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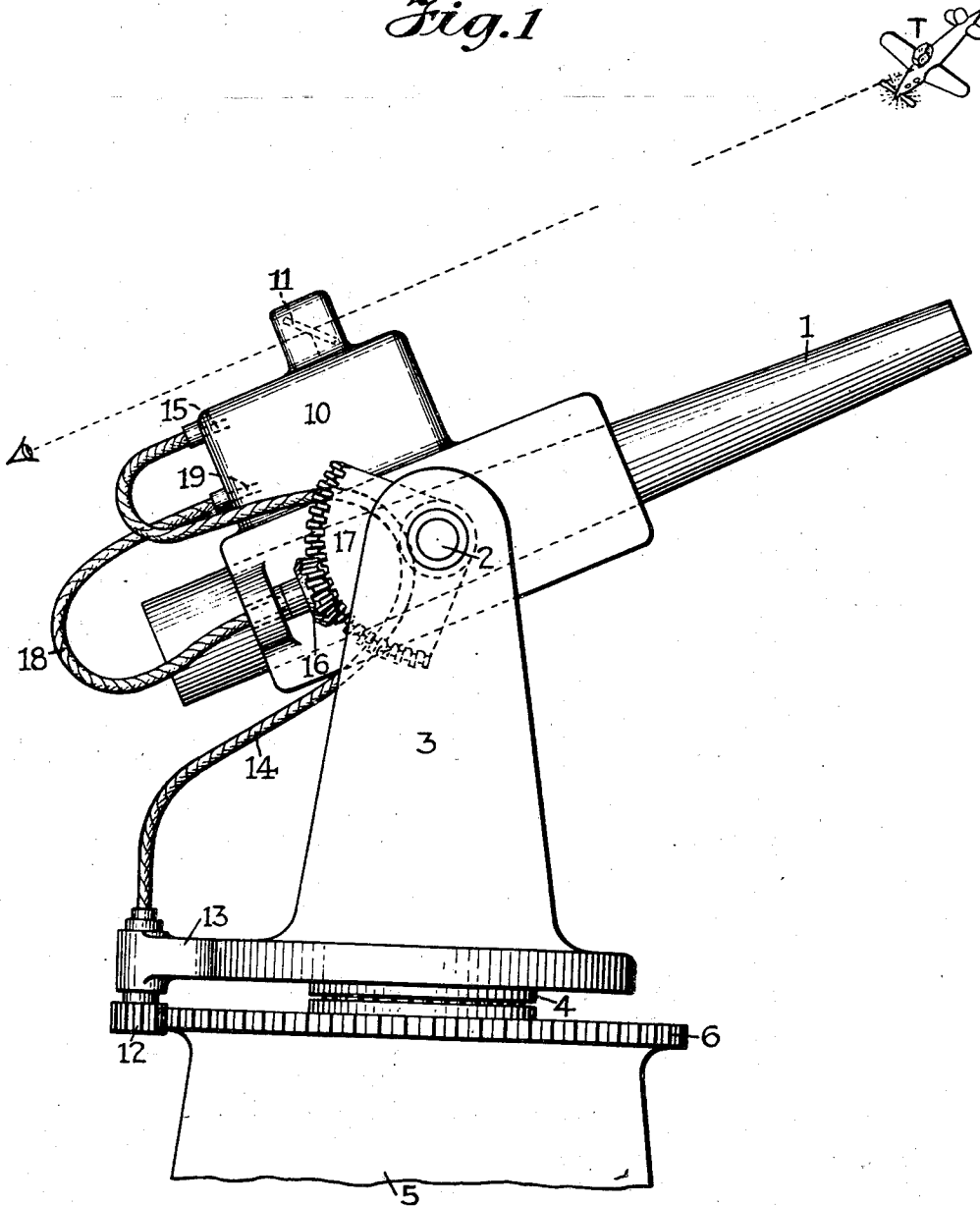
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COMPUTING GUN SIGHT

