May 8, 1956 E. BAHNIUK 2,744,467

INLET VALVES FOR HYDRAULIC PUMPS OF THE PLUNGER TYPE

Filed Nov. 26, 1954

Fig.1

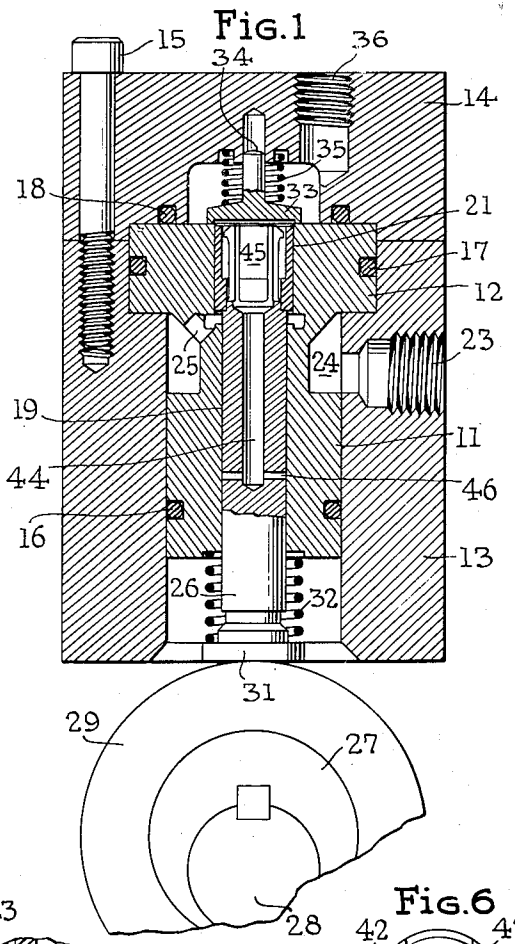


Fig.2

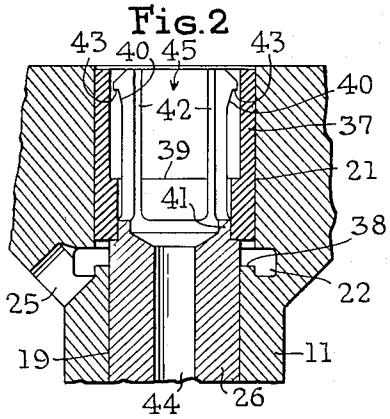


Fig.3

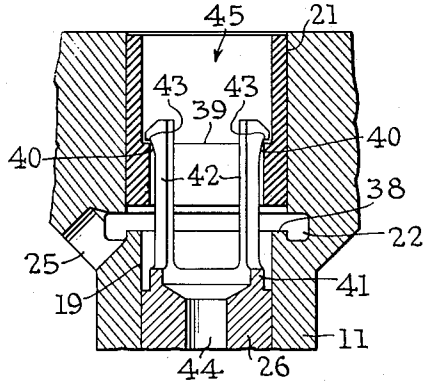


Fig.6

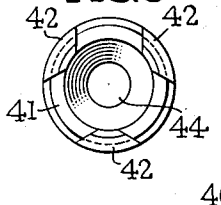


Fig.4

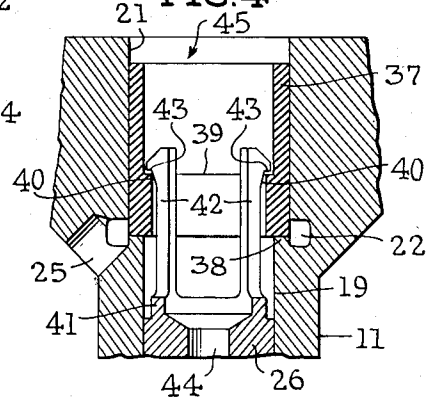


Fig.7

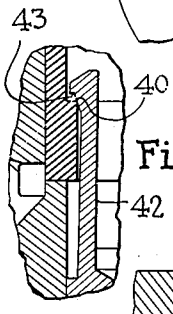
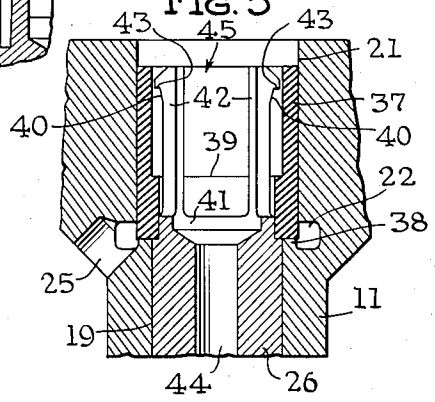


