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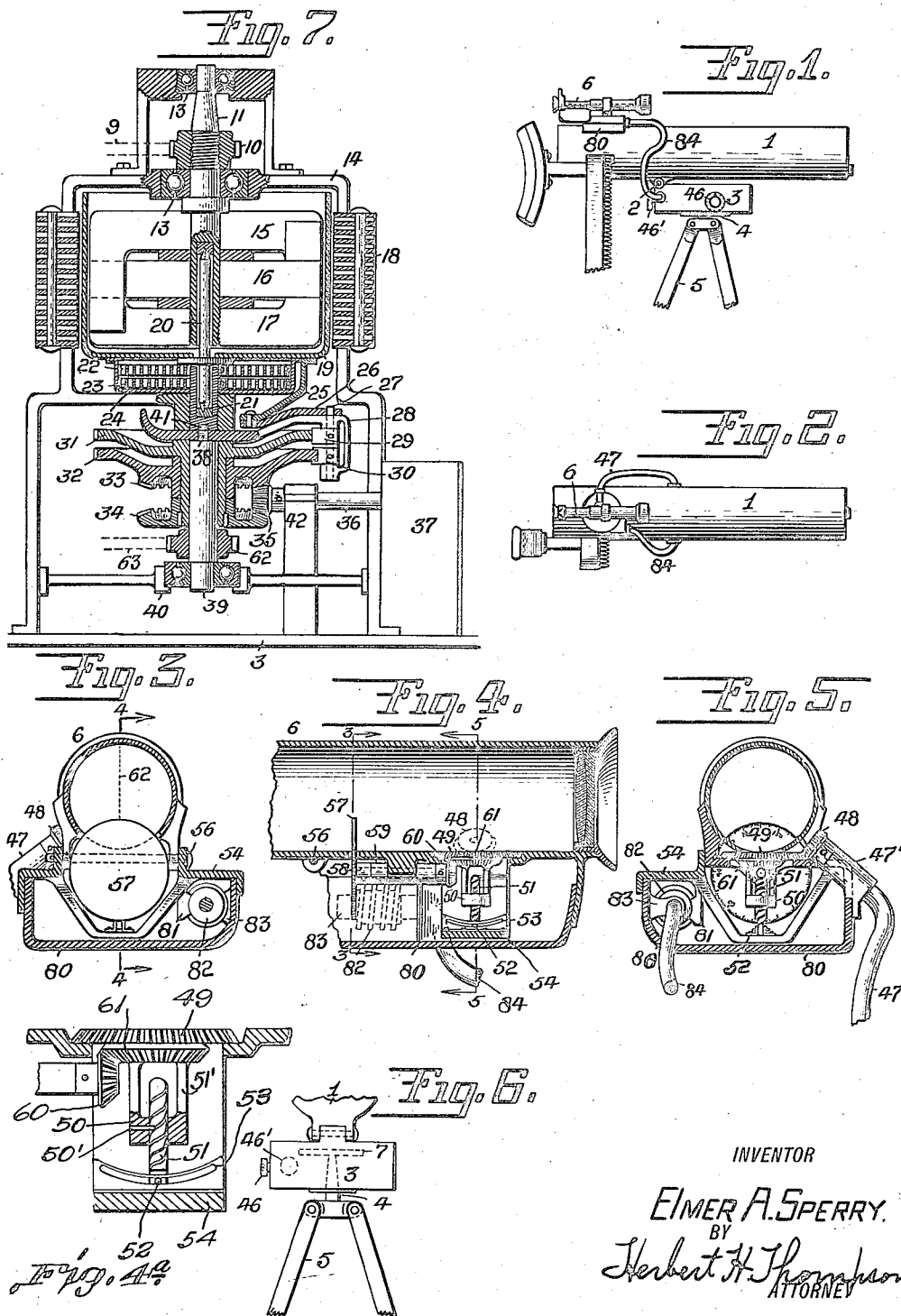
E. A. SPERRY

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AUTOMATIC SIGHTING MECHANISM FOR AIRCRAFT GUNS

Filed Dec. 22, 1917

3 Sheets-Sheet 1



Jan. 15, 1924.

