Jan. 16, 1945. P. F. DARBY 2,367,567

OPTICAL OBJECT ALIGNING DEVICE

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Fig. 1

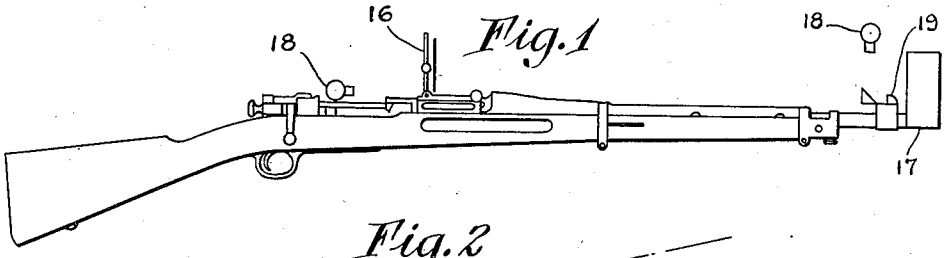


Fig. 2

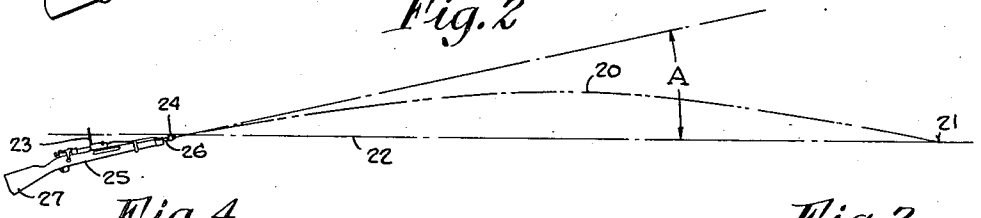


Fig. 4

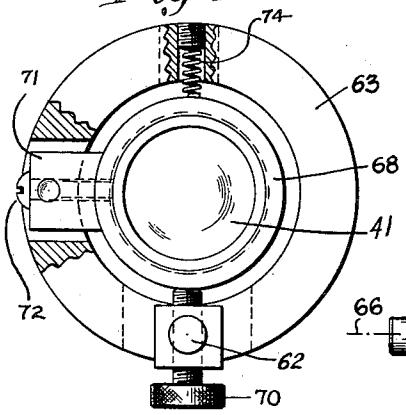


Fig. 3

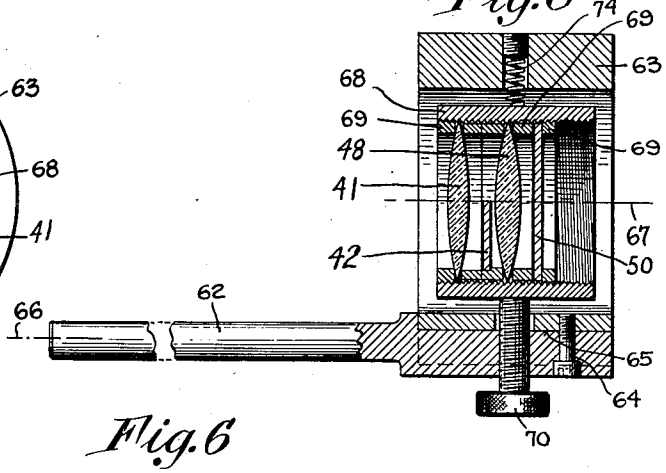


Fig. 6

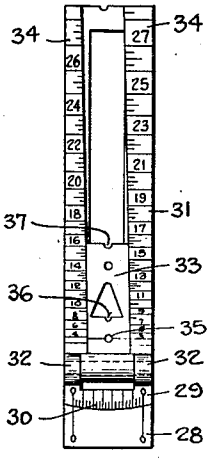


Fig. 5

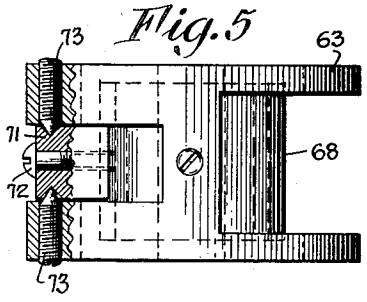
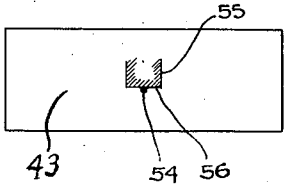


