April 10, 1951

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2,548,700

BORE SIGHTING APPARATUS

Filed Feb. 26, 1946

2 Sheets-Sheet 1

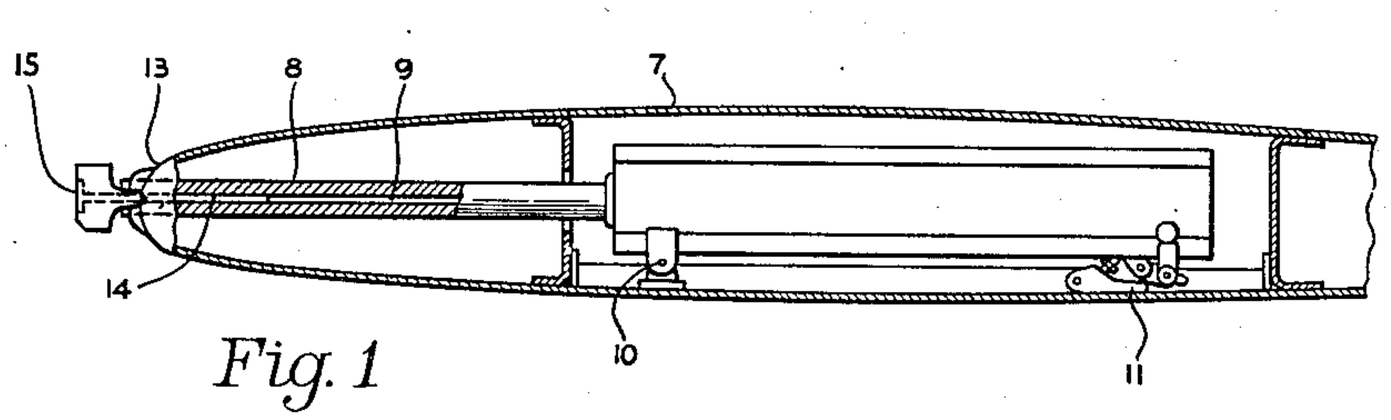

Fig. 1

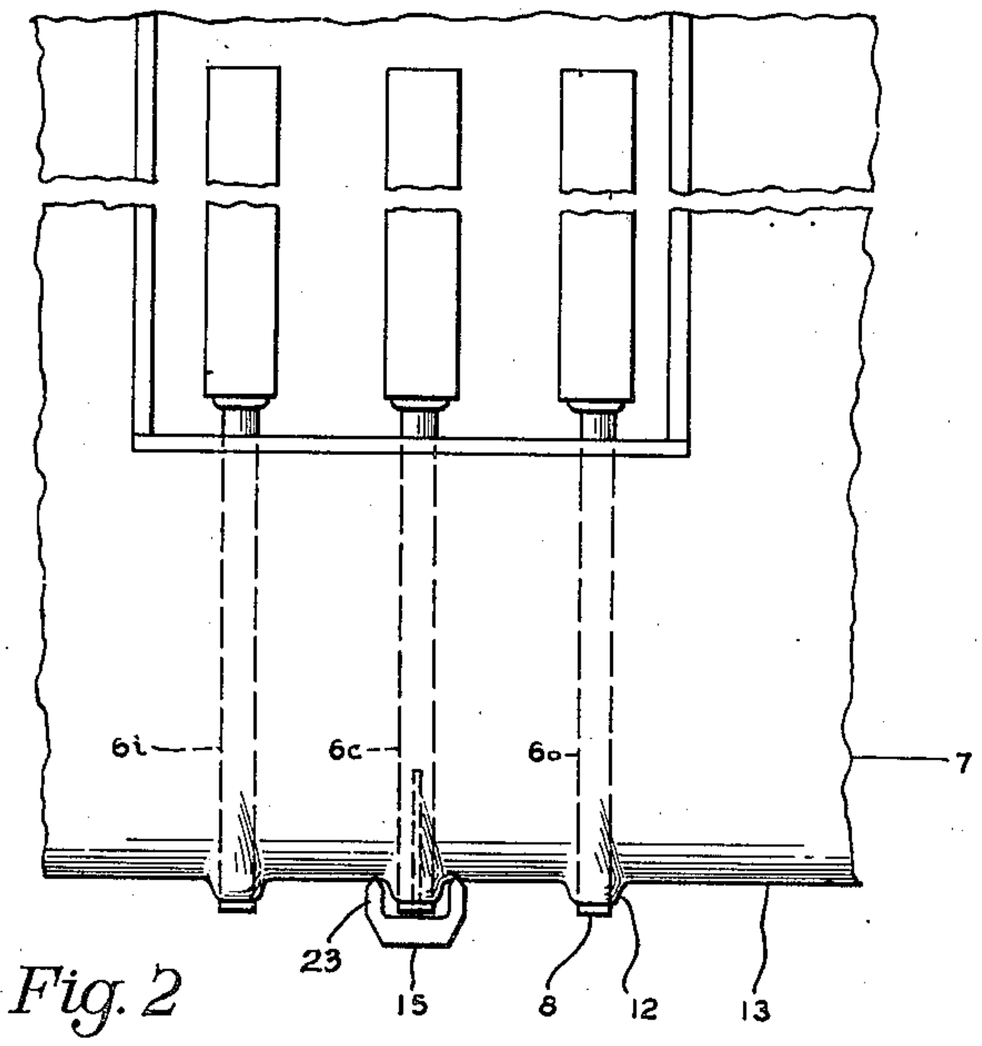

Fig. 2

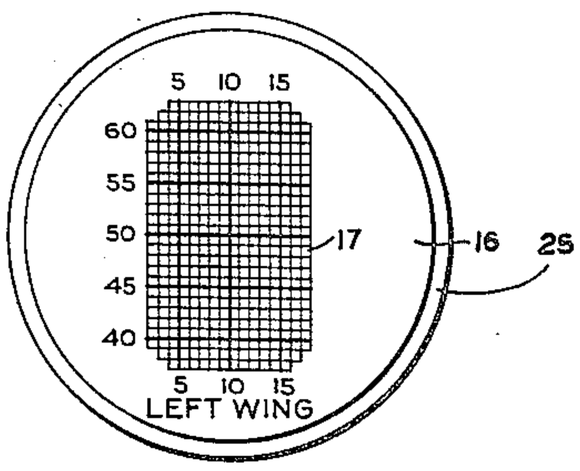

Fig. 3

