April 28, 1942. J. A. MULLER 2,281,372

HYDRAULIC MOTOR

Filed Sept. 9, 1938 4 Sheets-Sheet 1

Fig. 3.

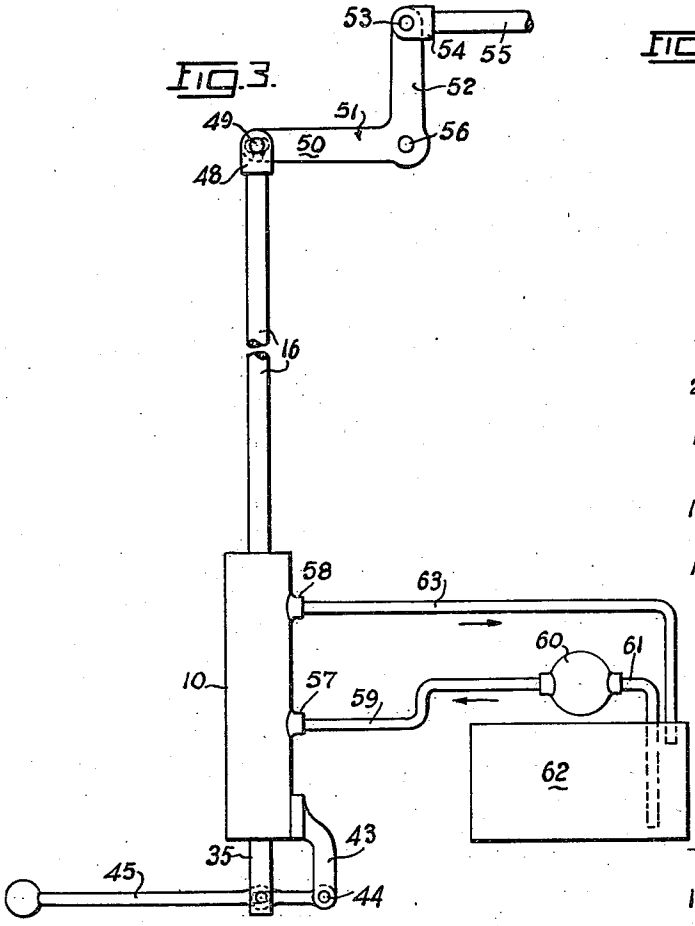


Fig. 2.

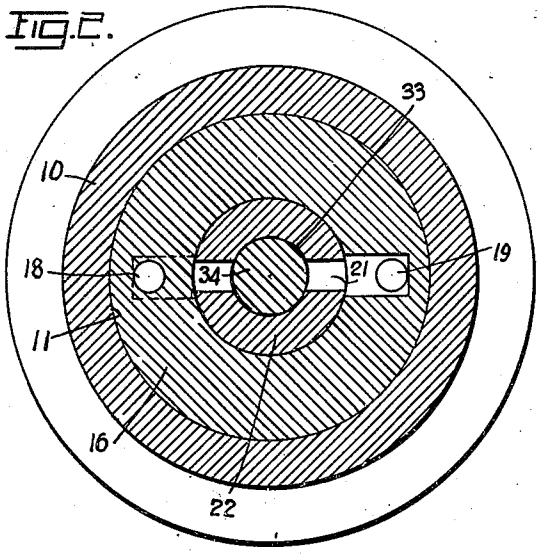
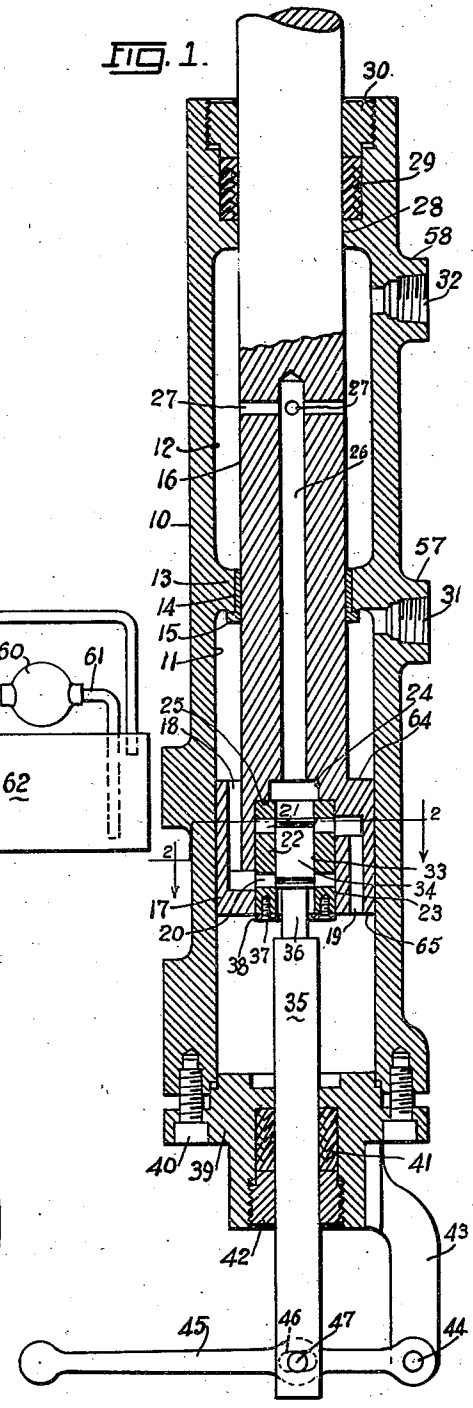


Fig. 1.



