Nov. 10, 1964 F. L. AUSTIN ETAL 3,156,192

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FIG. 2

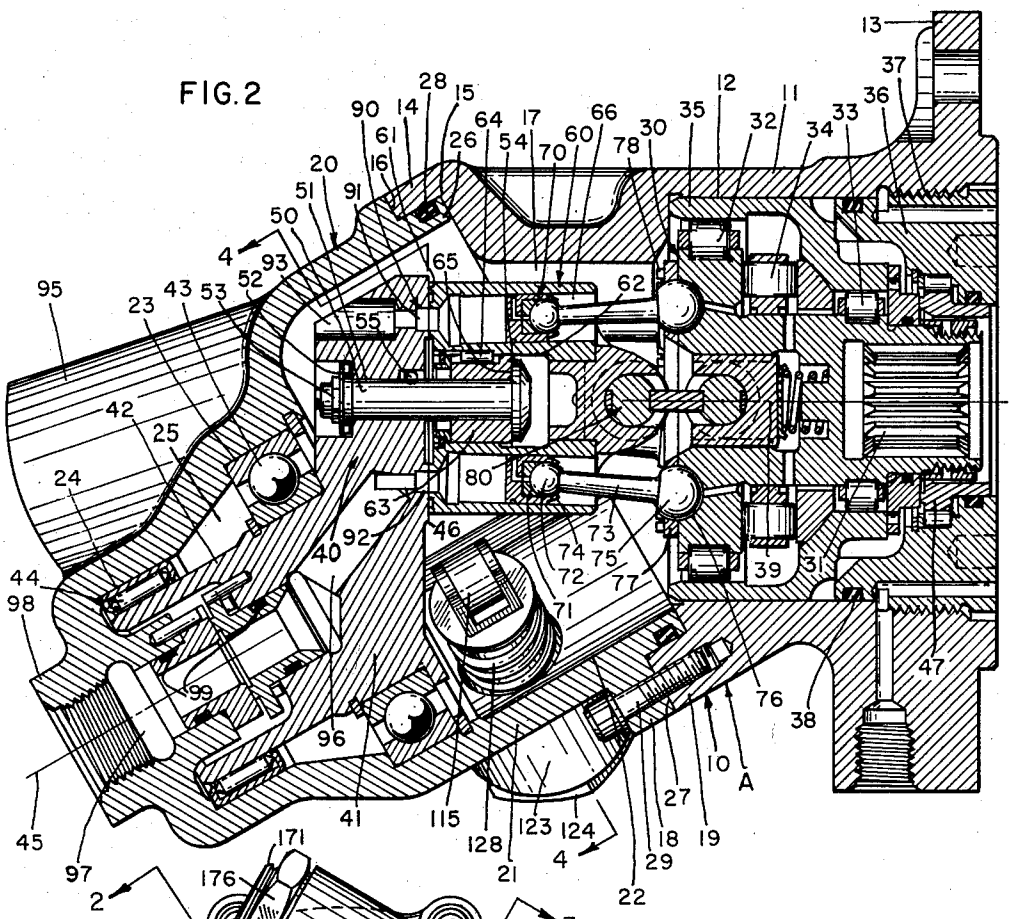


FIG. 1

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FIG. 3

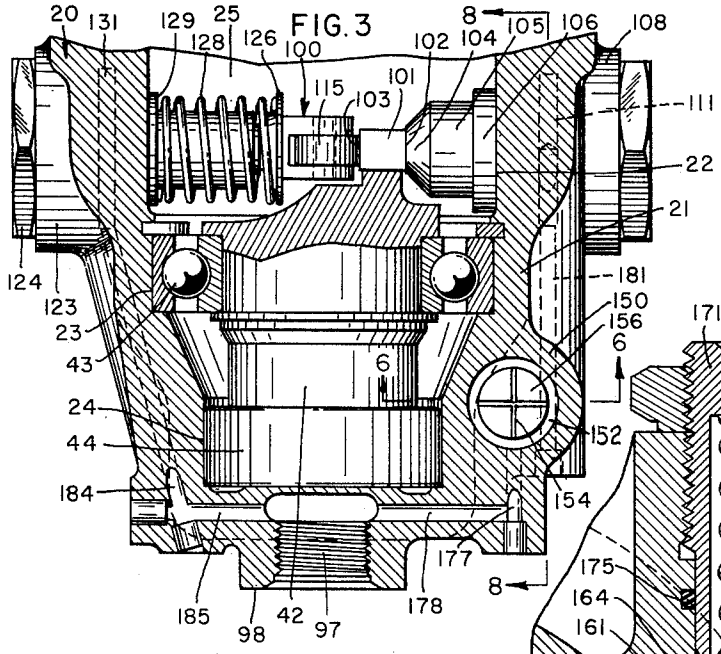


FIG. 6

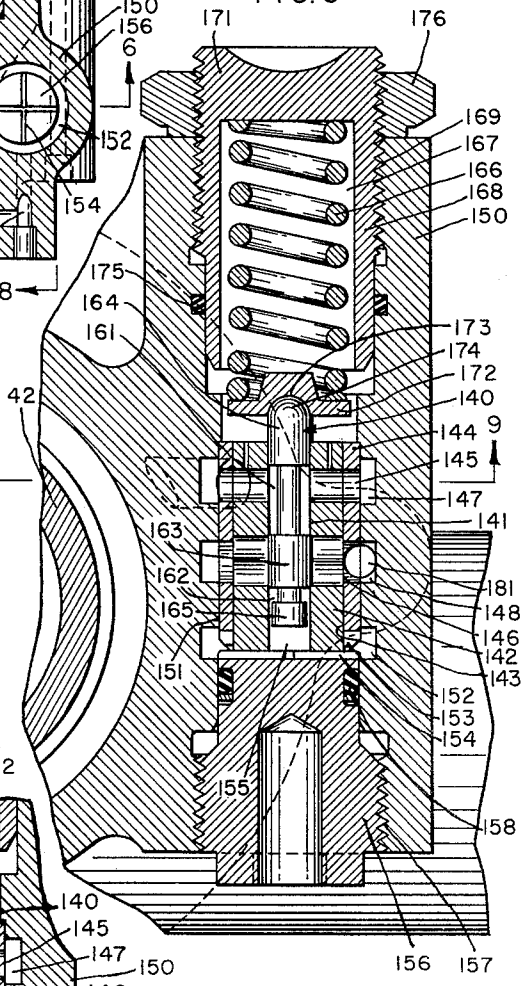


