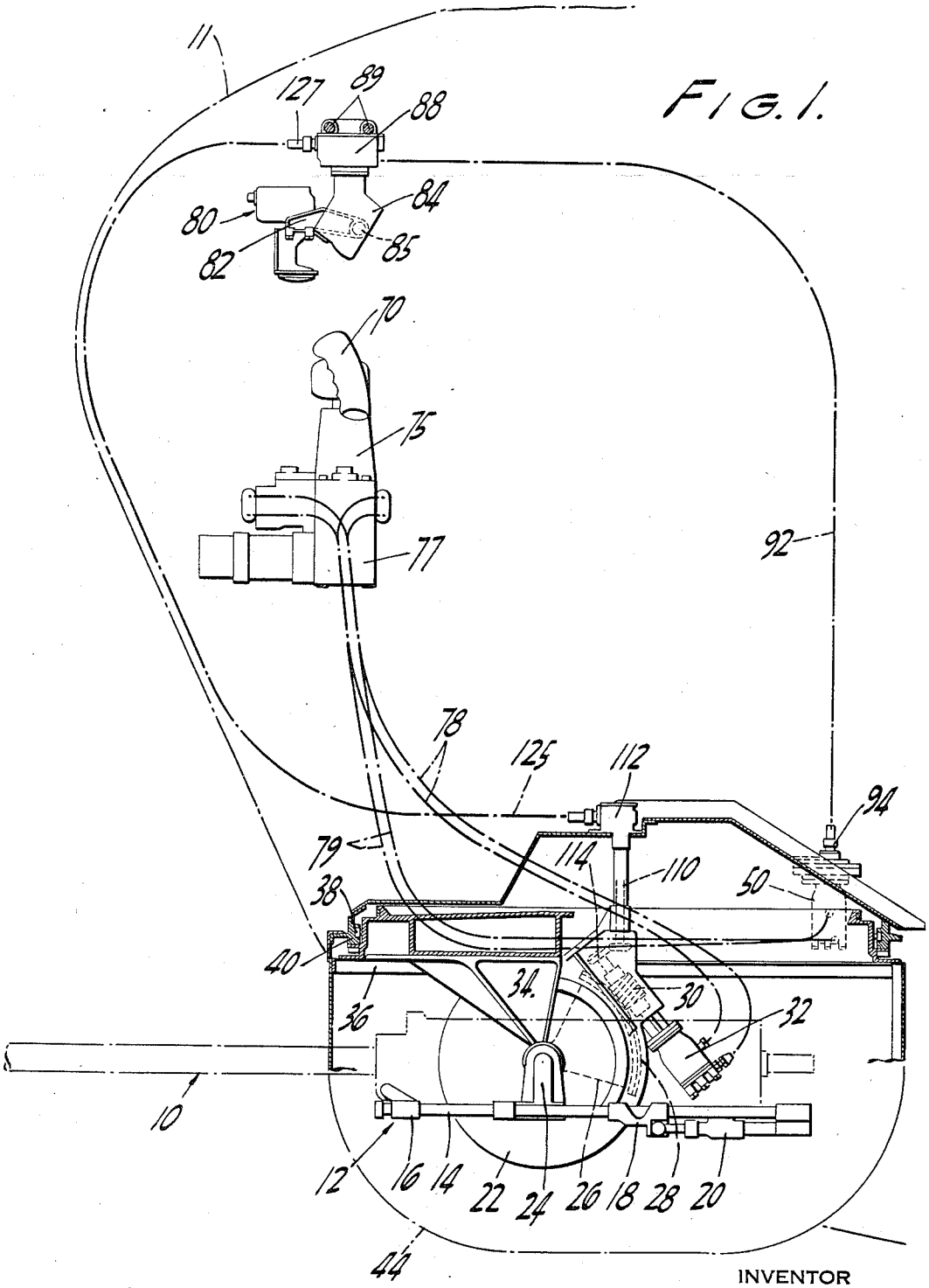
Nov. 6, 1945. J. C. TROTTER 2,388,509

ORDNANCE

Filed May 19, 1943 4 Sheets-Sheet 1

FIG. 1.



INVENTOR

JOHN C. TROTTER

BY

Bean, Brooks, Buckley & Bean.

