Nov. 21, 1933. W. W. WILLARD 1,936,442

GUN FIRE CONTROL APPARATUS

Filed Aug. 29, 1927 3 Sheets-Sheet 1

Fig. 1.

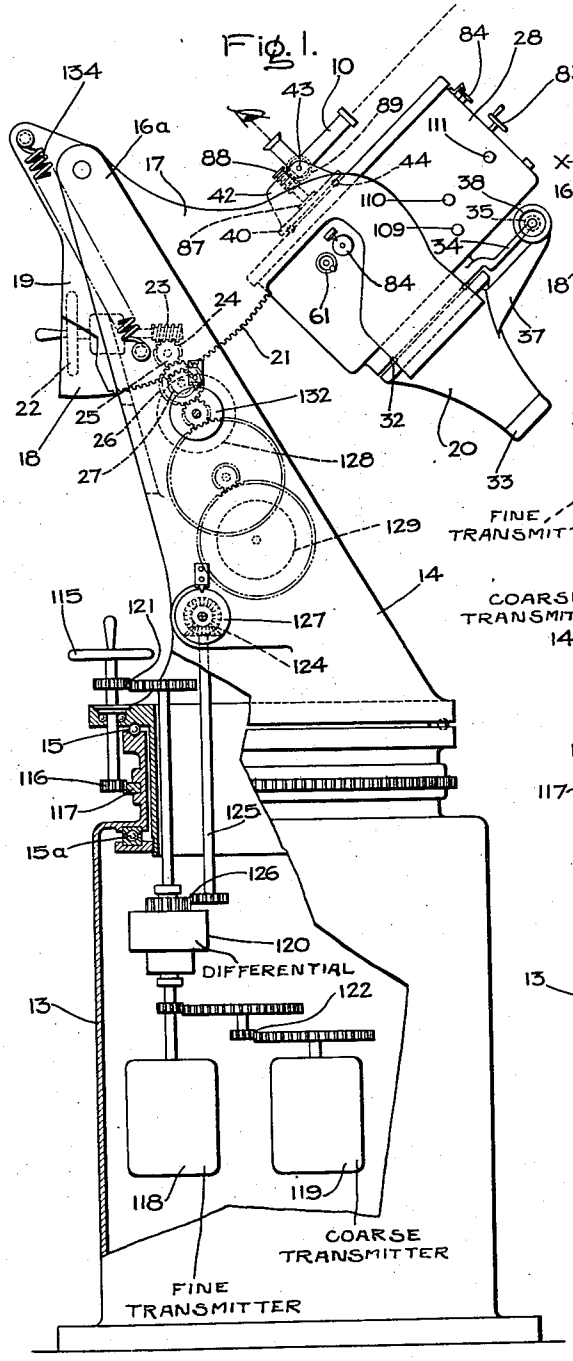
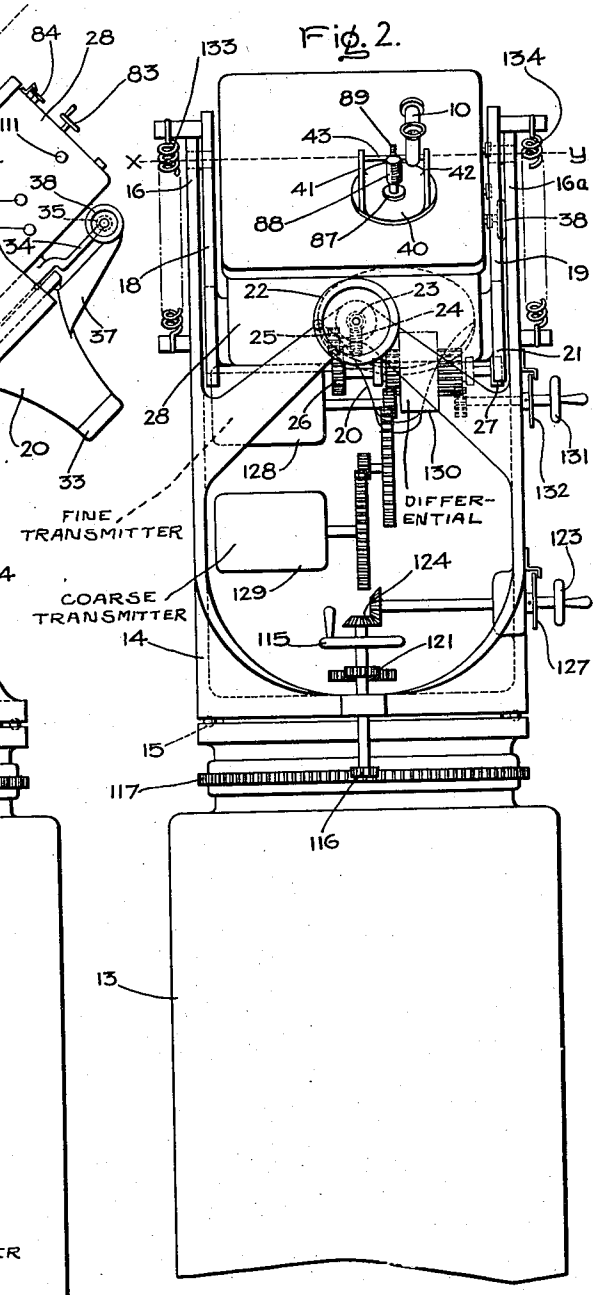


Fig. 2.