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5 Sheets-Sheet 1

Fig. 1



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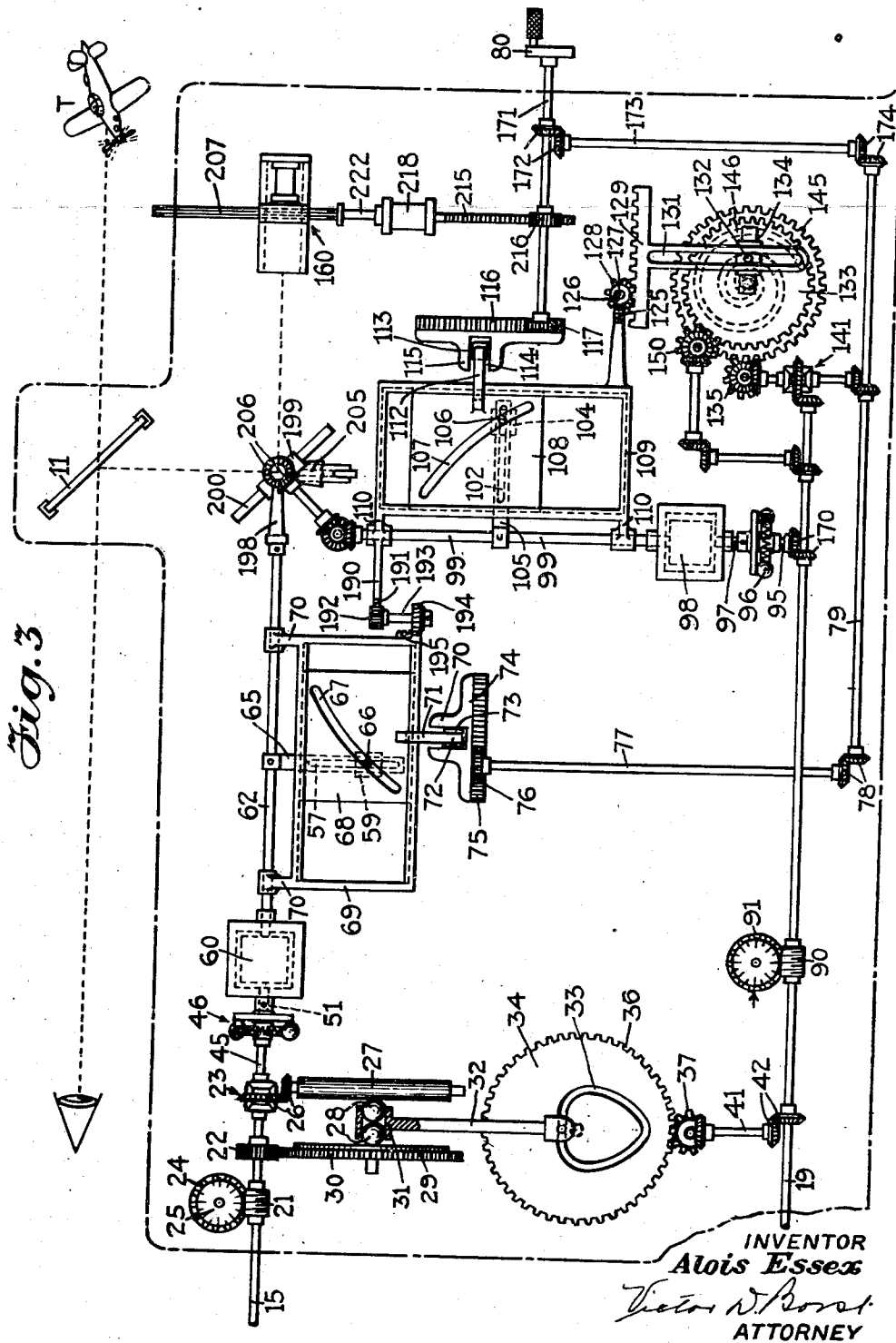
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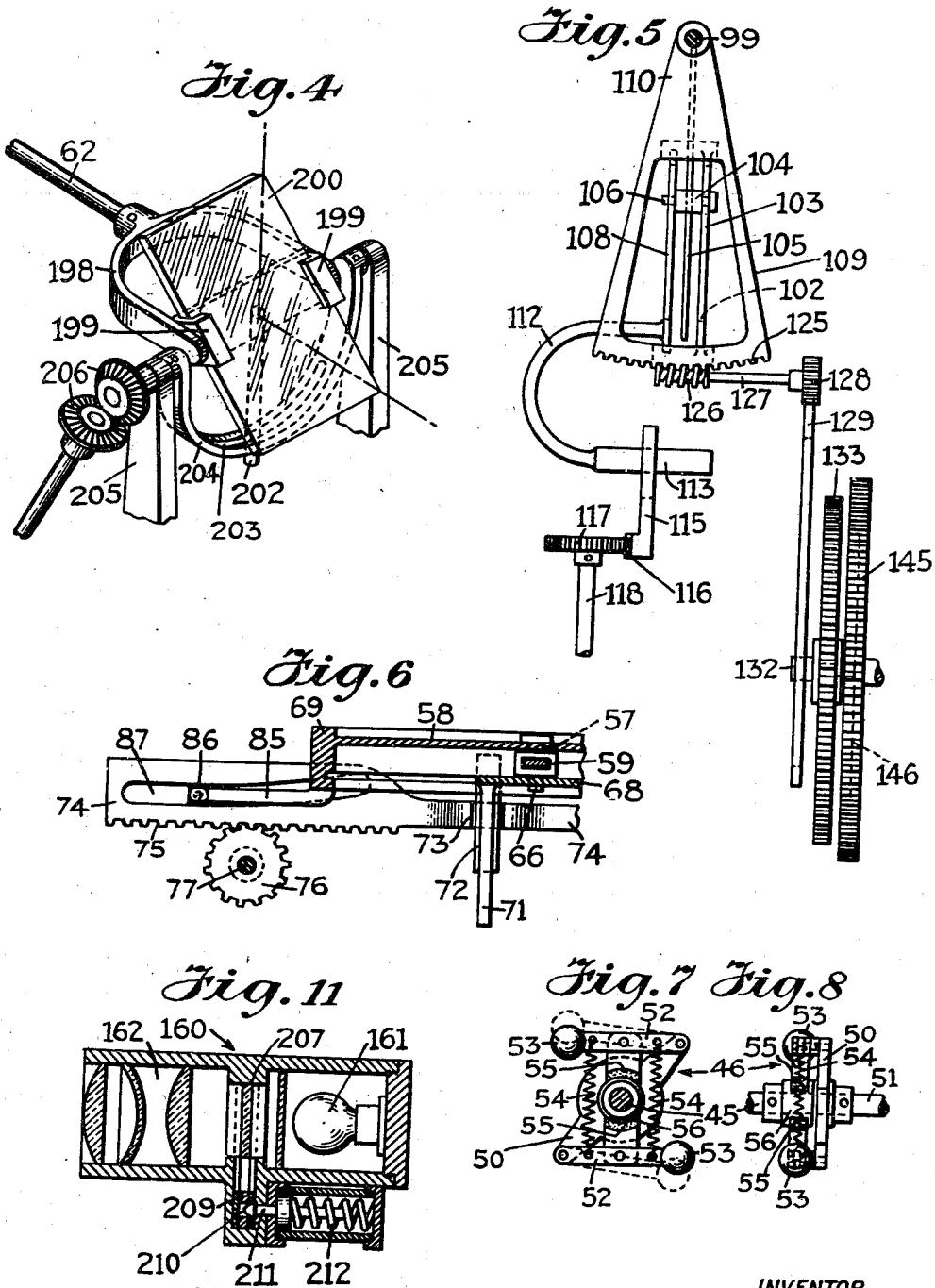
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COMPUTING GUN SIGHT

