Dec. 4, 1928. 1,693,712

J. B. HENDERSON

GUN MOUNTING

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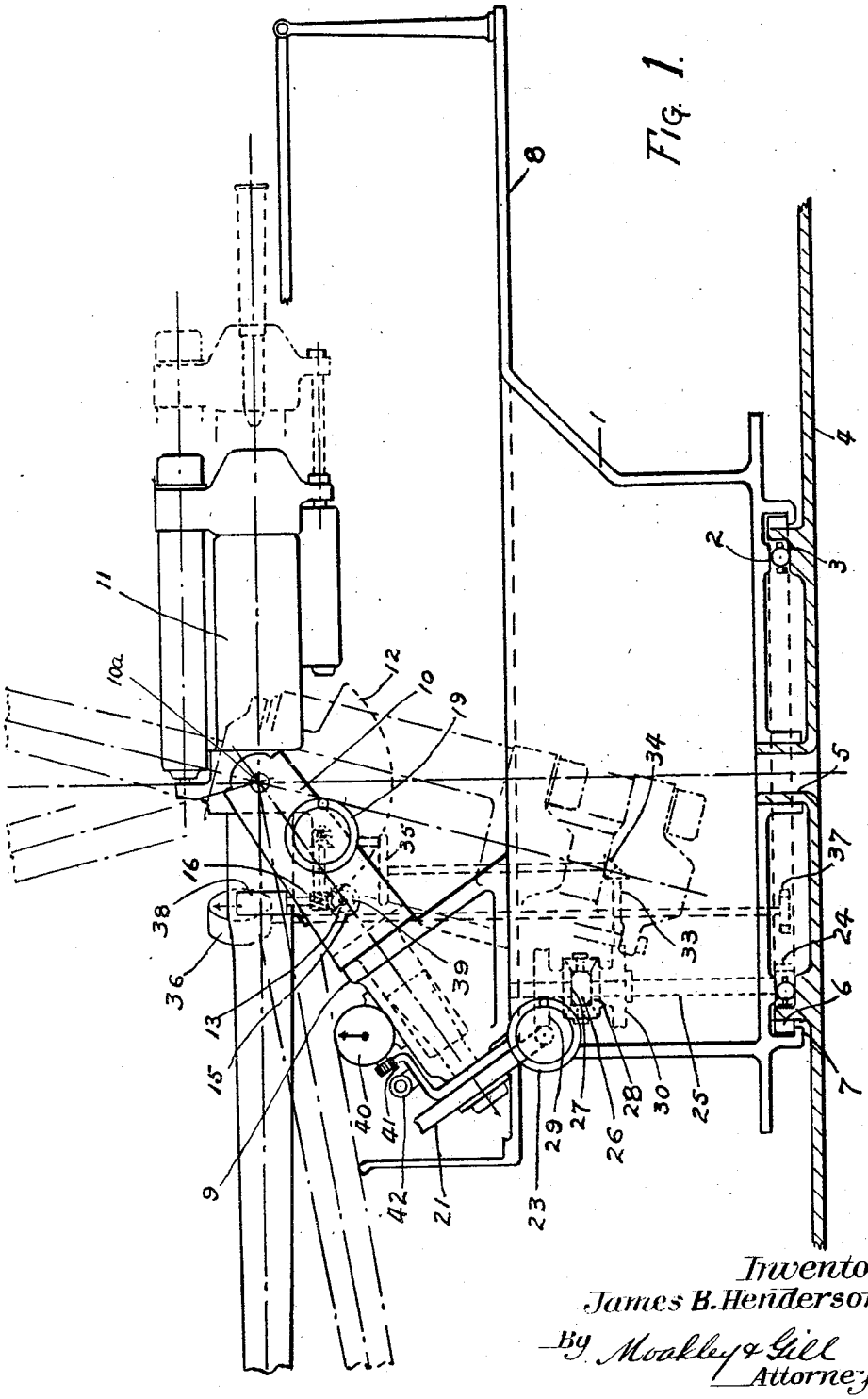


Fig. 1.

