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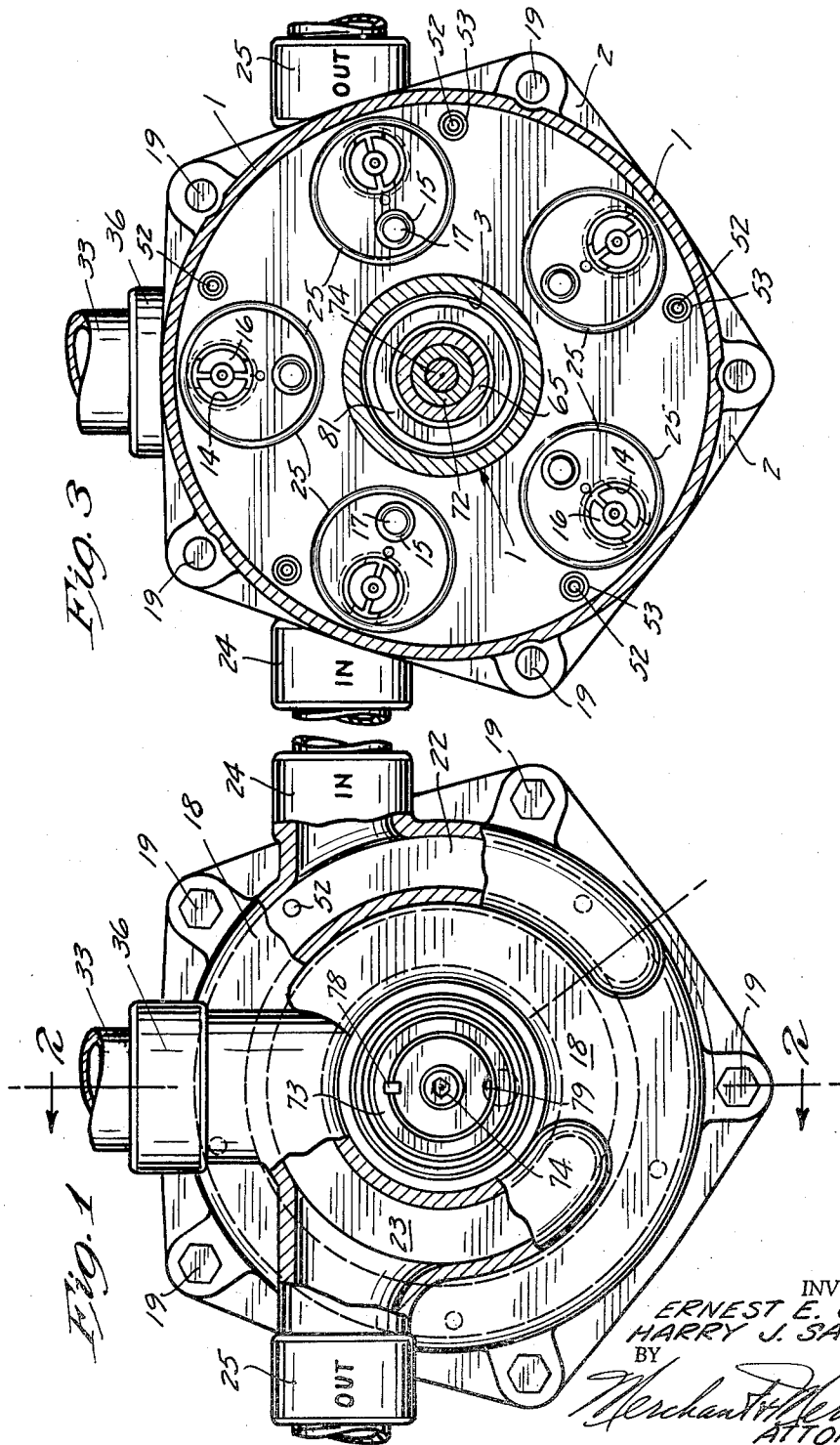
E. E. COOK ET AL

