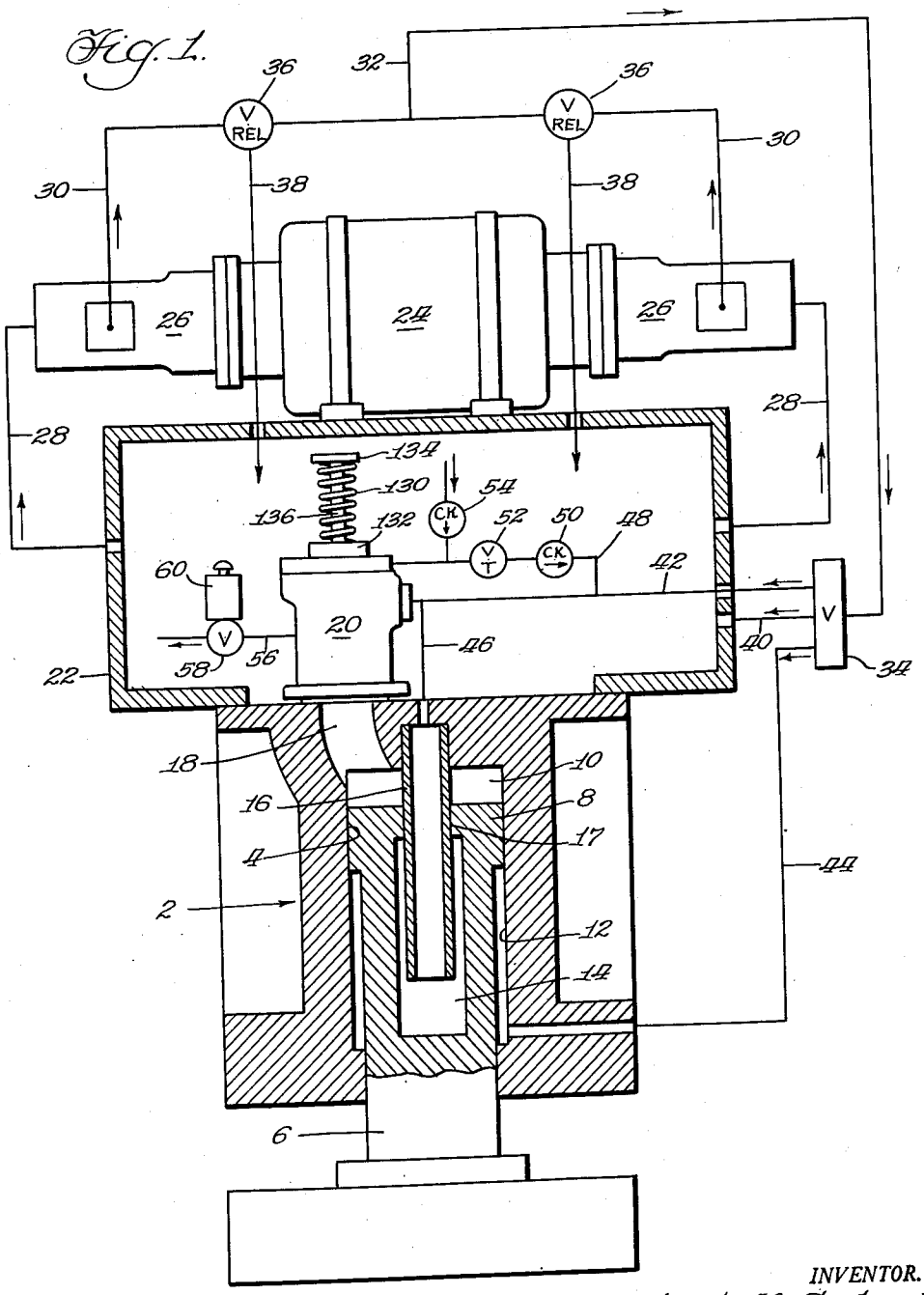
April 7, 1953 R. K. SEDGWICK 2,633,708

CONTROL FOR HYDRAULIC PRESSES

Filed July 7, 1948 2 SHEETS—SHEET 1

Fig. 1.