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2 Sheets-Sheet 2

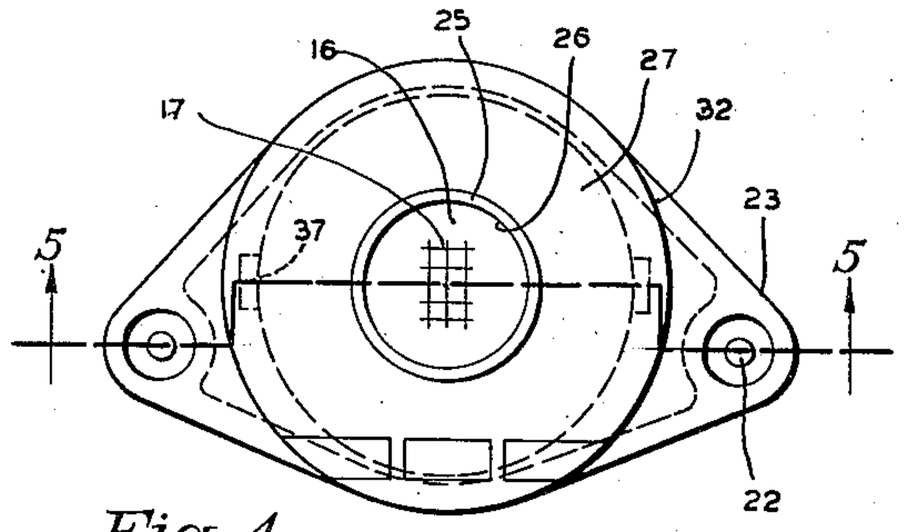

Fig. 4

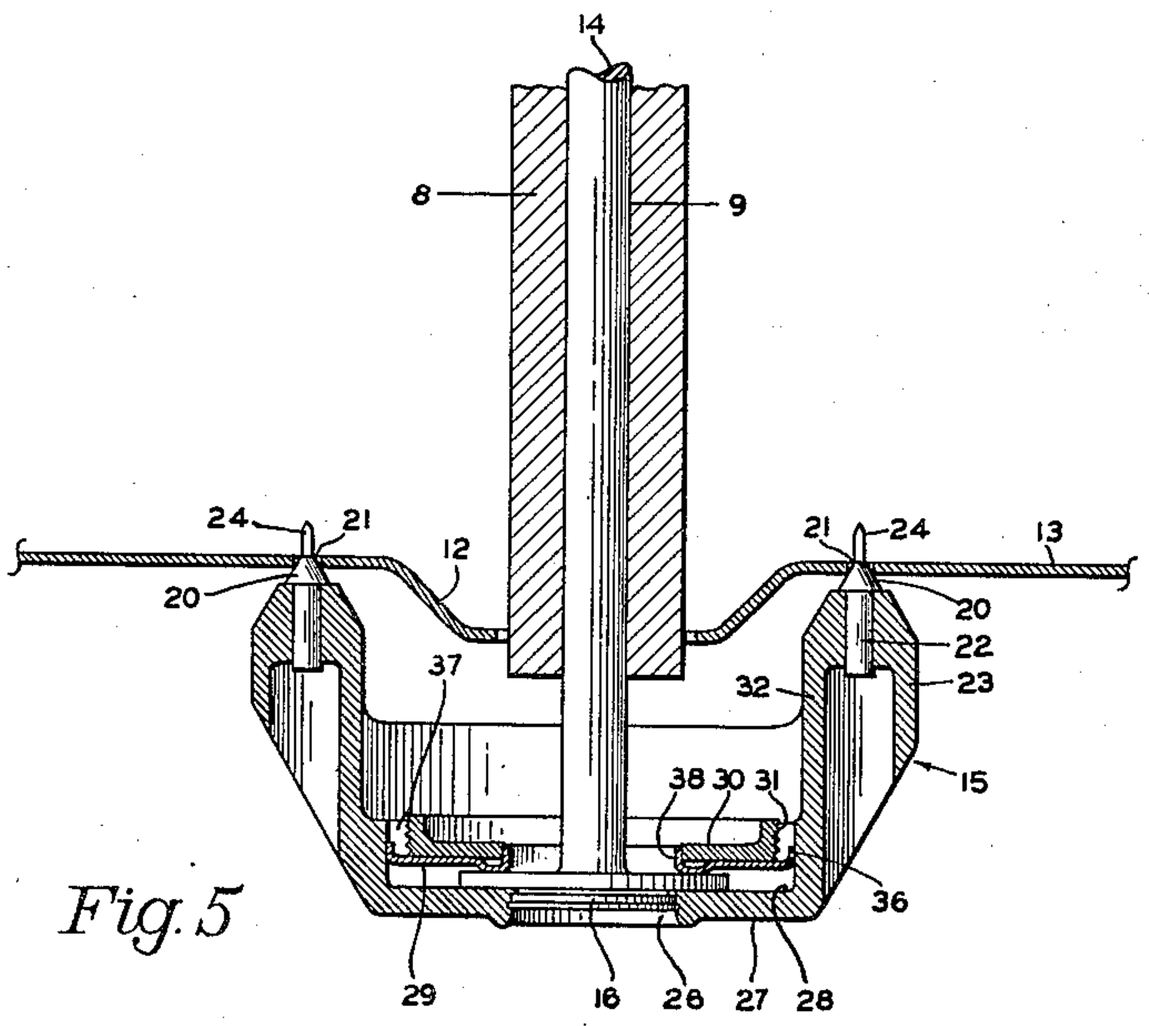

Fig. 5

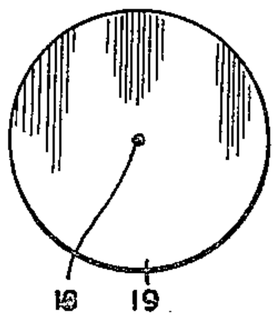

Fig. 6

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BORE SIGHTING APPARATUS

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3 Claims. (Cl. 33—180)

1

This invention relates to the bore sighting of aircraft guns, and has as its general object to provide a method and apparatus for bore sighting the barrels of machine guns or the like without the necessity for using a target or leveling the plane.