ATTORNEYS

Nov. 6, 1945. J. C. TROTTER 2,388,509

ORDNANCE

Filed May 19, 1943 4 Sheets-Sheet 2

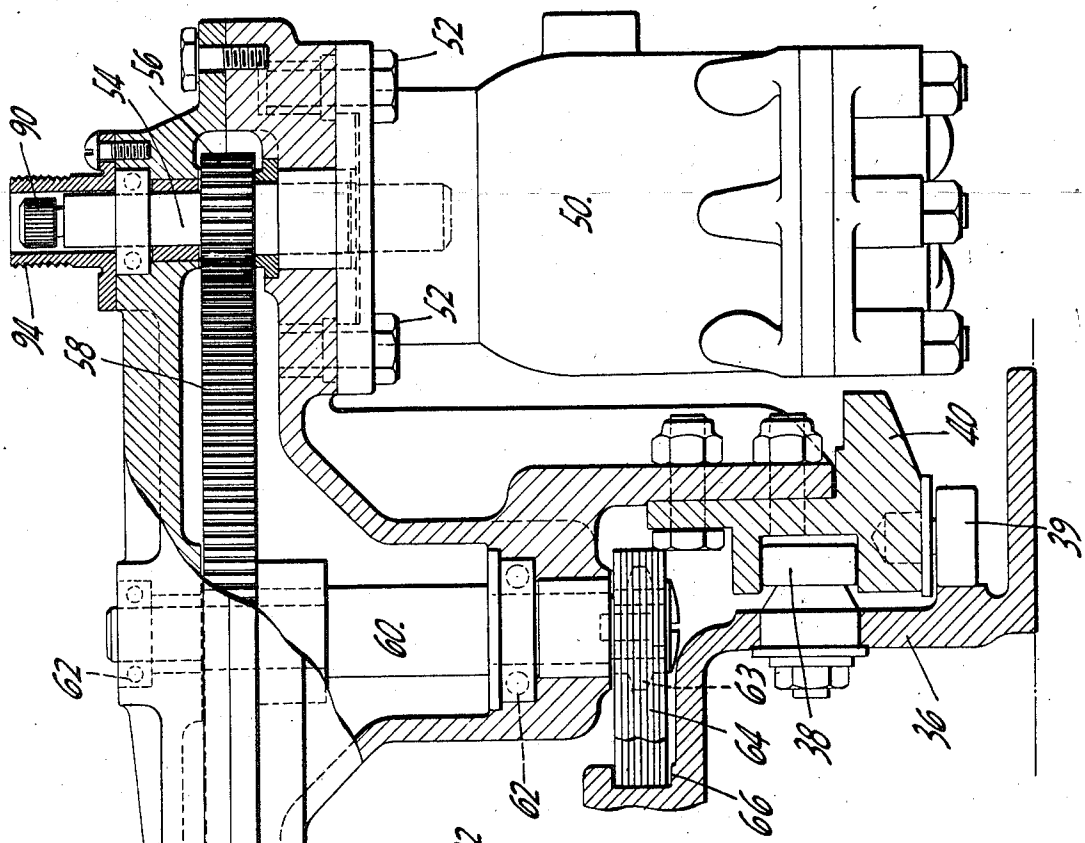


FIG. 3.

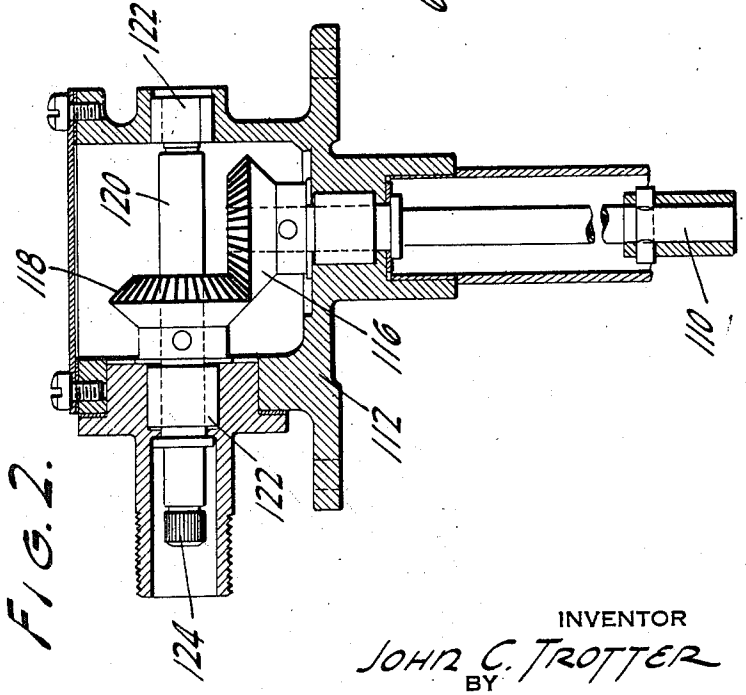


FIG. 2.

