March 19, 1946. C. DE GANAHL ET AL 2,396,643

HYDRAULIC CONTROLLING MECHANISM

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Fig. 1.

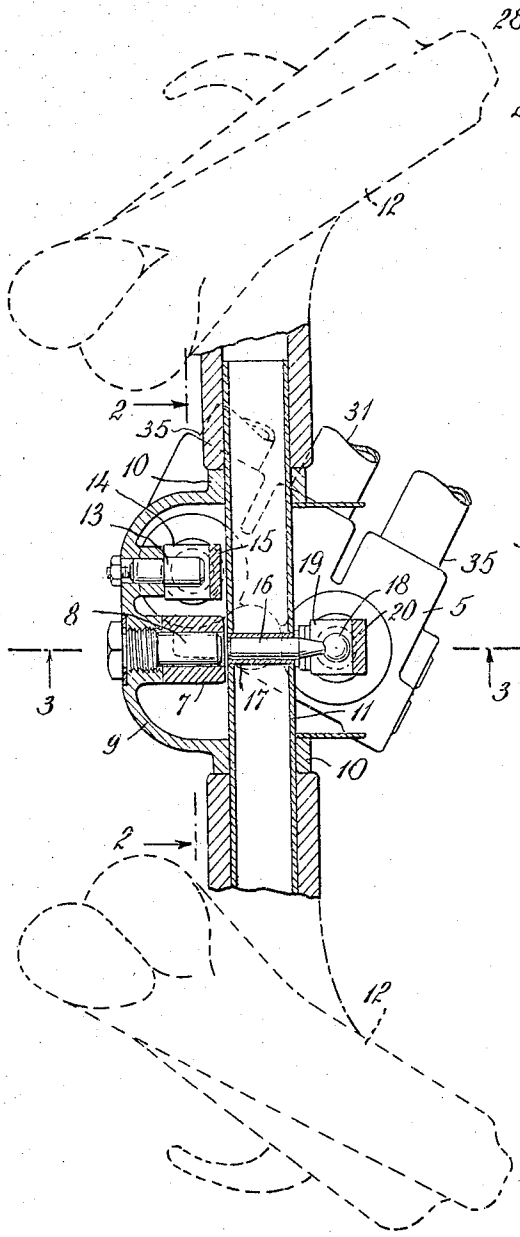


Fig. 4.

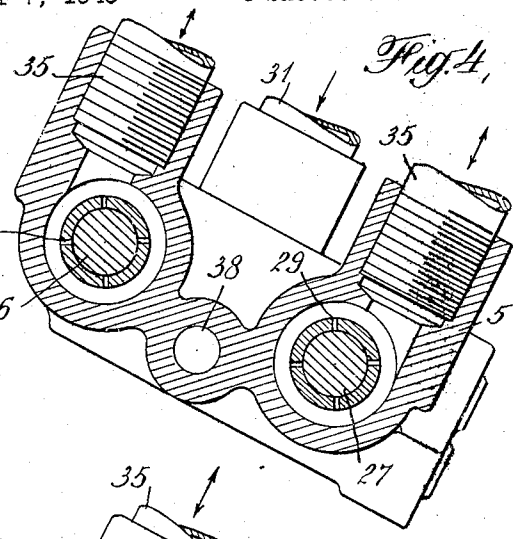


Fig. 5.