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HYDRAULIC MOTOR

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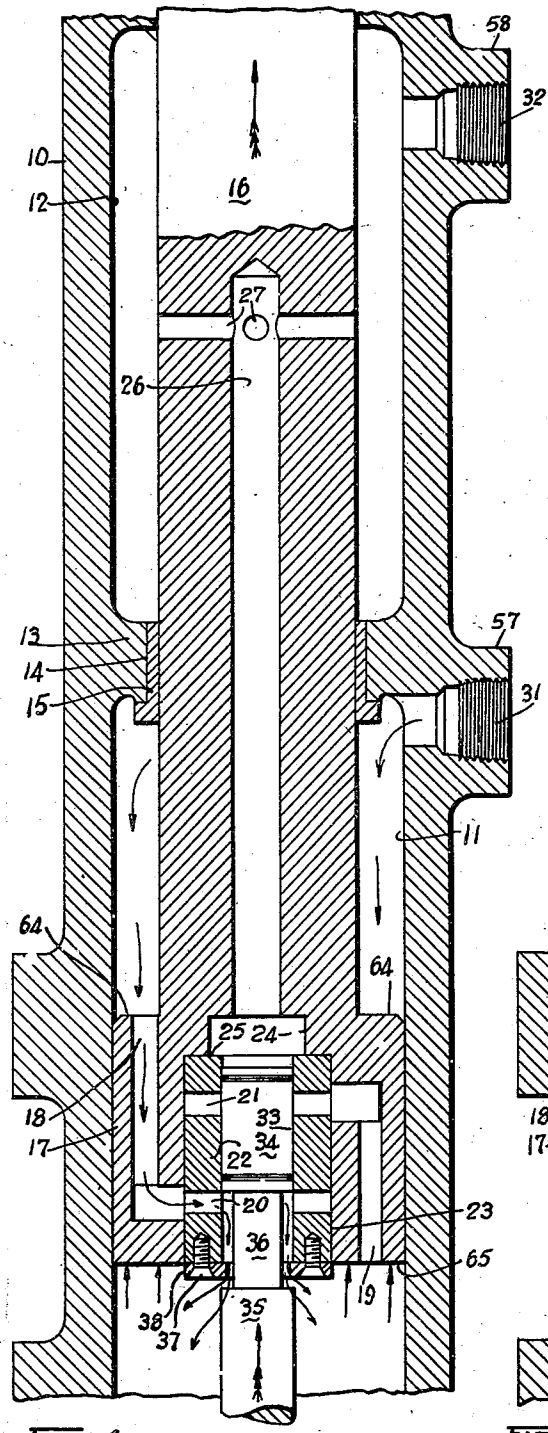


FIG. 4.

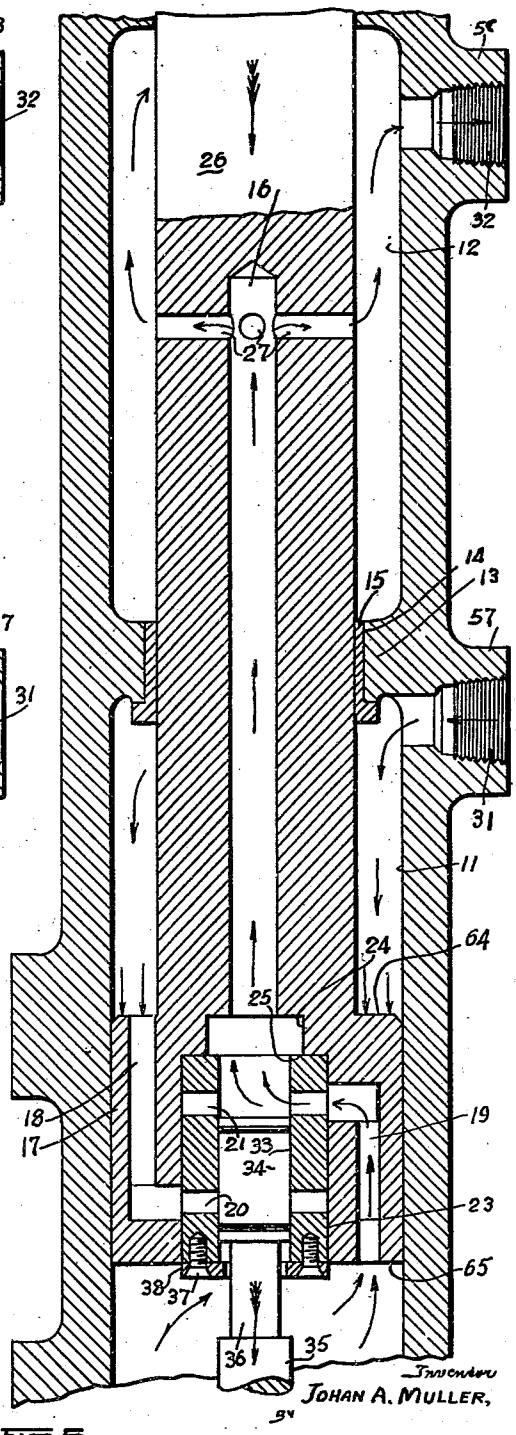


FIG. 5.

