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HYDRAULIC STOPS FOR GUN MOUNT SYSTEM

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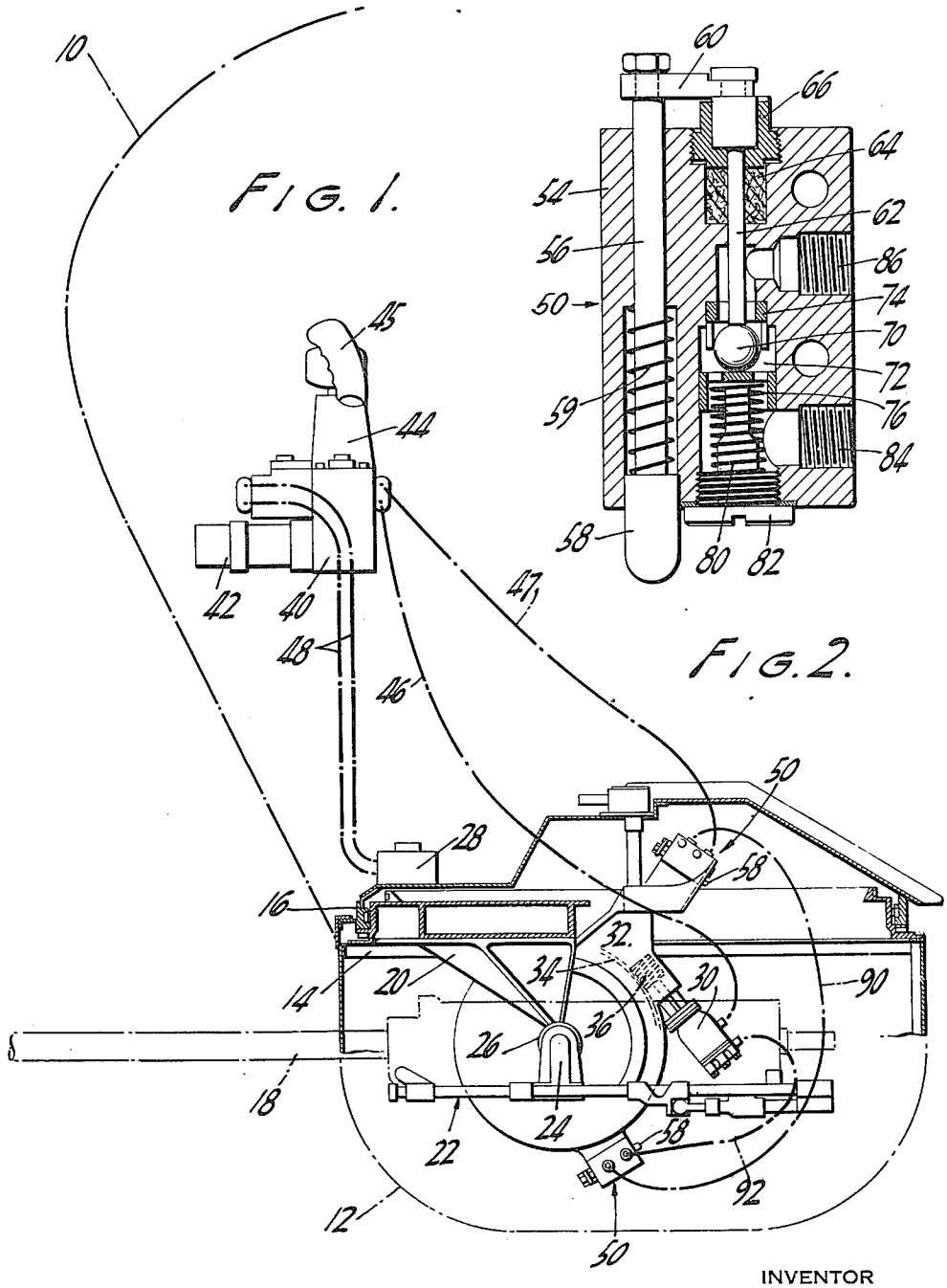


FIG. 1.

FIG. 2.

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HYDRAULIC STOP FOR GUN MOUNT SYSTEMS

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This invention relates to ordnance, and more particularly to improvements in powered aim control means for flexibly mounted machine guns, cannon, or the like. More specifically the invention relates to hydraulically actuated gun mounts and to improvements in aim adjustment movement stop means for use in conjunction therewith.