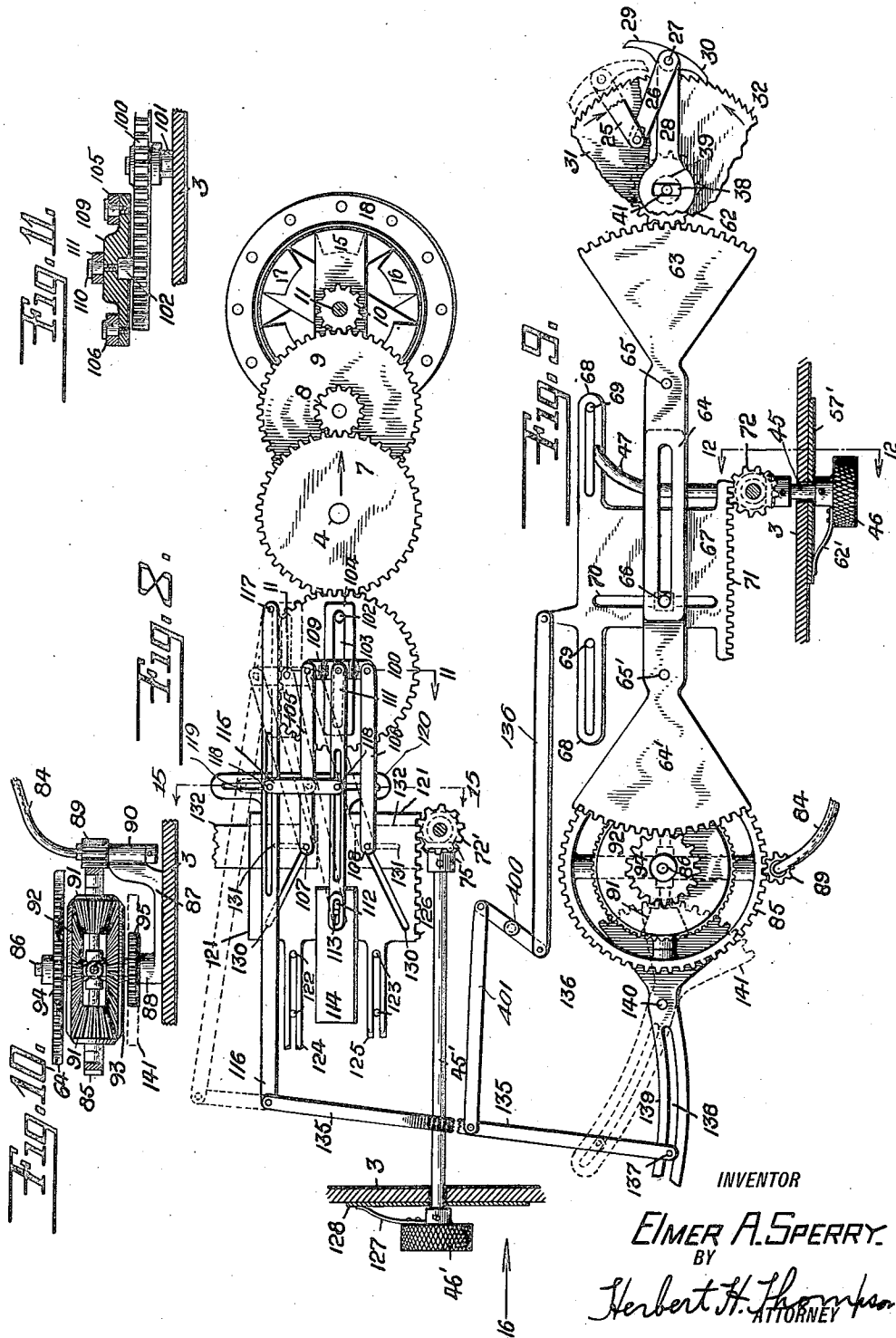
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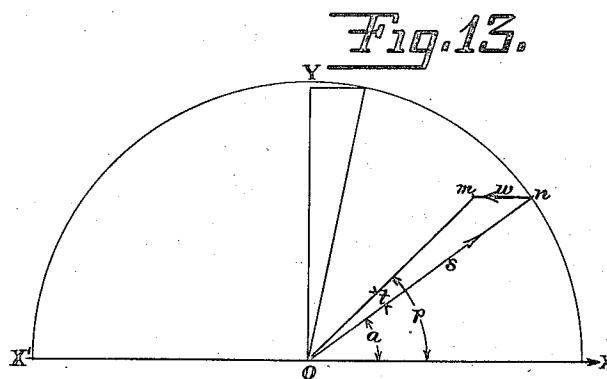
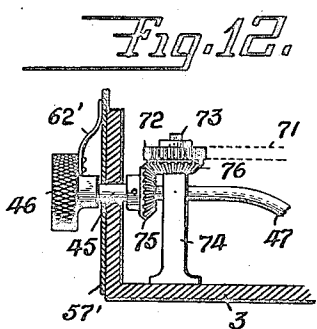
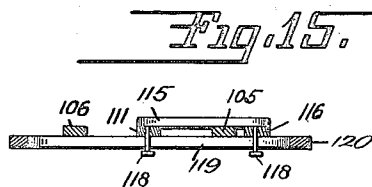
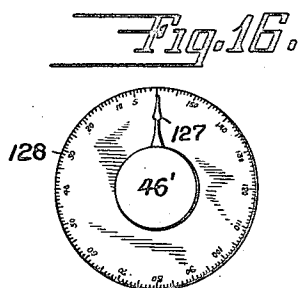
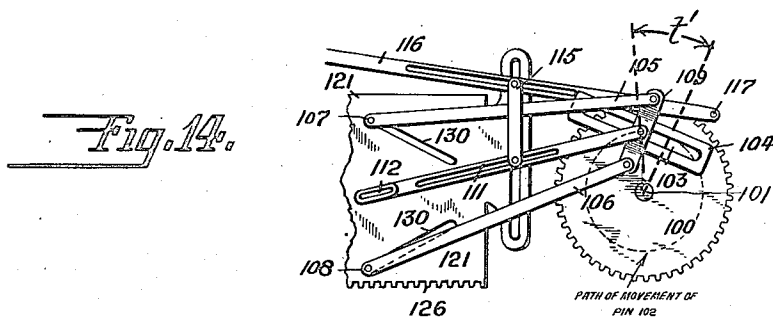
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AUTOMATIC SIGHTING MECHANISM FOR AIRCRAFT GUNS

Filed Dec. 22, 1917

3 Sheets-Sheet 3



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AUTOMATIC SIGHTING MECHANISM FOR AIRCRAFT GUNS.