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Fig. 9

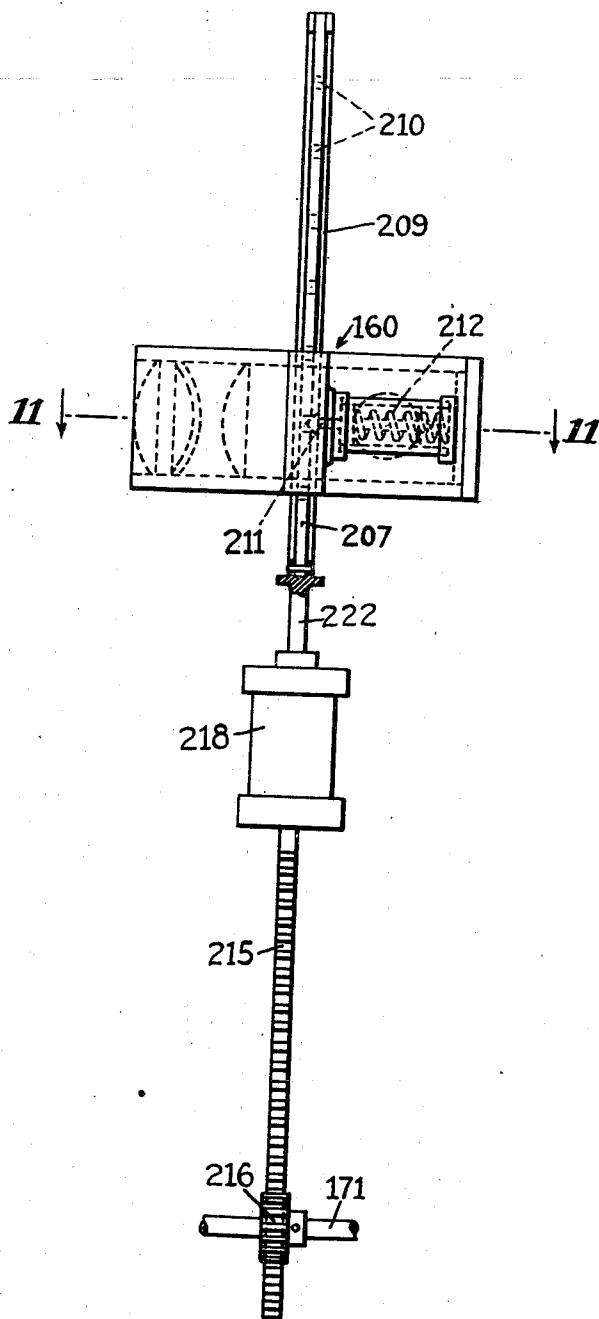
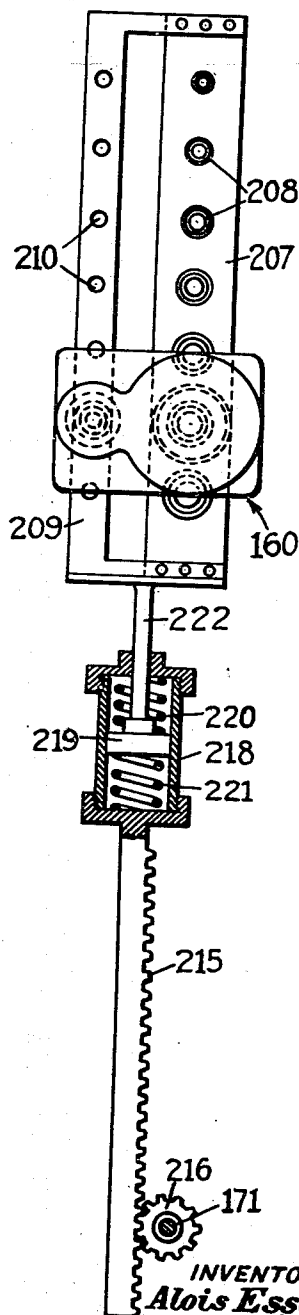


Fig. 10



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COMPUTING GUN SIGHT

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14 Claims. (Cl. 235—61.5)

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This invention relates to computing sights for land based light artillery such as anti-aircraft or anti-tank guns, and has for an object to provide an improved mechanism for automatically computing the reflection in train and in elevation and setting this deflection into the sight.

