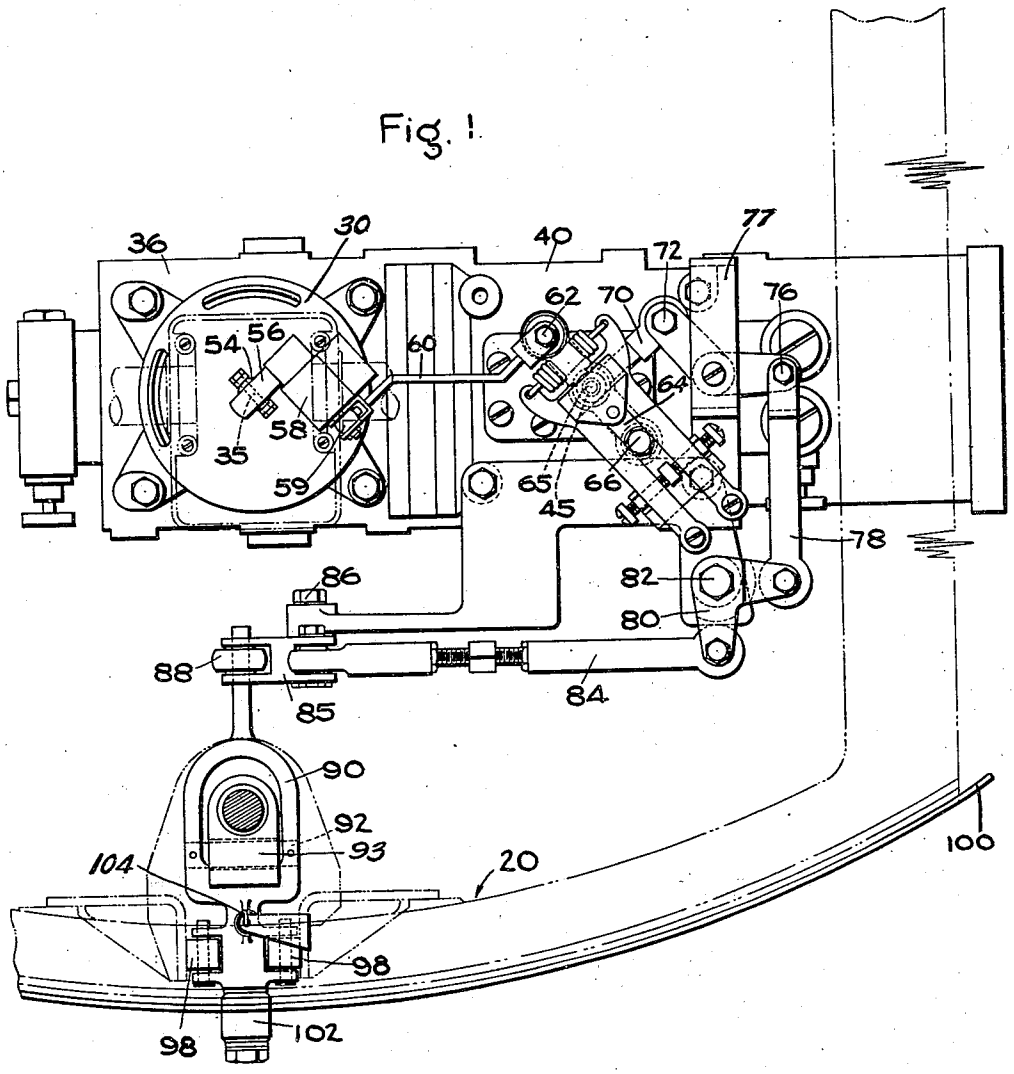
Oct. 15, 1946. J. C. TROTTER 2,409,406

SAFETY CONTROL MECHANISM FOR POWER-OPERATED ORDNANCE

