

May 29, 1951

E. J. CARLETON

2,554,614

SERVORAM OF THE FOLLOW-UP TYPE

Filed June 19, 1946

2 Sheets-Sheet 1

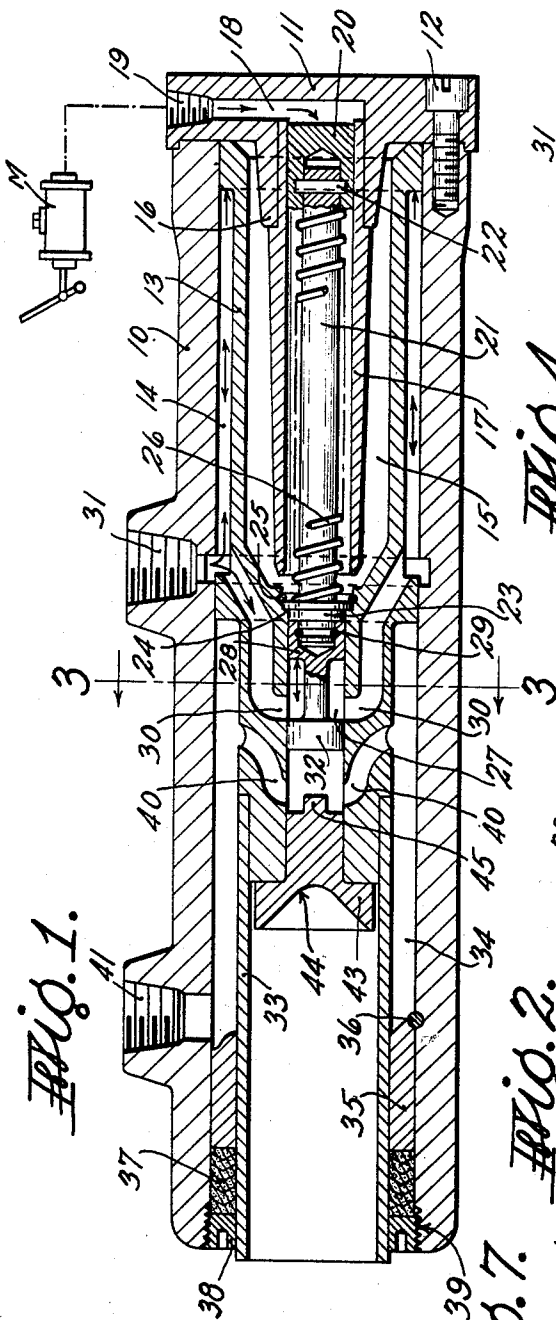


Fig. 4.

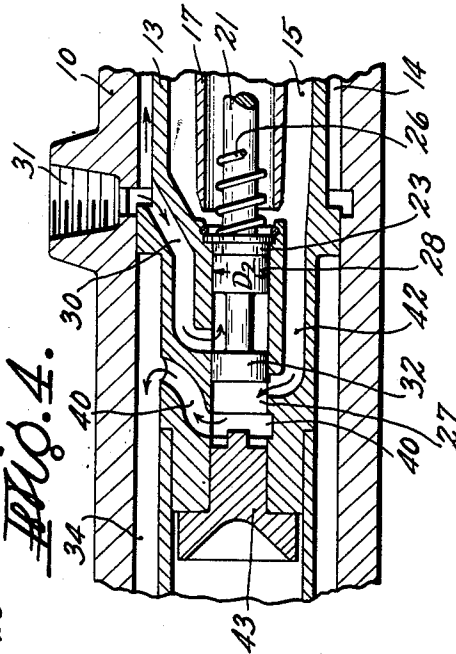


Fig. 2.

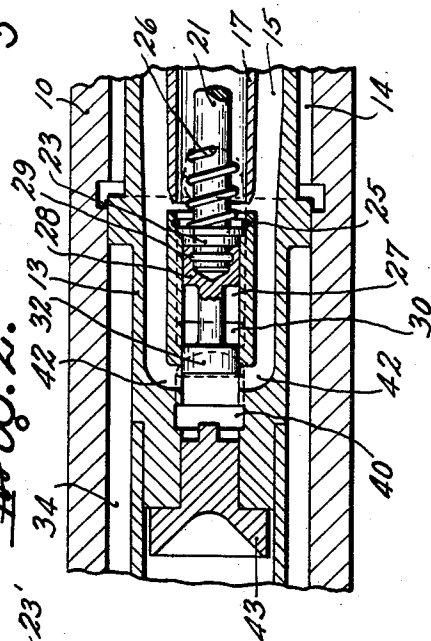


Fig. 7.