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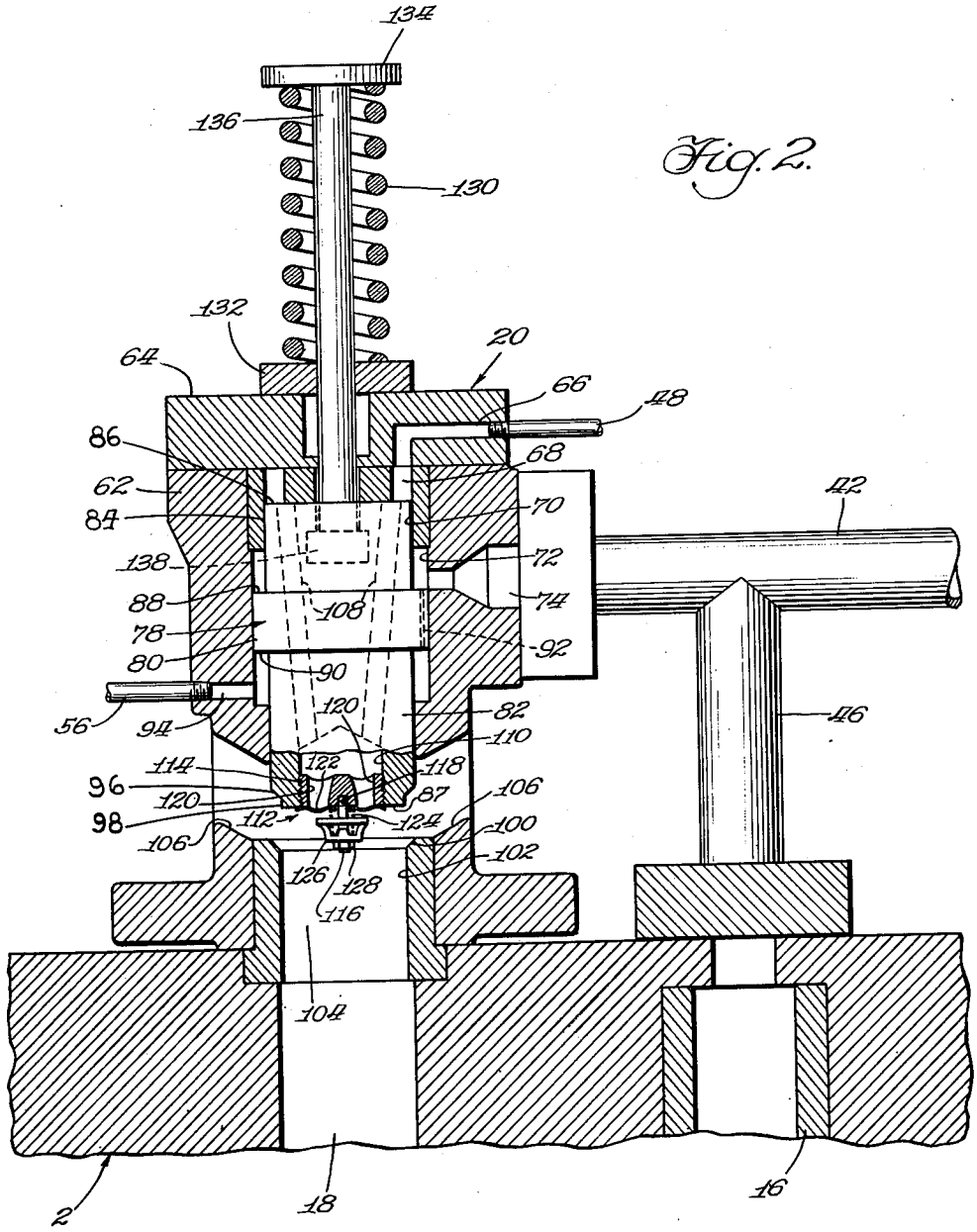

Fig. 2.

