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APPARATUS FOR ALIGNMENT OF GUNS AND GUN SIGHTS

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FIG. 1

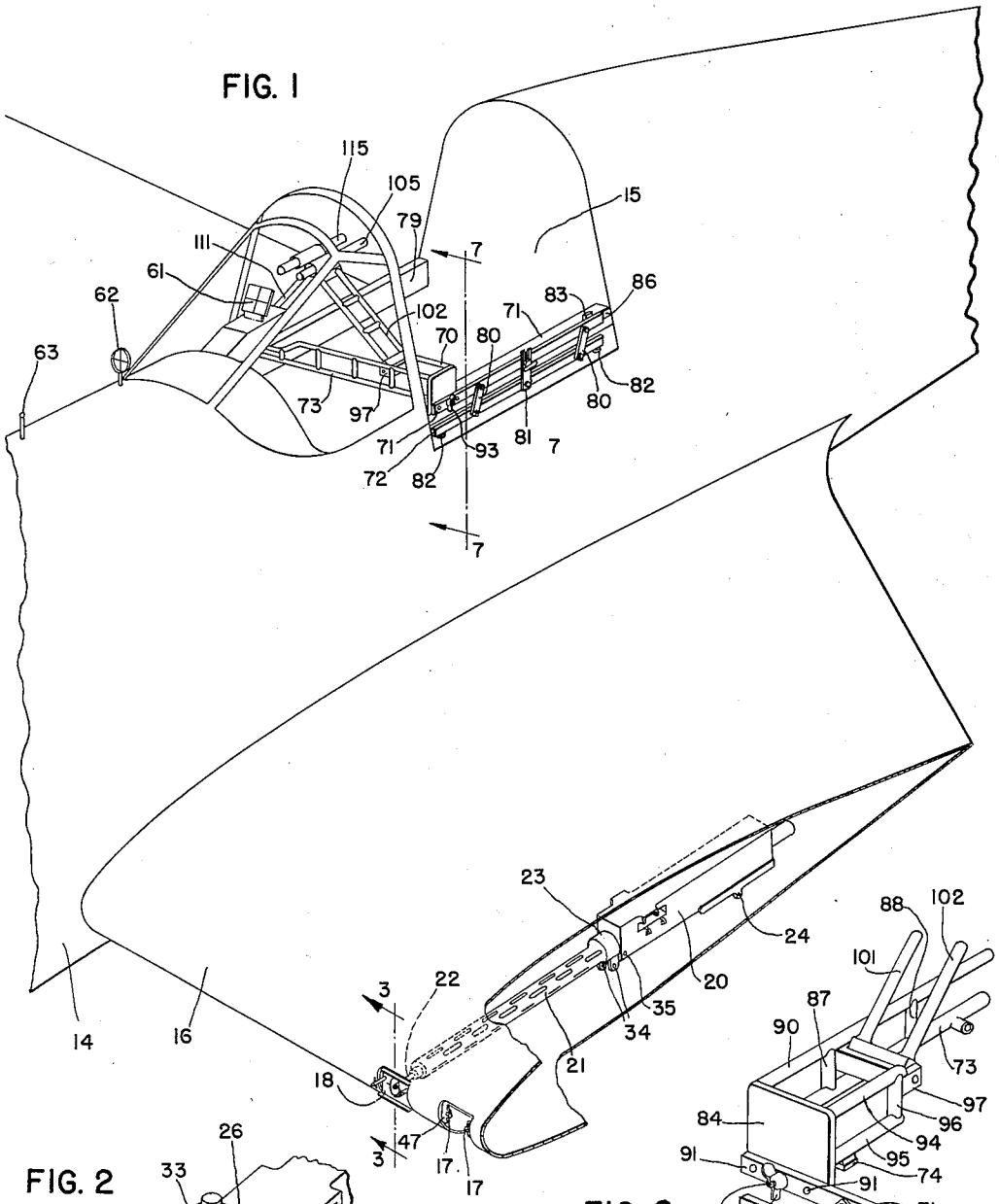


FIG. 2

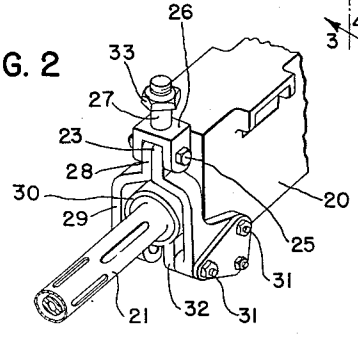