INVENTOR
JOHN C. TROTTER
BY
Bean, Brooks, Buckley & Bean
ATTORNEYS

Nov. 6, 1945. J. C. TROTTER 2,388,509

ORDNANCE

Filed May 19, 1943 4 Sheets-Sheet 3

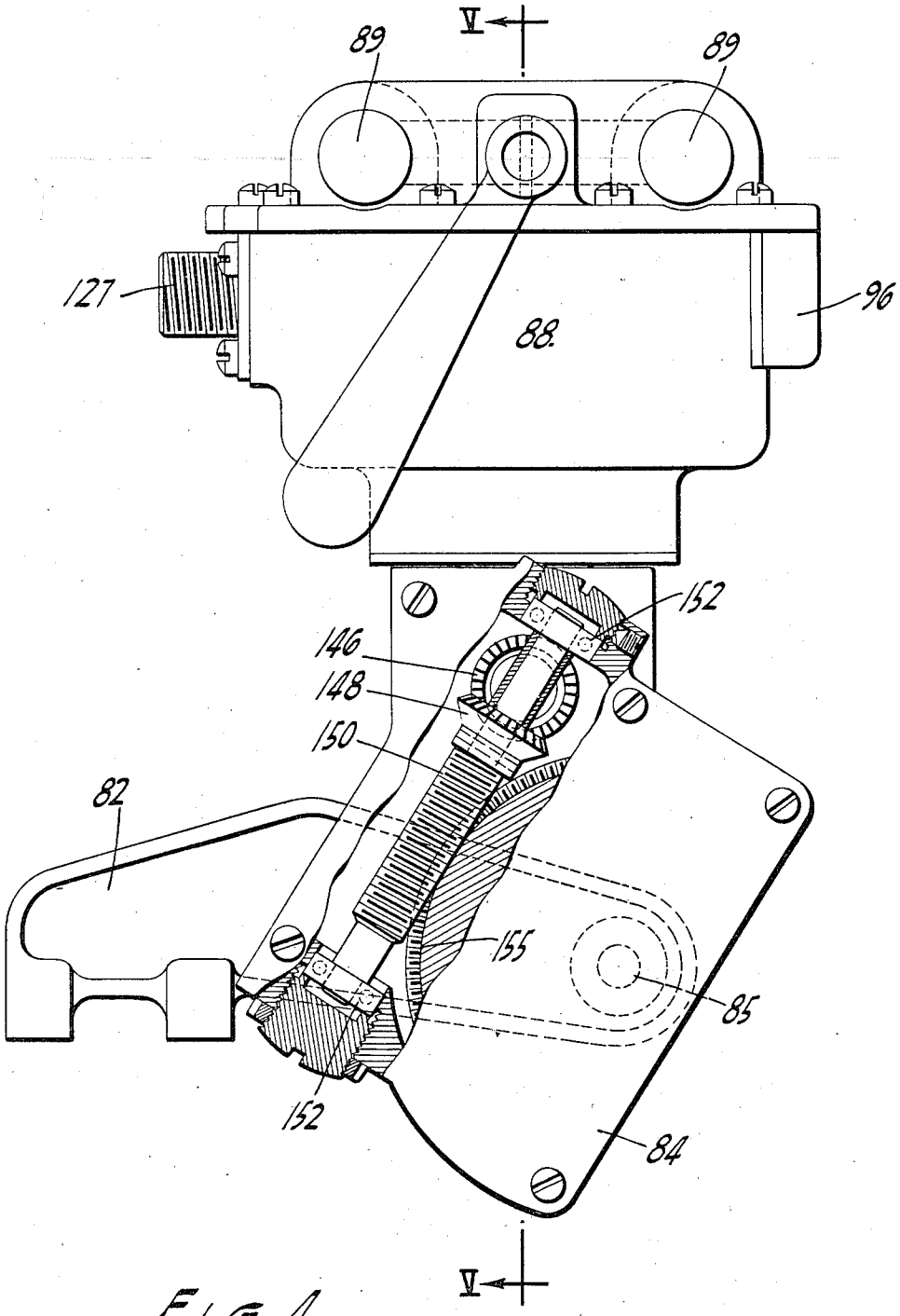


FIG. 4.

