Feb. 13, 1934. F. A. TRUESDELL 1,946,510

HYDRAULIC MECHANISM

Filed May 30, 1930 5 Sheets-Sheet 1

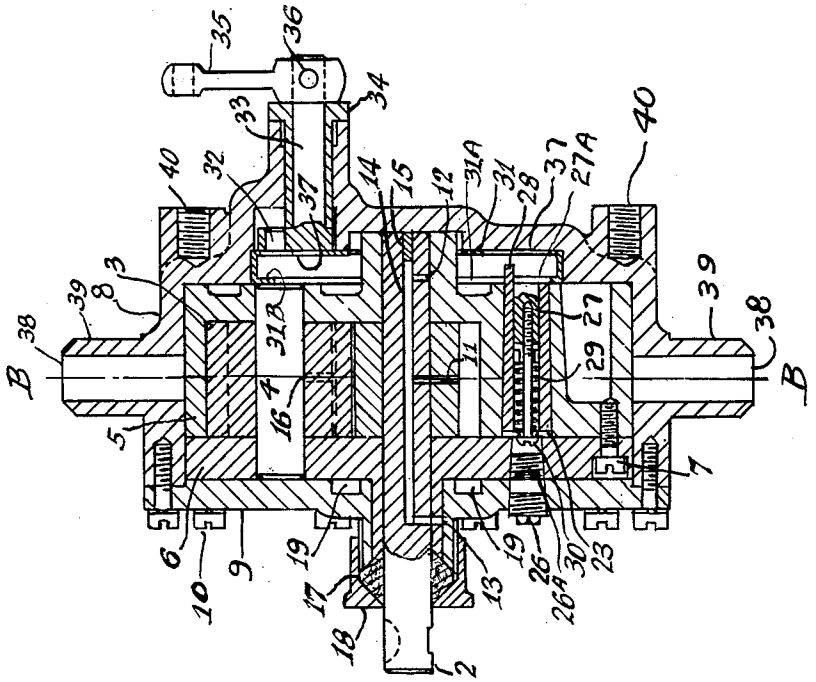


Fig. 2

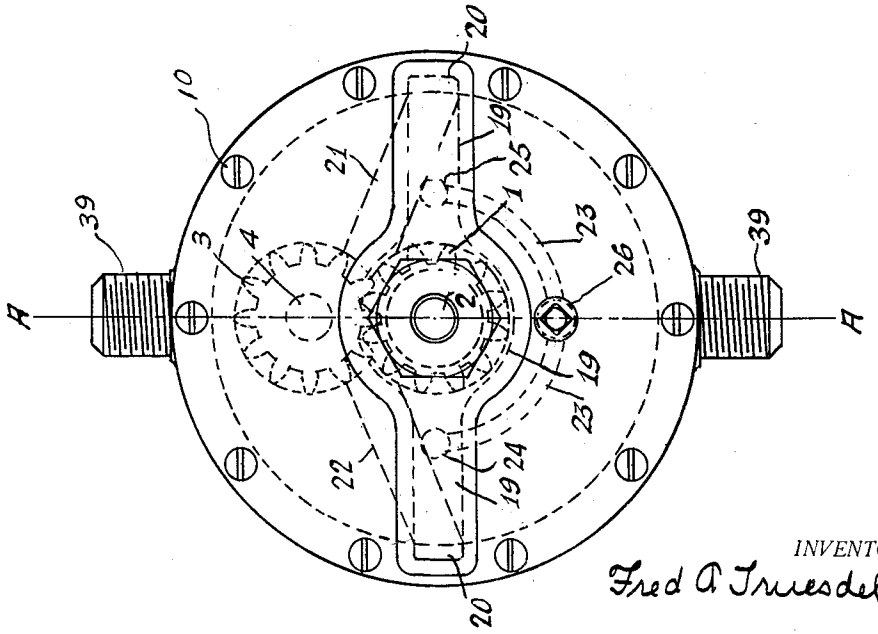


Fig. 1

INVENTOR.