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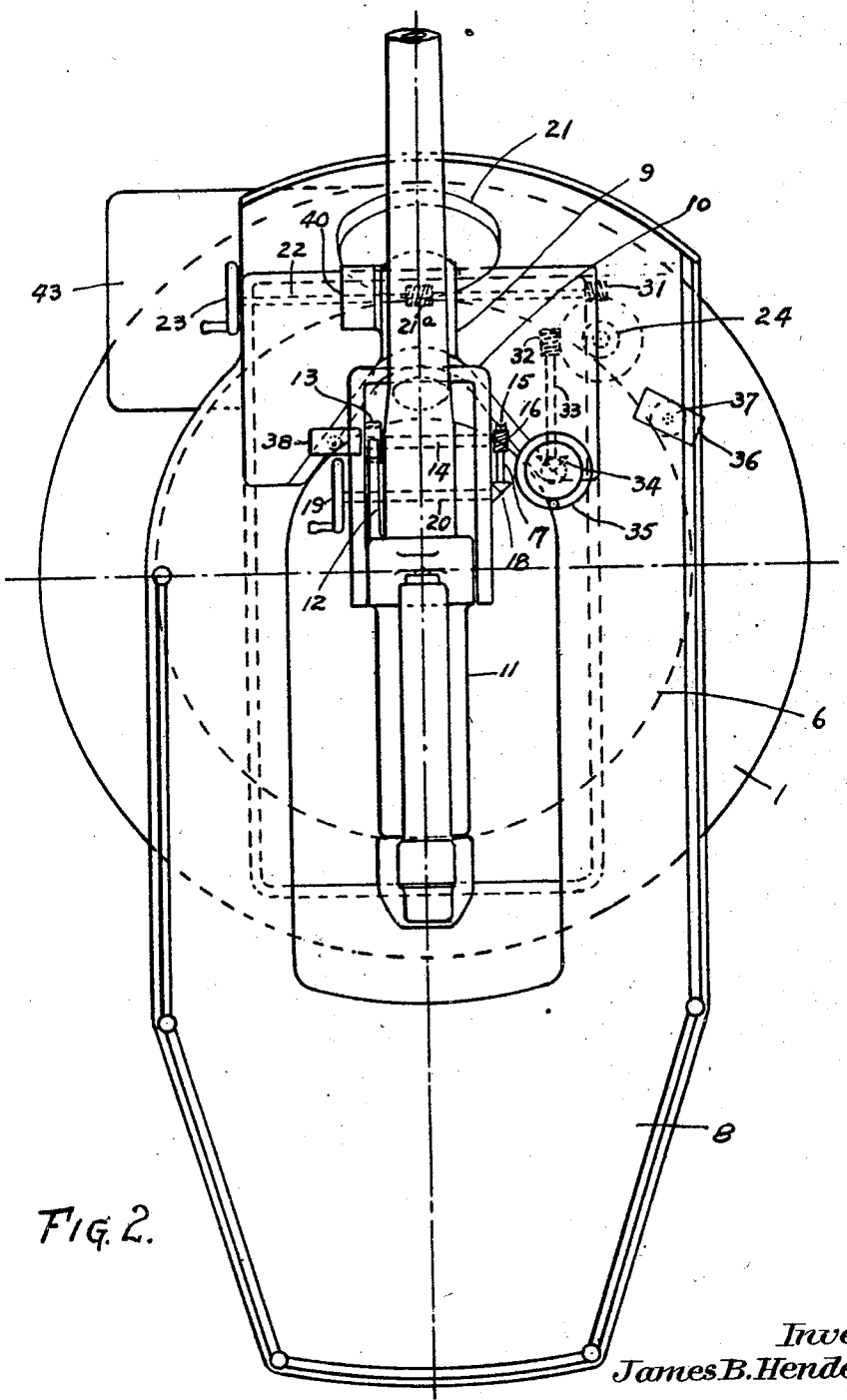


FIG. 2.

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UNITED STATES PATENT OFFICE.

JAMES BLACKLOCK HENDERSON, OF BLACKHEATH, ENGLAND.

GUN MOUNTING.

Application filed February 12, 1927, Serial No. 167,833, and in Great Britain March 22, 1926.

My invention relates to gun mountings and more particularly to improvements in the same for eliminating the deflection produced in the trajectory of the shell by a tilt of the gun trunnions from the horizontal. When the elevation of the gun is considerable and the gun is provided only with an elevation and a training trunnion axes, a very small tilt of the former involves very great adjustments in training to correct the deflection of the trajectory produced by the tilt. For example, when the gun is firing vertically upwards a tilt of the gun trunnions of only one minute of arc requires a 90° adjustment in training to correct the deflection.