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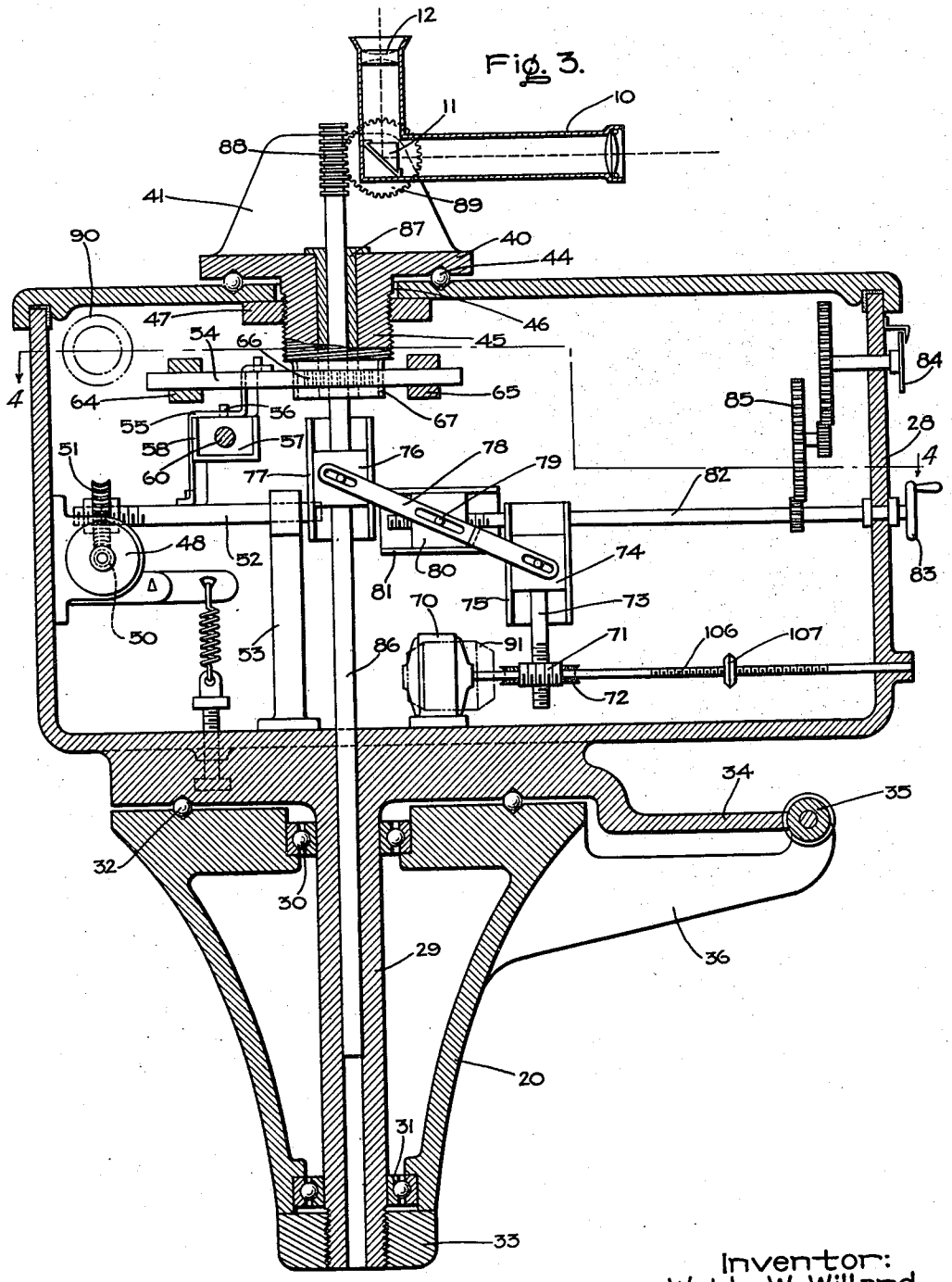
Nov. 21, 1933. W. W. WILLARD 1,936,442

GUN FIRE CONTROL APPARATUS

Filed Aug. 29, 1927 3 Sheets-Sheet 2

Fig. 3.



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Nov. 21, 1933. W. W. WILLARD 1,936,442

GUN FIRE CONTROL APPARATUS

Filed Aug. 29, 1927 3 Sheets-Sheet 3

Fig. 4.