Application filed December 22, 1917. Serial No. 208,390.

To all whom it may concern:

Be it known that I, ELMER A. SPERRY, a citizen of the United States of America, residing at 1505 Albemarle Road, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Automatic Sighting Mechanism for Aircraft Guns, of which the following is a specification.

This invention relates to gunsighting devices, more specifically to a sighting system for anti-aircraft guns and in its most specific aspect to a sighting system for guns adapted to be fired from one aircraft at another.

It is extremely difficult to hit a rapidly moving target, such as an aeroplane, even from a fixed base due to the fact that the range and bearing of the target are continuously and rapidly varying and deflection of the bullet or shell by the wind takes place. When the gun is fired from one aeroplane at another the difficulty of making a hit is further increased.

One of the principal objects of my invention is to provide a means for shifting the sight with respect to the gun so that by keeping the sight on the relatively moving target the gun will be automatically pointed in such a direction as to hit the target.

Another object is to provide a novel form of means for obtaining the rate of change of relative bearing of a gun and its target.

A further object is to provide means for automatically deflecting the sight with respect to the gun for introducing a correction due to the relative velocity of the wind with respect to the gun mount. Other objects and advantages will appear as the invention is hereinafter developed.

Referring to the drawings which illustrate what I now consider the preferred form of my invention:

Fig. 1 is an elevation of my invention applied to a machine gun.

Fig. 2 is a plan view of the structure shown in Fig. 1.

Fig. 3 is a sectional elevation of the sighting device and its support, taken on the line 3—3 of Fig. 4.

Fig. 4 is a fragmentary sectional detail taken on the line 4—4 of Fig. 3.

Fig. 5 is a section taken on the line 5—5 of Fig. 4.

Fig. 6 is a fragmentary end elevation of the structure shown in Figs. 1 and 2.

Fig. 7 is an elevation, partly in section, of one form of speed responsive device and follow-up forming a part of my invention.

Fig. 8 is a plan view of a part of the mechanism contained in the casing 3 of Figs. 1 and 2.

Fig. 9 is a plan view of the remaining mechanism contained in the casing 3, the upper part of the speed responsive mechanism being removed.

Fig. 10 is a detail elevation of the differential shown in Fig. 9.

Fig. 11 is a detail sectional elevation taken on the line 11—11 of Fig. 8, the crank pin 102 being shown in a different position.

Fig. 12 is a sectional detail elevation taken on the line 12—12 of Fig. 9.

Fig. 13 is a diagrammatic view employed in explaining the theory of operation of my invention.

Fig. 14 is a fragmentary plan view of a part of the mechanism illustrated in Fig. 9, certain of the elements being in a different position.

Fig. 15 is a fragmentary sectional elevation taken on the line 15—15 of Fig. 8.

Fig. 16 is a detail elevation looking in the direction of the arrow 16 in Fig. 8.

In order to hit a moving target by means of a projectile fired from a gun, it is necessary to aim the gun ahead of the position occupied by the target when the gun is fired.

Neglecting certain factors such as deflection due to windage, etc., this angular deflection necessary is equal to the rate of change of relative bearing of the target multiplied by the time of flight of the projectile. While these various factors may be determined and multiplied in various ways, I prefer to employ the structure illustrated which comprises means automatically positioned in accordance with the rate of change of relative bearing of the target, when the gun sight is kept on the latter; means for setting the sight in elevation in accordance with the range; means connected to the last mentioned means for combining the position of the first mentioned means with a function of the range (time of flight of the projectile) and means for automatically deflecting the gun with respect to the sight in accordance with the product of rate of change of relative bearing and the time of flight of the projectile.

It will be seen that I have illustrated the gun in the form of a machine gun 1 pivot-

ally mounted about a horizontal axis 2 on a casing 3 in turn rotatable about the normally vertical spindle 4 fixedly carried by the gun mount 5. The gun 1 is also shown as provided with a sight 6 which should preferably be either a wide angle or open sight. For determining the rate of change of relative bearing factor the following structure is preferred at this time.

A gear wheel 7 (see Figs. 6 and 8) is fixedly carried by the spindle 4 within the casing 3 and is adapted to cause rotation of a shaft 11 through a suitable train of gearing 7, 8, 9, 10, said elements 7 to 11 being carried by the casing 3. The shaft 11, shown as journaled in bearings 13, 13 in a frame 14 secured to casing 3, is provided with a plurality of permanent magnets 15, 16, 17 adapted to rotate within an annulus 18 of magnetic material, secured to said frame 14. A cup-shaped member 19 of non-magnetic electrical conducting material is oscillatable between magnets 15, 16, 17 and the annulus 18, said member 19 being mounted on a shaft 20 which telescopes and is journaled at one end within the shaft 11 and which shaft 20 is journaled at its other end in a member 21 fixed to frame 14. The member 19 is shown biased to normal central position by means of a pair of oppositely coiled springs 22, 23 mounted within and secured at one end to a housing 24, carried by said member 19, the other ends of said springs being secured to the relatively fixed member 21.