FIG. 8

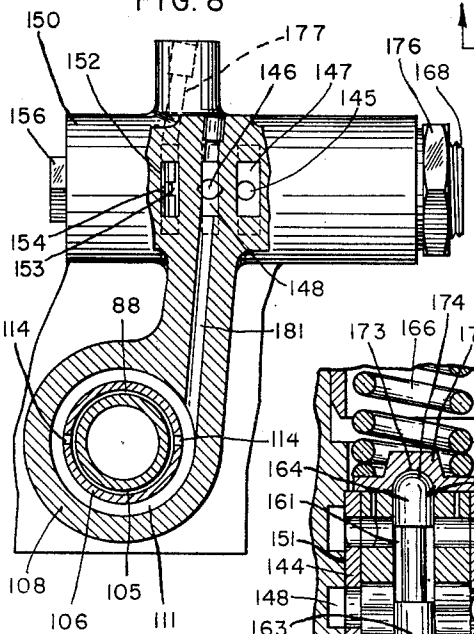
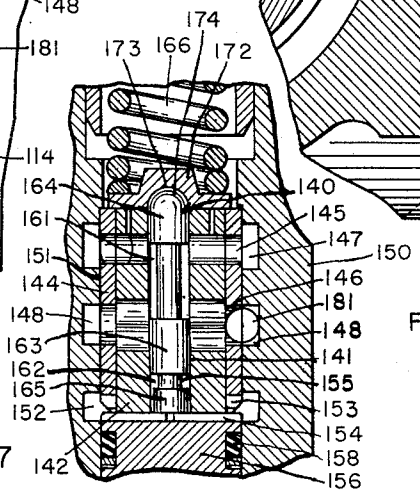


FIG. 7



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FIG. 9

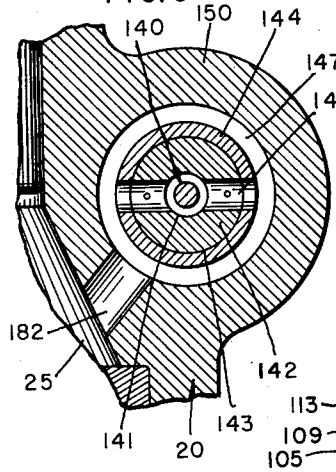


FIG. 4

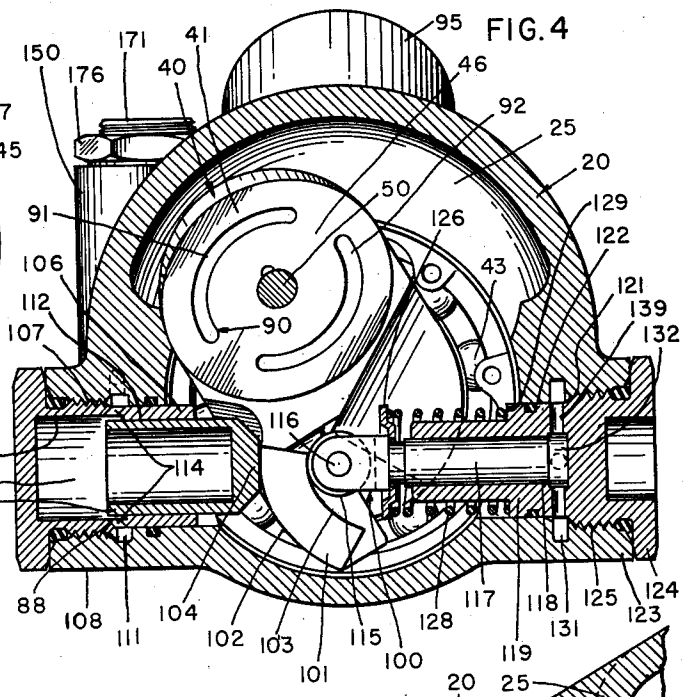
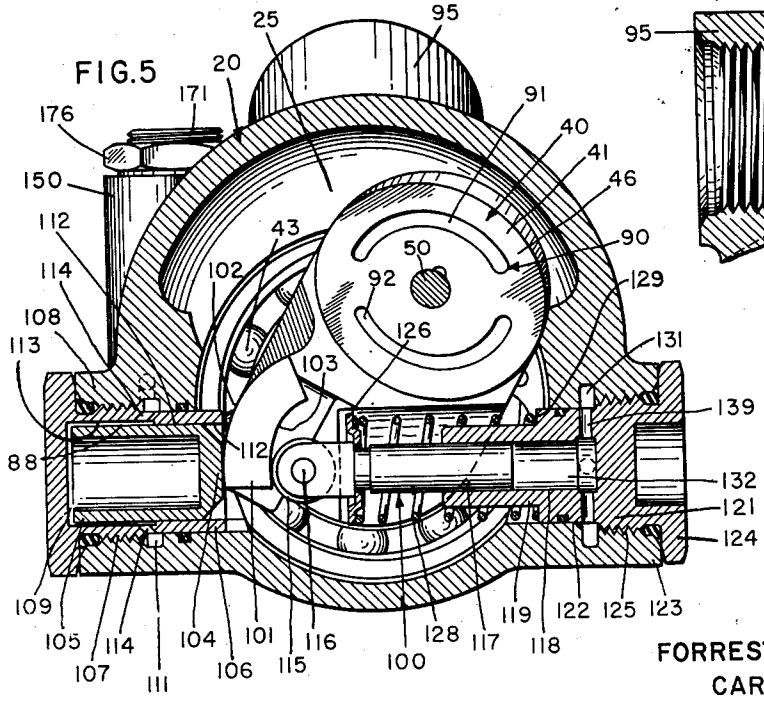


