March 17, 1953 O. E. DEMPSEY 2,631,572

FLUID MOTOR

Filed July 30, 1947 3 Sheets-Sheet 1

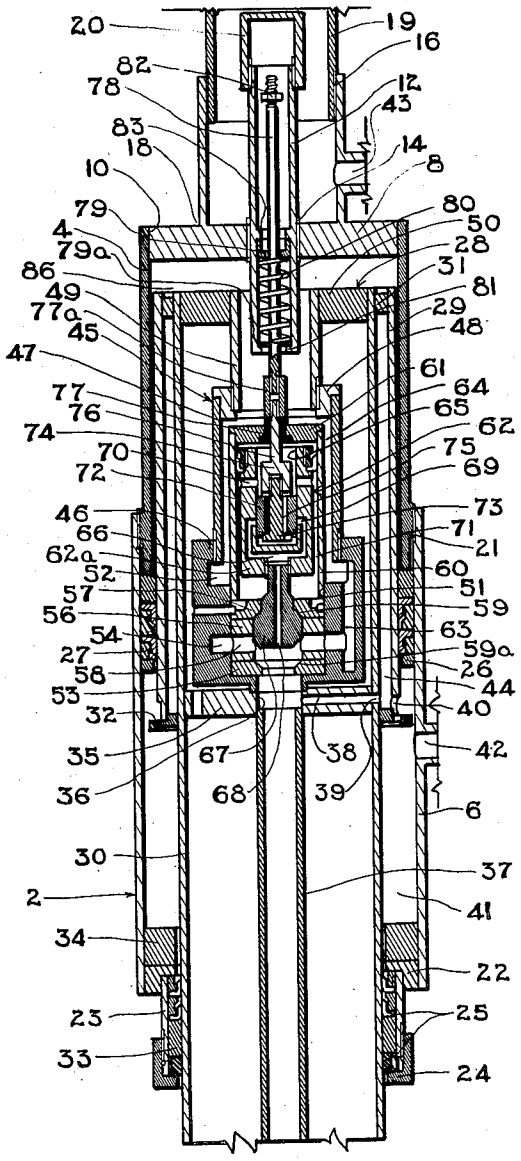


FIG. 1

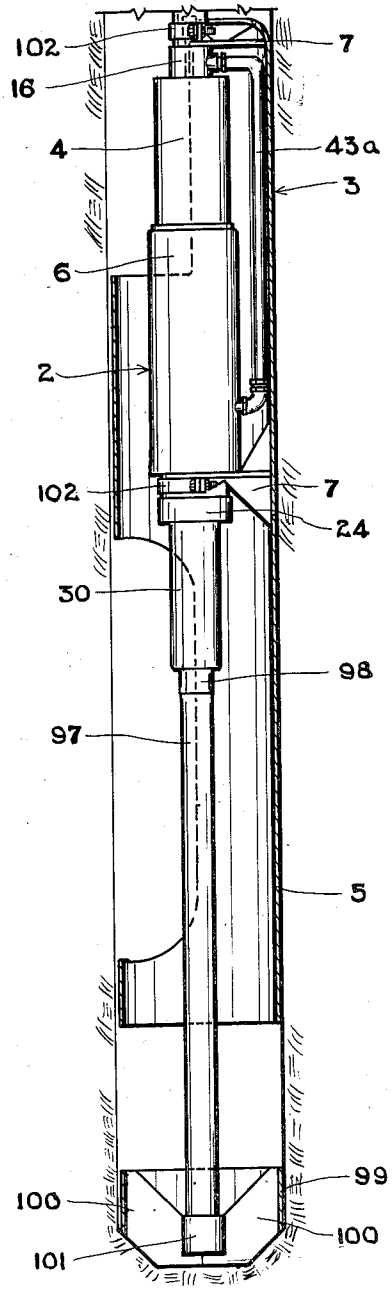


FIG. 2

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FLUID MOTOR

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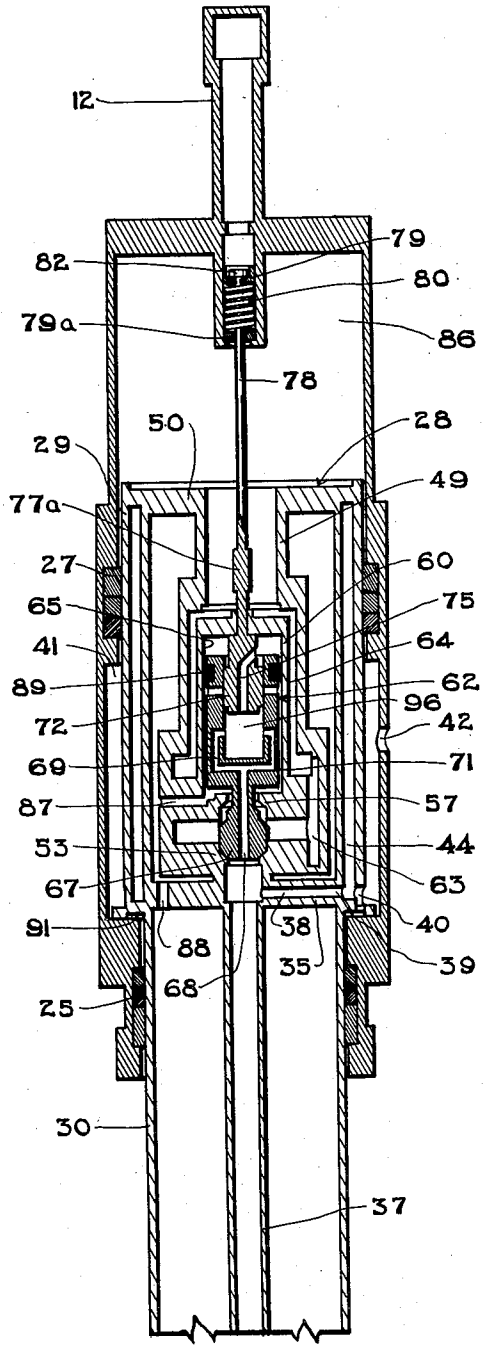