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HYDRAULIC MOTOR

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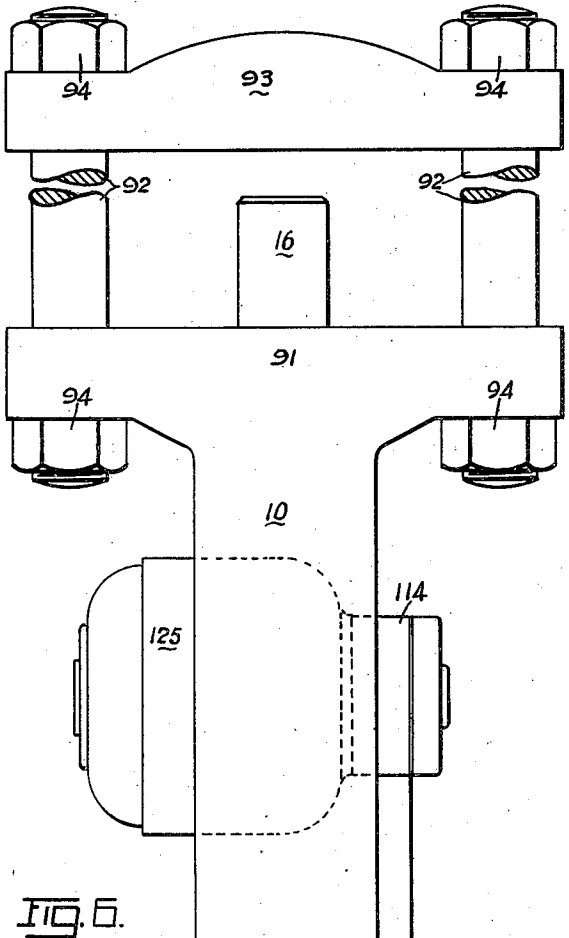


Fig. 6.

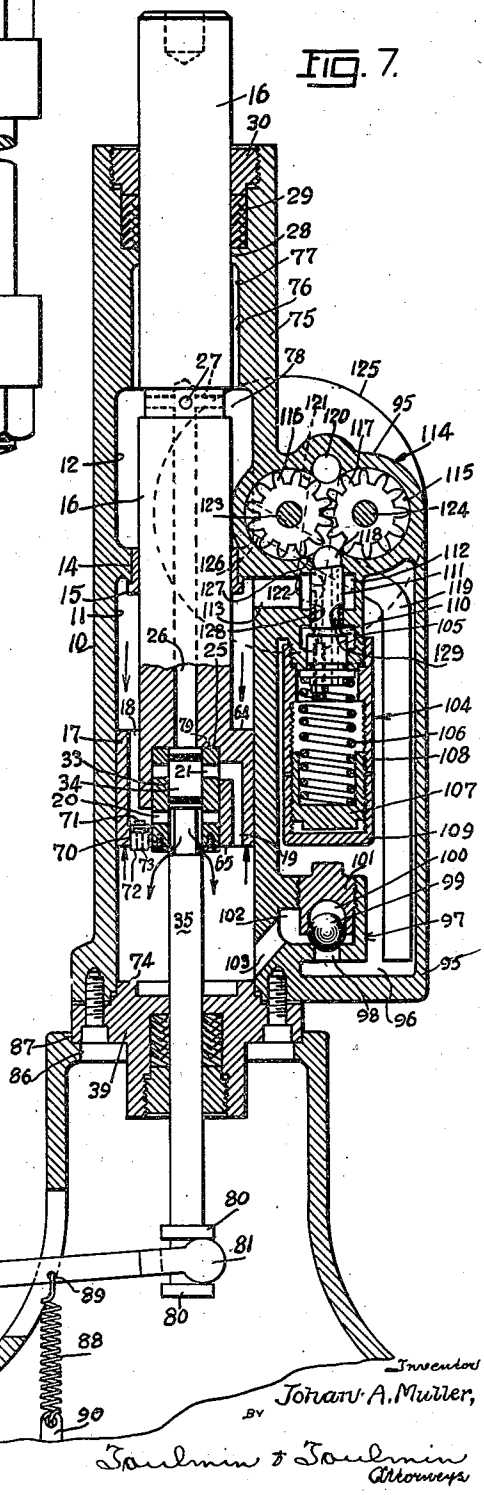


Fig. 7.

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HYDRAULIC MOTOR

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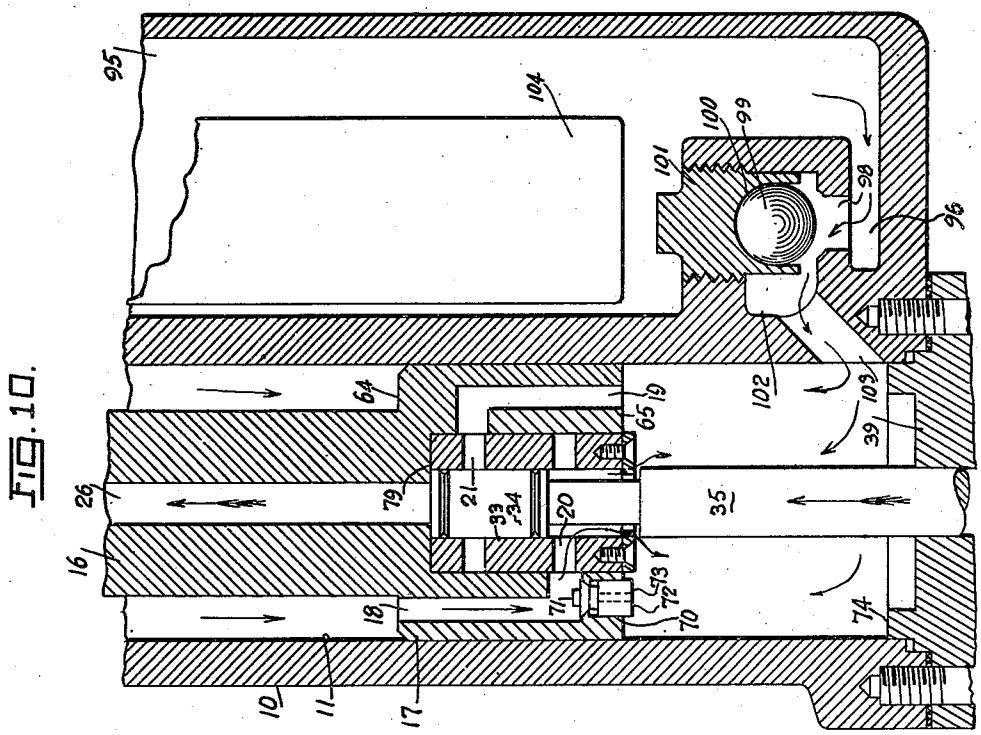