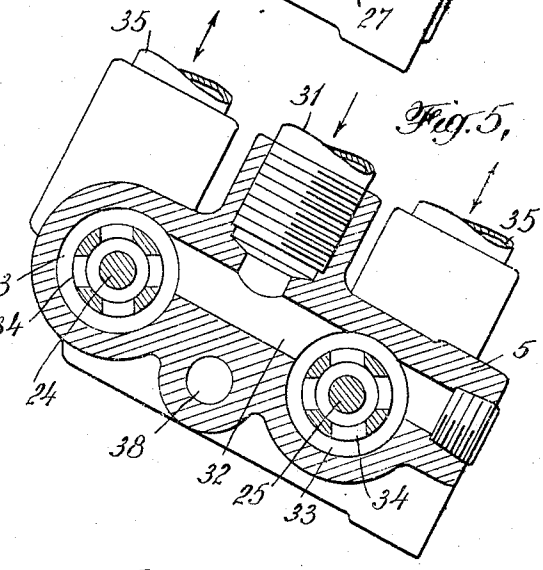
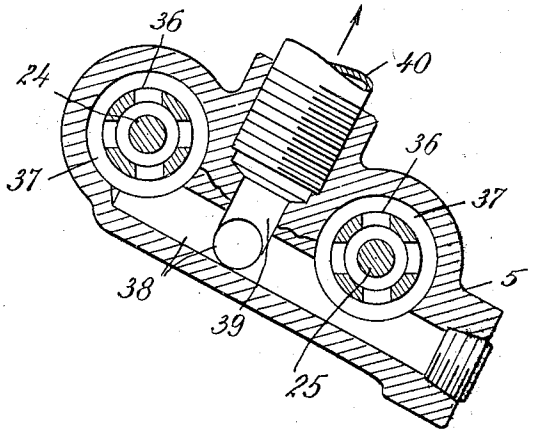


Fig. 6.



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HYDRAULIC CONTROLLING MECHANISM

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Fig. 2.