In accordance with the present invention the movement in train measured in the horizontal plane is converted to movements in train and rate of train in the slant plane which rate is combined with a range setting to compute and set the proper deflection into the sight. The rates are measured by magnetic drag devices having rotors driven at speeds proportional to the respective rates of train and elevation to develop torques which cause deflection of spring biased shafts carrying mirrors forming a part of the optical system. The effects of the springs are varied in accordance with range so that the deflections are functions of the respective rates and of range. Provision is also made to compensate for drift and to introduce super-elevation which are functions of range.

The mechanism for converting train movement in the horizontal plane into train movement in the slant plane includes a differential having one input element driven by train movement in the horizontal plane (Bg) and having a second input element driven by the train movement in the horizontal plane (Bg) modified by a function of elevation (Eg) represented by the formula $(\cos Eg - 1)$ so that the output of the differential represents $Bg + Bg(\cos Eg - 1)$ which is the formula for train movement in the slant plane.

Although the novel features which are characteristic of this invention are pointed out more fully in the claims the nature of the invention will be better understood by referring to the following description taken in connection with the accompanying drawings in which certain specific embodiments have been set forth for purpose of illustration.

In the drawings:

Fig. 1 is an elevation of light artillery piece showing the present sight and computing mechanism connected thereto;

Fig. 2 is a diagrammatic view of the computing mechanisms;

Fig. 3 is a diagrammatic view of a computing mechanism illustrating a further embodiment of the invention;

Fig. 4 is a detail view of the mirror and control mechanism therefor of Fig. 3;

Fig. 5 is an end elevation of the elevation range

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yoke, and super-elevation computing mechanisms of Fig. 2;

Fig. 6 is a horizontal section taken along the lines 6—6 of Fig. 2 showing the train range yoke and drift cam;

Fig. 7 is a transverse section taken along the lines 7—7 of Fig. 2 showing the centrifugal release clutch;

Fig. 8 is a side elevation of the centrifugal release clutch;

Fig. 9 is an enlarged end elevation of the range finder shown in Fig. 3;

Fig. 10 is a side elevation thereof; and

Fig. 11 is a section taken on the lines 11—11 of Fig. 9.

Referring to the drawings more in detail, the invention is shown in Fig. 1 as applied to a gun 1 mounted for movement in elevation on trunnions 2 supported in pedestal 3. The pedestal 3 is mounted on a track 4 for movement in train on a stationary base 5 carrying a gear 6. A box 10 containing the computing mechanism and carrying a sighting glass 11 is mounted for movement with the gun 1.

Movement in train is fed into the computing mechanism in the box by means of a pinion 12 carried on a bracket 13 attached to the pedestal 3 and meshing with the stationary gear 6. The pinion 12 is connected by a flexible shaft 14 to the train input shaft 15 of the computing mechanism.

Movement in elevation is fed into the computing mechanism by a pinion 16 engaging an elevation segment 17 mounted on the pedestal 3. The pinion 16 drives a flexible shaft 18 which drives the elevation shaft 19 of the computer.

Referring to Fig. 2, the train shaft 15 is shown as carrying a worm 21 and a spur gear 22 and as driving one side of a differential 23. The worm 21 drives a worm gear 24 carrying or having associated therewith a train dial 25 which indicates the position in train of the pedestal.

The second input of the differential 23 is driven through bevel gears 26 from a roller 27 which is driven by balls 28 from a disc 29 mounted on a gear 30 meshing with the gear 22. The balls 28 are mounted in a ball carriage 31, the position of which is controlled by a link 32 actuated by a cam slot 33 formed on a disc 34, the arrangement being such that the rotation of the roller 27 is dependent upon both the rotation of the disc 29 and the radial position of the balls 28 with respect to said disc.

The disc 34 constitutes an elevation disc which

is driven by teeth 36 meshing with a pinion 37, the latter being driven through a gear train including beveled gears 38, shaft 39, beveled gears 40, shaft 41 and beveled gears 42 from the elevation shaft 19. The position of the disc 34 thus represents the elevation of the gun (Eg). The cam slot 33 on the elevation disc 34 is designed to impart a movement to the link 32 represented by the formula $(\cos Eg - 1)$.

The output of the differential 23 drives a shaft 45 which carries a centrifugal clutch 46, shown more in details in Figs. 7 and 8. The clutch 46 comprises a carrier 50 attached to a driven shaft 51 and carrying pivoted arms 52 having weights 53 and held inwardly by springs 54. The arms 52 carry friction members 55 which engage a drum 56 mounted on the shaft 45, the arrangement being such that the shaft 51 is normally driven through the friction engagement of the members 55 with the drum 56, but is released due to the centrifugal force of the weights 53 when a predetermined speed is exceeded.

The shaft 51 drives the outer element of a magnetic drag 60 of the type which develops a torque in a rotor or inner element proportional to the speed of rotation of the outer element. If a magnetic drag of this type is driven at too high a speed it loses its magnetism. The centrifugal clutch 46 is designed to prevent this predetermined speed from being exceeded. The rotor of the magnetic drag is connected to a deflection shaft 62 carrying a mirror 63 which forms a part of the optical system and is inclined to the axis of rotation of the shaft 62 for the purpose to be described.

The rotation of the shaft 62 in response to the torque developed by the magnetic drag is controlled by a flat spring 65 which is attached to the shaft 62. The effective length of the spring 65 is controlled by the distance of a clip or sliding block 59 from the shaft 62. The block 59 is guided by a slot 57 in a plate 58 forming part of frame 69. A pin 66 extending from the block 59 extends into a cam slot 67 formed in a slide 68 mounted in the frame 69. The frame 69 is loosely journaled on the shaft 62 by means of brackets 70. The clip or block 59 extends around the spring 65 and its distance from shaft 62 is controlled by the cam slot 67 in the slide 68.