It is an object of the present invention to provide a hydraulic gun mount mechanism incorporating an improved automatic valve means adapted to be actuated upon movement of the mounted gun into a prescribed limit of aim adjustment position. Another object of the invention is to provide an improved hydraulic control system of the character described incorporating an automatic stop valve mechanism which permits reverse direction flow of hydraulic fluid through the system subsequent to each gun travel stoppage. Another object is to provide an improved stop mechanism for the purpose referred to which operates to avoid jamming of the mechanical parts so as to permit free reversal of the gun training direction. 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 mount and gun aim control arrangement of the invention; and

Fig. 2 is a section through a travel stop valve member of the mechanism.

The drawings illustrate the invention in conjunction with a gun mount embodied in a turret carried at the lower nose portion of an aircraft fuselage which is indicated generally at 10. However, it will be understood that the invention is not limited to such an application or to use upon aircraft, or in connection with the specific type of mount shown and described hereinafter; and that the drawing illustrates only one example of application of the invention.

The gun turret of the drawing comprises a bowl-shaped enclosure 12 carried by a ring 14 which mounts by means of rollers upon an annular base 16. Thus, the turret is freely rotatable, unless otherwise restrained, about a vertical axis disposed centrally of the turret, whereby the supported gun battery may be rotated as a unit for azimuth adjustments of the gun battery aim. One or more cannon or guns or machine guns as indicated at 18 are arranged to be mounted upon the turret frame 14 by means of a forked bracket device 20 extending rigidly from the frame. A gun mount frame consisting of interconnected struts and as indicated generally at 22 is suspended from the bracket 20 by means of paired stirrups 24 extending from the frame 22 at opposite sides of the gun battery into pivotal connection with bearing portions 26 of the bracket 20, whereby to enable the gun and gun mount unit to be freely pivotable about a horizontal axis extending through the bracket bearing portions 26—26 at opposite sides of the gun mount frame. The turret enclosure 12 will be vertically slotted at positions in registry with movement of the gun barrels, whereby it will be understood that the aim of the gun battery may be readily adjusted in elevation by actuating the gun mount frame to pivot about the axis of the bearings 26—26. Thus, the gun battery is mounted relative to the supporting vehicle so as to be universally adjustable for aiming purposes.

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To procure aim adjusting movements of the gun battery relative to the base 16, motor means as indicated at 28 will be carried by either the ring 14 or the base 16 and operationally connected to the other as by gearing, whereby operation of the motor will procure relative movement between the turret and the base to give the gun battery aim adjustment travel in traverse. Similarly, motor means will be provided to be carried by the gun mount bracket 20 to engage with the gun mount frame to procure relative movement therebetween for causing the gun mount frame 22 to rotate relative to the bracket 20 about the horizontal axis of the bearings 26—26, for elevational aim adjustment purposes.

The present invention deals with improvements in hydraulic motor control devices for such purposes, and therefore the azimuth control motor 28 and the elevational aim control motor as indicated at 30 are intended to be illustrated to comprise high speed hydraulic motors. The motor 30 is shown as being carried upon a portion 32 of the bracket 20, and the drive shaft of the motor 30 is arranged to extend into driving connection with a toothed sector 34 carried by the stirrups 24—24 of the gun mount frame, as by means of a worm gear 36. Thus, it will be understood that reverse direction operation of the motor 30 will procure corresponding pivotal adjustments of the gun frame about the axis of the bearings 26—26, for elevational aim adjustment purposes.

The hydraulic pressure generator is indicated at 40 to be driven by a motor 42; and the output of the generator 40 is arranged to be controlled by a valve mechanism carried in a case 44 and actuated by a manual control handle 45. The generator-control valve unit is mounted

within convenient reach of the gun battery operator, as at a position remote from the turret within a gunner's compartment portion of the airplane fuselage; and it will be understood that any suitable control handle and valve and generator mechanism may be employed. However, a suitable control mechanism of the character referred to has been illustrated and described in detail by me in my patent application issued November 11, 1947 as Patent No. 2,430,747. Paired conduits 46—47 lead from the pressure generator 40 into connection with the motor 30. Another pair of conduits 48—48 lead from the generator 40 to the traverse control motor 28 to provide controlled operation thereof.

To automatically stop the gun battery elevational aim adjustment travel at prescribed limits thereof, a pair of valve devices are carried, as indicated generally at 50—50 by the turret bracket 32, and are so arranged as to have actuating stem portions extending therefrom into the path of elevational aim adjusting travel of the gun battery. Hence, upon arrival of the gun battery at the prescribed maximum muzzle-depressed position thereof, the control stem portion of the upper valve device 50 will be depressed because of contact therewith by a portion of the gun battery-frame unit. Similarly, upon arrival of the gun battery at the prescribed maximum muzzle-elevated position thereof the actuating stem portion of the lower valve 50 will be automatically depressed by contact therewith of a portion of the gun battery frame unit.