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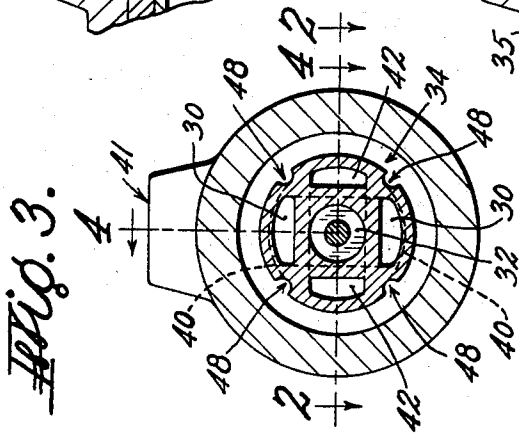
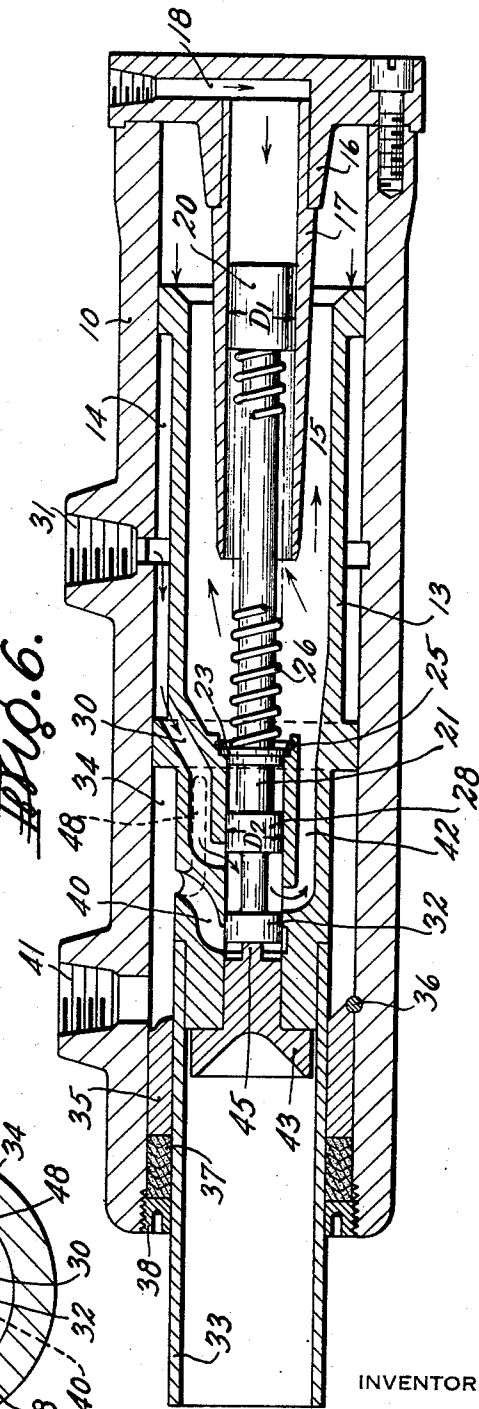
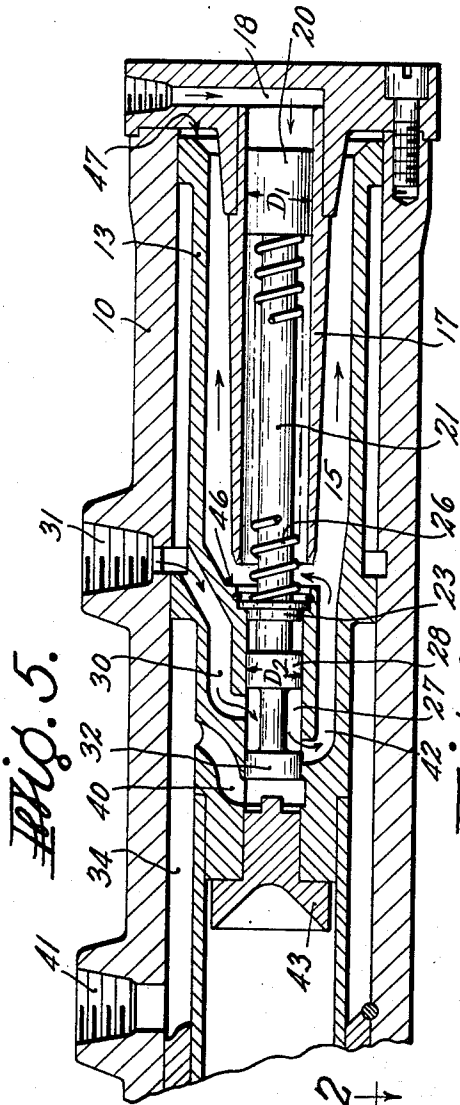
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SERVO RAM OF THE FOLLOW-UP TYPE