Filed June 28, 1944 5 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

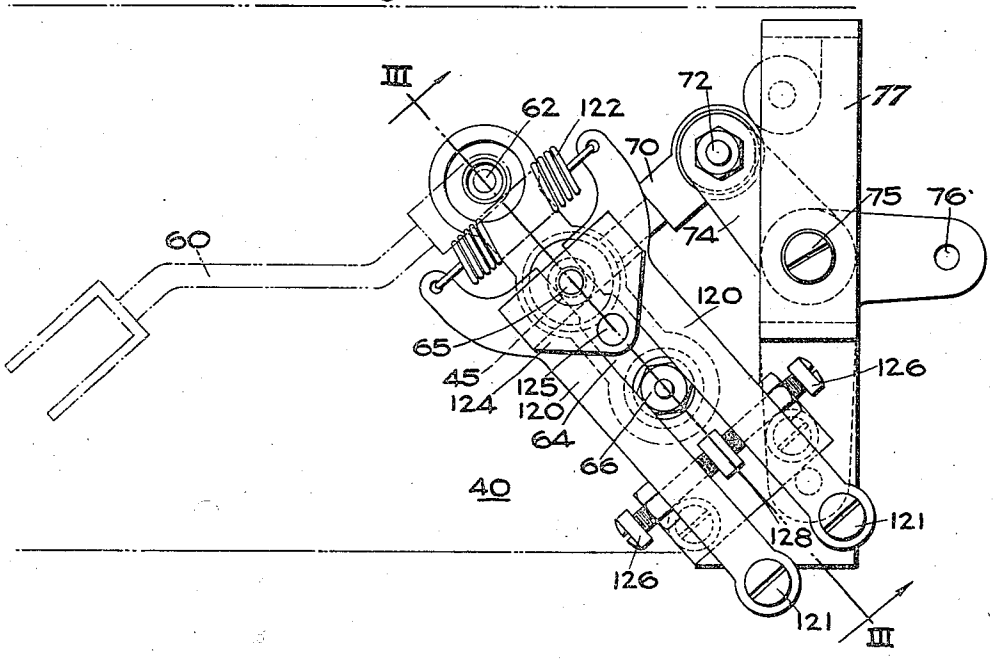
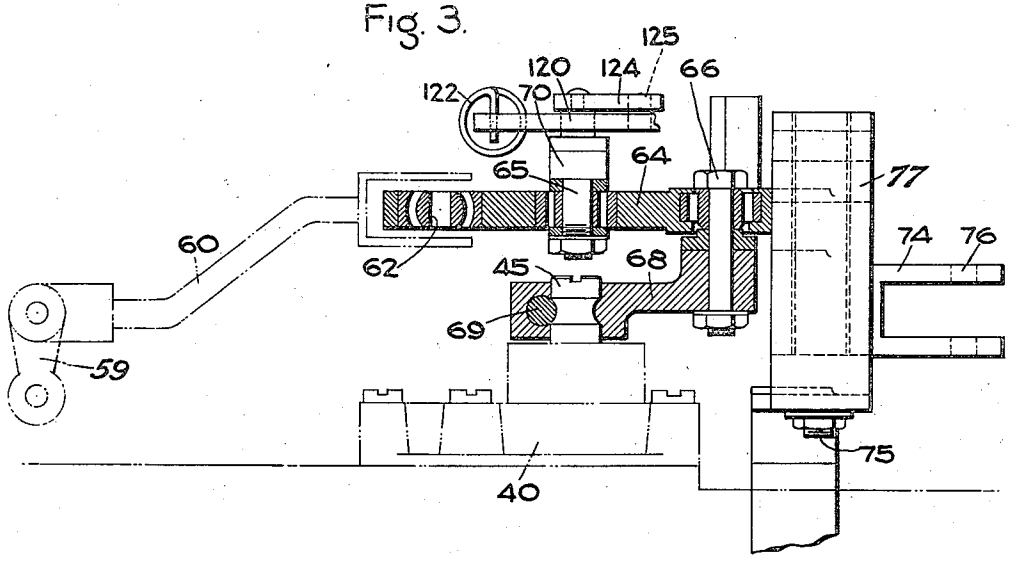


Fig. 3.



