and said erector lens and between said erector lens and said projection lens.

3. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting image bearing element spaced along the optical axis of the system from a picture bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci thereof respectively thereat to form an image of said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, and a picture image turning device operative in the system between said picture bearing and sighting elements and mounted for angular adjustment about said axis and providing a reflecting surface spaced from said axis and facing the same and two deflecting surfaces extending across said axis at oppositely disposed acute angles thereto for effecting reflection of the projection light by said reflecting surface.

4. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting element spaced along the optical axis of the system from a picture bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci thereof respectively thereat to form an image of said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, projection light constricting first and second field lenses disposed across said axis respectively between said picture bearing element and said erector lens and between said erector lens and said projection lens, and a picture image turning device operative in the system between said erector lens and said sighting element and mounted for angular adjustment about said axis and providing a reflecting surface spaced from said axis and facing the same and two deflecting surfaces extending across said axis at oppositely disposed acute angles thereto for effecting reflection of the projection light by said reflecting surface.

5. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting element spaced along the optical axis of the system from an image bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci thereof respectively thereat to form an image of

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said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, adjustable mounting means carrying said sighting element for adjustment transversely of said axis, and a picture image turning device operative in the system between said picture bearing and sighting elements and mounted for angular adjustment about said axis and providing a reflecting surface spaced from said axis and facing the same and two deflecting surfaces extending across said axis at oppositely disposed acute angles thereto for effecting reflection of the projection light by said reflecting prism.

6. In a projection system, the combination with a picture bearing element positioning means, of a light transmitting sighting element spaced along the optical axis of the system from a picture bearing element positioned by said positioning means, a relay projection lens system comprising an objective lens and an erector lens spaced along said axis and having said sighting element disposed therebetween and said erector lens being disposed between said picture bearing and sighting elements and having conjugate foci thereof respectively thereat to form an image of said picture bearing element at said sighting element and said objective lens being operative to project a composite image of said picture bearing and sighting elements, adjustable mounting means carrying said sighting element for adjustment transversely of said axis, projection light constricting first and second field lenses disposed across said axis respectively between said picture

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bearing element and said erector lens and between said erector lens and said projection lens, and a picture image turning device operative in the system between said erector lens and said sighting element and mounted for angular adjustment about said axis and providing a reflecting surface spaced from said axis and facing the same and two deflecting surfaces extending across said axis at oppositely disposed acute angles thereto for effecting reflection of the projection light by said reflecting surface.

BRUNO STECHBART.
PAUL C. FOOTE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,988,522	Stanley -----	Jan. 22, 1935
1,936,043	Thomas -----	Nov. 21, 1933
1,301,045	Edmison et al. -----	Apr. 15, 1919
2,267,649	Graves -----	Dec. 23, 1941
2,271,296	Hargrave et al. -----	Jan. 27, 1942
2,085,050	Stout -----	June 29, 1937
2,019,234	Nistri -----	Oct. 29, 1935
1,891,683	Morsbach -----	Dec. 20, 1932
1,921,214	Carpenter -----	Aug. 8, 1933
1,551,259	Merriman -----	Aug. 25, 1925
1,655,809	Brixey -----	Jan. 10, 1928
1,696,831	Baker -----	Dec. 25, 1928
1,447,403	Atherton -----	Mar. 6, 1923
2,190,294	Mill -----	Feb. 13, 1940