Fig. 7



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Fig. 8

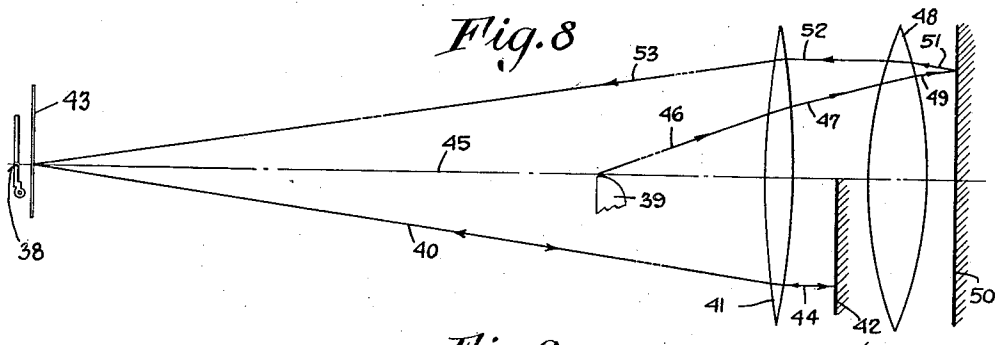


Fig. 9

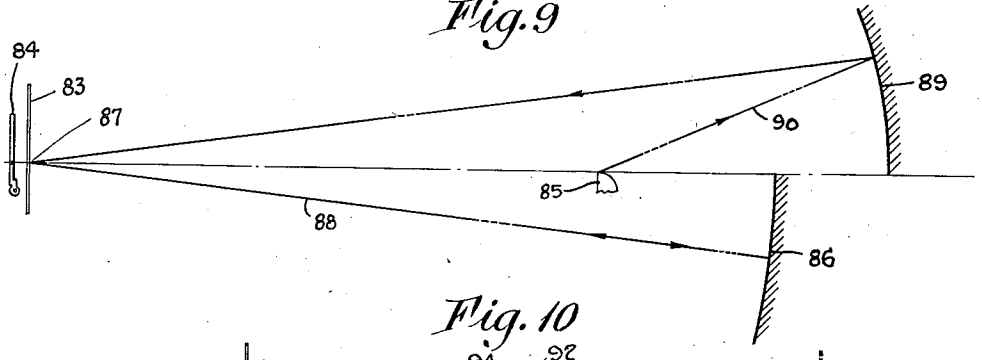


Fig. 10

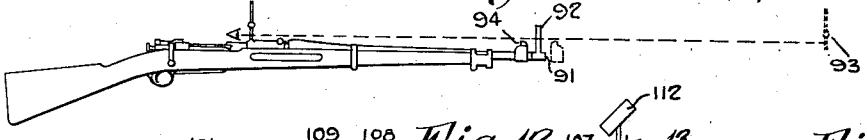


Fig. 12

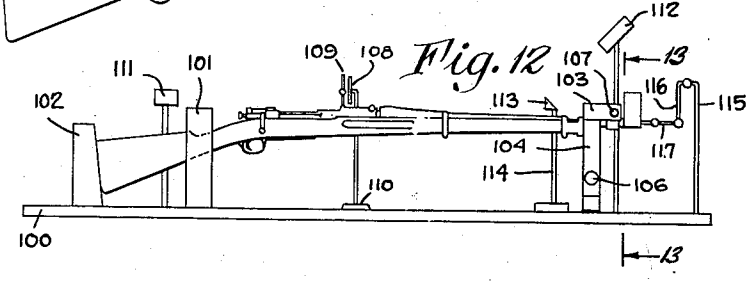


Fig. 13

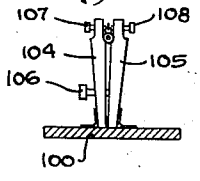


Fig. 11

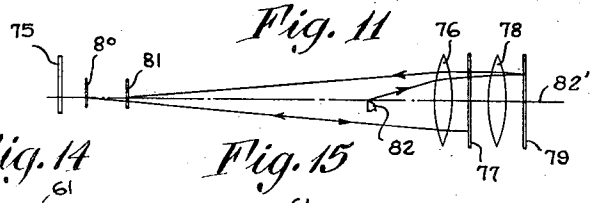


Fig. 14

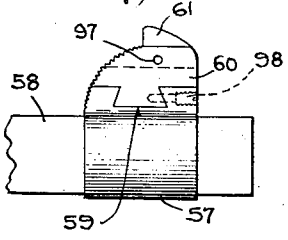
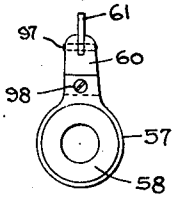


Fig. 15



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UNITED STATES PATENT OFFICE

2,367,567

OPTICAL OBJECT ALIGNING DEVICE

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Application October 17, 1942, Serial No. 462,336

16 Claims. (Cl. 88—24)

This invention relates to optical means for aligning two objects and particularly the setting of gun sights relative to the axis of the bore of a gun.

The previous practice of aligning front and rear sights of shoulder weapons, such as the U. S. rifle caliber .30 M1903 which is known as the "Springfield rifle," has been to position the sights by a cut and try method involving firing the gun at a target. After a shot is fired, the sights are moved in a direction to correct the point of impact on the target and then the process repeated until the sights are satisfactorily aligned. Ten shots are usually fired for this purpose which requires a large expenditure of ammunition when the rifles are being produced in quantity. Much time and labor is consumed in such a method of aligning sights. Another manner of aligning sights is by sighting through the bore and aligning it with a target and then adjusting the sights by looking at the same target and bringing the sights to the desired position. It is difficult to adjust the sights by these methods because of the distance to the target and the fact that the sights are in different planes. Sights aligned by sighting through the barrel are not sufficiently accurate owing to curves in the barrel which do not particularly affect accuracy but greatly influence its direction of fire and sight adjustment.