It has been proposed in the case of guns required to fire at high elevations, such as anti-aircraft guns, to mount them upon a system of horizontal gimbals, but the design of such a mounting has many practical objections, one of the chief of which is that the horizontal gimbal trunnion at right angles to the elevation trunnion interferes with the use of the gun at low elevations. This horizontal gimbal trunnion at right angles to the elevation axis is, however, the ideal cross levelling trunnion axis and my present invention is intended to reproduce as far as possible the effect and the advantages of having such an axis without the disadvantages introduced by an actual trunnion.

A gun mounting made according to my present invention has a conventional pedestal or turret mounted upon a training axis which is normally vertical. It has also the conventional gun cradle mounted on the pedestal or turret on a horizontal trunnion axis which rests on plummer blocks, but instead of fixing these blocks conventionally to the pedestal I fix them to a second cradle or frame which is pivotally mounted on the pedestal upon a cross levelling trunnion axis at right angles to the elevation trunnions but considerably inclined to the horizontal. This inclination will probably differ in different designs but may conveniently lie between 30 and 60 degrees.

I fit a mechanical gear to control the displacements of the gun about this cross levelling trunnion axis and I link this mechanism to the pedestal or turret training gear, so that every displacement of the gun about the inclined cross levelling trunnion is accompanied by a definite corresponding displacement in training, the relation between these two displacements being arranged so that the resultant movement of the elevation trunnions of the gun takes place about an imaginary cross levelling trunnion axis which is accurately or approximately at right angles to both the elevation and training axes of the gun. For accuracy in the training correction the condition to be fulfilled is that the tangent of the angle of displacement in training shall bear to the tangent of the angle of displacement about the inclined cross levelling axis a fixed ratio which is the sine of the angle of inclination of the latter axis to the horizontal when the training axis is vertical. The simplest mechanism which satisfies this requirement is a Hooke's universal joint, and I may use one in my invention to link the two displacements together, but I prefer for mechanical reasons to put the connection between two high-speed spindles and in the interests of mechanical simplicity I employ a gear which departs slightly from accuracy by fixing the ratio between the two angles instead of the ratio between their tangents.

Partly due to the action of the mechanism and partly due to the approximation just referred to, the cross levelling correction herein described introduces small errors both in elevation and in training and the mounting is therefore only approximately equivalent to a horizontal gimbal ring, but as other errors in elevation and training are constantly being introduced by the angular movements of the ship, the residual errors due to the cross levelling mechanism merge into them and are at once corrected by the layer and trainer.

The interconnection between cross levelling and training necessitates double control of the latter, one control providing ordinary training of the pedestal or turret and the other providing the displacement required by the cross levelling about an inclined trunnion. In hand-worked mountings I interconnect the two controls through a differential gear or its equivalent, and in power-operated mountings I preferably place the differential gear or its equivalent in the relay mechanism controlling the training.

In the accompanying drawings I have illustrated an application of my invention to a naval A. A. gun as the need for a continuous correction is best exemplified in such a case on account of the continuous rolling and pitching of the ship. But it must not be assumed that the invention is not applicable to land ordnance. On land the need for a cross

levelling correction arises from inequalities of the ground and the correction is fixed so long as the gun is stationary. But with the introduction of mobile A. A. guns adapted to fire on the move and guns of various calibres mounted on tanks, armoured cars etc., the need for a continuous and exact correction is now being experienced on land as well as at sea and my invention is equally applicable to both cases, subject to certain modifications which will be explained afterwards.

Fig. 1 shows a side elevation, partly in section, of a gun mounting constructed in accordance with my invention.

Fig. 2 is a plan view of the same mounting.

In Fig. 1 a turntable 1 is shown supported on balls 2, carried on a ball-race 3 secured to the deck 4. A centre pivot 5 locates the training axis of the mounting and is made hollow for convenience in introducing the various electrical cables to the mounting from the director sight or other fire control apparatus.

A training rack 6 is secured to the deck and clips 7 carried by the turntable engage with the lower side of the rack to prevent the turntable from being lifted under the forces of the gun's recoil.