Fred A. Truesdell

Feb. 13, 1934. F. A. TRUESDELL 1,946,510

HYDRAULIC MECHANISM

Filed May 30, 1930 5 Sheets-Sheet 2

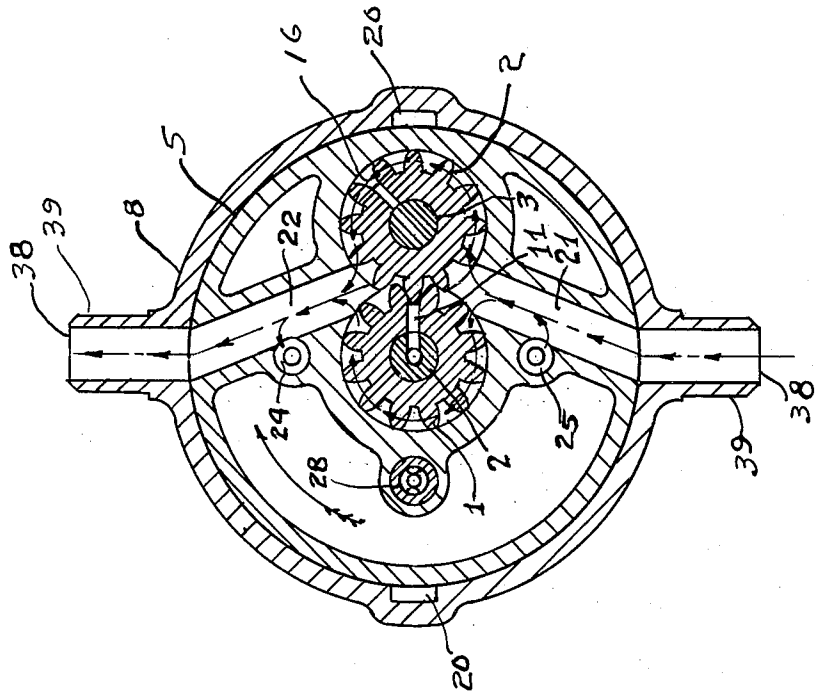


Fig. 4

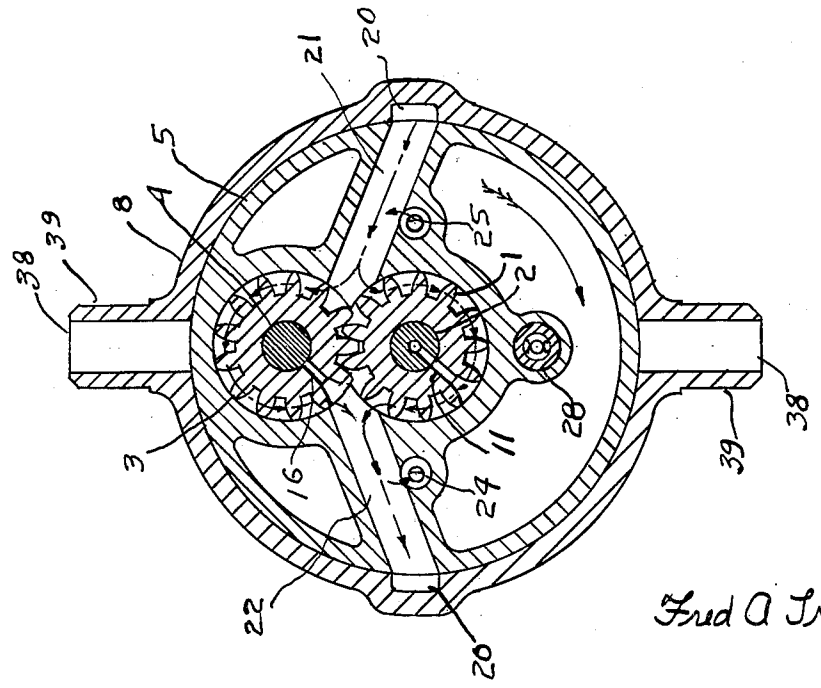


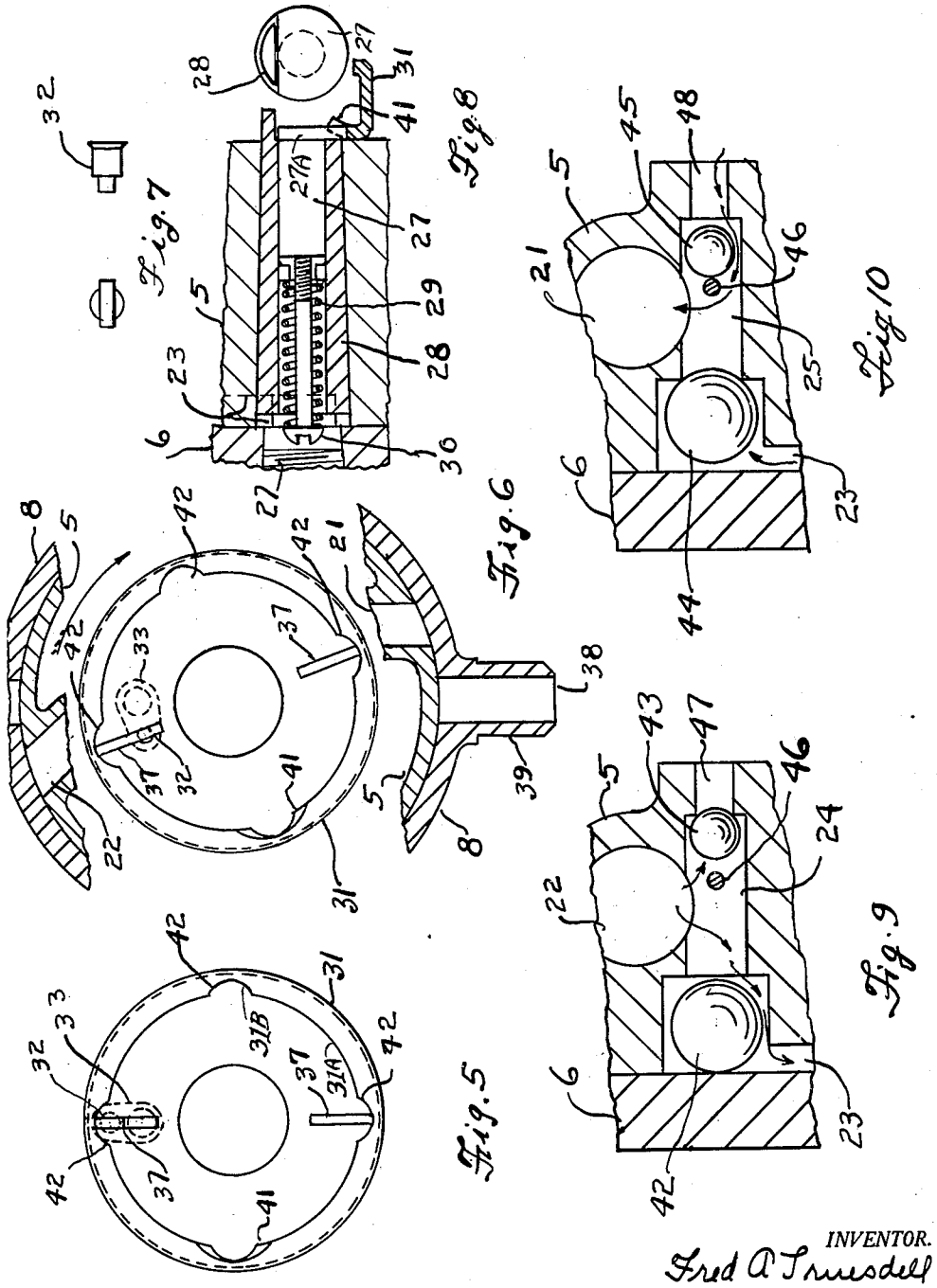
Fig. 3.