FIG. 9

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FIG. 3

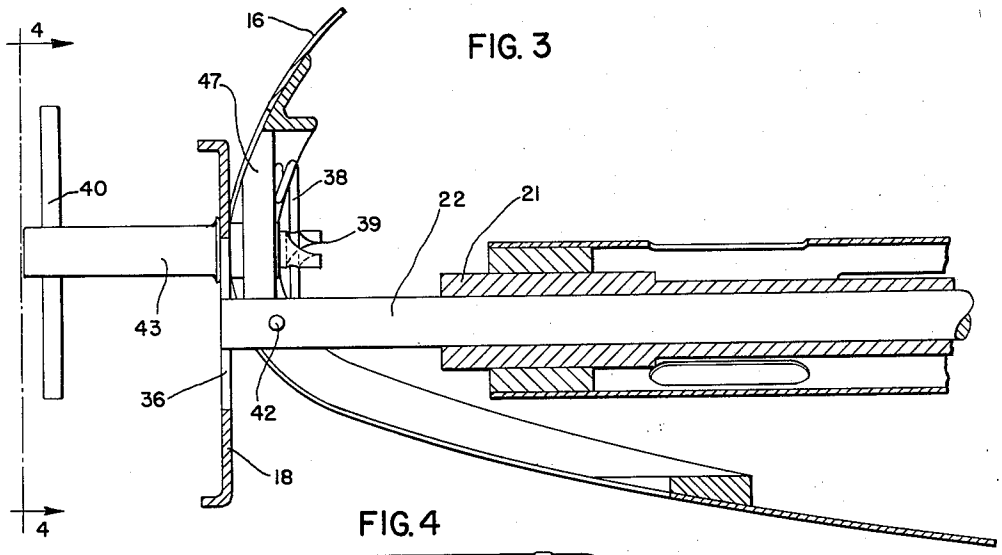


FIG. 4

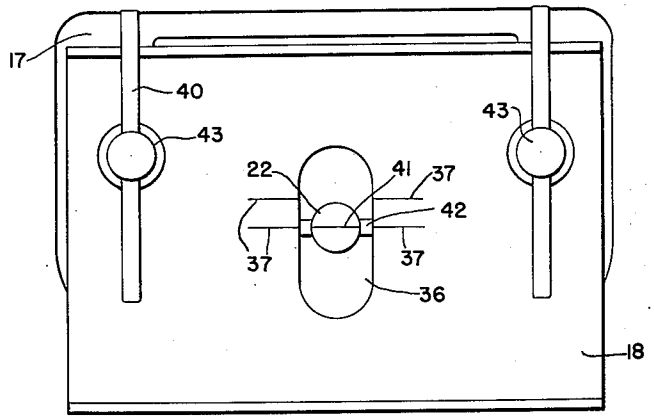


FIG. 6

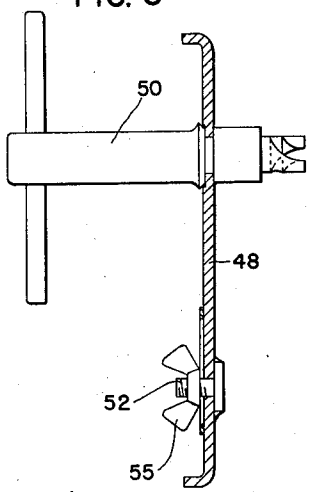
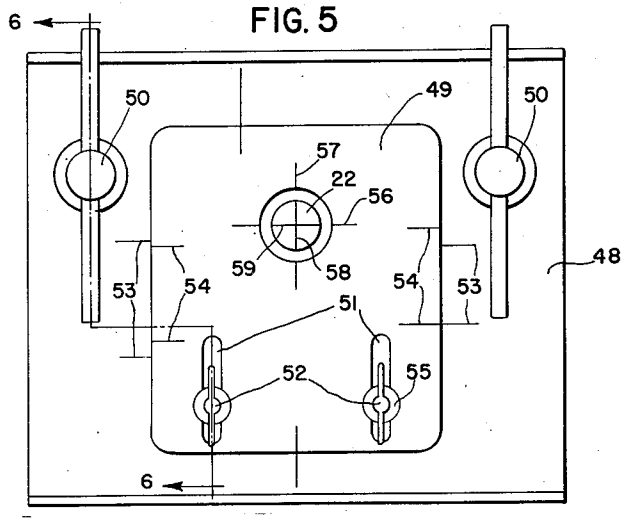