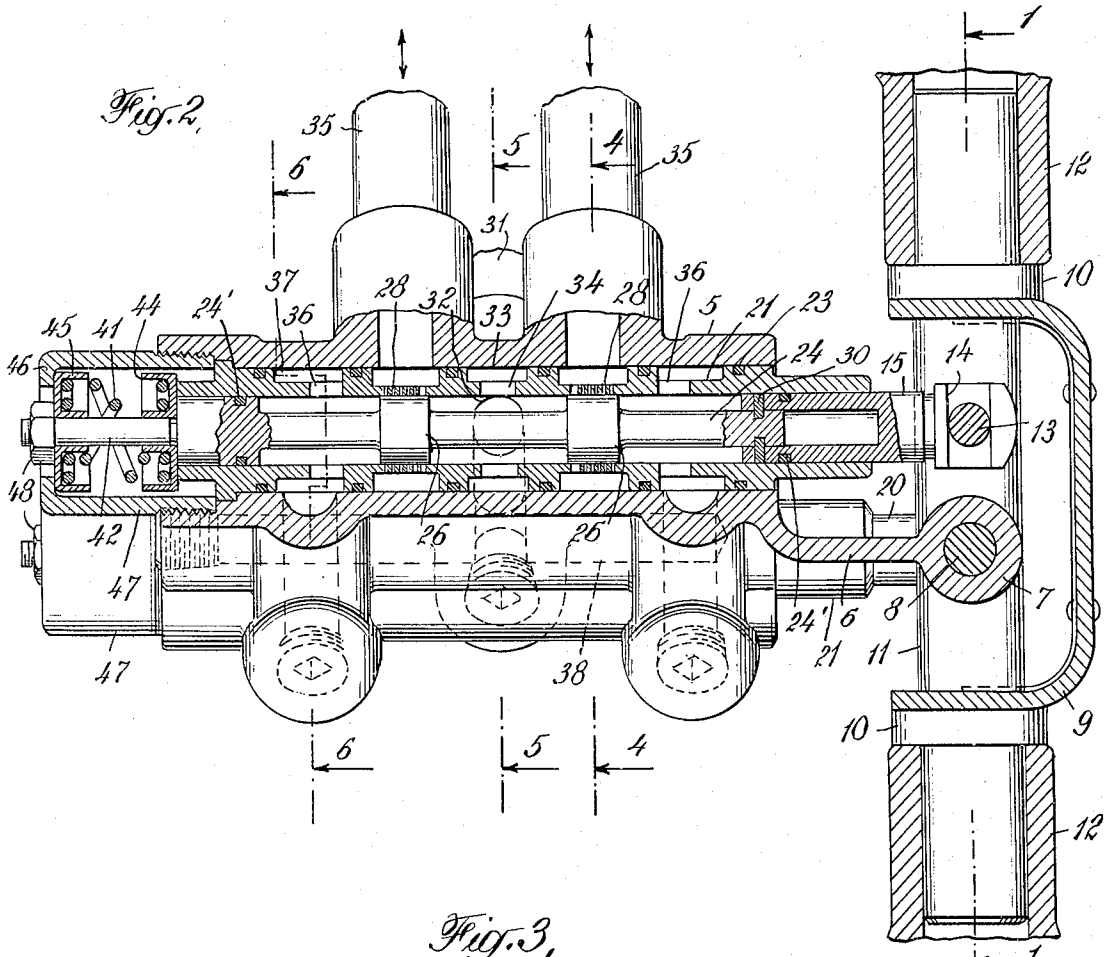
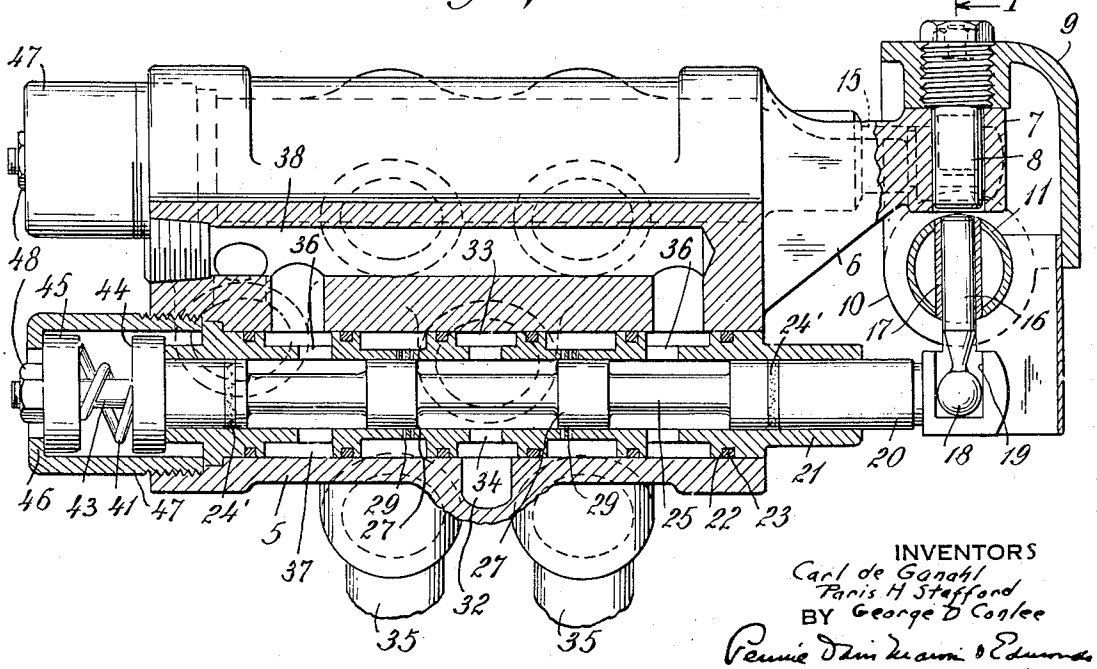


Fig. 3,



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HYDRAULIC CONTROLLING MECHANISM