As illustrated in detail of Fig. 2, each of the valve devices 50—50 comprises a housing 54 which is bored to slidably accommodate a valve actuating stem 56. The stem is fitted with an enlarged contact head 58 backed up by a compression spring 59 which normally biases the stem 56 to extend as shown in Fig. 2 from the housing 54. At its opposite end the stem 56 carries an arm 60 which engages one end of a pin 62 which is also slidably mounted upon a bored portion of the housing 54 to extend substantially parallel to the stem 56. The pin 62 is threaded through a hydraulic fluid seal 64 backed up by a gland 66; and when the stem 56 is in its normal spring-biased position the pin 62 is thereby arranged to bear against a hydraulic check valve ball 70 which is contained within a fluid chamber 72 of the housing in such manner as to force the ball 70 away from an annular valve seat 74. At the opposite side of the ball 70 a cylindrical cage 76 bears against the ball and is slidably mounted within the housing 54 to move with the ball toward and away from valve seat contacting position. A compression spring 80 is mounted within the housing 54 by means of a screw 82 to press upwardly against the cage 76 so as to tend to seat the valve 70 against the annulus 74. The springs 59—80 are so provided however as to enable the spring 59 to overcome the force of the spring 80 unless otherwise restrained, whereby the pin 62 will normally be actuated to hold the ball 70 in unseated position as shown in Fig. 2. Hydraulic fluid inlet-outlet ports 84—86, respectively are formed in the housing 54 in communication with the fluid chamber 72 at opposite sides of the valve seat 74. The conduit 47 leading from the generator 40 is connected into open communication with the fluid port 84 of the upper valve 50. One end of another conduit 90 is connected in open communication with the fluid port 86 of the same valve device, and the other end of the conduit 90 is connected in open communication with the fluid port 86 of the lower valve device 50. One end of a third conduit 92 is connected in open communication with the fluid port 84 of the lower valve 50, and the other end of the conduit 92 is connected into one of the fluid ports of the motor 30. The conduit 46 leading from the generator 40 connects into the other fluid port of the motor 30; thus providing a closed circuit fluid transmission system including, in series: the generator 40; the valves 50—50; and the motor 30.

As illustrated, the generator and valve and motor system is so arranged that, for example, when the control handle 45 is manually twisted forwardly and downwardly the valve mechanism 44 is thereby adjusted so as to cause fluid under pressure to be directed to flow from the generator 40 through the conduit 47 into the port 84 of the upper valve 50. Assuming that the control motion of the handle 45 referred to hereinabove is applied when the gun battery is in a substantially neutral or horizontal attitude as viewed in Fig. 1, the actuating stems 58—58 of both the upper and lower valves 50—50 will be free from contact with the gun mount port, and the valve devices 50—50 will therefore be disposed in the positions thereof as illustrated in Fig. 2. Consequently, the pressured fluid will be free to flow through the upper valve 50 from the port 84 and through the valve seat 74 and thence into the conduit 90 leading to the lower valve 50. The fluid will thereupon flow through the port 86 of the lower valve and then through the valve seat 74 thereof and out of the port 84 into the conduit 92 leading to the motor 30. The fluid will then flow through the motor 30 in such direction as to actuate the motor to rotate the gun mount frame 22 in counter-clockwise direction as viewed in Fig. 1 about the axis of the bearings 26—26, so as to depress the gun battery aim in consonance with the manual depression of the control handle 45 referred to hereinabove.

As long as the control handle 45 is held in the depressed inclination referred to, the hydraulic fluid will tend to flow from the generator 40 through the motor 30 in the manner referred to, and the gun battery will continue to rotate for elevational aim adjustment purposes as described. However, upon arrival of the gun battery at the predetermined lower limit of gun barrel depression, as indicated by relative positions of other structural elements of the aircraft or the like, the gun battery aiming movement referred to must be stopped just prior to any physical bearing of the gun barrel mechanism or the like against the interfering structures. As explained in the specification hereinabove, the upper valve 50 is mounted upon the bracket 32 in such manner that upon arrival of the gun battery at the predetermined maximum muzzle-depressed position thereof, the gun mount frame 22 will bear against the actuating stem 58 of the upper valve in such manner as to withdraw the pin 62 thereof away from the valve ball 70. This will permit the spring 80 to move the valve ball 70 into fluid sealing position against the valve seat 74, whereupon the circulation of pressured fluid referred to hereinabove will be interrupted. Consequently, operation of the motor 30 and aim adjusting motion of the gun battery will be simultaneously stopped; and the motor 30 will remain inactive so long as the control handle 45 is left to remain either in a depressed attitude as referred to hereinabove or in its neutral position.