The present invention contemplates the use of optical methods for setting the sights of a gun. When the sights are aligned by the method and apparatus described herein, it is merely necessary to fire two or three test shots to make certain that the gun is properly sighted and that there are no other defects present affecting the targeting of the gun, such as improper bedding of the barrel in the stock.

The other objects of the invention will become apparent from the following description, which description and illustrations are merely exemplary and are not intended to limit the invention to the forms shown and described.

In the drawings:

Fig. 1 is a side elevational view of a gun, such as the Springfield rifle, showing the optical device in place with the sources of light located relatively thereto.

Fig. 2 is a diagrammatic showing of a gun, trajectory of a bullet, and the line of sight.

Fig. 3 is an elevation in section of one form of a suitable optical device.

Fig. 4 is an end view partially in section of Fig. 3.

Fig. 5 is a top assembly view of the device shown in Figs. 3 and 4.

Fig. 6 is a top view of one form of rear sight, such as used in the Springfield rifle, the leaf being shown in its folded or horizontal position.

Fig. 7 is a schematic view of a ground glass screen showing the images of the rear and front sights.

Fig. 8 is a geometric optical ray diagram of the optical system shown in Figs. 3 to 5 inclusive, the distance between the sights being shortened.

Fig. 9 is a geometric optical ray diagram of a modification of the optical system.

Fig. 10 is a side elevational view of a rifle showing another modification of the optical system together with the optical ray diagram therefor.

Fig. 11 is an optical ray diagram of the optical system shown in Fig. 8 with two image screens.

Fig. 12 is a side elevational view of one form of device which may be employed for holding the gun and the various related parts.

Fig. 13 is an end view looking in the direction 13—13 of Fig. 12.

Fig. 14 is a fragmentary view of a front sight such as used in the Springfield rifle.

Fig. 15 is an end view of Fig. 14.