FIG. 10.

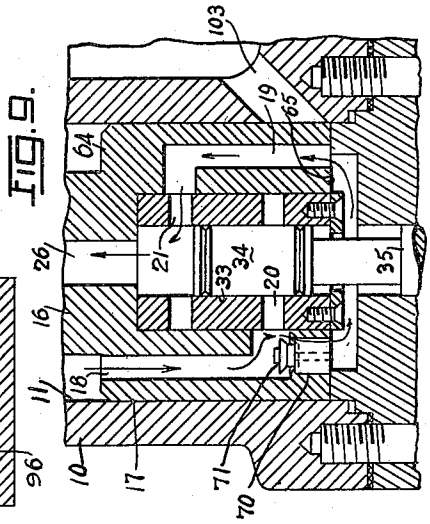


FIG. 9.

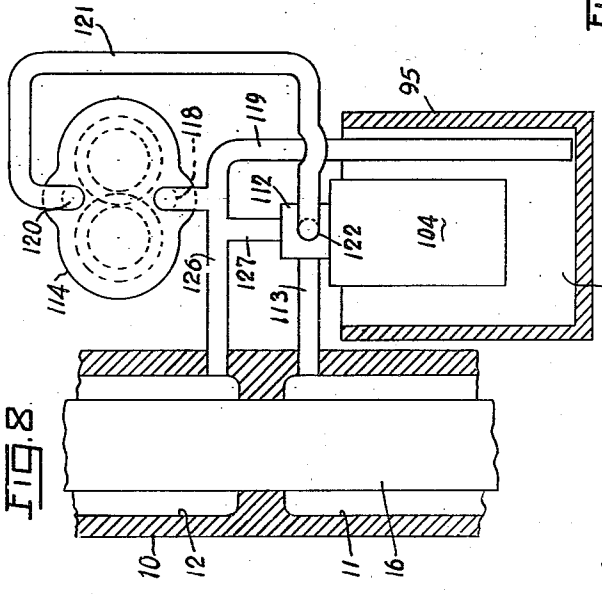


FIG. 8.

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UNITED STATES PATENT OFFICE

2,281,372

HYDRAULIC MOTOR

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Application September 9, 1938, Serial No. 229,215

3 Claims. (Cl. 60—52)

This invention relates to hydraulic motors, and in particular, to reciprocating motors.

One object of this invention is to provide a hydraulic motor having a reciprocating plunger which moves at the same rate and distance as a control member, but delivering a much greater force than is applied to the control member.

Another object is to provide a hydraulic motor having a reciprocating plunger with a piston valve member cooperating with ports in the head of the plunger so as to provide a point-for-point travel of the plunger with the piston valve member, but with the output of a relatively great force for a given force applied to the piston valve member.

Another object is to provide a hydraulic motor having a reciprocating plunger with a head having a chamber therein, with ports cooperating with the head of a piston valve member in such a manner as to uncover one of these ports to permit pressure fluid to flow through the plunger head to the opposite side thereof when the piston valve member is moved in one direction, but to uncover another port permitting the discharge of pressure fluid from one side of the plunger head when the piston valve member is moved in the opposite direction, thereby providing a follow-up motion of the plunger in correspondence with the motion of the piston valve member.

Another object is to provide a hydraulic motor having a plunger with a head having a passageway therethrough, and a piston valve member cooperating with the ports in the plunger head, the passageway thereof having a check valve therein operated in such a manner as to by-pass and unload the discharge from the source of pressure fluid when the plunger reaches a predetermined limit of its stroke in one direction.

Another object is to provide a hydraulic motor of the type set forth in the preceding paragraph, wherein the piston valve member is arranged to mechanically engage the plunger so as to advance the latter mechanically to provide a rapid traverse of the plunger to the working position instead of having to wait until the pressure from the pressure source forces the plunger to the working position.

Another object is to provide a hydraulic motor unit employing the hydraulic motor set forth in the preceding objects, the unit having a self-contained motor and pump together with a relief valve and a check valve for enabling the motor unit to be operated as a single entity without the need for external piping.

Another object is to provide a hydraulic press utilizing the motor of the foregoing objects, for actuating the ram thereof in follow-up relationship with the manually shifted piston valve member.

Another object is to provide a hydraulic motor having a plunger with a head providing a differential piston area when pressure is admitted simultaneously to both sides of the head, together with means controlled by a control member for selectively admitting or cutting off the supply of pressure fluid to one side of the plunger head so as to selectively provide or eliminate the differential effect and cause the plunger to move in opposite directions.

In the drawings:

Figure 1 is a central longitudinal section through a hydraulic motor according to the present invention.

