April 3, 1928. 1,664,409

G. GARDNER

BOMB SIGHT

Filed March 29. 1924 2 Sheets-Sheet 1

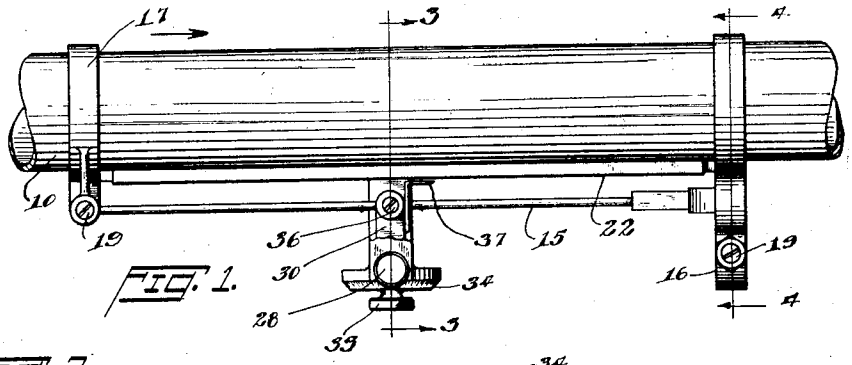


FIG. 1.

FIG. 2.

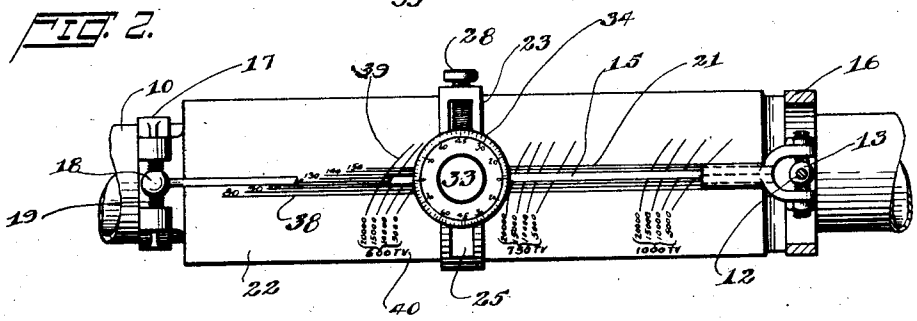


FIG. 3.

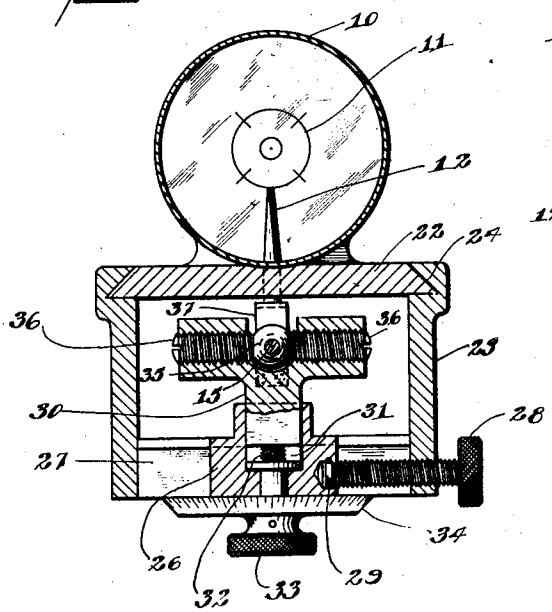
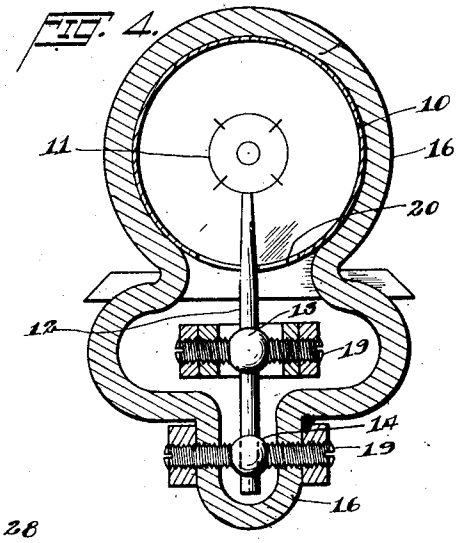


FIG. 4.



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FIG. 6.