FIG. 5



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FIG. 10

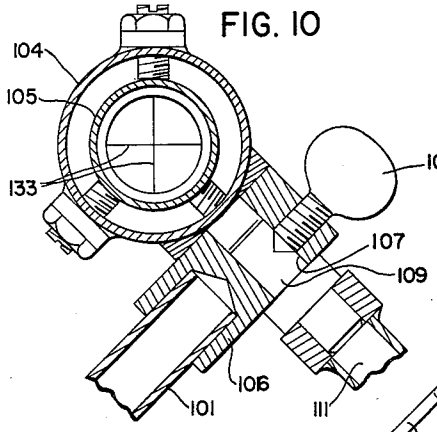
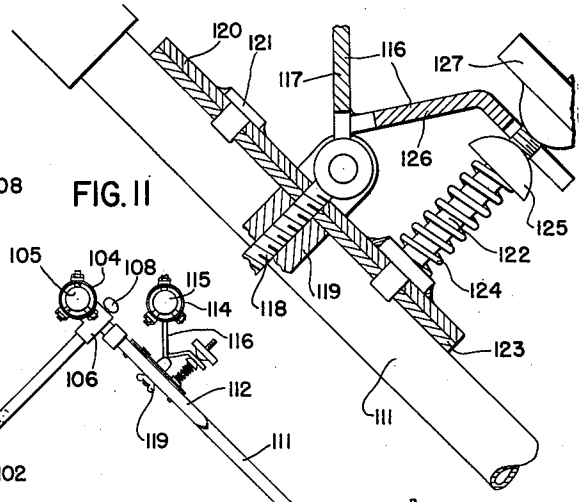


FIG. 11



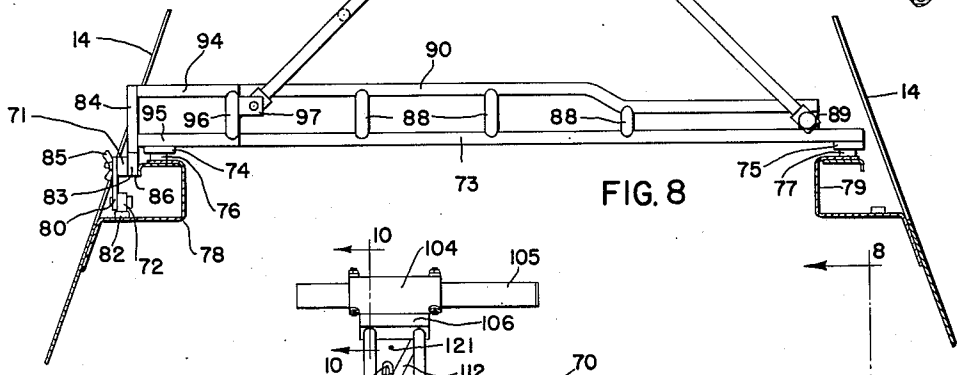
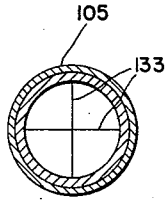


FIG. 8

FIG. 13



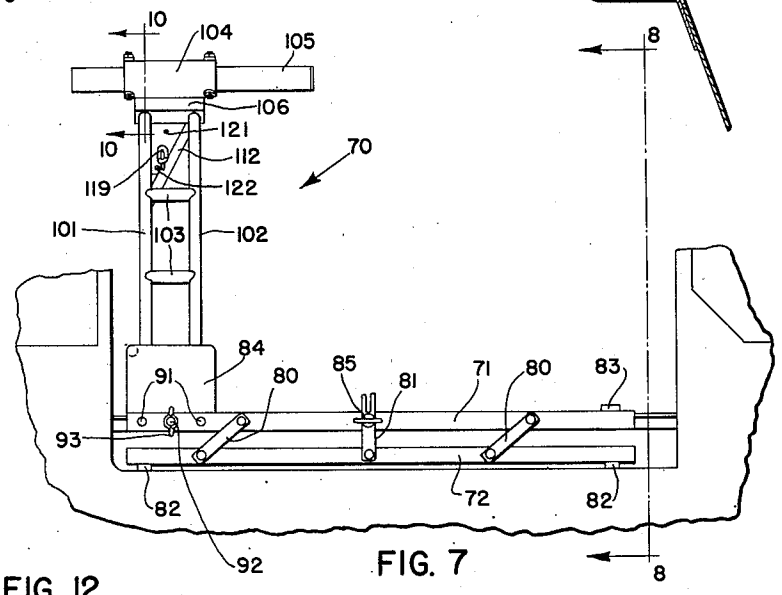
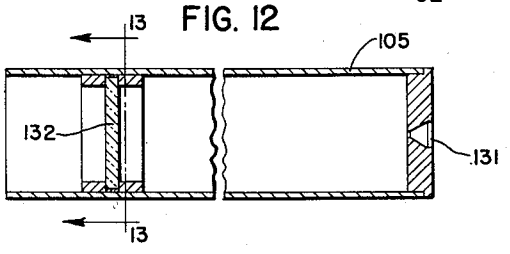