The slide 68 carries a downwardly extending bracket 71 having a transverse arm 72 (Fig. 6) which is adapted to slide transversely in a slot 73 formed in a slide 74. The slide 74 is provided with a rack 75 driven by a pinion 76 carried on a shaft 77 which is positioned through bevel gears 78 from a range shaft 79 having suitable range setting means shown as a manual handle 80. The slide 74 is mounted by suitable means, not shown, for sliding movement in a longitudinal direction in response to operation of the range shaft, and is shown as provided with a range scale.

The frame 69 also carries an arm 85 having on its end a pin 86 which engages a cam slot 87 (Fig. 6) formed in the slide 74. The cam slot 87 causes the frame 69, to swing about the shaft 62 and is shaped to introduce a movement corresponding to the drift at the various ranges.

The elevation shaft 19 carries a worm 90 driving a worm gear 91 having attached thereto or associated therewith an elevation dial to indicate the position of the gun in elevation. The elevation shaft 19 also drives, through bevel gears 92, shaft 93 and bevel gears 94, a shaft 95 driving a shaft 97 through a centrifugal clutch 96,

similar to the clutch 46 above described. The shaft 97 drives the outer element of a magnetic drag device 98 which is similar to the magnetic drag device 60 and is adapted to produce a torque on the inner element dependent upon the speed of rotation of the outer element. The magnetic drag device operates a deflection shaft 99 which, through beveled gears 100 controls the angular position of a mirror 101 forming part of the optical system.

The rotation of the shaft 99 in response to a given torque is controlled by a flat spring 105 attached to the shaft 99. The effective length of the spring 105 is controlled by the distance of a sliding block 104 from the shaft 99. The block 104 is guided by a slot 102 in a plate 103 forming part of a frame 109. A pin 106 extending from the block 104 extends into a cam slot 107 formed in a slide 108 mounted in the frame 109. The frame 109 is loosely journaled on the shaft 99 by brackets 110. The block 104 extends around the spring 105 and its distance from shaft 99 is controlled by the cam slot 107 in the slide 108.

The slide 108 carries a bracket 112 having an arm 113 adapted to slide transversely in a slot 114 formed in a slide 115. The slide 115 is provided with a rack 116 meshing with a pinion 117 carried by a shaft 118 which is driven through bevel gears 119 from the range shaft 79.

The frame 109 is swung about the shaft 99 to introduce a vertical deflection corresponding to super-elevation by means of a segmental gear 125 (Fig. 5) driven by a worm 126 mounted on a shaft 127 having a pinion 128 driven by a rack 129 (Figs. 2 and 5) on an L-shaped arm 130. The arm 130 is provided with a slot 131 receiving a pin 132 which is adjustable in a radial slot 134 in a super-elevation disc 133.

The disc 133 is driven by a pinion 150 and bevel gear 151 from a shaft 152 driven through bevel gears 153 from the elevation shaft 19.

The pin is adjusted radially in the slot 134 by means of a disc 145 having a spiral groove 146 which engages said pin. The disc 145 is driven through a gear train including pinion 135, bevel gears 136, shaft 137, bevel gears 138, shaft 139 and bevel gears 140 from the housing of a differential 141, one side of which is connected to the range shaft 79. The disc 145 is also turned with the disc 133 from the elevation shaft 19 by means of a shaft 155 connected to the second side of the differential 141 and having a bevel gear 156 meshing with a bevel gear 157 on the shaft 152.

The optical system comprises a collimator 160 having a light source 161 and a lens system 162, which projects rays upon the mirror 63. The mirror 63 is mounted to reflect these rays onto the mirror 101 which reflects the rays onto sighting glass 11 which is partially silvered to reflect light rays received from mirror 101, but is sufficiently transparent to permit the target T to be viewed therethrough.

In the operation of this form of the invention, the range, which is determined in any desired manner as by means of a range finder, is manually set into the shaft 79 by means of the handle 80. The gun is then moved in train and in elevation to bring the target T into the center of the light spot formed by the light rays projected onto the sighting glass 11 by the collimator 160. This movement in train and in elevation operates the train shaft 15 and the elevation shaft 19 respectively which set the corresponding values into the computing mechanism. Movement of the train shaft 15 drives the magnetic device 60

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through the differential 23 and the centrifugal clutch 46 and thereby produces a torque which causes a rotational movement of the shaft 62 proportional to the rate of movement of the train shaft 15 or to the rate of train of the gun in the horizontal plane (dBg).

If, in addition, the gun is elevated above or below the horizontal plane by an amount Eg supplemental movement is introduced into the shaft 45 by the roller 27 and differential 23 as follows: As elevation disc 34 is driven by the elevation shaft 19 by an amount representing Eg , the cam slot 33 causes a movement of the ball carriage 31 to a position representing $(\cos Eg - 1)$. Inasmuch as the disc 29 is actuated by the train shaft 15, the movement of this disc corresponds to movement in train (Bg) of the gun and the movements transferred through the balls 28 to the roller 27 represents $Bg(\cos Eg - 1)$. This movement of the roller 27 is combined by the differential 23 with the movement of the shaft 15 corresponding to Bg so that the resultant movement of shaft 45 represents $Bg + Bg(\cos Eg - 1)$ and the rate of movement of shaft 45 corresponds to the rate of train movement of the gun in the slant plane (dBs). The torque applied to the shaft 62 accordingly corresponds to dBs .