INVENTOR.
Fred A Truesdell

Feb. 13, 1934. F. A. TRUESDELL 1,946,510

HYDRAULIC MECHANISM

Filed May 30, 1930 5 Sheets-Sheet 3



INVENTOR.
Fred A Truesdell

Feb. 13, 1934. F. A. TRUESDELL 1,946,510

HYDRAULIC MECHANISM

Filed May 30, 1930 5 Sheets-Sheet 4

Fig. 11

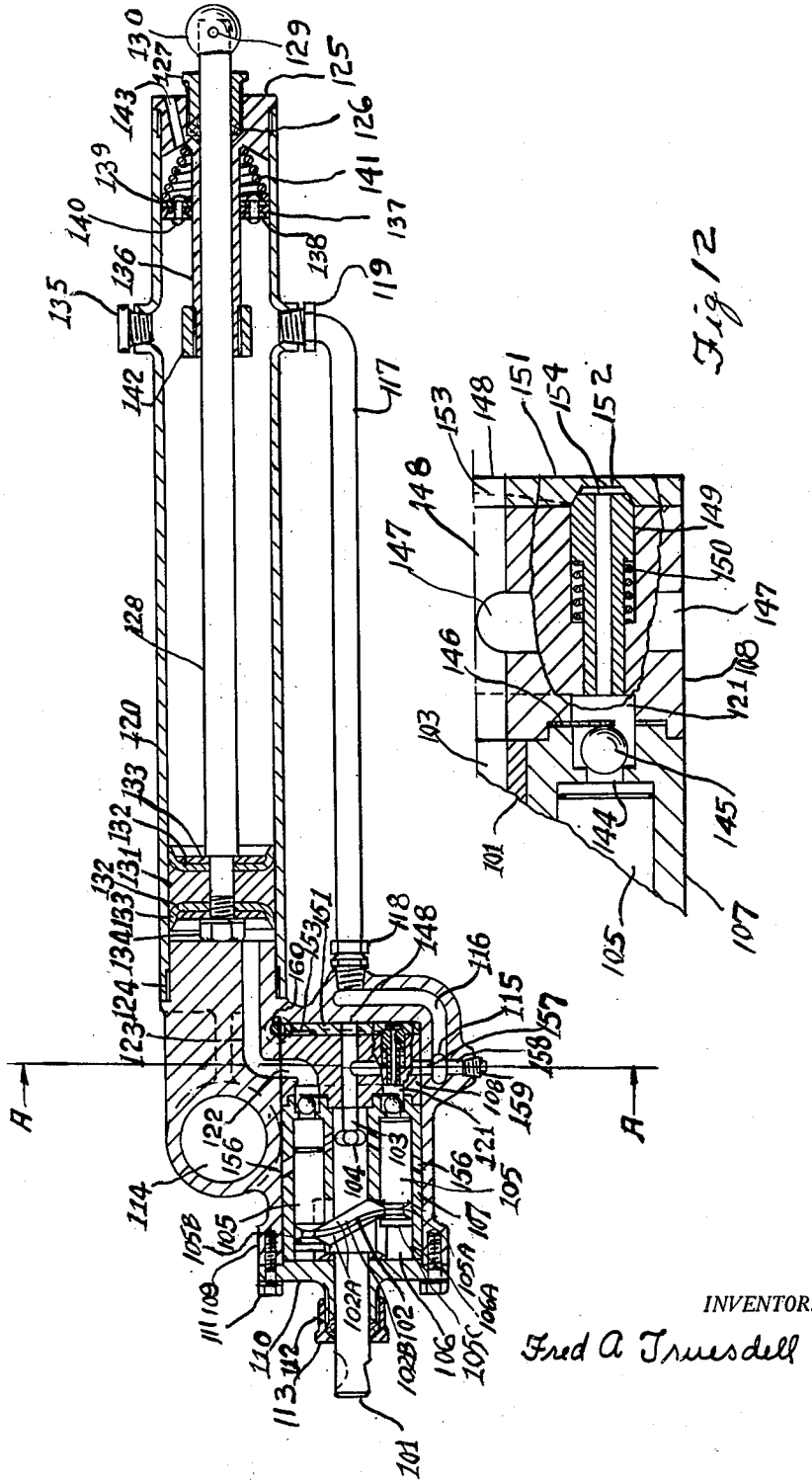


Fig. 12

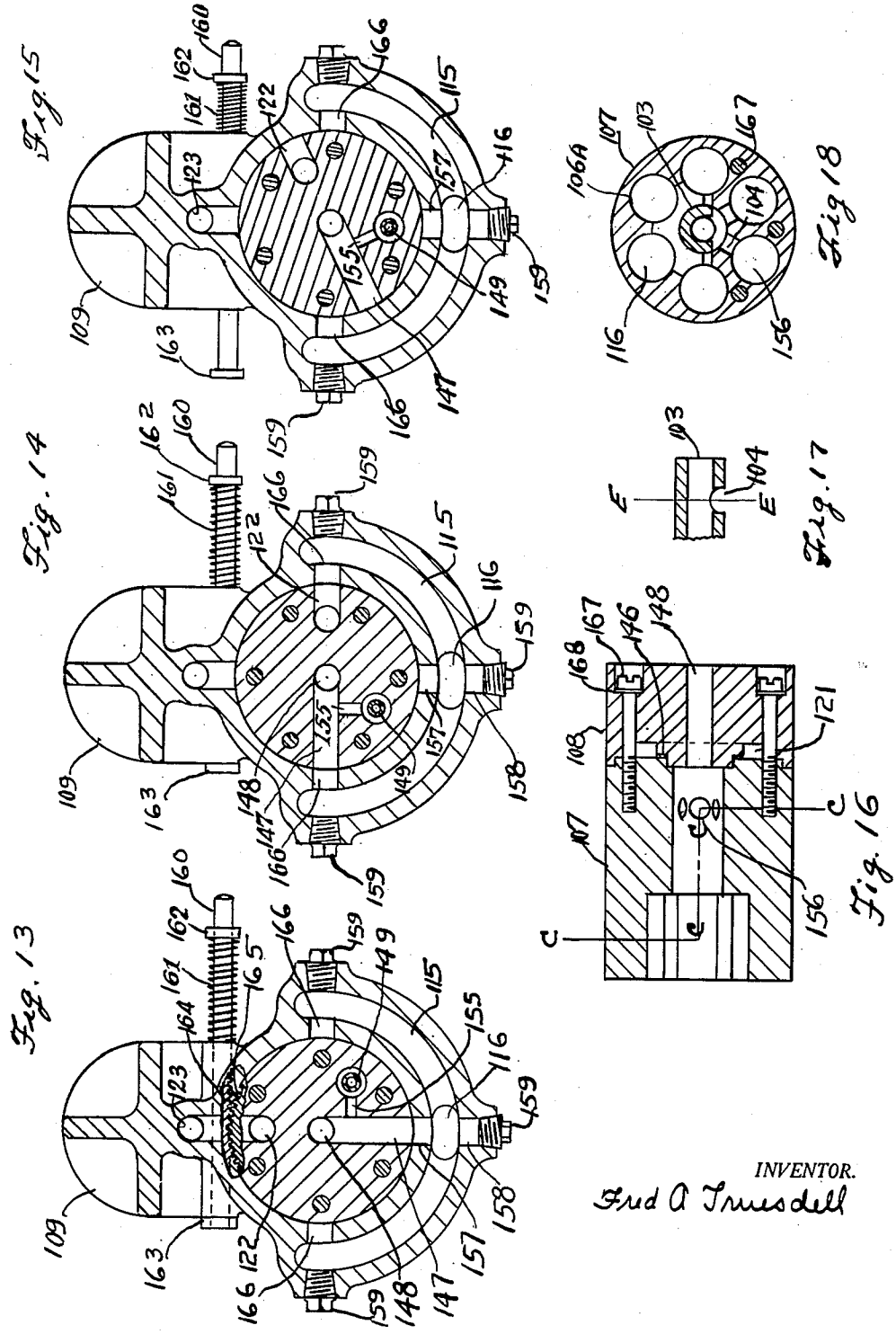
INVENTOR.

Fred A Truesdell

Feb. 13, 1934. F. A. TRUESDELL 1,946,510

HYDRAULIC MECHANISM

Filed May 30, 1930 5 Sheets-Sheet 5



Patented Feb. 13, 1934 1,946,510

UNITED STATES PATENT OFFICE

1,946,510

HYDRAULIC MECHANISM

Fred A. Truesdell, Cleveland, Ohio

Application May 30, 1930. Serial No. 457,650

20 Claims. (Cl. 103—1)

This invention relates to pumping systems of the type in which a continuously operating pump is employed to deliver fluid under pressure successively through a plurality of delivery conduits and particularly to the system in which the pump is employed to deliver fluid under pressure to one or more fluid pressure cylinders.

An important object of the present invention is to prevent the imposition of excessive loads on the pump actuating mechanism by making it impossible to develop an excessive pressure in the delivery line, this result being accomplished by means of a distributing valve which is automatically controlled by the pressure, and which is automatically indexed upon the creation of a predetermined pressure in the delivery line to connect the pump outlet with a second delivery line or to by-pass the fluid from the pump outlet to the pump inlet, so that any pressure less than a predetermined maximum pressure may be applied to the piston of a hydraulic cylinder to actuate the same but without the creation of a pressure which would impose an excessive load on the pump actuating mechanism.

A further object is to provide a manual control for the power operated valve by means of which the valve may be indexed during operation of the pump whenever desired.

A further object is to provide a pump mounted in a rotatable housing which is encased in an outer main housing from which the fluid delivery lines extend and which operates within the main housing as a valve to control the delivery of fluid to and from the pump.

A further object is to utilize the liquid in the pump for exerting a torsional thrust on the pump housing to rotate the same and to provide yielding retaining means for the combined housing and valve which is controlled by the pressure in the pump outlet passage and which operates to release the rotatable housing when a predetermined pressure is developed in said passage.

A further object of the invention is to minimize the leakage between the ports of the distributing valve by providing a large area of contact between the valve and the wall of the valve chamber between the ports, and further to provide means for returning any fluid leaking past said surfaces to the pump inlet, whereby the development of high pressures within the valve housing is prevented.

A further object of the invention is to provide an automatic locking element controlled by fluid pressure which serves to lock the movable pump housing with its inlet and outlet ports in registration with ports of the main housing.

A further object of the invention is to provide a pump capable of alternately delivering pressure to opposite sides of the piston in a hydraulic cylinder for positively operating the piston in both directions.

A further object is to provide means for automatically compensating for the fluid displacement of the piston rod of a hydraulic cylinder to prevent the creation of a vacuum due to the lack of sufficient liquid to fill the cylinder which would tend to cause leakage of air into the cylinder.

A further object of the invention is its adaptability to common types of fluid pumps.

Another object of the invention is the provision in a relatively long stroke piston type pump of grooved pistons having high angle thrust faces adapted to roll against similar thrust faces of a high angle sine curve cam and pass a narrow throat provided on such a cam.

Another object of the invention is the provision of heads on the pistons of a piston type pump which act as bearing shoes operating in semi-circular troughs to help take the thrust resulting from pistons having high angle thrust faces rolling against high angle thrust faces of a cam. A further object of the piston heads is to retain the pistons operatively connected to the cam.