FIG. 3

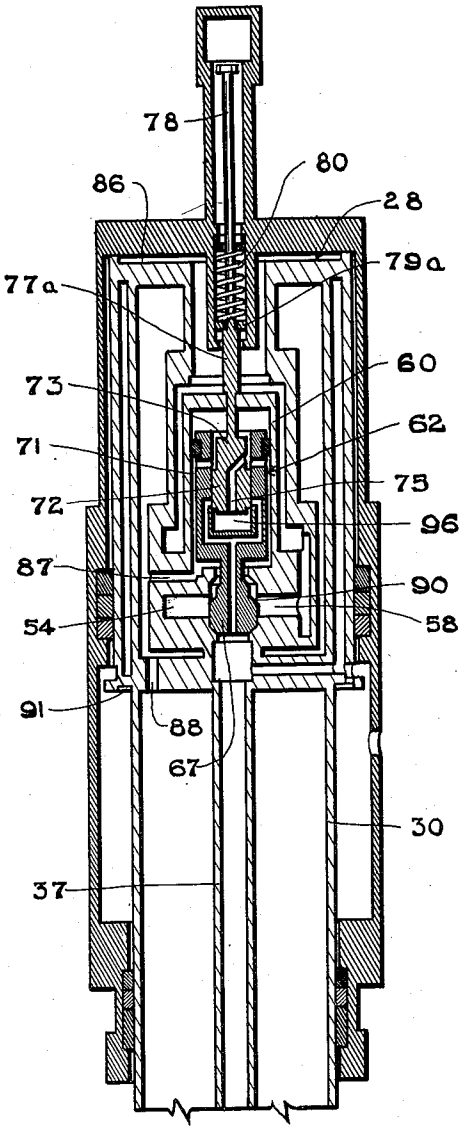


FIG. 4

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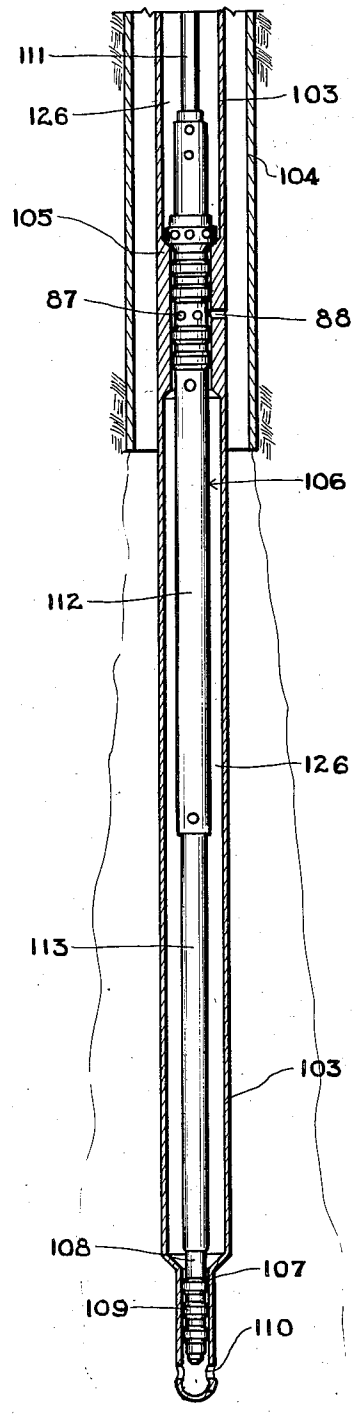


FIG. 5

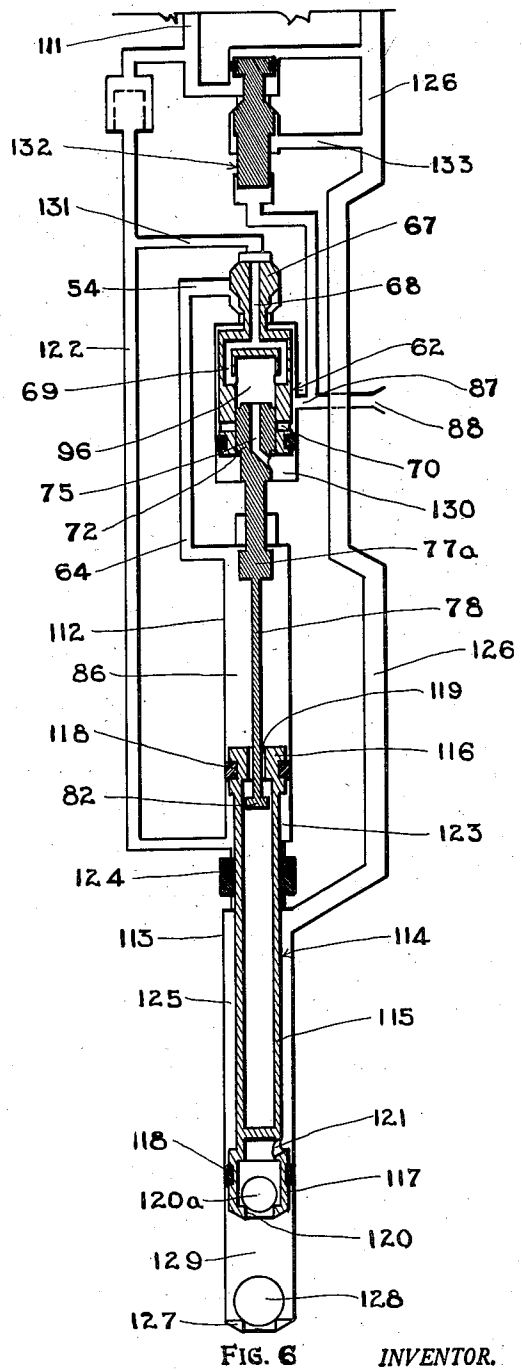


FIG. 6

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Patented Mar. 17, 1953 2,631,572

UNITED STATES PATENT OFFICE

2,631,572

FLUID MOTOR

Oscar E. Dempsey, Tulsa, Okla., assignor, by mesne assignments, to Byron Jackson Co., Los Angeles, Calif., a corporation of Delaware

Application July 30, 1947, Serial No. 764,668

18 Claims. (Cl. 121—123)

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This invention relates to a fluid actuated control apparatus, and more particularly but not by way of limitation to a fluid actuated motor plunger unit and the control valve mechanism therefor.