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CONTROL FOR HYDRAULIC PRESSES

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21 Claims. (Cl. 60—52)

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This invention relates to hydraulic circuits and more particularly to a novel actuating circuit for a hydraulic motor such as is commonly utilized in a press.

A general object of the invention is to devise an economical hydraulic circuit having novel means for controlling the rapid advance stroke, the full pressure stroke and the pullback stroke of a hydraulic motor.

In a hydraulic circuit, such as above described, it is frequently desirable to incorporate what is known in the art as a speed change control to slow the advance stroke of the hydraulic motor before resistance of the work is encountered and to thereafter initiate the full pressure stroke of the motor against the work. In prior art arrangements, various control mechanisms have been utilized for this purpose involving multiplicity of valves and complicated piping arrangements.

Accordingly, it is a primary object of the present invention to devise a simple hydraulic actuating circuit wherein the speed change control is incorporated in the valve mechanism heretofore utilized in the operation of a press, without the necessity of utilizing a special valve or valves.

A further object of the invention is to devise a novel circuit, such as above described, wherein the speed change control is incorporated in the prefill valve which connects the full pressure area of the ram means to a reservoir of low pressure fluid on the rapid advance and pullback strokes of the motor.

Another object of the invention is to devise a novel prefill valve incorporating a simple and economical speed change control mechanism constructed and arranged to afford speed change control of the hydraulic motor without complicating the normal functions of the prefill valve.

Still another object of the invention is to provide a system, such as above described, including means for throttling the prefill valve as the latter opens on the pullback stroke of the hydraulic motor thereby preventing sudden opening of the prefill valve and consequent chattering and damage to the equipment.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and the accompanying drawings, wherein:

Figure 1 is a diagrammatic view of a hydraulic press and the novel actuating circuit therefor, portions of the press structure being broken away in vertical section to clarify the illustration; and

Figure 2 is an enlarged vertical sectional view through the novel prefill valve and the associated portion of the hydraulic press motor.

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Describing the invention in detail and referring first to Figure 1, the novel hydraulic circuit is illustrated as applied to a hydraulic motor comprising a cylinder casting 2 having a cylinder 4 receiving a ram 6. The ram comprises a head 8 slidably fitted in the cylinder to define a main or full pressure advance chamber 10 and a return or pullback chamber 12.

The ram 6 is formed with an internal rapid advance chamber 14 having a tube 16 received therein in slidable fluid-tight engagement with a constricted portion of the chamber 14 as at 17. The tube is carried by the cylinder casting 2 and affords a convenient hydraulic connection to the rapid advance area of the ram 6 within the chamber 14. In this connection it may be noted that the hydraulic motor is diagrammatically illustrated and may be of any conventional form with the rapid advance area and the full pressure area of the ram in the same or separate cylinders, as will be readily understood by those skilled in the art.

The main pressure chamber 10 which contains the main or full pressure area of the ram 6 is connected by a passage 18 to a prefill valve 20, hereinafter described in detail. The prefill valve is disposed within a tank or reservoir 22 adapted to contain a supply of low pressure hydraulic fluid, such as, for example, oil, and the tank 22 is preferably mounted on the cylinder casting 2.

A motor 24 and one or more hydraulic pumps 26 operated thereby are preferably mounted on the tank 22, the pumps having their suction sides connected by suction lines 28 to the tank. The discharge or pressure sides of the pumps are connected to branch lines 30 of a pressure line 32 connected to an operating valve 34. Each branch line 30 comprises a conventional safety relief valve 36 adapted to discharge through a safety relief line 38 to the tank in the event that pressure in the branch lines 30 exceeds a predetermined maximum operating value.

