

Feb. 25, 1941.

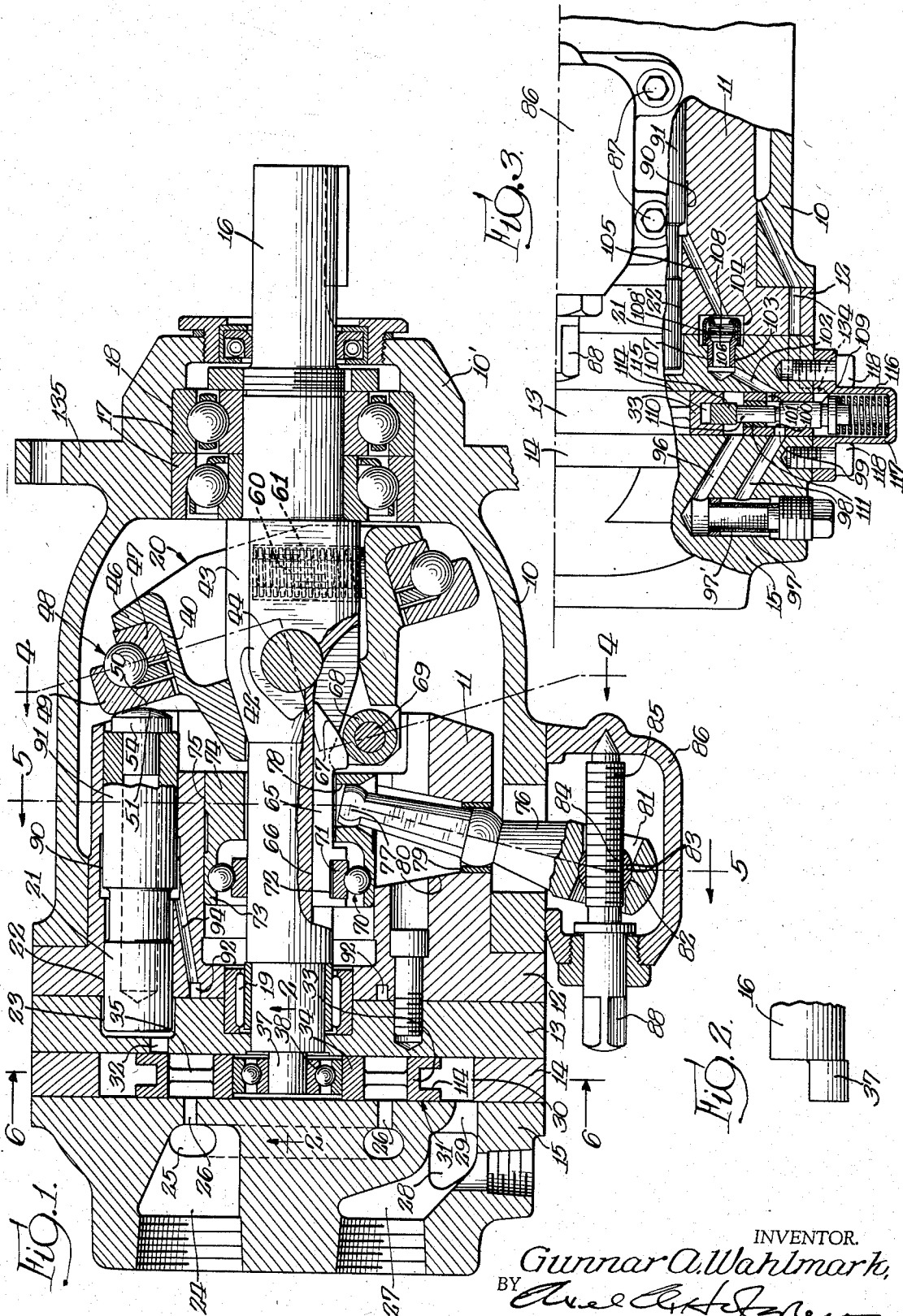
G. A. WAHLMARK

2,232,984

PUMP

Filed Sept. 8, 1938

3 Sheets-Sheet 1



INVENTOR.
Gunnar A. Wahlmark,
BY *Arne Eriksson*
his ATTORNEY.

Feb. 25, 1941.