A further object of the invention in connection with a piston type pump is that it provides a rolling as well as a reciprocating movement to the pistons which provides an ideal lubricating system and at the same time the operation of pistons in cylinders with much less clearance, therefore reducing the chance of fluid leakage past the pistons. If further leakage prevention is required small annular grooves may be cut in the ends of the pistons to act as scraper grooves. Such grooves should be shallow as such pistons are preferably hollowed out to lighten them to minimize inertia and centrifugal forces. A further object of rolling and reciprocating the pistons is to increase their thermal dissipation of heat.

With the above and other objects in view the invention may be said to comprise the pumping system as illustrated in the accompanying drawings hereinafter described and particularly set forth in the appended claims, together with such variations and modifications thereof as will be apparent to one skilled in the art to which the invention appertains.

Reference should be had to the accompanying drawings forming a part of this specification, in which:

Figure 1 is a front elevation showing the invention as applied to a pump of the gear type.

Figure 2 is a section taken on the line indicated at A—A in Figure 1.

Figure 3 is a section taken on the line indicated at B—B in Figure 2, showing the combined pump housing and valve in a position within the outer housing such that the pump intake and delivery passages register with the by-pass port to

permit the fluid to circulate within the housing as the pump is operated.

Figure 4 is a section similar to Figure 3 except that the pump housing has been rotated from a position shown in Fig. 3 to a position in which the pump intake and delivery passages are in registration with the ports of the outer housing to which the fluid conducting conduits are connected.

Figure 5 is a side elevation of the index ring which is mounted in one end of the outer housing.

Figure 6 is a fragmentary view showing the means for manually actuating the index ring to shift the pump housing out of registry with the ports of the outer main housing to cause pressure to be built up in the delivery passage of the pump housing to a point where the locking means is released to permit the housing to be rotated to a position in which the pump inlet and outlet passages are in registry with another pair of ports of the main housing.

Figure 7 is a detail view showing the manually operable pin for actuating the index ring.

Figure 8 is a detail view showing the pressure controlled locking device on an enlarged scale.

Figure 9 is an enlarged section through one of two ball check valves within the pump housing which control the flow of fluid to and from the pump passages.

Figure 10 is a sectional view showing the other check valve.

Figure 11 is a sectional view showing the invention applied to the actuation of a piston in the fluid pressure cylinder and its application to a compact long stroke piston type form of pump.

Figure 12 is a sectional view upon an enlarged scale showing the combined safety and indexing valve which controls the indexing of the pump shown in Fig. 11.

Figure 13 is a section taken on the line indicated at A—A in Figure 11, a portion being broken away to show the index ring and its actuating rack.

Figure 14 is a section similar to Figure 13 except that the pump housing has been rotated to a new position in which the inlet and delivery passages are in registration with by-pass ports of the housing.

Figure 15 is a section similar to Figures 13 and 14 showing the combined valve and pump housing positioned with its inlet and delivery passages out of registry with the ports of the housing, in which position, pressure will be built up in the delivery passage which acts to release the pressure controlled valve locking means so that the combined pump and valve may rotate as a unit inside the outer main housing into registry with the desired ports thereof.

Figure 16 is a longitudinal section through an end portion of the combined valve and pump housing.

Figure 17 is a fragmentary section through the rotary intake valve which controls the delivery of the fluid through the pump cylinders.

Figure 18 is a section taken on line C—C, C—C of Fig. 16 and on line A—D of Figure 17.

Figures 1 to 10 of the drawings show the invention applied to a pump of the gear type in which the pumping elements are a pair of intermeshing gears. As shown herein, one of the pumping elements is a drive gear 1 fixed to a suitable drive shaft 2. The other pumping element is an idler gear 3 which rotates on a dead shaft 4.

The gear shaped pump elements 1 and 3 are enclosed in a housing 5 which may be in the form of a die casting and which is closed on one side with a detachable cover 6 held in place on the body of the housing by means of cap screws 7. The housing 5 is of cylindrical form and the drive shaft 2 is mounted axially of the housing and projects through the cover 6 for connection with a suitable driving mechanism. The pump housing 5 is rotatably mounted within an outer main housing 8 which may also be a die casting and which is provided with a cylindrical chamber to receive the housing 5. The housing 8 is provided on one side with a detachable cover 9 which overlies the cover 6 of the pump housing and which is held in place on the body of the housing by means of cap screws 10.

When oil is used as the pressure fluid as is the usual practice in hydraulic machinery, this oil may be used to lubricate the bearings of the pump. As shown in Figure 2 of the drawings, a radial passage 11 is provided from the periphery of the pump gear 1 to the interior of the drive shaft 2, and radial passages 12 and 13 deliver the oil from the interior of the shaft 1 to the bearings of the shaft. The passages 12 and 13 lead from an axial bore 14 in the shaft 2 to which the passage 11 also leads, the outer end of the bore 14 being closed by a plug 15. The idler gear bearing may be lubricated by means of a radial passage 16 leading from the periphery of the gear 3 to the shaft 4.

To prevent leakage of oil from the main housing 8 a packing ring 17 is compressed on the shaft 2 outside the cover 9 by means of a gland nut 18 which is screwed on a boss formed on the cover 9. As clearly shown on Fig. 2 of the drawings, the outer face of the cover plate 6 of the housing 5 fits closely against the inner face of the cover plate 9 of the main housing, and the inner face of the cover plate 9 is grooved to provide a passage 19 diametrically across the end of the housing which communicates at its ends with diametrically opposite passages 20 extending across the peripheral wall of the housing and adapted to simultaneously register with pump intake and delivery passages 21 and 22 formed in the housing 5 and extending from opposite sides of the pump gears as shown in Fig. 3. Passages 19 and 20 provide a by-pass from the delivery passage 22 to the intake passage 21 of the pump to permit the liquid to circulate within the housing so that the pump may idle. The pump housing 5 is also provided with a cored passage 23 which as shown in dotted lines in Fig. 1 extends from the outlet passage 22 to the inlet passage 21, the opposite ends of this passage being controlled by oppositely acting check valves 24 and 25 which are shown in Figs. 9 and 10 of the drawings and which will later be described in detail.

As shown in Fig. 2 of the drawings the main casing cover 9 and the inner housing cover 6 are provided with openings which register in one position of the inner housing and these openings are closed by means of threaded plugs 26 and 26A which may be removed to provide access to a pressure controlled locking plunger 27 mounted in the housing 5.

The plunger 27 is slidably mounted in a tubular cage 28 which is of tapering form and which fits in a tapered opening extending transversely through the housing 5. The cored passage 23 in the housing extends across the opening in which the cage 28 is mounted and the large end of the tubular cage is offset inwardly

from the inner face of the cover 6 to provide a passage for liquid.

The plunger 27 is pressed toward the passage 23 by means of a compression coil spring 29 mounted within the cage 28 and interposed between the cage and the head of a screw 30 which is fixed to the plunger. The head of the screw 30 is accessible through the openings of the cover plates 6 and 9 when the plugs 26 and 26A are removed so that the tension of the spring 29 may be adjusted to vary the pressure exerted by the spring on the valve and increase or decrease the amount of fluid pressure required to shift the plunger to releasing position.

Fluid under pressure enters the open end of the cage 28 and exerts a pressure on the plunger 27 opposed to that of the spring 29 so that when a predetermined pressure is exerted the plunger will be moved to releasing position in opposition to its spring.

As shown in Fig. 2 of the drawings the rear wall of the outer housing 8 is recessed to receive an index ring 31 which may be in the form of a sheet metal stamping and which as shown in Figs. 5 and 6 is provided at its inner side with a flange 31A which projects inwardly from the periphery of the ring at the inner side thereof and which closely overlies the rear face of the rotary housing 5.