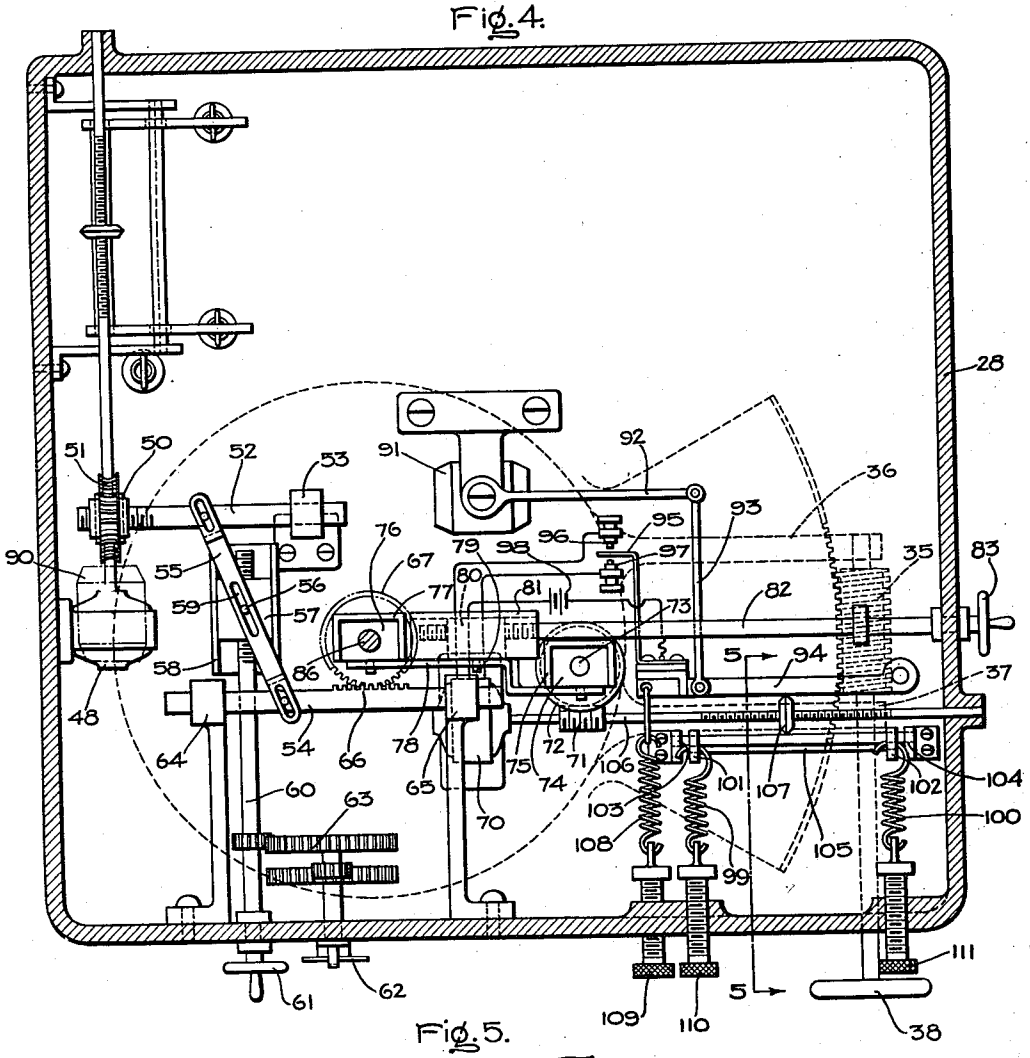
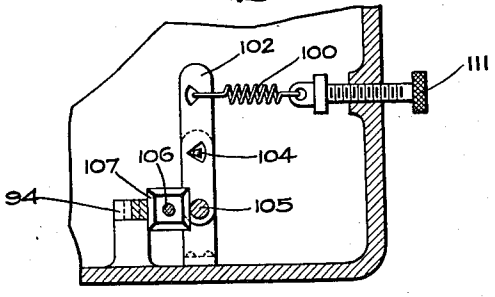


Fig. 5.



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Patented Nov. 21, 1933 1,936,442

UNITED STATES PATENT OFFICE

1,936,442

GUN FIRE CONTROL APPARATUS

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Application August 29, 1927. Serial No. 216,081

24 Claims. (Cl. 33—49)

My invention relates to the control of guns and the like, and has for its object the provision of reliable and accurate means for directing a projectile on a moving target.

More particularly my invention relates to the control of guns from a remote sighting or directing instrument and has special application to the directing of guns commonly known as anti-aircraft guns on a flying target, such as an airplane.

In carrying out my invention in one form, I provide a sighting device which in the operation of the system is directed on the moving target, together with means for transmitting the movements of the sighting device to the gun operator. I also provide means associated with the sighting device for introducing corrections which are dependent upon the speed of the target in order to anticipate the movement of the target during the time of flight of the projectile. In one form of my invention I provide means for displacing the sighting device to introduce corrections, said means comprising a gyroscope, means for applying a force to cause the gyroscope to precess in a predetermined relation with the movements of the sighting device together with means responsive to the precessional force of the gyroscope for displacing the sighting device to apply the corrections.

Since the precessional force of the gyroscope is proportional to the angular velocity of displacement of its axis and since the latter is proportional to the velocity of the target, it follows that for a given range the precessional force is proportional to the velocity of the target and hence becomes a measure of the velocity of the target. I also provide means for introducing corrections in the movement of the sighting device which are proportional to the time of flight of the projectile for the observed range of the target. It will thus be observed that corrections are introduced in accordance with both the velocity of the target and time of flight of the projectile for the lateral distance through which the target will move while the projectile is traveling from the gun to the target, and these corrections are applied in directing the gun in advance of the target so that the target and projectile will arrive at the same point at the same time. I also provide a special mount for the sighting device, together with various other features to be hereinafter pointed out.

For a more complete understanding of my invention reference should be had to the accompanying drawings in which Fig. 1 is a side elevation of gun directing apparatus embodying my invention; Fig. 2 is a front elevation of the apparatus shown in Fig. 1; Fig. 3 is an enlarged vertical sectional view showing details of construction; Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3 looking in the direction of the arrows; while Fig. 5 is a sectional view along the line 5—5 of Fig. 4 looking in the direction of the arrows.

