

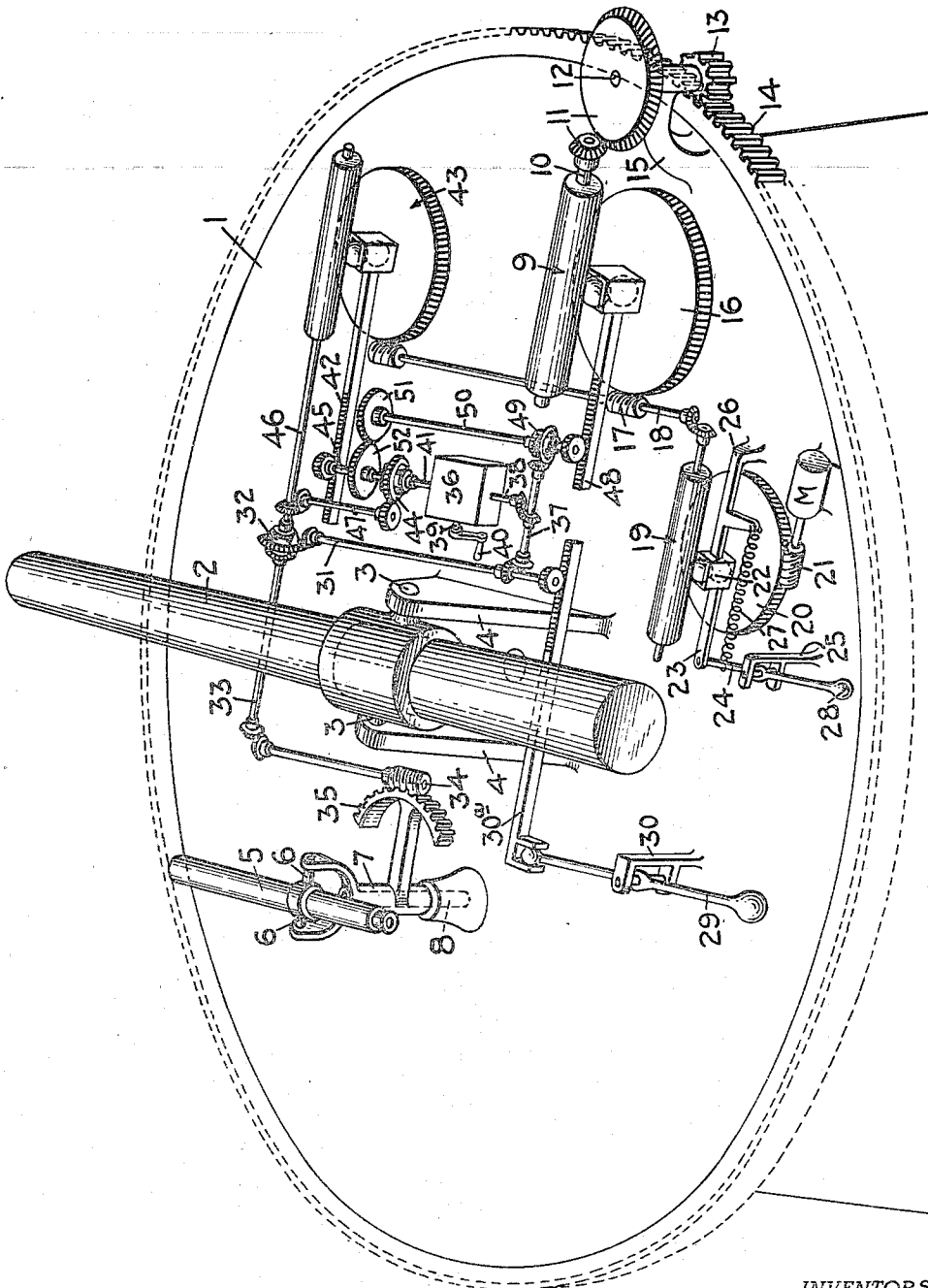
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GUN SIGHT

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GUN SIGHT

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8 Claims. (Cl. 89—41)

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This invention relates to that class of automatic gun sights in which the bearing rate is combined with a function of range to introduce the proper setting of the sight with respect to the gun, that is, the angle of deflection.

In an application of James D. Tear, Serial No. 358,246, filed September 25, 1940, covering Gun sights, there is shown a sight mechanism of this type, a characteristic of which is the fact that when an alteration in bearing rate is made by the operator, the sight moves first in relation to the gun in a direction to bring the sight towards the target, and then the sight moves in the opposite direction until the proper deflection angle is obtained for the bearing rate set up.

With sights of this type in order to bring the sight and with it the gun back on the target an over-correction in the rate of train must be set up by the operator and maintained until the sight comes on the target. One of the objects of this invention is the provision of means for automatically introducing and eventually eliminating that excess rate.