3,018,737

PUMP STRUCTURE

Filed Jan. 24, 1958

3 Sheets-Sheet 1



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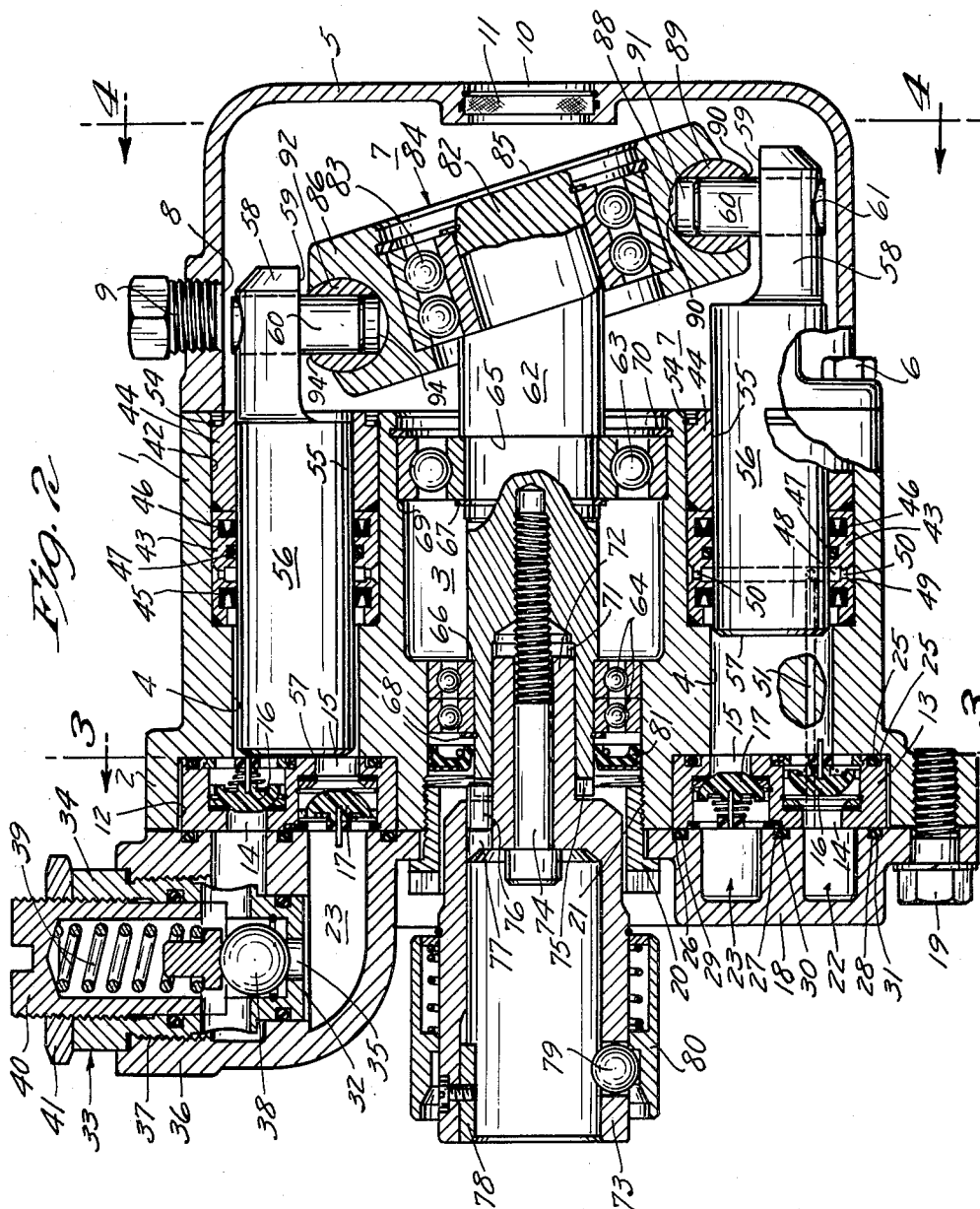