As stated, the method used hither to for setting of sights were costly, tedious and not sufficiently accurate. The present invention makes it possible to set the sights of a shoulder weapon easily and with the expenditure of only two or three cartridges to check the performance of the gun. The adjustment of the sights is accomplished by optically producing an image of each sight and then moving the sights relative to each other until they occupy predetermined positions indicative of correct alignment of the sights.

In general, the effective optical axis of an optical system is located parallel with or at a predetermined angle with the axis of the bore of the gun. In several forms of the invention as described hereafter, the effective optical axis is made parallel or coincident with the line of sight. This may be done by bringing the reflected image of one sight into coincidence with the directly projected image of the sight or by bringing the reflected image to a predetermined position on a screen or surface. The effective optical axis depends generally on the line of centers of the two lenses and the planes of the two mirrors. It may be determined experimentally for a given optical system by adjusting the peep sight and its image and the front sight and its image until all four

lie on the same straight line. This line is the effective optical axis of the lens system. By projecting an image, it is meant that an actual image is produced at a point such as a screen.

A Springfield rifle is shown in Fig. 1 having the rear sight leaf 16 elevated and with an optical system 17 diagrammatically shown supported in the muzzle of the gun. Sources of light 18 are also shown diagrammatically for projecting the images of the rear and front sights 16 and 19 respectively. It is to be understood that other types of rifles and shoulder or hand guns can be adjusted and that the optical device could be put in the breech end and the system reversed if desired. It is more convenient, however, to use the optical device at the muzzle as shown.

The path of the projectile from a gun follows a trajectory which can be indicated as shown at 20 in Fig. 2. Except for extremely short ranges, the gun bore must make an angle with the line of sight so that the projectile will strike the target at 21. Line 22 is a straight line from the shooter to the target and 23 and 24 are diagrammatic representations of the rear and front sights respectively of a gun. When these sights are aligned with the target 21, as shown by the line of sight 22, the gun will be pointed at an angle A with the line of sight. A gun is shown diagrammatically at 25 having a barrel 26 and stock 27.

It is to be understood that any portion of the rear sight or front sight may be used as is found convenient.

Fig. 6 shows a rear sight such as used on the Springfield rifle. This sight is composed of a fixed base 28 which is rigidly fastened to the gun in some manner and a movable base 29 rotatable on a pivot on the fixed base 28. The movable base 29 can be rotated so that the rear sight can be set in accordance with the cross wind existent.

Any suitable means may be used for changing the windage angle and/or locking the fixed base and movable base relative to each other. Indices are shown at 30 to designate the relative windage setting of the fixed and movable bases. The folding sight leaf 31 is pivoted on the arms 32 of the movable base. The folding sight leaf 31 has a slide 33 which may be moved between the rails 34 of the sight leaf 31 in accordance with the desired range, the rails being designed to compensate for drift due to rotation of the projectile. A peep sight hole is shown at 35 together with other sight notches in slide 33 at 36 and 37. When setting the sights of a Springfield rifle it has been found convenient to use the peep sight opening 35 set for one hundred yards. There is a very slight angle between the line of sight and axis of the bore for this setting.

This invention employs an optical system to produce an image of each sight on a screen or elsewhere and this is followed by an adjustment of the sights to bring the images into predetermined relationship on the screen, mirror, or other surface. The sights can be adjusted while the images are being observed.

In the form of the device shown in Figs. 3 and 8, two lenses and two mirrors are mounted as a unit on a plug which may be inserted in the muzzle of the gun. Provisions are made for adjusting the effective optical axis of this system in a plane transverse to the axis of the bore of the gun or the line of sight, and, at the same time, maintaining the predetermined angular relationship between the bore axis and the effective optical axis. The geometric optical ray diagram of Fig. 8 shows a schematic representation of the peep sight at 38 and a front sight at 39. The lenses and mirrors may be mounted, as shown in Figs. 3 to 5 inclusive, which will be described in detail hereafter.

A suitable source of light may be placed behind the peep sight 38 so that the opening of the peep sight will cause rays of light defining the same to follow a path such as 40, through lens 41 to mirror 42 where they will be reflected in the opposite direction and return to the screen 43. The peep sight is located very close to a screen 43 and said screen is located at the focus of lens 41 so that the portion 44 of the ray will be parallel to the effective optical axis 45.