To keep the sight 6 on the target the gun 1 is swung about its vertical axis causing shaft 11 to be rotated and if the said sight is continuously kept on the target the shaft 11 will be rotated at a rate proportional to the rate of change of relative bearing of the target. Furthermore, the deflection of the member 19 against the action of one or the other of the springs 22, 23 is proportional to the speed of rotation of the magnets 15, 16, 17, i. e., the speed of shaft 11. Thus it is clear that the deflection of member 19 from normal position is proportional to the angular velocity of revolution of the gun 1 about its vertical axis and practically proportional to the rate of change of relative bearing of the target. As the deflecting torque of the member 19 is comparatively small, I prefer to connect this member to the mechanism, it is employed to actuate, through a follow-up connection. While various forms of follow-up systems may be employed I prefer at present, the one illustrated in Figs. 7 and 9, which is entirely mechanical and constructed substantially as follows:

An arm 25 is secured to said member 19 and has pivotally connected thereto at its inner end an arm 26 which is secured at the outer end to a shaft 27 rotatably mounted in

the outer end of arm 28. The last mentioned arm is shown secured to a rectangular portion 38 of a shaft 39 rotatably mounted at one end in a journal 40 carried by frame 14 and at its opposite reduced circular end 41 in the lower end of member 21. The shaft 27 has fixedly connected thereto a pair of oppositely extending pawls 29 and 30 normally out of mesh with but adapted to engage respectively the ratchets 31, 32 rotatably mounted with respect to each other and with respect to the shaft 39 on which they are mounted. The last mentioned ratchets are preferably continuously rotated in opposite directions by means of a beveled pinion 35 meshing with a beveled gear portion 33 of gear 32 and with a beveled gear 34 secured to the hub of gear 31. The pinion 35 may be secured to a shaft 36, journaled in a bracket to the casing 3, which shaft may be continuously rotated by any suitable motor such as a spring motor 37.

The operation of my follow-up may best be understood by inspection of Fig. 9. If the member 19 is deflected in a counterclockwise direction (looking down in Fig. 7) the arm 25 will move in the same direction causing the inner end of the arm 26 to assume momentarily a position to one side of its normal position. This movement of arm 26 will rotate the shaft 27 to cause one or the other of the pawls to engage its corresponding gear wheel. Under the assumption made above, the pawl 30 will engage gear 32, which is rotating in the direction of the arrow, thus causing the arm 28 to be moved in a counterclockwise direction until it is directly under the arm 25 when the pawls 29, 30 will assume the position indicated in dotted lines in Fig. 9 and movement of arm 28 will cease. Movement of the arm 25 in a clockwise direction will cause the pawl 29 and gear 31 to come into action to move the follow-up arm 28 in a clockwise direction. In short, the clock train 37 will supply energy to arm 28 to cause the latter to follow-up the movements of arm 25.

The means for setting the sight in elevation in accordance with the range may assume various forms but preferably the setting should be accomplished from the casing 3. A preferred form of mechanism is indicated in Figs. 1 to 5 and 9. A shaft 45 is shown journaled in casing 3 and terminating at its opposite ends in a thumb nut 46 and a flexible shaft 47. The latter is journaled at its other end in a bearing 47' fixedly secured to the sight 6 and fixedly carries at that end a beveled pinion 48. The last mentioned element 48 meshes with a beveled gear 49 rotatably carried by the sight 6 and provided with a downwardly extending member 50 having an internal projection 50' adapted to engage a suitable cam groove 51' in a member 51. The last mentioned

member is shown as fixed to the base member 54, to which the sight is horizontally pivoted at 56 by means of a pin and slot connection 52, 53. Obviously rotation of the thumb nut 46 will cause the sight to be raised or depressed, depending on the direction of turning of said nut, through the connections above described, but this would raise and lower the sight with respect to the target. Since the sight must necessarily be held on the target at all times, the gun is raised or lowered by the operator with respect to the target. Thus, if the screw 46 is turned so that ordinarily the sight would be raised 2°, the sight is held on the target while the gun and base 80 are elevated 2°, the screw 51 traveling upwardly in member 51.

In order to inform the operator of the range for which the sight is adjusted in elevation I provide suitable indicating means which I prefer to mount in a position visible to the operator when the latter is looking through the sight 6. Thus a disk 57 extending into the sight 6 and properly calibrated to range may be carried by a shaft 58 journaled in a bearing 59 carried by the sight 6. The shaft 58 carries also a beveled pinion 60 which meshes with a beveled pinion 61 secured to gear 49. The disk 57 may be read, with the vertical cross-hair 62 of the sight 6 as a reference line to indicate to the operator the range for which the sight is set in elevation.