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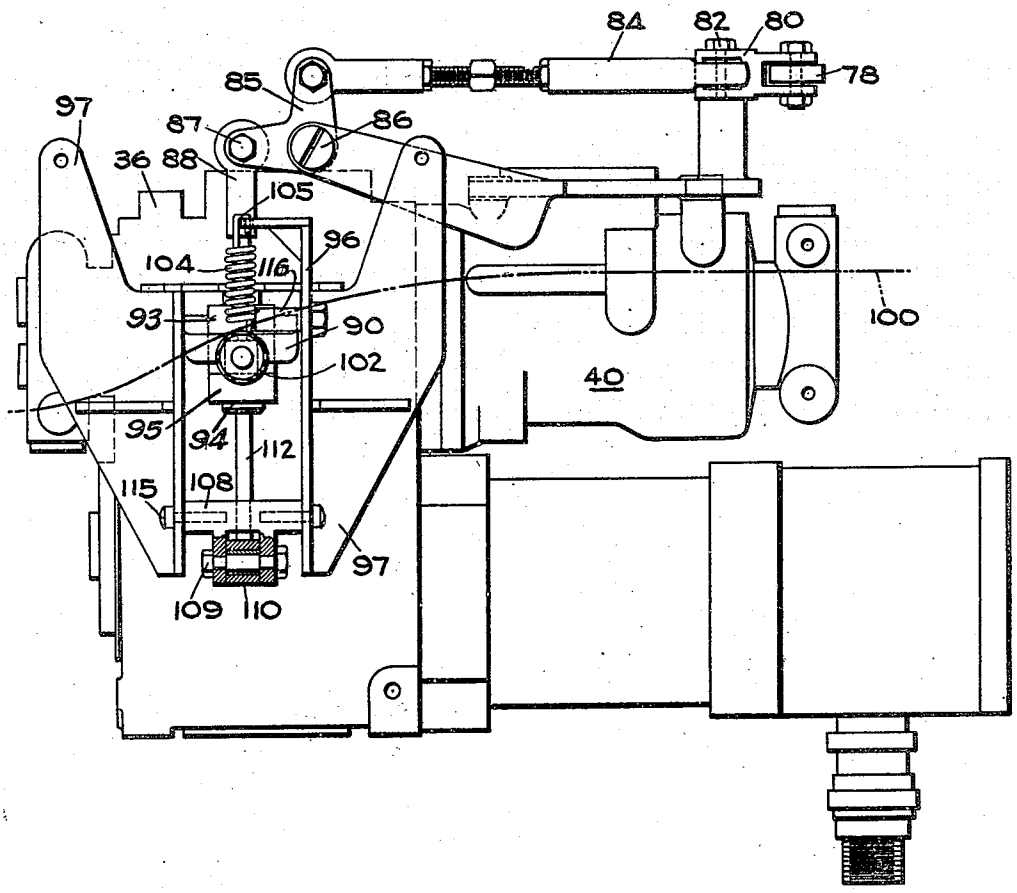
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SAFETY CONTROL MECHANISM FOR POWER-OPERATED ORDNANCE

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Fig. 4.



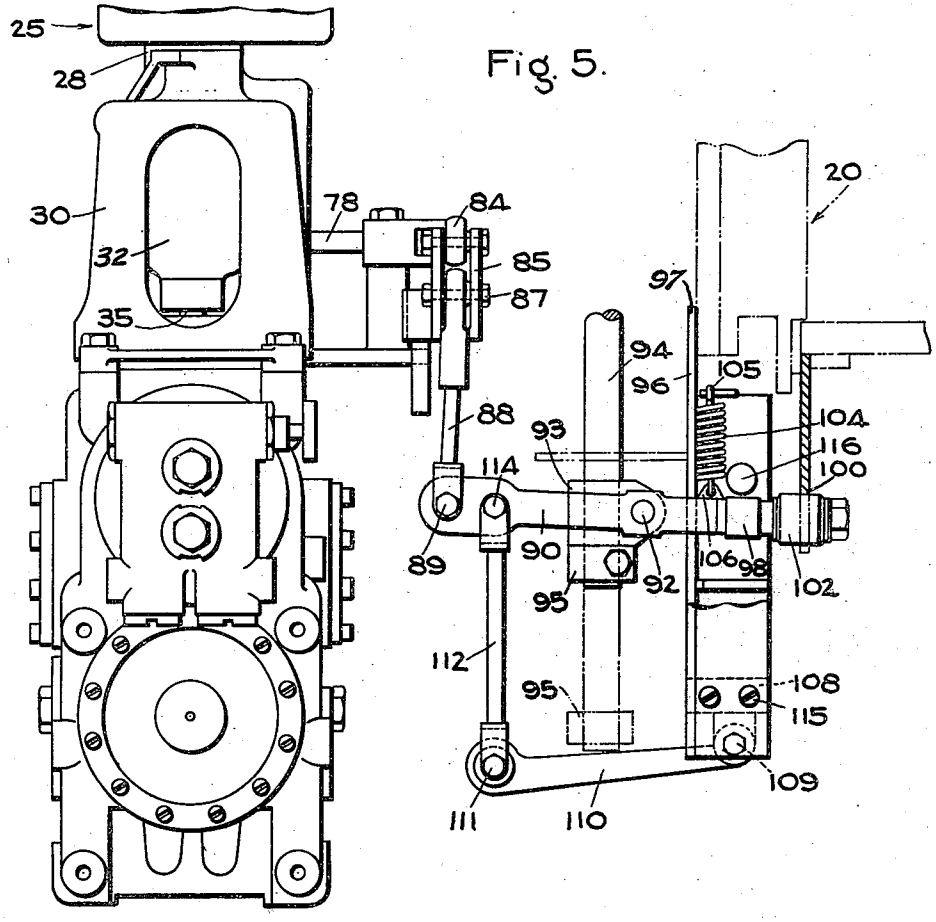
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SAFETY CONTROL MECHANISM FOR POWER-OPERATED ORDNANCE