Figure 2 is a cross section along the line 2—2 in Figure 1.

Figure 3 is a diagrammatic view of a simplified hydraulic circuit for operating and utilizing the hydraulic motor of Figures 1 and 2.

Figure 4 is an enlarged view of a portion of Figure 1, showing the relationship of the parts when the motor plunger is set for operation in an upward direction.

Figure 5 is a view similar to Figure 4, but with the parts set for operation in a downward direction.

Figure 6 is a front elevation of a modification consisting of a hydraulic press utilizing the hydraulic motor of the present invention, and providing a self-contained pump unit associated therewith.

Figure 7 is a central longitudinal section through the lower part of the press shown in Figure 6, illustrating the construction of the pumping unit.

Figure 8 is a diagrammatic layout of the circuit of the pump and valves shown in Figure 7.

Figure 9 is an enlarged view of a portion of Figure 7, with the plunger at its lowermost position, showing the means for by-passing the discharge of the pump in that position.

Figure 10 is a view similar to Figure 9, but showing the motor plunger being rapidly traversed mechanically by the direct mechanical application of the piston valve thereto instead of relying upon hydraulic pressure.

General construction

In general, the hydraulic motor of this invention consists of a cylinder with a double-acting plunger therein. The plunger has a head with

passages from opposite sides communicating with ports in a chamber within the head, these ports cooperating with the head of a piston valve member in such a manner as to selectively open and close one or the other of the ports. When one port is uncovered by the piston valve head, pressure fluid is enabled to engage both sides of the plunger head and urge the latter in one direction as a result of the differential piston area provided by the rod portion of the plunger. When this port is covered and the other port uncovered, however, fluid is permitted to act against but one side of the plunger head, thereby urging the plunger in the opposite direction. The device gives a follow-up motion by reason of the fact that when the piston valve head is moved a given distance in one direction, the uncovering of the ports within the plunger head causes the plunger to be moved in the same direction as the piston valve head, thereby again covering up the ports when a like distance has been traveled by the plunger head as was traveled by the piston valve head. The motor of this invention, however, gives a greatly increased mechanical advantage because the force produced by the motion of the plunger is vastly greater than the force necessary to move the piston valve head in one direction or the other. In other words, a point-for-point correspondence is effected between the motion of the piston valve member and the resulting motion of the plunger.

This invention is capable of use as a servomotor or as an auxiliary motor for controlling the servomotors of large hydraulic pumps. It may be used, however, in any position where it is desired to obtain a greatly increased force with a corresponding rate and distance of motion, such as in controlling the positions of members in heavy machinery, such as steel mill machinery. Another application is for regulating the position of the blade of a road grader so as to regulate the depth of cut. Still another application is that of a smaller press, such as for forcing bushings for riveting or for assembling. The device may also be used as a hydraulic jack or hoist.

A modification of the invention, as shown in Figures 6 to 10, utilizes the motor of Figures 1 to 5 with a built-in pump unit, together with means for by-passing the discharge of this pump unit when the motor piston reaches the end of its stroke in one direction. The piston valve member in this modification is made to directly engage the motor plunger when the latter is in its retracted position, so that the motor plunger may be rapidly traversed to the work by the force exerted by the operator himself, rather than requiring a wait for the action of the hydraulic pressure. Under such circumstances, a check valve is provided for admitting fluid to the space behind the head of the motor plunger.

Hydraulic motor

Referring to the drawings in detail, Figure 1 shows a preferred embodiment of the hydraulic motor of this invention as consisting of a casing 10 with bores 11 and 12 therein, separated by an annular partition 13 having a bore 14 with a bushing 15 therein. The bushing 15, which may be a bronze bushing, fits closely around the motor plunger 16 so as to prevent excessive leakage. The motor plunger 16 is provided with a head 17 having L-shaped passages 18 and 19 communicating with ports 20 and 21 in a sleeve 22 mounted within a longitudinal bore 23 within the plunger head 17. The bore 23 continues in the counterbore 24 to provide an annular wall 25 against which the sleeve 22 abuts. Beyond the counterbore 24 is a longitudinal bore or passageway 26 extending through the plunger 16 to the cross passages 27 opening out into the bore 12. Beyond the cross passages 27 the motor plunger 16 passes through an annular end wall 28, having beyond it a packing 29, compressed by a gland 30, for preventing leakage from the device. Threaded ports 31 and 32 open, respectively, into the bores 11 and 12. The port 31 serves as an inlet port for pressure fluid, and the port 32 as an outlet port for the discharge of fluid. The inner surface 33 of the sleeve 22 forms a bore for receiving a piston valve head 34 upon a piston valve rod 35, having a reduced diameter portion 36 connecting it with the head 34. Secured to the end of the sleeve 22, as by the screws 37, is a retaining ring 38 for preventing the valve head 34 from being withdrawn from the bore 33 in the event that the valve rod 35 is moved when no pressure fluid is being supplied at the pressure inlet port 31.

The bore 11 serves as a pressure chamber, and is provided with a cylindrical head 39 secured to the casing 10 by the screws 40, and containing a packing 41 compressed by a gland 42 for preventing leakage around the valve rod 35. Also mounted upon the cylinder head 39 is a bracket 43, having a pivot pin 44 pivotally supporting one end of a hand lever 45 having a slot 46 engaging a pin 47 in the end of the valve rod 35. By moving the hand lever 45 the valve rod 35 may be shifted to and fro, and with it the valve head 34. It will be understood, however, that the provision of the valve operating lever 45 is merely for convenience, and that any other means of moving the valve rod 35 may be adopted, such as a knob upon the valve rod 35.