The means for combining the rate of change of relative bearing with the time of flight of projectile (a function of the range) may assume the form shown in Fig. 9. The shaft 39, which is positioned in accordance with the rate of change of relative bearing, is provided with a pinion 62 which meshes with the segmental end 63 of a slotted lever 64 pivoted at 65. The slotted lever 64 is adapted to actuate a similar slotted lever 64', pivoted at 65', by means of a pin 66 passing through the slots of both of said levers 64, 64'. It will be seen that the lever 64 will impart movement to lever 64' proportional to the movement of said lever 64 and the ratio of movements of said slotted levers will depend on the position of the pin 66 with respect to the fulcrums 65, 65'.

Mechanism is provided for positioning the pin 66 with respect to fulcrums 65, 65' in accordance with the angular setting of the shaft 45 as indicated on the range scale 57. A plate 67 is slidably mounted on the base of casing 3 by means of fixed pins 69 cooperating with slotted extensions 68 secured to said plate 67. The plate 67 is provided with a slot 70 in which the pin 66 is constrained to move and is also provided adjacent one edge with a rack 71 which meshes with a gear 72 rotatably mounted on a spindle 73 (see Fig. 12) fixedly carried by a

bracket 74 mounted in casing 3. The shaft 45 which is rotatably journaled in the bracket 74 carries a beveled pinion 75 which meshes with a beveled pinion 76 secured to the gear 72.

By virtue of the above described structure it will be seen that the pin 66 is positioned with respect to the fulcrums 65, 65' in accordance with a function of the range as indicated on the dial 57 and the parts are so designed that with an even calibration of the range dial 57 the position of said pin 66 is in accordance with the time of flight of a projectile (of the gun employed) to a target at the range indicated. Thus the lever 64' will be given a position in accordance with or depending on the product of the rate of change of relative bearing and the time of flight of the shell. The lever 64', may, therefore, be employed to deflect the gun with respect to its sight so that when the latter is held on the target the gun will be pointing ahead of the target an angular distance necessary to cause a projectile to hit the latter. (Neglecting the effect of wind deflection.) One form of mechanism for effecting this connection is illustrated in Figs. 1 to 5, 9 and 10, and is constructed substantially as follows:

The sight 6 as previously described, is carried by a platform or base 54 (see Figs. 3 to 5) and this base is rotatable about a normally vertical axis with respect to the base 80 which is secured to the gun 1. Preferably the upper base should overlap the lower one so as to form a box-like water-tight container for the adjusting mechanism adjacent the sight. For adjusting the sight 6 about the normally vertical axis above mentioned the upper base 54 may carry a worm rack 81 which meshes with a worm 82 rotatably carried by the lower base 80 in brackets 83 secured to said lower base. The shaft of the worm is shown connected to a flexible shaft 84 which terminates at its opposite end within casing 3. Preferably, for a purpose which will hereinafter appear, the connection between the lever 64' and shaft 84 should be through a differential. One form of differential is shown in Figs. 9 and 10 as comprising three arms. One arm comprises a gear wheel 85 fixedly secured to a spindle 86 rotatably mounted at 88 in a bracket 87 secured to the casing 3. The gear 85 meshes with a pinion 89 fixed on shaft 84 journaled at 90 in the bracket 87 and carries on two of its spokes the beveled gears 91 which are rotatable with respect to said spokes. The last mentioned gears mesh with beveled gears 92, 93 rotatably mounted on the spindle 86 and each secured to a corresponding gear 94, 95. The gear 94 meshes with the segmental lever 64'. Assuming that the gear 95 is held against rotation and ignoring for the time being the effect of wind deflec-

tion the operation of my invention as thus far described is substantially as follows:

The gun 1 is moved in such a manner as to keep the sight 6 continuously on the target. The operator then adjusts the nut 46 until the indication of the dial 57 opposite the cross-hair 62 corresponds to the range of the target which may be ascertained in any suitable well-known manner. The adjustment of the nut 46 sets the sight for the elevation corresponding to the range and also positions the pin 66 in accordance with the time of flight of the projectile for the range indicated. The member 63 is positioned automatically in accordance with the rate of change of relative bearing of the target and gun and the lever 64, which combines the displacements of the pin 66 due to the movements of plate 67 and lever 64, rotates the flexible shaft 84 to an extent and in such a direction as to cause the gun to lead the sight (or the sight to lag behind the gun) an angular distance equal to the rate of change of bearing multiplied by the time of flight of the projectile.

The above operation however, as previously stated, ignores the effect of wind deflection on the projectile. I prefer, however, to correct for this factor, also as the relative velocity of the wind and aeroplane, (if the gun is fired from an aeroplane) which I will term the air-speed, is much higher than the same velocity when the gun is fired from a fixed base. The effect of the air speed on the path of the projectile may be understood by referring to Fig. 13. In this figure, axis O X represents the direction of flight of the aircraft on which the gun is mounted. The vectors s and w represent respectively the muzzle velocity of the projectile and a function of the air-speed for the type of bullet employed; α is the angle between the gun and the longitudinal axis O X of the aircraft; t the angular deflection for a unit interval of time due to the wind and p is the sum of angles t and α .