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Fig. 5.



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SAFETY CONTROL MECHANISM FOR POWER-OPERATED ORDNANCE

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Fig. 6.

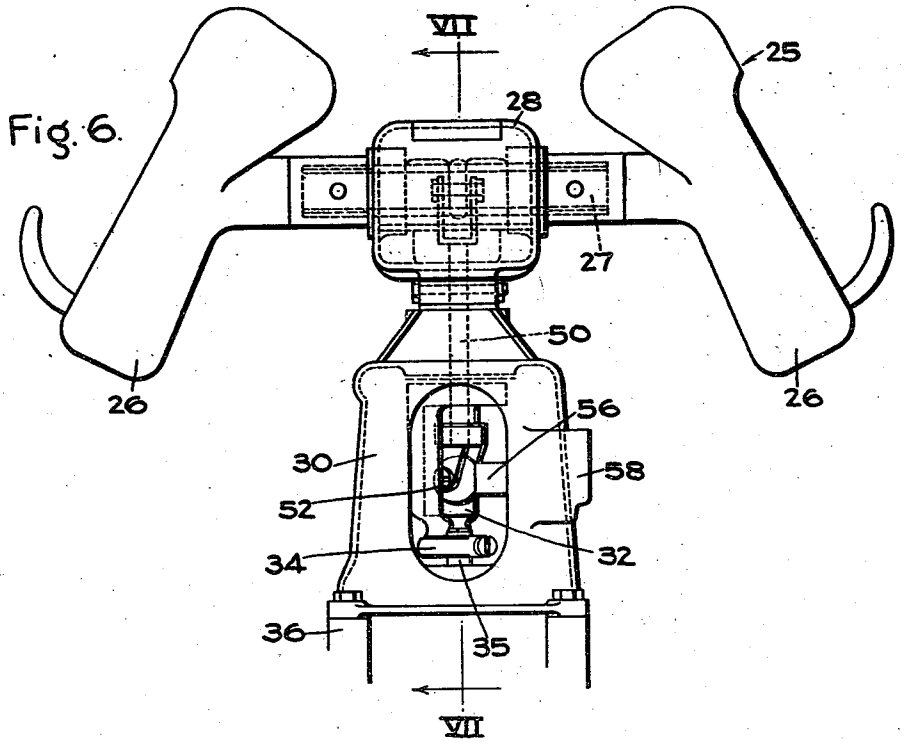
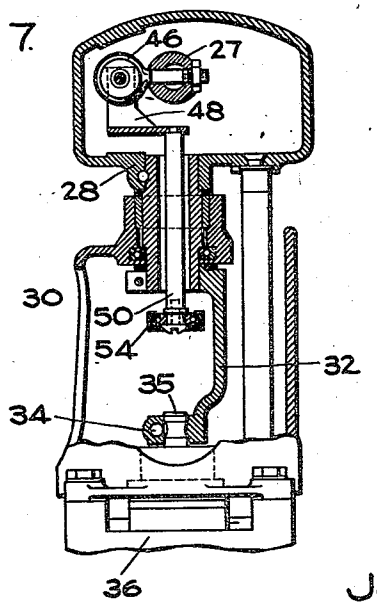


Fig. 7.