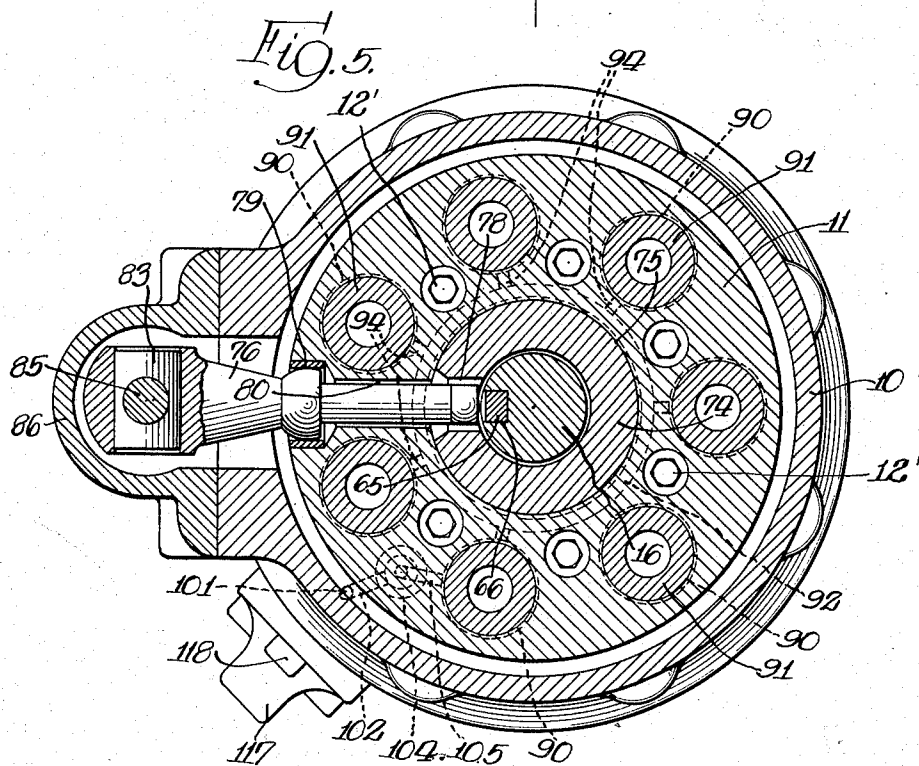
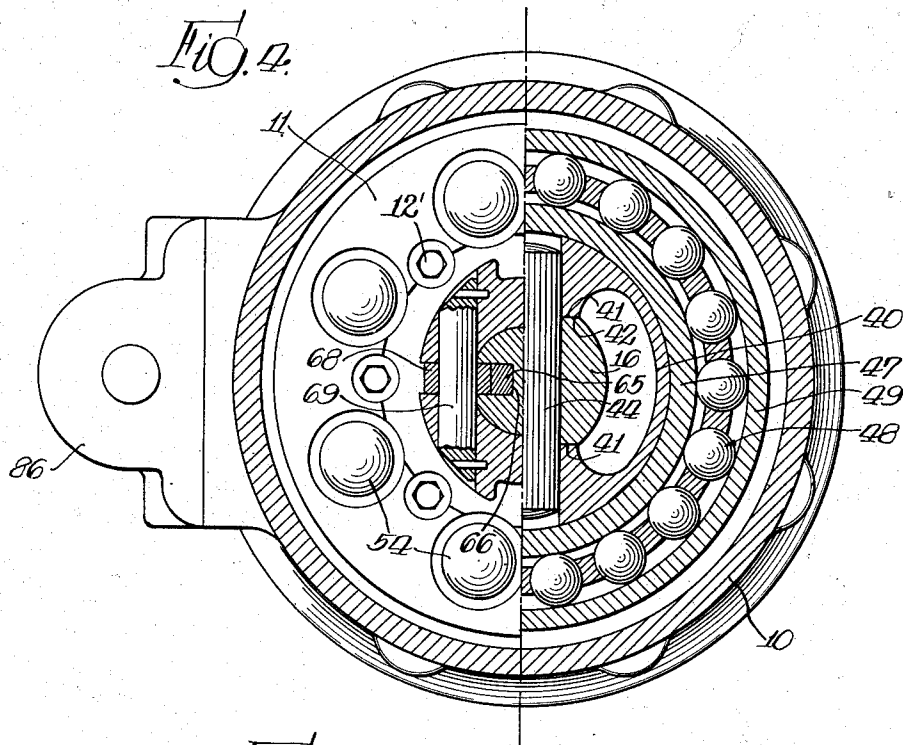
G. A. WAHLMARK

2,232,984

PUMP

Filed Sept. 8, 1938

3 Sheets-Sheet 2



INVENTOR.
Gunnar A. Wahlmark,
BY *Arne Carlsson*
his ATTORNEY.