Referring to Figs. 1, 2 and 3 of the drawings, in carrying out my invention in one form I provide a sighting device 10 which is maintained on the flying target by the operator. This device is in the form of a telescope and for convenience in sighting on aerial targets, it is provided with a refracting prism 11 for directing the line of sight at right angles to an eye piece 12 (see Fig. 3) which is convenient for the eye of the operator. The telescope is mounted for adjustment in train on a suitable support comprising a base 13 on which a supporting member 14 is mounted for rotation about a normally vertical primary train axis, ball bearings 15 and 15*a* being provided to support and accurately position the member 14 with respect to this train axis. The upper end of the support 14 is forked to provide two supporting posts 16 and 16*a* between which a second supporting member 17 is pivotally mounted. The member 17 comprises two parallel laterally extending arms 18 and 19 which are joined together at their extremities to form a supporting base 20. One of the arms of the member 17, as shown, the arm 19, is provided with a gear sector 21 whereby the member 17 may be raised and lowered about its pivot axis on the support 14 by means of a handle or handwheel 22 carried by the support 14 and connected to the gear sector through a suitable gear train shown as comprising a worm 23 meshing with a worm wheel 24 and connected to the gear sector 21 through spur gears 25, 26 and 27. This pivot axis of the member 17 on the support 14 is perpendicular to the train axis and constitutes a primary elevation axis. It is indicated on the drawings, Fig. 2, by the dotted line *x—y*.

The base 20 forms a support for a hollow member or casing 28 which is rotatably mounted on the base 20. As shown in Fig. 3 the casing 28 is provided with a tubular bottom extension 29 forming a pivot shaft which is rotatably secured against lateral displacement with respect to the base by means of ball bearings 30 and 31. An additional ball bearing having balls 32 is provided between the adjacent upper and lower surfaces respectively of the base 20 and the

casing 28. A cap member 33 is secured to the lower end of the pivot shaft 29 to prevent accidental displacement of the pivot shaft in an upward direction. The axis of rotation of the casing 28, defined by the shaft 29, is perpendicular to the elevation axis x—y and constitutes an auxiliary or secondary train axis. As shown in the drawings, the construction of the arms 18 and 19 as determining the angular position of the base 20 is such that the shaft 29 is normally inclined to a considerable angle with the vertical. Means are provided for adjusting the casing 28 on its pivot shaft 29 with respect to the base 20, comprising a gear sector 34 secured to the casing 28 cooperating with which is a worm 35 secured in suitable bearings in arms 36 and 37 (Fig. 4) forming a part of the base 20. On the shaft of the worm 35 is a handwheel 38, and a scale and pointer (not shown) will also be provided, for convenience in making this adjustment. Deflection corrections such as drift windage, etc., are applied by means of the handwheel 38.

On the upper surface of the casing 28 is rotatably mounted a member 40 provided with two trunnions 41 and 42 (Fig. 2) between which the telescope 10 is mounted on a pivot 43 (Fig. 1) so as to be movable thereon about an auxiliary or secondary elevation axis which is perpendicular to the axis of shaft 29. As shown, the member 40 is supported on ball bearings 44 on top of the casing and provided with a tubular portion 45 which extends downward through an aperture 46 in the casing. A nut 47 on the threaded inner end of this tubular portion cooperates with the casing to prevent upward movement of the member 40. The member 40 is thus mounted to rotate about the axis of the shaft 29 with respect to the casing 28, which rotation is effected by means of an electric motor 48 secured to the side wall of the casing. This motor has a worm 50 (Fig. 4) secured to its driving shaft and meshing with a worm gear 51 provided with a threaded bore cooperating with which is a threaded rod 52. The rod 52 is secured against rotation but slidably mounted for movement in a longitudinal direction, one end being slidably mounted in a support 53 and preferably splined with the support to prevent rotation of the rod. As the worm gear is turned by the motor, it will be observed that the rod 52 due to its threaded relation with the worm gear will be drawn to the left or pushed toward the right depending on the rotation of the worm gear. This rod 52 is connected to a parallel rod 54 by means of a link 55 and, as shown in Fig. 3, the rod 54 is somewhat above the rod 52, the link 55 being off-set to provide for this. An adjustable pivot 56 is provided for the link at approximately its center, this pivot pin being secured to a block 57 which is slidable in a suitable guide 58 in a direction at right angles to the rods 52 and 54. The pivot pin moves in an elongated slot 59 in the link to provide for adjustment of its position which is effected by turning a shaft 60 by means of a handwheel 61, this shaft being in screw threaded relation with the block 57. This adjustment of the pivot is made in proportion to the time of flight of the projectile in traveling from the gun to the target. In order that the correction may be introduced with accuracy, an indicator dial 62 is geared to the shaft 60 through a speed reducing gear train 63 whereby the dial is operated at reduced speed so that the many turns required of the shaft 60 may be read on a scale 62 of convenient size. The dial 62 is suitably calibrated in terms of time of flight, and cooperating with it is a stationary pointer, as shown.

The longitudinal movements of the shaft 52, corrected for time of flight introduced by the handwheel 61, are thus applied to the rod 54 which is slidably mounted and held against rotation in suitable supports 64 and 65. This rod carries a gear rack 66 which meshes with a spur gear 67 on the lower end of the member 40, whereby any longitudinal movement of the rod 54 is applied to the member 40 in terms of rotation of that member about its axis.

