Feb. 1, 1944. O. W. MACY 2,340,399

FLUID CONTROL VALVE

Filed April 5, 1941 3 Sheets-Sheet 1

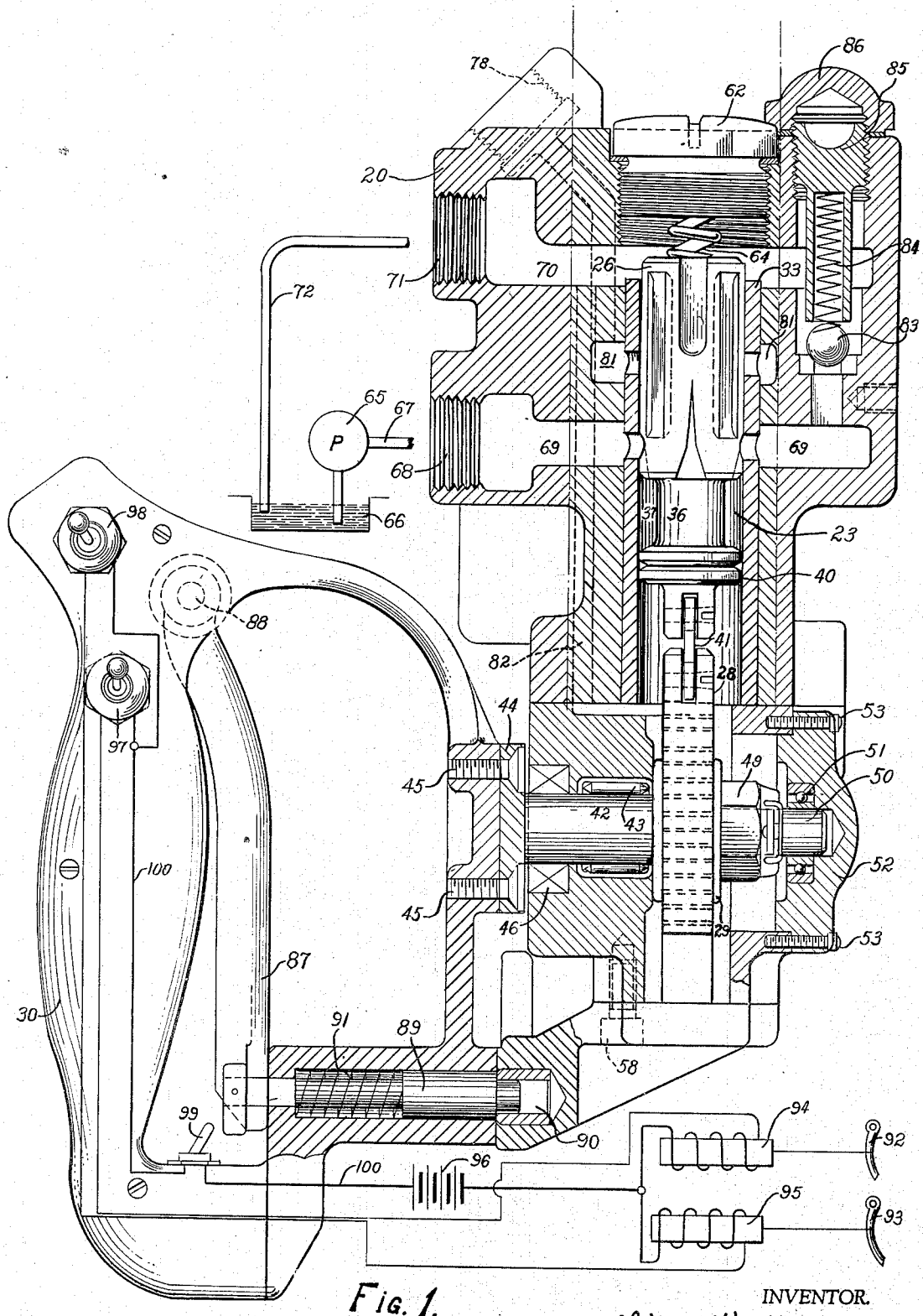


Fig. 1.