From the turntable is carried a platform 8 at a distance below the gun trunnions convenient for the gun crew to serve the gun. To this platform is secured an inclined socket bracket 9 in which is pivoted a forked frame 10 provided with bearings for the elevation trunnions 10^a of the gun cradle 11.

A toothed segmental rack 12 is attached to the gun cradle and gears with an elevating pinion 13 on a shaft 14 carried in bearings in the arms of the fork 10. A wormwheel 15 on the shaft 14 is engaged by a worm 16 on a shaft 17 connected by bevel gearing 18 to an elevating handwheel 19 on a shaft 20 which is carried in bearings in the arms of the fork 10. The wormwheel 15 may be secured to the shaft 14 by friction plates in the customary manner to prevent the elevation control gear from shocks or from a sudden stoppage or reversal of the handwheel 19.

At the end of the pivot of the fork 10 is mounted a wormwheel 21 in which engages a worm 21^a on a shaft 22 carrying a handwheel 23. The wormwheel 21 may be secured to the pivot of the fork 10 by friction plates to protect the cross levelling gear from shocks due to recoil or inertia.

A training pinion 24 carried by a shaft 25 in bearings on the turntable 1 engages the training rack 6, and the shaft 25 is provided at its upper end with arms 26 on which are mounted the bevel planet pinions of a differential gear, these pinions engaging in the usual way with opposing bevel wheels 27 and 28, to each of which is secured a worm wheel, numbered 29 and 30 respectively. The upper worm wheel 29 is geared to a worm 31 on the cross levelling shaft 22 and the lower wormwheel 30 to a worm 32 on a shaft 33 which is connected by bevel gearing to a training handwheel 35.

By this method of connecting the cross levelling gearing of the fork 10 to the training gear of the turntable 1 the lateral deviation of the gun resulting from the cross-levelling adjustment about an inclined trunnion is approximately neutralized by the simultaneous training movement of the turntable and cross levelling trunnion, provided that the training movement bears to the cross levelling displacement about the inclined trunnion a ratio equal to the sine of the angle of inclination of the cross-levelling trunnion to the plane of the training rack, i. e. its inclination to the horizontal when the training axis is vertical. This proportional relation of the two movements is very simply allowed for in the various gears of the cross-connection.

As a datum of reference in the horizontal plane to enable the cross levelling mechanism to be operated I attach a telescope 42 to the pivot of the fork 10 and normally horizontal and parallel with the elevation trunnions of the gun. Alternatively, if more convenient, the telescope may be mounted on a separate pivot parallel with that of the fork 10 and coupled to the fork by a parallel linkage so as to be maintained parallel with the elevation trunnions of the gun. The sole requirement is that the telescope must be kept parallel with the elevating trunnions of the gun in a position convenient to the observer and so as to give him a clear view of the horizon in the direction of the gun trunnions. A small platform 43 projecting from the turntable may be provided for the observer in the position most convenient for him to operate the cross levelling handwheel 23 with his eye at the eyepiece of the telescope 42.

Any suitable form of sighting apparatus may be attached to the gun or gun cradle or mounting, and to enable the gun to be operated under the direction of a controlling sight or fire control apparatus dials and pointers are fitted to indicate the position of the turntable in relation to the deck and also the relations between the gun and turntable about the elevation and cross levelling axes. The training indicator 36 is driven, for example, by a pinion 37 from the training rack 6, the elevation indicator 38 by bevel gearing 39 from the shaft 14 and the cross levelling indicator 40 by a segmental rack 41 attached to the pivot of the fork 10.

For the convenience of the gun layer and trainer seats (not shown) may be carried by the trunnion bracket fork 10 so that these operators will swing with the gun when it is cross levelled.

Instead of the gun being adjusted by hand any convenient form of power motors may be

employed, and with heavy guns the use of power will be essential.

Preferably the gun mounting is arranged so that the gun can be elevated past the vertical. In Fig. 1 the gun is allowed 15° of elevation beyond the vertical. When extra elevation is thus provided the gun is able to engage an overhead target, and in the overhead zone of fire contained in a cone with sides inclined at 15° to the vertical axis of the mounting it is not necessary to use the training gear, the target being followed by adjusting the gun through the elevation and cross levelling gears alone, a separate sight being provided for the cross levelling operator instead of the horizon telescope 42.