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UNITED STATES PATENT OFFICE

2,409,406

SAFETY CONTROL MECHANISM FOR POWER-OPERATED ORDNANCE

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Application June 28, 1944, Serial No. 542,498

7 Claims. (Cl. 89—41)

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This invention relates to ordnance, and more particularly to automatic fire control means for use in connection with adjustable aim gun batteries whereby to prevent shooting at non-hostile objects such as portions of the battery mounting vehicle or the like when the direction of gun aim at a moving target intercepts the positions thereof.

One of the objects of the invention is to provide improvements in power-controlled gun batteries, whereby operator-imposed control effects incidental to tracking a moving target or the like are automatically overcome in improved manner whenever the direction of gun aim intercepts the position of a non-hostile object such as a portion of the gun battery mounting vehicle or the like. Another object of the invention is to provide in conjunction with a manually controlled power-aimed gun battery or the like an automatic over-control mechanism which is of improved form and adapted to shift the gun aim away from non-hostile objects while avoiding interference with the target-tracking technique of the gun operator, and to automatically return the gun aim into consonance with the gun operator's control setting subsequent to passage thereof beyond the object to be protected. Other objects and advantages of the invention will appear in the specification hereinafter.

In the drawings:

Fig. 1 is a top plan of a gun aim control mechanism of the invention;

Fig. 2 is an enlarged plan view of a differential mechanism portion of Fig. 1;

Fig. 3 is a fragmentary section taken along line III—III of Fig. 2 through a portion of the automatic over-control mechanism of the invention;

Fig. 4 is a side elevation of the mechanism of Fig. 1;

Fig. 5 is a side elevation thereof taken transversely to the view of Fig. 4;

Fig. 6 is an end view of a manual control device for the gun aim control mechanism; and

Fig. 7 is a section taken along line VII—VII of Fig. 6.

The invention contemplates, generally, for example in an airplane having a manually controlled powered gun turret amidships its fuselage, the provision of a cam track carried by fixed structure of the aircraft to circle the gun turret and means of improved form coacting with the cam track and carried by the turret to adjust the turret gun elevating control device automatically so that as the turret rotates the guns will be automatically elevated whenever necessary to avoid hitting them against fixed aircraft structure

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such as the after deck of the fuselage or shooting at non-hostile objects, such as interfering parts of the airplane. For this purpose a differential motion device is connected to the control stem of the gun elevation control motor, and the cam controlled device is linked to the differential. The manual control for aiming the gun battery in elevation is also linked to the differential unit; and thus the elevation motor control stem is operable either independently or conjointly by the gunner and by the cam track during rotation of the gun turret. The mechanisms are so arranged for example, that in spite of an accidental aiming of the battery by the gunner at too low an elevation coincident with turning of the turret into the direction of the airplane fuselage, the cam control mechanism will automatically cause the gun muzzles to rise so as to maintain clearance with respect to the fixed structure of the aircraft.

It will be understood that the invention is to be used in connection with a gun and its mount supported by a base as shown in co-pending application Serial No. 474,106, filed January 30, 1943, such details having been omitted from this application for clearness of illustration.

For purposes of exemplification the invention is illustrated in Fig. 1 in conjunction with a gun turret designated generally at 20; and it will be understood that the turret-gun unit is rotatable relative to the mounting vehicle body about a vertical axis disposed centrally of the turret for azimuth adjustments of the gun aim. A hydraulic motor or other suitable drive device (not shown) is carried by either the turret or the vehicle frame and geared to the other, whereby to provide reverse-direction rotational operation of the turret.