INVENTOR.
Oliver W. Macy

BY

Hoadley and Kroot attys

Feb. 1, 1944. O. W. MACY 2,340,399

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Filed April 5, 1941 3 Sheets-Sheet 2

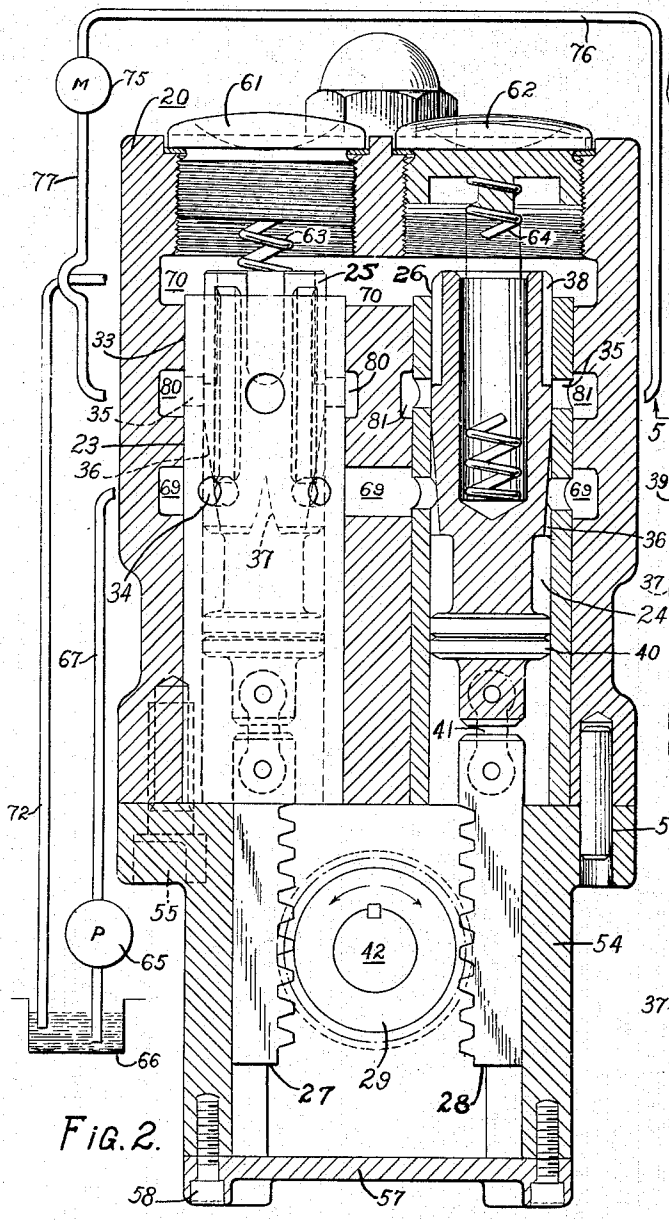


Fig. 2.

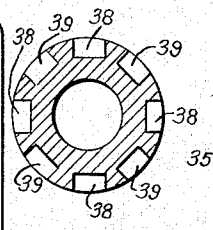


Fig. 5.

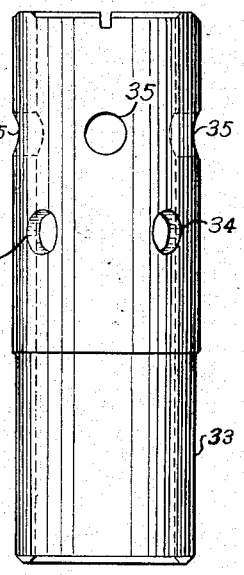


Fig. 3.