FIG. 7

FIG. 12



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Patented July 25, 1950 2,516,435

UNITED STATES PATENT OFFICE

2,516,435

APPARATUS FOR ALIGNMENT OF GUNS AND GUN SIGHTS

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Application February 1, 1944, Serial No. 520,682

6 Claims. (Cl. 33—46)

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This invention relates to the alignment of guns and sights therefor, of the type wherein the sights are not directly attached to the guns in connection with which they are used. More particularly the invention relates to apparatus for aligning separately mounted guns and sights therefor on a vehicle, such as an airplane.

In the production of modern military aircraft, particularly of the fighter type, it has been customary to install the guns in the wings and on other places distant from the operator of the guns and to sight and operate the guns by remote control. In such an installation it is impossible to employ the conventional type of gun in which the sight is directly mounted on the barrel and substantially in line therewith. For such aircraft, therefore, it is customary to mount the sights in the cockpit and the guns in the wings or elsewhere with no direct connection between the two except through the airplane structure itself. The conventional method of aligning such guns and sights, in an arrangement of this sort, is to mount the airplane in firing position and then to actually line up both guns and sights on a target. This method is rather cumbersome and consumes a considerable amount of time, since the tail of the airplane must be lifted into flying position before the gun sights can be lined up on a target.

It is therefore an object of this invention to provide apparatus for aligning guns and gun sights on an aircraft or other vehicle without requiring that both guns and sights must be lined up on an actual target. It is another object to provide apparatus which will considerably reduce the time hitherto required for aligning guns and sights on miliary aircraft. It is a further object to provide apparatus for this purpose which is simple and easy to operate. Other objects will appear hereinafter.

These objects are accomplished, according to the present invention, by mounting on the aircraft or other vehicle two or more separate fixtures, hereinafter described more in detail, which are lined up with respect to certain accurately jigged parts of the basic airplane structure. At least one of such fixtures is associated with a gun sight, and at least one other of such fixtures is associated with a gun. The sights and guns are then aligned by means of the fixtures associated therewith, as hereinafter described.

This invention may be more easily understood by reference to the accompanying drawings, in which: Figure 1 is a perspective view, with parts broken away for convenience in illustration, of a general arrangement according to the present invention, mounted on an airplane of the fighter type. Figure 2 is an enlarged detail view of a portion of Figure 1, with the airplane structure omitted. Figure 3 is a transverse section, on an enlarged scale, through the wing of the airplane taken along the line 3—3 of Figure 1. Figure

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4 is a view taken along the line 4—4 of Figure 3, with the airplane wing structure omitted. Figure 5 is a view, corresponding to Figure 4, of an embodiment employing a modified form of fixture. Figure 6 is a view taken along the line 6—6 of Figure 5. Figure 7 is a side view, on an enlarged scale, taken along the line 7—7 of Figure 1, with parts of the airplane omitted for convenience in illustration. Figure 8 is a view taken along the line 8—8 of Figure 7. Figure 9 is a detail view, in perspective, of a portion of the structure illustrated in Figures 7 and 8. Figure 10 is a view, on a still larger scale, taken along the line 10—10 of Figure 7. Figure 11 is an enlarged view, on the same scale as Figure 10, of a portion of Figure 8, with some parts in cross section for convenience in illustration. Figure 12 is an enlarged longitudinal cross section of a sighting tube employed in the apparatus illustrated in Figures 7 and 8. Figure 13 is a view taken along the line 13—13 of Figure 12.