INVENTOR
JOHN C. TROTTER
BY
Bean, Brooks, Buckley & Bean.
ATTORNEYS

Nov. 6, 1945. J. C. TROTTER 2,388,509

ORDNANCE

Filed May 19, 1943 4 Sheets-Sheet 4

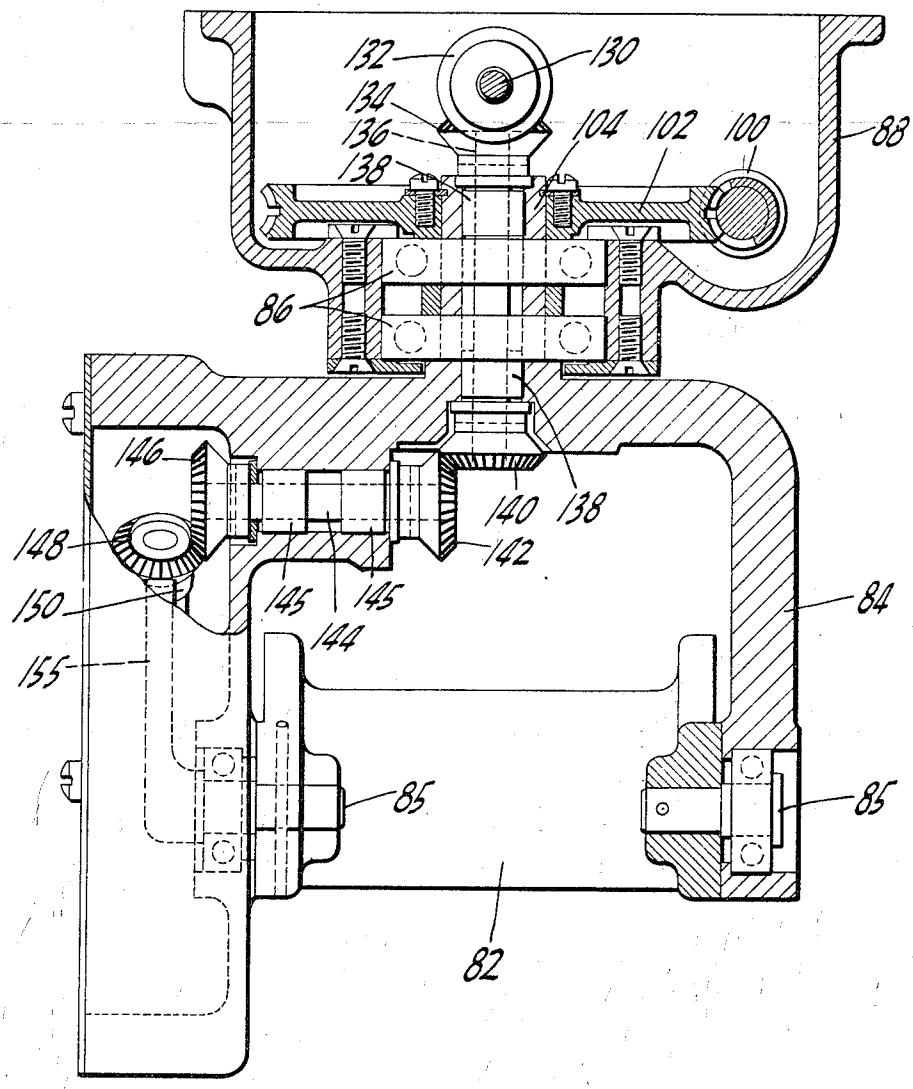


FIG. 5.

INVENTOR
JOHN C. TROTTER
BY
Beam, Brooks Buckley & Beam.
ATTORNEYS

Patented Nov. 6, 1945 2,388,509

UNITED STATES PATENT OFFICE

2,388,509

ORDNANCE

John C. Trotter, Williamsville, N. Y., assignor to Bell Aircraft Corporation, Buffalo, N. Y.

Application May 19, 1943, Serial No. 487,607

5 Claims. (Cl. 89—41)

This invention relates to ordnance, and more particularly to improvements in means for coordinating aiming movements of operably associated gun and gun sight devices.

It is an object of the present invention to provide an improved gun battery of the type wherein the gun mechanism is disposed remotely from the target sighting and gun aim control devices. Another object of the invention is to provide, in gun battery arrangements of the type referred to, improved means for coupling the gun aim adjusting means to the gun sight device in such manner as to provide perfect coordination of the movements thereof. A more specific object of the invention is to provide an improved gun and gun sight coupling mechanism including a force transmitting torque element and novel transmission means at the opposite ends thereof whereby torsional deflection effects within the torque drive member will be automatically so reduced as to provide no appreciable discordance of the gun and gun sight aiming movements. Other objects and advantages of the invention will appear from the specification hereinafter.