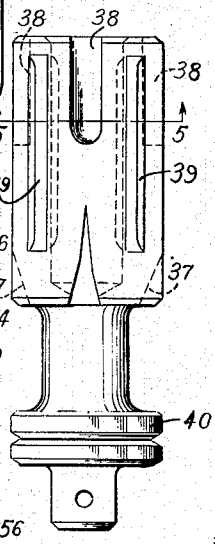


Fig. 4.

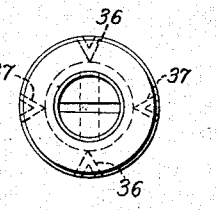


Fig. 6.

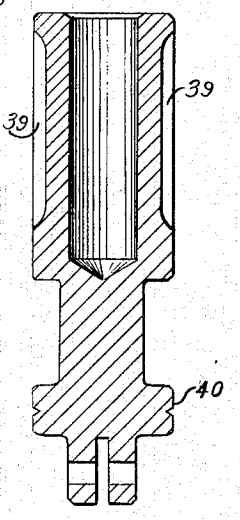


Fig. 7.

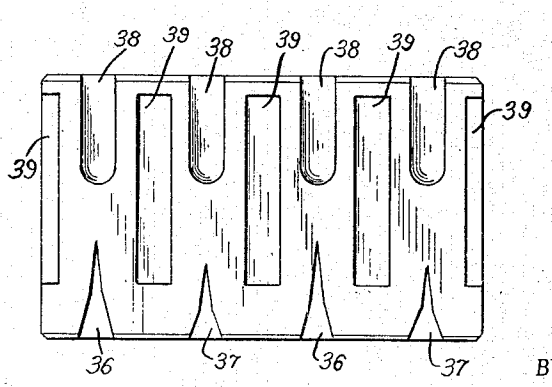


Fig. 8.