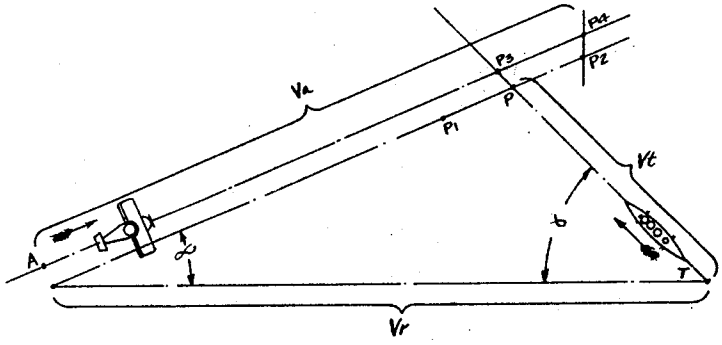
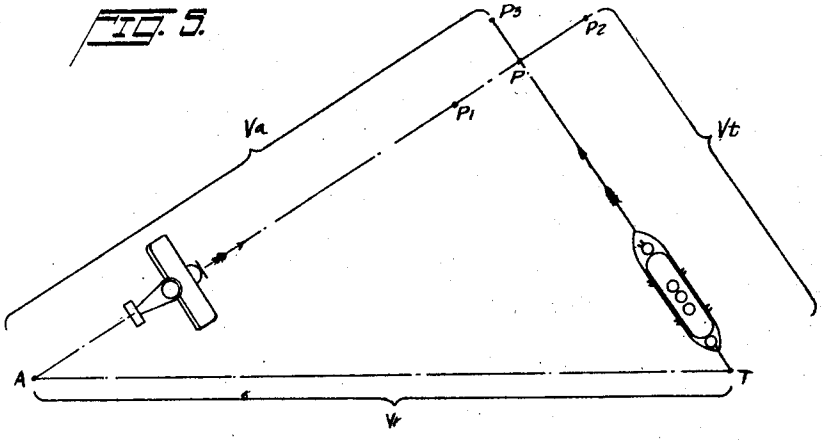


FIG. 5.



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UNITED STATES PATENT OFFICE.

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BOMB SIGHT.

Application filed March 29, 1924. Serial No. 702,882.

This invention relates to bomb sights for aircraft, and is generally concerned with means to compensate for drift of the bombs as they fall in trajectory in cross wind bombing or bombing across the course of a moving target.

One of the principal objects of the invention is to provide an adjustment capable of application to standard types of bomb sights, providing in connection with the standard optical system of the sights, an adjustable target reticle, and a means for adjusting the reticle to correct the sighting fore and aft and laterally, to compensate for drift of the bombs.

A second object of the invention is to provide in a means of the character described, a scale, and means connected with the target reticle of the optical sight for adjusting the reticle according to the altitude, the airspeed, terminal velocity of the bombs to be dropped, and according to the drift determined by observation of the target.

The invention is described in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a portion of an optical bomb sight fitted with sight correction means in accordance with my invention.

Fig. 2 is a side view of Fig. 1.

Figs. 3 and 4 are cross sectional views taken on the lines 3—3 and 4—4 of Fig. 1, looking in the direction indicated by the arrows.

Figs. 5 and 6 are diagrams illustrating in a graphical manner the problems in aircraft bombing dealt with in my invention.

The same reference numerals are applied to corresponding parts in all views.

Before proceeding with the description of the improved bomb sight of my invention, it will be well to discuss briefly the problems toward which my invention is directed. The present invention is intended to be used in connection with practically any standard type of bomb sight having means for making rough corrections to fix the time of releasing the bomb, and is designed especially to make finer corrections on the sighting to compensate for drift; this having ordinarily been disregarded or only crudely approximated heretofore with consequent disadvantages, as will be apparent in the course of the following specification.

Referring first to Fig. 5, indicating in a diagrammatical fashion an airplane in flight over a hostile battleship or other moving target. The airplane is shown travelling on the line A—P with an airspeed, that is, movement of the plane through the air, of Va while the battleship is moving at right angles to the path of the plane along the line PT with a speed of Vt. To simplify the explanation and calculations, only the air velocity of the aircraft, that is, its movement through the air, and the air velocity of the target will be considered, in order to merge the two cases into one in which the air velocity of any target fixed relative to the earth is the velocity of the wind and the air velocity of a target moving relative to the earth is considered the resultant of its motion relative to the earth and the wind. When the plane A sights the target T, in order to fly over the target, it is only necessary to keep any type of drift sight on the line AT and along lines parallel to AT and adjust the direction of flight until the target approaches along the drift sight and maintains a constant position in the sight. In the present case the plane and target are shown where the plane has assumed such a course and the two will meet on a perpendicular line through the point P and with ordinary synchronizing sights, the position at which to release the bomb in order that it will descend and hit the target when the plane and the target are both on the vertical line P may be determined. However, this calculation does not take into account the drift of the bomb. In Fig. 6 I have illustrated graphically the manner in which the bomb sight of my invention is to be used to compensate for drift of the bomb as it falls in trajectory.