Referring now to Figure 1, a machine gun 20 is positioned inside the wing of an airplane indicated generally at 16. In the structure indicated in the drawings, the barrel 21 of the gun does not pass through the leading edge of the wing. In such a structure, during actual use of the plane and guns in military combat, a blast tube (not shown) fits over the end of the gun barrel and extends through the leading edge of the wing. Alternatively, the gun barrel itself may be sufficiently long to extend through the leading edge of the wing. In any case, the hole in the leading edge of the wing, through which the blast tube or gun barrel passes, is normally filled up (except for the space occupied by the blast tube or gun barrel), during actual use in military combat, by means of a cover plate or fairing (not shown) attached by screws through threaded holes 17. Both blast tube and fairing are removed for aligning the guns according to the present invention, and their places taken by a bore bar 22 within the barrel of the gun and an aligning fixture 18 attached to the leading edge of the wing, both as hereinafter described in greater detail.

The sight aligning fixture, indicated generally at 70, and as hereinafter described in greater detail, is mounted in the cockpit 15 of the airplane. It comprises two sighting tubes 105 and 115, optical sight 61 being aligned through tube 105 and ring sight 62 and bead sight 63 being aligned through tube 115. The entire fixture 70 is removed, as in the case of bore bar 22 and fixture 18, after the alignment is completed, and the guns and sights are then ready for use.

Referring now to Figures 1 and 2, the machine gun 20 is fastened to the wing 16 at two points. The forwardmost point 23 is fixed and, in accordance with this invention, is made one of the basic reference points or jigging points in the construction of the wing 16. Thus, it is very ac-

curately located with respect to the points of attachment of the wing to the fuselage 14 of the airplane. Although the location of point 23 is fixed, the orientation of the gun with reference to the point is not fixed, so that rotation of the gun 20 about the point 23 as a pivot is permitted. To accomplish this, a supporting strut (not shown) has drilled therethrough an accurately located hole through which passes a snugly fitting cylindrical stem 27 of a yoke member 26. A pin 25 passes through the arms of the yoke member and also through lugs 28 on a two-piece adapter 29 fitting over a collar 30 on the barrel 21 of the gun 20. The lugs 28 fit snugly between the arms of the yoke member 26. The downwardly extending arms of the adapter 29 are provided with four pins 31 which fit into two holes 34 on lugs 32 attached to collar 30, and two holes 35 on opposite sides of the housing for the mechanism of the gun.

The position of the supporting strut and its accurately located hole through which passes cylindrical stem 27 is made one of the basic reference or jigging points in the construction of the wing 16. A lock nut 33 on the threaded stem 27 of the yoke member 26 serves to draw up the assemblage tightly and accurately maintain its position. It will be seen that the gun 20 can rotate about stem 27 or pin 25 as axes, but cannot rotate about its own horizontal axis. The true location of fixed point 23 is seen to be the intersection of the axes of stem 27 and pin 25.

The rearmost point 24, on the other hand, is movable, and alignment of the gun is accomplished by movement of this point either horizontally or vertically until the desired position is reached. When alignment is completed, the position of point 24 with relation to the wing is fixed by any convenient form of permanent or semi-permanent fastener (not shown).

Referring now to Figures 3 and 4, the aligning fixture is indicated generally at 18. It consists of a plate in which several openings are accurately drilled. Two of these openings coincide in spacing with the spacing of the threaded holes 17. In these two openings two fasteners 43 are positioned, being held rigidly in place against any movement except rotational movement about the longitudinal axis of the fastener by providing that the shank of the fastener is larger is diameter than the hole, except actually within the boundaries of the hole, where a close fit is obtained. The third opening 36 is vertically elongated, and is slightly wider than the diameter of the bore bar 22. On each side of the opening 36 are provided one or more sets of horizontal marks 37 which serve as reference points for the alignment operation.

The holes 17 are accurately located in lugs 47 constituting part of the wing structure of the airplane, and made accurate reference or jigging points in the construction of the wing 16. The shank of each of the fasteners 43 fits snugly in a hole 17, and is held in place by abutment of the plate 18 against the leading edge of the wing and by means of the spring 38 at the back of lug 47. Turning the handle 40 of the fastener 43 to the position as shown in Figure 4, forces the spring 38 into a slot 39 at the rear end of the fastener.