It is an important object of this invention to provide a fluid actuated motor adapted to provide a positive working stroke for utilization in numerous types of reciprocating piston apparatus.

And still another object of this invention is to provide a hydraulic piston impact unit having a pilot valve responsive to movement of the piston unit for controlling the position of a main valve which in turn controls the supply pressure fluid for actuating the piston unit.

And still another object of this invention is to provide a hydraulic plunger unit having a valve control mechanism which includes a pilot valve controlling the position of the main valve wherein said pilot valve is always moved or pushed into or against a high pressure condition regardless of its direction of movement.

And still another object of this invention is to provide a hydraulic plunger unit having an independent valve control mechanism regulating the stroke of the plunger so that on the working stroke of the plunger, the exhaust pressure is substantially eliminated thereby providing a more positive and efficient working stroke for the hydraulically actuated plunger unit.

And still another object of this invention is to provide a hydraulic plunger unit where the input pressure is constantly maintained on one face of the plunger, and regulated or controlled pressure is directed to the opposite face of the plunger to cause a working stroke thereof.

And still another object of this invention is to provide a hydraulic plunger unit having an independent valve control mechanism regulating the stroke of the plunger and which includes a pilot valve movable into a position to cause an exahust of the pressure fluid actuating the plunger prior to the completion of the working stroke of the plunger.

And still another object of this invention is to provide a fluid actuated piston unit incorporating a component valve mechanism therein, comprising a main and pilot valve assembly so arranged that the power fluid consumed on the piston back stroke transfers to the power stroke cavity of the piston cylinder without hindrance from exterior environment, thus allowing the fluid power to implement the forward

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stroke in an unrestricted thrust against the piston.

And still another object of this invention is to provide a fluid actuated motor so devised that the piston moves through its forward or power stroke without spent or exhausting power fluid leaving the piston cylinder, and also wherein the combined fluid displacement of a complete piston cycle exhausts during the sequent reverse or back stroke thereof.

An additional object of this invention is to provide a hydraulic piston body having two working faces of selective cross-sectional area wherein the constantly maintained input pressure against one face is sufficient to cause reverse or backward power movement of the piston body while effecting the manageable exhaust of fluid responsible for a previous piston cycle into an environment of variable pressure, and wherein the cross-sectional area of the second face may be proportionately small so that the power fluid implementing the reverse stroke constitutes the major portion of the fluid movement toward the second face to effectively snub excessive forward piston speed.

Other objects and advantages of the invention will be evident from the following detailed description read in conjunction with the accompanying drawings which illustrate my invention.

In the drawings:

Figure 1 is a vertically sectional view of the working parts of the invention, and showing one position of the valve control mechanism and the piston unit.

Figure 2 is a vertically elevational view with certain parts in section disclosing the invention adapted for use with an impact punch.

Figure 3 is a view similar to Figure 1 showing another position of the valve control mechanism and piston unit.

Figure 4 is a similar view to Figure 1 and showing still another position of the working parts.

Figure 5 is a vertically sectional view with certain parts in elevation showing the invention utilized in the oil well pump.

Figure 6 is a schematic view of the valve and piston mechanism of the unit shown in Figure 5.

Referring to the drawings in detail, and more particularly Figures 1 and 2, the piston unit comprises an outer sectional housing generally indicated at 2, having an upper sleeve 4 and a lower sleeve 6. An adaptation of the valve and piston unit is disclosed in Figure 2, and relates to a road punch or horizontal digger generally

indicated at 3, and comprising an outer shell 5 having a plurality of spaced brackets 7 supporting the outer housing 2 of the valve unit disclosed in Figure 1. It will be understood that although the invention is preferably shown with a horizontal ditch cutter, that the application or utilization of the apparatus is not limited thereto. The further adaptation of the piston and valve unit to the road punch 3 will be hereinafter set forth.

Referring to Figure 1 and the working parts of the plunger unit and its co-operating valve control mechanism, the upper cylinder 4 is provided with an end plate 8 welded thereto at 10. The end plate 8 is provided with a sleeve 12 extended therethrough by threading into an aperture 14 in the plate 8. A pipe or sleeve 16 is welded at 18 to the upper face of the end plate 8 and, in turn, is adapted to receive a supply pressure conduit 19 secured thereto. The upper end of the tube 12 receives a cap 20 threaded thereto. The upper housing 4 is secured by threading (not shown) at 21 to the lower housing 6. The lower housing 6 receives angled spacer plate 22 welded thereto and, in turn, having a pipe 23 of smaller diameter welded thereto. A nut 24 is threaded to the pipe 23 for holding packing 25 between the pipes 23 and 30 for a purpose as will be hereinafter set forth. A ring 26 is welded to the inner periphery of the cylinder 6 for supporting a plurality of packing rings 27 for a purpose as will be hereinafter set forth.

A piston generally indicated at 28 is disposed in the housing 2, and comprises an outer cylinder 29 and inner cylinder 30 spaced therefrom. The cylinders 29 and 30 are secured together at their upper end by a spacer ring 31 welded thereto, and at their lower end by a welded spacer ring 32. It will be noted that the outer cylinder 29 extends vertically only a portion of the length of the inner cylinder 30, particularly at the location of the spacer ring 32. However, the inner cylinder 30 extends below the spacer ring 32 and outside of the housing cylinder 6. Leakage is prevented by the packing 25. It will be apparent that the retaining nut 24 and spacer 22 holds the packing as well as the piston bearing sleeve 33 in the space between the cylinder 30 and the short cylinder 23. A ring 34, preferably of rubber or resilient material, is disposed immediately above the spacer 22 and within the housing cylinder 6. This circular ring acts as a bumper and particularly for the spacer ring 32 as will be hereinafter set forth.