Feb. 25, 1941.

G. A. WAHLMARK

2,232,984

PUMP

Filed Sept. 8, 1938

3 Sheets-Sheet 3

FIG. 6.

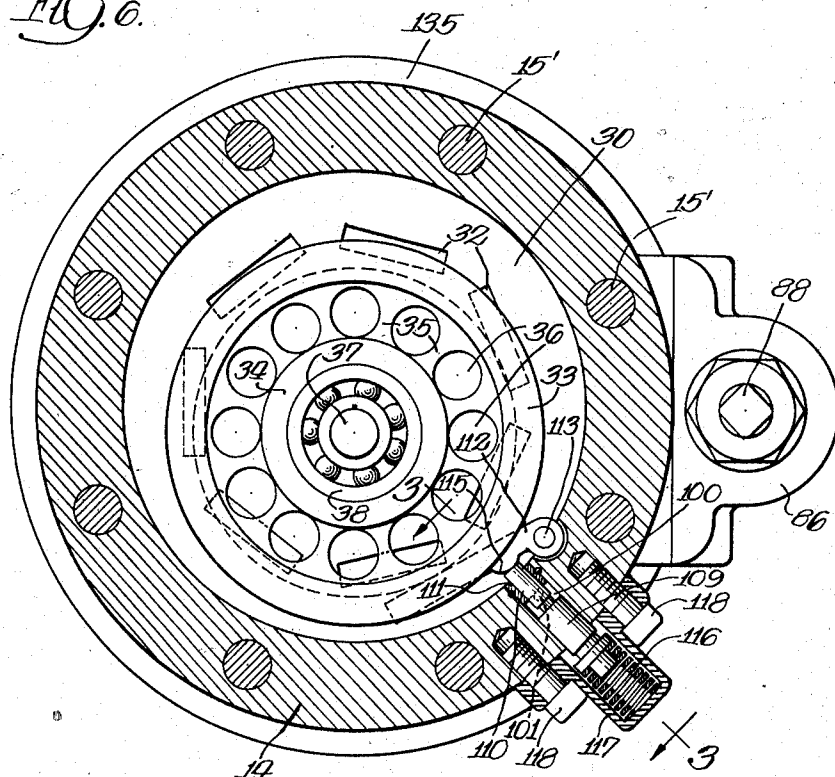
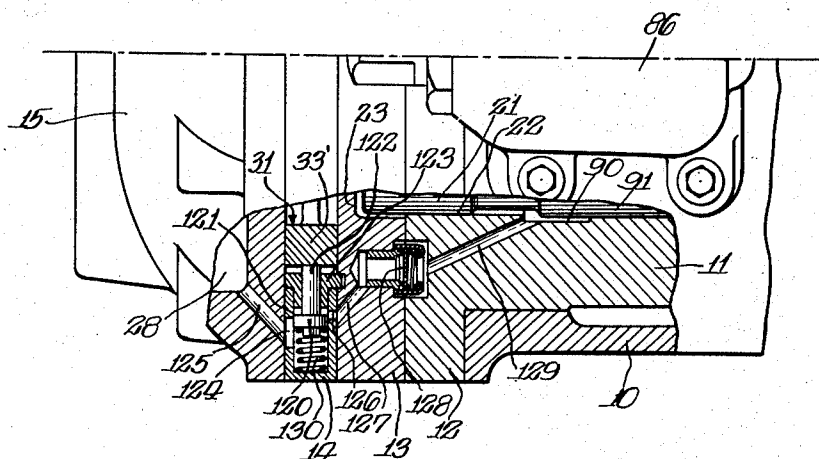


FIG. 7.



INVENTOR.
Gunnar A. Wahlmark,
BY *Olaf A. Jensen*
his ATTORNEY.

UNITED STATES PATENT OFFICE

2,232,984

PUMP

Gunnar A. Wahlmark, Rockford, Ill.