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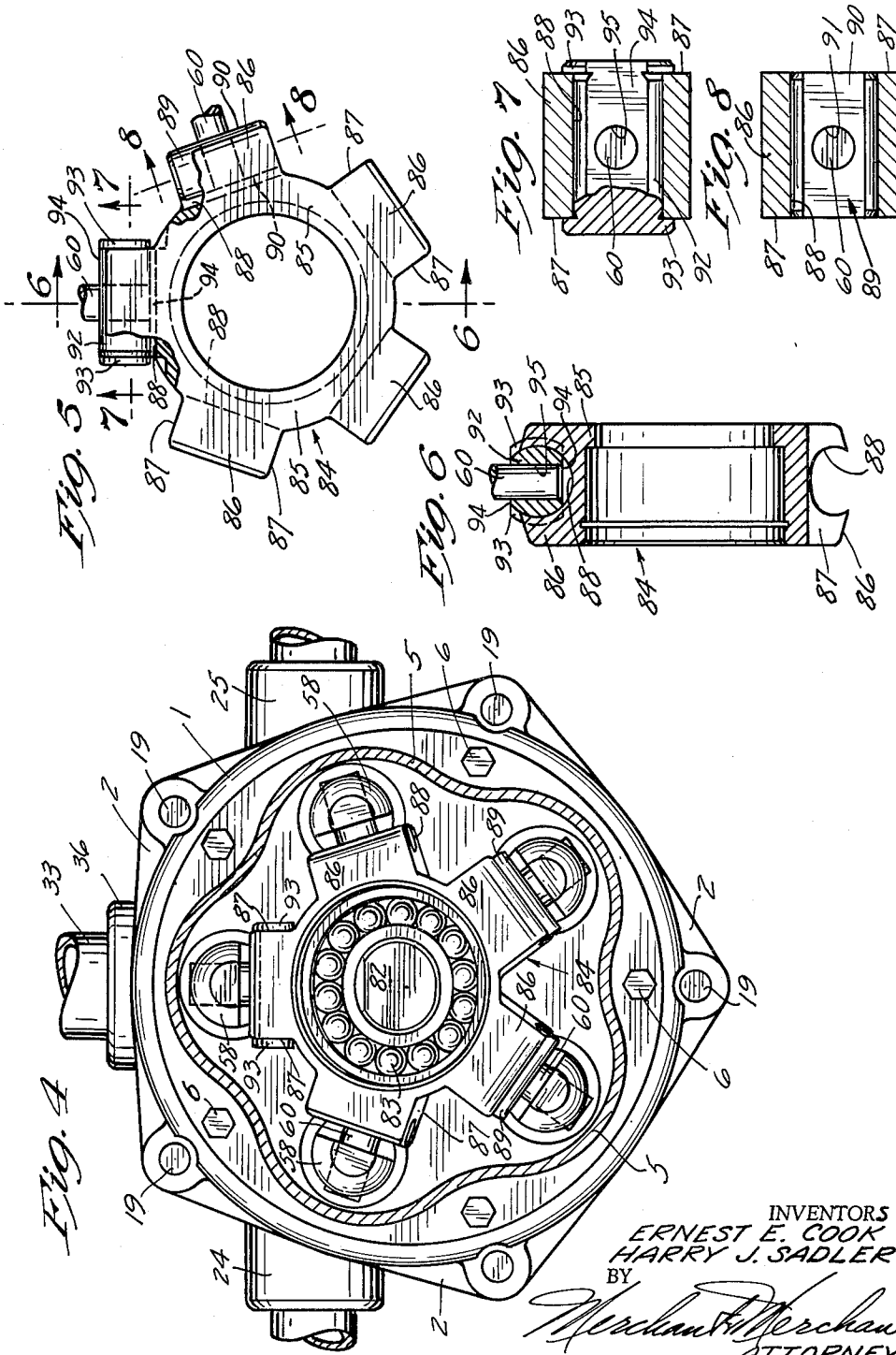
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3 Sheets-Sheet 3