A gun battery aim manual control device is mounted interiorly of the turret as indicated at 25 (Figs. 6–7) to comprise a pair of handle members 26 keyed to a cross shaft 27 which is journaled centrally thereof upon a control post 28. The post 28 extends downwardly and is carried by a housing 30 to be rotatable thereon about a vertical axis, and the post 28 is shell-shaped at its lower end 32 and embraces in locked relation at 34 upon the valve control stem 35 of the pump 36 which energizes the turret azimuth aim control motor. In the drawings, the azimuth and elevational control systems are shown to be both of hydraulic type, and it will be understood that the elevational and azimuth aim control motors are connected to their corresponding pump devices by conduits in such manner as to procure selective reverse-directional operations of the motors in response to suitable manipulations of

the manual aim control device. Preferably, the control device 25 is so arranged that upon manual twisting of the hand grips 26—26 about the horizontal axis of the cross shaft 27 the elevational control motor device will be energized to drive the gun battery to adjust the elevational aim thereof in consonance with the direction of twisting of the control 25; whereas upon rotation of the control 25 about the vertical axis of the post 28 the valve stem 35 will be adjusted to cause the azimuth control motor to be energized in such manner as to drive the turret to rotate in a direction corresponding to the direction of turning of the control 25. The elevation control pump unit is designated at 40, and the valve control stem thereof is illustrated at 45. To provide for manual control of the stem 45 the handle shaft 27 of the control device 25 is fitted with a crank 46 carrying a depending link 48 supporting a stem 50 (Figs. 6–7) which threads downwardly through the hollow interior of the azimuth control post 28. At its lower end the stem 50 connects at 52 by means of a bearing 54 with one arm of a bell crank 56 which is pivoted upon the housing 30 by means of a bearing block 58. The other arm of the crank 56 is illustrated at 59 (Fig. 1) to extend vertically into pivotal connection with one end of a push-pull link 60; whereby it will be understood that twisting movements of the handles 26 about the axis of the cross shaft 27 will procure corresponding push-pull movements of the link 60 in horizontal directions.

The push-pull member 60 connects by means of a ball bearing pivot 62 to a lever 64 which is fulcrumed upon a pin 65. The other end of the lever 64 pivotally connects through a pin 66 to a crank arm 68 which is keyed to the gun elevation control stem 45 by means of a pin 69. Thus, it will be understood that reciprocation of the push-pull member 60 in response to twisting of the handles 26—26 about their horizontal axis will normally cause the gun elevation control stem 45 to be rotated in either direction away from its neutral or valve closed position shown in Figs. 1–2 so as to procure any desired elevational aim adjustment of the gun battery.

The fulcrum pin 65, however, is carried by one end of a strut 70 which pivotally connects at 72 to one arm of a bell crank 74. This crank is pivoted upon the control frame 77 at 75 and the other arm of the crank 74 connects at 76 to a push-pull member 78 which in turn connects to a second bell crank 80 carried by the control frame by means of a pin 82. (Figs. 1 and 4). The other arm of the crank 80 pivotally connects to one end of a push-pull member 84 which leads to a third bell crank 85 which pivotally mounts upon the control frame by means of a pin 86. The other arm of the crank 85 connects at 87 to the upper end of a pitman 88 (Figs. 4–5). The pitman 88 pivotally connects at its lower end by means of a pin 89 to a forked lever 90 which is fulcrumed at 92 upon a bracket or collar 93 which is loosely slip-fitted about a shaft 94 which in the example illustrated is coupled to the gun battery elevation gearing, as by a rack and pinion device or the like, in such manner that whenever the gun battery rises in elevation the shaft 94 is displaced in a downward direction, and vice versa. A stop block 95 is fixed upon the lower end of the shaft 94 to provide a step for lifting the fulcrum bracket 93, as will be explained hereinafter. A bracket 96 comprising a pair of flanged plates 97—97 (Fig. 4) is bolted to the turret structure 20, and the lever 90 carries a pair of rollers 98—98 at opposite sides thereof to bear against the parallel flanges of the plates 97—97 for guiding the lever movements in vertical directions.

The cam track for controlling automatic adjustments of the gun battery elevating mechanism is illustrated at 100, and the outer end of the lever 90 carries a roller 102 arranged to bear upwardly against the underface of the cam track 100. A tension spring 104 is connected to the bracket 96 as at 105, and at its other end to the lever 90, as at 106, whereby it will be understood that the spring 104 tends to bias the lever and maintain the roller 102 in bearing relation against the cam track 100 under all conditions of operation. A down gun movement stop device 116 is provided for bearing against the lever 90 to prevent undesirable movements thereof whenever the roller 102 runs off the cam track 100, as for example whenever the cam track is of shortened length and less than the total periphery of the gun turret. An up stop device comprising a bracket 108 is mounted upon the plates 97—97 and supports a pivot pin 109 connecting to one end of a lever 110. The other end of the lever pivotally connects at 111 to a strut 112 which leads vertically into pivotal connection at 114 with the lever 90. The lever 110 is adapted to bear against the bottom end of the shaft 94 when the gun reaches its maximum elevation position, thus neutralizing the pump control stem position to stop the gun elevating movements. The bracket 108 is secured in place between the plates 97—97 by means of screws 115.