INVENTOR.
Oliver W. Macy.
BY
Hoodling and Kroat attys

Feb. 1, 1944. O. W. MACY. 2,340,399

FLUID CONTROL VALVE

Filed April 5, 1941 3 Sheets-Sheet 3

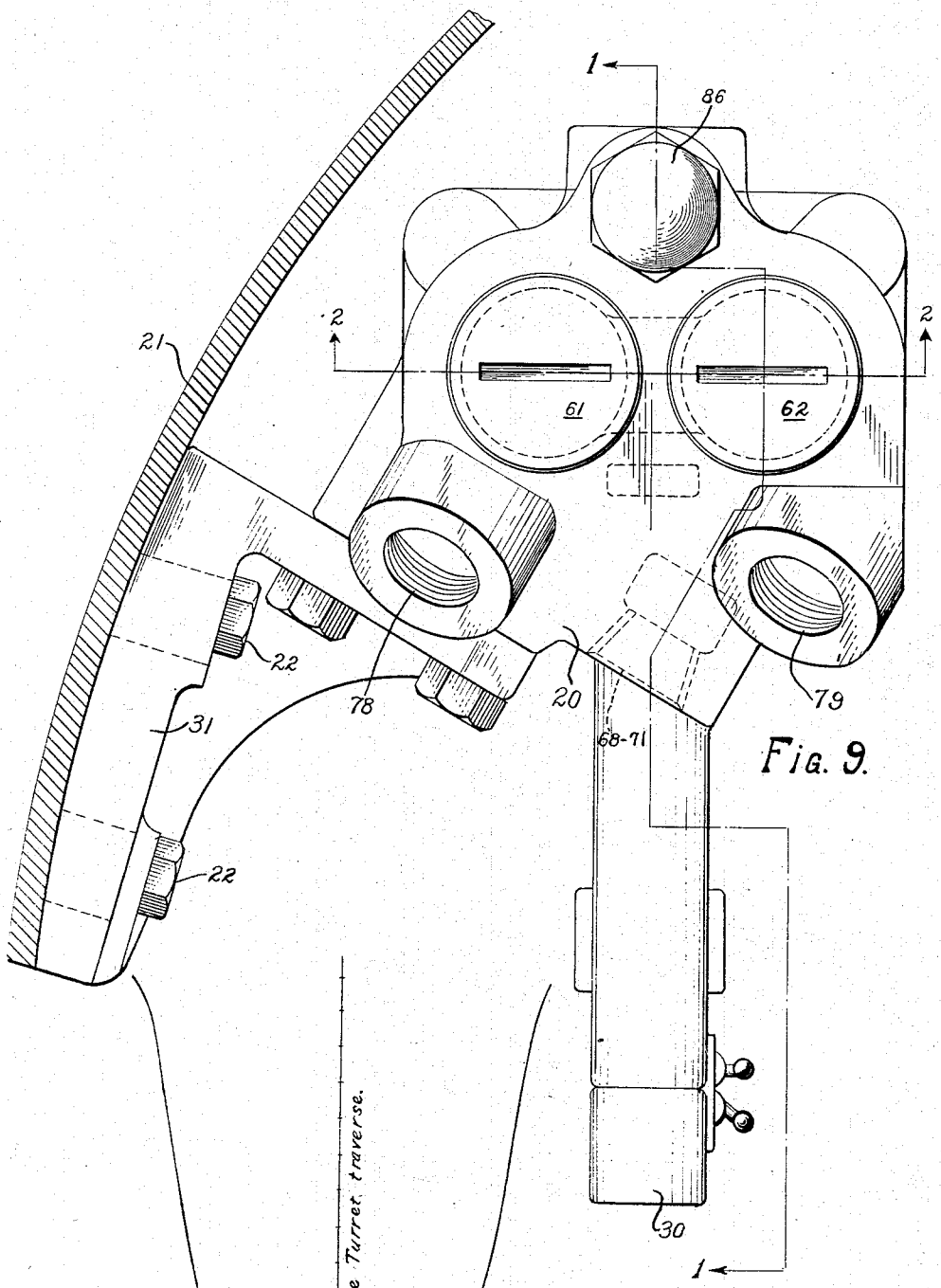


Fig. 9.

Fig. 10.

INVENTOR.
Oliver W. Macy
BY
Spaulding and Kront attys.

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UNITED STATES PATENT OFFICE

2,340,399

FLUID CONTROL VALVE

Oliver Wendell Macy, Logansport, Ind., assignor to Logansport Machine, Inc., a corporation of Indiana

Application April 5, 1941, Serial No. 387,105

2 Claims. (Cl. 251—76)

My invention relates in general to valves and more particularly to a fluid control valve adapted to govern the operation of a turret for aiming and firing a gun which may be mounted on tanks or other equipment.

An object of my invention is the provision of a fluid control valve which may be readily mounted upon the inside of a turret on tanks or other equipment and which may be easily operated by twisting or turning a handle.

Another object of my invention is the provision of a fluid control valve which is compact and which is of a balanced design to give uniform control of the traverse of the turret for both directional movements.

Another object of my invention is the provision of arresting the movements of the turret when the handle is in a vertical position and of traversing the turret in either one of two directions by merely twisting or turning the handle from a vertical position.

Another object of my invention is the provision of controlling the flow of the fluid through the valve to give a non-linear characteristic between the traverse of the turret and the twisting or turning of the control handle.

Another object of my invention is the provision of a hand-grasping lever mounted on the control handle of the control valve which when the hand-grasping lever is ungripped the firing circuit for controlling the firing of the guns is interrupted, with the result that the firing of the guns cease upon the release of the hand-grasping lever.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 represents a side elevational view, mainly in cross-section, taken along the line 1—1 of Figure 9;

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 9 and shows in addition thereto the fluid control pipes interconnecting the fluid pump and the control valve and the fluid motor and the control valve;

Figure 3 is a side view of a cylindrical sleeve in which the fluid control plungers slidably operate;

Figure 4 is a view of a fluid control plunger which reciprocally operates within the sleeve shown in Figure 3;

Figure 5 is a cross-sectional view taken along the line 5—5 of Figure 4;

Figure 6 is an end view of the plunger shown in Figure 4 and looking upwardly thereof;

Figure 7 is a longitudinal cross-sectional view of the plunger shown in Figure 4;

Figure 8 is a view showing the side of the valve portion of the plunger of Figure 4, developed in the flat;

Figure 9 is a plan view of the casing of my valve and is shown as being mounted upon the inside of a turret which may be mounted upon a tank or other equipment; and

Figure 10 is a chart showing the non-linear characteristics of my control valve illustrating the relationship between the speed of the turret traverse and the degrees of inclination of the control handle from a neutral position.