Observing Fig. 6, it will be noted that due to air resistance, a bomb dropped under the conditions stated above, will not strike at a point P but will strike at some point P_1 short of the point P. To correct for this error, more improved recent sights are set so that the bomb will fall approximately at the point P when the plane has reached a point at about P_2, the distance between the points P and P_2 being termed the trail of the bomb. With this correction if the target has no air velocity, there will be a direct hit. However, where the target air velocity is not zero, it will have reached a point P_3 or thereabouts. It is therefore evident that in order to produce a direct hit, the airplane must fly not over P, but over point P_3 and will be at

about the point P_4 instead of the point P_2 when the bomb strikes the target at P_3.

Representing the trail of the bomb by the distance D, the drift angle, that is, the angle between the line AT and the line VA by the letter alpha, the altitude by the letter H, and the angle of inclination of the sight by the letter beta, the tangent of the trail angle ordinarily set on bomb sights is $\frac{D}{H}$, but since the sight is set along the line AT, this angle should be

$$\frac{D \times \text{cos. alpha}}{H}.$$

The tangent of the angle of inclination of the sight necessary to fly along the line VA and observe along a line always parallel to AT in order that the target will maintain a steady position in the sight is

$$\frac{D \times \text{sin. alpha}}{H}.$$

The plane with such a setting of the sight will pass over the point P_3 and the bomb will strike at that point when the plane has reached the point P_4. In my improved bomb sight, I contemplate correcting the position of the cross hairs of the target reticle to the right or left proportional to D and sin. alpha, and relatively up and down to correct fore and aft proportional to D and cos. alpha, an amount determined by the length of the optical system but always such that the tangents of the above described angles are

$$\frac{D \times \text{cos. alpha}}{H} \text{ and } \frac{D \times \text{sin alpha}}{H}.$$

Referring now to Figs. 1 to 4 inclusive, an optical bomb sight is designated by the reference numeral 10 and may be of any standard well known type having a target reticle 11 which in standard bomb sights maintains a certain fixed relation in the optical system of the sight. According to my present invention, the reticle 11 is mounted on a needle 12 and adjusted uniformly in a plane laterally and up and down to compensate for the drift of a bomb as it falls in trajectory, so that cross-wind bombing or bombing across the course of a moving target is rendered easier and more effective. The needle 12 is connected through joints at 13 and 14 with a universally adjustable rod 15 and a bracket 16 fixed upon the tube of the sight 10. A second bracket 17 has a gimbal joint 18 of a similar type to the joints 13 and 14 permitting universal adjustment therein of the rod 15. The joints 13 and 18 are in the form of spheres integral with or secured rigidly on the needle 12 and the rod 15 respectively, while the joint 14 is in the form of a sphere in which the needle 12 has a sliding fit, for a purpose which will presently appear. In all of the joints referred to, there are set screws 19 having concave inner ends which engage with an easy sliding fit on the opposite side faces of the spheres. The needle 12 is adjustable in a slot 20 in the side wall of the bomb sight 10. The brackets 16 and 17 are suitably fixed against longitudinal movement on the sight.