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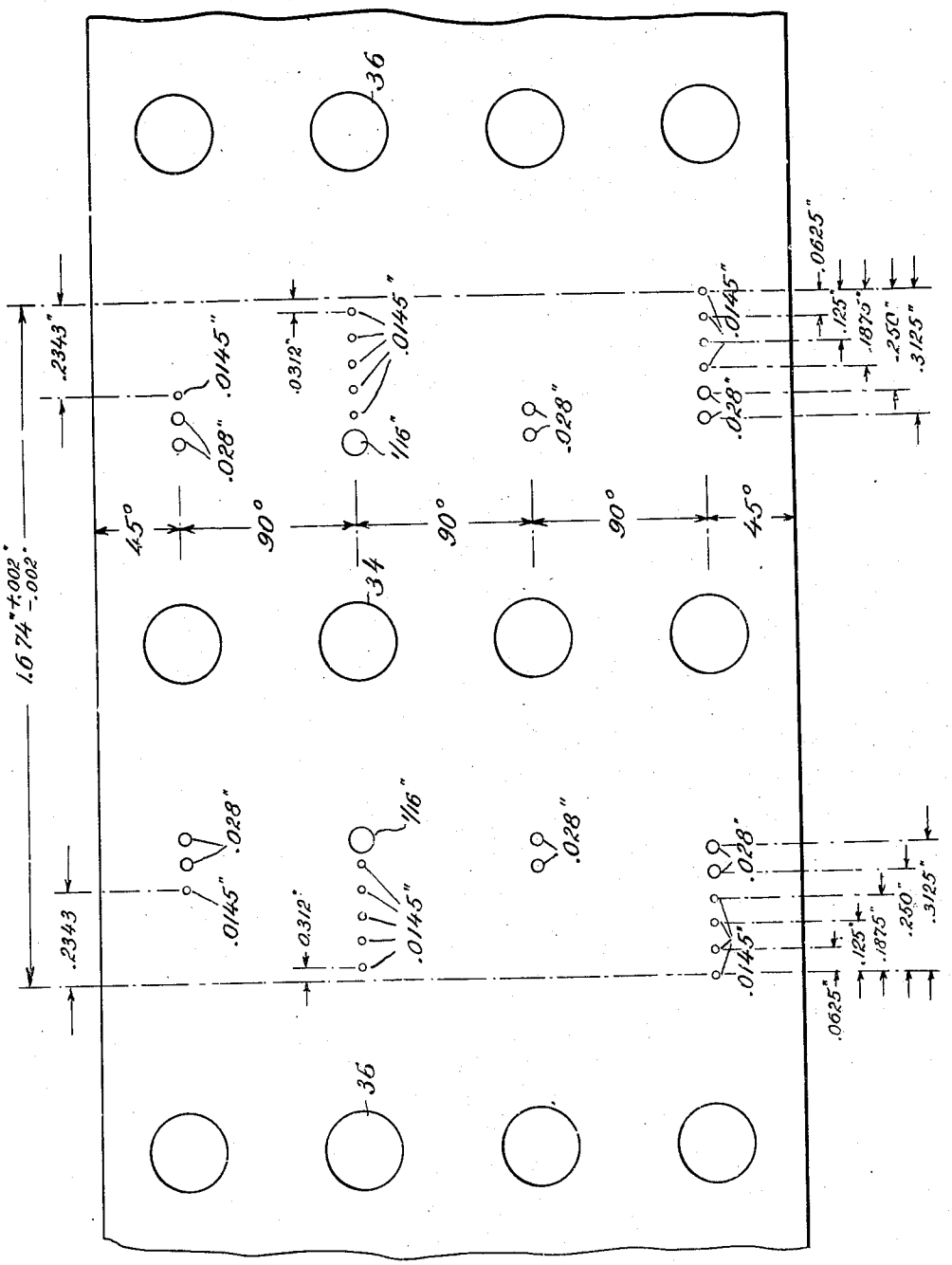

Fig. 7.