The operating valve 34 is provided with discharge line 40 adapted to connect the line 32 to the tank 22 in the neutral position of the valve. The valve also comprises an advance pressure line 42 and a return or pullback pressure line 44, the advance line 42 being adapted for connection to the pressure line 32 in the advance position of the valve 34 whereat the return line 44 is connected to the line 40. The return line 44 is adapted to be connected to the pressure line 32 in the return or pullback position of the valve 34 whereat the advance line 42 is exhausted to the tank 22 through the line 40. The return or pullback line 44 is connected to the pullback

chamber 12 and the advance line 42 is connected to the prefill valve 20, as hereinafter discussed, and comprises a rapid advance branch line 46 connected to the tube 16 and an outlet branch line 48 connected to the prefill valve, as hereinafter described. The branch line 48 comprises a check valve 50, an adjustable throttle valve 52 and another check valve 54 adapted to accommodate flow of fluid from the tank 22 into the branch line 48 under the conditions hereinafter described in connection with the operation of the press.

The prefill valve 20 is also connected to a discharge or exhaust line 56 having a shut off valve 58 therein adapted in open position to accommodate flow of fluid to the tank 22 and adapted in closed position to positively shut off flow of fluid to the tank. The valve 58 is preferably actuated to open position by a solenoid 60.

The prefill valve 20 is shown in detail in Figure 2 and comprises a body 62 including a cap 64 having a port 66 connected to the before-mentioned branch line 48. The body comprises an internal chamber 68 having a smaller diameter portion 70 and also having a larger diameter portion 72 connected by a high pressure inlet port 74 to the advance pressure line 42.

The chamber 68 contains a valve stem, generally designated 78, which comprises a larger diameter portion 80 slidably fitted within the chamber portion 72 in substantially fluid-tight engagement therewith. The stem also comprises a smaller diameter portion 82 slidably fitted within a complementary passage in the body 62 and another portion 84 slidably fitted within the portion 70 of the chamber 68. The stem portion 84, as hereinafter discussed in connection with the operation of the press, comprises a closing pressure area 86 at the upper end of the stem which is greater than the opening pressure area 87 at the lower end of the stem. The top surface of the stem portion 80 within the chamber portion 72 presents a rapid advance closing area 88 which is smaller than the rapid advance opening area 90 on the bottom surface of the stem portion 80 which is provided with a throttle port 92 connecting the areas above and below the stem portion 80. The chamber portion 72 adjacent its lower end is connected by a port 94 to the before-mentioned line 56.

The stem is provided at its lower end with a conical seat 96 merging with a cylindrical seat 98, said seats being formed and arranged for cooperation with complementary seats 100 and 102 at the uper end of a high pressure outlet port 104 in the prefill valve body 62 connected with the before-mentioned passage 18, said body also comprising low pressure ports 106 connected to the hydraulic fluid within the reservoir 22. The stem 78 is provided with one or more longitudinal passages 108 accommodating flow of fluid from the upper end of the chamber 68 to a chamber 110 in the stem at the lower end thereof. The chamber 110 is provided with a check valve 112 illustrated in the form of a body 114 threaded into the stem chamber 110 and carrying a bolt or stud 116 threaded into the body 114 as at 118. The body 114 is provided with one or more flow passages 120 closed by a valve plate 122 which is actuated to closed position by a spring 124 supported by a spring seat 126. The spring seat is adjustably positioned on the bolt 116 by a nut 128 threaded thereon, thereby accommodating adjustable compression of the spring 124 to yieldingly resist flow of fluid from the passages 108 to the port 104.

The stem 78 is yieldingly maintained in open position by a spring 130 supported by a spring seat 132 on the cap 64 and reacting against a spring cap 134 on the upper end of a rod 136 extending through the spring seat 122 and the cap 64. The lower end of the rod 136 is provided with a head 138 received within a complementary recess in the upper end of the stem 78 to afford an interlock therewith.