In actual operation, the bore bar 22 is inserted into the barrel 21 before installing the fixture 18 on the leading edge of the wing 16. The bore bar is first pushed well back so that it is out of the way while the fixture is being installed. After installation of fixture 18, the rear end of the

gun 20 is manipulated until the bore bar is in line with the opening 36. The bore bar is then brought forward by means of handle 42 through the opening 36 until it is substantially flush with the face of the fixture 18. Lateral alignment is accomplished either visually or by inserting a feeler gauge of predetermined thickness between the bore bar 22 and one edge of the slot 36, and then manipulating the rear end of the gun until the feeler gauge contacts both bore bar and slot. Vertical alignment is obtained by similar manipulation until a horizontal mark 41 on the front face of the bore bar is in line with the required set of marks 37. When both lateral and vertical alignments have been completed, the rear end of the gun is fastened securely in place, the fixture 18 removed, the blast tubes and fairings replaced, and the gun is ready for firing.

From the above description, it will be seen, in effect, that the gun is sighted on the fixture 18. Since the point 23 at about the center of the gun 20 is fixed, adjustment being accomplished by horizontal or vertical movement of the rear end of the gun, it is seen that this is substantially equivalent to sighting the gun on a distant target. Since the positions of the holes 17 and the point 23 are very accurately located or jigged in the manufacture of the airplane, it is seen that the plate fixture 18, with the point 23, provides a very accurate reference point for aligning the gun. Since, as hereinafter pointed out, the gun sight is accurately aligned in a similar fashion, the gun and sights therefor are very easily and accurately aligned in the proper position.

The proper position for the marks 37 and the opening 36 of the fixture 18 are found by accurately sighting and adjusting a gun by the conventional aligning method hitherto in use. The target, in this case, can be positioned at any suitable distance. In practice, it has been found that 250 yards is the most satisfactory. With this arrangement, the guns can then be aligned to provide converging fire at 250 yards. The hole 36 is then accurately drilled to cooperate with the bore bar 22, and this fixture may then be used on all subsequent airplanes of the same type. The position of the marks 37 are accurately located in the same fashion. The same plate 18 may sometimes be used on different sub-varities of the same general type of airplane, but in this case it is usually necessary to provide separate marks 37 for each separate sub-variety. In the cases where more than one gun is mounted in each wing, it is usually necessary to provide a separate plate fixture 18 for each gun position, since the angle of convergence and, therefore, the position of the hole 36 is different in each case. The plate fixtures are properly marked to indicate to which gun positions they apply, while the marks 37 are appropriately identified to indicate the sub-variety of airplane to which they apply. Separate fixtures may or may not necessary for the various types of guns which may be interchangeably employed in the same airplane. For example, some airplanes may be provided with 30 caliber and other airplanes with 50 caliber guns. In this case different sighting fixtures 18, or different marks 37 thereon, may be employed.

A slightly different type of fixture, which can be used in the place of the fixture 18, is shown in Figure 5. This fixture, indicated generally at 48, is provided with a pair of fasteners 50 similar to the fasteners 43 in Figure 4. The plate 48 contains a large central opening covered over

by a second plate member 49. The latter is held in place by means of bolts 52 fixed in holes in plate 48 and passing through slots 51 in plate 49. The plate 49 is then moved vertically until the alignment marks 53 on plate 48 are in line with the corresponding alignment marks 54 on plate 49. When this adjustment is made the plate 49 is fastened securely in place by tightening the wing nuts 55 on bolts 52. The alignment is then accomplished, as in the case of the embodiment of the invention shown in Figure 2, except that the front end of the bore bar has a horizontal alignment mark 59 and a vertical mark 58 to be put in line with the corresponding alignment marks 56 and 57 respectively on the plate 49.

The marks shown on the plates and bore bars of the embodiments shown in Figures 4 and 5 may be of any convenient type, such as paint markings, grooves, ridges, etc., or may be an edge portion of either plate or bore bar. The term "mark" is understood to include such alternative forms of marking.

Referring now to Figures 1, 7, 8 and 9, the gun sight aligning device 70 consists of a triangular support mounted on a frame, the apparatus being placed in the cockpit 15 of the airplane. The frame comprises two longitudinally extending base bars 71 and 72 and a transversely extending base bar 73. The transverse bar 73 is attached to two leveling pads 74 and 75 which serve to level the device about the longitudinal axis of the fuselage 14. These leveling pads are rested on lugs 76 and 77, respectively, attached to longerons 78 and 79, respectively, of the airplane fuselage 14. The positions and orientations of longerons 78 and 79 are basic reference points or jigging points in the construction of the fuselage 14. Thus, it is very accurately located with respect to the center line of the airplane and to the points of attachment of the fuselage to the wing 16, and with respect to the general aspect of the airplane during flight.