Rotation of the telescope 10 about its pivot axis 43 on the member 40 is effected by means of the driving motor 70 (Fig. 3) secured to the casing. This motor is provided with a driving connection similar to that previously described for the motor 48, the motor being provided with a worm 71 on its shaft which cooperates with a worm gear 72. The worm gear advances or withdraws a rod 73 secured to a slider 74 moving in a guide 75. This slider is connected to a similar slider 76 moving in a guide 77 by means of a link 78 having an adjustable pivot 79. This pivot 79 is mounted on a slider 80 movable in a guide 81 in a direction at right angles to the rod 73 and this adjustment is applied by means of a shaft 82 in screw threaded relation with the slider, which shaft may be turned by the handwheel 83. This adjustment of the pivot pin 79 is for the purpose of introducing a correction for the time of flight, this correction being the same as applied by turning the handwheel 61. A dial 84, suitably calibrated, is driven at a reduced speed with respect to the shaft 82 by means of a gear train 85. This dial facilitates the making of the corrections with accuracy.

The slider 76 is secured to a rod 86 which is slidably mounted in a bore provided for it in the shaft 29, and slidably and rotatable mounted in a bushing 87 provided for it in the member 40. The longitudinal center of the rod 86 is concentric with the axis of the shaft 29. On the upper end of the rod 86 is an annular rack 88 consisting of a plurality of circular flanges on the shaft suitably spaced to mesh with a spur gear 89 secured to the telescope 10. It should be noted that the rod 73 is mounted in parallel relation with respect to the rod 86. With this driving connection, rotation of the motor raises or lowers the rod 86 as the case may be, whereby the telescope 10 is elevated or depressed about its axis 43 in a direction opposite to the movement applied to the telescope about axis x—y by means of the handwheel 22.

The driving motors 48 and 70 are automatically controlled by means of gyroscopes 90 and 91, respectively, which are secured to the casing 28. Although two gyroscopes are shown, it will be understood that a single gyroscope can be used to control both motors. The motors are controlled in response to the amount of the precessional force exerted by the gyroscopes which forces are in turn proportional respectively to the velocities with which the telescope is adjusted in train on the base 13 and in elevation about axis x—y by means of the handwheel 22. Since the two control mechanisms for the motors are similar in construction, only one has been shown in detail, this being the mechanism associated with the driving motor 70.

Referring to Fig. 4, the gyroscope 91 is secured to the casing so that its axis of rotation is initially parallel with the line of sight of the tele-

scope. It will be observed that any movement of the telescope in elevation by means of the handwheel 22, whereby the gyroscope and telescope are moved together, produces a precessional force in the gyroscope due to angular displacement of its axis of rotation. This precessional force is applied by a crank arm 92 secured to the precession axis trunnions of the gyroscope and a link 93 to a pivoted contact arm 94. This contact arm carries a contact 95 in insulated relation thereto which is positioned between two stationary contacts 96 and 97 for controlling the circuit of the motor for rotation in either direction from a suitable source of supply shown as a battery 98. The operation of the motor actuates a suitable counterbalancing mechanism for the precessional force whereby, after the motor has made a predetermined adjustment of the telescope in elevation with respect to member 40 corresponding to the amount and direction of the precessional force, the motor is brought to rest. This counterbalancing mechanism (Figs. 4 and 5) is shown as comprising helical springs 99 and 100 which are connected to the upper ends of lever arms 101 and 102, respectively. These lever arms are pivoted centrally on knife-edge bearings 103 and 104 which are secured to suitable supporting posts carried by the casing. The lower ends of these arms are connected together by means of a rod 105 which extends in parallel relation with the extension 106 of the shaft of motor 70. This extension 106 is threaded and carries a square traveling nut 107, against which the rod 105 is forced by the springs 99 and 100. The switch arm 94 is held against the opposite side of the nut 107 by means of a helical spring 108. Suitable means is provided for adjusting the tension of the springs 99, 100 and 108, such as screws 109, 110, and 111, to which the springs are secured, respectively, at one end.

In the operation of this control for the motor, it will be observed that the springs 99 and 100 tend to force the switch arm in a clockwise direction about its pivot, i. e., in an upward direction, as viewed in Fig. 4, this force being applied through the traveling nut 107. Furthermore, the position of the shaft of the motor determines the effective value of this force as applied to the switch arm. The arrangement is thus, in effect, a spring scale. In order to more definitely define the point of application of the force, the sides of the nut 107 are beveled to provide knife edge bearings on the rod 105 and the switch arm 94. With the motor at rest the nut 107 will be in such a position that the force applied to the switch arm by the springs 99 and 100 is exactly counterbalanced by the spring 108 and the precessional force, if any, so that the contact arm 95 is held in mid-position between its cooperating contacts. If now the movement of the telescope in elevation, either upward or downward, as applied by handwheel 22, is such that a precessional force is exerted by the gyroscope tending to move the arm 92 in a clockwise direction, as viewed in Fig. 4, the switch arm will be depressed to engage contact 97 whereby the motor 70 is started in such a direction as to move the telescope about its axis 43 in a direction opposite to the movement being applied by handwheel 22, and in so doing the nut 107 is drawn toward the left. When the required counter movement has been applied to the telescope, the nut will be in such position that the forces are balanced so that the contact arm 95 will be moved to an intermediate position and the motor stopped. Conversely, when the telescope is moved in elevation to produce a counterclockwise precessional force on the arm 92, the nut will be moved toward the right whereby the force applied to the switch arm is decreased until its return to a position to stop the motor by the spring 108.