FIG. 5



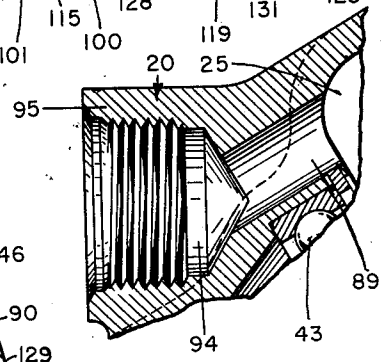


FIG. 10

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United States Patent Office 3,156,192 Patented Nov. 10, 1964

3,156,192

PUMP

Forrest L. Austin, Hopkins, and Carl Potter, Minneapolis, Minn., assignors to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Filed Sept. 22, 1961, Ser. No. 139,993
11 Claims. (Cl. 103—162)

The herein disclosed invention relates to hydraulic pumps and motors and has for an object to provide a pump and motor of the type having a rotor driven by or driving some rotary structure and connected to the connecting rods of a number of pistons disposed within a cylinder block having a plurality of cylinders arranged in the form of a circle and in which the cylinder block rotates relative to a valve head.

An object of the invention resides in providing bearing means for said valve head whereby the valve head is rotated about an axis forming an angle with the axis of said rotor other than ninety degrees.

Another object of the invention resides in supporting said cylinder block for rotation with respect to said valve head about an axis forming an angle other than ninety degrees with the axis of rotation of said valve head.

A still further object of the invention resides in providing a construction in which the axis of the rotor, the axis of the cylinder block and the axis of the valve head all intersect at a common point.

Other objects of the invention reside in the novel combination and arrangement of parts and in the details of construction hereinafter illustrated and/or described.

In the drawings:

FIGURE 1 is an elevational view of a pump illustrating an embodiment of the invention.

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1.

FIGURE 3 is a fragmentary sectional view taken on line 3—3 of FIGURE 1.

FIGURE 4 is a cross-sectional view taken on line 4—4 of FIGURE 2.

FIGURE 5 is a view similar to FIGURE 4 with the parts shown in altered position.

FIGURE 6 is a cross-sectional view taken on line 6—6 of FIGURE 3 and drawn to a greater scale.

FIGURE 7 is a view similar to FIGURE 6 of a portion of the structure shown therein and illustrating the parts in altered position.

FIGURE 8 is a fragmentary sectional view taken on line 8—8 of FIGURE 3.

FIGURE 9 is a cross-sectional view taken on line 9—9 of FIGURE 6 and drawn to the same scale as FIGURE 6.

FIGURE 10 is a fragmentary sectional view taken on line 10—10 of FIGURE 1.

While the invention may be used either as a pump or as a motor the same will be described and referred to as a pump though it will be understood that the invention embraces either construction.

The pump shown in the drawings comprises a case A having a base 10 and a cap 20 mounted thereon. The base 10 has a cylindrical portion 11 formed with a bore 12. A flange 13 extends outwardly from the cylindrical portion 11 and serves as supporting means for attaching the pump to a suitable motor or other supporting structure. The cylindrical portion 11 terminates in an annular portion 14 which has a cylindrical recess 15 and whose axis is disposed at an angle with respect to the axis of the bore 12 other than ninety degrees. The end of the annular portion 14 is formed with a flat face 16. Within the annular portion 14 is formed a space 17 which communicates with the bore 12.

The cap 20 consists of a cylindrical portion 21 having a bore 22 in the same. This bore is formed with annular

sockets 23 and 24 and the socket 23 is of smaller diameter than the bore 22 and the diameter of the socket 24 is less than that of the socket 23. The bore 22 communicates with the space 17 and in conjunction therewith forms a chamber 25 within the interior of the cap 20. The bore 22 is open at its end and communicates with the space 17. The cylindrical portion 21 of the cap 20 is formed with a rim 26 which is received within the annular portion 14 and which has a face 27 resting upon the face 16 of said annular portion. An O-ring 28 is disposed between the annular portion 14 and the rim 26 and forms a fluid tight connection therebetween. Screws 29 extending through lugs 18 on the cylindrical portion 21 are threaded into corresponding lugs 19 on the annular portion 14 clamp the cap 20 to the base.

Disposed within the bore 12 of base 10 is a rotor 30 which has a splined socket 31 for the reception of the end of a shaft connected to the driving motor for operating the pump. Rotor 30 is journalled for rotation in the bore 12 by means of inner and outer roller bearings 32 and 33 and by means of an end roller bearing 34. The rollers of these bearings engage suitable surfaces on race 35 received in the bore 12 of the cylindrical portion 11 of base 10 and corresponding surfaces on the rotor proper. A plug 36 screwed into threads 37 in the end of the cylinder portion 11 holds the race 35 in position. A seal 38 carried by said plug forms a fluid type connection between the base 10 and the plug 36. A dynamic seal 47 is disposed between the plug 36 and the rotor 30.