The mirror 42 may be a half or partial mirror as shown in Fig. 8 or may be a complete mirror with a silvered or reflecting surface which is half silvered or porous so as to allow part of the light to pass for the purpose about to be described. Mirror 42 does not need to be exactly half if it is of the complete reflecting type and may be more or less than one half the size of the lens. The front sight 39 may be illuminated by a suitable source (not shown in Fig. 8) so that there may be traced from the front sight 39 a ray 46 which passes through lens 41 and is bent as it passes therethrough to ray 47, enters lens 48 and is bent to ray 49. Ray 49 is then reflected on the mirror 50 as ray 51 and passes through lens 48 in a return direction.

The lens is so selected as to cause ray 52 to be parallel to the line of sight or effective optical axis 45 so that when ray 52 enters lens 41 it will be affected in the same manner as ray 44 or parallel light and the emerging ray 53 will be directed to the focus of lens 41. In this manner, the image of front sight 39 will fall on the screen 43 or the same plane as the images of the peep sight 38. The upper edge of front sight 39 can be brought into a predetermined relationship with the peep sight 38 by adjusting front sight 39 in various manners. An example of the images on screen 43 may be seen in Fig. 7 wherein 54 represents an image of the peep sight. The reflected and direct image can be made coincident so that only one circle will appear. The reflected image will, in actuality, be inverted, but such is of no consequence because the peep sight is circular. The image of the front sight is shown at 55 and the top surface 56 may be brought to its proper relationship with the peep sight by adjusting the front sight 39. The horizontal side position of the sight may also be adjusted. It is also evident that the relative location of the rear sight may be adjusted instead of the front sight. In the construction of the Springfield rifle, it is more convenient to adjust the front sight.

As shown in Fig. 14, a fixed stud or base 57 surrounds the barrel 58 and has a groove 59 therein. The movable stud or base 60 is slidable sideways in groove 59 by a means of a tongue slidable in groove 59. The sight leaf 61 is similar to 39 and is located in a slot in the base 60 and may be held in position by a pin 97 after the correct sight has been positioned. Various heights of sight leaves may be selected and the base 60 may be moved sideways until the proper relationship of the images, as shown in Fig. 7, is obtained. The movable base can then be affixed in position by means of set screw 98. If the mirror 42 is of the half silvered or porous type, part of the light from front sight 39 will be reflected therethrough and back to the screen 43.

Figs. 3 to 5 inclusive, show one method in which the lens and mirror system of Fig. 8 may be mounted. A plug 62 is provided for insertion in the muzzle of the gun and a holder 63 is mounted on the plug 62 which may be held in place by screw or pin 64. The relative angle between the holder 63 and plug 62 may be adjusted by means of shims or by the machining of surface 65 to give the desired angle between the axis 66 of plug 62 and the effective optical axis 67. The lens and mirrors are mounted in the lens barrel 68 by means of suitable threaded rings and spacers 69, the interior of the lens barrel 68 being threaded as is well known in optical instruments.

The lens barrel 69 may be adjusted for vertical position relative to the bore of the gun by means of the adjusting screw 70, the barrel being pivotally mounted in the holder 63 by means of lug 71 which is screw fastened to the lens barrel 68 by screw 72. The vertical adjustment is necessary so as to bring the effective optical axis coincident with the line of sight.

Pivot screws 73 have conical points entering suitable depressions in the lug 71. A spring 74 can be used to hold the lens barrel 68 against the adjusting screw 70. The holder 63 can be cut away in the interest of lightness as indicated. The effective optical axis of the lens barrel 68 can be made to bear the desired angular relationship with the axis of the plug 62, and, therefore, the barrel of the gun. Then, when the plug 62 is inserted in the barrel of the gun, the lens barrel 68 may be adjusted transversely relative to the axis of the barrel and line of sight by means of adjusting screw 70 until the images of the peep sight coincide, at which time the peep sight and optical axis of the lens barrel bear the desired relationship with the axis of the bore of the gun. There will also be some rotation of the plug in the bore to bring the optical axis coincident with the line of sight through the peep sight. The next step is then to bring the front sight top surface to the line of sight which has been established in the manner just described.