Application September 8, 1938, Serial No. 228,966

9 Claims. (Cl. 103—173)

The invention relates more particularly to a piston and cylinder type of pump, it being the general object of the invention to provide a new and improved multi-piston pump.

5 Another object of the invention is to provide a pump embodying a plurality of pistons and cylinders actuated by a wobble plate device with new and improved means for moving the pistons through their suction strokes.

10 Another object is to provide a pump having a plurality of piston and cylinder devices actuated by an adjustable wobble plate together with fluid pressure operated means for returning the pistons through their suction strokes.

15 In fluid pumps of the wobble plate type, the pistons are generally returned through their suction strokes by means of springs which maintain the outer ends of the pistons in engagement with a portion of the wobble plate or by means of connecting rods or links. Such devices are provided to insure the return of the pistons and permit the pump to suck fluid into the cylinders during the return or suction strokes of the pistons. Devices of this kind, however, 25 have given considerable trouble. It is, therefore, a more specific object of the invention to eliminate the need for such mechanical devices and to provide a pump of this character with means for subjecting the pistons to fluid to obtain a total pressure against the piston on the return stroke sufficient to maintain the outer end of the piston in engagement with the wobble plate device.

30 Another object is to provide a pump having a plurality of piston and cylinder devices and a wobble plate mechanism with pistons having enlarged portions forming auxiliary pistons and means for subjecting these auxiliary pistons to fluid under pressure so as to effect the proper return of the pistons during the operation of the pump.

35 Another object is to provide a pumping mechanism having a plurality of main piston and cylinder devices, auxiliary pistons and cylinders associated one with each main piston, fluid conducting means interconnecting the auxiliary cylinders to form a substantially closed fluid circuit so that fluid forced out of auxiliary cylinders during the pressure strokes of the associated main pistons is transferred to other auxiliary cylinders to act against the auxiliary pistons therein and move the associated main pistons through their return or suction strokes, and means for maintaining the auxiliary cylinders and the interconnecting means full of fluid.

Another object is to provide such a pumping mechanism with means for priming the fluid circuit to which the auxiliary cylinders are connected.

Further objects will become readily apparent 5 from the following detailed description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a longitudinal, horizontal central section through a preferred form of the invention. 10

Fig. 2 is a fragmentary view along the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary elevation partly in section along the line 3—3 of Fig. 6.

Fig. 4 is a transverse section approximately 15 along the line 4—4 of Fig. 1.

Fig. 5 is a transverse section approximately along the line 5—5 of Fig. 1.

Fig. 6 is a transverse section approximately 20 along the line 6—6 of Fig. 1.

Fig. 7 is a fragmentary elevation similar to Fig. 3 of a modified form of the invention.

While my invention is susceptible of embodiment in many different forms, I have shown in the drawings and shall herein describe in detail 25 one such embodiment and a modification thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention, and it is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

As shown in the drawings, the invention is embodied in a pump comprising a cup-shaped casing 10, a cylindrical cylinder block 11 positioned 35 in the casing and having a flange 12 abutting the open end of the casing, a plate 13 positioned against the cylinder block and forming a cylinder head, an annular member 14 positioned against the plate 13 and a closure member 15 40 abutting the annular member 14. The parts 12, 13, 14, and 15 are preferably secured together by a plurality of headed screws 12' (Figs. 4 and 5). These same parts as a unit are secured to the casing 10 by means of a plurality of annularly 45 spaced and headed screws 15' which pass through bores in said parts and into screw-threaded sockets in the casing. A shaft 16 is rotatably mounted in the casing by means of a pair of ball bearings 17 positioned in a recess 18 in the closed 50 end portion 10' of the casing, and a roller bearing 19 supported partly on the cylinder block 11 and partly on the plate 13. The shaft 16 carries a wobble plate device or mechanism 20 which is arranged to actuate a plurality of pistons 21 55