The adjustment of the rod 15 to adjust the needle 12 and effect a predetermined desired positionment of the reticle 11 is made in accordance with a scale 21 fixed on a tab 22 extending between the brackets 16 and 17. A slide 23 has grooves 24 to receive the dove-tail edges of the tab 22 to permit adjustment of the slide longitudinally of the tab over the scale 21. The slide 23 is slotted transversely as shown at 25 and receives a head 26 adjustable in guides 27 in the sides of the slot 25. The cross-wise adjustment of the head 26 is effected by a thumb screw 28 threaded through the side of the slide 23 and having a smooth end 29 held in the head 26 as shown. Since the sight is used with the scale 21 extending vertically on the side thereof, preferably the right hand side, adjustment of the screw 28 effects up and down adjustment of the reticle 11 in an obvious manner, and corrects the sighting fore and aft relative to a target. A plunger 30 is adjustable in a socket 31 in the head 26 by a screw 32, the adjustment of which is effected by a thumb nut 33 having a graduated dial 34 thereon. The dial 34 is suitably calibrated so that adjustment of the plunger 30 will effect a certain predetermined desired lateral adjustment of the target reticle 11 and thereby compensate for drift determined from an observation of the target. The plunger 30 has a gimbal joint 35 in the form of a sphere having a sliding fit on the rod 15 and mounted for universal movement in the concave ends of the screws 36 threading in from opposite sides of the plunger 30. An indicator 37 is fixed on the plunger 30 and has the rod 15 extending through an opening therein. This indicator maintains coplanar relation with the plunger 30, head 26, and slide 23 and is universally adjustable over the scale 21 with these parts.

The scale 21 has horizontal lines 38 inscribed thereon which represent the values of V_a or airspeed. Curves 39 cross the lines 38 and are placed in groups under headings 40 referring to the terminal velocity of the bombs to be dropped. The curves are each labeled in reference to the altitude at which the plane is flying.

The operation of the sight will best be understood by reference to a concrete example. Let us assume a case where the airspeed V_a of the plane is 100 miles per hour, the airspeed of the target is about 50 miles per hour, the altitude H of the plane is assumed as 8,000 feet, and the terminal ve-

locity of the bomb 1,000 feet. To take care of all of these values in compensating for the drift of the bomb as it falls in trajectory the slide 23 is set usually at some time previous to the actual bombing upon the curve of the terminal velocity of the type of bomb selected, and at the altitude 8,000 feet. This curve is followed by the indicator to a point representing the airspeed of the plane, 100 miles per hour. The target is then observed and when the course of the plane is adjusted so that the target maintains a fixed position in the sight, the drift, which we will assume has been found by observation to be 30 degrees, is set by adjusting the thumb nut 33 until the dial 34 indicates a 30-degree adjustment. With the setting of the sight as above stated, it only remains for the aviator to drop the bomb at the proper instant. This matter is taken care of by any of the standard types of devices, in connection with which the present compensating means is employed. These devices, in certain improved forms at least, are electrically equipped and contacts are closed at the proper instant to release the bomb. The present invention is concerned merely with a means for making a fine correction of the sighting to compensate for drift. Therefore it is not deemed necessary to go into any of the details of any other portion of the sighting and bomb dropping mechanism. These are assumed to be well known and understood by those skilled in this art.

I claim:—

1. A bomb sight comprising an optical sight system carried by a moving body, a target reticle in said optical system and means to adjust the reticle in horizontal and vertical plane relative to said optical system, said means comprising universal joints attached thereto and co-acting therewith whereby the reticle is adjustable as described.

2. A bomb sight comprising an optical sighting tube carried by a moving body, a universally movable target reticle, means for predeterminately setting said reticle in the tube to compensate for drift, and means comprising universal joints whereby the reticle is adjustable as described.

3. A bomb sight comprising an optical sighting device carried by a moving body, a target reticle in said sighting device for sighting on a moving target, and means for predeterminately setting said reticle to compensate for a plurality of factors which effect the trail of the bomb, said means including universal joints attached thereto and co-acting therewith whereby the reticle is adjustable as described.

4. A bomb sight comprising an optical tube carried by an aircraft, a universally movable target reticle therein for sighting on a moving target and means for adjusting the position thereof to compensate for drift, altitude, and the comparative speeds of the aircraft and target.

5. A bomb sight comprising an optical sight device carried by a moving body, a target reticle therefor, a scale on said sight device adapted to indicate the factors governing the trail of the bomb, and means for adjusting said reticle according to said scale.

6. A bomb sight comprising an optical sight device, a target reticle therein, and means mounted on said device for adjusting the position of the target reticle in a horizontal and vertical plane, universal joints connecting said means with said reticle and a scale on said sight device for determining the position of adjustment of said means.

7. In a bomb sight, an adjustable reticle, a scale on said bomb sight for indicating the terminal velocity of a bomb, and an index movable relative to a scale and universal joints connecting said index with said reticle whereby said reticle is adjusted upon movement of the index.