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6 Claims. (Cl. 121-41)

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This invention relates to an improved servo ram and more particularly to rams in which the application of the operating hydraulic pressure is initiated and controlled through hydraulic pressure supplied from a master control cylinder.

The principal object of the invention is to provide a ram of the above type which is positive in operation and in which the conditions of the resistance against which the ram is operating is perceptible to the operator of the lever or pedal by which the master cylinder is controlled.

Other and further objects residing in the details of construction will be made apparent in the following specification and claims.

In the accompanying drawings which illustrate one embodiment of the invention,

Fig. 1 is a longitudinal sectional view, the parts being in inoperative position;

Fig. 2 is a fragmentary sectional view substantially on line 2-2 of Fig. 3;

Fig. 3 is a transverse sectional view substantially on line 3-3 of Fig. 1;

Fig. 4 is a fragmentary sectional view substantially on line 4-4 of Fig. 3;

Fig. 5 is a sectional view similar to Fig. 4 but showing the initial step in the operation of the ram;

Fig. 6 is a sectional view similar to Figs. 4 and 5 showing the parts in a further stage of operation; and

Fig. 7 is a detail view of the chamber separating collar.

Referring to Fig. 1 of the drawings the ram cylinder is indicated at 10, one end being closed by a cap member 11 secured to the cylinder by machine screws, one of which is shown at 12. Operating in cylinder 10 is a ram piston 13. Piston 13 is formed on its outer wall with an annular groove 14, the interior of the piston being hollow to form a chamber 15. The cap member 11 is formed with a hollow cylindrical portion 16 which extends part way into chamber 15, and supports a valve operation cylinder 17 which is press fitted or otherwise secured in the projection 16. The rear end of cylinder 17 opens to a passage 18 formed in cap member 11, the outer end of passage 18 being threaded as at 19 to receive any suitable pipe connection to the master cylinder M.

Operating in cylinder 17 is a valve piston 20, having a diameter D_1 , pinned to a forwardly projecting stem 21 by a pin 22. Stem 21 extends through a collar 23 which is held against a shoulder 24, formed at the forward end of chamber 15, by a lock ring 25. A spring 26 surrounding

stem 21 and engaged between valve piston 20 and collar 23 normally maintains valve piston 20 at the rear end of valve cylinder 17.

Forwardly of collar 23 the central chamber of the ram is radially reduced to form a valve chamber 27 in which operates a valve plunger 28, which is of slightly less diameter, D_2 , than piston 20. Plunger 28 is secured to the forward end of stem 21 by a snap ring 29. Collar 23 is provided with openings 23' (see Fig. 7) to expose the rear face of plunger 28 to the pressure in chamber 15. Two diametrically opposite passages 30 connect chamber 27 with groove 14 which in turn opens to a port 31 adapted to be connected to a source of working hydraulic pressure. Plunger 28 is formed with a valve head 32 which in the inoperative position of Fig. 1 is positioned just forwardly of ports 30 so that hydraulic pressure entering groove 14 and chamber 27 is balanced against the rear face of head 32 and the opposite face of plunger 28 as well as in groove 14 so no movement is imparted to the valve head or to the ram piston 13.

Forwardly spaced from groove 14 the ram piston 13 is reduced in diameter and fitted with a cylindrical extension 33 forming with casing 10 an annular chamber 34 the forward end of which is closed by a short hollow cylinder 35 fitting between the extension 33 and casing 10. Cylinder 35 is held against rearward movement by a snap ring 36 and a suitable packing 37 is positioned between cylinder 35 and an annular member 38 threaded at 39 into the end of the casing, thereby rendering the end of chamber 34 fluid tight. Passages 40 connect the portion of chamber 27 forwardly of head 32 with chamber 34 and the latter opens to an exhaust port 41 adapted to be connected to a sump or the low side of a pump, not shown.