which are slidably mounted in cylinders formed in part by bores 22 in the cylinder block and in part by recesses 23 in the plate 13. An inlet port 24 for the pump is formed in the closure member 15 and connects with an annular passage 25 in the closure, which in turn connects with a series of circumferentially spaced supply ports 26. An outlet port 27 in the closure member 15 connects with an arcuate discharge passage 28 which in turn communicates with a series of circumferentially spaced discharge ports 29. The discharge ports at their inner ends communicate with the outer portion of a cylindrical valve chamber 30 formed within the annular member 14 and between the adjacent faces of the plate 13 and closure member 15. The inlet ports 26 communicate with the valve chamber at points spaced radially inwardly from the discharge ports, as shown in Fig. 1. A valve 31 is operable in the chamber 30 and is arranged to connect the supply and discharge ports alternately with cylinder ports 32 which are formed in the plate 13 and communicate with the recesses 23. These cylinder ports preferably terminate in rectangular openings which communicate with the chamber 30, as shown in Fig. 6, in order to obtain slow opening and closing of the ports when functioning as outlets, and rapid opening of the cylinder ports when functioning as inlets. This prevents the hammering action which otherwise occurs and causes noise due to the incomplete filling of the cylinders on the suction strokes.

The valve device 31 is herein shown in the form of a wheel (Figs. 1, 3 and 6) having an outer rim 33 and an inner hub 34 which are connected by means of a web 35 provided with a plurality of apertures 36 (Fig. 6). This valve device is mounted on an eccentric pin 37, formed on the adjacent end of the shaft 16, by means of a ball bearing 38 so that during operation of the shaft the valve device has an orbital movement which results in a sliding movement of the rim 33 across the cylinder ports 32 so as first to connect the cylinder ports to the supply ports 26 and alternately to the discharge ports 29. Both the rim 33 and the hub 34 of the valve device have a sliding fit against the adjacent surfaces of the plate 13 and closure member 15 so as to confine the inlet fluid within the annular space formed intermediate the rim 33 and hub 34 and to confine the discharge fluid within the valve chamber 30 externally of the valve.

The construction and operation of the pump and its valve mechanism are more fully described and claimed in my copending application Serial No. 143,069, filed May 17, 1937.

The wobbler mechanism 20 for actuating the pistons 21 through their pressure strokes is herein disclosed as comprising an annular member 40 having a pair of opposed flat surfaces 41 which fit against flat surfaces 42 formed on an enlarged portion 43 (Fig. 1) of the shaft 16. The annular member 40 is pivotally mounted on the shaft by means of a pin 44 extending through aligned bores in the member and shaft. The annular member 40 has an outwardly extending flange 46 against which one race 47 of a ball bearing 48 is positioned. The other race 49 of the ball bearing is provided with a flat surface 50 for engaging the adjacent rounded ends 51 of the pistons 21. Preferably, the adjacent ends of the pistons 21 are provided by round headed inserts 54 which engage the adjacent flat surface 50 of the race 49 so as to provide a driving connection between the wobble plate and the pis-

tons to actuate the pistons through their pressure strokes.

The wobble plate device is adjustable angularly about the pivot pin 44 for the purpose of adjusting the stroke of the pistons. As illustrated in the drawings, this adjusting means comprises an adjusting member 65 which is slidable longitudinally like a key in a recess or keyway 66 in the shaft 16 and has an inclined cam surface 67 which engages a follower on the wobble plate consisting of a roller 68 mounted on a shaft or pin 69 (Figs. 1 and 4). It will be readily apparent from Fig. 1 that movement of the adjusting member 65 toward the right swings the wobble plate device in a counter-clockwise direction around the pivot pin 44 to lengthen the stroke of the pistons, and that movement of the adjusting member 65 in the opposite direction permits the wobble plate device to swing in a counter-clockwise direction to shorten the stroke of the pistons. A coiled spring 60 is positioned partly in a diametrical bore 61 in the shaft and engages the annular member 40 and urges said member in a direction to maintain contact of the roller 68 with the cam 67.

The adjusting member 65 is movable longitudinally of the shaft by means including a ball bearing 70, the inner race 71 of which slides longitudinally on the shaft 16 and fits into a recess 72 in the member 65 and the outer race 73 of which is formed on a collar 74 which surrounds the shaft 16 and is slidably mounted in a bore 75 in the cylinder block 11. A lever 76 has one end 77 inserted in an opening 78 in the collar 74 and is pivoted intermediate its ends by means of a bushing 79 secured in a tapered opening 80 in the cylinder block 11. The other end of the lever 76 has an opening 81 therethrough provided with a spherically surfaced portion 82 in which a ball 83 is positioned. This ball has a screw-threaded bore 84 through which a screw device 85 passes, the screw device 85 being rotatably mounted in a housing 86 which is secured to the casing 10 by means of screw devices 87 (Fig. 7). The screw device 85 is preferably provided with a squared end 88 to facilitate operation thereof by a suitable tool. The wobble plate and adjusting mechanism are similar to that disclosed in my copending application Serial No. 189,049, filed February 7, 1938.