Upon manual twisting of the control handle 45

to an upwardly inclined attitude, however, the valve mechanism 44 will be thereby adjusted so as to direct fluid to flow under pressure from the generator 40 through the conduit 46 and through the motor 30 in direction reverse to the previously referred to flow of fluid through the motor. Consequently, the fluid pressure forces will then tend to circulate fluid through the hydraulic system so as to pass through the still open lower valve 50 and thence through the conduit 90 so as to enter the upper valve 50 through the port 85 thereof to apply fluid pressure forces against its valve ball 70 in opposition to the forces of the spring 80. The fluid pressure force system and the valve spring 80 are provided so as to be of such relative strength that the reverse flow pressure forces referred to are capable of unseating the valve ball 70 against the action of the spring 80. Consequently, under such conditions of adjustment of the control handle 45 the fluid pressure force system will operate in reverse direction to immediately commence elevation of the gun battery aim. The gun battery will thereupon back away from bearing relation against the upper valve stem 58, whereby the spring 59 will be enabled to actuate the pin 62 to maintain the upper valve unit positively in open condition. Thus, the gun battery aim elevating movement will continue if the control handle 45 is maintained in upwardly twisted attitude, but only until the gun battery reaches the predetermined maximum muzzle-elevated position thereof, whereupon the gun battery frame will impinge against the actuating stem 58 of the lower valve 50. This will permit the valve ball 70 to seat itself so as to stop the elevating movement of the gun battery in a manner identical to the operation of the upper valve 50 as explained hereinabove.

Therefore, the hydraulic control system will again be in condition to be adjusted to operate in reverse direction only upon subsequent manipulation of the control handle 45 to a downwardly tilted attitude; and that the hydraulic control system of the invention is therefore provided to control the gun battery to move upon the bearings 26—26 for elevational aim adjustment purposes in direct consonance with similar movements of the control handle 45 as applied manually by the gun battery attendant. Thus, it will be appreciated that the automatic aim movement stop means of the invention is adapted to function to positively limit the aim adjusting movements of the gun battery without involving mechanical interferences of parts of the mechanism such as might otherwise bind or lock the mechanism in stopped positions, or impose undue wear upon the control mechanism. It will be understood that although the automatic stop means of the invention has been illustrated and described herein only in connection with the elevational aim adjustment mechanism of the gun battery, it may be applied if desired with equal facility to control the operation of the azimuth control motor 28; and that the stop mechanisms referred to may also be employed to provide the features and advantages of the invention in conjunction with other types of gun mounts and aim adjusting devices.

I claim:

1. In a gun aiming hydraulic power supply system for stopping the movement of a gun at predetermined limits including a fluid circuit, a normally open circuit interruption valve comprising a housing having a fluid passageway there-

through in normally open series communication with the fluid circuit, a valve seat disposed intermediately of said passageway, a valve disposed within said passageway and adapted to move between seated and unseated positions to alternately close and open said valve device for controlled fluid passage purposes, a spring tending to bias said valve toward seated position, and push rod means extending from exteriorly of said housing into said fluid passageway portion to register in abutting relation with said valve for forcibly unseating the latter against the action of said spring, said push rod being arranged to be actuated by the gun upon its arrival at a predetermined position, whereby the fluid to said motor will be interrupted by the actuated valve.

2. A hydraulic motor system for moving a gun to be aimed, said system including a pressure generator and a motor adapted to be connected to a gun for aiming purposes, said hydraulic system including a stop valve device comprising a housing having a fluid passageway therethrough, a valve seat disposed intermediately of said passageway, a valve disposed within said passageway and adapted to move between seated and unseated positions to close and open said valve device for controlled fluid passage purposes, a spring tending to bias said valve toward seated position, a push rod extending from exteriorly of said housing to register with said valve, means normally biasing said push rod for forcibly unseating said valve against the action of said spring, said push rod being arranged to be actuated by the gun upon its arrival at a predetermined position whereby said valve will be released so as to be subjected to the action of said spring to interrupt the flow of fluid to said motor.