As previously stated, the control mechanism for the motor 48 is identical in construction and operation to that described for the motor 70. The gyroscope 90, which controls this motor, has its axis of rotation perpendicular to the axis of the pivot shaft 29. Therefore, when the telescope is moved in train by moving the member 14 on the base 13, the axis of this gyroscope is correspondingly rotated in train, and a precessional force thereby produced. This force is utilized in controlling motor 48 in a manner previously described in connection with motor 70 so as to cause the motor to adjust the telescope about the axis of shaft 29. This adjustment about the shaft 29, it will be observed, is an adjustment in a plane containing the target and parallel with the elevation axis x—y. This rotation applied to the telescope by the motor 48 is in such direction that its lateral component, i. e., component about the train axis, is in a direction opposite to the movement in train applied to the telescope by adjustment of the member 14.

Bearing in mind the characteristics of a gyroscope, it will be understood that the force applied to each gyroscope to counterbalance its precessional force actually causes precession of the gyroscope on the axis about which the gyroscope was originally forcibly moved by the telescope. Therefore, as long as the speed of the target is constant, the counterbalancing mechanism after it has once been adjusted will continue to apply a predetermined force which will cause the gyroscope to precess with the telescope. As a result, when this condition of affairs exists no additional driving force for the gyroscope is required from the telescope. In other words, the telescope at first forcibly moves the gyroscope about one axis and in response to the precessional force thereby produced about a second axis, a force is applied to counterbalance this precessional force, which force in turn causes the gyroscope to precess about the first axis.

Referring to Figs. 1 and 2, the member 14 is rotated in train on the support 13 by means of a handwheel 115 which is carried by the member 14 and actuates a shaft carrying a gear 116 meshing with a gear rack 117 secured to the base 13. This movement is transmitted to a suitable control station or to the gun in high and low speed ratios, respectively, by means of electrical motion transmitting devices 118, 119. The rotor shaft of the transmitter 118 is connected to the handwheel 115 through a suitable mechanical differential device 120 and gears 121 so as to operate in a high speed ratio with respect to the movement of member 14 such, for example, as 72:1. The transmitting device 119 is connected to the transmitting device 118 through a speed reducing gear train 122 so as to be driven in a suitable low speed ratio with respect to the member 14, such as 1:1. The transmitting devices may be operated independently of the handwheel 115, in order to introduce corrections when firing at a surface target, by means of a handwheel 123 which is connected through bevel gears 124, shaft 125 and gears 126 to a second driving element of the differential 120. A dial 127 is actuated by the handwheel 123 and a cooperating stationary pointer is provided whereby the corrections may be introduced with accuracy.

These corrections are the corrections in train for deflection, such as for windage, drift, etc. The transmitting devices 118 and 119 and the driving mechanism therefor are mounted on the member 14. They have been indicated diagrammatically in the drawings for the sake of clarity.

Electrical transmitting devices 128 and 129 are mounted on the member 14 and driven by the handwheel 22. The driving connection between the handwheel 22 and the gear sector 21 includes a suitable mechanical differential device 130, and the transmitting devices 128 and 129 are connected to a driving element of this differential device, a high speed, such as 72:1, connection being provided for the transmitting device 128, whereas the transmitting device 129 is driven in a suitable low speed ratio, such as 1:1. These transmitting devices may also be operated independently of the handwheel 22 in order to introduce corrections by means of a handwheel 131 which is connected through suitable gearing to one element of the differential device 130. A dial 132 is connected to the handwheel and is provided with a stationary pointer whereby the corrections may be accurately introduced. These corrections are those in elevation for the range of the target, i e., corrections necessary to compensate for the curvature of the trajectory.

Helical springs 133 and 134 each having one end secured to the member 14 and the other end secured to the member 17 are provided for counterbalancing the weight of the mechanism carried by member 17 so that the member can be easily adjusted about axis $x—y$ by means of the handwheel 22. These springs are attached to the member 17 on the opposite side of the axis $x—y$ from the supporting base 20 and mechanism carried thereby.

In the operation of the instrument, the operator sights through the telescope 10 and maintains the telescope on the airplane or other flying target by adjusting it by means of the handwheels 22 and 115. The telescope is thus moved continuously to follow the target. At the same time suitable elevation corrections are introduced by means of a handwheel 131, and suitable deflection corrections are introduced by the handwheel 38. The transmitting devices, it will be observed, now transmit the corrected elevation and train movements of the telescope for the present position of the target. For a moving target, however, this is not sufficient since the target will move a considerable distance during the time of flight of the projectile, so that if the gun were fired with these adjustments alone the target would be some distance away by the time the projectile reached the present position of the target.

As the telescope moves, however, it is automatically adjusted with respect to the member 17 by the precessional force of the gyroscopes and corrections thereby introduced, which are proportional to the speed of the target. At the same time corrections are introduced manually for the time of flight of the projectile for the observed range of the target, these corrections being applied by means of the handwheels 61 and 83. The telescope is thus corrected for both speed and time, i. e., for the distance through which the target will move during the flight of the projectile. The application of these corrections tends to move the telescope off the target, but the observer brings the telescope back on the target by training the handwheels 22 and 115, whereby the corrections are applied to the transmitting devices. This will be understood with reference to the previous detailed description. These corrections give the gun a lead with respect to the target. It will be observed that these corrections produce a displacement between the telescope and the axis of the gyroscope.

The gun may be adjusted automatically in accordance with the information sent out by the transmitting devices. In any case suitable receiving devices at the gun are actuated by the transmitting devices, and if desired these receiving devices may be connected to drive suitable indicating dials, and the gun operator will then adjust the gun to the position designated by the indicators as disclosed in U. S. Patent No. 1,626,824 to Hewlett & Willard dated May 3, 1927. Due to the corrections applied, as previously described, the gun is adjusted for the future position of the target so that the projectile and the target will arrive at the same point at the same time and a hit will be made.