8. In a bomb sight, an adjustable reticle, a tab on the outside of said sight, a member supported for adjustment relative thereto, means connecting said member to the reticle, an indicator on said member, and a replaceable scale on said tab containing curves and lines relative to the terminal velocity of bombs, the altitude of flight, and the airspeed of the plane.

9. In a bomb sight, an adjustable reticle, a tab on the outside of said sight, a member supported for adjustment thereon, means for universally connecting said member to the reticle, an indicator on said member, a scale adjacent said member and co-acting with said indicator, said scale containing groups of curves and lines relative to the terminal velocity of bomb adapted for use to determine the position of said indicator and hence of said member to adjust the relation in said sight of said reticle, different curves being referred to depending upon the terminal velocity of the bomb to be dropped.

10. In a bomb sight, an adjustable reticle, a tab on the outside of said sight, a member supported for adjustment relative thereto, means connecting said member to the reticle, an indicator on said member, a replaceable scale on said tab containing curves and lines relative to the terminal velocity of bombs, the altitude of flight and the airspeed of the plane, and an auxiliary adjustment for adjusting said member for drift.

11. In a bomb sight, an adjustable reticle, a tab on the outside of said sight, a member supported for adjustment relative thereto, means connecting said member to the reticle, an indicator on said member, and a replaceable scale on said tab containing curves and lines relative to the terminal velocity of bombs, the altitude of flight and the airspeed of the plane, in relation to which said

indicator is adjustable to adjust the position of said reticle in said sight up and down to correct the sight fore and aft.

12. In a bomb sight, an adjustable reticle, a tab on the outside of said sight, a member supported for adjustment relative thereto, means connecting said member to the reticle, an indicator on said member, a replaceable scale on said tab containing curves and lines relative to the terminal velocity of bombs, the altitude of flight, and the airspeed of the plane, a relation to which said scale is adjustable to adjust the position of said reticle up and down in correcting the sight fore and aft, and an auxiliary adjustment for adjusting said indicator to adjust the position of said reticle laterally to correct the sight for drift.

13. In a bomb sight, an adjustable reticle, a member provided with grooves and mounted for adjustment on the outside of said sight and comprising guides thereon coacting with said grooves, means for universally connecting said member to the reticle, and means for adjusting said member to adjust said reticle laterally.

14. In a bomb sight, an adjustable reticle, a member provided with grooves and mounted for adjustment on the outside of said sight and comprising guides thereon coacting with said grooves, means for universally connecting said member to the reticle, and means for adjusting said member to adjust said reticle laterally in accordance with the scale to correct for drift.

15. In a bomb sight, an adjustable reticle, a member provided with grooves and mounted for adjustment on the outside of said sight and comprising guides thereon coacting with said grooves, means for universally connecting said member to the reticle, means for adjusting said member to adjust said reticle laterally, and a second means for adjusting said member to adjust said reticle up and down.

16. In a bomb sight, an adjustable reticle, a member, means for supporting said member for adjustment on the outside of said sight, means for connecting said member with said reticle, means for adjusting said member to adjust said reticle laterally, and lastly, means for adjusting said member to adjust said reticle up and down, the lateral adjustment being for drift and the up and down adjustment for correcting for the terminal velocity of the bomb used, the altitude of flight, and the airspeed of the plane.

17. A bomb sight comprising an optical sight device, gimbal joints mounted on said optical sight device, a reticle mounted for universal adjustment thereon, means comprising parts interconnecting with said gimbal joints for adjusting said reticle, a scale on said optical sight device, and an indicator universally adjustable relative thereto for adjusting said means.

18. In a bomb sight, a reticle, a needle extending thru the side wall of the sight for adjusting said reticle, a tab extending along the outside of said sight, a scale mounted thereon, a rod mounted for universal swivel movement at one end of said tab and connecting with said needle to adjust the latter universally, a slide movable lengthwise of said tab, and means adjustable universally relative to said slide having an indicator movable relative to the scale on said tab.

19. In a bomb sight having a target reticle, means for adjusting said reticle universally in a single plane comprising a needle extending through the side wall of said sight, a stationary pivotal and sliding mount for the outer end of said needle, a support on the outside of said sight, a scale mounted on said support, a rod having a positive universal adjustable connection with said needle, at one end, and mounted for universal adjustment relative to said support at the other end, a slide movable lengthwise of said support over the scale thereon and provided with parts having a sliding universal joint connected with said rod and universally adjustable relative to said slide.

In testimony whereof I affix my signature.

GRANDISON GARDNER.