Positioned 90° from passages 30 the forward portion of ram cylinder 13 is provided, Fig. 2, with passages 42 connecting the portion of chamber 27 forwardly of head 32 with the central chamber 15 of ram piston 13. Thus in the inoperative position of the parts shown in Figs. 1, 2 and 3 the chamber 15 is open to the exhaust port 41. Since Figs. 4, 5 and 6 are taken on a quarter section (line 4-4 of Fig. 3) these figures show one of each pair of passages 30, 40 and 42.

The forward end of chamber 27 is closed by a press fitted member 43 which forms the working head of the ram piston, member 43 being recessed as at 44 to receive the brake link or other element to be operated by the ram. The rear end of member 43 is formed with a projection 45 which acts

as a stop to limit the forward movement of valve piston 20 and valve head 32 relative to the ram piston.

Referring to Fig. 5, when hydraulic pressure is admitted to the piston 20 through passage 18 valve stem 21 is moved forward against the pressure of spring 26, and head 32 is moved forwardly in chamber 27 thereby connecting passages 42 with chamber 27 at the same time shutting off said passages 42 from the exhaust. Hydraulic pressure from power port 31 now enters chamber 15 through passages 30, chamber 27 and passage 42. The hydraulic pressure entering chamber 15 acts on the working surfaces of the ram cylinder, including surfaces 46 and 47, to move the ram piston forwardly and actuate whatever mechanism is operatively engaged by the working head 43. Fig. 5 shows the initial movement of the ram piston as valve piston 20 and valve head 32 are advanced to open passages 42 to the power port of the ram.

In Fig. 6 is shown the conditions when the piston 20 and valve head 32 have reached the forward limit of movement relative to ram piston 13; the head 32 being in engagement with the stop 45, and the ram piston has advanced a substantial distance in its working stroke.

Let us now consider the operating conditions at and between the positions of Figs. 4, 5 and 6. We will assume that passage 18 is connected to a master control cylinder having a hand or foot operated piston such as is used in the central control system of a power shovel, crane or similar apparatus. As will be seen from Fig. 4 the valve head 32 has a slight forward movement before passage 42 is closed to the exhaust and opened to the power port, the reaction against the pressure in control passage 18 being only that of spring 26. This condition changes as the passage 42 is partially opened to the power port, as in Fig. 6, and ram piston moves forward against whatever working resistance is acting on working head 43. As the power fluid, preferably oil, enters chamber 15 it acts against the forward annular face of valve piston 20 and the rear face of plunger 28. Since piston 20 is of slightly larger diameter than plunger 28 the pressure entering chamber 15 creates a resistance to the forward movement of valve piston 20 in addition to the load of spring 26, which increase is perceptible to the operator. The degree of this reaction may be adjusted or controlled by increasing or decreasing the difference between the diameters of plunger 28 and piston 20, with a consequent decrease or increase in the effective forward area of valve piston 20. This reaction from the pressure of the working fluid reaches its maximum when the full pressure of the working fluid is acting in chamber 15. A further change in condition takes place when the valve piston 20 and the valve head 32 are advanced to their foremost position, relative to ram piston 13, with head 32 engaging the stop 45, as shown in Fig. 6. This relative position of the parts is obtained either by an increase of the pressure in control passage 18 or by a slowing up of the ram piston due to an increasing resistance in the working load on working head 43. With valve head 32 engaged with stop 45, as in Fig. 6, the excess of the pressure in passage 18 over the load of spring 26 plus the back pressure on the forward annular face of piston 20 becomes in effect part of the working pressure on the working head and changes in the working load will be perceptible to the operator to a degree which is proportion-

ate to the proportion of the working load being carried by piston 20. For greater sensitivity this proportion may be increased by so dimensioning the valve plunger portion 28 that the latter throttles the power passages 30 when valve head 32 is in engagement with stop 45 and as it approaches such engagement, as is shown in Fig. 6.

Upon relief of the pressure in passage 18 spring 26 returns valve piston 20 and valve head 32 to the position relative to the ram piston shown in Fig. 4, thus opening chamber 15 to the exhaust and permitting the thrust on working head 43 to return the ram to the position of Fig. 1.