The cam track 100 is formed to curve in plan view concentrically of the vertical axis of rotation of the gun turret, and in side elevation the bottom profile of the cam track is shaped to rise and fall in such manner as to provide a variable contour adapted to be followed by the roller 102 as the turret rotates; and the track is formed to rise and fall in accord with the positions of non-hostile objects relative to the gun battery. For example, when the gun turret is mounted amidships of an airplane fuselage or the like, the cam track 100 will be formed so as to cause the roller 102 to be depressed whenever the gun turret rotates as to swing the gun aiming direction toward the rear deck or empennage structures of the airplane. In such case, the lever 90 will be thereby actuated to cause the connecting linkage system to shift the position of the fulcrum pin 65 to one side of the neutral or central position thereof shown in Figs. 1 and 2. This will produce a corresponding movement of the lever 64 about the pivot pin 62 as a center of rotation, whereby the crank arm 68 will be rotated to turn the valve control stem 45. Consequently, the gun elevating motor will be energized to lift the direction of gun aim over the object to be protected, despite the fact that the gunner in control of the turret may have inadvertently turned the manual control 25 in such manner as would otherwise adjust the elevational control stem 45 to cause the gun battery to aim at the object to be protected. However, upon swinging of the gun turret beyond the direction of the object to be protected, the cam track profile will permit the roller 102 to rise again in such manner as to free the roller connecting linkage to permit the fulcrum pin 65 to return to its normal or neutral position, whereby the gun battery aim will be in complete control of the gunner and may be trained upon a target moving laterally of the airplane and even at elevations therebelow.

To provide the automatic return movement of the fulcrum pin 65 referred to hereinabove an automatic centralizer is provided in conjunction with the shiftable fulcrum device 65. This is shown in Figs. 2–3 to comprise a pair of arms 120—120 pivotally mounted at 121—121 upon the control frame structure to extend therefrom in parallel relation so as to straddle the upper end of the fulcrum pin 65. A tension spring 122 is connected between corresponding free end portions of the arms 120—120 to bias the latter to clamp together upon the fulcrum pin 65. A guide plate 124 is provided to be carried by the top end of the pin 65 and to carry a vertically depending post 125 extending into the space between the arms 120—120 of the centralizer unit to maintain the centralizer arms 120—120 against accidental displacement from operative position relative to the fulcrum 65. Each of the arms 120—120 carries an adjustable set screw 126 to extend inwardly therefrom to abut against corresponding opposite sides of a fixed stop block 128 (Fig. 2) extending from the control frame 77; and the set screw and spring devices of the centralizer mechanism are so adjusted as to normally hold the pin 65 in neutral position but to allow it to be biased in either direction therefrom by the cam and link mechanism against the action of the spring 122.

It will be clear from the foregoing that under normal firing conditions the position of the roller 102 will not be altered. When however the movement of the gun approaches a position where some portions of the aircraft might be hit, a rise or undulation in the surface of the cam track 100 will cause the movement of the roller either up or down about its pivot point 92 which will, through the linkage arrangement hereinabove described, cause the gun elevating mechanism to be energized through the operation of the valve control stem 45 and irrespectively of the manual control. After the gun has reached a position in its horizontal travel where the non-hostile object is beyond its range, the gun will be returned to its normal firing position thus permitting the operator to maintain the target within the gun sights.

Thus it will be appreciated that the present invention provides a particularly effective gun aim control mechanism for use in conjunction with relatively heavy guns and gun mount arrangements such as single or plural gun battery turrets which are rotatably mounted upon modern aircraft and the like, and which must be aim-adjusted by motor means because of the heavy weight and inertia forces acting upon the movable gun battery parts. It will also be understood that although only one specific form of the invention has been illustrated and described herein in detail, various changes may be made therein without departing from the spirit of the invention and the scope of the appended claims.