The flange 31A is provided with circumferentially spaced notches 31B which are adapted to receive the locking plunger 27 to lock the housing 5 in various positions of adjustment with respect to the main housing 8. The pressure actuated plunger 27 has an enlarged head 27A which is positioned beyond the inner end of the cage 28 and which engages with the cage to limit the movement of the plunger toward the front of the pump casing under the influence of the spring 29. The head 27A may be held against the rear face of the pump housing 5 by the spring 29, if it is positioned within one of the notches 31B of the index ring and when so positioned holds the housing 5 against rotation in the housing 8.

As pressure builds up in the delivery passage 22 of the pump housing, this pressure is communicated to the liquid in the passage 23 and acts upon the plunger 27 in opposition to the spring 29. When a predetermined pressure is reached, the plunger will be moved in opposition to the spring, shifting the head 27A into the ring 31 a sufficient distance to clear the flange 31A and release the plunger from the index ring, whereupon the housing 5 will rotate with the drive shaft 2, due to the body of liquid trapped in the pump and locking the gears, until the plunger 27 is brought into registry with another notch of the index plate and the intake and delivery passages of the pump housing 5 are brought into registry with a second pair of ports of the main housing. The rotation of the housing 5 closes the line in which high pressure has been developed so that the pressure on the locking plunger 27 is relieved and when the head 27A comes into registry with another notch in the index ring 31 it will be moved into engagement therewith by the spring 29. The automatic action above described may be employed to automatically shift the pump to an idling position after a piston has been forced to the end of its stroke, or may be employed to automatically reverse the stroke of a piston depending upon the arrangement of the ports of the main housing 8.

In many instances it is desirable to manually control the actuation of the combined valve and housing 5 to index the samef rom an idling position or from a pumping position before the pressure necessary to release the locking plunger has been developed. In order to provide manual control, means is provided for imparting a turning movement to the index ring 31 through a small angle sufficient to move the ports of the housing 5 out of registry with ports of the main housing 8 so that a high pressure will be instantly developed in the delivery passage 22 to release the locking plunger 27 and cause the indexing movement of the housing 5. The manual actuation of the index ring 31 is accomplished by means of a pin 32 carried by one arm of a bell crank 33 which is journalled in the sleeve 34 in the rear wall of the housing 8 and which has attached thereto an actuating arm 35 outside the housing located by pin 36. The pin 32 has a flat end which engages in one of two diametrically opposite radial slots 37, in the back of the index ring 31. Provision is made for detachable engagement between the index plate and actuating lever to enable the position of the index plate in the housing to be reversed when desired. The sleeve 34 and bell crank 35 are so mounted in the housing 8 that the lever may be backed bodily away from the index ring 31 to withdraw the pin 32 from the slot 37 to permit reversal of the ring. Certain of the notches 31B which are positioned to control the delivery of fluid through high pressure ports have marginal portions 41 bent inwardly so that the head 27A of the plunger 27 is required to move a greater distance into the ring 31 to release its head 27A from the ring and a higher pressure is required to release the plunger from the index ring. The reversibility of the index ring enables the notches 31B to be properly positioned when the direction of rotation of the pump gears is reversed. The manually operable bell crank 33 is actuated to shift the index ring 31. The plunger 27 will be disengaged from one notch of the index ring and will automatically engage with the next if the lever is quickly released. However, the ring 31 may be held in non-registering position and the housing 5 will continue to turn until the index ring is released so that registry with any desired ports may be obtained by means of the manual control. Anchor screws are provided for by tapped holes 40 in the housing 8.

As shown in Figs. 3 and 4 of the drawings, the housing 8 has diametrically opposite ports 38 through threaded nipples 39 to which pipe lines may be connected. When the passages 21 and 22 are in registry with the ports 38 as shown in Fig. 4 of the drawings, fluid is drawn into one of the ports and forced out of the other port under pressure. When the combined valve and pump housing 5 is turned in either direction ninety degrees from the position shown in Fig. 4, the passages 21 and 22 are brought into registry with the passages 20 of the housing to establish communication between the inlet and outlet passages of the pump to permit the pump to idle.

The check valve 24 is located, as shown in Fig. 9, adjacent the delivery passage 22 and consists of a pair of balls 42 and 43, the ball 42 being disposed so that it will be opened by liquid under pressure flowing from the passage 22, and the ball 43 being so disposed that it will be closed by the pressure of liquid flowing from the passage 22.

The valve 25, as shown in Fig. 10, consists of

two balls 44 and 45, the ball 44 being so disposed that it is closed by pressure from the passage 23, and the ball 45 being so disposed that it will be held open by suction in the pump intake passage 21. The balls 43 and 45 control passages 47 and 48 leading to the inner face of the rotary housing 5 so that any oil leaking into the space between the housing 5 and outer housing 8, such as oil leaking from bearings, may be sucked into the intake passage of the pump.

It will be apparent that, when pressure is developed in the outlet passage 22, the ball 42 will be forced into open position allowing the liquid to flow into the passage 23, and that the pressure of the liquid in the passage 23 will force the ball 44 into closed position so that the liquid is prevented from flowing into the intake passage 21 and a pressure is maintained in the passage 23 and upon the plunger 27 which corresponds to the pressure existing in the outlet passage 22 of the pump. While the pump is operating in this manner, should any pressure develop between the housing 5 and outer housing 8 it will force the liquid through the passage 48 past the check valve 45 into the intake passage 21. It will also be apparent that it is immaterial which of the two passages 21 or 22 is the delivery passage. If the direction of the rotation of the pump were reversed and the liquid delivered through the passage 21 the action of the pressure on the check valves 24 and 25 would simply be reversed, the ball 44 in this case being held in open position and the ball 42 in closed position. In either case the pressure developed in the passage 23 would act on the locking plunger 27.

The pump as illustrated herein is particularly applicable to hydraulic feeds for machine tools or hydraulic hoists such as are employed to tilt the body of a dumping truck, in which case the outlet ports 38 would be connected to opposite ends of the hoist cylinder. When the passages 21 and 22 are aligned with the ports 38 and the pump is driven, fluid under pressure will be forced into one end of the hydraulic cylinder to move the piston to the opposite end of the cylinder. When the piston reaches the end of the cylinder the pressure in the delivery passage 22 will be quickly increased until sufficient pressure is developed to release the locking plunger 27, whereupon continued rotation of the drive gear 1 will rotate the housing 5 bodily, closing the ports 38 so that the liquid is trapped in the hydraulic cylinder to hold the piston against movement. The rotation of the housing 5 will cause the pump to cease pumping and will release the pressure in the passage 23 sufficiently to enable the spring 29 to press the head 27A into engagement with the next notch of the index ring.

In the pump as herein illustrated, the housing would be locked at intermediate position shown in Fig. 3 where the pump would idle until it was desired to lower the piston, whereupon the bell crank 33 would be actuated manually to move the passages 21 and 22 out of registry with the passages 20, causing pressure to again build up in the passages 22 and 23 to release the locking plunger, whereupon the pump would rotate to a position in which the passages 21 and 22 are reversely registered with the ports 38 to draw fluid from the cylinder and to deliver the same under pressure into the opposite end of the cylinder to return the piston to its original position.

It will be apparent that the present invention provides a distributor valve of large diameter and that several pairs of outlet ports 38 may be provided in the housing 8 if it be desired to operate a plurality of hydraulic cylinders successively. It will also be apparent that the intermediate idling by-pass may be omitted, for instance, where it is desired to continuously reciprocate a piston. In the latter case, the pump would index automatically from one pumping position to a reverse pumping position to alternately supply and exhaust pressure from opposite ends of a cylinder.

Figs. 11 to 18 show a high lead angle sine curve cam, operating a relatively long stroke piston type form of pump embodying the invention operatively connected to a hydraulic cylinder, the pump being connected to the cylinder in such manner that fluid under pressure may be delivered from the pump to either end of the cylinder.