Figure 3 shows one application of the motor of Figure 1, wherein the plunger 16 carries a clevis 48 carrying a pivot 49 passing through one arm 50 of a bellcrank, generally designated 51, the other arm 52 of which is provided with a similar pivot pin 53 passing through a clevis 54, attached to a rod or link 55. The bellcrank 51 is itself mounted upon a pivot shaft 56. The rod 55 may consist of the servomotor valve rod of a large hydraulic pump of the type having a movable flow-control element controlled by a servomotor, such as that shown in the Ernst Patent No. 2,038,272, issued April 21, 1936. The casing 10 is provided with bosses 57 and 58 surrounding the ports 31 and 32. Connected to the port 31 is a conduit 59, constituting the pressure conduit from a pump 60, the latter having a suction conduit 61 extending downwardly into a fluid tank 62. Connected to the port 32 is a discharge conduit 63, likewise leading downwardly into the tank 62.

In the operation of the hydraulic motor of Figures 1 to 5, the pump 60 delivers pressure fluid through the conduit 59 and port 31, into the bore 11, whence it passes downwardly through the L-shaped passageway 18, into the port 20. If, now, the valve rod 35 is moved upwardly (Figure 4), the valve piston head 34 thereof uncovers the port 20 so that pressure fluid can flow onward through the bore 33 of the sleeve 22, into the space beneath the plunger head 17. The latter is provided with upper and lower head areas 64 and 65, respectively, the difference between these areas providing a differential piston area which is effective when both of the head

areas 64 and 65 are supplied simultaneously with pressure fluid. This occurs when the upward motion of the valve rod 35 and valve head 34 uncovers the sleeve port 20 so that pressure fluid acts simultaneously upon the small annular area 64 and the large annular area 65. The effective piston head area thus brought into play is equal to the difference between the areas of the portions 64 and 65, with the balance in favor of the lower head area 65. As a consequence, the plunger head 17 and plunger 16 are moved upwardly. When this occurs, however, the port 20 is moved upwardly until it passes the lower edge of the valve head 34, again covering up the port 20. The port 21, meanwhile, has been covered up in the initial raising of the valve rod 35, thereby cutting off communication between the head passageway 19 and the longitudinal bore 26 in the plunger 16. If the valve rod 35 is moved upwardly a given distance, therefore, the plunger head 17 and plunger 16 will move upwardly a corresponding distance. As the piston valve head 34 is a small piston, however, it is easily moved with little effort on the part of the operator, whereas the plunger head 17, because of its large area, exerts a much greater force on the plunger 16 than it is necessary to apply to the valve rod 35 to move the valve piston head 34.

If it is desired to move the plunger 16 in the opposite direction, the operator shifts the hand lever 45 to move the valve rod 35 downwardly (Figure 5), carrying with it the valve piston head 34 and uncovering the port 21 in the sleeve 22. This opens up the L-shaped head passageway 19 for communication through the port 21 with the longitudinal plunger passageway 26, and at the same time closes off the port 20 and the L-shaped head passageway 18 against the discharge of pressure fluid therethrough. As a result the pressure fluid from the pump 60 is applied solely within the upper end of the bore 11 against the annular plunger head area 64, and all pressure is released against the lower plunger head area 65. The plunger 16, therefore, moves downwardly, the fluid displaced from beneath it moving upwardly through the passageway 19, the port 21, the counterbore 24, the plunger passageway 26, the cross passageways 27, the cylinder bore 12, the outlet port 32 and the conduit 63, into the tank 62. The plunger head 17 and plunger 16 move downwardly until the port 21 in the sleeve 22 moves past the upper edge of the valve piston head 34 and is covered up thereby. This again closes off the L-shaped passageway 19 in the discharge circuit, thereby entrapping the fluid beneath the plunger head 17 and halting further motion of the latter. Meanwhile, the port 20 has been covered up by the piston valve head 34.

In this manner, it will be seen that when the operator shifts the valve rod 35 and valve head 34 a given distance in one direction, the plunger 16 will move exactly the same distance in the same direction and halt. During its motion, however, the plunger 16 will make available a vastly greater working force than the force applied in shifting the valve rod 35, due to the greater head area of the plunger head 17. Thus, in an upward direction of motion of the valve rod 35, both of the plunger head areas 64 and 65 are brought into operation simultaneously, with the resulting application of a plunger head area equivalent to the difference between these two areas. In a downward motion of the valve rod 35 and valve head 34, however, the lower plunger head area 65 is prevented from receiving pressure fluid and at the same time is connected to the discharge circuit so that it is under substantially zero pressure. When this occurs the upper plunger head area 64 alone operates to move the plunger 16 downwardly. If this area 64 is made very small by making the plunger 16 of nearly the same diameter as the plunger head 17, a very rapid downward motion of the plunger 16 can be brought about. This is valuable when it is desired to advance the plunger 16 upwardly at a slow rate with the production of a great force, yet to retract the plunger 16 in a downward direction at a high rate of speed.