The base bar 71 is connected to base bar 72 through parallel links 80 and an adjustable link 81. After the device is rested on lugs 76 and 77, the base bar 72 is allowed to drop until it rests on lugs 82 attached to longeron 78. The wing nut 85 is then tightened to maintain the relative positions of base bars 71 and 72. Finally, the aligning device 70 is moved as a whole, to the right (Figure 8) until pad 83 and plate 84, situated at opposite ends of base bar 72, rest against inner edge 86 of longeron 78. This serves to level the device about the transverse axis of the fuselage 14, and also orients it correctly about the vertical axis of the fuselage. The device is then in line with the center line of the airplane.

Transverse base bar 73 is tubular in structure, and is strengthened by means of parallel tubular transverse bar 90, to which it is connected by tubular cross-braces 87, 88 and 89. Bars 73 and 90 are welded to plate 84, and all connections between tubular elements 73, 87, 88, 89 and 90 are also welded. Longitudinal base bar 71 is also connected to plate 84, but the latter connection is detachable. It is effected by two studs 91 and a third threaded stud 92 welded to plate 84 and passing through holes in bar 71. The assemblage is held together by means of wing nut 93 on threaded stud 92. Transverse rigidity is secured by two short horizontal tubular braces 94 and 95, welded at their opposite ends to plate 84 and to a short vertical tubular brace 96.

A horizontal cross piece 97 is welded to the two

vertical tubular braces 87 and 96. At opposite ends of the cross piece 97 are journaled two tubular legs 101 and 102, provided with cross braces 103. At the upper end of legs 101 and 102 there is rigidly mounted a support 104 for a tubular sight 105. A third tubular leg 111 is journaled at its lower end on cross brace 89, and is welded near its upper end to a diagonal member 112. A second support 114 for a second tubular sight 115 is adjustably and removably mounted near the upper end of tubular members 111 and 112.

Figures 10 and 11 illustrate the mounting for sight supports 104 and 114, and also the method of connecting leg 101 to leg 111. The means for mounting sight support 104 is simple, and consists merely of a member 106 welded to legs 101 and 102 and sight support 104. The mounting for support 114, however, consists of a bracket 116 welded at the ends of the upper arm 117 along the length of support 114. The angle of the bracket is pivotally mounted in bearing pillows provided at the fore and aft ends of a plate 120. Welded to plate 120 is a bolt 118 which also passes through a second plate 123 which is welded to members 111 and 112. Plate 120 is oriented with respect to plate 123 by means of two studs 121 and 122 welded to plate 120 and passing through plate 123. Plates 120 and 123 are held together by means of wing nut 119 threaded on bolt 118. Stud 122 is elongated, and has loosely fitted over its shank, in order, a spring 124, hemispherical element 125, a slot in lower arm 126 of bracket 116, and a knurled adjusting nut 127. It is easily seen that movement of the sight 114 through an arc at right angles to the line of sight may be effected by manipulation of nut 127. In addition, the entire sight 115, together with its support and adjusting mechanism, and plate 120, may be removed from fixture 70 by merely removing wing nut 119.

In member 106 there is provided a cylindrical socket 107. Into this socket there is fitted an extension 109 of member 111. The two legs 101 and 111 are held in place by means of a set screw 108 seating into a depression on extension 109. Members 102 and 112 are held together by similar means.

Referring now to Figures 12 and 13, the tubular sight 105, to which sight 115 is similar, is composed of a peep-opening 131 and a lens 132, on which are mounted cross-hairs 133. Alignment of optical sight 61 is effected by looking through the peep-opening 131 towards the lens 132, and then adjusting the position of the optical sight 61 until its cross-hairs coincide with the cross-hairs 133. Similarly, alignment of ring sight 62 and bead sight 63 is effected by means of the second tubular sight 115, until the ring and bead sights coincide with the cross-hairs 133 of sight 115.

It is seen that sight 115, its support and mounting may be removed entirely from the apparatus by merely removing wing nut 119 and then lifting the sight and mounting. This is desirable because in some varieties of planes only a single sight is provided. The gun sight aligning device itself, when removed from the airplane, may be collapsed and stowed in a small space. This may be accomplished by loosening set screw 108, lifting legs 101 and 102 from members 111 and 112, and then collapsing all three legs downwards about their lower pivoted ends. Longitudinal base bars 71 and 72 are then separated from the remainder of the apparatus by removing wing nut 93.

The gun sight aligning device 70, since it aligns the sights with respect to the center line of the airplane, may be used on any airplane on which gun aligning fixtures 18 are used. It is not necessary to provide different devices 70 for different sub-varieties of airplane.