Describing the operation of the novel circuit and assuming that the valve 34 is in neutral position directing pressure fluid from the line 32 through the line 40 into the tank 22, the rapid advance stroke of the ram 6 is initiated by actuation of the valve 34 to the advance position thereof whereat the pull back line 44 is exhausted to the tank 22 through the line 40 and pressure fluid from the line 32 is delivered to the advance line 42 and the rapid advance branch 46 thereof. Pressure fluid is delivered by the line 46 to the tube 16 and acts on the rapid advance area of the ram 6 within the rapid advance chamber 14 thereof to actuate the ram on its rapid advance stroke with the prefill valve 20 in the open position illustrated in Figure 2 accommodating flow of fluid from the reservoir 22 into the main pressure chamber 10. The stem 78 is held in open position under these conditions by pressure fluid acting through parts 74 and 92 on the area 90 in opposition to that acting on the area 88 and by the spring 130.

The rapid advance stroke of the ram 6 is terminated at any desired position by opening of the valve 58 which, as above noted, is actuated by the solenoid 60. It will be understood that the solenoid may be energized by switch means (not shown) operated either manually or by means responsive to position of the ram 6. Opening of the valve 58 exhausts the lower end of the chamber portion 72 (Figure 2) containing the opening area 90 of the stem 78 which, as above noted, is held in open position on the rapid advance stroke of the ram 6 by the pressure acting against the area 90 and by the spring 130. When the lower end of chamber portion 72 is exhausted by opening of the valve 58, the pressure acting against the closing area 88 of the stem 78 urges the latter downwardly until the cylindrical seat 98 is fitted within the complementary seat 102 which occurs immediately prior to the opening of valve chamber portion 72 to communication with the top of the chamber 68. After the seat 98 engages seat 102, the stem 78 continues to move downwardly, under the pressure acting against closing area 88 thereof, until the top of the stem moves into chamber portion 72, whereupon pressure fluid acting against the upwardly facing area of the stem 78 and the plate 122 urges the seat 96 tightly against the seat 100 and urges the stem portion 80 to closed position.

As the stem 78 moves downwardly to its closed position, the space vacated by the stem is filled by hydraulic fluid drawn from the tank 22 through the check valve 54 (Figure 1) into the line 48 and the port 66 and thence into the top of the chamber 68.

With the valve stem 78 in its closed position and seats 96 and 98 engaging seats 100 and 102, as above described, pressure fluid in the top of the chamber 68 is delivered from the port 74 through the passages 108 and the chamber 110 urging the check valve 112 to open position whereupon pressure fluid is delivered to the main pressure chamber 10 simultaneously with deilvery of

pressure fluid from the branch line 46 to the rapid advance chamber 14 to obtain full pressure across the entire advance area of the ram 6 urging the latter on its full pressure stroke against the resistance of the work.

The return stroke of the ram 6 is initiated by actuation of the valve 34 (Figure 1) to return or pullback position thereof whereat pressure fluid in the line 32 is delivered to the line 44 and pressure fluid in the line 42 is exhausted through the line 40 to the tank 22. Under these conditions, the branch line 48 accommodates exhausting of the port 66 and the top of the chamber 68 through the throttle valve 52 which may be adjusted to regulate the opening of the prefill valve stem 78 thereby accommodating a gradual opening of the stem relieving pressure from the chamber 18 to the tank 22 without noise and damage to the equipment. The ram 6 thus moves on its pullback or return stroke to the position shown in Figure 1 whereat the valve 34 is actuated to neutral position preparatory to initiation of another operating cycle, and the valve 58 restored to its closed position.

I claim:

1. In a hydraulic circuit having a hydraulic motor including cylinder means, and ram means reciprocal therein presenting a rapid advance area, a spaced main pressure area, and a return area, and having a reservoir of low pressure fluid, an advance line connected to the rapid advance area, a return line connected to the return area, and operating valve means for alternately delivering high pressure fluid to and exhausting pressure fluid from respective lines; the combination of a prefill valve body having a port connected to the reservoir and another port communicating with the main pressure area, a chamber in said body, a valve stem slidably fitted in said chamber in substantially fluid-tight engagement therewith, said stem in closed position preventing communication between said ports, a longitudinal passage through said stem connected at one end thereof to said chamber and at the other end thereof to said other port in the closed position of said stem, check valve means for preventing flow of fluid through said passage from said other port, said stem having a closing area at said one end thereof and an opening area at its other end smaller than said closing area and acted upon by the pressure in said other port, another closing area on said stem intermediate its ends and communicating with the advance line, another opening area on said stem intermediate its ends, said intermediate opening area being greater than said intermediate closing area, valve means for exhausting said intermediate opening area to said reservoir in open position of said last mentioned valve means and for cutting off communication between said reservoir and said intermediate opening area in closed position of said last mentioned valve means, passage means for accommodating flow of fluid between said intermediate areas at a rate of flow less than that accommodated by the last-mentioned valve means, said stem in closed position thereof opening said intermediate closing area to communication with the first-mentioned closing area, a branch line connecting the advance line to the portion of said chamber containing the first-mentioned closing area of the stem, check valve means in said branch line accommodating flow of fluid to the advance line, adjustable throttle valve means in said branch line downstream of said last-mentioned check valve means, and

check valve means in said branch line downstream of said throttle valve means for accommodating flow of fluid from the reservoir to said chamber as said stem moves to closed position, and spring means for yieldingly urging said stem to open position.

2. A circuit, according to claim 1, wherein the stem is provided with a cylindrical seat, and the port communicating with the main pressure area of the ram means is provided with a complementary cylindrical seat engageable with the stem seat, said seats terminating respectively in complementary conical seats, and the stem is so formed and arranged that the cylindrical seat thereof enters the cylindrical seat of the port before the closing areas of the stem are opened to communication with each other by movement of the stem to closed position.

3. A prefill valve mechanism comprising a valve body having a low pressure port and a high pressure outlet port communicating therewith, a chamber in said body, a valve stem slidably fitted in said chamber in substantially fluid-tight engagement therewith, said stem in closed position cutting off communication between said ports, a longitudinal passage through said stem connected at one end thereof to said chamber and at the other end thereof to said outlet port in the closed position of said stem, check valve means for preventing flow of fluid from said outlet port into said passage, said stem having a closing area at said one end thereof and having an opening area at said other end smaller than said closing area and acted upon by the pressure in said outlet port, a high pressure inlet port in said body connected to said chamber, another closing area on said stem intermediate its ends and communicating with said high pressure inlet port, another opening area on said stem intermediate its ends, said intermediate opening area being greater than said intermediate closing area, valve means in open position exhausting a portion of said chamber containing said intermediate opening area and in closed position positively cutting off flow of fluid from said intermediate opening area, passage means through said stem for accommodating flow of fluid between said intermediate areas at a rate of flow less than that accommodated by the exhaust valve means when open, said stem in closed position thereof uncovering said intermediate closing area to communication with the first-mentioned area for admitting high pressure fluid from said high pressure inlet port to said passage as said stem moves to closed position, and spring means for yieldingly urging said stem to open position.

4. A prefill valve mechanism, according to claim 3, wherein the stem is provided with a cylindrical seat and the outlet port is provided with a complementary cylindrical seat engageable with the stem seat when the stem is in closed position, said seats terminating respectively in complementary conical seats, the stem being so formed and arranged that the cylindrical seat thereof enters the cylindrical seat of the outlet port before the closing areas of the stem are opened to communication with each other by movement of the stem to closed position.

5. In a hydraulic circuit having a hydraulic motor including cylinder means and ram means therein presenting a rapid advance area and a spaced main pressure area, and having a reservoir of low pressure fluid; the combination of prefill valve means including a body having a port connected to the reservoir and another port

communicating with said main pressure area and with the first mentioned port, a valve stem in said body preventing communication between said ports in closed position of the stem, said stem having an opening area acted upon by the pressure fluid acting against said main pressure area in closed position of the stem, and said stem having a closing area in said body greater than said opening area, passage means through said stem for accommodating flow of fluid between said areas, a rapid advance closing area on said stem spaced from the other stem areas in the open position of the stem and connected to the rapid advance area of said ram means and to said source, a rapid advance opening area on said stem greater than said rapid advance closing area, a throttled connection between said rapid advance areas, valve means for exhausting said rapid advance opening area to accommodate movement of said stem to closed position thereby terminating the rapid advance stroke of said ram means, said stem in closed position thereof opening said rapid advance closing area to the first-mentioned closing area of the stem whereby said stem is held in closed position by pressure fluid acting on both closing areas thereof while said pressure fluid flows through said passage means to act on said main pressure area of said ram means.