Hydraulic machine with self-contained pumping unit

The hydraulic machine shown in Figures 6 to 10, inclusive, utilizes the hydraulic motor of Figures 1 to 5, with slight modifications in combination with a self-contained pumping mechanism, together with a relief valve and check valves for enabling the discharge of the pump to be unloaded or by-passed back to the tank when the plunger head of the motor reaches the extreme limit of its stroke in one direction. The parts of the motor itself, in general, remain unchanged to a substantial extent, and are designated with like numerals to those employed in Figures 1 to 5. The plunger head 17, in Figure 7, however, is provided with an additional passageway 70, containing a check valve plunger 71 with flutes 72 and guides 73. The cylinder head 39 is provided with an annular internal shoulder 74 positioned to engage and lift the check valve plunger 71 when the main plunger head 17 reaches the lower limit of its position, thereby unloading the discharge of the pump in the manner hereinafter explained. The casing 10 at its upper end, in Figure 7, is provided with an extension 75 containing longitudinal grooves 76 and guides 77 for providing additional support for the plunger 16. The latter is also provided with an annular recess 78 immediately adjacent the cross passages 27, these cooperating with the grooves 76 in the extension 75 to permit the discharge of oil into the upper bore 12 when the plunger 16 nears the top of its stroke. This construction prevents the covering up or restriction of the cross passages 27, which would otherwise occur when they passed into the extension 75.

In the plunger 16 of Figure 7, the counterbore 24 at the upper end of the bore 23 has been omitted. In the lower positions of the plunger 16, this construction permits the upper end of the valve piston head 34 to engage the annular projecting portion 79 of the end wall 25. The lower end of the valve rod 35 carries spaced collars 80, engaged by the yoke 81 upon the end of the foot pedal 82. The latter is pivotally mounted upon the shaft 83, supported by the bracket 84 extending upwardly from the base 85, the latter having an aperture 86 and recess 87 for receiving and supporting the cylinder head 39. A spring 88, connected as at 89 to the foot pedal 82 and at 90 to a fixed abutment, such as the base 85, constantly urges the yoke 81 and valve rod 35 downwardly toward its lowermost position. The upper end of the casing 10 (Figure 6) is provided with a cross member 91, either integral therewith or attached thereto and serving for the connection of strain rods 92, the upper ends of which are secured to the press head 93. The strain rods 92 terminate in nuts 94 upon the threaded ends thereof. In Figure 7 the strain

rods 92 and head 93 have been omitted. This structure is omitted when the device is used as a hydraulic jack, or for similar purposes. Instead of the strain rods 92 and head 93, a frame of any other type may be provided, such as for example, an open gap frame, as is understood by those skilled in the hydraulic art.

For supplying pressure fluid for the operation of this device the casing 10, in Figure 7, is provided with a hollow casing extension 95, containing an inner chamber 96 serving as a fluid tank or reservoir. Mounted in this chamber 96 is a check valve, generally designated 97, having a port 98 engaged by a check valve ball 99, adapted to move up and down in the recess 100 within the screw plug 101. When the ball 99 is raised the port 98 communicates with a chamber 102, connected by the passageway 103 to the lower end of the cylinder bore 11. The middle portion of the casing extension 95 is occupied by a pressure relief valve, generally designated 104, having a reciprocable valve member 105 urged upwardly by a spring 106 within the cap 107, threaded into the valve casing 108. The cap 107 is protected by a threaded cover 109. The mid-portion of the relief valve member 105 opens into a chamber 110, whereas the upper portion 111 opens into a chamber 112, directly connected to the passageway 113 opening into the top of the cylinder bore 12, in a manner analogous to the port 31 in Figure 1. The relief valve 104 in its details forms no part of the present invention, and is disclosed in the Ernst Patent No. 2,086,295, issued July 5, 1937.

Above the pressure relief valve 104, at the upper end of the casing extension 95, is a pump, generally designated 114, and including a pump chamber 115 containing intermeshing pump gears 116 and 117. One side of the chamber 115 opens into the suction port 118, connected by the suction conduit 119 to the bottom of the reservoir or chamber 96. The other side of the pump chamber 115 opens into the pressure port 120, from which the conduit 121 runs to the port 122, opening into the upper relief valve chamber 112. The pump gears 116 and 117 are mounted upon shafts 123 and 124. The shaft 123 is connected to an electric motor 125 and driven thereby. The details of the gear pump 114 form no part of the present invention, and are disclosed in the Ernst Patent No. 2,103,524, issued December 28, 1937. Beyond the suction port 118 the passageway 126 continues, opening into the upper cylinder bore 12 in a member analogous to the port 32 of Figure 1, and connecting the upper bore 12 with the reservoir chamber 96 by means of the downwardly extending suction conduit 119. The upper end 111 of the relief valve plunger 105 opens into the passageway 127, connecting it with the conduit 119. In order to move the relief valve plunger 105, the latter is provided with a passageway 128 extending from the chamber 112 to the chamber 110. A passageway 129 also extends through the relief valve plunger 105, from end to end, and provides for drainage.

In the operation of the modification shown in Figures 6 to 10, inclusive, let it be assumed that the plunger head 17 is in its lowermost position instead of in approximate mid-stroke, as shown in Figure 7. In its lowermost position the lower piston head area 65 engages the annular shoulder 74, the latter forcing upwardly the check valve plunger 71 into its open position. The motor 125, meanwhile, has been started in operation, rotating the shaft 123 and operating the pump 114. The latter draws fluid from the reservoir chamber 96, through the conduit 119 and port 118, into the pump chamber 115, discharging it under pressure through the pressure port 120, the passageway 121 and the port 122, into the relief valve chamber 112, thence through the passageway 113, into the lower cylinder bore 11, whence the fluid proceeds through the L-shaped passageway 18 and the now open check valve passageway 70, into the space beneath the plunger head 17.