Mounted for rotation in the cap 20 is a valve head 40. This valve head includes a plate 41 and a shank 42 extending angularly outwardly therefrom. This shank is cylindrical in form and has mounted on it a ball bearing 43 and a needle bearing 44 which are received in the sockets 23 and 24 in the cylindrical portion 21 of cap 20. The axis 45 forms an acute angle with the axis 39 of the rotor 30, which as shown in FIG. 2 is approximately 30° from the parallel. The plate 41 has a face 46 which has issuing from it a stub shaft 50. The face 46 is inclined at an angle from axis 45 that is the complement of the angle between the axes 39 and 45 or is thus approximately 60°. The stub shaft 50 is normal to the face 46 and lines up with the axis 39 in one position as shown in FIG. 2 of valve head 40 but otherwise merely extends through the point of intersection of axes 39 and 45. Shaft 50 is received in a bore 51 formed in the plate 41, and held from rotation therein by means of a key 55. This shaft has mounted on the end of it a spring 52 which is held in position thereon by means of a nut 53. The other end of said shaft has formed on it a head 54 which is urged toward the face 46 by means of said spring.

Disposed within the chamber 17 is a cylinder block 60 which has a face 61 overlying and resting upon the face 46 of valve head 40. This cylinder bock is cylindrical in form and has a number of cylinders 66 formed therein. These cylinders are arranged in a circle concentric with the axis of the stub shaft 50. The cylinder block 60 is provided with a bore 62 and in which is mounted a bushing 63 which is keyed to the cylinder block by means of a key 64. The bushing 63 is constructed with a surface 65 at its end and which is engaged by the head 54 of the stub shaft 50.

Slidably mounted in the cylinders 66 are pistons 70 which are formed with sockets 71 and which receive balls 72 formed on the ends of connecting rods 73. The marginal portion 74 of the pistons 70 are turned over to retain the balls 72 with the said sockets. The other ends of the connecting rods 73 are also formed with balls 75 which are received in sockets 76 formed in the rotor 30. A retaining plate 77 attached to the end of the rotor 30 by means of screws 78 holds the balls 75 within the sockets 76.

Disposed between the rotor 30 and the cylinder block 60 is a universal joint 80. This joint may be of any suitable construction capable of transmitting uniform rotary movement. One such joint is disclosed in the patent to Richard T. Cornelius, No. 2,787,143, and which has been found to give satisfactory results.

Valve means for the cylinders 66 is indicated by the reference numeral 90 and includes two crescent shaped ports 91 and 92 formed in the face 46 of the plate 41 of valve head 40. These ports are best shown in FIGURES 4 and 5. The port 91 communicates with a passageway 93 which communicates with the chamber 25 within the case A. The chamber 25 in turn communicates by means of a passageway 89 shown in FIGURE 10 with a passageway 94 in a threaded boss 95 and to which a hose or other conduit may be connected. Passageway 94 constitutes the inlet of the pump. The port 91 serves as the inlet port of the valve means. The port 92 serves as the outlet port of the valve means and is connected by means of a passageway 96 in the plate 41 of valve head 40 and which communicates with a passageway 97 in a threaded neck 98 formed on the end of the cylindrical portion 21 of cap 20. The outlet of the pump may be connected from this passageway by means of a hose or other conduit to the system with which the pump is to be used. Suitable seals 99 form a fluid type connection between the plate 41 and the cap 20.

For varying the displacement of the pump a control mechanism 100 is employed which is best shown in FIGURES 4 and 5. This control mechanism includes a cam 101 which is mounted on the valve head 40 and which extends outwardly therefrom. This cam member has two cam surfaces 102 and 103. The cam surface 102 is engaged by the end 104 of a piston 105. This piston is slidable in the bore 112 of a cylinder 106 having a threaded portion 107 screwed into a boss 108 formed on the cap 20. The cylinder chamber 109 formed in the cylinder 106 communicates with an annular passageway or groove 111 encircling the said cylinder and formed in the boss 108. The bore 112 is enlarged at 113 to form an annular passageway 88 encircling said piston and which communicates through ports 114 with the passageway 111. The cam surface 103 is engaged by a roller 115 which is mounted for rotation on a pin 116 secured to the end of a piston 117. Piston 117 is slidable in the bore 118 of a cylinder 119 having a threaded portion 121 screwed into threads 125 formed in a boss 123 on the cap 20. Mounted on the end of the piston 117 is a washer 126. A compression coil spring 128 at one end engages a shoulder 129 on cylinder 119 and at its other end bears against the washer 126. This spring urges the roller 115 to the left as shown in FIGS. 4 and 5 and the opposite direction from that produced by the piston 105. Encircling the cylinder 119 at its outermost end is an annular passageway or groove 131. This passageway communicates through diagonal radial passageways 139 with the chamber 132 formed by the bore 118.

The control mechanism 100 further includes a sliding plunger 140 shown in detail in FIGURE 6. The plunger is slidable in a bore 141 formed in a cylinder 142. Cylinder 142 is itself disposed in the bore 143 of a sleeve 144. Said sleeve is in turn mounted on a bore 151 formed in a boss 150 integral with the cap 20. The said sleeve and cylinder have ports 145 and 146 formed in the same and which communicate with annular passageways or grooves 147 and 148 encircling the sleeve 144 and formed in the boss 150. Encircling the sleeve 142 at one end of the same is an annular groove 152 formed in the boss 150. This groove communicates with passageways 154 in the end of the plug 156 which in turn communicates with the cylinder chamber 155 formed at the end of bore 141.

The sleeve 144 and cylinder 142 are held within the bore 151 in boss 150 by means of a threaded plug 156 screwed into threads 157 in the end of the boss 150. An O ring 158 forms a fluid tight connection therebetween.