In the drawings:

Fig. 1 is a fragmentary elevation of a gun battery and aim control and gun sight arrangement of the invention, shown as being mounted upon an airplane;

Fig. 2 is a sectional view through an elevational aim adjustment coordinating mechanism portion thereof;

Fig. 3 is a sectional view through an azimuth aim adjustment coordinating mechanism portion thereof;

Fig. 4 is a view partly in elevation and partly in section of the gun sight mounting and aim coordinating mechanism thereof; and

Fig. 5 is a section taken substantially along line V—V of Fig. 4.

The invention is illustrated in the drawings in conjunction with a gun battery arrangement adapted to mount in side-by-side relation a pair of machine guns or cannon, or the like, as indicated at 10. The gun mount structure is shown as being mounted upon an airplane fuselage 11 and to comprise a frame indicated generally at 12 consisting of a system of parallel bearer tubes 14 at opposite sides of the guns and upon which the guns are mounted by means of slide brackets 16—18 to be longitudinally reciprocable in conjunction with recoil and counter-recoil operation thereof. Oleo-pneumatic shock absorbing and counter recoil devices are indicated at 20 as being operably connected between the gun carrying slide brackets and the mounting frame members for controlling the recoil and counter-recoil movements of the guns relative to the gun mount frame.

The gun mount frame is arranged to support the guns in parallel spaced apart relation, and a block 22 is disposed between the guns for support of the frame relative to the aircraft. A pair of arms 24 extend from corresponding inside portions of the gun mount frame into aligned pivotal connection with the block support 22, whereby it will be understood that the guns are mounted to be pivotal as a unit for elevational aim adjustment purposes about a horizontal axis extending centrally through the block 22.

One of the arm portions 24 is keyed to a sector 26 having a toothed peripheral portion 28 adapted to mesh with a worm gear 30 carried by the block support 22 and arranged to be driven by a hydraulic motor 32. Thus, it will be understood that operation of the motor 32 will drive the worm 30 to pivot the gun mount frame in either direction about the horizontal axis through the support for adjusting the elevational aim of the gun battery. The support 22 is carried by means of a bracket 34 extending from the base plate 36 of a rotatable turret device. The plate 36 is provided with vertically directed rollers 38 and horizontally directed rollers 39 at intervals about the perimeter thereof for rolling engagement upon an annularly grooved rail 40 (Figs. 1 and 3) extending from the stationary aircraft structure; whereby it will be understood that the turret frame is free to rotate relative to the aircraft about a vertical axis concentrically of the turret plate 36 and to carry as a unit therewith the gun mount frame for azimuth adjustments of the gun battery aim.

As indicated at 44, the turret may be enclosed by means of a shell of metal or transparent material or the like to protect the gun battery mechanism from the elements; and it will be understood that in such case the shell 44 will be slotted to permit the gun barrels to extend therethrough and to be adjusted vertically relative to the turret shell in connection with elevational aim adjustments of the battery. Empty cartridge case and ejected link chute means may be provided in any manner desired to carry the spent ammunition parts to a disposal port through the turret shell; and any suitable cartridge belt guide means may be employed to assist the cartridge belts training from positions within the aircraft fuselage to feed the guns.

A hydraulic motor as indicated at 50 is mount-

ed upon the turret support rail 40 by means of connectors 52 (Fig. 3). The motor 50 includes a drive shaft 54 to which is keyed a pinion 56 meshing with a spur gear 58 carried by a countershaft 60 supported upon the rail 40 by means of bearings 62—62. At its lower end the countershaft 60 carries a sprocket 63 meshing with a chain belt 64 which encircles a grooved portion 66 of the turret plate 36; and at a position on the turret plate which is normally diametrically opposed to the position of the motor 50 the chain belt 64 is fixed to the turret. Thus, it will be understood that operation of the motor 50 in either direction of rotation will cause the gun battery turret to be rotated in a corresponding direction for adjustments of the gun battery aim in azimuth.