The spring 88, meanwhile, holds the valve rod 35 in its extreme lowermost position, thereby uncovering the port 21 from closure by the valve piston head 34 and opening communication between the L-shaped passageway 19 and the bore 33, by way of the now uncovered port 21. Fluid discharged by the pump into the space beneath the plunger head 17, in the manner previously described, is then exhausted through the passageway 19, the port 21, the plunger passageway 26, the cross passages 27, the upper cylinder bore 12, the passageway 126 and the port 118, into the pump chamber 115. The pump is therefore free to continue to run and circulate oil at no pressure so long as the valve rod 35 and valve piston head 34 are in their lowermost positions. In this condition, therefore, when the plunger head 17 lies in its lowermost position, the discharge of the pump is completely unloaded at zero pressure.

To cause the plunger 16 to move upwardly on a rapid traverse stroke, the operator merely steps on the foot pedal 82. When he does this the upper end of the valve piston head 34 engages the shoulder 79 within the plunger 16, and forces not only the valve rod 35 but also the plunger 16 upwardly. In this manner the operator can move the plunger 16 upwardly to the work at a more rapid rate than would be possible with the use of the pressure fluid alone. The suction created beneath the plunger head 17 is filled with fluid reaching it from the reservoir 96, past the ball 99 of the check valve 97 and through the passageway 103. The check valve plunger 71, of course, closes immediately after its removal from engagement with the internal shoulder 74 as soon as the plunger 17 rises. Thus the operator is not obliged to wait for the pressure fluid to raise the plunger 16, but can force the entire plunger assembly upward until the plunger encounters the workpiece.

Meanwhile, (Figure 10), as soon as the operator has raised the valve piston head 34 past the port 20, pressure fluid is free to discharge through the L-shaped passageway 18 and port 20, into the space beneath the piston head 65, likewise assisting in filling the space therebeneath. When the plunger 16 halts upon engagement with the workpiece and builds up resistance so that the operator can raise it no further with foot pressure, the pressure fluid acting upon the plunger head area 65 builds up and urges the plunger upwardly. At this time the port 21 is, of course, closed by the valve piston head 34 so that fluid cannot escape from the lower portion of the cylinder bore 11. The operation of the motor is henceforth similar to that described in connection with Figure 1. By making the plunger 16 almost as large as the plunger head 17, so that the annular head area 64 is very small, the plunger 16 may be retracted at a rapid rate even though the pump 114 has but a small delivery.

To retract the plunger 16, the operator removes his foot from the foot pedal 82, whereupon the spring 81 pulls the valve rod 35 and valve head 34 downwardly, closing the port 20 and uncovering the port 21. In the manner previously

described in connection with Figure 1, this allows fluid to be exhausted from the space beneath the plunger head 17 while pressure is built up above the latter, causing it to be retracted. The plunger head 17 and plunger 16 continue to move downwardly until the plunger head 17 comes to rest against the internal shoulder 74, which then raises the check valve plunger 71 (Figure 9) and again causes the pump 114 to by-pass its discharge at zero pressure, in the manner previously set forth. For the sake of simplicity of showing, the check valve ball 99 and check valve plunger 71 are shown as urged downwardly by gravity. By spring loading the ball 99 and plunger 71, the motor may be enabled to operate horizontally, vertically or in any other position.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a hydraulic motor unit, casing means having a cylinder bore, a plunger reciprocable in said bore and having a head with a passageway therethrough, a pump mounted on said casing means and connected to deliver pressure fluid to said cylinder bore on one side of said head, a valve member positioned to selectively open and close said passageway to admit and exclude pressure fluid respectively from the other side of said head, said valve member being adapted to physically contact said plunger throughout a portion of its stroke for moving said plunger a portion of its stroke in response to a manual movement of said valve member whereby to rapidly traverse said plunger to its working position by means of said valve member, and valve means for admitting fluid behind said plunger to fill the space evacuated by the motion of said plunger by its mechanical engagement with said valve member.

2. In a hydraulic motor unit, casing means having a cylinder bore and an exhaust bore, a plunger passing through said bores and having a head with unequal head areas on opposite sides which is reciprocable in said cylinder bore, said head having a passageway therethrough, a pump mounted on said casing means and connected to deliver pressure fluid to said cylinder bore on one side of said head, a passageway leading from the other side of said head to said exhaust bore, a valve member positioned to selectively open one passageway while closing the other passageway, said valve member being adapted to physically contact said plunger throughout a portion of its stroke for moving said plunger a portion of its stroke in response to a manual movement of said valve member whereby to rapidly traverse said plunger to its working position by means of said valve member, and valve means for admitting fluid behind said plunger to fill the space evacuated by the motion of said plunger by its mechanical engagement with said valve member.

3. A hydraulic motor comprising a cylindrical casing containing a plunger terminating in a piston head of greater diameter than said plunger and fitting snugly within the casing, said head being hollow and provided on the interior with a sleeve having end ports, passageways extending axially through the piston head from each working surface thereof and terminating at positions so as to communicate with said ports, a valve head of solid section contained within the sleeve and adapted to be reciprocated with respect thereto, said valve head upon movement being adapted to cover one of said ports and to uncover the other of said ports, means for manually and simultaneously moving said valve head and said piston head along the casing, means for admitting fluid into the space between the piston head and the casing left during the manual movement of the piston head, and means for power driving the piston head at the conclusion of the manual movement, said last-mentioned means including a device for admitting pressure fluid simultaneously to that side of the piston head to which the plunger is secured and also to the passageway leading to the opposite side of the piston head through an uncovered port in said sleeve, whereby the piston head is power driven in the same direction as the manual movement due to the total difference of pressure exerted by the pressure fluid on opposite sides of the piston head.

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