I claim:

1. The combination with manual control means for regulating the aim of a gun, and a motor regulator actuated by said means, of an automatic safety device for controlling the aim of the gun irrespective of the manual control means during predetermined intervals of travel of the gun, said safety device comprising a double ended control lever having its pivotal fulcrum point substantially intermediate its ends during manual control, one end of said lever being operatively connected to said manual control means

and its other end connected to an arm carried by the motor regulator, a cam track, a pivoted arm having one end engaging said track and its other end operatively connected to the central pivotal fulcrum point of said control lever, whereby to change the pivotal fulcrum point of said control lever during operation of said safety device and to cause it to be rotated about the end thereof which is operatively connected to the manual control means, thus causing the arm of said regulator to be rotated independently of the manual control.

2. A differential safety control for regulating a gun aiming device, comprising a motor regulator, manual control means operatably connected to said regulator, a double ended control lever having its pivotal fulcrum point during normal manual operation substantially midway its ends, means for operatively connecting one end of said control lever to said manual control means, an arm connecting the opposite end of said control lever to said regulator, and means actuated irrespectively of the manual control means for shifting the fulcrum pivotal point of said control lever to its connection to said manual control means, whereby the opposite end of the control lever will cause the regulator to be operated.

3. A differential safety control for regulating a gun aiming device, comprising a motor regulator, manual control means operatably connected to said regulator, a double ended control lever having its pivotal fulcrum point during normal manual operation substantially midway its ends, means for operatively connecting one end of said control lever to said manual control means, an arm connecting the opposite end of said control lever to said regulator, means actuated irrespectively of the manual control means for shifting the pivotal fulcrum point of said control lever to its connection to said manual control means, whereby the opposite end of the control lever will cause the arm of the regulator to be operated, and means for normally maintaining the manual control pivotal fulcrum point of said control lever in its manual operative position.

4. A differential safety control for regulating a gun aiming device, comprising a motor regulator, manual control means operatably connected to said regulator, a double ended control lever having its pivotal fulcrum point during normal manual operation substantially midway its ends, means for operatively connecting one end of said control lever to said manual control means, an arm connecting the opposite end of said control lever to said regulator, means actuated irrespectively of said manual control means for shifting the pivotal fulcrum point of said control lever to its connection to said manual control means, whereby the opposite end of the control lever will cause the arm of said regulator to be operated, and a pair of opposed arms operatively engageable with said control lever for normally maintaining the pivotal fulcrum point thereof in manually operating position, and resilient means for holding said arms together.

5. A differential safety control for regulating a gun aiming device, comprising a motor regulator, manual control means operably connected to said regulator, a control lever having a centrally arranged pivotal fulcrum point substantially coincident with the axis of said regulator, said lever having oppositely extending pivotal ends, one of said ends being operatively connected to said manual control means, the other

end of said lever being connected to a control arm carried by said regulator, a cam track operatively associated with said aiming device, and means controlled by said cam track for changing the pivotal fulcrum point of said control lever at intervals of travel during the aiming of the gun.

6. A differential safety control for regulating a gun aiming device, comprising a motor regulator, manual control means operatably connected to said regulator, a control lever having a centrally arranged pivotal fulcrum point substantially coincident with the axis of said regulator, said lever having oppositely extending pivotal ends, one of said ends being operatively connected to said manual control means, the other end of said lever being connected to a control arm carried by said regulator, a cam track operatively associated with said device, means controlled by said cam track for changing the pivotal fulcrum point of said control lever at intervals of travel during the aiming of the gun, a pair of opposed arms operatively engageable with said control lever for normally maintaining the pivotal fulcrum point thereof in manually operating position, resilient means for holding said arms together, and adjusting means for centralizing said arms to maintain said manual control pivotal point in normal manually operable position.

7. An automatic safety device for use in combination with a manually operable gun aiming device comprising a motor regulator, a control arm carried by said regulator, a frame, a bell crank lever carried by said frame, a control pivot arm operatively connected to one end of said bell crank lever, a manual control pivot pin carried at the extremity of said last mentioned arm, cam operated means operatively connected to the other end of said bell crank for causing the movement of said bell crank at predetermined intervals in the travel of the gun, a double ended control lever carried by said manual control pin, manual control means operatively connected to one end of said control lever, and the opposite end of said control lever being connected to said control arm, and resilient means for retaining said manual control pivot pin in its manual control position.

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