While I have described my invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the Patent Statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Means for directing a gun on a moving target, comprising a sighting device, means for moving said sighting device in elevation and train to maintain it on a moving target, and a pair of gyroscopes connected to said sighting device so as to be responsive respectively to the speed of said elevation and train movements for adjusting said sighting device in elevation and train.

2. Means for directing a gun on a moving target, comprising a sighting device, means for moving said sighting device in elevation and train to maintain it on a moving target, motion transmitting means driven by movements of said sighting device, and gyroscopic means responsive to the speed of said elevation and train movements for adjusting said sighting device in elevation and train independently of said first adjusting means.

3. Means for directing a projectile on a target, comprising a sighting device movable about predetermined axes, said sighting device and said target having relative motion with respect to each other, a gyroscope connected to said sighting device, means for moving said sighting device about said axes to direct said sighting device on said target whereby movement is imparted to said gyroscope tending said gyroscope to precess, and means responsive to the resulting precessional tendency of said gyroscope for generating corrections for the relative speed of the target and sighting device with relation to each other.

4. Means for directing a projectile on a target, comprising a sighting device movable about predetermined axes, said sighting device and said target having relative motion with respect to each other, a gyroscope mounted on an axis perpendicular to its axis of rotation, a driving connection between said sighting device and said gyroscope, means for moving said sighting device whereby movement is imparted to said gyroscope about said perpendicular axis, tending said gyroscope to precess, and means responsive to the resulting precessional force of said gyroscope for generating corrections for the relative movement

of the target during the time of flight of the projectile.

5. Projectile directing means comprising, in combination with a sighting device, a gyroscope driven by said sighting device so as to tend to precess upon movement of said sighting device, and means responsive to said precessional tendency of said gyroscope resulting from movement of said sighting device for generating corrections for the relative movement of the target during the time of flight of the projectile.

6. The combination with a sighting device, means for moving said sighting device, a gyroscope, a driving connection between said sighting device and said gyroscope whereby said gyroscope is moved angularly upon movement of said sighting device and thereby tends to precess, means mounting said sighting device for movement independently of said gyroscope and means responsive to said precessional tendency of said gyroscope for moving said sighting device independently of said gyroscope.

7. The combination with a sighting device, of a gyroscope having its axis of rotation substantially parallel with said sighting device, a connection between said sighting device and gyroscope whereby said gyroscope is moved angularly with said sighting device, and means dependent upon the precessional tendency of said gyroscope induced by change of its rate of movement with the sighting device for displacing said sighting device with relation to said gyroscope.

8. The combination with a sighting device mounted for movement about predetermined axes, of a gyroscope mounted for movement with said sighting device so that its axis of rotation is substantially parallel with the line of sight of said sighting device whereby said gyroscope is caused to precess upon movement of said sighting device about said axes, and means dependent upon the precessional tendency of said gyroscope induced by change of its rate of movement with the sighting device for displacing said sighting device with relation to the axis of rotation of said gyroscope.

9. The combination with a sighting device mounted for movement about two sets of train and elevation axes, a gyroscope mounted for movement with said sighting device about one set of said axes so that its axis of rotation is substantially parallel with the line of sight of said sighting device whereby said gyroscope tends to precess upon movement of said sighting device about said set of axes, and means dependent upon the precessional force of said gyroscope for displacing said telescope with relation to said gyroscope about at least one axis of the other set of axes.

10. Means for directing guns and the like on a moving target, comprising a sighting device mounted for movement about predetermined axes, a gyroscope mounted for rotation about an axis and for movement about an axis perpendicular to said axis of rotation, a driving connection between said sighting device and said gyroscope whereby said gyroscope tends to precess upon angular movement of said sighting device, and means responsive to the precessional force of said gyroscope for adjusting said sighting device about one of said axes.

11. The combination with a sighting device mounted for movement about a predetermined axis, of a gyroscope mounted for movement with said sighting device having its axis of rotation perpendicular to said axis of movement of said sighting device, and means responsive to a precessional tendency of said gyroscope due to a change in the rate of its movement with said telescope about said axis for displacing said telescope relative to said gyroscope about said axis.

12. Means for directing guns and the like on a moving target, comprising a sighting device mounted for movement about predetermined axes, a gyroscope mounted for movement with said sighting device so that movement of the sighting device to follow a moving target tends to cause precession of said gyroscope, means for transmitting the movements of said telescope to said gun, and means responsive to the precessional tendency of said gyroscope for applying a correction between the gun and said telescope for the anticipated movement of the target during the time of flight of the projectile.

13. The combination, with a sighting device, of a support for said sighting device mounted for movement about a predetermined axis, a gyroscope secured to said support so that its axis of rotation is perpendicular to said axis whereby said gyroscope tends to precess when said sighting device is moved about said axis, and means responsive to the precessional tendency of said gyroscope for adjusting said telescope about said axis independently of said gyroscope.

14. A directing device for guns and the like, comprising a sighting device mounted for movement about predetermined axes, means for adjusting said sighting device to follow a moving target, a gyroscope mounted for movement with said sighting device having its axis of rotation perpendicular to one of said sighting device axes, whereby said gyroscope is caused to generate a precessional force upon movement of said sighting device, which force is proportional to the speed of movement of said sighting device, means responsive to said force for displacing said sighting device with relation to said gyroscope, and means for transmitting the movements of said sighting device about said axis to the gun.