Another object of the invention is to provide in such a gun sight a wider range of rate of train of the gun and sight for more readily bringing the sight on the target than has heretofore been known.

Other objects will be apparent from a consideration of the specification and the drawing in which the single figure is an isometric view of one embodiment of the invention.

In the present invention means actuated by the rate control member are provided for generating an over-correction to the rate or an excess rate and this excess rate is translated into an increment of bearing and applied to the training of the gun. Specifically in the preferred embodiment, the rate member of a variable speed device which trains the gun in azimuth is not connected solely and directly to the train rate control handle, as has been the practice heretofore, but is connected to the output of a differential, one of the inputs of which is a shaft turned directly by the train rate control handle and the other input of which is a shaft turned by the train rate control handle through a separate train of gears. By this arrangement the temporary over-correction to the rate of train necessary to bring the sight on the target is automatically set up in the training device.

The over-correction in rate so introduced is promptly eliminated by the reverse movement of the said other input, which is effected by the restoring or neutralizing action of a delayed fol-

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low-up or relay mechanism. In the disclosed embodiment of the invention, the delayed follow-up or relay mechanism is the mechanism the output of which is connected to the sight to move it in a direction opposite to that in which the sight was first moved by the rate control handle as will be explained hereinafter.

In this disclosure a multiplier, which converts the movement of the rate control handle to a change in deflection, is connected between the rate control handle and the relay mechanism, but it is obvious that the multiplier could be placed in other positions such as next to the sight, as shown in the reference application. When placed as in this embodiment, corrections to sight deflection due to changes in range settings will introduce a compensatory increment in the train angle of the base and hence will not displace the sight from the target.

Referring to the drawing, 1 represents a base adapted to angular movement about its axis. On base 1 is mounted gun 2 on trunnions 3 and brackets 4. Sight 5 is mounted on trunnions 6 and bushing 7, which is free to turn on stud 8 mounted on base 1.

On the base 1 is mounted a variable speed device 9 whose output, shaft 10, is connected by gears 11 to shaft 12 on the end of which is pinion 13 which meshes with teeth 14 of a fixed ring gear surrounding the base 1. Bracket 15 on base 1 forms a bearing for shaft 12.

The driving plate 16 of variable speed device 9 is driven through worm 17 and shaft 18, which is the output of variable speed device 19. The driving plate 20 of variable speed device 19 receives its power from motor M through worm 21 and the teeth in the edge of plate 20. The output of variable speed device 19 will be proportional to the distance of the rate member or ball carriage 22 from the axis of plate 20. The ball carriage 22 is moved by links 23 and 24, the latter being pivoted on bracket 25 mounted on base 1.

In order that plate 16 of variable speed device 9 may be driven normally at a predetermined and minimum speed, a stop 26 in the form of a bracket is mounted on base 1 and is of such length that its free end will engage ball carriage 22 when the ball carriage is at the proper distance from the axis of plate 20. Ball carriage 22 is kept in engagement with stop 26 by the action of spring 27, which is attached to link 24 and stop 26, except when a force is applied to slewing control handle 28 to move link 24 to the left.

The rate of train control handle 29 is pivoted on bracket 30 mounted on base 1. Handle 29 is

connected to a racked control member 30a, which is connected to sight 5 by shaft 31, differential 32, shaft 33, worm 34, arm 35, and bushing 7. Shaft 31 is also connected to one input of multiplier 36 by shafts 37 and 38. The other input to multiplier 36 is shaft 39, which is turned by crank 40 in accordance with a function of the range. The output of multiplier 36, shaft 41, is connected to the rate member 42 of variable speed device 43 through differential 44 and shaft 45. The output of variable speed device 43 is shaft 46, which is connected to one side of differential 32, the other side of the differential being shaft 31, as previously described. Shaft 46 is also connected to differential 44 by shaft 47.

The rate member 48 of variable speed device 9 is connected to the output of differential 49, the inputs of which are shaft 37 and shaft 50, the latter being connected to shaft 45 through gears 51 and 52.

Operation

Assuming that the apparatus is in its neutral or secured position, as shown in the drawing, and it is desired to train the gun and sight on a target, say to the right, rate control handle 29 is pointed to the right, moving rate member 48 and the ball carriage of variable speed device 9 through control member 30a, shafts 31 and 37 and differential 49. In this manner the turning of the base 1 to the right is controlled. If it is desired to turn the base 1 around quickly, handle 28 is pointed to the left moving control member or link 23 and the rate member or ball carriage 22 to the left, thus increasing the rate of output of variable speed device 19 and the rate of movement of plate 16. Control handle 28 may conveniently be arranged as a foot treadle, thus leaving the hands of the gunner free for other operations while swinging the base 1 around, such as setting the range into multiplier 36.