Fig.5



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INLET VALVES FOR HYDRAULIC PUMPS OF THE PLUNGER TYPE

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4 Claims. (Cl. 103—153)

This invention relates to inlet valves for plunger type hydraulic pumps.

It is common practice in plunger pumps to use inlet ports in the cylinder walls and control them by the pump plunger. This necessarily impairs volumetric efficiency, and the impairment increases with pump speed. Since the trend is toward higher speeds (and also toward higher head pressures), the need for improved inlet control is great.

The present invention provides an inlet valve in the form of a sleeve which is reciprocable in an enlarged terminal portion of the pump-cylinder bore. This valve sleeve has means affording a lost-motion connection with the pump plunger so that the valve is shifted in opposite directions by the plunger during respective terminal portions of opposite plunger strokes. Throughout each displacement stroke of the plunger, the valve sleeve is biased to obstruct the inlet port by pressure developed in the cylinder bore by the plunger.

It is contemplated that the valve will be used in each cylinder of multicylinder pumps and with pumps having spill-back control of displacement, but these features are not involved in the invention.

To simplify disclosure this invention will be described as applied to a single cylinder pump devoid of any displacement control.

In the drawing:

Figure 1 is an axial section of a pump embodying the invention. The plunger is at the end of its displacement stroke.

Figures 2–5 inclusive are enlarged scale fragmentary views similar to portions of Figure 1 and showing successive positions, viz.

Figure 2 shows the end of the displacement stroke.

Figure 3 shows point in the suction stroke at which the plunger starts to close the inlet valve.

Figure 4 shows the end of the suction stroke, the inlet valve being then closed.

Figure 5 shows the plunger in the displacement stroke and about to shift the valve above the inlet cylinder port.

Figure 6 is an end elevation of the plunger.

Figure 7 is an enlarged fragmentary radial section through one of the members 42 in the position of Figure 4.

The distinctive feature of this invention is the mounting of the valve sleeve in an enlarged extension of the bore. The inner end of this enlarged bore extension is at the inlet port. As a consequence the valve is shifted at the end of each stroke by the plunger acting through the lost-motion connection, but exercises a double control of flow from the working space. Through all the displacement stroke, it is biased to close against flow toward the inlet by the pressure differential between the cylinder working space and the inlet port. Through most of the displacement stroke the valve sleeve obstructs the cylinder inlet port. Toward the end of that stroke it is shifted to expose that port, but then seats against a shoulder on the plunger end to interrupt the back-flow path.

Statements of direction refer to the pump positioned as in Figure 1.

Figure 1 shows the significant elements of a single cylinder pump. A cylinder bushing 11 with positioning flange 12 is confined in body 13 by a cap 14. The cap is fixed in place by machine screws, one of which appears at 15. Toric gaskets 16, 17, 18 are used for sealing purposes.

Bushing 11 has a main bore 19 with a coaxial extension 21 of larger diameter. Substantially at the junction of the main bore 19 and extension 21 is the inlet port 22 formed as a bore-encircling groove. This is supplied with liquid to be pumped by inlet connection 23 in body 13, channel 24 encircling the cylinder bushing and a drilled passage 25. See Figure 3 which shows port 22 exposed.

The plunger 26 is reciprocated in bore 19 by an eccentric 27 on rotary shaft 28. The eccentric carries a freely rotatable sleeve or roller 29 which engages a follower 31 on the lower end of plunger 26. A coil compression spring 32 biases the plunger toward the eccentric actuator. The discharge valve 33 is an ordinary poppet valve guided by a stem 34 which enters a guideway drilled in cap 14. The valve is biased by coil compression spring 35 to seat against the end of bushing 11, and has a peripheral seating rim which encircles the end of extension bore 21. Discharge flow leaves by way of connection 36.