The method of using the device just described is to place the optical device, plug 62, within the bore of the muzzle of the gun and establish the source of light behind the raised peep sight leaf, a screen being placed immediately in front of the peep sight. An image resulting from the light passing through the peep sight will appear upon this screen. A reflected image will also appear on this screen and the optical axis of the optical device is adjusted until these images are coincident so as to bring the effective optical axis in line with the line of sight at the predetermined angle with the bore of the gun. The image of the front sight is noted on the screen and the front sight adjusted until the edge thereof is tangent with the peep sight. It is to be understood that other portions of the sight may be used and a particular relationship of the images will depend upon which sights are selected and the setting of the optical device relative to the support. By making the focal lengths of the optical systems producing the first and second images of different values, movements of the optical system transversely of the line of sight will cause the image of one sight to move at a different rate than the other. This will facilitate adjustment of the optical axis to coincide with the line of sight to be established. As, for example, in the Springfield rifle, the sights are approximately twenty-two inches apart. The focal length of the first lens can be made about twenty-three inches and the focal length of the combined lens and reflecting system for the front sight about 1.5 inches. The focal length in such a combination of the second lens can be made about 3.5 inches. It is to be understood, however, that these values depend upon the gun and other related matters.

In Fig. 11, a modification is shown of the device of Figs. 3 to 5, inclusive, wherein the focal lengths of the optical systems are made such that the images of each sight fall on two separate screens. The peep sight is diagramatically shown at 75 with a first lens 76, a restricted mirror 77, second lens 78 and a second mirror 79. The two screens are shown at 80 and 81 and the front sight at 82. The screens 80 and 81 may be predeterminedly fixed and fiducial marks placed thereon with which the images of the sights may be aligned. It is evident these fiducial marks must bear the proper relationship with the optical axis or line of sight 82'.

Another modification of the lens and optical system is shown in Fig. 9, wherein 83 represents the screen, 84 the peep sight and 85 the front sight leaf. A half concave mirror 86 may be used with its center of curvature at point 87 on the screen 83. The reflection of image 87 will take the direction of ray 88 to the mirror and be returned to the same point. The image of sight 85 is reflected to the point 87 by means of a concave mirror 89, the curvature of the mirror being made such that the light ray 90 will be reflected to the point 87. The images on screen 83 may be brought into the proper relationship to establish the desired line of sight. The mirrors 86 and 89 may be mounted on a device similar to that shown in Figs. 3 to 5 inclusive. It is also evident that concave mirror 86 may be of the type permitting part of the light to pass therethrough so that the image from 85 will be formed on the screen 83.

Another modification is shown in Fig. 10, wherein a plug 91 may have a plain mirror 92 mounted thereon. In this case, the person adjusting the gun must look through the peep sight and he will see a virtual image of the peep sight in mirror 92, which image will be located as shown in the dotted lines at 93. He will also see a virtual image of the front sight leaf 94 in mirror 92 and can adjust the sights relative to each other so as to obtain the desired alignment. The mirror 92 must be given the proper angle to the axis of the plug 91 so as to obtain the desired line of sight.

In the use of the invention for production purposes, it is desirable to have a clamping means which can be used to hold the gun when the sights are being set. One form which may be employed is shown in Figs. 12 and 13. The base 100 may have a V notch holder 101 for holding the stock of the gun and an abutment member 102 against which the butt can rest. A pivoted vise arrangement 103 having two arms 104, 105 may be used for supporting the muzzle end of the gun. The arms 104 and 105 may be pivotally mounted on the base 100 and provided with a screw arrangement 106 for forcing the arms together so as to clamp the barrel. The upper ends of the arms 104 and 105 may have hand wheels 107, 108 which threadedly engage the same and can be advanced or retracted for moving the movable front sight base 60 transversely of the fixed sight base 57 on the barrel. A screen 109 may be supported by a base 110 which rests on the fixed base 100. A light source 111 and light source 112 can

be mounted on base 100 for the rear and front sights respectively. A prism or reflecting surface 113 can be mounted on a movable stand or arrangement 114 for reflecting light from 112 onto the front sight leaf. The optical system can be mounted on a double universal joint arrangement mounted on support 115 and comprising arms 116 and 117 which are connected by ball or universal joints to the support, to each other and to the optical system. It is apparent that there are equivalent means for operating the vise, holding the lights, screens and the optical system.