15. Means for directing a gun on a moving target, comprising a member movable about a train axis, a second member mounted on said first member so as to be movable about an elevation axis, a sighting device mounted on said second member, means for transmitting the movements of said members, said sighting device being mounted on said second member so as to be movable about auxiliary elevation and train axes, a gyroscope mounted on said second member so as to tend to precess when said second member is moved to maintain said sighting device on a moving target, and means responsive to the precessional tendency of said gyroscope for adjusting said sighting device about one of said auxiliary axes.

16. Means for directing a gun on a moving target, comprising a member movable about a train axis, a second member mounted on said first member so as to be movable about an elevation axis, a sighting device mounted on said second member, means for transmitting the movements of said members, said sighting device being mounted on said second member so as to be movable about an auxiliary elevation axis parallel with said first elevation axis and about an auxiliary train axis perpendicular to a plane containing the target and said second elevation axis, a gyroscope mounted on said second member so as to tend to precess when said second member is moved to maintain said sighting device on a moving target, and means responsive to the precessional tendency of said gyroscope for adjusting said

sighting device about one of said auxiliary axes.

17. Means for directing a gun on a moving target comprising a base member, a supporting member mounted on said base member for movement about a train axis, a second supporting member mounted on said first supporting member for movement about an elevation axis perpendicular to said train axis, means for transmitting the movements of said supporting members, a third supporting member mounted on said second supporting member, a sighting device mounted on said third supporting member for movement about a second auxiliary elevation axis, said third supporting member being rotatable on said second supporting member about a second auxiliary train axis perpendicular to a plane passing through the target and containing said second elevation axis, means for adjusting said first and second supporting members about said train and elevation axes so as to maintain said sighting device on a moving target, a gyroscope mounted on said second supporting member so as to tend to precess when said sighting device is maintained on a moving target, and means responsive to the precessional tendency of said gyroscope for adjusting said sighting device about one of said auxiliary axes.

18. Gun fire directing apparatus comprising a support mounted for movement about a predetermined axis, a sighting device mounted on said support for movement with relation to said support, a gyroscope mounted on said support so that its axis of rotation is perpendicular to the axis of rotation of said support, a motor mounted on said support, a driving connection between said motor and said sighting device, and control means for said motor responsive to the precessional tendency of said gyroscope when said sighting device is turned upon said axis to follow a moving target, whereby said telescope is displaced with relation to said support to anticipate the movement of the target during the time of flight of the projectile.

19. A directing device for guns comprising a support angularly movable in an inclined plane containing a moving target, a gyroscope mounted on said support having its axis of rotation parallel to said plane, a telescope mounted on said support for rotation with relation thereto about an axis perpendicular to said plane, a motor for driving said telescope, and control means for said motor responsive to the precessional force of said gyroscope upon movement of said support in said plane to cause said telescope to follow a moving target, whereby said telescope is displaced about said axis with relation to said support, and means for transmitting the movements of said support in terms of the train and elevation axes of the gun.

20. A device for directing guns on a flying target comprising a base member mounted for rotation about a train axis, means for moving said base member about said axis, motion transmitting means driven by said base member, a support mounted on said base for movement about an elevation axis perpendicular to said train axis, means for moving said support about said axis, motion transmitting means driven by said support, a telescope mounted on said support for rotation thereon about an axis perpendicular to an inclined plane parallel to said elevation axis and containing the flying target, a gyroscope mounted on said support having its axis of rotation parallel with said plane, a motor for moving said telescope in said inclined plane, and control means for said motor responsive to the precessional tendency of said gyroscope when said second support is turned with said base member to cause said telescope to following a moving target.

21. A directing device for guns comprising a base member mounted for rotation about a train axis, means for moving said base member about said axis, motion transmitting means driven by said base member, a support mounted on said base for movement about an elevation axis perpendicular to said train axis, means for moving said support about said elevation axis, motion transmitting means driven by said support, a second support mounted on said first support for rotation about an axis perpendicular to said elevation axis, means for rotating said second support with relation to the first to introduce corrections, a telescope mounted on said second support for rotation with respect thereto about an axis perpendicular to said elevation axis, a gyroscope mounted on said second support with its axis of rotation perpendicular to the axis of movement of said second support, a motor on said second support connected to turn said telescope with relation to said second support, and control means for said motor responsive to the precessional force of said gyroscope when said second support is turned with said base member to follow a moving target.

22. Means for directing a projectile on a moving target comprising a gyroscope, control means movable in accordance with the movement of the target, means responsive to the movements of said control means for applying force to said gyroscope to move it about a predetermined axis whereby a precessional tendency is produced in said gyroscope, means responsive to said precessional tendency for generating corrections for movement of the target and means for applying said corrections to said control means.

23. The combination with a sighting device mounted for angular movement about a predetermined axis, of means for moving said sighting device about said axis, a gyroscope, actuating means responsive to movement of said sighting device for applying a force to said gyroscope to cause it to precess with a speed having a predetermined relation to the speed of angular movement of said sighting device about said axis, and correction means driven by said actuating means.

24. The combination with a sighting device, of means for adjusting said sighting device, a gyroscope, means responsive to movement of said sighting device for applying a force to said gyroscope to cause said gyroscope to precess at a speed having a predetermined relation to the speed of said sighting device, and means responsive to said force for moving said sighting device independently of said adjusting means.

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