It may be demonstrated that:

$$(I) \quad \sin t = \frac{w}{s} \sin p$$

and as the angle t is comparatively small $\sin t$ may be placed equal to t so that equation (I) becomes:

$$(II) \quad t = \frac{w}{s} \sin p$$

Let it be assumed that the angle p is equal to the angle α , which is approximately correct. Equation (II) then may be written:

$$(III) \quad t = \frac{w}{s} \sin \alpha,$$

which means that the deflection of the projectile due to the air-speed for a unit in-

terval of time is approximately equal to the product of a function of the air-speed, the reciprocal of the muzzle velocity of the projectile and the sine of the angle between the gun and the line of flight of the aircraft on which the gun is mounted. Obviously the angle through which the gun 1 must be deflected with respect to its sight 6 to allow for the wind deflection is numerically proportional to angle t . Furthermore, when the gun is being pointed at a target to the side Y of the line of flight the sight 6 must be shifted an angle proportional to t in a counterclockwise direction with respect to the gun to correct for wind deflection. If the gun is pointed to the opposite side of Y the sight must be shifted in a clockwise direction with respect to the gun.

Calling attention to Figs. 8, 11, 14 and 15 it will be seen that I have provided a means for automatically positioning a part in accordance with the sine of the angle α between the gun and the longitudinal axis of the gun-supporting aircraft and in the proper direction. A gear wheel 100 of the same size as fixed gear wheel 7 meshes with the latter and is rotatably supported in casing 3 on a shaft 101 (see Fig. 11). A crank pin 102 on gear 100 engages in a slot 103 in a member 104 which is provided with a cross-piece 109 forming the connecting link of a pair of links 105, 106, of equal length and pivoted at 107 and 108 respectively (see Fig. 8). The cross-piece 109 besides having pivoted thereto the links 105, 106 carries at its middle a pin 110 to which an arm 111 is connected at one end, the opposite end of said arm 111 being provided with a slot 112 engaged by a fixed pin 113 carried by a bracket 114. The arm 111 is slotted and connected to a slotted arm 116, pivoted at 117, by means of a link 115 slidably connected in the slots of said arms 111, 116. The link 115 is preferably provided with a plurality of downwardly extending pins 118 (see Fig. 15) which are adapted to slide in a slot 119 provided in an extension 120 provided on a plate 121 which will hereinafter be described in greater detail.

Assuming that the plate 121 is stationary in the position shown in Fig. 8 with the links 105, 106 parallel to each other and assuming further that the gun is so mounted on the aircraft that the arrow shown on the gear 7 is pointing directly ahead, it will be seen that the movement of the gun and consequently the casing 3 about the axis of the spindle 4 will displace the arm 116 an amount proportional to the sine of the angle α , above mentioned, in one direction or other depending on which side of the line of flight of the gun-supporting aircraft the gun is swung to. The maximum deflection or displacement of the arm 116 with the structure thus far described occurs when

α is equal to 90° which is indicated by the dotted line position of the parts 104, etc., in Fig. 8. This dotted line position represents the position of the parts with respect to the casing 3 when the gun is rotated counter-clockwise as viewed in Fig. 8.

Returning now to Equation III it will be seen that the angular correction of the sight to correct for wind deflection is not only proportional to the sine of the angle α but also to the air-speed. Remembering that for any specific gun the muzzle velocity s is approximately constant it is obvious that the angular deflection necessary to correct for wind deflection is proportional to the product of the air speed w , angular position α and a constant.

In order to combine the factor $\sin \alpha$ and the air speed w I provide means for moving the plate 121 and consequently the link 115 in accordance with the air speed. The plate 121 is constrained to move in a direction parallel to the axis of the gun 1, as by means of slotted guides 124, 125 carried by said plate 121 and cooperating with pins 122 and 123, respectively, fixed to the casing 3. The plate 121 may be adjusted by means of a thumb nut 46', on the exterior of casing 3 and connected through gears 75', 72' to a rack 126 on said plate, said elements 46', 75' and 72' being similar to the members 46, 75 and 72 shown in Fig. 12. An indicator may be provided to aid the operator in adjusting the nut 46'. Thus calling attention particularly to Figs. 8 and 16 it will be seen that I have provided a pointer 127 on nut 46' adapted to cooperate with a dial 128 on casing 3, which dial 128 may be calibrated to air-speed of the gun-supporting vehicle. It will be seen that by adjusting the nut 46' to the air-speed (w) the position of link 115 with respect to the pivots of the arms 111 and 116 will be so adjusted as to cause the displacement of the arm 116 to be in accordance with the product of air-speed (w) and the sine of the angle of the gun displacement ($\sin \alpha$).