At a point adjacent the spacer ring 32 the inner cylinder 30 is provided with a plate or baffle 35 welded to the inner periphery thereof. The plate 35 is provided with a central bore 36 into which is threaded a tube 37 extending downwardly therefrom. A horizontal bore 38 provides communication with an aperture 39 in the cylinder 30 thereby providing communication with the chamber 44 between cylinders 29 and 30, and the aperture 36 in the plate 35. It will also be apparent that the outer cylinder 29 is provided with an orifice or aperture 40 providing communication between the chamber 44 and a chamber 41 between the cylinder 30 and the cylinder 6. The outer housing 6 is provided with an aperture 42 adapted to communicate with an outlet aperture 43 in tube 16 by any conventional conduit 43*a* (Fig. 2). The piston unit 28 is adapted to receive an internal valve unit generally indicated at 45.

The valve unit comprises a housing 46 having a cylinder 47 secured thereto and extending upwardly therefrom to receive a threaded nut 48 which, in turn, is threaded to a cylinder 49 extending upwardly into welded contact with an apertured plate 50 threaded to the piston cylinder 30. The housing 46 is provided with a central bore 51 having vertically spaced counterbores 52 and 54. An apertured valve seat 53 is pressed into the bore 51. At a point adjacent to counterbore 54 the main bore 51 is provided with an apertured spacer ring 56 pressed therein. Immediately above the spacer ring 56 is provided a second apertured valve seat 57 arranged in inverted position relative to the valve seat 53 as will be hereinafter set forth. The spacer ring 56 is provided with transverse apertures 58 in alignment with the counterbore 54. It will be noted that the upper valve seat 57 is provided with a central aperture 59 of variable diameters, and is arranged in a substantially convex position. The lower valve seat 53 is provided with a central aperture 59*a* of variable diameters, but arranged in a concave position. A vertically disposed cylinder 60 is pressed in the bore 51, and is closed at its upper end with a plate 61 threaded thereinto. Encased in the cylinder 60 is the main valve generally indicated at 62. A vertical passageway 63 in the housing 46 provides communication between the counterbores 52 and 54. The counterbore 52 also communicates with the chamber 64 provided between the cylinders 47 and 60.

The valve 62 freely disposed in cylinder 60 comprises a cylinder or sleeve 62*a* having a central bore 65 extending longitudinally through a portion thereof. The lowermost end of the valve 64 is provided with an aperture 66 into which is secured an extension valve 67 having an outer periphery of varying diameters adapted to co-operate with the apertured valve seats 53 and 57, as will be hereinafter set forth. The valve 67 is provided with an axial bore 68. The aperture 66 communicates with drilled passageways 69 in valve 62, which in turn communicate with the central bore 65. Furthermore, the valve cylinder 62*a* is provided with drilled transverse exhaust passageways 70 providing communication between the bore 65 and the space 71 between the outer periphery of the valve sleeve 62*a* and the cylinder 60.

A pilot valve is loosely disposed in the bore 65 of the main valve 62 and comprises a sleeve 72 loosely disposed on an inverted T-shaped rod 73. The rod 73 is secured to a yoke connection 74 disposed in the bore 65 above the valve sleeve 72. The loose disposition of the sleeve 72 on the rod 73 is such to provide a passageway 75 providing communication from the lower side of the valve sleeve 72 to the upper side thereof. The yoke 74 has a leg portion 76 extending vertically upward through a bushing 77 provided in the apertured plate 61. The leg 76 is coupled by nut 77*a* with a valve rod 78. The valve rod 78 extends upwardly into the sleeve 12 and through a bushing 79 moveable within the sleeve 12. The bushing also anchors one end of a helical spring 80 disposed in the sleeve 12 between the bushing 79 and a lower bushing 79*a* disposed adjacent the apertured lower end 81 thereof. The end 81 of the sleeve 12 is apertured to permit extension of the shaft or valve rod 78 therethrough into the connection with the nut 77*a*. The upper end of the shaft 78 receives a nut 82 for a purpose as will be hereinafter set forth. The inner periphery of the sleeve 12 is provided with in-

wardly projecting shoulders 83 which limit the upper travel of the bushing 79.

Operation

When it is desired to actuate the piston unit 28 to do work in conjunction with an auxiliary member such as a lifting jack, pump plunger, ram, or the like as will be hereinafter set forth, then constantly maintained fluid pressure from a surce of supply (not shown) and in communication with tubing 19 is directed through outlet 43 and into the inlet 42 to be placed in communication with the orifice 40, passageway 38, and aperture 36 of the plate 35. Although not shown, the lower extending tube 37 is plugged off at its lowermost end to prevent dissipation of the supply pressure fluid. The supply pressure fluid at orifice 40 is directed into communication with the lowermost face of the valve 67 shown in its uppermost position in Figure 1. It will be apparent that in this position of the valve 67, the supply fluid is in communication with the passageway 58 of the spacer 56, and the counterbore 54 of the valve housing 46, and is thus directed into the vertical passageway 63 which communicates with the chamber 64 and in turn is in communication with a chamber 86 above the plate 50. The supply pressure fluid discharges through cylinder 49 above the apertured plate 50 of the piston unit 28, and thus exerts its pressure against the piston plate 50 to cause movement of the piston 28 away from the end plate 8 of the housing 4. It will be apparent that the supply pressure fluid acting against the piston plate 50 will cause movement of the piston 28 in a downward direction due to the effective area of the piston cylinder 30 times the pressure exerted, since supply pressure fluid is also present in the chamber 41.