When the sight of the gun approaches the target, the slewing control handle 23 is released and control member 23 and its ball carriage are pulled to the right under the action of spring 27 until the ball carriage comes up against stop 28, when the variable speed device operates to produce the predetermined rate of turning of plate 16. Handle 29 is pointed to the right or left to adjust the rate of train of base 1 so that sight 5 follows the target. In this condition the rate of train, as represented by the position of shaft 37, has been set into the training device by the movement of rate member 48 to a corresponding distance from its mid-position and the rate of train has been multiplied by the time of flight of the projectile by the multiplier 36 and the product of the multiplication has been transmitted to the sight through variable speed device 43, shaft 45, differential 32, and shaft 33. With no further movement of handle 29, control element or rate member 42 of variable speed device 43 is in its neutral position, having been brought there by the follow-up action of shaft 47 connected to shaft 45 through differential 44. As shaft 45 is in its mid-position, so also is shaft 50. The operation of shaft 50, connected to shaft 45 by gears 51 and 52, will be explained hereinafter.

The ratio of transmission between the control member 30a and shaft 33 through shaft 31 and differential 32 is selected as (k) and the ratio of the gearing between the control member 30a and shaft 33 through the variable speed device 43

is $(t+k)$, where t is the time of flight factor introduced into the system by the multiplier 36.

To illustrate the operation of the apparatus to effect a change in rate of train and set up a change in deflection, it is assumed that the target is moving to the right and the rate of train (dB) , represented by the position of shaft 37, is underset, that is, the sight is lagging behind the target both in rate and in distance and a higher rate of train (dB') and therefore a greater deflection are required and an excess rate of train must be temporarily introduced to overcome the distance that the sight lags behind the target.

The operator points handle 29 further to the right. He thereby turns the center of the differential 32 through $-k (dB' - dB)$. This causes a turning of the shaft 33 and hence a movement of the sight to the right or toward the target. Coincidentally the shaft 37 which is geared to shaft 31 turns shaft 38 which is one of the inputs to multiplier 36. Shaft 41, the output of multiplier 36, is moved in proportion to the increase in rate of train multiplied by the constant k plus the time of flight, or $(k+t) (dB' - dB)$, where t is the time of flight as set into multiplier 36 by crank 40. Shaft 41 being connected to shaft 45 through differential 44 moves the rate member 42 of variable speed device 43. The actuation of the output shaft 46 of this variable speed device is thus initiated and continues until the rate member 42 is returned to its zero position through shaft 47 and differential 44 in the usual manner of such follow-up devices.

The total movement of the shaft 46 and hence of the side of the differential 32 to which it is connected is of the value $(k+t) (dB' - dB)$. This therefore operates to neutralize the quantity $-k (dB' - dB)$ set into the differential 32 by shaft 31, and additionally to effect a positive output of differential 32 equal to $t (dB' - dB)$. Due to the mechanical time lag which is inherent in follow-up mechanisms of this type, the neutralizing of the quantity $-k (dB' - dB)$ lags behind its introduction into the differential 32 and hence the shaft 33 is first turned to move the sight toward the target, as above stated, and then is reversed and actuated to give to the sight the correct deflection angle for the new rate of train. In other words the final change in the setting of the shaft 33 is $t (dB' - dB)$.

At the same time that shaft 45 is moved to change the position of rate member 42 of variable speed device 43, shaft 45 moves shaft 50 through gears 51 and 52. The movement of shaft 50 is combined with that of shaft 37 by differential 49, so that the rate member 48 is moved directly in accordance with the increase in the training rate $(dB' - dB)$ and also is moved an additional amount due to the movement of shaft 50 by shaft 45 and the gears 51 and 52. This additional movement of member 48 is neutralized by the follow-up action of shaft 47 and differential 44, so that when the rate member 42 is being moved to its mid-position, the additional or excess movement of member 48 is being removed. When member 42 is in its mid-position, all of the excess movement of member 48 has been neutralized. The gear ratio between shaft 45 and differential 49 is such that the temporary excess movement of member 48 and the corresponding temporary excess training rate of base 1 will automatically train the base 1 such an amount that it is not necessary for the operator to over-correct the rate of train by the handle 29 to overcome the distance that the sight

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had lagged behind the target when the operator introduced the higher rate of train and, if the new train rate is correct, the sight will be on the target when the new deflection is set up and the sight will remain on the target.

The invention is shown as applied to the training of a gun and the deflection of the associated sight, but it is apparent and intended that the invention shall be applied to other movements of the gun, such as elevation. It is also contemplated that various dials may be applied to the mechanism for indicating the instantaneous values represented by different parts of the mechanism as desired.