With reference to the drawings, the valve casing for my control valve is indicated generally by the reference character 20 and as shown in Figure 9 may be mounted to the inside of a turret 21 which may be mounted upon a tank or other equipment. The turret 21 as illustrated in Figure 9 is but a small portion of the entire turret which in actual practice may be in the neighborhood of five feet in diameter. Any suitable means may be employed to mount the valve casing 20 upon the inside of the turret and as illustrated I employ bolts or cap screws 22 which extend through a bracket portion 31 and threadably engage the turret wall.

The construction of my control valve is shown principally in Figures 1 to 8, inclusive, and comprises generally fluid cylinders 23 and 24, valve plungers 25 and 26, respectively, mounted in the fluid cylinders 23 and 24, actuating members 27 and 28 for respectively actuating the valve plungers 25 and 26, a gear wheel 29 positioned between and engaging the actuating members and a handle 30 mounted externally of the casing 20 for governing the movements of the gear wheel and the valve plungers 25 and 26. The fluid cylinders 23 and 24 are identical and are disposed side-by-side and are substantially parallel to each other. Each of the fluid cylinders 23 and 24 is provided with a cylindrical sleeve 33, which is shown in side elevation in Figure 3. As illustrated, the cylindrical sleeve 33 is arranged to fit snugly within longitudinal bores in the valve casing 20. In order to control the flow of the fluid, the cylindrical sleeve 33 is provided with a set of inlet openings 34 and a set of outlet openings 35 spaced longitudinally from each other but radially about the cylindrical sleeve.

The valve plungers 25 and 26 are identical and a side-elevational view of same is shown in Figure 4. The plungers are arranged to be reciprocally operated within the cylindrical sleeve to

control the flow of the fluid through the valve casing. The lowermost portion of the valve plunger is provided with a seal portion 40 which fits closely within the inside longitudinal bore of the cylindrical sleeve 33. As illustrated, the seal portion 40 is provided with a fluid groove in order to make a good sealing engagement to prevent the fluid from leaking downwardly into the lowermost portion 54 of the valve casing. The uppermost portion of the valve plungers which may be designated as the valve portion of the plungers is provided with a plurality of groups of fluid grooves which regulate the flow of the fluid through the valve casing 20. One group of fluid grooves may be designated as the metering grooves and are designated by the reference characters 36 and 37 disposed around the lowermost portion of the valve part of the plunger. The distinction between the metering grooves 36 and 37 is that the metering grooves 36 are long and the metering grooves 37 are short. As illustrated, the metering grooves 36 are disposed diametrically opposite each other and the metering grooves 37 are disposed diametrically opposite each other and all grooves are arranged 90 degrees apart around the lowermost portion of the valve part of the plunger. The metering grooves 36 and 37 may be provided in the plunger by cutting same therein with suitable cutters. The development of the size of the valve portion of the plunger is shown in the flat in Figure 8. The bases of the metering grooves 36 and 37 are relatively broad whereas the apexes of the grooves are relatively sharp or narrow. Thus, the construction or shape of the metering groove is such as to give a non-linear characteristic as shown in Figure 10 of the drawings. The ordinate represents the speed of the turret traverse and the abscissa represents the degrees of inclination of the control handle which actuates the plungers within the fluid cylinders. The group of grooves represented by the reference character 38 may be characterized as exhaust grooves and are disposed 90 degrees apart around the upper portion of the valve part of the plunger. The group of grooves represented by the reference character 39 may be characterized as by-path grooves and are disposed 90 degrees apart around the valve plunger for permitting the fluid to by-pass through the valve casing when the handle 30 is in its neutral or vertical position.