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PUMP STRUCTURE

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3 Claims. (Cl. 103-173)

Our invention relates generally to fluid pumps, and more particularly to improvements in pumps of the type involving reciprocatory pistons and a wobble member mounted on a rotary drive shaft for imparting reciprocatory movement to the pistons.

An important object of our invention is the provision of a pump of the above type having a novel wobble member and connections therebetween and the pumping piston which are extremely simple and inexpensive to produce without the use of equipment other than standard machine tools.

Another object of our invention is the provision of a pump as set forth, having novel means for holding the wobble member against common rotary movement with the rotary drive shaft for the pump.

Another object of our invention is the provision of a pump of the wobble member operated piston variety, wherein the wobble member is provided with a plurality of wrist pins journaled therein on axes tangent to a circle substantially concentric to the central drive shaft and in which the pistons are provided with transverse piston pins extending through the wrist pins radially of said drive shaft whereby universal movement is obtained between the wobble member and said pistons.

Another object of our invention is the provision of a pump as set forth, having a novel inlet and outlet valve arrangement for the pumping cylinders thereof, and a novel mounting for the valves whereby said valves may be quickly and easily removed and replaced.

Another object of our invention is the provision of a pump which is highly efficient in operation, rugged in construction and durable in use.

The above, and still further highly important objects and advantages of our invention, will become apparent from the following detailed specification, appended claims, and attached drawings.

Referring to the drawings, which illustrate the invention, and in which like characters indicate like parts throughout the several views:

FIGURE 1 is a view in end elevation of a pump built in accordance with our invention, some parts being broken away and some parts being shown in section;

FIGURE 2 is an enlarged axial section taken substantially on the line 2-2 of FIG. 1;

FIGURE 3 is a transverse section taken on the line 3-3 of FIGURE 2, on a reduced scale, some parts being broken away;

FIGURE 4 is a view partly in end elevation and partly in section taken substantially on the line 4-4 of FIGURE 2, on a reduced scale;

FIGURE 5 is a view in end elevation of the wobble member of my invention, some parts being broken away and some parts shown in section;

FIGURE 6 is a view in transverse section taken substantially on the line 6-6 of FIGURE 5;

FIGURE 7 is a fragmentary section taken substantially on the line 7-7 of FIGURE 5; and

FIGURE 8 is a fragmentary section taken substantially on the line 8-8 of FIGURE 5.

In the preferred embodiment of the invention illustrated, the numeral 1 indicates a cylinder block formed at its inner end to provide a flange 2, and defining a central opening 3 extending axially therethrough and a plurality, as shown five, of circumferentially spaced pump

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cylinders 4, parallel to the central opening 3. A generally cup-shaped end cap 5 is rigidly secured to the outer end of the cylinder block 1 by means of cap screws or the like 6, and defining an end chamber 7. At its top portion, the end cap 5 is provided with a screw threaded opening 8 through which lubricant may be added to the chamber 7, said opening 8 being normally closed by a threaded plug or the like 9. The end cap 5 is further provided with a side opening 10 substantially in alignment with the central opening 3 of the block 1, said opening 10 being closed by a window 11 of suitable transparent material such as glass or transparent synthetic plastic material. The window 11 provides means for a visible check on the level of lubricant within the chamber 7.