Movement of the piston unit 28 moves the valve rod 78 to bring the nut 82 in contact with the bushing 79 in order to place the helical spring 80 under compression. During this movement of the valve rod 78, the high fluid pressure in the cylinders 12 and 49 exerts pressure against the nut 77*a* and the cross-sectional area of rod 76 to prevent the valve 73 from moving upward during the initial downward movement of the piston unit 28. However, continued pressure contact of the nut 82 and bushing 79 against the spring 80 under compression will increase the tension of the spring to such an extent it overcomes the fluid pressure in cylinders 12 and 49, thereby moving the shaft 78, and the top of the yoke 74 upward into contact with the lower face of the plate 61. Continued downward movement of the piston to the end of its stroke does not change the relative position of the valve sleeve 72 and yoke 74, as will be hereinafter set forth. The pilot valve 72 in its original down position shown in Figure 1 closes off the upper portion of the bore 65 from the input of the supply pressure fluid by blocking the passageways 69 communicating therewith. However, when the pilot valve sleeve 72 is moved upward it will open passageways 69 to bore 65 and close off the exhaust passageways 70 from the bore 65 (Fig. 3). These exhaust passageways are in communication with the space or chamber 71 communicating with an exhaust port 87 in valve housing 46 and an exhaust port 85 in baffle plate 35. With the exhaust passageways 70 closed off by the upward movement of valve 72 (Fig. 3), the input pressure is then permitted to flow through the bore 68 of valve 67 and into

the passageways 69 and 75 to a point above the upper face or topmost portion of the main valve 62.

The presence of the supply pressure fluid acting against the top face of the valve 62 will cause movement of the valve 62 downward in the cylinder 60, thereby moving the extension valve 67 away from the top valve seat 57 into contact with the lower valve seat 53. It will be apparent that the area of the valve 62 is greater in diameter than that of valve 67 to permit the downward movement, and change the seating position of the valve 67. Furthermore the valve 62 is provided with circular packing rings 89 (Fig. 3) on its outer periphery to prevent leakage of the supply pressure fluid in the downward movement of the valve 62.

This new position of the valve 67 precludes input pressure from orifice or port 59 and permits an exhaust of the supply pressure fluid acting against the top of the piston unit 28. The motivating pressure in the chambers 86, passageways 64 and 63 is allowed to exhaust between the intermediate portion 90 (Fig. 3) of the valve 67 and the apertures 59 and thereby flow to the exhaust ports 87 and 88, and hence to atmosphere (not shown). Similarly, any supply pressure fluid flowing into port 68 enters passageways 69 and 75 to maintain the pressure on top of the main valve 62. In this position the piston 28 has been moved through its complete stroke against the rubber bumpers 34. As soon as the exhaust pressure at the top of the piston unit 28 is depleted, the constantly maintained supply pressure in chamber 41 will exert itself against the undercut surface 91 of the piston spacer 32. The larger diameter of the spacer 32 relative to piston cylinder 30 will cause upward movement of the piston toward the upper plate 8. The upward movement of the piston moves the complete main valve housing 46, valve unit 62, valve rod 78, and coupling member or nut 77 into contact with the lower face 81 of the sleeve 12.

The upstroke of the piston unit 28 is influenced by the supply pressure fluid acting against the undercut surface and it will also be apparent that the supply pressure fluid is present in chamber 96 and influences the cross-sectional area of valve rod 76 to maintain a simultaneous upward movement of the valve 72 and its rod 78 with that of the piston unit 28. This movement will continue until the top of the coupling nut 77*a* contacts the bushing 79*a* acting as a lower anchor for the spring 80 encased in sleeve 12. During the upward movement of the piston 28 and the valve 72, the nut 82 is moved away from engagement with the spring 80 to relieve the compression thereof. Engagement of nut 77*a* with the bushing 79*a* again places the spring 80 under compression in a reverse manner to such an extent that the tension exerted by the spring 80 will overcome the high pressure in chamber 96, and cause movement of the pilot valve 72 downward against the high pressure in chamber 96 (Fig. 4). This pushing or moving of the pilot valve 72 will close off chamber 96 to supply pressure fluid and uncover the exhaust ports 70 to relieve the pressure condition against the top of the main valve unit 62 through the exhaust passageways 87 and 88. As soon as the pressure on top of main valve 62 is sufficiently depleted, the supply pressure fluid in communication with the valve 67 will cause movement of the valve unit 62 upwardly to uncover the port 58 for discharging supply pressure fluid to the chamber

86 above the piston unit 28 and thus repeating the working stroke of the piston unit 28.

It will be apparent that the spring functions to cause movement of the pilot valve before the piston unit 28 completes its full working stroke, however the momentum of the piston actuated by the supply pressure fluid will permit the piston to move through a complete working stroke into contact with the rubber bumper 34 as will be hereinafter set forth.

From the foregoing it will be apparent that the pilot valve 72 is caused to be moved by a motivation of the main piston which motivation is controlled by the pilot valve determining the position of the main valve 62 which controls the supply pressure fluid.

Movement of the piston unit 28 moves the pilot valve 72, movement of the pilot valve 72 controls the position of the main valve 62, and the position of the main valve 62 controls the supply pressure fluid for moving the piston 28 in one of two directions.

It will also be apparent that the pilot valve rod is always moving into or pushed into or against a high pressure area regardless of the direction of movement of the piston unit 28, and consequently away from a low pressure area. Furthermore, the pilot valve 72 is always moved in a direction opposite the next desired movement of the main valve 62. The particular operation of the pilot valve is such that the piston unit 28 is provided with a reciprocating stroke without regard to the velocity of the stroke, rhythm or momentum. The positive action of the pilot valve is such that it does not have any on-center position and its movement is highly sensitive to any changes in pressure conditions on either side of the piston unit causing movement thereof.

The application of the valve and piston unit with a road punch or impact tool (Fig. 2) utilizes a ram, such as an extension pipe 97 coupled to the piston cylinder 30 by any conventional coupling means 98. A circular cutter head 99 is secured to the end of the ram 97 by cross bars 100 secured to a nut 101. Clamp members 102 co-operate with the brackets 7 for maintaining the housing unit 2 in the cylindrical sleeve 5.