The valve plungers 25 and 26 are operated by actuating members 27 and 28, respectively, which are spaced apart and have rack teeth facing each other which are engaged by the teeth of the gear wheel 29. The actuating members are connected to the valve plungers by means of a connecting link 41 to permit relative alignment movement between the actuating members and the plungers and thereby allow the plungers to reciprocate up-and-down within the cylindrical sleeve without any restraint being transmitted thereto from the gear wheel and the actuating members. As illustrated in Figure 1, the gear wheel 29 is carried by a shaft 42 which extends externally of the valve casing 20 and is there provided with an external flange 44 to which the handle 30 may be attached by means of threaded members or screws 45. The shaft 42 may be designed to operate in roller bearings 43 to minimize the friction against the turning of the handle. The shaft may also be sealed with the casing 20 by means of a fluid seal diagrammatically illustrated by the reference character 46 to prevent any fluid sinking along the shaft and out of the casing. The gear wheel 29 may be securely fastened to the shaft 42 by means of a nut 49, see Figure 1. The shaft 42 extends to the right and is provided with a reduced end section 50 which is arranged to be rotatively mounted in ball bearings 51 carried by a removable cap 52 which may be attached to the valve casing 20 by means of threaded screws or members 53. As the gear wheel 29 is actuated, the actuating members 27 and 28 move up-and-down in the bottom portion 54 of the casing which may be attached to the main body of the casing by means of threaded screws or members 55 and dowel pins 56 which insure perfect alignment between the actuating members and the valve plungers which reciprocally operate within the fluid cylinders. The bottom portion 54 of the casing may be enclosed by means of a plate 57 which is removably connected thereto by means of threaded screws or members 58.

The upper end of the main part of the valve casing 20 is enclosed by two threaded caps 61 and 62 against which a spring 63 and 64, respectively, engage for urging the valve plungers 25 and 26 downwardly. The threaded cap 61 is placed above the plunger 25 and the threaded cap 62 is placed above the plunger 26 and both are arranged to be removably connected to the main valve casing to give access to the plunger and cylindrical sleeve.

The fluid pump which supplies fluid for actuating the turret is indicated diagrammatically by the reference character 65 in Figures 1 and 2 and is arranged to pump fluid from a supply fluid reservoir 66 through a feed pipe 67 to a threaded inlet opening 68 which leads to an inlet common communication 69. The fluid in the inlet common communication 69 flows to the bottom of both plungers 25 and 26 through the inlet openings 34 in the cylindrical sleeve. That is to say, the fluid as it is pumped from the pump 65 is carried to the bottom portion of the valve plungers which are in common communication with each other. When the handle 30 is in its vertical neutral position the fluid flows from the inlet common communication 69 through the inlet openings 34 of the sleeve and thence through the by-pass grooves 39 to the upper end of the valve plungers 25 and 26 to a common outlet communication 70, whereupon the fluid flows through a threaded outlet opening 71 and a return pipe 72 to the supply reservoir 66. Therefore, in the neutral position of the handle 30, the fluid is pumped from the fluid pump 65, through the by-pass grooves 39 and back the return pipe 72 to the supply reservoir 66. Upon the actuation or turning of the handle from the neutral position, the fluid from the fluid pump 65 is then conducted to a fluid motor indicated diagrammatically by the reference character 75 which drives the turret upon which the guns are mounted on the tank or other equipment. The control pipes connecting the fluid motor 75 with the valve casing 20 are indicated by the reference characters 76 and 77 and are threadably connected to the valve casing 20 by engaging the threaded openings 78 and 79, see Figure 9. From the threaded opening 78, the fluid is conducted through a core in the valve casing to a fluid core 80 which communicates with the outlet opening 35 in the sleeve 33, see Figure 2. By a similar construction, the threaded opening 79 is connected by a core in the valve casing 20 to a fluid core 81 which is in communication with the openings 35 in the sleeve 33. The fluid core 80 and the fluid core 81 are thus not in common com-

munication with each other but each leads respectively to the threaded openings 78 and 79. The pipe connections in Figures 1 and 2 do not extend to the respective fluid ports or cores of the valve casing but are shown diagrammatically and cut off outside of the valve casing which if they were permitted to extend would lead to the fluid communications to which they are actually connected.