Reciprocable in extension bore 21 is a valve sleeve 37. This sleeve makes a close sliding fit in the bore 21 and is so dimensioned that in its upper position (Figures 2 or 3) it is above port 22 and consequently exposes this port. In its lower position (Figures 4 or 5) it seats on a shoulder 38, and obstructs port 22.

The bore of sleeve 37 is reduced at its lower end to afford an internal shoulder 39 and to fit somewhat freely around the annular rim 41 which is formed integrally in the end of plunger 26. This closeness of fit is such that impacts between the plunger 26 and valve sleeve 37 will be hydraulically cushioned. The outside diameter of rim 41 is materially smaller than the diameter of plunger 26.

Extending from rim 41 in directions parallel with the axis of the plunger are the integral members 42 (three being shown). Each of these has at its upper end an outward extending shoulder 43 which can engage behind shoulder 39 and each of which is at the upper end of a slightly flaring conical surface 40. The members 42 can be elastically bowed sufficiently to permit assembly of the plunger and sleeve. After such assembly the members 42, with surfaces 40, 43, the shoulder 39 and the end of plunger 26 outside rim 41 afford a cushioned lost-motion connection through which the plunger shifts the sleeve in reverse directions as the plunger approaches its opposite limits of motion.

When plunger 26 moves upward from the position of Figure 4 cushioning between plunger and valve starts when the upper margin of rim 41 passes the lower margin of valve sleeve 37, and depends on retarded escape of liquid from the space around rim 41.

When the plunger moves downward from the position of Figure 2 cushioning between plunger and valve starts before the position of Figure 3 is reached and is caused by engagement of the flaring portion 40 with the inner margin of shoulder 39.

Whether or not surface 43 engages shoulder 39 (and it is believed to do so at least momentarily), sleeve valve 37 will move by momentum until it seats on shoulder 38.

Then when plunger 26 reverses and starts upward the elastic reaction of members 42 and the resulting wedging action of the conical surfaces 40, assist in holding valve sleeve 37 against shoulder 38 until pressure in the working space starts to rise. This pressure biases the valve sleeve downward. Obviously the inclination of the flaring surfaces 40 must be carefully related to the coefficient

of friction between the surfaces 40 and the valve sleeve.

Plunger 26 has an axial bore 44 leading from the working space 45 above the plunger to radial lubricating ports 46. It is customary in the art to use an oil as the hydraulic fluid, and to avail of its lubricating property.

The extent of lost motion afforded between plunger 26 and valve sleeve 37 must be less than the plunger stroke by an amount sufficient to assure functional shifting of sleeve 37. The function just alluded to is a dual one, i. e., alternating exposure and obstruction of port 22 and alternating opening and closing of the slot ports above rim 41 and between members 42. Flow to the working space 45 occurs serially through these two sets of ports. The sleeve 37 is not merely a valve controlling cylinder port 22. It is also a valve controlling the slot ports above rim 41 and between the members 42. Inlet flow occurs only when sleeve 37 exposes port 22 and also the slot ports above rim 41 concurrently.

Operation

Assume that the plunger 26 has just completed a discharge stroke and is in the position of Figure 2. The discharge valve 33 will just have closed.

Retreat of plunger 26 creates suction in working space 45. The resulting upward bias on the sleeve and friction each resist downward motion of sleeve 37, so retreat of plunger 26 draws oil into the working space through cylinder port 22 and between members 42.

When the plunger reaches the position of Figure 3 plunger 26 starts to draw down sleeve 37. When the position of Figure 4 is reached sleeve 37 obstructs port 22 and plunger 26 is about to reverse its motion, starting the displacement stroke.

The plunger then forces oil through the working space 45 and out through discharge valve 33. Shortly before the plunger reaches the end of the stroke sleeve 37 seats around rim 41 so that flow between the sleeve 37 and plunger 26 is inhibited before sleeve 37 is lifted to expose port 22. Hence the parts reach the position of Figure 2 without danger of back flow through the inlet port 22. Retreat of the plunger starts the next cycle.

In the cycle, just described, the cushioning effects occur as already explained.