The improved gun mounting herein described not only enables cross levelling to be performed with comparative ease at any angle of gun elevation or any angle of tilt of the gun trunnions, but it also enables the gun to engage a target with rapidity at any position within the range of the gun, whether the target is on the horizon or overhead.

It has already been stated that the invention is applicable to land ordnance, but in view of the fact that on land the horizon is not a good datum of reference, the cross levelling horizon telescope is unsuitable and could be replaced by a pendulum or level for stationary firing, or if firing on the move be contemplated then the pendulum or level should have a long period, or better still, a gyroscope should be used.

In addition to gun mountings the invention is applicable to other mechanisms such as sights, searchlights, etc., which are subject to deflection from a required direction by causes the same as, or similar to, those which create the necessity for the cross levelling correction of guns. In some cases the required direction of these mechanisms may be parallel to the gun axis, or parallel to the line of sight, or it may be determined by quite different factors, but in all cases the disturbance produced by rolling of the ship at sea or by unevenness of the ground on land is the same and the correction is identical, at least in type. It is therefore evident that my invention is applicable to all such types of directional mechanisms.

I claim:—

1. The combination with a device mounted to be variously directed, of a support for the device including trunnions on two axes, and simultaneously operable interconnections adapted to be actuated to effect a displacement of said device about an axis to which the two trunnion axes are inclined.

2. In a gimbal mounting for a gun or the like, a gun, a pivotal support therefor provided with gimbal trunnions, and linkage mechanism movable in accordance with displacements of the support about the gimbal trunnion axes thereby causing displacement of the gun about an axis inclined to both of said trunnion axes.

3. A gimbal mounting for a gun or the like comprising a pedestal having a vertical training axis, a frame carried by said pedestal and displaceable about an oblique cross levelling axis and a gun mounted on said frame on trunnions at right angles to both said axes.

4. A gimbal mounting for a gun or the like comprising a pedestal having a vertical training axis, a frame carried by said pedestal and displaceable about an oblique cross levelling axis, a gun mounted on said frame on trunnions at right angles to both said axes, and mechanism operable to displace said frame about the cross levelling axis and operatively connected with said pedestal to proportionately displace the same about the training axis simultaneously with any displacement of said frame about the cross levelling axis.

5. A cross levelling mechanism for guns or the like comprising a pedestal having a vertical training axis, training mechanism therefor, a frame carried by said pedestal and mounted on an oblique trunnion, operating means for effecting cross levelling movement of said frame about the axis of said trunnion, and gearing interconnecting said operating means and training mechanism for combining the cross levelling movement with that of the training mechanism.

6. A cross levelling mechanism for guns or the like comprising a pedestal having a vertical training axis, training mechanism therefor, a frame carried by said pedestal and mounted on an oblique trunnion, operating means for effecting cross levelling movement of said frame about the axis of said trunnion, and mechanism including differential means operable in response to the actuation of said operating means and said training mechanism to modify that of the latter.

7. A gimbal mounting for a gun or the like comprising a pedestal having a vertical training axis, a frame carried by said pedestal and displaceable about an oblique cross levelling axis, a gun mounted on said frame, and actuating mechanism operatively connected to said frame and pedestal and operable to effect displacements of the gun about the training and cross levelling axes at a ratio equal to the sine of the angle of the cross levelling axis to the horizontal when the training axis is vertical.

8. A gimbal mounting for a gun or the like comprising a pedestal having a vertical training axis, a frame carried by said pedestal and displaceable about an oblique cross levelling axis, a gun mounted on said frame, and actuating means operatively connected to said frame and pedestal and operable to effect displacements of the gun about the training and cross levelling axes in a relation in which the ratio between the tangents of the angular displacements applied to the gun about the train-

ing and cross levelling axes is equal to the sine of the angle of inclination of the cross levelling axis to the horizontal when the training axis is vertical.

9. A gimbal mounting for a gun or the like comprising a pedestal having a vertical training axis, a frame carried by said pedestal and displaceable about an oblique cross levelling axis, a gun mounted on said frame, mechanism comprising a Hooke's universal joint operatively connected to said frame and pedestal and operable to effect displacements of the gun about the training and cross levelling axes in a relation in which the ratio between the tangents of the angular displacements applied to the gun about the training and cross levelling axes is equal to the sine of the angle of inclination of the cross levelling axis to the horizontal when the training axis is vertical.

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