The effectiveness of the armament of a fighter plane armed with multiple machine guns is largely dependent upon the fire pattern of the guns, and the fire pattern in turn depends upon the accuracy of the bore sighting of the guns. Maintenance of a uniform fire pattern over an extended period of service requires the employment of periodic bore sighting checks. In the past, such bore sighting checks have entailed the use of elaborate equipment and the expenditure of a considerable amount of time, and accordingly, they have been difficult. Furthermore, it is frequently desirable to change the fire pattern to meet changing combat conditions. For example, it may be desirable to change the distance of convergence of the guns from a low value of 270 yards to a higher figure of 350 yards. Using old methods, such a change would involve considerable difficulty.

One of the primary objects of the present invention is to provide a method and apparatus whereby a group of guns may be bore sighted to develop a desired fire pattern irrespective of the position of the plane and without employing a target. More specifically, the invention contemplates the development of a fire pattern from information derived from charts and tables.

Another object of the invention is to provide a method and apparatus through which changes in both the elevation and convergence of the guns of an airplane can be made very quickly and in accordance with any desired pattern (an unlimited number of patterns). In its provision for the development of an unlimited number of patterns without the use of bore sighting targets or ranges and without the necessity for leveling the plane, it is believed that the invention is unique, since to the best of my knowledge, previous bore sighting apparatus, designed for use without targets, has permitted only a few preselected settings to be made.

A further object of the invention is to provide a method and apparatus whereby guns of an airplane may be bore sighted to a fine degree of accuracy.

A further object of the invention is to provide a bore sighting apparatus and method which are exceedingly simple in structure and use, considering the results that are obtained.

2

The invention provides a transparent dial which is adapted to cooperate with a member carried by each gun, to indicate, by a sighting process, the position of the gun both in elevation and in azimuth, within the range of adjustment permitted by the gun mountings.

Other objects of the invention will appear from a perusal of the following specification, when read in connection with the appended drawings, in which:

Fig. 1 is a side elevation, partially in section, showing a wing gun installation for aircraft with the bore sighting fixture in position.

Fig. 2 is a plan view of a portion of an aircraft wing incorporating a multiple gun installation (with the gun bay door removed) showing the bore sighting fixture in position on the central gun.

Fig. 3 is an enlarged detail of the dial.

Fig. 4 is a front elevation of the bore sighting fixture.

Fig. 5 is a plan view, partially in section, of the bore sighting fixture in position with reference to the leading edge of the aircraft wing and the gun muzzle, taken on the line 5—5 of Fig. 4; and

Fig. 6 is a face view of the head of the indicator rod.

As an example of one form in which the invention may be embodied, I have shown in the drawings a bore sighting apparatus adapted for use in the bore sighting of a group of machine guns 6*i*, 6*c* and 6*o*, mounted in the wing 7 of a fighter aircraft. Each of these guns includes a barrel 8 having a bore 9, and is mounted upon a universal fulcrum 10, located near the center of the gun, and an adjustment mechanism 11, located near the rear end of the gun. Manipulation of the adjustment mechanism 11 provides for adjustment of the gun barrel 8 either in elevation or in azimuth, the gun pivoting about the fulcrum 10.

The muzzle of each gun may project through an apertured blister 12 in the leading edge 13 of the skin of the wing 7, or may be terminated somewhat short of the aperture in the leading edge. While the gun installation of only one wing of the aircraft has been shown, it will be understood that the installation is duplicated in the other wing or other part of the aircraft structure.

Initially, the guns are bore sighted by the conventional target method. That is, the plane is leveled, in front of a target which is located at a predetermined distance therefrom, and the target is then sighted through the bores of the guns,

each gun being adjusted until the line of sight therethrough intersects a predetermined point on the target in accordance with the firing pattern that is to be established. The gun mounts are then locked with the guns in the positions thus determined. The aircraft may then be flown for combat duty, or may be specially modified to permit the future use of my improved sighting apparatus.