The rotation of the shaft 62 produced by this torque is controlled in accordance with the time of flight by varying the effective length of the spring 65 as follows. Longitudinal movement of the slide 74 caused by movement of the range shaft 79 shifts the slide 68 along the frame 69. The cam slot 67 thus shifts pin 66 and the block 59 along the spring 65 to vary its effective length. The cam slot 67 is designed to modify the action of the spring 65 so that the resultant rotational position taken by the shaft 62 represents the computed deflection in train in the slant plane ($TdBs$).

Drift which is also a function of range, is introduced by the cam slot 87 (Fig. 6) of the slide 74 which causes pivotal movement of the frame 69 to shift the position of the spring 63 and thereby modifies the rotational deflection of the shaft 62 to correct for drift. Hence, the position taken by the shaft 62 represents total computed deflection in the slant plane between the line of sight and the gun. This movement of the shaft 62 and of the mirror 63 shifts the direction of the light rays reflected from the sighting glass 11 by a corresponding amount.

The deflection in elevation is applied by means of the mirror 101 in a similar manner as follows: The elevation movement applied to the elevation shaft 19 is converted by the magnetic drag 98 to a torque on the shaft 99 which is proportional to the rate of elevation movement and represents dE . The time of flight is introduced as in the case of the shaft 62, by movement of the pin 106 along the spring 105 due to cam slot 107 as the slide 108 is shifted by means of the rack 116 which is driven by the range shaft 79. The arrangement is such that the rotating deflection of the shaft 99 represents TdE .

Super-elevation, which is a function of both elevation and range is introduced from the disc 133 which is driven by the elevation shaft 19 through the shaft 152 and pinion 150. The pin 132 is positioned radially of the disc 133 by means of the spiral groove 146 in the disc 145, which is adjusted from the range shaft 79 through the differential 141, shafts 139 and 137 and pinion 135. These elements are so designed that

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movement of the rack 129 produced by the pin 132 when the slot 134 is parallel to the rack 129 represents the super-elevation, for zero elevation of the gun. As the elevation (Eg) of the gun departs from zero the movement imparted to rack 129 for a given range is decreased in proportion to the cosine of the elevation of the gun (Eg). This movement of the rack 129 drives the shaft 127 and worm 126 Fig. 5 and causes the frame 109 to swing about the shaft 99 to modify the rotational deflection of the shaft 99 so that its resultant position corresponds to the computed deflection in elevation plus the required super-elevation.

The shaft 99 tilts the mirror 101 and shifts the direction of the light rays reflected from the sighting glass 11 vertically by an amount corresponding to the computed total deflection in elevation.

The shifting of the direction of the light rays reflected from the sighting glass 11 automatically introduces the computed deflection between the gun and the target as the operator maintains the target in the center of the light spot established in his eye by the reflected rays.

In the embodiment shown in Fig. 3, the mechanism is similar to that above described except that a single adjustable mirror is utilized in place of the two mirrors 63 and 101 of Fig. 2 and that a range finder is incorporated in the collimator. In this embodiment the elements producing the rotational deflection of the shaft 62 representing $TdBs$ are similar to those above described and have been given the same reference characters. Likewise, the elements producing the rotational deflection of the shaft 99 corresponding to TdE are similar to those above described except that the shaft 95 of Fig. 3 is driven by bevel gears 170 directly from the elevation shaft 19. The range shaft 79 of Fig. 3 is driven from the range handle 80 through the shaft 171, bevel gears 172, shaft 173 and bevel gears 174. The shaft 171 carries the pinion 117 which actuates the rack 116 as set forth in connection with Fig. 2.

The super-elevation rack 129 of Fig. 3 corresponds to the rack 129 of Fig. 2. This rack 129 drives a pinion 128 which actuates the worm 126 meshing with a segmental gear 125 attached to the frame 109, to cause the frame to swing about the shaft 99 by an amount suited to introduce the required super-elevation. In the embodiment of Fig. 3 the frame 109 is provided with an arm 190 having an arcuate rack 191 which actuates a pinion 192 carried on a shaft 193 provided with a bevel pinion 194 which meshes with a segment 195 of a bevel gear attached to the frame 69 and causes the frame 69 to swing about the shaft 62 an amount proportional to the movement of the frame 109. The adjustments for drift and super-elevation which are approximately proportional, are thus both taken from the rack 129.

In Fig. 3 the shaft 62 carries a U-shaped bracket 198 (Fig. 4) to which is pivoted a frame 199 carrying a mirror 200. The frame 199 carries a pin which slides in a slot 203 in an arcuate bail 204, mounted for pivotal movement about a horizontal axis in brackets 205 and actuated by bevel gears 206 from the shaft 99.

The arrangement is such that movement of the shaft 62 causes the mirror 200 to turn about the axis of shaft 62 for deflecting the projected light rays in train, and movement of the shaft 99 causes the mirror to pivot about its trans-

verse axis for deflecting the projected light rays in elevation.

The range finder mechanism of Fig. 3 is of the steadier type and comprises a sliding plate 207 (Figs. 3, 9, 10 and 11) having a plurality of sets of rings 208 marked therein. The sliding plate 207 is mounted in the collimator 160 in a position to project the light rays from the rings 208 onto the sighting glass 11. The plate 207 may be made of non-transparent material having openings therein in which are inserted transparent material on which the rings 208 are marked or the plate 207 may be made of transparent material, in which event the areas surrounding the rings 208 may be rendered non-transparent if desired.