The plunger 140 is formed with two annular grooves 161 and 162 which forms a land 163 which is adapted to cover the port 146. A reduced button 165 on the end of the plunger 140 engages the end of the plug 156 and limits movement of the plunger to a position in which land 163 partially uncovers port 146 as shown in FIG. 7.

Plunger 140 is urged toward the plug 156 by means of a compression coil spring 166 received in a cavity 167 formed in a threaded cage 168. This cage is a screwed into threads 169 formed in the boss 150. An O ring 175 forms a fluid tight connection therebetween. One end of the spring 166 engages the end wall 171 of the cage 168 while the other end of said spring engages a spring seat 172 having a socket 173 receiving the rounded end 174 of the plunger 140. Turning of cage 168 varies the pressure of spring 166 upon plunger 140 and a lock nut 176 screwed on the end of the said cage holds the same in adjusted position.

Groove 152 in boss 150 as shown in FIGS. 3, 6, 7, and 8 communicate with the outlet passageways 97 in cap 20 by means of two intersecting passageways 177 and 178 also formed in said cap. Groove 148 in said cap as shown in FIG. 8 communicates with grooves 111 in boss 108 by means of a passageway 181. Groove 147 in boss 150 as shown in FIG. 9 communicates with the chamber 25 within the cap 20 by means of a passageway 182. Groove 131 in boss 123 as shown in FIG. 3 communicates with outlet passageway 97 through passageways 184 and 185.

The operation of the invention is as follows:

Assume that the pump is connected to an oil operated motor, not shown, by means of a conduit having a shut off valve and the motor discharging into the reservoir from which the pump is fed with oil. When the pump is standing still and likewise the motor plunger 140 is in the position shown in FIG. 7 and the piston 105 and associated components are in the position shown in FIG. 5. At such position piston 105 is all the way in and spring 128 urges the cam 101 to the left and the valve head 40 on cylinder block 60 are in the position of maximum capacity. With the plunger 140 disposed as shown in FIG. 7 the cylinder chamber 155 is in communication with the pump outlet 97 through passageways 154, and 153, groove 152, and passageways 177 and 178, the passageway 178 communicating with the outlet passage 97. In such position the cylinder chamber 109 at the end of bore 112 in which piston 105 travels is in communication with the inlet passageway 94 of the pump through groove 111, passageway 181 to the groove 148 in boss 150. The port 146 being partially uncovered by the land 163 on plunger 140, is in communication with the passageway formed by the groove 161 in said plunger which also is in communication with the port 145. Port 145 is in communication with the inlet passageway 94 through groove 147 in boss 150, passageway 182, chamber 25 in case A and with which the inlet passage 94 communicates through passageway 89.

Assume now that the pump is actuated with the motor valve closed. Pressure builds up in the outlet of the pump which is communicated to cylinder chamber 155 in boss 150. Plunger 140 now moves upwardly as viewed in FIGS. 6 and 7 until the pressure in chamber 155 equals the pressure for which the spring 166 is set and the ports 146 are covered by the land 163 of plunger 140. During movement of plunger 140 the cylinder chamber 109 remains in communication with the inlet 94 and piston 105 remains stationary until plunger 140 reaches the position shown in FIG. 6. Chamber 109 at such time is no longer in communication with the inlet 94. When the pressure in chamber 155 increases plunger 140 is moved still further upwardly and cylinder chamber 109 is in communication with chamber 155 through port 146 and groove 148. From then on pressure is being transmitted from groove 148 to the cylinder chamber 109 and

piston 105 moves cam 101 toward the right as viewed in FIG. 5 and against the action of spring 128 and piston 117 until the valve head 40 and cylinder block 60 are in the position shown in FIG. 4. In such position the cylinders 66 are parallel with the axis of rotor 30 and no pumping action takes place. Pumping hence ceases. If now the motor valve is turned on oil flows from the outlet 97 of the pump and to the motor and the outlet pressure drops. Spring 166 now forces plunger 140 downwardly as viewed in FIG. 6 against the reduced pressure in cylinder chamber 155 and uncovers portions of the ports 146 covered by land 163, again bringing the cylinder chamber 109 in communication with the inlet 94. Spring 128 and piston 117 now take over, forcing the valve head 40 and cylinder block 60 toward the position shown in FIG. 5. The pump then operates at an intermediate position providing the pressure for which spring 166 is set and furnishing sufficient flow to operate the motor at such pressure. During operation of the motor the oil flowing through the motor is discharged into the oil reservoir and recovered by the pump. When the motor is shut off the pump operates as previously described under no load conditions.

The valve ports 91 and 92 in the valve head 40 are located so that each port is wholly on one side of the plane defined by the rotor axis and the cylinder block axis. This causes the centroid of the piston forces to act to one side of the axis of the valve head, tending to rotate the valve head in a counter-clockwise direction as viewed in FIGS. 4 and 5, the force varying with the pressure. Cylinder chamber 132 being in communication with the outlet passageway 97 through port 139, groove 131, and passageways 184 and 185 exerts a force on the cam 101 tending to counteract the centroid of the piston forces and being also actuated by the outlet pressure compensates for the centroid force at all pressures. Spring 128 is so designed that the combined pressures exerted by said spring and piston 117 counter balance the pressure exerted by piston 105.

The advantages of the invention are manifest. An extremely small and compact pump results with a low weight for its capacity. Valve ports are extremely short resulting in higher efficiency. The cost of the pump can be materially reduced below the cost of present similar pumps. The pump will operate at high pressures and is completely automatic in operation, providing a required output capacity at the desired pressure.