Referring now to Fig. 5, my improved bore sighting apparatus comprises generally two relatively movable units one of which is a rod 14 adapted to fit in the muzzle of the barrel 8, and the other of which is a dial fixture, indicated generally at 15, adapted to be located in a fixed relation to a leading edge 13, and carrying a transparent dial 16 upon which the position of the end of the rod 14, and thus the position of the barrel 8, may be accurately located with reference to a grid 17 on the inner face of the dial 16. The location of the rod 14 relative to the grid 17 is determined by sighting, through the grid 17, an indicator dot 18 on the face of a disc shaped head 19 on the end of the rod 14 (Fig. 6).

The dial fixture is located relative to the leading edge 13 by a pair of conical locating pins 20 adapted to coact with apertures 21 in the leading edge 13. The pins 20 have shank portions 22 which are securely mounted in arms 23 of the fixture 15, and each pin has a pilot stem 24 for easy insertion in the corresponding opening 21. With the conical pins 20 pressed firmly against the edges of the openings 21, the fixture 15 will be accurately located with reference to the leading edge 13, in a position that is predetermined in a manner that will be explained hereinafter.

The dial 16, provided with a binding rim 25 which may be of metal, is mounted in a window 26 in the central web portion 27 of the fixture 15. The head 19, which is in the form of a flat faced disc integral with the end of the rod 14, bears against the inner face 28 of the web portion 27, and may be clamped against the surface 28 with different degrees of frictional engagement, under the yielding pressure of a spring washer 29, which is held against rotation by lugs 36 engaged in keyways 37 and which is centered by an upturned flange 38 piloted in a central hole in a nut 30. The spring washer or yieldable member 29 is yieldingly urged against surface 28 by the nut 30, which has an externally threaded periphery coacting with a series of internal threads 31 in a cylindrical wall portion 32 of the fixture 15. The pressure on the rear face of the head 19 may thus be adjusted from a point where the head 19 is loosely received in the annular space between the web member 27 and the spring washer, through an intermediate stage where the head 19 may be moved about in said annular space with some resistance to such movement, and to a point where the head 19 is firmly locked in a fixed position with reference to the fixture 15.

The positions of the holes 21 in the leading edge 13 of the plane wing are determined by initially sighting the gun barrels by the target method. While this initial sighting is taking place the rod 14 and fixture 15 are of course removed from the gun barrel and the leading edge of the plane. The proper positions of the gun muzzles having been determined by this method, the rod 14 is attached to the fixture 15 with the head 19 locked therein in the proper position with horizontal lines of the grid parallel to the line established by the holes 21—21 to bring the locating dot 18 in alignment with a

prescribed reading on the grid 17 which is fixed to fixture 15. This reading is identified in terms of horizontal and vertical readings on the grid 17, which is provided with vertical and horizontal grid lines that are provided with numbered values as shown in Fig. 3. This prescribed grid reading can be taken from a chart which has been previously prepared by the use of target sighting.

The rod 14 is then inserted into the gun barrel until the pins 24 touch the leading edge 13. With the airplane leveled laterally, a plumb line is held in front of the dial 16 and the fixture 15 is oscillated about the axis of the rod 14 until the vertical lines of the grid 17 are exactly parallel to the plumb line. The exact points at which the pins 24 touch the leading edge 13 are then marked in some appropriate manner. For example, the ends of the pins 24 may be sharpened to fine points and sufficient pressure exerted against the fixture 15 to produce slight indentations in the skin 13. The fixture 15 is then removed and the marks are center punched and pilot drilled to the proper size to receive the pins 24. The fixture is then reinserted in order to ascertain whether the holes have been drilled properly. If they have, the pins 24 will slide freely into the drill holes. The fixture is then again removed and the pilot holes are reamed to a proper size to receive the conical locating pins 20.