It is evident that various changes may be made in the form, construction and arrangement of the various parts of the mechanism without departing from the spirit of the invention as defined in the appended claims. For example it will be understood that the temporary additional rate movement generated by the drive branching from the direct drive to the rate member of the variable speed device may be otherwise translated into an increment of train movement of the base. It will also be understood that other types of variable speed devices may be used, such as hydraulic or electric, or a gyroscope acting under a precessing force proportional to the movement of the rate control handle.

We claim:

1. In combination, an angularly movable base, a gun mounted on the base for angular movement therewith, a sight mounted on the base and adapted to angular movement relative to the gun, a differential having an output member connected to move the sight, a variable speed device adapted to train the base at a variable rate and including a rate member positionable to control the rate, a second differential having an output member connected to position the rate member, a control handle, means connecting the control handle to input members of the first and the second differentials, a multiplier having inputs setttable by the control handle and in accordance with a function of the range, a third differential having an input member connected to the output of the multiplier, a second variable speed device including a second rate member, means connecting the second rate member to an input member of the second differential and the output member of the third differential, and means connecting the output of the second variable speed device to input members of the first and the third differentials, whereby the delayed follow-up action of the output of the second variable speed device moves the sight in a direction opposite to and in an amount greater than that caused directly by movement of the control handle and moves the rate member of the first variable speed device in a direction opposite to and in amount equal to that caused by movement of the control handle as applied through the multiplier.

2. In combination, a variable speed device including an output member and an adjustable rate member for varying the rate of movement of the output member, a control member, means for positioning the rate member in accordance with the position of the control member, means actuated by changes in position of the control member for temporarily modifying the position of the rate member, a second control member, and means actuated by said second control member to increase the effect of the first control member in varying the rate of movement of the output member.

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3. In combination, an angularly movable base, a variable speed drive including an output member connected to angularly move the base at a variable rate and a rate member movable to vary the rate, a movable control member, means for positioning the rate member directly in accordance with the position of the control member, a relay actuated in response to movement of the control member, said relay including an element positioned in accordance with the rate of movement of the relay, and means for additionally moving the rate member in accordance with the position of the element.

4. In combination, an angularly movable base, a variable speed drive including an output member connected to angularly move the base at a variable rate and a rate member adapted to vary the rate in accordance with its position, a movable control member, means for initially positioning the rate member directly in accordance with the position of the control member, means for modifying the position of the rate member in accordance with the movement of the control member, and a delayed action relay actuated by movement of the control member for restoring the rate member to its initial position.

5. In combination, an angularly movable base, a gun mounted on the base for angular movement therewith, a variable speed drive including an output member connected to angularly move the base at a variable rate and a rate member adapted to vary the rate in accordance with its position, a sight mounted on the base for angular movement relative to the gun, a movable control member, means for positioning the rate member directly in accordance with the position of the control member, means for initially moving the sight in one direction in accordance with the movement of the control member, means actuated by movement of the control member for introducing additional movement into the rate member, a delayed action relay actuated in response to movement of the control member, means actuated by the relay for removing the additional movement of the rate member, and means actuated by the relay to move the sight in a direction opposite to its initial movement.

6. In combination, an angularly movable base, a gun mounted on the base for angular movement therewith, a variable speed drive having a driving member, a rate member and a driven member, means connecting the driven member to angularly move the base, a sight mounted on the base for angular movement relative to the gun, a movable control member, means for positioning the rate member directly in accordance with the position of the control member, means for initially moving the sight in one direction in accordance with the movement of the control member, means actuated by movement of the control member for introducing additional movement into the rate member, a delayed action relay actuated in response to movement of the control member, means actuated by the relay for removing the additional movement of the rate member, means actuated by the relay to move the sight in a direction opposite to its initial movement, a second variable speed drive including a driven member, and means connecting the driven member of the second variable speed drive to the driving member of the first mentioned variable speed drive.

7. In combination, a variable speed device including an input member, an output member and a positionable rate member for varying the ratio

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of movement between the input member and the output member, a control member, means for positioning the rate member directly in accordance with the position of the control member, means actuated by change in position of the control member for modifying the position of the rate member temporarily, a second variable speed device including an input member, an output member and a positionable rate member for varying the ratio of movement between the input member and the output member, power means for driving the input member of the second variable speed device, driving means connecting the output member of the second variable speed device to the input member of the first mentioned variable speed device, biasing means to normally position the rate member of the second variable speed device at a predetermined posi-

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tion, and a second control member adapted to overcome the biasing means and to position the rate member of the second variable speed device at a position to increase the rate of movement of the output member.

8. In combination, a variable speed device including an output member and an adjustable rate member for varying the rate of movement of the output member, a control member, means for positioning the rate member in accordance with the position of the control member, a second control member, and means actuated by said second control member to increase the effect of the first control member in varying the rate of movement of the output member.

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