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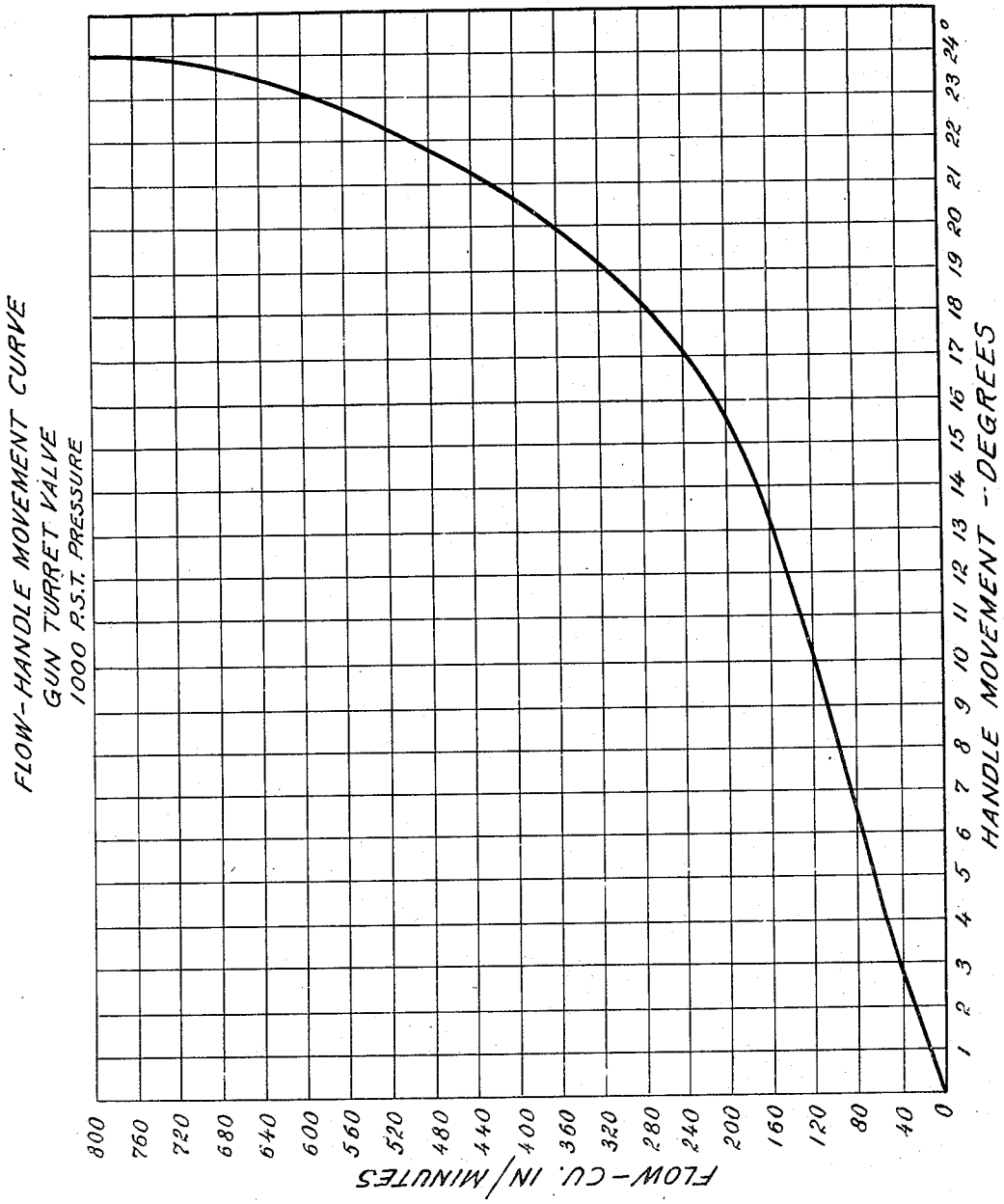
Fig. 8.



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Patented Mar. 19, 1946 2,396,643

UNITED STATES PATENT OFFICE

2,396,643

HYDRAULIC CONTROLLING MECHANISM

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Application April 7, 1943, Serial No. 482,130

1 Claim. (Cl. 251—76)

This invention relates to the control of hydraulic mechanism employed to actuate gun mounts and turrets and particularly to a valve designed to correlate the flow of pressure fluid proportionately and in a predetermined manner with the movement of an operating handle by the gunner.