To control the gun battery aim in elevation and in azimuth, a manually operable control handle or the like is indicated at 70 to be disposed within convenient reach of the gunner when seated or standing at his combat post. The control device 70 may be of any suitable character so as to be adapted to be pivoted or twisted or otherwise moved in one plane of adjustment for actuating a control valve mechanism such as indicated generally at 75 to control flow of fluid under pressure from a pump device as indicated at 77 through a pair of parallel conduits 78—78 for feeding the motor 32 which controls the elevational aim adjustments of the gun battery. Likewise, movement of the control member 70 in a transverse plane will be adapted to control the flow of fluid under pressure through a second pair of parallel conduits 79—79 for feeding fluid from the pump 77 to the motor 50, for controlling azimuth adjustments of the gun aim. For example, a suitable gun aim control and hydraulic pump and control valve mechanism corresponding to the units indicated generally at 70—75—77 has been disclosed in my earlier filed patent application Serial Number 474,106; but it will be understood that any other suitable type of control mechanism may be employed for the purpose of controlling the aim adjustments of the gun mount frame in accord with the concept of the present invention.

A gunner's target sight is indicated generally at 80 as being disposed within convenient range of the gunner's eyes when at combat post; and it will be understood that the sight mechanism 80 may be of any suitable type, and that the present invention does not relate to any specific type of sight device or the like. In any case the sight mechanism will be arranged to be carried by a mounting bracket as indicated at 82 (Figs. 1, 4, 5); the mount bracket 82 being adjustably mounted upon a frame 84 by means of aligned bearings 85—85 so that the sight is pivotable about a horizontal axis for elevational aim adjustments of the sight relative to the frame 84. In turn, the frame 84 is pivotally mounted by means of bearings 86—86 so as to be rotatable about a vertical axis relative to a frame mount base 88 which is adapted to be fixed to stationary supports 89—89 extending from the structure of the aircraft. Thus, the frame and sight mount bracket unit is adapted to rotate about a vertical axis for azimuth adjustments of the sight aim.

As illustrated in Fig. 3, the gun battery azimuth control motor shaft 54 is formed with a splined end portion 90 for geared connection to one end of a flexible torque shaft or cable or the like as designated generally at 92 (Fig. 1). The torque drive member will preferably be enclosed within armour in the form of a flexible woven wire casing, or the like, and the armour case may be connected at one end to the motor support frame by a threaded nipple connection as indicated at 94. At its other end, the torque drive member is led into the frame base 88 at a port 96 thereof, and is keyed into driving connection with a worm 100 (Fig. 5) which is rotatably supported upon the frame base or housing 88 by suitable bearings. The worm 100 meshes with a worm gear 102 which is keyed to a hub portion 104 of a gun sight carrying frame 84. Thus, it will be understood that whenever the gun battery azimuth control motor operates to adjust the gun battery aim in azimuth, the torque drive member 92 will be similarly driven at high velocities to actuate the worm gear mechanism 100—102 to rotate the gun sight carrying frame at decreased velocities about the vertical axis of movement thereof for corresponding adjustment of the gun sight aim in azimuth.

It is a particular feature of the mechanism of the invention, however, that the azimuth control motor 50 is geared to the gun mount frame through a speed reduction gear and chain drive system of high ratio type so as to provide a relatively great speed reduction between the motor 50 and the corresponding azimuth adjusting movement of the gun battery. Likewise, the gear mechanism 100—102 for procuring corresponding adjustments of the sight aim in azimuth is of high velocity ratio type, whereby it will be understood that the torque drive member 92 will rotate at speeds much greater than the speeds of the corresponding rotations of the gun mount frame and of the sight support frame. Consequently, in event the torque drive member 92 deflects torsionally because of elasticity qualities thereof, the amount of such deflection will in effect be subdivided in proportion to the gear ratios referred to before being translated into lag movements of the sight relative to the gun battery.

For example, a suitable gearing arrangement in accord with the concept of the present invention will provide that the torque drive member 92 will rotate at a speed ratio of the order of 200:1 relative to the speeds of the gun turret and the sight. That is, the torque drive member 92 will be caused to rotate say 200 times faster than the rate of the corresponding azimuth adjustment rotations of the gun battery and of the sight. Therefore, in event the torque drive member 92 becomes elastically deformed or deflected under the sight driving loads, the effects of such deflection would be divided by a factor of 200, and the gun sight movement lag would therefore be equivalent to only $\frac{1}{200}$ of the degree of deflection of the drive member 92. Thus, it will be appreciated that a gun battery and remote sight coordinating mechanism may be constructed in accord with the concept of the present invention so as to provide no appreciable lag of the sight movement in response to gun battery aim adjustments.