The inner flanged end of the cylinder block 1 defines an annular recess 12 that is concentric with the central opening 3 and into which the inner ends of the cylinder 4 open. An annular valve plate 13 is seated in the recess 12, and is provided with a plurality of circumferentially spaced pairs of inlet and outlet passages 14 and 15 respectively. The inlet passages 14 are normally closed by spring biased inlet check valves 16, whereas the outlet passages 15 are normally closed by similar spring biased check valves 17. Each pair of inlet and outlet passages 14 and 15 respectively is in direct communication with a different one of the cylinders 4 through respective check valves 16 and 17. The annular valve plate 13 is held securely in place within the recess 12 by an annular manifold 18 that is anchored in place at its peripheral portion by a plurality of circumferentially spaced machine screws or the like 19 screw threaded into suitable threaded apertures in the flange 2 of the cylinder block 1. The central portion of the annular manifold 18 is releasably anchored to the cylinder block 1 by a tubular anchoring screw 20 that is screw threaded into a reduced diameter threaded end portion of the central opening 3 of the cylinder block 1, as indicated at 21. The manifold 18 defines concentric outer and inner manifold chambers 22 and 23 respectively, the former of which communicates with an inlet 24, and the latter of which communicates with an outlet 25. The relative positions of the inlet and outlet passages 14 and 15 are such that all of the inlet passages 14 are in communication with the annular inlet manifold chamber 22, all of the outlet passages 15 being in communication with the annular outlet manifold chamber 23. Leakage of fluid from one cylinder 4 to another thereof through the annular recess 12 is prevented by a plurality of rubber-like sealing rings 24 that are mounted in annular grooves or channels 25, each of said grooves 25 surrounding a different pair of said inlet and outlet passages 14 and 15, each sealing ring 24 having sealing engagement with the bottom of its respective annular groove 25 and with the bottom of the recess 12 around each of the cylinders 4. The annular manifold 18 defines concentric inner, intermediate and outer axially opening annular grooves 26, 27 and 28 respectively, which contain annular sealing rings 29, 30 and 31 which have sealing engagement with the flat surface of the adjacent end of the annular valve plate 13 to prevent leakage of fluid between the manifold chambers 22 and 23 and from either thereof to atmosphere. With reference to FIGURE 2, it will be noted that the valve plate 13 is of slightly greater thickness than the depth of the annular recess 12, so that the valve plate 13 is securely anchored in the recess 12 against movement when the screws 19 and 20 are tightened. Tightening of the screws 19 and 20 places the various sealing rings 24, 29, 30 and 31 under compression to effectively seal the connections between the cylinder block 1, valve plate 13 and manifold 18.

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The manifold 18 defines an opening 32 between the inlet and outlet chambers 22 and 23 respectively, in which opening is seated a pressure relief valve indicated in its entirety at 33. The valve 33 comprises a tubular valve body 34, the lower end of which defines a passage 35 communicating with the inlet and outlet manifold chambers, the valve body being screw threaded into a portion 36 of the manifold 18, as indicated at 37, see particularly FIGURE 2. The relief passage 35 is normally closed by a ball valve element 38 that is yieldingly urged toward the adjacent end of the passage 35 by a coil compression spring 39 contained within an adjustment screw 40 screw threaded into the upper end portion of the valve body 34. The adjustment screw 40 is held against accidental movement by a conventional lock nut 41.

Each of the cylinders 4 is counterbored from its outer end to provide a diametrically enlarged portion or recess 42 for the reception of annular holders 43 and guide sleeves 44. Each annular holder 43 is provided with sealing rings 45 and 46 of conventional structure, each thereof being located adjacent an opposite end of each holder. Each holder 43 is further provided, intermediate the sealing rings 45 and 46, with a sealing ring 47, which, like the sealing rings 24, 29, 30 and 31, is in the nature of a conventional O-ring. Intermediate the sealing ring or element 45 and O-ring 47, each holder 43 is formed to provide inner and outer circumferential channels 48 and 49 respectively, and circumferentially spaced connecting passages 50. The cylinder block 1 is drilled to provide a plurality of breather passages 51, one of which is shown in FIG. 2, there being one for each of the cylinders 4. Each breather passage 51 communicates at one end with a different one of the outer channels 50, and at its inner end with a different one of a plurality of cooperating passages 52 extending through the annular valve plate 13 whereby to communicate with the inlet manifold chamber 22. As shown in FIGURE 3, the valve plate 13 is provided with a plurality of annular grooves concentric with each passage 52 for the reception of small O-rings 53 that have sealing engagement with the adjacent end of the cylinder block 1. The annular holders 43 are held in position at the bottom of their respective recesses 42 by the guide sleeve 44 and snap rings 54 suitably mounted in grooves in the outer end portions of each recess 42 and engaging the outer end portions of the guide sleeve 44.