If during the forward movement of the ram piston 13 under the pressure admitted to the chamber 15 through passages 42 as in Figs. 5 and 6, the pressure in passage 18 is reduced to a point just sufficient to balance the pressure of spring 26 together with that portion of the pressure in chamber 15 acting with the spring, in other words if the stem 21 and the valve members 32 and 28 carried thereby are halted, the piston 13 will move forward relative to the stationary members 32 and 28 until the ports 42 overtake and are closed by the member 32, thus trapping the fluid in chamber 15 and halting further forward movement of piston 13.

With the parts in such position it will be seen that an increase or decrease of the pressure in control passage 18 will cause the member 32 to advance or retreat respectively, to respectively open port 42 to exhaust or pressure and thereby cause the piston 13 to resume its forward movement or to move rearwardly. Thus the piston 13 may be halted at any point in its forward or backward stroke by stopping the movement of member 32, the movement of which is controlled by the pressure in control passage 18.

The length dimension of the casing 10 and the travel therein of the ram piston 13 will of course be made such that the normal working stroke of the member operated by head 43 is within the length of exhaust chamber 34 so that the openings of exhaust passages 40 do not pass beneath the member 35 at the forward end of the working stroke of head 43. However, to assure the exhausting of chamber 15 when the valve piston returns to inoperative position, even if the exhaust openings 40 have been carried beneath member 35, I preferably provide grooves 48 extending rearwardly from the openings of passages 40 on the outer surface of the ram piston to maintain connection of the passages 40 with exhaust chamber 34 through a substantial range of over travel of the ram piston.

What I claim is:

1. A fluid pressure ram adapted to be controlled by a master cylinder, comprising in combination, a ram cylinder formed with a power port and an exhaust port, a ram piston reciprocally mounted in the ram cylinder, an end closure for the ram cylinder forming a pressure chamber at the rear of the ram piston, a valve member for selectively connecting said pressure chamber to the power port or the exhaust port of the ram cylinder, a fluid pressure valve operating cylinder having a valve piston reciprocally mounted therein of greater diameter than the diameter of the valve member, said valve piston being operably connected to the valve member, a spring normally maintaining said valve piston at the rear of the valve cylinder with the valve member connecting the pressure chamber to the exhaust port of the ram cylinder, a constantly open passage from the pressure chamber to the opposed faces of the

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valve member and valve piston to admit pressure thereto only when pressure is admitted to the pressure chamber by the valve member, and a port in the valve operating cylinder for admitting fluid pressure from the master cylinder to the rear face of the valve piston to actuate the valve member.

2. A fluid pressure ram comprising in combination, a ram cylinder formed with a power port and an exhaust port, a ram piston reciprocally mounted in the ram cylinder, an end closure for the ram cylinder forming a pressure chamber at the rear of the ram piston, a valve member for selectively connecting said pressure chamber to the power port or the exhaust port of the ram cylinder, a fluid pressure valve operating cylinder having a valve piston reciprocally mounted therein of greater diameter than the diameter of the valve member, said valve piston being operably connected to the valve member, a spring normally maintaining said valve piston at the rear of the valve cylinder with the valve member connecting the pressure chamber to the exhaust port of the ram cylinder, a constantly open passage from the pressure chamber to the opposed faces of the valve member and valve piston to admit pressure thereto only when pressure is admitted to the pressure chamber by the valve member, a port in the valve operating cylinder for admitting fluid pressure to the rear face of the valve piston to actuate the valve member, and a stop member carried by the ram piston limiting the forward movement of the valve piston relative to the ram piston.

3. A fluid pressure ram comprising in combination, a ram cylinder formed with a power port and an exhaust port, a ram piston reciprocally mounted in the ram cylinder, an end closure for the ram cylinder forming a pressure chamber at the rear of the ram piston, a valve member for selectively connecting said pressure chamber to the power port or the exhaust port of the ram cylinder, a fluid pressure valve-operating cylinder having a valve piston reciprocally mounted therein of greater diameter than the diameter of the valve member, said valve piston being operably connected to the valve member, a spring normally maintaining said valve piston at the rear of the valve cylinder with the valve member connecting the pressure chamber to the exhaust port of the ram cylinder, a constantly open passage admitting pressure from the pressure chamber to the opposed faces of the valve member and valve piston when pressure is admitted to the pressure chamber by the valve member, a port in the valve operating cylinder for admitting fluid pressure to the rear face of the valve piston to actuate the valve member, and a stop member carried by the ram piston limiting the forward movement of the valve piston relative to the ram piston, the valve member being formed to partially throttle the flow of pressure fluid to the pressure chamber at the forward limit of movement of the valve piston relative to the ram piston.