The pump illustrated in Figs. 11 to 18 is a multi-piston pump which is provided with a piston actuating drive shaft 101 which carries a generated cam 102 for actuating the pistons. The shaft 101 has an axial passage 103 extending into the inner end thereof which terminates in a laterally opening port 104. The passage 103 forms a part of the pump intake passage and the lateral port 104, which registers successively with cylinder intake ports during rotation of the shaft, provides a valve for automatically controlling the delivery of liquid to the cylinder. A series of pistons 105 are mounted in axially extending cylinders 106 formed in a cylindrical housing 107 through which the shaft 101 extends. The shaft 101 extends axially through the housing 107 and the cylinders 106 are preferably equiangularly spaced around the drive shaft. The cam 102 which is a generated high angle sine curve cam having angle thrust faces 102A of equivalent or greater angle than the lead angle of the cam and narrowed throats 102B, engages in grooves 105A having faces 105B of corresponding angle to faces 102A on cam 102, formed in the outer ends of the pistons 105 so that when the housing 107 is held stationary and the drive shaft 101 is rotated the pistons 105 having grooves 105A and faces 105B are rolled and reciprocated by the cam faces 102A of cam 102 having narrowed throats 102B allowing groove 105A of piston 105 to pass. The outer end of the cylinder block is counterbored to accommodate the cam 102, the counter bore providing openings in the walls of the cylinders to receive the periphery of the cam. The outer portions of the cylinder walls, however, extend to the outer end of the block and provide semi-circular bearings 106A to take the thrust of the cam against the outer ends of the pistons 105 and their heads 105C. The pistons 105 are free to roll in the cylinders 106, so that the wear due to frictional engagement with the cylinder walls is uniformly distributed throughout the peripheries of the pistons.

A cylindrical valve casting 108 is secured to the inner end of the cylindrical housing 107 by screws 167 pulled down on cone shaped copper washers 168, which flatten out as the screws are tightened, thus forming a seal between the counter bore provided for the heads, and the shanks of the screws. This valve casting is provided with suitable ports and passages for controlling the passage of fluid to and from the pump cylinders. The housing 107 and the attached casting 108 are rotatably mounted within an outer housing 109 and form a combined pump housing and distributor valve which may be turned within the housing 109 to control the delivery of fluid under pressure from the pump. The housing

109 has a cylindrical bore to receive the combined valve and pump housing and the open end of the bore is closed by a head 110 which may be secured to the body of the housing 109 by means of bolts 111. The shaft 101 extends centrally through the head 110, and in order to prevent liquid leaking through the head along the surface of the shaft a packing ring 112 is provided which is held in place by a packing nut 113. The housing 109 may be formed with an anchor hole 114 through which a bar for supporting the pump may be inserted.

As best shown in Figs. 13, 14 and 15 the housing 109 is provided in the wall thereof with an arcuate cored passage 115 which is concentrically disposed with respect to the valve casting 108. Midway between the ends thereof, the passage 115 opens into a longitudinal passage 116 which extends to the inner end of the housing 109 and partially across said end. A pipe 117 is connected by fittings 118 and 119 with the inner end of the housing 109 and with the outer end portion of a cylinder 120. The pipe 117 communicates with the passage 116 at one end and opens into the cylinder 120 at the other. The inner end of the cylinder 120 communicates with the pump through an annular passage 121 formed in the valve casting 108 and a passage 122 formed in the housing 109 which communicates with the annular passage 121 of the valve in certain positions of the valve, as will be hereinafter more fully explained.

The inner end of the cylinder 120 is screwed onto a boss 124 formed on the housing 109 and the passage 122 extends through the boss 124 and opens into the cylinder. The outer end of the cylinder 120 is closed by a screw plug 125 which is in the form of a tubular casting carrying a packing ring 126 and a packing nut 127 through which a piston rod 128 extends. The outer end of the piston rod 128 is provided with a ball 129 held in place thereon by a pin 130 to which may be pivotally secured the member which is actuated by the hydraulic cylinder. A piston head 131 is attached to the inner end of the rod 128 and this piston head is provided with leather cup washers clamped against opposite faces of the head by means of steel washers 133, the washers and head being clamped together and to the rod 128 between a shoulder on the rod and a nut 134 at the inner end thereof. The cylinder 120 may be provided with an opening closed by means of a combined filler plug and safety valve 135 as is common practice in the art. The closure plug 125 has an elongated pilot bearing 136 extending inwardly within the cylinder 120 and provides a support for a pressure compensating plunger 137, which consists of a leather washer held by steel discs 138 and 139 which are clamped against the opposite faces of the leather washer by means of rivets 140. The plunger 137 slides on the pilot bearing 136 and is pressed inwardly against the liquid in the cylinder by means of a cone spring 141 interposed between the plunger 137 and the plug 125. The plunger 137 compensates for the displacement of the piston rod 128 and prevents the creation of an empty space within the cylinder 120 as the rod 128 is moving out of the cylinder, which would tend to cause leakage of air into the cylinder. The inward movement of the plunger 127 is limited by a nut 142 on the inner end of the pilot bearing 136 and the plug 125 is provided with a vent opening 143 which maintains atmospheric pressure on the outer side of the plunger 137 so that movement of the plunger will not be influenced by a vacuum created between the plunger and plug 125. The compensating plunger 137 prevents the creation of an air pocket in the end of the cylinder and permits the cylinder to be completely filled with liquid.

Each of the cylinders 106 is provided with a delivery port 144 at its inner end which opens into the annular delivery passage 121 of the valve member 108, and each of the ports 144 is controlled by a check valve consisting of a ball 145 and a star spring 146 for yieldingly holding the ball against its seat. Each of the balls 145 is arranged to move outwardly to open the ports 144 to perm t the liquid to flow from the cylinder into the outlet passage 121 when the liquid is compressed in the cylinder but is held against its seat by reverse pressure.

The valve member 108 and the cylinder housing attached thereto are held in different positions of adjustment by means of a pressure actuated plunger 149 which is mounted in an axially extending bore in the valve member 108 and which is pressed rearwardly by means of a spring 150 interposed between the head of the plunger and the valve member 108 in which the plunger is mounted. An index plate 151 is mounted in the rear end of the housing 109 and is provided with circumferential pockets 152 in which the head of the plunger 154 is adapted to fit to lock the combined valve and pump housing against turning movements within the main housing. The pockets 152 in the plate 151 are of different depths so that a greater pressure is required to release the plunger from certain of the pockets than is required for others. In order to provide pockets of different depths the index plate is made of varying thickness along the marginal portion thereof where the pockets 152 are located. The tapering inner face of the plate being indicated by dotted lines 153 in Fig. 12. The plunger 149 is provided with an axial passage 154 extending throughout the length thereof and opening at the inner end of the plunger into the delivery passage 121 of the valve member 108 and at its outer end into the space between the end of the valve member 108 and the index plate 151.

When the plunger 149 engages in one of the pockets 152 as shown in Fig. 12 of the drawings, fluid under pressure entering the space between the head of the plunger and the bottom of the pocket exerts a pressure on the head of the plunger tending to move the plunger inwardly against the spring 150, and since the area of the head of the piston is greater than the area of the inner end of the plunger this pressure when sufficiently high will be effective to move the plunger in opposition to the spring 150, so that when the pressure of the liquid reaches a predetermined point the plunger will be moved entirely out of engagement with the pocket 152, whereupon the reaction of the pistons 105 on the actuating cam 102 will cause the pump housing 107 and the attached valve member 108 to be rotated bodily within the housing 109, moving the ports of the valve member 108 out of registry with the ports of the housing 109 and cutting off the flow of the liquid to the cylinder 120. As the valve member moves out of registry with the ports of the housing 109 pressure in the delivery passage 121 is released sufficiently to permit the spring 150 to press the head of the plunger 149 against the face of the index plate 151 so that the plunger will snap into the next pocket 152 of the index plate.