The invention provides a fluid operable means for actuating the pistons 21 through their return or suction strokes and for keeping the round surfaces 51 of the inserts 54 in contact with the race 49. In the form disclosed in the drawings, this means includes auxiliary piston and cylinder devices associated one with each of the main pistons. Thus, auxiliary cylinders 90 (Fig. 1) are formed as enlarged portions of the bores 22 and auxiliary pistons 91, in the form of enlarged portions of the pistons 21, operate therein. The auxiliary cylinders 90 are interconnected by means of an annular passage 92, formed in the cylinder block 11, and a plurality of ports 94 extending between the auxiliary cylinders 90 and the annular passage 92. The fluid circuit formed by the annular passage 92, ports 94, and auxiliary cylinders 90 is completely filled with fluid so that when some of the pistons are moving through their pressure strokes (toward the left in Fig. 1), the fluid displaced from the associated auxiliary cylinders flows through the corresponding ports 94 and through the passage 92 and through other ports 94 and into the auxiliary cylinders of pistons moving through their suction strokes. Since

for any given piston stroke the total volume of this circuit remains substantially constant, the fluid displaced by some of the auxiliary pistons serves to actuate other auxiliary pistons.

In order to insure efficient operation of the pistons, means is provided for replenishing the fluid circuit with fluid for any which might leak out and at the same time maintain the fluid in the circuit under pressure so as to avoid any lost motion. This means is herein disclosed as comprising a passage for conducting fluid from the lower part of the discharge portion of the valve chamber 30 to the fluid circuit, and a pump device in the passage operable to pump fluid through the passage at times when the fluid in the outlet passage is not under sufficient pressure. As shown in Fig. 3, the passage comprises (in order) a port 96, a bore 97 and a port 98 in the closure 15, a pump inlet port 99, a pump cylinder chamber 100 and a pump discharge port 101 in the annular member 14, a port 102 and a bore 103 in the plate 13, and a recess 104 and a port 105 in the cylinder block. The port 105 communicates at its discharge end with one of the auxiliary cylinders 90. A check valve 106 is positioned in the recess 104 against the end of a bushing 107 which lines the bore 103 and functions to pass fluid from the bore 103 and into the port 105 and to prevent reverse flow of fluid. This valve is normally held against the end of the bushing by means of a coiled spring 108 which is backed up by a flanged annular member 108' pressed onto the bushing.

A piston 109 is slidably mounted in the pump chamber 100 and has an integral rod 110 which slides in a bushing 111 fitted into one end of the chamber 100. The inlet port 99 and outlet port 101 are so arranged that the inlet port closes first during the pressure stroke and by reciprocating the piston 109 fluid is pumped into the port 103. As shown in Fig. 3, the inlet port 99 is positioned somewhat below the outlet port 101 so that when the piston 109 is raised a quantity of fluid is trapped in the upper portion of the chamber 100 and forced out through the port 101. The piston 109 is actuated through its suction strokes by a lever 112 (Figs. 3 and 6) which is pivoted at one end by a pin 113 and has its other end positioned in a peripheral groove 114 in the rim 33 of the valve 31. Due to the orbital movement of the valve caused by the eccentric driving pin 37, the lever 112 is oscillated about the pin 113, an intermediate portion 115 of the lever engaging the piston rod 110 and serving as an actuator for the return stroke. The piston 109 is moved through its pressure stroke by means of a coiled spring 116 positioned in a housing 117 which is secured to the pump parts by screw devices 118. Preferably, a strainer 97' is positioned in the bore 97. A relief passage 134 is provided to prevent pressure from building up in the housing 117.

In the modified form illustrated in Fig. 7, the modification resides in the specific form of the priming pump. As illustrated, a pump piston 120 is mounted in a cylinder 121 formed in the annular member 14 and has a rod 122, the outer end of which is in direct engagement with the rim 33' of the main valve 31. A bushing 123 surrounds the rod 122 and is secured in the cylinder 121 so as to close the upper end thereof. In this form of the invention, fluid is supplied to an inlet port 124 by means of a passage 125 which communicates at its other end with the

main pump discharge passage 28. A discharge port 126 for the priming pump communicates with a port 127 corresponding to the port 102 of the form of the invention illustrated in Figs. 1 to 6. A check valve device 128 is positioned intermediate the port 127 and a port 129 which communicates with one of the auxiliary cylinders 90. The piston 120 is operated through its suction stroke by means of the valve rim 33' and is operated through its pressure stroke by means of a coiled spring 130.