It will be noted that three rings are shown in each set 208. These rings are of different diameters to be used according to the size of the target, as for sighting on small, medium, or large sized planes.

The plate 207 is mounted on a frame including a slide 209 having a plurality of recesses 210 formed therein which are engaged by a pin 211 (Fig. 11) having a rounded or cone shaped end suited to engage and position the slide 209 so that the selected rings 208 register with the collimator. The pin 211 is held in engagement with the recesses 210 by means of a spring 212. The slide 209 and plate 207 slide in a suitable channel formed in the collimator 160.

For converting the continuous movement of the shaft 171 into step by step movement of the plate 207 there is provided a rack 215 engaging a pinion 216 on shaft 171 and carrying a cylinder 218 in which a plunger 219 is seated between springs 220 and 221. The plunger 219 is attached to a rod 222 which is secured to the slide 209, the arrangement being such that the springs 220 and 221 hold the plunger 219 in a central position of the cylinder 218 until the pin 211 engages one of the recesses 210 to position one of the sets of rings 208 in the center of the path of the collimator rays. The slide 209 is held in this position until sufficient force has been built up by compression of one of the springs 220 or 221, to overcome the holding force of the pin 211 and move the slide 209 until the pin 211 engages the next recess 210. Hence, one set of rings 208 is always presented in the path of the collimator rays.

The operator adjusts the range handle 80 of Fig. 3 until the size of the selected ring which is projected by the collimator onto the sighting glass 11 just encompasses the target. The setting of the range shaft 171 then corresponds to the approximate range of the target.

The operation of the system shown in Fig. 3 is similar to that described in Fig. 2 except that the operator, in addition to training and elevating the gun so as to keep the target in the center of the light spot formed in his eye by the light rays reflected from the sighting glass 11, actuates the range handle 80 so as to cause the collimator to project on sighting glass 11 and thence to his eye, a ring which corresponds in size with the apparent size of the target. This adjustment of the shaft actuates the racks 75 and 116 as described in connection with Fig. 2.

It will be noted in the above described computing mechanism that movement in train in the horizontal plane is converted automatically into the movement in the slant plane which represents the true rate of train of the tar-

get. This latter quantity is used for computing the deflection.

The mechanism is comparatively simple and is especially suited for use with land based light artillery or machine guns.

Although certain specific embodiments of the invention have been set forth for purpose of illustration, it is to be understood that the invention is capable of various adaptations and uses as will be apparent to a person skilled in the art. The invention is only to be restricted in accordance with the following claims.

I claim:

1. A mechanism for computing the deflection of a line of sight with respect to a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train (dBg) and the rate of elevation (dE), variable ratio mechanism having an input driven by the movement of said train shaft, having a ratio control member driven by said elevation shaft and having an output shaft driven at a rate representing the rate of train in the slant plane (dBs), a drag device having an input driven by said last shaft and adapted to produce a torque proportional to the rate of movement of said shaft, a spring biased shaft connected to be actuated in response to said torque, and means for varying the spring bias of said last shaft as a function of range so that the deflection of said shaft represents the computed deflection in train.

2. A mechanism for computing the deflection of a line of sight with respect to a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train (dBg) and the rate of elevation (dE), variable ratio mechanism having an input driven by the movement of said train shaft, having a ratio control member driven by said elevation shaft and having an output shaft driven at a rate representing the rate of train in the slant plane (dBs), a drag device having an input driven by said last shaft and adapted to produce a torque proportional to the rate of movement of said shaft, a spring biased shaft connected to be actuated in response to said torque, means for varying the spring bias of said last shaft as a function of range so that the deflection of said shaft represents the computed deflection in train, and means actuated as a function of range to produce an additional movement in said spring biased shaft to compensate for drift of the projectile.

3. A mechanism for computing the deflection of a line of sight with respect to a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train (dBg) and the rate of elevation (dE), a differential having an input driven by said train shaft, a variable ratio mechanism having an input driven by said train shaft and a ratio control member driven by said elevation shaft as a function of elevation represented by the formula $(\cos E_g - 1)$, means connecting the output of said variable ratio mechanism to drive a second input of said differential, a shaft driven by the output of said differential, and said last shaft having a rate representing rate of

train in the slant plane, a drag device having an input driven by said last shaft and operable to produce a torque proportional to the rate of movement of said last shaft, a device having a spring biased element and means responsive to said torque to deflect said element by an amount representing the computed deflection.

4. A mechanism for computing the deflection of a line of sight with respect to a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train (dBg) and the rate of elevation (dE), a differential having an input driven by said train shaft, a variable ratio mechanism having an input driven by said train shaft and a ratio control member driven by said elevation shaft as a function of elevation represented by the formula $(\cos Eg - 1)$, means connecting the output of said variable ratio mechanism to drive a second input of said differential, a shaft driven by the output of said differential, said last shaft having a rate representing rate of train in the slant plane, a drag device having an input driven by said last shaft and operable to produce a torque proportional to the rate of movement of said last shaft, a device having a spring biased element, and means responsive to said torque to deflect said element by an amount representing the computed deflection, said last device including means for adjusting the spring bias in accordance with range.