In order to prevent interference with the action of the spring 150 by liquid leaking past the head of the plunger 149 into the spring chamber, a small by-pass opening 155 leads from the spring chamber to the radial intake passage 147 of the valve member, so that any liquid leaking into the spring chamber may readily escape through the hole 155 into the passage 147 and through the passage 148 to the intake passage 103 in the shaft 102. The cylinders 106 are provided with intake ports 156 which are spaced circumferentially around the shaft 103 in circumferential alignment with the lateral port 104 of the shaft, so that the intake ports of the cylinder are successively brought into communication with the intake passages of the valve member 108 to allow liquid to flow into the cylinder during the outward movement of the pistons 105 and closing the inlet ports during the inward movement of the pistons 105.

The housing 109 is provided with a port 157 which opens centrally into the arcuate passage 115 and which is adapted to register either with the passage 122 of the valve member 108 or with the intake passage 147 thereof depending on the position of the valve member, the port 157 being diametrically opposite the passage 123 in the housing 109 so that when one of the passages 122 or 147 of the valve member register with the port 157 the other registers with the outlet passage 123 so that liquid will be pumped to one end or the other of the cylinder 120. The arcuate passage 115 may be provided with cleanout openings 158 which may be closed by threaded plugs 159, the openings 158 being preferably in alignment with inner ports through which communication is established between the passage 115 and the passages of the valve member.

As shown in Figs. 13 to 15, diametrically opposite ports 166 are provided at opposite ends of the arcuate passage 115 in the housing 109 which are adapted to register with the passages 122 and 147 of the valve member 108, and, since the passage 122 is the pump delivery passage and the passage 147 is the pump intake passage, direct communication will be established between the pump inlet and outlet passages through the arcuate passage 115 when the valve is held in the position shown in Fig. 14. In the operation of the pump, the valve member 108 may be positioned as shown in Fig. 13 of the drawings to deliver liquid to the passage 122 and into the inner end of the cylinder 120. In this position of the valve the plunger 149 is in engagement with one of the pockets in the thicker part of the index plate 151 and the valve will remain in this position until the piston 131 reaches the outer end of the stroke, whereupon pressure will be built up in the delivery passage 122, until a pressure is reached at which the plunger 149 is forced rearwardly out of engagement with the pocket 152 of the index plate, whereupon the liquid trapped in the cylinders holds the pistons against inward movement and causes the cylinder housing and attached valve member to turn bodily with the shaft 102 within the housing 109 until the spring pressed plunger 149 snaps into engagement with the next succeeding pocket 152 of the index plate.

In the pump as shown herein the pockets 152 are spaced apart ninety degrees, and after the combined pump and valve has been released from either of its pumping positions, it will be automatically turned ninety degrees and brought to a stop in the intermediate by-passing position shown in Fig. 14, in which position of the valve the liquid is trapped in the cylinder 120 and the piston 131 is held in its outermost position. When the cylinder 120 is used as a hoist cylinder for operating a tilting truck body, it is desirable that the piston 131 be held in extended position until it is desired to lower the truck body. In order to reversely actuate the piston when desired, means is provided for manually controlling the operation of the delivery valve, and this manual controlling means will now be described.

A rack bar 160 extends transversely through the housing 9 above the valve chamber and directly over the periphery of the index plate 151, and this rack bar is normally held in extended position by means of a coil spring 161 interposed between one side of the housing and a collar 162 pinned to the bar 160 adjacent the outer end thereof. The outward movement of the bar 160 is limited by a second collar 163 secured to the opposite end thereof and engaging the opposite side of the housing 109. The rack bar is normally held in the position shown in Figs. 13 and 14 by the spring 161, but may be pushed inwardly by hand against the spring to the position shown in Fig. 15 of the drawings. The rack bar 160 has teeth 164 which mesh with gear teeth 165 formed on the periphery of the index plate 151, so that when the rack bar 160 is pushed inwardly to the position shown in Fig. 15 the index plate 151 is turned through a small angle. Since the valve member 108 is locked by means of the valve plunger 149 to the index plate, the valve member will also be turned through a small angle which is sufficient to move the delivery and the intake passages 122 and 137 thereof out of registry with ports of the housing 109, whereupon pressure will be developed in the outlet passage of the pump which will act on the plunger 149 to release the combined valve and pump housing from the index plate and cause the same to turn within the main housing 109, until the plunger 149 engages with another notch of the index plate. If the rack bar 160 is pressed in to the position shown in Fig. 15 and then released, the spring 161 will snap the rack bar 160 to its outermost position and quickly return the index plate to its normal position, so that when the plunger 149 engages with the next pocket 152 of the index plate, the index plate will be in proper position to register the passages of the valve with the ports of the housing 109. Assuming that the piston 131 has been moved to its outermost position by liquid pumped through the delivery passage 122 into the cylinder, and the valve member 108 has been moved to its intermediate by-passing position as above described, by the automatic release of the plunger 149, the connection of the pump to the cylinder 120 may be reversed whenever desired by actuating the rack bar 160 to cause release of the valve member from the index plate. The next position of the valve will be with the delivery ports 122 in registry with the port 157 and the intake ports 147 in registry with the passage 123, so that liquid will be drawn from the rear end of the cylinder 120 and forced under pressure into the outer end thereof.

It will be apparent that the number of outlet passages leading from the housing 109 may be increased to operate a plurality of hydraulic cylinders, and that, when it is desired to operate the pump to continuously reciprocate a piston in a cylinder, the by-pass ports and passages may be omitted so that the pump will automatically move from one pumping position to the

reverse pumping position, to actuate the piston alternately in opposite directions.

In both modifications of the invention herein disclosed the pump housing is rotatably mounted and serves also as a distributor valve for controlling the discharge of liquid from the pump housing. In both modifications the pump driving mechanism is protected against excessive strain by the automatic release of the distributor valve when a predetermined pressure is developed in the pump delivery passage so that the driving mechanism is never required to carry more than a predetermined load.

It will also be observed that the pump is of simple and compact design, capable of being housed within a relatively small housing and adapted to be manufactured at relatively low cost.

Furthermore, it is to be understood that the particular form of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. The combination with a fluid pump, of a rotatable distributor valve controlling the flow of fluid through the intake and outlet of said pump, and means automatically controlled by the pressure of the fluid at the pump outlet for indexing said valve.

2. The combination with a fluid pump having a housing provided with inlet and delivery passages, of a distributor valve comprising a valve member having passages communicating with the pump inlet and outlet passages, and a housing enclosing said valve having delivery passages adapted to be successively registered with the passages of the valve, and means controlled by the pressure in the pump delivery passage for changing the registration of the passages of the valve member with the ports of the housing.

3. The combination with a pump housing having fluid inlet and outlet passages, said housing having circumferentially spaced fluid delivery ports, a distributor valve rotatably mounted in said housing and having passages communicating with the pump inlet and outlet passages and adapted to register successively with the ports of said housing, and means controlled by the pressure of fluid in the pump outlet passage for indexing said valve.

4. The combination with a pump housing having fluid inlet and outlet passages, a housing having circumferentially spaced fluid delivery ports, a distributor valve rotatably mounted in said housing and having passages communicating with the pump inlet and outlet passages and adapted to register successively with the ports of said housing, means controlled by the pressure of fluid in the pump outlet passage for automatically indexing said valve, and means for manually controlling said indexing means.