The illustration of the invention is intended to simplify explanation and does not imply necessary limitations. For example, the differential between the diameters of bore 19 and extension 21 determines the cross sectional area of sleeve 37 and the hydraulic pressure differentials effective upon it. These dimensions have to be related to speed of operation and head pressure. The drawings tend to exaggerate differentials to make them visible. Proportions appropriate for a slow speed pump might be unworkable in the high speed, high pressure ranges.

For the above reasons, among others the illustrated pump is merely exemplary. It is subject to variations dependent on the duty for which it is designed.

What is claimed is:

1. The combination of means enclosing a cylinder having a side inlet-flow port; a reciprocable plunger defining a variable volume working-space in said cylinder, and having an extension with a through port adapted to receive inlet flow to said working space from said inlet-flow port in the cylinder; a sleeve valve encircling the extension and independently controlling each of said ports by longitudinal motion of the sleeve relatively to each port; means for reciprocating said plunger between definite limits; a lost-motion connection between the plunger and sleeve affording lost motion less than the plunger stroke by an amount approximating the desired shift of the valve, whereby the plunger shifts the sleeve reversely as the plunger approaches respective limits of its reciprocation, the timing being such that both ports are open substantially throughout the suction stroke and the ports are closed sequentially so that one or the other is closed throughout the displacement stroke; and a valve controlling discharge from said working space.

2. The combination of means enclosing a cylinder having a side inlet-flow port; a reciprocable plunger defining a variable volume working space in said cylinder, and having an extension with a through port adapted to receive flow to said working space from said inlet-flow port in the cylinder; a sleeve valve encircling the extension and independently controlling each of said ports by longitudinal motion of the sleeve relatively to each port, said sleeve valve being exposed at opposite ends to pressure in said working space and to pressure in said side inlet-flow port whereby the sleeve is subjected to a stabilizing pressure-bias opposite in direction to the motion of said plunger; means for reciprocating said plunger between definite limits; a lost-motion connection between the plunger and sleeve affording lost motion less than the plunger stroke by an amount approximating the desired shift of the valve, whereby the plunger shifts the sleeve reversely against said bias as the plunger approaches respective limits of its reciprocation, the timing being such that both ports are open substantially throughout the suction stroke, and during the displacement stroke the ports are closed sequentially so that one or the other is closed throughout the displacement stroke; and a valve controlling discharge from said working space.

3. A pump comprising in combination, means enclosing a cylinder having a main bore, an extension bore coaxial therewith and of larger diameter, and an inlet port opening into the extension bore at the junction of the bores; a plunger reciprocable in the main bore to define a variable volume working space; means for reciprocating said plunger between definite limits of motion; a discharge valve controlling flow from said working space; a valve sleeve reciprocable in said extension bore between positions in which respectively it obstructs and exposes said inlet port, said valve sleeve surrounding a portion of said working space and being exposed at one end to pressure existing in said inlet port and at its opposite end to pressure existing in said working space whereby the valve sleeve is biased to obstruct the inlet port during displacement strokes of the plunger; a lost-motion connection between the valve sleeve and plunger approximating, but less than the plunger stroke whereby the valve sleeve is shifted reversely by the plunger during terminal portions of suction and displacement strokes of the plunger; and valve means exerting a secondary control on flow between said inlet port and said working space and comprising interacting seat and valve portions on the valve sleeve and on the plunger, arranged to close as the plunger approaches its limit of lost motion relatively to the sleeve during displacement strokes.

4. The combination of means enclosing a cylinder having a side inlet-flow port; a reciprocable plunger defining a variable volume working-space in said cylinder, and having an extension with a through port adapted to receive inlet flow to said working space from said inlet-flow port in the cylinder; a sleeve valve encircling the extension and independently controlling each of said ports by longitudinal motion of the sleeve relatively to each port; means for reciprocating said plunger between definite limits; a lost-motion connection between the plunger and sleeve affording lost motion less than the plunger stroke by an amount approximating the desired shift of the valve, whereby the plunger shifts the sleeve reversely as the plunger approaches respective limits of its reciprocation, the timing being such that both ports are open substantially throughout the suction stroke and the ports are closed sequentially so that one or the other is closed throughout the displacement stroke; impact cushioning means incorporated in said lost-motion connection; and a valve controlling discharge from said working space.

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