In the operation of fighting aircraft, for example, the gun mounting or turret is moved to cover the target in two relatively perpendicular components of the resultant direction by fluid pressure actuated motors. The gunner controls the direction of movement by adjustment of a handle which in turn actuates the valves to determine the flow of pressure fluid from any suitable source. When the target is in or near the sights, only relatively slight and slow movement is necessary. On the other hand, rapid acceleration is frequently desirable to direct fire at a target which is at a considerable angle to the immediate line of fire, or where the relative movement of the target is very rapid or in a direction which results in rapid and wide angular displacement from the immediate line of fire.

It is the object of the present invention to provide a simple and effective valve mechanism whereby the flow of pressure fluid is controlled so that for a relatively slight movement of the valve the rate of flow is slow, and for progressively greater movement of the valve the flow is accelerated according to a predetermined pattern.

Another object of the invention is the provision of a valve which avoids the effect of wind pressure on the guns and the resulting possibility of cavitation, thus ensuring movement of the guns at the desired speed to the direction indicated, regardless of external wind factors.

Another object of the invention is the provision of means to effect movement of the gun mounting or turret in a smooth variable from ¼° per second to 45° per second in a predetermined pattern.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and accompanying drawings, in which

Fig. 1 is a section on the line 1—1 of Fig. 2;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 2;

Fig. 5 is a section on the line 5—5 of Fig. 2;

Fig. 6 is a section on the line 6—6 of Fig. 2;

Fig. 7 is a development indicating the position and size of the orifices in the valve sleeve controlling the flow of fluid; and

Fig. 8 is a graph illustrating a particular pattern of flow of the pressure fluid resulting from movement of the valve having orifices as shown in Fig. 7.

The hydraulic motors which are employed to actuate gun mountings and turrets are well known and form no part of the present invention. These devices are capable of reversible movement depending upon direction of flow of the pressure fluid therethrough. The movable parts are connected to the mechanism to be actuated, i. e., the gun mounting or turret, in any suitable way. As is evident, it is necessary to have a separate motor for each of the two components of the resultant movement. Where one of the components is zero, as in the case of movement of the gun mounting or turret in a single plane, one of the motors will be stationary. The motors are connected by suitable pipes to the controlling valves. Fluid under pressure from any suitable source is delivered to the valves, and provision is likewise made for return of the pressure fluid to a collecting reservoir. The motors, source of fluid pressure, and connections are not illustrated because they are common in the art.

Referring to the drawings, 5 indicates a valve housing which is adapted to be fixedly supported in any suitable manner to the structure with which it is embodied, as for example the turret in which the gunner sits and which is moved by the motors under his control. The housing 5 carries an arm 6 having a bearing 7 thereon. A pin 8 engages the bearing and is threadedly secured to a yoke 9 having bearings 10 supporting a hollow tubular member 11. Operating handles 12 are secured to the tubular member 11 and are adapted to be grasped by the gunner who can thus turn the tubular member 11 in its bearing and also move the structure about the axis of the pin 8. In other words, the handles are movable about two axes perpendicular to each other.

The yoke 9 carries a pin 13 which engages a groove 14 in a valve-actuating member 15 which is connected to one of the controlling valves as hereinafter described. The hollow member 11 carries a pin 16 in a socket 17 provided therein. The end 18 of the pin 16 engages a slot 19 in a valve-actuating member 20 connected to one of the controlling valves as hereinafter described.