To drive the sight mount bracket to procure elevational aim adjustments of the gun sight in coordination with corresponding elevational aim adjustments of the gun mount frame, a counter shaft indicated at 110 (Figs. 1–2) is carried by fixed bracket structure as indicated at 112 and is arranged to be coupled to the gun mount frame elevational control worm 30, as by means of a bevel gear mechanism at 114 (Fig. 1). The counter shaft 110 is arranged to extend vertically

and coaxially of the axis of azimuth rotation of the gun mount turret. At its upper end the counter shaft 110 carries a bevel gear 116 (Fig. 2) meshing with a gear 118 carried by a shaft 120 which is rotatably supported by bearings 122—122 upon the bracket 112, whereby the shaft 120 extends horizontally and intersects the vertical axis of azimuth rotation of the gun mount frame. At its outer end the shaft 120 is provided with a spline connection device 124 for coupling to a second torque drive member indicated generally at 125 (Fig. 1); and it will be understood that the torque drive member 125 will be of the same type referred to hereinabove in connection with the torque drive device 92.

At its opposite end the torque drive device 125 extends through a coupling 127 into the interior of the sight mount base 88 to operatively connect with a horizontal shaft 130 (Fig. 5) carrying a bevel gear 132. The gear 132 meshes with a bevel gear 134 carried by a shaft 136 which mounts upon bearings 138—138 to be disposed vertically and to extend through the hub 104 of the gun sight carrying frame 84, whereby the driven shaft 136 is disposed coaxially of the axis of azimuth rotation of the sight carrying frame 84. At its lower end the shaft 136 carries a bevel gear 140 which meshes with a gear 142 carried by a counter shaft 144 disposed horizontally to have its axis of rotation intersecting the axis of azimuth rotation of the frame 84. Bearings 145—145 mount the counter shaft 144 upon the frame 84.

At its other end, the counter shaft 144 carries a bevel gear 146 which meshes with a gear 148 carried at one end of a worm 150. The worm 150 is rotatably supported upon the sight carrying frame 84 by means of bearings 152—152, and the worm 150 is so arranged as to lie tangent to and meshed with a toothed sector 155 carried by one of the sight mount support pins 85. The sector 155 is thus keyed to the sight mount bracket 82 to cause the latter to rotate about the horizontal axis of the aligned pins 85—85 in consonance with driving rotation of the torque drive member 125 in response to operation of the elevational adjustment motor 32. Again, it will be appreciated that because the motor 32 drives the gun mount frame to be elevationally adjusted through the high ratio worm gear mechanism 30—28, the torque drive member 125 is thereby arranged to rotate at greatly increased speed relative to the rate of rotation of the gun mount frame for elevational aim adjustment purposes. Also, due to the fact that the torque drive device 125 operates to drive the sight through the high ratio worm gear mechanism 150—155, the rate of sight movement in connection with elevational adjustments of the aim thereof will be correspondingly greatly reduced relative to the rate of rotation of the torque drive member. Therefore any torsional deflections of the torque drive member 125 in response to the sight driving loads thereon will in effect be correspondingly subdivided as explained hereinabove, with the result that any elasticity within the torque drive member 125 will be so subdivided and reduced in effect as to be inappreciable. Hence, the sight will be caused to move for elevational adjustments, for all practical purposes, in exact conformity with the aim adjusting movements of the gun battery.

It is another particular feature of the mechanism of the invention that the elevational aim control mechanism for driving the sight device emanates from the rotating gun mount turret structure coaxially therewith and enters the gun sight support frame structure in line with the axis of azimuth adjustment thereof and that by reason of the mechanism arrangement referred to the possibility of interferences with proper elevational aim control of the gun sight by azimuth aim control motions of the mechanism, are avoided. It will be appreciated that whenever the gun turret is caused to rotate about its azimuth adjustment axis for gun battery aim purposes, the bevel gear mechanism 114 will cause the countershaft 110 to rotate to a corresponding degree as a unit with the gun turret. Consequently, the shaft 110 causes the torque drive device 125 to rotate, and this in turn causes the vertical shaft 136 of the gun sight elevational control mechanism to rotate to a corresponding degree. This motion, however, will not be translated into operation of the sight elevational control worm 150 because simultaneously therewith the azimuth control torque drive member 92 is being rotated in similar manner by the azimuth control motor 50 to cause the sight carrying frame 84 to rotate in the same direction and at exactly the same speed as the elevation control shaft 136. Thus, there is no relative movement between the vertical shaft 136 and the sight carrying frame 84, whereby the elevational control worm 150 remains inactive. Also, it will be apparent that elevational aim adjusting operations of the motor 32 and associated gearing will in nowise effect the attitude of the azimuth control system.