It will be apparent that the piston unit 28 disclosed in Figures 1, 3 and 4 in a movement toward the ring 34 causes a power stroke of the ram 97, and its complementary cutter 99. Furthermore, the valve unit 62 and pilot valve 72 control the supply pressure fluid to permit a reversal of the piston unit 28 to move the ram 97 and cutter 99 in a direction toward the ring 34, where again the piston unit 28 is in position to provide a working stroke to the cutter 99. The horizontal road punch is particularly adapted as auxiliary apparatus utilized in the laying of pipe line across the country. Many difficulties have been experienced in providing a ditch for the pipe underneath paved roadways, streams, canals and the like. The road punch may be placed contermineous with the pipe line ditch and actuated to drill or bore an aperture under a roadway necessary to lay a pipe line therethrough. The movement of the shell 5 longitudinally in the boring operation is controlled by any conventional mechanism (not shown). It will be apparent that the cuttings from the circular cutter 99 are pushed or moved into the interior of the cylindrical shell 5 during the operation of the ram 97. As the shell 5 is filled with the earth cuttings, the apparatus is removed and dumped, where it is again disposed in the bore to continue the cutting or boring operation.

The action of the spring to move the pilot valve and cause a movement of the main valve 62 prior to the completion of the stroke of the piston unit is particularly advantageous in the road punch, shown in Figure 2, particularly where the boring operation is only through dirt and the like. The momentum of the piston is such to move it through its complete stroke after reversal of the valve 72, in boring through the earth, and thus provide an additional boring action for the piston. However where the cutter is contacting shale, hard rock and other material difficult to penetrate, the additional boring action by the momentum of the piston is not present, and the action of the spring changing the position of the pilot valve will provide an immediate retrograde action of the piston unit 28 in order to provide successive impact strokes against the hard shale or the like.

Figures 5 and 6 disclose a modified adaptation of the valve and piston unit shown in the preferred embodiment, as a vertical reciprocating unit for use in a bottom hole oil well pump. The mechanism in this adaptation is shown disclosed in a tubing string 103 disposed in spaced relation to the well casing 104. The tubing string is provided with inwardly projecting shoulders 105 for supporting the pump housing generally indicated at 106. The lower end of the string 103 is of reduced diameter as at 107 for receiving the lower end 108 of the unit 106, supported therein by packing cups 109. A plurality of circumferentially spaced inlet apertures 110 are provided in the reduced portion 107. The pump unit 106 connects with a string of macaroni tubing 111 extending from the well surface for supplying the motive pressure fluid from a source (not shown) as will be hereinafter set forth. The valve and piston mechanism of the preferred embodiment is utilized as the bottom hole pump 106, however the structure is arranged as shown in the schematic drawing of Figure 6. In this adaptation the main valve 62 of the preferred embodiment is shown disposed in an inverted position relative to Fig. 1 with the extension valve 97 and pilot valve 72 likewise inverted. The piston unit 28 of the preferred embodiment has been modified and is disposed in the lower housing portions 112 and 113 of the pump unit 106.

Referring to the Figure 6, the modified piston unit 114 comprises a cylindrical piston 115 having an enlarged head or flange 116 at one end, and a similar enlarged head 117 at the opposite end. The piston heads 116 and 117 are provided with packing rings 118. The valve rod 78 of the preferred embodiment extends through an aperture 119 of the upper flange 116. The lower piston head 117 has an aperture 120. A ball valve 120a is disposed above the aperture 119 acting as the valve seat. A port 121 is provided in the head 117 for a purpose as will be hereinafter set forth. In the schematic showing of Figure 6 the supply pressure fluid from the tubing 111 is directed through a passageway 122 in housing 106 to a chamber 123 beneath the underface of the upper piston flange 116.

In the position shown in Figure 6, the piston has completed its working stroke, and has started the upward or exhaust stroke. The supply pressure fluid in chamber 123 will react against the difference in cross-sectional area between the packing ring 118 and the packing gland 124 to cause upward movement of piston unit 114 as exhaust supply fluid leaves chamber 36, which simultaneously moves lower piston head 117 upward to displace any well fluid present in a cham-

ber 125 into a displacement or reservoir chamber 126. The up-stroke of the piston 120 will relieve the pressure against the standing valve 127 so that the sand pressure will move valve 127 away from the seat 128 and permit discharge of production fluid into the lower chamber 129. The upward movement of the piston unit 114 moves the head 116 into engagement with the coupling nut 77a connected with the valve 72 to cause movement of the nut 77a in the same direction thereof with a simultaneous movement of the valve 72 to close off the passageways 69 and the chamber 96 from supply pressure fluid, and uncover the exhaust passageways 70 in communication with the exhaust passageways 87 and 88, thereby relieving the pressure in chamber 130 on one side of the main valve 62. This position of valve 72 directs the supply pressure fluid in passageways 131 against the valve 67 to move the valve 67, and the connecting main valve 62 in a direction toward the piston unit 114, thereby opening the inlet port 54 and passageway 64 to supply pressure fluid.

Supply pressure fluid is then directed into the chamber 86 to influence one face of piston flange 116 and cause movement of the piston 115 in a direction towards the standing valve 127 in a working stroke. The downward or working stroke of the piston unit 114 displaces production fluid that may be present in chamber 129 through the valve 120, orifice 121, and into the chamber 125, which fluid is partially displaced on the downward movement of the piston 115.

Continued downward movement of the piston unit 114 will engage flange 116 with the nut 82 to positively move the valve 72 simultaneously therewith. Downward movement of the valve 72 with block off exhaust ports 70 and permit flow of supply pressure fluid through passageways 68 and passageway 75 into the chamber 130. As soon as the supply pressure in chamber 130 is increased, it will move the main valve unit 62, and extension valve 67 into a seating position as shown in Figure 6 and close off the supply pressure fluid from orifice 54 and chamber 86. The supply pressure fluid is constantly maintained through passageway 122 to the chamber 123, then influences the underface of flange 116 and moves the piston unit 120 upwardly in a repeated operation.