Changes in the specific form of the invention, as herein described, may be made within the scope of what is claimed without departing from the spirit of the invention.

Having described the invention, what is claimed as new and desired to be protected by Letters Patent is:

1. In combination, a variable capacity hydraulic pump or motor unit, comprising a casing, first and second members supported by the casing to rotate, respectively, about first and second rotational axes fixed relative to one another and to the casing and intersecting at a given acute angle less than 45°, reaction areas on the first and second members spaced apart and generally facing each other, the first of the reaction areas on the first member being offset from and inclined relative to the rotational axis of said first member at an angle the complement of the above-mentioned given angle, the second of the reaction areas on the second member being fixed relative to the rotational axis of the second member and extended normal thereto and symmetrically thereof, said first reaction area being movable upon rotation of the first member transversely of the rotational of axis of the second member and being in only one rotatable position of the first member normal to and generally symmetrical of said second rotational axis, and expansible fluid chamber means confined between the reaction areas, said fluid chamber means including a cylinder block having a valve surface mating flush on one of the reaction areas and having a plurality of spaced through-cylinder bores each open at one end to the valve surface to be closed by the one reaction area, means to support the cylinder block to rotate about a rotational axis fixed normal to symmetrically of the one reaction area, a piston in each of the cylinder bores defining therein with the one reaction area a fluid chamber, connecting rods fixed between the pistons and the other of the reaction areas at spaced locations thereon symmetrically of its transverse symmetrical axis, and inlet and outlet port means in the one reaction area for porting fluid for the chambers, whereby rotation of the first member about the first rotational axis moves the first reaction area thereon transversely of the second rotational axis of the second member to adjust the operating stroke of the hydraulic unit effected upon rotation of the second member and the cylinder block about their respective rotational axes.

2. A variable capacity hydraulic pump or motor unit, comprising the combination of, a casing, a first member supported by the casing to rotate about a first rotational axis, a second member supported by the casing to rotate about a second axis intersecting the first axis, a reaction area on one of the members offset from and extended at an acute angle relative to the rotational axis of said one member adapted in at least one of the rotatable positions of the one member relative to the casing to extend generally normal to and symmetrically of the rotational axis of the other of the members, a second reaction area supported by the casing fixed relative to the other member extended generally normal to and symmetrically of the rotational axis of the other member, a cylinder block having a valve surface on one end and having a plurality of spaced through cylinder bores each open at one end to the valve surface, a piston in each of the cylinder bores, a guide member, connecting rods each connected at its opopsite ends to one of the pistons and to the guide member at spaced locations thereon, said guide member and cylinder block being interposed between the reaction areas, with the reaction area confining the valve surface of the cylinder block closing the cylinder bores thereof and defining with said pistons expansible fluid chambers, means for supporting the guide member and cylinder block for rotation about separate rotational axes fixed relative to the supporting reaction areas, wherein one of the rotational axes is coincidental with the rotational axis of the other member and wherein the other of the rotational axes is always at an angle with respect to the rotational axis of the one member, inlet and outlet port means in the closing reaction area for porting fluid for the expansible chambers, and means interconnecting the other member, the guide member and the cylinder block to drive them together, whereby rotation of the one member moves the reaction area thereon transversely of the rotational axis of the other member for adjusting the operating piston stroke of the unit and rotation of the other member causes like rotation of the cylinder block and the guide member for effecting the operating stroke of the unit.

3. A variable capacity hydraulic pump or motor unit, comprising in combination, a casing, a member supported by the casing to rotate about a first rotational axis fixed relative to the casing, a first reaction area on the member offset from the first rotational axis and extending at an acute angle with respect thereto, first pivot means fixed relative to the first reaction area, said first pivot means defining a second rotational axis extending transverse to the first reaction area and fixed relative thereto but inclined relative to the first rotational axis and movable relative to the casing upon rotation of the member, a second reaction area supported by the casing extended transverse to the first rotational axis at all times and extending transverse to the second rotational axis in at least one rotatable position of the member relative to the casing, second pivot means fixed relative to the second reaction area, said second pivot means defining a third rotational axis fixed relative to the second reaction area but movable

relative to the second rotational axis upon movement of the member, a cylinder block having a valve surface on the one end and having a plurality of spaced cylinder bores open to the valve surface and to the opposite end of the cylinder block, a piston in each of the cylinder bores defining an expansible chamber, a guide member, connecting rods interconnecting each piston and the guide member at spaced locations thereon, said cylinder block and guide member being interposed between the reaction areas in confining support thereby and being connected by said pivot means to rotate separately about the second and third defined rotational axes to stroke the pistons in the bores, drive means connectable from the exterior of the unit connecting the guide member and/or the cylinder block, and port means in the reaction area confining the valve surface for porting the chambers, whereby adjustment by rotation of the one member about the first rotational axis moves the first reaction area transversely of the third rotational axis and varies the stroke of the pistons in the cylinder bores for varying the per cycle capacity of the unit.

4. A variable capacity hydraulic pump or motor unit, comprising the combination of, a casing, first and second members supported by the casing to rotate about first and second rotational axes fixed relative to the casing and inclined at an acute angle with respect to one another, a reaction area on one of the members offset from and inclined at an acute angle other than 90° relative to the rotational axis of said one member, a cylinder block having a valve surface symmetrically disposed of its longitudinal axis and having a plurality of circumferentially spaced through cylinder bores radially spaced from the longitudinal axis and open at corresponding ends to the valve surface, pistons in each of the cylinder bores, connecting rods each swivelably connected at its opposite ends to the pistons and to the other of the members spaced from its rotational axis, said cylinder block being confined with its valve surface flush with the reaction area, means to support the cylinder block to rotate about a third rotational axis fixed relative to and symmetrically of the confining reaction area, said third rotational axis always being inclined at an acute angle relative to the first rotational axis and being inclined relative to the rotational axis of the other member in all but at most one rotatable position of the one member relative to the casing, so that each of the cylinder bores and its piston therein define with the reaction area an expansible fluid chamber, and inlet and outlet port means in the reaction area for porting fluid for each expansible chamber, whereby the one member is rotatable about its axis through a small angle to move the reaction area thereon transversely of the rotational axis of the other member to adjust the effective stroke and fluid capacity per cycle of the hydraulic unit.