3. A hydraulic pressure system for moving a gun for aiming purposes, said system including a motor adapted to be connected to the gun for gun aim purposes, and a stop valve device comprising a normally open spring-biased check valve connected in normally open communication with said motor and a push rod extending from exteriorly of said check valve to register with the valve element thereof, and means normally biasing said push rod for forcibly unseating said valve element against the action of its spring, said push rod being arranged to be actuated by the gun upon its arrival at a predetermined position, whereby the fluid to said motor will be interrupted by the actuated stop valve device.

4. A hydraulic pressure conduit system for actuating a gun for aiming purposes, said system including a motor for driving the gun for aiming purposes, and a normally open stop valve device comprising a housing having a fluid passageway therethrough, a valve seat disposed adjacent said passageway, a valve member disposed to move against said seat to close said valve device against flow of fluid through said passageway, means tending to bias said valve toward seated position, and push means extending from exteriorly of said housing to register with said valve for forcibly unseating the latter against the action of said biasing means, said push means being arranged to be actuated by the gun upon its arrival at a predetermined position, whereby the fluid to said motor will be interrupted by the actuated stop valve device.

5. A hydraulic conduit system for actuating a gun for aiming purposes, said system including in series; a reverse direction hydraulic pressure generator; a reverse direction motor for driving a gun for gun aim purposes; a control device

for adjusting said generator to discharge fluid under pressure to circulate through said conduit system in opposite directions; and a stop valve device adjacent the limit of gun movement in each direction, each of said stop valve devices comprising a housing having a fluid passageway therethrough in normally open series communication with said conduit system, a valve seat disposed adjacent said passageway, a valve disposed to move between seated and unseated positions to alternately close and open said valve device for controlled fluid passage purposes, a spring tending to bias said valve toward seated position, and push rod means extending from exteriorly of said housing to register with said valve and normally biased for forcibly unseating the valve against the action of said spring, said push rod being arranged to be actuated by the gun upon its arrival at predetermined opposite positions, whereby said valves and springs are released and said valve devices are freed to operate as check valve devices.

6. A hydraulic conduit system for actuating a gun for aiming purposes, said system including a reversible motor for connection to a gun for gun aim purposes, said hydraulic system including a pair of normally open stop valve devices in normally open series communication with said motor, each device comprising a spring-biased check valve, push means extending from exteriorly of said check valve to register with the valve element thereof, and means normally biasing said push means for forcibly unseating said valve element against the action of its spring, said push means being arranged to be actuated by the gun upon its arrival at opposite predetermined positions, whereby the fluid to said motor will be interrupted by the actuated stop valve device.

7. In a hydraulic gun training system, a reversible hydraulic pressure generator, a reversible motor for connection to a gun for gun training purposes, a pair of stop valve devices arranged one at each end of the gun aiming travel, conduit means connecting said generator, said motor, and said valve devices in series with each other in a fluid-tight system, means for directing the fluid in said system from said generator in either direction through the conduit and associated means, each of said valve devices comprising a housing having a fluid passageway therethrough in open communication with said system, a valve seat disposed intermediately of said passageway, a valve disposed within said passageway and adapted to be moved between seated and unseated positions to close and open said valve devices for controlled fluid passage purposes, a spring tending to bias said valve toward seated position, a push rod extending from exteriorly of said housing to register with said valve and normally biased for forcibly unseating the valve against the action of said spring, one of said push rods being arranged to be actuated by the gun upon its arrival at either end of predetermined aiming travel, whereby the spring and said valve of the actuated devices will be released and the device free to operate as a check valve device.

8. In a fluid-tight gun training system, a gun mounted for swinging movement between two predetermined positions, a pair of valve devices connected in said system in series with each other for alternate opening and closing to interrupt the flow of fluid in said system, each valve comprising a housing having a fluid passageway therethrough for normal uninterrupted communication with said system, a valve seat disposed intermediately of said passageway, a valve disposed within said passageway and adapted to move between seated and unseated positions to alternately close and open said valve device for controlled fluid passage purposes, a valve spring tending to normally bias said valve toward seated position, push rod means extending from exteriorly of said housing into said fluid passageway portion to register in abutting relation with said valve for forcibly unseating the latter against the action of said valve spring, and an actuating stem slidably carried by said housing and attached to the exposed end of said rod, a stem spring tending to bias said stem toward normal operative position, said stem spring also serving to counteract said valve spring to normally maintain said valve in open position, said actuating stem having an operating portion extending exteriorly of said housing for engagement by the gun upon its arrival at oppositely arranged predetermined positions in said movement thereof.

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