In operation, when the handle is turned or inclined to the right, the fluid motor 75 is caused to operate in one direction to operate the turret to the right and when the handle 30 is turned or inclined to the left the fluid motor 75 is caused to operate in the reverse direction and operates the turret to the left. Let it be assumed for the purpose of explaining the flow of the fluid through the valve casing that the handle 30 is inclined or turned to the left, in which event as illustrated in Figure 2, the valve plunger 26 moves upwardly and the valve plunger 25 moves downwardly. The movement of the valve plunger 26 upwardly permits fluid to flow from the common communication 69 through the long metering groove 36 to the fluid core 81 whereupon the fluid flows through the control pipe 76 to the fluid motor 75. The fluid upon leaving the motor 75 flows through the control pipe 77 to the fluid core 80 where fluid then flows through the openings 35 in the sleeve 33 to the exhaust grooves 38 and the common outlet communication 70, where the fluid then flows back through the return pipe 72 to the supply reservoir 66. Just as soon as the valve plungers 25 and 26 are shifted from their neutral position, the fluid no longer can flow from the common communication 69 to the common communication 70 through the by-pass grooves 39 since they are blanked off. Upon the turning of the handle 30 to the right from the neutral position, the valve plunger 25 is moved upwardly and the valve plunger 26 is moved downwardly. The downward movement of the plunger 25 permits the fluid in the common communication 69 to flow to the fluid core 80 through the metering grooves whereupon the fluid flows through the control pipe 77 to the fluid motor 75 for operating it in the reverse direction. The fluid upon leaving the motor 75 flows through the control pipe 76 to the fluid core 81 where the fluid flows through the exhaust grooves 38 to the common fluid communication 70, where the fluid then flows through the return pipe 72 to the supply reservoir 66. The flow of the fluid from the common communication 69 to either one of the fluid cores 80 or 81 is governed by the metering grooves 36 and 37. In the initial stages of the movement of the valve plungers, the fluid passes through the long metering grooves 36 only and as the fluid plungers are moved further in a longitudinal direction, the short metering grooves 37 are brought into operation to allow more fluid to flow therethrough. The shape and construction of the metering grooves 36 and 37 are such as to give a non-linear characteristic as shown in Figure 10 of the drawings. As the handle approaches the neutral position, the change in speed of the turret traverse becomes relatively slow as compared to the angular turning in degrees of the handle. This gives very delicate control to the aiming of the gun. As the handle 30 is turned to the extreme right or to the extreme left, a small change in angular movement effects a relatively large change in the speed of the turret traverse. The metering grooves 36 and 37 are V-shaped as shown in Figure 6. The exhaust grooves 38 and the by-pass grooves 39 are not shown in dotted lines in Figure 6 for the purpose of clarity.

In the event that fluid leaks past the seal portion 40 of the valve plunger and down into the lower or bottom portion 54 of the casing the fluid may escape therefrom through a duct 82 which leads to the outlet common communication 70, see Figure 1. Also, as shown in Figure 1, a ball check release valve 83 is provided between the common inlet communication 69 and the common outlet communication 70. The object of the ball check release valve 83 is to permit the fluid to flow from the inlet common communication 69 to the outlet common communication 70 in the event that the pressure of the pump tends to build up to a high predetermined value. The setting of the ball check release valve 83 is determined by the adjustment of an adjustable stem 85 which varies the pressure or force of a spring 84 urging the ball member against the seat of the ball check relief valve 83. When the adjusting stem 85 is once set it may be secured in a fixed position by means of a threaded cap 86 which screws down against the top of the main valve casing 20. The threaded cap 86 also prevents any fluid from leaking out of the casing should the fluid attempt to flow along the threads of the adjusting stem 85.