The valve housing 5 is preferably constructed of a light metal alloy, although it may be made of any suitable material. We prefer to employ in connection with the device the structure described in the application of Frederick F. Gmitter, Ser. No. 479,822, filed March 20, 1943. In this

structure, sleeves or cylinders 21 of a hard, dense metal are fitted within bores in the casing 5 forming the valve cylinders. Any suitable metal may be used, but we prefer spun "Nitri" cast iron which affords a glass-hard, smooth inner surface when properly finished. The sleeves or cylinders 21 may have merely a sliding fit with the casing 5. Suitable passages may be provided in the sleeves 21 as hereinafter described. To prevent leakage between the casing 5 and the sleeves 21, a plurality of grooves 22 are provided in the outer surface of the sleeves, and suitable packing 23 is disposed in the grooves. For this purpose, we prefer to employ the annular type of packing described in the patent to N. A. Christensen No. 2,180,795, since it is well adapted for the purpose. However, any form of packing which will ensure a tight joint and prevent the escape of fluid under pressure between the casing 5 and the sleeves 21 may be utilized.

Piston valves 24 and 25 are disposed within the sleeves 21 and are provided with broad flanges or lands 26 and 27 to control the flow of fluid through orifices 28 and 29. The orifices 28 and 29 constitute motor ports for the passage of pressure fluid to and from a hydraulic actuating mechanism. The pistons 24 and 25 may be constructed of a hard, dense metal. We employ preferably "Nitraloy EZ" which affords a suitable hard surface. Packing 24' prevents leakage at the ends of the pistons. The piston 24 is connected by a key 30 to the valve-operating member 15, and the piston 25 is similarly connected to the valve-operating member 20. The valve 24 controls the flow of fluid to the motor which actuates the gun mounting or turret laterally, and the valve 25 similarly controls elevation and depression of the gun mounting or turret under control of the operator. Thus when the operating handles are turned about the pin 8, the valve 24 is actuated. When the handles are turned about the axis of the hollow member 11, the valve 25 is actuated. Both movements may be made simultaneously at any speed and in any degree. Under the actuation of the pressure fluid and the control of the valves 24 and 25, similar movement of the gun mounting or turret is effected.

To accomplish this movement, the pressure fluid is introduced through a pipe 31 to a passage 32 in the housing 5 which delivers it to annular passages 33 formed in the sleeves 21. It passes thence through ports 34 into the interior of the sleeve. If the valves 24 and 25 are in neutral position as shown in Figs. 2 and 3, no fluid is permitted to flow from the sleeves and consequently no movement of the gun mounting or turret occurs. If, however, either or both of the valves 24 and 25 are shifted from neutral position in either direction by movement of the handles 12, flow is permitted through the orifices 28 through pipes 35 to and from the motors (not shown). The resultant movement effected by the motors will depend upon the direction of flow through the pipes 35. Thus, if the valve 24 is moved to the right, viewing Fig. 2, the pressure fluid will flow outwardly through the pipe 35 at the right and will return through the pipe 35 at the left. Movement of the valve 24 in the opposite direction effects a reversal of the flow. The same result follows from movement of the valve 25 which controls elevation or depression of the gun mounting or turret.

The return flow of the fluid is delivered through ports 36 in the sleeves 21 to annular passages 37 communicating with a transverse passage 38 in the housing 5. A passage 39 connects the passage 38 with an exhaust pipe 40 which delivers the fluid to a reservoir (not shown).

The valves 24 and 25 are normally held in neutral position by springs 41 surrounding extensions 42 and 43 of the respective valves. The springs are disposed between cups 44 and 45 resting respectively against shoulders on the ends of the pistons 24 and 25 and flanges 46 in members 47 threadedly secured to the housing 5. The ends of the extensions 42 and 43 are threaded to receive nuts 48 permitting adjustment of the loading on the springs 41. In many cases, no preloading of the springs is desirable, but adjustment of the screws 48 permits pre-loading to any desired extent. Whether or not the springs are pre-loaded, movement of the valves 24 and 25 in either direction will tension the springs, which will tend to return the valve to neutral position if the handles 12 are released.