The apparatus of the present invention is preferably employed in an airplane or other vehicle having a standardized construction, that is, in which the basic reference or jigging points are uniformly located in all airplanes of a given type. However, the invention is also applicable to airplanes or other vehicles in which the construction is less standardized, but in which the guns, sights or other equipment are often removed for modification, adjustment, cleaning, servicing, replacing of broken or worn parts, or other treatment. In this case a separate set of fixtures is provided for each airplane or other vehicle. After the guns and sights in a vehicle are initially aligned by the conventional method and the fixtures calibrated therewith, these fixtures constitute part of the equipment of that vehicle and provide a method and means for realigning the guns and sights when they are replaced in the vehicle.

The above discussion has been in connection with a specific form of the invention. It is obvious, however, that many changes may be made in this form without departing from the spirit of the invention. It is to be understood, therefore, that the invention is not to be limited except as defined in the appended claims.

We claim:

1. Apparatus for aligning a gun and a gunsight separately mounted in a vehicle, the gun being pivotally attached to the vehicle at a basic reference point for the construction of said vehicle, a bar member for slidable insertion into the barrel of said gun, a plate member mountable in a fixed position with respect to another basic reference point for the construction of said vehicle, an opening in said plate member for determining alignment of said bar member therewith, a support and a sighting device mounted in predetermined relation thereon for optically determining the alignment of the gun sight, said support being arranged for seating upon said vehicle in predetermined relationship to still other basic reference points for the construction of said vehicle.

2. Apparatus for aligning a gun mounted in the wing and a gunsight mounted in the fuselage of an airplane, said gun being pivoted at a point accurately located with respect to a basic reference point for the construction of said airplane, comprising a bar member for slidable insertion into the barrel of said gun, a plate member mountable in a fixed position with respect to another basic reference point for the construction of said airplane at the leading edge of said wing, an opening in said plate member for determining the alignment of said bar member therewith, marks on said bar member and said plate member for accurately determining the alignment of said bar member and said plate member, a support mountable in the fuselage of said airplane, a tubular sight accurately mounted on said support, said support comprising a frame having a transverse frame member and a longitudinal frame member detachable from each other, legs attached at one set of their ends to said transverse frame member and at their opposite ends to said tubular sight, said legs being detachable at one set of ends thereof and pivotally mounted at the opposite ends thereof, and stops on said longitudinal frame member for accurately orienting said frame with respect to the longitudinal center line of said airplane.

3. Apparatus for aligning a gun mounted in a vehicle, said gun being pivoted at a point accurately located with respect to a basic reference point for the construction of said vehicle, comprising a bar member for slidable insertion into the barrel of said gun, a plate member mountable in a fixed position with respect to another basic reference point for the construction of said vehicle, an opening in said plate member for aligning said bar member therewith, and marks on said bar member and said plate member.

4. Apparatus for aligning a gun mounted in the wing of an airplane, said gun being pivoted at a point accurately located with respect to a basic reference point for the construction of said airplane, comprising a bar member for slidable insertion into the barrel of said gun, a plate member mountable in a fixed position with respect to another basic reference point for the construction of said airplane at the leading edge of said wing, an opening in said plate member for aligning said bar member therewith, and marks on said bar member and said plate member for accurately adjusting the alignment of said bar member and said plate member.

5. Apparatus for aligning a gunsight mounted in the fuselage of an airplane, comprising a support mountable in the fuselage of said airplane, a tubular sight accurately mounted on said support, said support comprising a frame having a transverse frame member and a longitudinal frame member detachable from each other, legs attached at one set of their ends to said transverse frame member and at the opposite ends to said tubular sight, said legs being detachable at one set of ends thereof and pivotally mounted at the opposite ends thereof and stops on said longitudinal frame member for accurately orienting said frame with respect to the longitudinal center line of said airplane.

6. Apparatus for aligning a gun sight mounted in the fuselage of an airplane, comprising a support mountable in said fuselage, said support comprising a frame having a transverse member and a longitudinal member, legs pivotally attached at their lower ends to said transverse frame member and detachably connected to each other at their upper ends, said legs when so connected defining with said transverse frame member a substantially triangular support, a sighting device for optically determining the alignment of the gun sight mounted on one of said legs near the apex of said triangular support, and stop means in said longitudinal frame member for orienting said frame with respect to the longitudinal axis of said airplane.

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