6. A prefill valve having a body with a low pressure port and a high pressure outlet port connected thereto, a valve stem reciprocal in said body and adapted in closed position to cut off communication between said ports, said stem having an opening area acted upon by the pressure fluid in said outlet port and said stem having a closing area in said body greater than said opening area, passage means through said stem for accommodating flow of fluid between said areas, a second closing area on said stem spaced from the other stem areas, a high pressure inlet port in said body connected at all times to said second closing area, a second opening area on said stem greater than said second closing area, a throttle connection between said second opening and closing areas, an exhaust port for exhausting said second opening area to accommodate movement of said stem to closed position by the pressure of fluid from said high pressure inlet port against said second closing area, said stem and body being so constructed and arranged that in the closed position of the stem the high pressure inlet port is connected to the first-mentioned closing area and at other times is disconnected therefrom, whereby said stem is held in closed position by pressure fluid from the high pressure inlet port acting on both closing areas of the stem while pressure fluid from said high pressure inlet port flows through said passage means into said outlet port.

7. A circuit, according to claim 5, wherein the stem is provided with means operable in the closed position of said stem to cut off communication between the exhausting valve means and the rapid advance opening area of the stem.

8. A prefill valve, according to claim 6, wherein the stem is provided with means operative in the closed position thereof to cut off communication between the exhaust port and the second opening area of the stem.

9. A circuit, according to claim 5, wherein the stem passage means are provided with one-way check valve means accommodating flow of fluid to the main pressure area of the ram means.

10. A prefill valve, according to claim 6, wherein the stem passage means are provided with check valve means positively preventing flow of fluid through said passage means from the outlet port and accommodating flow of fluid through said passage means into the outlet port when the stem is in closed position.

11. In prefill valve and speed change control system for a hydraulic circuit having a hydraulic motor including cylinder means and ram means therein presenting a rapid advance area, a spaced mean pressure area, and a return area, and having a reservoir of low pressure fluid, and means for alternately delivering high pressure fluid to the rapid advance area and to the return area; the combination of prefill valve means including a body having a port connected to the reservoir and another port communicating with said main pressure area, a valve stem in said body engaging a seat around said other port in closed position of the stem, thereby cutting off communication between said ports, said stem having an opening area acted upon by the pressure fluid in said other port and said stem having a closing area in said body greater than said opening area, a passage through said stem from end to end thereof spaced from the periphery thereof and connected to said other port in the closed position of the stem and to the portion of said body containing said closing area, said stem comprising another closing area intermediate its ends and spaced from the first-mentioned closing area in the open position of the stem, said intermediate closing area being connected to said rapid advance area, another opening area on said stem intermediate its ends greater than said intermediate closing area, a throttled connection between said intermediate areas, valve means for exhausting said intermediate opening area to accommodate movement of said stem to closed position, said stem in closed position thereof opening said intermediate closing area to communication with the first-mentioned closing area.

12. A prefill valve having a body including a low pressure port and a high pressure outlet port communicating therewith, a valve stem mounted for reciprocal movement in said body and in closed position engageable with a seat around said outlet port thereby cutting off communication between said ports, said stem having an opening area acted upon by the pressure fluid in said outlet port and said stem having a closing area in said body greater than said opening area, a passage through said stem from end to end thereof spaced from the perimeter thereof and connected to said outlet port in the closed position of the stem and connected at all times to the portion of said body containing the stem closing area, said stem comprising another closing area intermediate its ends and spaced from the first-mentioned closing area in the open position of the stem, a high pressure inlet port through said body connected to the portion thereof containing said other closing area of the stem, another opening area on said stem intermediate its ends greater than said intermediate closing area, a throttle connection between said intermediate areas, a port in said body connected to the portion thereof containing said intermediate opening area and adapted to convey fluid therefrom at a rate of flow greater than that through said throttle connection, said first-mentioned closing area of the stem being movable, as the stem is closed, into the portion of the body containing said other closing area of the stem, whereby pressure fluid from the high pressure

inlet port acts against both closing areas of the stem in closed position thereof.