5. A variable capacity hydraulic pump or motor unit, comprising in combination, a casing, a first member supported by the casing to rotate about a first rotational axis fixed relative to the casing, a first reaction area on the first member offset from the first rotational axis and extended at an acute angle greater than 45° with respect thereto, a first pivot means fixed relative to the first reaction area, said first pivot means defining a second rotational axis extending transverse to and symmetrically of the reaction area and extending at an acute angle relative to the first rotational axis, a second reaction area defined by the casing extended generally symmetrical of and transverse to a third rotational axis intersecting the first rotational axis at a point spaced from the first reaction area and extending transverse to symmetrically of the first reaction area in one rotatable position of the first member relative to the casing, second pivot means fixed relative to the second reaction area symmetrically of the third rotational axis, a cylinder block having a valve surface and having a plurality of spaced through cylinder bores each open at one end to the valve surface, a piston in each of the cylinder bores, a guide member, connecting rods interconnecting the pistons and the guide member at spaced locations thereon, said cylinder block and guide member being interposed between the reaction areas in confining support thereby and each being connected by one of said pivot means to rotate separately about the second and third defined rotational axes, coupling means interconnecting the guide member and the cylinder block effective to cause them to rotate together at the same speed in the same direction about the separate rotational axes, port means in the reaction area confining the valve surface radially aligned with the cylinder bore openings adapted to communicate successively therewith upon rotation of the cylinder block, and means operatively connected to the cylinder block externally of the unit effective for the external drive connection thereof, whereby adjustment by rotation of the first member about the first rotational axis varies the operating stroke of the unit for varying the volumetric capacity per cycle of the unit.

6. In combination, a variable capacity hydraulic pump or motor unit, comprising a casing, first and second members supported by the casing to rotate, respectively, about first and second axes fixed relative to the casing and intersected at an acute angle of approximately 30°, reaction areas on the first and second members spaced apart and generally facing each other, the first of the reaction areas on the first member being offset from and inclined at an acute angle relative to the rotational axis of said member, the second of the reaction areas on the second member being fixed relative to the rotational axis of the second member and extended generally transverse thereto and symmetrically thereof, said first reaction area being movable upon rotation of the first member transversely of the rotational axis of the second member and being extended in at least one rotatable position of the first member transverse to and generally symmetrical of said second rotational axis, and expansible fluid chamber means confined between the reaction areas, said fluid chamber means including a cylinder block having a valve surface mating flush on one of the reaction areas and having a plurality of spaced through-cylinder bores each open at one end to the valve surface and closed by the one reaction area, means to support the cylinder block to rotate about a rotational axis fixed transverse to symmetrically of the one reaction area, a piston in each of the cylinder bores defining therein with the one reaction area a fluid chamber, connecting rods between the pistons and the other of the reaction areas at spaced locations thereon symmetrically of its transverse symmetrical axis, and inlet and outlet port means in the one reaction area for porting fluid for the chambers, whereby rotation of the first member about its axis moves the first reaction area presented thereon transversely of the rotational axis of the second member to adjust the operating stroke of the hydraulic unit effected upon rotation of the second member and the cylinder block about their respective axes.

7. A variable capacity hydraulic pump or motor unit, comprising in combination, a casing, a first member supported by the casing to rotate about a first rotational axis fixed relative to the casing, a first reaction area on the first member offset from the first rotational axis and extended at an angle of the order of 60° with respect thereto, first pivot means fixed symmetrically of the reaction area to define a second rotational axis extending transverse to the reaction area fixed relative thereto and intersecting the first rotational axis at a point fixed relative to the casing spaced from the first reaction area, a second reaction area defined by the casing spaced from and facing the first reaction area and extended generally symmetrical of and transverse to a third rotational axis, said third rotational axis intersecting the first rotational axis and being parallel to the second rotational axis in one only rotatable position of the first member relative to the casing, second pivot means fixed relative to the

second reaction area symmetrically of the third rotational axis, expansible fluid chamber means including a cylinder block having a valve surface on one end and having a plurality of spaced through cylinder bores open to the valve surface, a piston in each of the cylinder bores, a guide member, connecting rods interconnecting the pistons and the guide member at spaced locations thereon, said cylinder block and guide member being interposed between the reaction areas in confining support thereby and being connected by said pivot means to rotate about the second and third defined rotational axes, means interconnecting the guide member and the cylinder block effective to cause them to rotate together at the same speed in the same direction about their rotational axes, port means in the reaction area confining the valve surface of the cylinder block adapted to communicate with the cylinder bore openings successively upon rotation of the cylinder block, and means connecting the expansible fluid chamber means externally of the unit effective for the external drive connection thereof, whereby adjustment by rotation of the first member about the first rotational axis varies the operating stroke of the pistons in the cylinder bores for varying the volumetric capacity per cycle of the unit.