5. The combination with a pump having fluid inlet and outlet passages, of a housing having a cylindrical valve chamber provided with circumferentially spaced peripheral ports, a bypass passage in said housing connecting certain of said ports, a distributor valve rotatably mounted in said valve chamber and having passages communicating with the pump inlet and outlet passages and adapted to register successively with ports of said housing, the passages of said valve being positioned to simultaneously register with the ports leading to the bypass passage of the housing and to simultaneously register with other of said peripheral ports in other positions of the valve, and fluid pressure controlled means for automatically indexing said valve.

6. The combination with a pump having fluid inlet and outlet passages, of a housing having a cylindrical valve chamber provided with circumferentially spaced peripheral ports, the passage of said housing connecting certain of said ports, a distributor valve rotatably mounted in said valve chamber and having passages communicating with the pump inlet and outlet passages and adapted to register successively with the ports of said housing, the passages of said valve being positioned to simultaneously register with the ports leading to the bypass passage of the housing and to simultaneously register with other of said peripheral ports in other positions of the valve, means including a pressure controlled plunger mounted in said valve for locking the valve against rotation in said housing, and means acting automatically to turn said valve upon the release of said plunger.

7. A pump comprising a main housing having a cylindrical chamber therein, a combined pump housing and distributor valve rotatably mounted in said chamber, a drive shaft journalled in said housing and extending axially into said rotatable pump housing, pump elements in the pump housing actuated by said shaft, intake and delivery passages in the pump housing, passages in the outer housing adapted to register with passages of the pump housing, means for locking said pump housing in a plurality of positions within the main housing, and pressure controlled means for indexing the pump housing to any desired position within the main housing.

8. A pump comprising a main housing having a chamber therein provided with a series of spaced ports, a combined pump housing and distributor valve mounted in said chamber, said pump housing having a pump therein and pump inlet and outlet passages adapted to simultaneously register with pairs of spaced ports of the main housing, and means for releasably holding the pump housing in different registering positions in the main housing and for shifting said pump housing from one registering position to another.

9. A pump comprising a main housing having a cylindrical chamber therein provided with a series of circumferentially spaced ports, a combined pump housing and distributor valve mounted in said chamber, said pump housing having a pump therein and pump inlet and outlet passages adapted to simultaneously register with pairs of circumferentially spaced ports of the main housing, and means for releasably holding the pump housing in different registering positions in the main housing and for turning said pump housing from one registering position to another.

10. A pump comprising a main housing having a cylindrical chamber therein provided with a series of circumferentially spaced ports, a combined pump housing and distributor valve mounted in said chamber, said pump housing having a pump therein and pump inlet and outlet passages adapted to simultaneously register with pairs of circumferentially spaced ports of the main housing, and means for releasably locking the pump housing in different registering positions comprising a plunger carried by the pump housing and subjected to the fluid pressure exist-

ing in the pump outlet passage, and a spring acting on said plunger in opposition to the fluid pressure.

11. A pump comprising a main housing having a cylindrical chamber therein provided with a series of spaced ports, a combined pump housing and distributor valve rotatably mounted in said chamber, a gear pump in said pump housing comprising a pump chamber having therein a driving gear coaxial with the pump housing and an idle gear meshing with the driving gear, a drive shaft fixed to the driving gear and extending to the exterior of the main housing, inlet and outlet passages in the pump housing extending from opposite sides of the pump chamber, and positioned to simultaneously register with pairs of main housing ports, spring actuated locking means for releasably holding the pump housing in any of its registering positions, and pressure controlled means for releasing said pump housing and indexing the same.

12. A pump comprising a main housing having a cylindrical chamber therein which is provided with circumferentially spaced ports, a combined pump housing and valve rotatably mounted in said chamber, an index plate mounted in the main housing and having circumferentially spaced locking recesses, a plunger mounted in said pump housing and positioned for engagement with any of the recesses of the index plate, a spring acting on said plunger in a direction to press the same toward the index plate, means for subjecting said plunger to the fluid pressure in the pump outlet passageway to move the same in opposition to the spring to release the pump housing, and means for manually turning the index plate to move the pump housing out of registry with the outlet ports so cause an increase in pressure in the pump outlet passage to release said plunger.

13. A pump comprising a main housing having a cylindrical chamber therein which is provided with circumferentially spaced ports and which has a bypass passage connecting certain of said ports, a combined pump housing and valve rotatably mounted in said chamber and provided with pump inlet and outlet passages adapted to register with pairs of ports in the main housing, an index plate mounted in the main housing having locking recesses spaced circumferentially in accordance with the spacing of the pairs of ports in the main housing, means including a plunger in the valve engageable with the recesses in the index plate and controlled by the fluid pressure in the pump outlet passage for locking the combined housing and valve in registry with ports of the main housing, and means for manually turning said index plate.

14. A pump comprising a main housing having a cylindrical chamber therein which is provided with circumferentially spaced ports and which has a bypass passage connecting certain of said ports, a combined pump housing and valve rotatably mounted in said chamber and provided with pump inlet and outlet passages adapted to register with pairs of ports in the main housing, an index plate mounted in the main housing having locking recesses spaced circumferentially in accordance with the spacing of the pairs of ports in the main housing, means including a plunger in the valve engageable with the recesses in the index plate and controlled by the fluid pressure in the pump outlet passage for locking the combined housing and valve in registry with ports of the main housing, and means for turning said pump housing and index plate through a small angle to move the valve out of registry with the ports of the main housing to cause release of said locking plunger.

15. A pump comprising a main housing having a cylindrical chamber provided with circumferentially spaced ports, a cylindrical housing rotatably mounted in said main housing, said cylindrical housing having a plurality of axially extending circumferentially spaced cylinders, pistons in said cylinders, a shaft positioned axially of said cylindrical housing, means connecting said shaft to said pistons to reciprocate the pistons as the shaft is rotated, passages in said cylindrical housing communicating at their inner ends with inlet and outlet ports of said cylinders and adapted to register with ports in the main housing, means for releasably holding the cylindrical housing in registering positions, and pressure controlled means for automatically indexing said cylindrical housing.

16. A pump comprising a main housing having a cylindrical chamber provided with circumferentially spaced ports, a cylindrical housing rotatably mounted in said main housing, said cylindrical housing having a plurality of axially extending circumferentially spaced cylinders, pistons in said cylinders, a shaft positioned axially of said cylindrical housing, means connecting said shaft to said pistons to reciprocate the pistons as the shaft is rotated, passages in said cylindrical housing communicating at their inner ends with inlet and outlet ports of said cylders and adapted to register with ports in the main housing, means for releasably holding the cylindrical housing in registering positions, and manually operable means for controlling said indexing means.

17. The combination with a fluid pump, of a distributor valve, controlling the direction of fluid flow from said pump and a means whereby the pressure of said fluid is used to actuate said distributor valve.

18. The combination with a fluid pump, of a distributor valve to control the direction of fluid flow to and from said pump and a means whereby the fluid pressure created by said pump is used to shift the distributor valve.

19. The combination with a fluid pump, of a distributor valve to control the direction of fluid flow from said pump, and a means whereby said distributor valve is automatically shifted by fluid pressure created by said pump.

20. A fluid pump comprising a ported housing, a ported cylinder block rotatably mounted coaxially therein, annularly disposed cylinders axially in said block, grooved pistons in said cylinders, a sine curved cam having a high lead angle, rotatably mounted axially in relation to and engaging said grooves in said pistons to impart a rolling and reciprocating motion to said pistons, engaging faces between said cam and said pistons grooves, having angles equivalent to or greater than the lead angle of said cam, heads on said pistons to retain them in engagement with said cam, narrowed portions on said cam to permit the headed pistons to roll past the throats of said cam, semi-circular cylinder extensions in said block to act as thrust bearing surfaces for the pistons and piston heads, and a means of rotatably controlling said ported cylinder block by fluid pressure to control the fluid flow to and from said pump.

FRED A. TRUESDELL.