The guide sleeves 44 each define cylinder extension portions 55 of slightly smaller diameter than the cylinders 4 between the recesses 42 and the valve equipped inner end of the block 1, each of the cylinder extension portions 55 snugly slidably receiving a different one of a plurality of elongated pistons 56 the inner ends 57 of which are adapted to move freely between the inner ends of the cylinders 4 and the bottoms of the recesses 42. At their outer ends, the pistons 56 are formed to provide extended portions 58 that project outwardly into the chamber 7, see FIGURE 2. The piston end portions 58 are generally semi-cylindrical in cross section, and define flat surfaces 59 which face toward the axis of the central opening 3, each of said faces 59 being disposed closely adjacent the axis of its respective piston 56. The outer end portions 58 of each piston 56 is provided with a rigid piston pin 60, the axis of which is normal to the face 59 of its respective piston, and which extends radially inwardly toward the axis of the central opening 3. Preferably, the piston pins 60 are each mounted in transverse apertures 61 in their respective piston outer end portions 58 and are held against movement relative to their respective piston portions 58 by being press fitted in their respective transverse openings 61, or secured therein in any suitable manner.

A drive shaft 62 extends axially of the central opening 3 and is journaled therein by means of anti-friction bearings 63 and 64, the shaft 62 defining annular shoulders 65 and 66 which abut the bearings 63 and 64 respectively. The bearings 63 and 64 are held against their respective shoulders 65 and 66 by conventional snap rings 67 and

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68 respectively, the bearing 63 being held against axial movement with respect to the cylinder block 1 by engagement with an annular stop shoulder 69 in the cylinder block 1, and a snap ring 70 mounted in the outer end portion of the central opening 3. The inner end portion of the drive shaft 62 is provided with an axial recess 71 for reception of the diametrically reduced portion 72 of a coupling element 73. An anchoring bolt 74 extends axially through a central aperture in the reduced portion 72 and has screw threaded engagement with the drive shaft 62 to hold the coupling elements 73 against axial movement with respect to the drive shaft 62. The inner end of the drive shaft 62 is provided with a plurality of circumferentially spaced teeth 75 between an adjacent pair of which extends a shear pin 76 that is mounted in a longitudinally extended opening 77 in the coupling element 73. As shown in FIGURE 2, the outer end of the coupling element 73 is recessed to receive a motor shaft not shown, and is provided with a key 78 and a ball detent 79 for engagement with a suitable notch in the motor shaft, not shown, the ball detent being releasably locked in place by a spring pressed locking sleeve 80 mounted on the outer end portion of the coupling elements 73 for limited axial movement relative thereto. A conventional annular sealing element 81 closely encompasses the inner end portion of the drive shaft 62 between the anti-friction bearings 64 and the tubular screw 20 to prevent escape of lubricant from the chamber 7 and central opening 3.