What is claimed is:

1. An apparatus for aligning two objects relative to each other and to an axis, including an optical assembly; means to support said assembly relative to said axis; means including at least a portion of said optical assembly to produce an image of one of said objects on a surface; means including at least a portion of said optical assembly for producing an image of the other of said objects on a surface; and means to adjust said objects so as to bring the images to predetermined locations.

2. An apparatus for aligning gun sights relative to the bore of a gun, including an optical system; means to adjustably support said optical system relative to the bore of the gun; means including a portion of said optical system to produce an image of one of said sights on a screen; means including a portion of said optical system for producing an image of another of said sights on a screen; means to adjust the optical system to bring the first image to a predetermined position on said screen; and means to adjust the sights relative to each other to bring the second image to a predetermined position on said screen.

3. An apparatus for aligning the sights of a gun relative to the bore thereof, including an optical device with two correlated optical systems mounted thereon; means to support said assembly relative to said bore; means including one of said optical systems to produce an image of one of said sights on a screen; means to adjust said image to bring the optical systems into a predetermined relationship with the gun bore; means including the other of said optical systems to produce an image of the other sight on a screen; and means to adjust the relative positions of said sights to bring the second image to a predetermined position.

4. An apparatus for aligning gun sights relative to a gun bore, including an optical device with two reflecting surfaces; means to adjustably support said optical device relative to the gun bore; means including one of said reflecting surfaces to project an image of one of said sights on a screen; means to adjust said image to bring said optical device into a predetermined relationship with said gun bore; means including the other reflecting surface to project an image of the other sight on a screen; and means to adjust the relative position of said sights to bring the second image to a predetermined position to thereby align the sights relative to each other and to the gun bore.

5. An apparatus for aligning gun sights relative to a gun bore, including an optical assembly having two reflecting surfaces; means to adjustably support said optical assembly relative to the gun bore; means including one of said reflecting surfaces for projecting an image of one of said sights on a screen; means to adjust said image to bring said optical device into a predetermined relationship with said gun bore; means including the other reflecting surface to project an image of the other sight on said screen; and means to adjust said sights relative to each other to bring the two images into a predetermined relationship.

6. An apparatus for aligning gun sights relative to a gun bore, including an optical assembly having two correlated optical systems, each having a reflecting surface and one system having a longer focal length than the other; means to support said assembly relative to said bore; means including one of said optical systems to project an image of one of said sights on a screen; means to adjust said assembly relative to the bore to bring said image to a predetermined point on the screen; means including the other of said optical systems to project an image of the other sight on said screen; and means to adjust said sights relative to each other to bring the images to a predetermined relationship, thereby aligning the sights relative to the gun bore.

7. An apparatus for aligning gun sights relative to a gun bore, including an optical assembly; means to adjustably support said optical system in the bore of the gun; means to directly project an image of one of said sights on a screen; means including said optical system to project a second image of said sight on said screen; means to adjust said support to bring said images into coincidence and thereby locate the optical system relative to the gun bore; means including said optical system to project an image of the other sight on the screen; and means to adjust said sights relative to each other to bring the last mentioned image into a predetermined relationship with the second mentioned image.

8. An apparatus for aligning gun sights relative to a gun bore, including an optical device with a pair of lenses and reflecting surfaces; means to adjustably support said optical device relative to the gun bore; means including one of said lenses and reflecting surfaces to project an image of one of said sights on a screen; means to adjust said lens and reflecting surfaces to bring said image to a predetermined location on the screen; means including the other lens and reflecting surface to project an image of the other sight on a screen; and means to adjust the relative position of said sights to bring the second image to a predetermined position and thereby align the sights relative to each other and to the gun bore.