The nut 30 is then loosened so that the head 19 may move freely with reference to the fixture 15, and the fixture 15 is then replaced and adjusted so that the pins 20 are exactly centered in the holes 21. The position of the indicator dot 18 with reference to the grid 17 is then rechecked, and the vertical and horizontal readings thus obtained are stenciled upon the leading edge 13, together with the serial number of the bore sighting kit.

Two of the fixtures 15 are provided for each airplane, one for the left wing and the other for the right wing. Each fixture is used for bore sighting each of the guns in the wing for which it is provided. The readings for the several guns will of course differ, and the invention permits the adjustment of the rod 14 to various positions with reference to the fixture 15, to correspond to the three prescribed sets of readings for the three guns (or for any other three sets of readings that may be prescribed).

With the prescribed readings stenciled upon the leading edge 13, periodic bore sighting can be quickly accomplished by proceeding through the following steps:

1. The nut 30 is loosened and the head 19 of the rod 14 is moved with reference to the fixture 15 until the indicator dot 18 gives a reading corresponding to the readings for the gun that is being bore sighted (the readings stenciled on the leading edge 13 adjacent that gun). The nut 30 is then tightened and the readings are rechecked on the grid 17.

2. The rod 14 is inserted into the gun barrel and the pins 24 are advanced into contact with the leading edge 13 (or into the holes 20 if they are already in alignment with the holes).

3. The gun mounts 10 and 11 are then adjusted until the pins 20 are absolutely centered in the holes 21.

4. The gun that has thus been adjusted is now properly sighted, and the procedure is repeated for each of the other guns of the group.

It will now be apparent that after the initial target bore sighting and the subsequent orientation of the fixture 15 with reference to the wing

13 by the drilling of the holes 21, that the subsequent bore sighting operations can be carried on without reference to the position of the airplane and without the use of a target.

Once the fixture has been properly located with reference to the leading edge of the wing at each of the gun stations, it is possible to change the bore sighting of the guns at will without the necessity for using a target or leveling the plane. This may be accomplished by employing a series of fixture setting charts containing data from which can be determined the fixture settings for any combination of horizontal and vertical adjustment required for various flight and air speed conditions. The invention is particularly adapted for use in connection with charts illustrating various dispersal patterns in connection with various convergence distances, and showing the grid setting that will produce the various patterns illustrated. In each case, the bore sighting of each individual gun is guided by chart data showing vertical and horizontal grid settings for that particular gun.

Instead of using the bore sighting fixture for locating the pilot holes to be drilled in the leading edge of the wing, such pilot holes may be located by the use of a drill jig that also engages the gun barrels after target sighting has been accomplished, in a manner similar to the fixture assembly. Future bore sighting is then carried out through the use of charts, as indicated previously, in conjunction with this improved bore sighting apparatus.

Orientation of the guns may be made with reference to any adjacent portion of structure wherein the guns are mounted, and is not necessarily restricted to the leading edges of the wings.

I claim as my invention:

1. Apparatus for bore sighting the barrel of a gun mounted in an airplane wing, comprising a fixture having locating pins adapted to be located in holes in the leading edge of said wing, said fixture having a wall provided with a window and having an adjustable clamping device spaced from said wall, and a rod adapted to be received within said barrel and having on its end a flat head adapted to be engaged between said wall and said adjustable clamping device, said head having an outer face provided with an indicator mark and said fixture having means mounted in said window and defining indicia through which said indicator mark can be sighted in order to indicate the position of said barrel.

2. The apparatus defined in claim 1, wherein said adjustable device is provided with a yieldable member adapted to yieldingly engage the rear face of said head.

3. Apparatus for selectively aligning the barrel of a gun adjustably mounted in an aircraft structure with the muzzle of the barrel in proximity to the surface of such structure, comprising an indicator element having a head; means for attaching said element to said barrel; a fixture overlying the muzzle of said barrel and having means for predeterminately positioning the same with reference to said structure, said fixture having an opening therein which is positioned generally in alignment with said barrel; means for clamping said head with respect to said fixture; and transparent grid means positioned in said opening, said indicator element and said grid being correlated so that a reading may be taken of the position of the indicator element on said grid to determine the adjusted position of said barrel with respect to said structure.

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