When the preferred form of the invention is installed and ready for operation, the shaft 16 is connected to a suitable prime mover, the inlet port 24 is connected to a fluid supply and the outlet port 27 is connected to some form of load. The pump is mounted by means of a flange 135 on the casing 10 in a position such that the priming pump chamber 100 is near the bottom of the pump, so that it will always be supplied with fluid by gravity from the discharge side of the valve 31 or the passage 28. Upon driving the shaft 16, the wobble plate then acts to move the pistons through their pressure strokes as the valve device 31 functions to control the inlet and outlet of fluid to and from the pump cylinders. In the event the fluid circuit, including the auxiliary cylinders, is filled with fluid, the pump immediately operates at whichever stroke has been previously selected by means of the adjusting member 65. In the event the fluid circuit is not filled and there is no pressure in the discharge passage 28, the piston 109 is operated and serves as a priming pump to pump fluid into the port 102, past the check valve 106, and into the fluid circuit. The priming piston 109 functions in this manner until the fluid circuit is completely filled.

Although the invention is suitable for use in many different types of applications, a particularly important application is that of supplying fluid under pressure for actuating supports in machine tools. When the pump is embodied in a circuit with a suitable actuator, an incompressible fluid, such as oil, is generally used. Under these circumstances, the pressure developed by the pump depends upon the resistance encountered by the actuator of the hydraulic circuit. In the form of the invention illustrated, the coil spring 116 for actuating the primary pump piston 109 has been selected so as to force fluid at pressures up to 400 or 500 pounds per square inch through the outlet port 101. The priming pump continues to function as long as the pressure in the discharge passage 28 is less than this amount. When the pressure in the discharge passage 28 exceeds this amount (the pressure in this passage frequently arising to 1,000 pounds, if necessary), the pressure on the upper side of piston 109 (Fig. 3) becomes sufficiently great to hold the piston 109 in its lowermost position against the action of the spring 116. Fluid from the discharge passage 28 then flows through the connecting passage to the fluid circuit under the discharge pressure of the main pump, and the priming pump piston is no longer actuated by the valve 31.

In providing a fluid means for returning the pistons of the pump through their suction strokes, the invention has eliminated the need for springs, links, and other mechanical devices which cause trouble due to wear and the attendant lost motion. Furthermore, the pistons during their return strokes are normally under the output pressure of the pump and, therefore,

there is a uniformly distributed pressure all around the surface 50 of the ball bearing race 49 so as to provide a balanced load on the wobble plate. This form of means for returning the pistons also eliminates the need for any torque arm. The result is a pumping mechanism which operates smoothly and efficiently.

The cylinder ports 32, when provided with rectangular openings communicating with the valve chamber 30, are instrumental in reducing noise and providing smooth operation due to the fact that the slow opening and closing of these ports when functioning as outlets prevents the hammering action which usually occurs by the inrush of pressure under fluid into the incompletely filled cylinders.

By locating the wobble plate adjusting member 65 on that portion of the shaft 16 which is surrounded by the cylinders and extending the operating lever 76 outwardly through an opening passing intermediate to adjacent cylinders, the overall length of the fluid pump is materially reduced, the control mechanism then lying within a portion of the device already occupied by the cylinders.

I claim as my invention:

1. A fluid pump comprising, in combination, a plurality of main piston and cylinder devices, means for controlling the flow of fluid into and out of the cylinders of said devices, means for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, fluid conducting means interconnecting the auxiliary cylinders in a substantially closed circuit, and means for maintaining said auxiliary cylinders and circuit filled with fluid under pressure comprising an auxiliary pump and a passage connecting the outlet of said auxiliary pump with said circuit.

2. A fluid pump comprising, in combination, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices, means for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising fluid conducting means between the outlet of the pump and said auxiliary cylinders, a check valve operable to permit flow through said fluid, conducting means to the auxiliary cylinders when the outlet pressure of the pump exceeds a predetermined value, and an auxiliary pump operable to force fluid through said fluid conducting means and check valve when the outlet pressure of the pump is insufficient to operate the check valve.