As shown in Figure 1, the handle 30 is provided with a hand-grasping lever 87 having its upper end connected to the handle by means of a pivot connection 88. The lower end of the hand-grasping lever 87 is arranged to actuate a locking plunger 89 having its right-hand end arranged to fit in a locking recess 90 of the valve casing 20. The locking plunger 89 is constrained to the right by means of a spring 91. The locking plunger 89 holds the handle 30 in its neutral vertical position, and the operator must squeeze the handle 30 and draw the hand-grasping lever 87 rearwardly and thus release the locking plunger 89 before he can turn the handle either to the right or left for aiming the gun mounted upon the turret of the tank or other equipment. The hand-grasping lever 89 is also interlocked with the electrical control system for governing the triggers 92 and 93 of the guns which are illustrated as being diagrammatically controlled by two solenoids 94 and 95, respectively. A snap switch 98 mounted on the handle is arranged to control the energization of the solenoid 94 from the battery 96 and a snap switch 97 is arranged to control the energization of the solenoid 95 from the battery 96. The common conductor 100 which leads from the battery 96 to the snap switches 97 and 98 is governed by an interlocking switch 99 controlled by the hand-grasping lever 87. The snap switches 97 and 98 when once snapped are continuously held open or closed as the case may be. The electrical system is such that so long as the switches 97 and 98 are closed the guns repeatedly operate, provided of course, that the interlocking switch 99 is held closed by the hand-grasping lever 87. The snap switches 98 and 97 may be referred as firing switches and the object of the interlocking switch is such that the firing is caused to cease in the event that the operator fails or is incapacitated to squeeze the control handle 30 and draw the hand gripping lever 87 to the rear where it engages the interlocking switch 99 and holds it closed for establishing the common circuit to the two firing switches 97 and 98. My control valve

is easy to operate and governs both the aiming of the guns as well as the firing of the guns.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim as my invention:

1. In a fluid control valve having a casing with a fluid cylinder, said casing having exhaust opening means in communication with the cylinder and inlet opening means in communication with the cylinder at a spaced distance from the exhaust opening means, a control opening means in communication with the cylinder at a location between the said exhaust and inlet opening means, and valve actuating means, the improvement of valve means comprising a valve plunger slidably mounted in the cylinder and actuated by the valve actuating means, said plunger having valve groove means providing valve communication between the inlet opening means and the control opening means upon actuation in one direction from a neutral position and having valve groove means providing valve communication between the control opening means and the exhaust opening means upon actuation in the reverse direction from the neutral position, said plunger upon actuation to the neutral position blanking the valve communication between the said inlet opening means and the control opening means and having by-pass groove means providing free communication between the inlet and the exhaust opening means, said plunger sealing the valve groove means and by-pass groove means from the actuating means.

2. In a fluid control valve having a casing with a fluid cylinder, said casing having exhaust opening means in communication with the cylinder and inlet opening means in communication with the cylinder at a spaced distance from the exhaust opening means, a control opening means in communication with the cylinder at a location between the said exhaust and inlet opening means, and valve actuating means, the improvement of valve means comprising a valve plunger slidably mounted in the cylinder and actuated by the valve actuating means, said plunger having metering valve groove means providing valve communication between the inlet opening means and the control opening means upon actuation in one direction from a neutral position and having valve groove means providing valve communication between the control opening means and the exhaust opening means upon actuation in the reverse direction from the neutral position, said metering valve groove means being graduated from a small size to a large size to provide a gradually increasing valve opening as the valve actuating means is actuated farther away from the neutral position, said plunger upon actuation to the neutral position blanking the valve communication between the said inlet opening means and the control opening means and having by-pass groove means providing free communication between the inlet and the exhaust opening means, said plunger sealing the valve groove means and by-pass groove means from the actuating means.

OLIVER WENDELL MACY.