9. An apparatus for aligning gun sights relative to a gun bore, including an optical assembly with two lenses and two reflectors; means to adjustably support said optical assembly relative to the gun bore; a projecting system including one of said lenses and reflectors to produce an image of one of said sights on a screen; means to adjust said optical assembly to bring said image to a predetermined location on the screen; a second projecting system including the other lens and reflector for producing an image of the other sight on the screen, the focal lengths of the two projecting systems being different; and means to adjust the relative position of the sights.

10. An apparatus for aligning gun sights relative to a gun bore, including an optical assembly with a pair of lenses and reflecting surfaces; means to adjustably support said optical assembly relative to the gun bore; means including a first lens and reflecting surface to project an image of one of said sights on a screen; means including the two lenses and the second reflecting surface for projecting an image of the second

sight on said screen; and means to adjust the relative positions of said sights to bring the second image to a predetermined position and thereby align the sights relative to each other and to the gun bore.

11. An apparatus for aligning gun sights relative to a gun bore, including an optical device having two lenses and two reflecting surfaces, one reflecting surface being located between the two lenses and only partially restricting the path of light therebetween; means to adjustably support said optical assembly relative to the gun bore; means including a first lens and said restricted reflecting surface for projecting an image of one of said sights on a screen; means including the two lenses and the second reflecting surface for projecting an image of the second sight on said screen; and means to adjust the relative positions of said sights and thereby align the sights relative to each other and to the gun bore.

12. An apparatus for aligning front and rear gun sights relative to a gun bore, including an optical device having two lenses and two reflecting surfaces, one reflecting surface being located between the two lenses and reflecting only part of a light beam passing through the first of said lenses; means to adjustably support said lenses and reflecting surfaces as a unit relative to the gun bore; means to directly project an image of the rear sight on a screen and to project a reflected image of the rear sight by means of said first lens and partial reflecting surface; means to adjust said optical device to bring the images into a predetermined relationship; means including the two lenses and second reflecting surface to project an image of the front sight on said screen; and means to adjust the relative position of said sights to bring the last image of the front and rear sights into a predetermined relationship.

13. An apparatus for aligning gun sights relative to a gun bore, including an optical device with two concave mirrors; means to adjustably support said optical device relative to the gun bore; means including one of said mirrors to project an image of one of said sights on a screen; means to adjust said optical device to bring said image into a predetermined relationship with said gun bore; means including the second mirror to project an image of the other sight on a screen; and means to adjust the relative position of said sights to bring the second image to a predetermined position.

14. An apparatus for aligning gun sights relative to the bore of a gun including a base; clamping and positioning means on said base for the gun; an optical device with means to support the gun relative to the bore of the gun; a support on the base for holding the optical device; means including a source of light mounted on said base and said optical system for producing an image of one of said sights on a screen; means including a second source of light mounted on said base and said optical system for producing an image of the other of said sights on said screen; and means carried by the clamping means for adjusting one of the sights to bring the images to predetermined positions.

15. An apparatus for aligning two gun sights relative to a gun bore, including an optical assembly having two lenses and two reflecting surfaces, one reflecting surface being located between the two lenses and partly restricting the path of light therebetween; means to adjustably support said optical assembly relative to the gun bore in a plane which is substantially perpendicular to the axis of the support; means including a first lens and said reflecting surface for projecting an image of one of said sights on a screen; means including the two lenses and the second reflecting surface for projecting an image of the second sight on said screen, the focal length of the first lens being different than the focal length of the combined lenses; and means to adjust the relative positions of said sights and thereby align the sights relative to each other and to a gun bore.

16. An apparatus for aligning two gun sights relative to each other and to the axis of the bore of a gun, including an optical device having a planar reflecting surface; a bore plug extending in said bore sufficiently to maintain the axis of the plug parallel with the axis of the bore, said bore plug adjustably supporting said reflecting surface exteriorly and laterally above said bore, said surface facing said sights and being located in a plane substantially perpendicular to said bore axis; and means to adjust one of said two sights to align the image thereof with said two sights.

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