4. A fluid pressure ram comprising in combination, a ram cylinder, formed with a power port and an exhaust port, a closure member closing one end of the cylinder, a ram piston reciprocally mounted in the cylinder, a pressure chamber formed in the rear portion of the ram piston and opening toward said member, a valve cylinder extending forwardly from said member part way into the pressure chamber, the forward end of said valve cylinder opening to the pres-

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sure chamber, a valve chamber formed in the forward part of the ram piston, a passage through the ram piston connecting the valve chamber to the power port of the ram cylinder, a passage through the ram piston connecting the valve chamber to the exhaust port of the ram cylinder, a passage in the ram piston connecting the valve chamber with the pressure chamber, a valve member including a valve head reciprocally mounted in the valve chamber, the rear face of the valve member being exposed to the pressure chamber, a valve piston reciprocally mounted in the valve cylinder and a stem connecting said valve member and valve piston, said valve piston being of greater diameter than the valve member to expose a greater area to the pressure chamber, said valve head when in the rear portion of the valve chamber opening the pressure chamber to the exhaust port and when in a forward portion of the valve chamber opening the pressure chamber to the power port, a spring normally maintaining the valve member in its rearmost position, and a passage, opening through said closure member to the rear face of the valve piston for admitting fluid pressure to the valve cylinder.

5. A fluid pressure ram comprising in combination, a ram cylinder, formed with a power port and an exhaust port, a closure member closing one end of the cylinder, a ram piston reciprocally mounted in the cylinder, a pressure chamber formed in the rear portion of the ram piston and opening toward said member, a valve cylinder extending forwardly from said member part way into the pressure chamber, the forward end of said valve cylinder opening to the pressure chamber, a valve chamber formed in the forward part of the ram piston, a passage through the ram piston connecting the valve chamber to the power port of the ram cylinder, a passage through the ram piston connecting the valve chamber to the exhaust port of the ram cylinder, a passage connecting the valve chamber with the pressure chamber, a valve member including a valve head reciprocally mounted in the valve chamber, the rear face of the valve member being exposed to the pressure chamber, a valve piston reciprocally mounted in the valve cylinder and a stem connecting said valve member and valve piston, said valve piston being of greater diameter than the valve member to expose a greater area to the pressure chamber, said valve head when in the rear portion of the valve chamber opening the pressure chamber to the exhaust port and when in a forward portion of the valve chamber opening the pressure chamber to the power port, a spring normally maintaining the valve member in its rearmost position, a passage, opening through said closure member to the rear face of the valve piston for admitting fluid pressure to the valve cylinder, and a stop member carried by the ram piston and engageable by said valve head to limit the forward movement of the valve member relative to the ram piston.

6. A fluid pressure ram comprising in combination, a ram cylinder, formed with a power port and an exhaust port, a closure member closing one end of the cylinder, a ram piston reciprocally mounted in the cylinder, a pressure chamber formed in the rear portion of the ram piston and opening toward said member, a valve cylinder extending forwardly from said member part way into the pressure chamber, the forward end of said valve cylinder opening to the pressure cham-

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ber, a valve chamber formed in the forward part of the ram piston connecting the valve chamber to the power port of the ram cylinder, a passage through the ram piston connecting the valve chamber to the exhaust port of the ram cylinder, a passage connecting the valve chamber with the pressure chamber, a valve member including a valve head reciprocally mounted in the valve chamber, the rear face of the valve member being exposed to the pressure chamber, a valve piston reciprocally mounted in the valve cylinder and a stem connecting said valve member and valve piston, said valve piston being of greater diameter than the valve member to expose a greater area to the pressure chamber, said valve head when in the rear portion of the valve chamber opening the pressure chamber to the exhaust port and when in a forward portion of the valve chamber opening the pressure chamber to the power port, a spring normally maintaining the valve member in its rearmost position, a passage, opening through said closure member to the rear

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face of the valve piston for admitting fluid pressure to the valve cylinder, and a stop member carried by the ram piston and engageable by said valve head to limit the forward movement of the valve member relative to the ram piston, said valve head when in engagement with said stop member partially throttling the flow of pressure fluid to the pressure chamber.

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