8. In a hydraulic pump or motor unit of the type including expansible fluid chamber means confined between spaced reaction areas extended at or movable to an angle relative to one another, where the fluid chamber means includes a cylinder block having a valve surface disposed flush with one of the reaction areas and having a plurality of spaced through cylinder bores open at corresponding ends to the valve surface to be closed by the one reaction area, a piston in each of the cylinder bores, and connecting rods connected at corresponding ends to the pistons and fixed at their opposite ends relative to the other of the reaction areas at spaced locations thereon, with the cylinder block and other reaction area being rotated at the same speed in the same direction about their rotational axes to cause the operating stroke of the unit, and where the one reaction area confining the valve surface has port means thereon including two separate ports radially aligned with the openings of the cylinder bores for successive communication therewith, an improved configuration defining the reaction areas operable as a variable capacity hydraulic unit, comprising a first member supported to rotate about a fixed first rotational axis, said first member having the first of the reaction areas thereon offset from the first rotational axis and inclined at an acute angle relative thereto, a second member supported to rotate about a fixed second rotational axis, said second member having the other of the reaction areas thereon disposed transverse to and surrounding the second rotational axis, and the members and axes being positioned with said second rotational axis extending transverse to the first reaction area and generally through the center thereof in only one rotatable position of the first member, whereby rotation of the first member moves the first reaction area transversely of the second rotational axis and varies the operating stroke and volumetric capacity per cycle of the unit.

9. In a hydraulic pump or motor unit of the type including expansible fluid chamber means confined between spaced reaction areas extended at or movable to an angle relative to one another, where the fluid chamber means includes a cylinder block having a valve surface disposed flush with one of the reaction areas and having a plurality of spaced through cylinder bores open at corresponding ends to the valve surface to be closed by the one reaction area, a piston in each of the cylinder bores, and connecting rods connected at coresponding ends to the pistons and fixed at their opposite ends relative to the other of the reaction areas at spaced locations thereon, with the cylinder block and other reaction area being rotated at the same speed in the same direction about their rotational axes to cause the operating stroke of the unit, and where the one reaction area confining the valve surface has port means thereon including two separate ports radially aligned with the openings of the cylinder bores for successive communication therewith, an improved configuration defining the reaction areas operable as a variable capacity hydraulic unit, comprising a first member supported to rotate about a fixed first rotational axis, said first member having one of the reaction areas thereon offset from the first rotational axis and extended symmetrically of a different transverse axis at an acute angle with respect to the first rotational axis, a second member supported to rotate about a fixed second rotational axis extended transverse to the first reaction area and intersecting the symmetrical axis thereof in only one rotatable position of the first member, and said second member having the second of the reaction areas thereon generally symmetrical of and transverse to the second rotational axis, whereby rotation of the first member about the first rotational axis moves the first reaction area transversely of the rotational axis of the second reaction area and varies the operating stroke and volumetric capacity per cycle of the unit, for each revolution of the cylinder block about its rotational axis.

10. In a hydraulic pump or motor unit of the type including expansible fluid chamber means confined between spaced reaction areas extended at or movable to an angle relative to one another, where the fluid chamber means includes a cylinder block having a valve surface disposed flush with one of the reaction areas and having a plurality of spaced through cylinder bores open at corresponding ends to the valve surface to be closed by the one reaction area, a piston in each of the cylinder bores, and connecting rods connected at corresponding ends to the pistons and fixed at their opposite ends relative to the other of the reaction areas at spaced locations thereon, with the cylinder block and other reaction area being rotated at the same speed in the same direction about their rotational axes to cause the operating stroke of the unit, and where the one reaction area confining the valve surface has port means thereon including two separate ports radially aligned with the openings of the cylinder bores for successive communication therewith, an improved configuration defining the reaction areas operable as a variable capacity hydraulic unit, comprising a first member supported to rotate about a fixed first rotational axis, said first member having one of the reaction areas thereon offset from the first rotational axis and extended symmetrically of a different axis at an acute angle with respect to the first axis, a second member supported to rotate about a fixed second rotational axis intersecting the first rotational axis, said second member having the other of the reaction areas thereon disposed transverse to and surrounding the second rotational axis, and said members and first and second axes being arranged so that the second rotational axis is transverse to and through the center of the first reaction area in one rotatable position of the first member, whereby rotation of the first member about the first rotational axis moves the first reaction area transverse to the rotational axis of the second member and varies the operating stroke and volumetric capacity per cycle of the unit.

11. In a hydraulic pump or motor unit of the type including expansible fluid chamber means confined between spaced reaction areas extended at or movable to an angle relative to one another, where the fluid chamber means includes a cylinder block having a valve surface disposed flush with one of the reaction areas and having a plurality of spaced through cylinder bores open at corresponding ends to the valve surface to be closed by the one reaction area, a piston in each of the cylinder bores, and connecting rods connected at corresponding ends to the pistons and fixed at their opposite ends relative to the other of the reaction areas at spaced locations thereon, with the cylinder block and other reaction area being rotated at the same speed in the same direction

about their rotational axes to cause the operating stroke of the unit, and where the one reaction area confining the valve surface has port means thereon including two separate ports radially aligned with the openings of the cylinder bores for successive communication therewith, an improved configuration defining the reaction areas operable as a variable capacity hydraulic unit, comprising a first member supported to rotate about a fixed first rotational axis, said first member having one of the reaction areas thereon offset from the first rotational axis and extended symmetrically of a different axis intersecting the first rotational axis at an angle of approximately 30° with respect thereto, a second member supported to rotate about a fixed second rotational axis intersecting the first rotational axis at the above-mentioned point of intersection and being coincidental with the symmetrical axis

of the first reaction areas in one and only one rotatable position of the first member, and said second member having the other of the reaction areas thereon disposed transverse to and symmetrically of the second rotational axis, whereby rotation of the first member about the first rotational axis moves the first reaction area transversely of the rotational axis of the second member and varies the operating stroke and volumetric capacity per cycle of the unit.

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