As previously pointed out this setting of arm 116 is not accurate to accomplish the function intended due to the fact that the angles α and p (see Fig. 13) which were assumed to be equal, are in fact not equal at all times. To view the problem from a different standpoint, it will be seen on inspection of Fig. 13 and Equations II and III that the maximum displacement of the arm 116 from central position should occur when p is equal to 90° ; i. e., when the angle α is less than 90° . To state this in still another way, other conditions being the same, the maximum deflection of the projectile due to the wind, or more accurately the air-speed, will occur when the gun is aimed ahead of the athwartship position, i. e., when angle α is less than 90° . From Equations

II it will also be seen that the position of the gun at which the maximum deflection of projectile occurs depends on the air-speed (w). I have, therefore, provided means for causing the maximum displacement of the arm 116 to occur an angular amount forward of the athwartship position of the gun 1 dependent on the air speed (w). One form of such means is shown in Figs. 8 and 14 and constructed substantially as follows:

The plate 121 is provided with a pair of diverging slots 130 through which the pivots 107, 108 of the links 105, 106 pass. The last mentioned pivots pass also through slots 131 in plates 132 fixed to casing 3. When the plate 121 is moved toward the right (Fig. 8) in accordance with the air speed the pivots 107 and 108 will be moved farther apart so that the member 104 instead of moving parallel to itself will be shifted through an angle with respect to its normal central position as the gear 100 rotates. Thus when the gun 1 and casing 3 are rotated to an athwartship position the parts will assume the position indicated in Fig. 14. The maximum displacement of the member 104 and consequently arm 116 does not occur in this position but when the gun is at an angular distance t' ahead of this position. By virtue of the above described mechanism it will be seen that by setting the thumb-nut 46' to the air-speed, the displacement of the arm 116 may at all times be made substantially proportional to the product of the air speed (w) and the sine of the sum of two angles, which angles are the wind deflection angle (t) and the angle (α) of displacement of the gun. In short the displacement of arm 116 is at all times substantially proportional to $w \sin p$ (Equation II) and as the muzzle velocity is a constant for any specific gun it will be seen that the displacement of said arm 116 will be proportional to t (see Equation II and Fig. 13).

In the description up to this point the deflection of the projectile due to the relative wind has been discussed from the standpoint of deflection in a unit interval of time. The total wind deflection of the projectile is however a function of the time of flight of the projectile which in turn is a function of the range. I therefore provide means for combining the displacement or movement of the arm 116 with the time of flight, or in other words with a function of the range. This means may assume the form illustrated in Figs. 8 and 9.

The free end of the arm 116 is shown pivotally connected to one end of a link 135 which is provided at its other end with a pin 137 slidable in a slot 138 in a segmental lever 139 pivoted at 140. A link 136 is shown connected at one end to the plate 67

and at its other end to an intermediate portion of the link 135 through a reversing lever 400 and a link 401. Bearing in mind that the position of the plate 67 is in accordance with the time of flight of the projectile it will be seen that the position or displacement of the lever 139 will at all times correspond to the total angular deflection of the projectile under the conditions of air-speed, time of flight and angular displacement of the gun existing at that time. Or to state this in another way the displacement of lever 139 will be at all times proportional to the product of $w \sin \alpha$ and the time of flight of the projectile. The lever 139 may therefore be employed to deflect, automatically, the sight 6 with respect to its gun 1 an angular amount necessary to counteract or neutralize the angular deflection of the projectile due to the wind.

Referring to Figs. 9 and 10 it will be seen that the segmental gear 141 meshes with the gear 95 of the differential so that the latter combines two factors, one the angular displacement of the sight 6, with respect to its gun 1, made necessary due to the change in relative position of the gun and target, and the other, the displacement necessary to correct for wind deflection.

It will now be clear from the above description that if the gun operator swings the gun 1 so as to keep the sight 6 on the target, adjusts the nut 46' to the air-speed of his own vehicle and the nut 46 until the range of the target is indicated at 57—62, the gun will occupy such a position as to cause the projectile to strike the target when the gun is fired.

The entire mechanism shown in Figs. 8 and 9 is preferably contained in the casing 3 and as the mechanism adjacent the sight 6 is contained in the box like container 54, 80 it will be recognized that I have provided a compact, water-proof device for greatly increasing the accuracy of gun fire from one aircraft at another or from a fixed base at an aircraft.

I have not shown my invention mounted on an aircraft as a preferred means of so mounting the gun has been made the subject matter of a separate application filed by me on January 12, 1918, Serial No. 211,472. It will be understood that my invention may be applied to any of the existing types of guns or aircrafts provided that the gun-mount is so positioned that the arrow shown on the gear 7 in Fig. 8 points in the direction of the line of flight of the aircraft on which it is mounted. If desirable the nut 46 may be provided with a pointer 62' adapted to cooperate with a dial 57', similar to dial 57 except that the former is fixed, to indicate the range for which the apparatus is set.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination, a gun sight, a support therefor, means adapted to be set in accordance with the range of a target, means actuated in accordance with the angular velocity of said sight relative to said support and means controlled by said two first-named means for moving said sight.

2. In combination, a gun, a sight therefor, a support for said gun and sight, means adapted to be set in accordance with the range of a target, means actuated in accordance with the angular velocity of said sight relative to said support, and means controlled by said two first-named means for moving said sight to cause the latter to lag behind said gun.

3. In combination, a gun, a sight therefor, a support for said gun, means for revolving said gun and means including a part actuated by said gun and in accordance with the angular velocity thereof relative to said support for causing said sight to lag behind said gun.

4. In combination, a gun, a sight therefor, a support for said gun, means for revolving said gun, means for causing said sight to lag behind said gun, when the latter is revolved on said support, to an extent dependent on the angular velocity of said gun relative to said support and means settable in accordance with the range of a target and in accordance with the relative wind velocity for varying the amount of lag of said sight.