The displacement of fluid into the reservoir chamber 126 constantly creates an increase in the hydrostatic head therein, which when sufficiently high will cause actuation of a differential valve unit 132 similar to that of applicant's copending application, Serial No. 690,006, filed August 6, 1946, now Patent No. 2,501,380, issued March 21, 1950, to direct flow of supply pressure from the tubing 111 through passageway 133 for slugging the fluid in the reservoir 126 to the surface of the well.

From the foregoing it will be apparent that the present invention contemplates a hydraulic power apparatus that can be utilized for various purposes. The apparatus contemplates a reciprocating piston unit having a positive and efficient working stroke by the substantial elimination of exhaust pressure against the working stroke which permits the piston to move in a power stroke as expeditiously as the regulated supply pressure fluid is directed thereto. Furthermore the valve mechanism and particularly the action of the pilot valve is such that it moves against the pressure of supply pressure fluid at all times, in order to permit variable positioning of the main valve for controlling or regulating the flow of the supply pressure fluid to the power face of the piston unit. Any pre-determined cushioning of the return or exhaust stroke of the piston unit may be controlled through the size of the exhaust ports which has the particular advantage of either speeding up or slowing down the back or return stroke of the piston for various purposes. The hydraulic power apparatus may be modified to various adaptation, as shown, such as a horizontal road punch or a bottom hole oil well pump without any substantial modification of the apparatus and particularly the operation of the valve mechanism controlling the actuation of the piston unit.

Changes may be made in the specification and drawings without departing from the spirit of the invention within the scope of the following claims, as set forth.

What I claim is:

1. In a fluid motor comprising a cylindrical housing having a piston unit adapted to reciprocate therein, said piston unit comprising a plurality of cylindrical members arranged in spaced relation to each other, an inlet conduit providing constantly maintained supply pressure fluid in communication with the housing, a passageway for directing pressure fluid to one end of the piston unit to cause actuation thereof in a power stroke, a main valve unit disposed in the piston unit for controlling the flow of pressure fluid to the piston, a pilot valve slidably disposed in the main valve and responsive to the movement of the piston to control the positioning of the main valve, and spring means responsive to movement of the piston to control the movement of the pilot valve.

2. In a hydraulic motor comprising a cylindrical housing having a piston unit adapted to reciprocate therein, means providing constantly maintained supply pressure fluid in communication with the housing and in constant contact with one face of the piston unit, main valve means disposed in the piston unit for controlling the flow of the supply pressure fluid to the opposite face of the piston unit to cause actuation thereof in a power stroke, a pilot valve slidably disposed in the main valve, a valve rod therefor, a nut coupling the pilot valve with the rod, said pilot valve maintained in one position by the pressure of the supply fluid acting against the rod and nut, a helical spring co-operating with the valve rod and responsive to movement of the piston unit to cause movement of the pilot valve against the pressure of the supply fluid, said movement of the pilot valve permitting a positioning of the main valve by the supply fluid pressure to control the flow of supply pressure fluid to the last mentioned face of the piston.

3. In a hydraulic power apparatus comprising a housing having a piston unit adapted to reciprocate therein, means providing constantly maintained supply pressure fluid in communication with the housing and in constant contact with one face of the piston, an automatic valve mechanism operable in one direction to direct the supply pressure fluid to an opposite face of the piston, said valve mechanism operable in another position to preclude supply pressure fluid to the last mentioned face of the piston and simultaneously permitting exhaust of the supply pressure fluid from the last mentioned face of the piston, a pilot valve slidably disposed in the valve mechanism, and spring means co-operating with the pilot valve and responsive to

a movement of the piston for moving the pilot valve to a position to control the position of the valve mechanism.

4. In combination with a hydraulic power unit and a horizontal boring apparatus, a fluid actuated reciprocating piston having an impact cutter connected therewith, an automatic valve mechanism operable in one direction to direct the supply pressure fluid to one end of the piston, said valve mechanism operable in another position to preclude supply pressure fluid to the last mentioned end of the piston and simultaneously permitting exhaust of the supply pressure fluid from the last mentioned end of the piston, a pilot valve slidably disposed in the valve mechanism, said pilot valve maintained in at least one operative position by the supply pressure fluid, and spring means co-operating with the pilot valve and responsive to a movement of the piston for moving the pilot valve to a position to control the position of the valve mechanism.

5. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit having a passage therein adapted, when open, to communicate said oppositely directed end face of said piston unit with the source of operating fluid; main valve means carried by the piston unit and operable by fluid pressure to alternately open and close said passage; and a pilot valve mounted in said main valve means and movable with the piston unit and operable, upon predetermined movement of the piston unit, to control the application of operating fluid pressure to said main valve means to actuate the same.

6. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit including a piston rod having an exhaust passage therein; said piston unit having a first passage in constant communication with the source of operating fluid and a second passage in constant communication with said exhaust passage; main valve means carried by the piston unit and operable by fluid pressure to provide communication between said oppositely directed end face of the piston unit and, alternately, said first passage and said second passage; and a pilot valve mounted in said main valve means and movable with the piston unit and operable, upon predetermined movement of the piston unit, to control the application of operating fluid pressure to said main valve to actuate the same.

7. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit including a valve housing carried thereby and main valve means reciprocable in said housing and operable to control the application of operating fluid pressure to said oppositely directed end face of the piston unit, said main valve means having a relatively small pressure area constantly subjected to operating fluid pressure and an oppositely directed relatively large pressure area; and a pilot valve carried by and movable with the piston unit and operable, upon predetermined movement of the piston unit, to control the application of operating fluid pressure to said relatively large pressure area of said main valve means.

8. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit including a valve housing carried thereby; main valve means reciprocable in said valve housing in opposite directions to alternately apply and release operating fluid pressure to and from said oppositely directed end face of the piston unit; and a pilot valve mounted within and movable with said valve housing, said pilot valve being reciprocable relative to said main valve means upon predetermined movement of said piston unit and being operable, upon movement thereof in one direction, to effect movement of said main valve means in the opposite direction.

9. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; main valve means carried by the piston unit and operable by fluid pressure to control the application of operating fluid pressure to said oppositely directed end face of the piston unit; a pilot valve carried by said main valve means and movable therewith during the major portion of each stroke thereof, said pilot valve being movable relative to said main valve means to control the application of operating fluid pressure to said main valve means to actuate the same; and actuating means connected to said pilot valve and engageable with cooperating abutment means associated with said cylinder to effect movement of said pilot valve relative to said piston unit upon predetermined movement of said piston unit.

10. A fluid motor comprising: a cylinder and a differential area piston reciprocable therein and having a relatively small effective pressure area and an oppositely directed relatively large effective pressure area, said cylinder having fluid inlet means adapted to provide constant communication between said relatively small pressure area and a source of operating fluid under pressure; a valve housing; main valve means reciprocable in said housing and operable to provide communication between said relatively large pressure area and, alternately, said source of operating fluid and a zone of lower pressure than that of the operating fluid to effect reciprocation of said piston; said main valve means having a relatively small pressure area constantly subjected to operating fluid pressure and having

an oppositely directed relatively large pressure area; and a pilot valve carried by and reciprocable in said valve housing and operable, upon predetermined movement of said piston, to provide communication between said relatively large pressure area on said main valve means and, alternately, said source of operating fluid and said zone of lower pressure.

11. A piston and valve assembly for a fluid motor comprising: a piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage therein communicating with said oppositely directed end face thereof, and a third passage therein communicating with an exhaust passage; fluid-actuated main valve means carried by the piston and movable relative thereto to provide communication between said second passage and, alternately, said first passage and said third passage; and a pilot valve mounted in said main valve means and operable to control the actuation of said main valve means.

12. A piston and valve assembly for a fluid motor comprising: a piston and a piston rod connected thereto, said piston rod having an exhaust passage therein, said piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage communicating with said oppositely directed end face thereof, and a third passage communicating with said exhaust passage in said piston rod; fluid-actuated main valve means carried by the piston and movable relative thereto to provide communication between said second passage and, alternately, said first passage and said third passage; and a pilot valve mounted in said main valve means and operable to control the actuation of said main valve means.

13. A piston and valve assembly for a fluid motor comprising: a piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage therein communicating with said oppositely directed end face thereof, and a third passage therein communicating with an exhaust passage; a first valve seat associated with said first passage, and a second valve seat associated with said third passage; a fluid-actuated valve member carried by the piston and movable into engagement with said first seat to close said first passage and provide communication between said second and third passages, said valve member being movable, alternately, into engagement with said second seat to close said third passage and provide communication between said first and second passages; and a pilot valve mounted in said valve member and operable to control the actuation of said valve member.

14. A piston and valve assembly for a fluid motor comprising: a piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage therein communicating with said oppositely directed end face thereof, and a third passage therein communicating with an exhaust passage; a first valve seat associated with said first passage, and a second valve seat associated with said third passage; a fluid-actuated valve member carried by the piston and movable into engagement with said first seat to close said first passage and provide communication between said second and third passages, said valve member being movable, alternately, into engagement with said second seat to close said third passage and provide communication between said first and second passages; said valve member having oppositely directed pressure areas, one of which is exposed to said first passage; said valve member having a fourth passage communicating at one end with said first passage, and having a fifth passage communicating at one end with said third passage; and a pilot valve movably mounted in said valve member and operable to provide communication between the other of said pressure areas on said valve member and, alternately, said fourth passage and said fifth passage.

15. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit including a valve housing carried thereby, main valve means slidably mounted within said housing and operable by fluid pressure to control the application of operating fluid pressure to said oppositely directed end face of the piston unit, and a pilot valve slidably mounted within said housing and movable with the piston unit, said pilot valve being operable, upon predetermined movement of the piston unit, to control the application of operating fluid pressure to said main valve means to actuate the same; said pilot valve having a valve rod connected therewith and extending through a wall of said valve housing, said valve rod having abutment means thereon adapted to engage cooperating abutment means associated with said cylinder to move said pilot valve relative to said housing to an intermediate position wherein it is effective to cause actuation of said main valve means by fluid pressure, said pilot valve being adapted to be moved from said intermediate position to a final position and to be held in said final position by a fluid pressure differential between the interior and exterior of said valve housing, established by actuation of said main valve means.

16. A fluid motor comprising: a cylinder and a piston unit reciprocable therein and having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said cylinder having fluid inlet means adapted to provide constant communication between said first end face of the piston unit and a source of operating fluid under pressure; said piston unit having a passage therein adapted, when open, to communicate said oppositely directed end face of said piston unit with the source of operating fluid; main valve means carried by the piston unit and operable by fluid pressure to alternately open and close said passage; and a pilot valve carried by said piston unit in coaxial relation to said main valve means and operable, upon predetermined movement of the piston unit, to control the appli-

cation of operating fluid pressure to said main valve means to actuate the same.

17. A piston and valve assembly for a fluid motor comprising: a piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage therein communicating with said oppositely directed end face thereof, and a third passage therein communicating with an exhaust passage; fluid-actuated main valve means carried by the piston and movable relative thereto to provide communication between said second passage and, alternately, said first passage and said third passage; and a pilot valve carried by the piston in coaxial relation to said main valve means and operable to control the actuation of said main valve means.

18. A piston and valve assembly for a fluid motor comprising: a piston having a first end face of relatively small effective area and an oppositely directed end face of relatively large effective area, said piston having a first passage therein communicating with said first end face thereof, a second passage therein communicating with said oppositely directed end face thereof, and a third passage therein communicating with an exhaust passage; and a valve unit detachably secured to said piston, said valve unit comprising a valve housing, fluid-actuated main valve means mounted in said valve housing and operable to provide communication between said second passage and, alternately, said first passage and said third passage, and a pilot valve mounted in said valve housing and operable to control the actuation of said main valve means.

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