As hereinbefore indicated, it is desirable to effect movement of the motors and consequently of the gun mounting or turret at a relatively low rate by relatively slight movement of the handles, but to permit accelerated movement upon greater and more rapid movement of the handles. This is illustrated in Fig. 8, in which the graph represents the rate of flow of the fluid under pressure against the handle movement in degrees. As will be readily seen, the rate of flow is relatively low so long as the handle movement is relatively slight, but when the movement of the handle is increased, the rate of flow increases rapidly to the maximum. This permits rapid shifting of the gun mounting or turret when necessary, and at the same time enables the gunner to hold the target within the sights when the movement of the target from the line of fire is relatively slight. Accuracy of fire is thus readily maintained. The particular graph is determined by the requirements of the situation. It can be modified to effect operation as desired by changing the arrangement of the orifices 28 in the sleeves 21.

The particular arrangement of the orifices required to produce the result illustrated by the graph is shown in Fig. 7 which is a development of one of the sleeves 21. The sleeves 21 in the two valves may be identical or they may be varied. Usually they will be identical because of the desirability of movement in the two components at the same rate at any given time. As shown in Fig. 7, the orifices in the several quadrants of the sleeve 21 are of different size, and they are differently arranged. They are, however, identical at opposite ends in any particular quadrant. The size and arrangement can be varied to secure different results, that is to say, a modification of the operation illustrated in the graph in Fig. 8.

An important characteristic of the size and arrangement of the orifices is that the larger orifices are always nearer the center of the sleeve, that is to say, the point at which fluid under pressure is introduced. Hence upon movement of the valves 24 and 25 in either direction to permit the flow of pressure fluid through one or the other of the pipes 35 to the reversible motor, resistance to flow is reduced to a minimum. On the other hand, since movement of the valves 24 and 25 in either direction must uncover orifices to permit return flow of fluid, the orifices nearest the ends of the sleeve 21, being smaller, afford resistance to flow of the return fluid. This ensures against any possibility that wind pressure might cause the gun mounting or turret to move independently of the delivery of pressure fluid to

the motor for the purpose of effecting the desired movement. Outflow of the fluid is always retarded, whereas inflow meets no resistance in its passage through the valve. This arrangement of the orifices affords an important advantage in the present invention, since otherwise movement of the gun mounting or turret in the desired direction would be erratic and could not be adequately controlled. Regardless, therefore, of the selected sizes for the orifices, which sizes can be determined readily to effect any desired pattern similar to the graph in Fig. 8, the orifices nearest to the center of the sleeves must always be larger than those nearest the ends.

The device as described effects an important improvement in the control of hydraulic motors for the purpose described. While intended primarily for use in connection with gun mountings and turrets, it obviously may be employed in the control of hydraulic mechanism of a similar nature, regardless of the elements which may be actuated thereby.

Various changes may be made in the form, arrangement and construction of the device without departing from the invention or sacrificing the advantages thereof.

We claim:

An hydraulic valve for controlling the flow of pressure fluid to hydraulic actuating mechanism where under some conditions the force of the return-flow tends to be greater than the force of the out-flow, comprising a cylinder having an inlet for pressure fluid, two sets of orifices extending longitudinally of the cylinder one at each side of said inlet, said sets of orifices constituting motor ports for passage of pressure fluid from and back to the cylinder, a piston valve movable in opposite directions and having lands covering the orifices of both sets when in a central position, said cylinder having fluid exhaust ports for the passage of pressure fluid returned to the cylinder through said sets of orifices, said exhaust ports being positioned at opposite sides of said inlet and longitudinally outwardly of said respective sets of orifices, the size of the orifices of each set varying longitudinally of the cylinder and being smaller towards the respective ends of the cylinder, whereby when the piston valve is moved from said central position, the orifices of each set progressively will be uncovered by the lands on the piston valve, with the orifices of the set controlling the flow of fluid from the cylinder being uncovered in the order of progressively decreasing size, and the orifices of the set controlling the return flow of fluid to the cylinder being uncovered in the order of progressively increasing size, so that, at least during the initial stages of movement of the piston valve, the capacity for the outflow of fluid from the cylinder through said orifices will exceed the capacity for return flow of fluid to the cylinder.

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