Although only one form of the invention has been shown and described in detail, it will be apparent to those skilled in the art that the invention is not so limited but that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. For use in a gun battery wherein a gun pivotally mounted for movement in elevation and azimuth has a sight remotely placed relative to the gun position, a sight mount frame pivoted to said sight for relative movement of the latter about a horizontal axis, said sight frame being pivotable for rotation about a vertical axis; the combination with said sight of sight azimuth aim adjustment means comprising a torsional drive member operably connected at one end to the gun by means of a velocity increase gear and at its other end to said sight by means of a velocity decrease gear for pivoting said sight about said sight frame axis in consonance with gun elevational aim adjustments, and a second torsional drive member operably connected at one of its ends to the gun by means of a velocity increase gear and at its other end to said sight by means of a velocity decrease gear while being threaded intermediately of its ends through said sight frame rotation axis for procuring elevational aim adjustment movements of said sight in synchronism with gun elevational movements.

2. For use in a gun battery wherein a gun pivotally mounted upon a base for adjustments of the gun battery aim has a gun sight remotely placed relative to the gun position and pivotally mounted upon the base for rotation relative thereto; the combination with said sight of sight aim adjustment means comprising a velocity increase gear means coupled to the gun, a torque drive member operably connected at one of its ends to said gear means for translating relatively slow aim adjustment movements of the gun into

relatively high speed rotations of said torque drive member, said torque drive member being threaded intermediately of its ends axially of the pivotal mounting of said sight relative to said base, and a velocity decrease gear means interconnecting the other end of said torque drive member and said sight for pivoting the latter in synchronism with aim adjustments of the gun, whereby elastic torsional deflections of said torque drive member will be greatly reduced in effect and whereby said sight will be actuated thereby to rotate in parallel directions and in substantially exact conformity with gun aim adjustments.

3. For use in a gun battery wherein a gun pivotally mounted upon a base for movement in elevation and azimuth has a sight remotely placed relative to the gun position, a sight mount frame pivoted to said sight for relative movement of the latter about a horizontal axis, said sight frame being pivotally mounted upon the base for rotation relative to the base about a vertical axis; the combination with said sight of sight azimuth aim adjustment means comprising a flexible drive member operably connected at one end to the gun and at the other end to said sight for pivoting the latter about said sight frame axis in consonance with azimuth aim adjustments of the gun, and sight elevational aim adjustment means comprising a second flexible drive member operably connected at one end to the gun and at its other end to said sight while being threaded intermediately of its ends through said sight frame rotation axis for procuring elevational aim adjustment movements of said sight in synchronism with gun elevational movements.

4. For use in a gun battery wherein a gun pivotally mounted upon a base for movement in elevation and azimuth has a sight remotely placed relative to the gun position, a sight mount frame pivoted to said sight for relative movement of the latter about a horizontal axis, said sight frame being pivotally mounted upon the base for rotation relative to the base about a vertical axis; the combination with said sight of sight azimuth aim adjustment means comprising a torque drive device operably connected at one end to the gun and at the other end to said sight for pivoting the latter about said sight frame axis in consonance with gun azimuth aim adjustments, and a second torque drive device operably connected at one end to the gun and at its other end to said sight while being disposed intermediately of its ends axially of said gun vertical axis and axially of said sight frame rotation axis for procuring elevational aim adjustment movements without interference by actuations of said azimuth adjustment means.

5. For use in a gun battery wherein a gun pivotally mounted upon a base for movement in elevation and azimuth has a sight remotely placed relative to the gun position, a sight mount frame pivoted to said sight for relative movement of the latter about a horizontal axis, said sight frame being pivotable for rotation about a vertical axis; the combination with said sight of sight elevational aim adjustment means comprising a velocity increase gear means coupled to the gun, a torque drive member operably connected at one of its ends to said gear means for translating relatively slow aim adjustment movements of the gun into relatively high speed rotations of said torque drive member, and a velocity decrease gear means interconnecting the other end of said torque drive member and said sight for pivoting the latter in synchronism with aim adjustments of the gun whereby elastic torsional deflections of said torque drive member will be greatly reduced in effect, said torque drive member being threaded intermediately of its ends axially of the pivot axis of said sight frame, whereby said sight will be actuated by said aim adjustment means in substantially exact conformity with gun aim adjustments.

JOHN C. TROTTER.