13. A system, according to claim 11, wherein the stem is provided with means intermediate its ends for cutting off communication between the exhausting valve means and the prefill valve means in the closed position of the stem.

14. A system, according to claim 11, wherein the prefill valve stem is provided with a check valve preventing flow of fluid from the main pressure area of the ram means and yieldingly resisting flow of fluid to the main pressure area of the ram means.

15. A prefill valve comprising a body having a chamber, a pair of ports in said body, a reciprocally moving stem having spaced portions and an intermediate or larger diameter portion, each portion being slidably fitted within said chamber in substantially fluid-tight engagement therewith, one end of said stem being adapted in closed position to close one of said ports, a passage through said intermediate portion connecting the chamber at opposite sides thereof, a high pressure inlet port in said body connected to the chamber at one side of said intermediate portion, an exhaust port in said body connected to said chamber at the other side of said intermediate portion, a port in said body connected to the chamber at the opposite end of the stem, and passage means through the stem, spaced from said passage and accommodating flow of fluid from end to end of the stem.

16. A prefill valve, according to claim 15, wherein the stem is provided with one-way check valve means accommodating flow of fluid in one direction only through said passage.

17. A prefill valve, according to claim 15, wherein the stem is formed and arranged to uncover the last-mentioned port to communication with the adjacent inlet port in the closed position of the stem and the stem passage is provided with one-way check valve means positively preventing flow of fluid from the body port closed by the stem.

18. A prefill valve unit for a hydraulic press, said unit comprising a body with spaced ports, a chamber in said body, a stem slidably fitted within said chamber and in closed position cutting off communication between said ports, spring means connected to the stem for biasing the same to open position, said stem comprising a closing area thereon intermediate its ends and comprising an opening area thereon intermediate its ends, the opening area facing said ports and being greater than the closing area, a throttle connection through the stem between said areas, means for accommodating movement of the stem to closed position comprising control valve means for exhausting a portion of said chamber containing the opening area, and a port connected to the chamber at another portion thereof containing said closing area for admitting pressure fluid thereto to urge said stem to its closed position when the portion of said chamber containing the opening area is exhausted by said control valve means.

19. A prefill valve comprising a body having a chamber, a valve stem in said chamber, a pair of ports in said body adapted to be closed by the stem in closed position thereof, a port connected to a portion of the chamber containing one end of the stem, another port connected to the chamber intermediate the ends of the stem, said other port being closed at all times by said stem from communicating with said pair of ports, passage means extending through the stem from end to end thereof, said passage means being connected to said chamber portion, said stem being adapted in closed position to uncover the last-mentioned port to communication with said portion of the chamber.

20. A prefill valve, according to claim 19, wherein the stem passage is provided with one-way check valve means accommodating flow of fluid from the chamber portion through said passage.

21. A prefill valve comprising a body having a chamber, a valve stem in said chamber, a pair of ports in said body communicating with each other in open position of the stem and cut off from communication by one end of the stem in closed position thereof, a port connected to the chamber intermediate the ends of the stem, passage means extending through the stem from end to end thereof, said stem in open position positively cutting off flow of fluid from the last mentioned port to the portion of said chamber containing the other end of the stem, and said stem in closed position uncovering said last mentioned port to communication with said chamber portion, a larger-diameter portion on said stem between its ends slidably fitted in a complementary portion of the chamber, said stem portion having at one side thereof a closing area facing the last mentioned port and communicating therewith, and said stem portion having at its opposite side an opening area greater than said closing area, a throttle connection between said areas, and means for exhausting pressure fluid from said opening area independently of said throttle connection.

ROBERT K. SEDGWICK.

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