5. In combination, a gun, a sight carried thereby, a support for said gun, means for revolving said gun relative to said support and means actuated by revolution of said gun for causing said sight to move with respect to said gun in a direction opposite to the direction of revolution of said gun.

6. In a gun sighting system for aircraft, a gun, a sight therefor, a support for said gun, means positioned in accordance with a function of the angular velocity of said gun in azimuth with respect to its support and means operatively connected to said first named means for deflecting said sight.

7. In a gun sighting system for air craft, a gun, a sight therefor, a support for said gun, means positioned in accordance with a function of the angular velocity of said gun in azimuth with respect to its support, mechanism settable in accordance with the range of a relatively moving target and connections between said means, mechanism and sight for deflecting the latter.

8. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of means positioned in accordance with a function of the angular velocity of said gun with respect to the aircraft, mechanism settable in accordance with the air speed of the aircraft and connections between said means, mechanism and sight for deflecting the latter.

9. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of means settable in accordance with the range of a relatively moving target, mechanism settable in accordance with the airspeed of the aircraft and connections between said means, mechanism and sight for deflecting the latter.

10. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of an element positioned in accordance with a function of the angular velocity of said gun with respect to the aircraft, a second element settable in accordance with the range of a target, a third element settable in accordance with the air speed of the aircraft and connections between said first, second and third elements and said sight for deflecting the latter.

11. In combination, a support, a gun revolvably mounted thereon, an element positioned in accordance with a function of the angular velocity in azimuth of said gun with respect to its support, a second element positioned in accordance with the angular velocity of said gun with respect to its support, a sight for said gun and connections between said elements and sight for deflecting the latter.

12. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of an element positioned in accordance with a function of the instantaneous angular relationship of said gun with respect to the aircraft, a second element settable in accordance with the air speed of the aircraft, a third element positioned in accordance with the angular velocity of said gun with respect to the aircraft, and means connecting said first, second and third elements and said sight for deflecting the latter.

13. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of an element settable in accordance with the air speed of the aircraft, a second element positioned in accordance with the angular velocity of said gun with

respect to the aircraft and connections between said elements and said sight for deflecting the latter.

14. The combination with a gun adapted to be fired from an aircraft and a sight therefor, of an element positioned in accordance with the angular velocity of said gun with respect to the aircraft, a second element settable in accordance with the range of a relatively moving target, a device connected to said first and second elements and positioned in accordance with the combined movements thereof, a third element positioned in accordance with a function of the angular velocity of said gun with respect to the aircraft, a fourth element settable in accordance with the air speed of the aircraft, a second device connected to said second, third and fourth elements and positioned in accordance with the combined movements thereof and means connecting said first and second devices to said sight for causing a deflection of the latter.

15. In combination, a gun, a sight therefor, means for changing the elevation of said sight with respect to said gun and an indicator visible through the eye-piece of said sight and connected to said means.

16. In combination, a gun, a sight therefor, a support for said gun, a shaft connected to said sight for deflecting the latter, a speed responsive device actuated on revolution of said gun relative to said support and connections between said shaft and speed responsive device.

17. In combination, a gun, a sight therefor, a support for said gun, a shaft connected to said sight for deflecting the latter, a speed responsive device actuated on revolution of said gun relative to said support and means including a follow-up device connecting said shaft and speed responsive device.

18. In combination, a gun, a sight therefor, a support for said gun, a shaft connected to said sight for deflecting the latter, a speed responsive device actuated on revolution of said gun relative to said support, means comprising a lever connecting said shaft and device and means for changing the effective length of said lever in accordance with a function of the range of a target.

19. In combination, a gun, a sight therefor, a differential having at least three arms, a connection between one of said arms and said sight, a speed responsive device, connections between another of the arms of the differential and said device, a manually settable member and connections between the third arm of said differential and said member.

20. In combination, a gun, a sight therefor, an element connected with said gun for revolution thereby, a member actuated by said element, manually adjustable means for

varying the path of movement of said member and connections between said member and sight.

21. In combination, a gun, a sight therefor, a support for said gun, an element positioned in accordance with the angular velocity of said gun with respect to its support, a member connected to said element to be displaced thereby, means for varying the position of maximum displacement of said member and connections between said member and sight.

22. In combination, a support, a gun rotatably mounted on said support, an adjustable sight mounted thereon, and means actuated by said gun in accordance with the angular velocity of the latter for adjusting said sight with respect thereto.

23. In combination, a gun, a sight therefor, a support for said gun, means adapted to be set in accordance with the range of a

target, means connected with said gun for actuation thereby in accordance with the angular velocity thereof relative to said support, and means controlled by said two first named means for actuating said sight in accordance with the product of said angular velocity and a function of the range.

24. In combination with a gun rotatably mounted, an adjustable sight thereon, a member connected to said gun for movement thereby, a follow-up member, power means, mechanical clutch means between said follow-up member and power means, means called into action upon relative movement of said members for rendering said clutch means operative, and means controlled by said follow-up member for adjusting said sight.

In testimony whereof I have affixed my signature.

ELMER A. SPERRY.