3. A fluid pump comprising, in combination, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices, means for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising fluid conducting means between

the outlet of the pump and said auxiliary cylinders and an auxiliary pump device operable to pump fluid through said fluid conducting means.

4. A fluid pump comprising, in combination, a plurality of main piston and cylinder devices, a drive shaft, means driven by said shaft for actuating said pistons through their pressure strokes, inlet and outlet ports, means for controlling the flow of fluid into and out of said cylinders, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, fluid conducting means interconnecting the auxiliary cylinders in a substantially closed circuit, means for maintaining said auxiliary cylinders and circuit filled with fluid under pressure comprising a passage connecting said circuit with the outlet for the pump, a check valve in said passage for preventing return flow therethrough, and a pumping device in said passage intermediate the pump outlet and said check valve having a piston and cylinder, means operated by said drive shaft for actuating said last mentioned piston through its suction strokes, and spring means for actuating said last mentioned piston through its pressure strokes.

5. A fluid handling device comprising, in combination, a casing, a drive shaft rotatably mounted thereon, a plurality of parallel cylinders arranged annularly about a portion of said shaft, pistons in said cylinders, means for controlling the flow of fluid to and from the cylinders, an angularly adjustable wobble plate carried on said shaft, and means for adjusting said wobble plate comprising a longitudinally movable element slidably mounted on and rotatable with the portion of said shaft surrounded by said cylinders, a collar surrounding said shaft, a ball bearing connecting said collar to said element and an operating member connected at one end to said collar and extending substantially radially outwardly through an opening in the casing passing intermediate two adjacent cylinders.

6. A fluid pump comprising, in combination, a casing, a shaft rotatably mounted in the casing, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices including a wheel-like valve and eccentric means on said shaft for actuating said valve, means driven by said shaft for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising means interconnecting the auxiliary cylinders in a substantially closed circuit, a fluid passage between the outlet of the pump and said circuit, an auxiliary pump device operable to pump fluid through said passage comprising a piston and a cylinder, means actuated by the rim of said wheel for moving the auxiliary piston through its suction strokes, and spring means for actuating said piston through its pressure strokes.

7. A fluid pump comprising, in combination, a casing, a shaft rotatably mounted in the casing, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices including a wheel-like valve and eccentric means on said shaft for actuating said valve,

means driven by said shaft for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising means interconnecting the auxiliary cylinders in a substantially closed circuit, a fluid passage between the outlet of the pump and said circuit, an auxiliary pump device operable to pump fluid through said passage comprising a piston and cylinder, means actuated by the rim of said wheel for moving the auxiliary piston through its suction strokes, said means including an arm pivoted at one end on said casing and having its free end engaging the rim of said wheel so as to be oscillated thereby and means on the intermediate portion of said arm for operating said piston, and spring means for actuating said piston through its pressure strokes.

8. A fluid pump comprising, in combination, a casing, a shaft rotatably mounted in the casing, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices including a wheel-like valve and eccentric means on said shaft for actuating said valve, means driven by said shaft for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of

said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising means interconnecting the auxiliary cylinders in a substantially closed circuit and means for maintaining said auxiliary cylinders and circuit filled with fluid under pressure comprising an auxiliary pump device actuated by the rim of said wheel-like valve and having a discharge port connected to said circuit.

9. A fluid pump comprising, in combination, a casing, a shaft rotatably mounted in the casing, a plurality of main piston and cylinder devices, inlet and outlet ports, means for controlling the flow of fluid into and out of the cylinders of said devices including a wheel-like valve and eccentric means on said shaft for actuating said valve, means driven by said shaft for actuating the pistons through their pressure strokes, means for returning the pistons through their suction strokes comprising auxiliary piston and cylinder devices associated one with each of said main piston and cylinder devices, and means for maintaining fluid under pressure in said auxiliary cylinders comprising means interconnecting the auxiliary cylinders in a substantially closed circuit, a fluid passage between the outlet of the pump and said circuit, an auxiliary pump device operable to pump fluid through said passage comprising a piston and cylinder, and means including the rim of said wheel-like valve for actuating the piston of said auxiliary pump device.

GUNNAR A. WAHLMARK.