5. A mechanism for computing the deflection of a line of sight with respect to a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rates of train (dBg) and the rate of elevation (dE), a differential having an input element driven by said train shaft, a disc driven by said train shaft, a roller parallel to said disc for driving the second input of said differential, adjustable driving means inter-connecting said disc and roller for driving said roller in response to rotation of said disc, cam means driven by said elevation shaft to shift said driving means radially of said disc in accordance with a function of the movement of said elevation shaft represented by the formula $(\cos Eg - 1)$ so that the output of said differential represents $Bg + Bg(\cos Eg - 1)$, a shaft driven by the output of said differential, a deflection element, means for displacing said deflection element in accordance with the rate of said last shaft, spring means to control the deflection of said last element, and means for varying the effect of the spring means in accordance with the range, whereby the angular position of said deflection element represents the computed deflection in train.

6. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring and means responsive to movement of said range shaft to adjust said block longitudinally of said spring for varying the effective length of the spring whereby the resultant movement of said element due to the

applied torque represents a function of the rate of train and range and is a measure of the corresponding deflection in train of the line of sight.

7. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring, a sliding member having a cam slot engaging a cam follower on said block and adapted to move said block longitudinally of said spring for varying the effective length of said spring, and means responsive to movement of said range shaft for actuating said sliding member.

8. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring, a sliding member having a cam slot engaging a cam follower on said block and adapted to move said block longitudinally of said spring for varying the effective length of said spring, means responsive to movement of said range shaft for actuating said sliding member, a frame carrying said sliding member and pivoted for movement about the axis of said deflection element, and a cam member driven by said range shaft and adapted to swing said frame to modify the position of said deflection element, said last cam member being adapted to swing said frame an amount representing the drift of the projectile corresponding to the setting of the range input shaft.

9. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring, a frame pivoted for movement about the axis of said deflection element, a slide carried by said frame and movable axially of said deflection element, said slide having a slot engaging said block to adjust the same for varying the effective length of said spring, a rack driven by said range shaft, and means connected to said rack to drive said slide, whereby the angular position of said deflection element is a function of both rate of train and range and represents the corresponding deflection in train.

10. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring, a frame pivoted

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for movement about the axis of said deflection element, a slide carried by said frame and movable axially of said deflection element, said slide having a slot engaging said block to adjust the same for varying the effective length of said spring, a rack driven by said range shaft, means connected to said rack to drive said slide, whereby the angular position of said deflection element is a function of both rate of train and range and represents the corresponding deflection in train, and cam means actuated by said rack to modify the angular position of said frame about the axis of said deflection element, said last cam means introducing a correction representing drift.

11. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft and a train input shaft, a deflection element, means responsive to the rate of movement of said train input shaft to apply a torque to said deflection element, means for opposing the torque applied to said deflection element including a spring secured to and extending from said element, an adjustable block positioning the outer end of said spring, a frame pivoted for movement about the axis of said deflection element, a slide carried by said frame and movable axially of said deflection element, said slide having a slot engaging said block to adjust the same for varying the effective length of said spring, a rack driven by said range shaft, means connected to said rack to drive said slide, whereby the angular position of said deflection element is a function of both rate of train and range and represents the corresponding deflection in train, means for shifting said frame to modify the angular position of said deflection element, a mechanism having inputs settable in accordance with elevation and by the range input shaft respectively and having an output representing super-elevation, and means for actuating said last means proportionally from said output to introduce a correction representing drift.

12. A mechanism for computing the deflection between the line of sight and a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train and the rate of elevation, a range shaft to be adjusted in accordance with range, a train deflection element and an elevation deflection element, means for applying torques to said elements proportional to the rates of train and elevation respectively of said train and elevation shafts, means for opposing the torques applied to said elements comprising springs secured to and extending from said elements respectively, blocks adjustably engaging said springs for controlling the effective length thereof, slides having cam slots engaging follower pins secured to said blocks to shift the blocks longitudinally of said springs, and drive means actuated by said range shaft to control the posi-

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tion of said slides whereby the positions of said deflection elements represent functions of the respective rates and of range.

13. A mechanism for computing the deflection between the line of sight and a gun mounted for movement in train and in elevation, comprising a train shaft driven by movement of said gun in train and an elevation shaft driven by movement of said gun in elevation at rates respectively representing the rate of train and the rate of elevation, a range shaft to be adjusted in accordance with range, a train deflection element and an elevation deflection element, means for applying torques to said elements proportional to the rates of train and elevation respectively of said train and elevation shafts, means for opposing the torques applied to said elements comprising springs secured to and extending from said elements respectively, blocks adjustably engaging said springs for controlling the effective length thereof, slides having cam slots engaging follower pins secured to said blocks to shift the blocks longitudinally of said springs, drive means actuated by said range shaft to control the position of said slides whereby the positions of said deflection elements represent functions of the respective rates and of range, frames carrying said slides and mounted for pivotal movement about the axis of the respective deflection members, a mechanism having inputs driven by said elevation shaft and said range shaft respectively and having an output representing super-elevation, and means connecting said output to effect pivotal movement of both of said frames for adjusting the elevation deflection element in accordance with super-elevation and for adjusting said train deflection element in accordance with drift.

14. A mechanism for computing the deflection between the line of sight and a gun, comprising a range input shaft, a second input shaft representing the angular movement of the gun, a deflection element, means responsive to the rate of movement of the second input shaft to apply a torque to the deflection element, means to oppose the torque applied to the deflection element, and means controlled by the range input shaft to adjust the torque opposing means.

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