The outer end of the drive shaft 62 projects into the chamber 7 and is there provided with an integrally formed oblique crank portion 82 on which is journaled, by means of an anti-friction bearing 83, a wobble member, indicated generally at 84. Said wobble member 84 comprises a central portion 85 and a plurality of circumferentially spaced, radially outwardly projecting lugs 86 each having approximately parallel opposite sides 87. Each of the lugs 86 defines a radially outwardly opening cross sectionally arcuate or generally cylindrical recess 88, the arcuate wall of which extends for more than 180° of circular arc, whereby the distance across the radially outermost portion of each recess is less than the maximum width or diameter thereof. The lugs 86, together with their respective recesses 88 are five in number, there being one for each of the pistons 56. The recesses 88 are so arranged that the axes thereof are tangent to a circle substantially concentric with the drive shaft 65. With reference to FIGURES 2 and 4, it will be seen that the outer ends of the lugs 86 are disposed in close proximity to the radially inwardly directed flat faces 59 of their respective piston end portions 58. Of the five recesses 88 in the lugs 86, four thereof have rotatably and axially slidably movable therein generally cylindrical wrist pins 89, each of said wrist pins 89 having a pair of flat sides 90 that are disposed in diametrically opposed parallel relationship to each other, and each of said wrist pins 89 having a central transverse opening 91, the axis of each opening 91 being normal to the flat sides 90 of its respective wrist pin 89. The distance between the flat sides 90 of each wrist pin 89 is slightly less than the distance across the radially outer portion of its respective recess 88, so that, if desired, the wrist pins may be inserted into their respective recesses 88 in a direction radially inwardly with respect to the wobble member 84. The transverse openings 91 in the wrist pins 89 are of a size to slidably and rotatably receive respective ones of the piston pins 60.

During operation of the pump, particularly when high pressures are involved, there is a slight tendency for the wobble member 84 to rotate with the drive shaft 62 in spite of the anti-friction bearing 83. This tendency toward rotation of the wobble member 84 causes the wrist pins 89 to move axially in their recesses 88. Any such axial movement on the part of the wrist pins 89 is transferred to their respective pistons 56 through their respective piston pins 60, to cause the pistons 56 to rotate on their cylinder axes and cause binding between their

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respective piston pins 60 in the transverse openings 91 of their cooperating wrist pins 89. Further, this situation tends to cause binding between each wrist pin 89 and the walls of its respective recess 88, and uneven wear on the cooperating surfaces of the recesses, wrist pins, and piston pins results. For the purpose of positively preventing rotation of the wobble member 84, the fifth wrist pin, indicated at 92, is provided with radially outwardly projecting flanges 93 at its opposite ends, said flanges 93 having opposed inner faces 94 which snugly but slidably engage adjacent sides 87 of the lug 86 the recess of which contains the wrist pin 92. Except for the end flanges 93, the wrist pin 92 is identical to those indicated at 89, having a pair of flat sides 94 which are disposed in diametrically opposed parallel to each other and which are spaced apart a distance slightly less than the width of its cooperating recess 88 at its radially outer portion so that the wrist pin 92 may be inserted into its cooperating recess 88. Like the wrist pins 89, the pin 92 is provided with a transverse opening 95 for reception of its respective piston pin 60. In practice, it has been found that but a single flanged wrist pin 92 is necessary to curb any tendency of the wobble member 84 to rotate, and binding and uneven wear of the pins is reduced to a minimum. By using generally cylindrical piston pins and wrist pins in the manner above described, we have been able to produce the necessary free running universal movement between the wobble member 84 and the pistons 86 with component parts that are easily machined in standard machine tools such as lathes, screw machines, milling machines and the like, and without the necessity of resorting to the ball and socket joints usually found in wobble plate operated structures, such ball and socket joints usually requiring highly specialized machining setups. It will be appreciated that the flat sides 90 and 94 of the wrist pins 89 and 92 respectively, adjacent the inner ends or bottoms of their respective recesses 88, provide passages for free movement of air to and from the radially inner ends of the openings 91 and 95 during movement of the piston pins 60 axially therein, and permit entry of lubricant to the bottoms of said recesses 88 and the inner ends of said openings 91 and 95. With this arrangement, generation of pressures different from atmospheric pressure, within the inner ends of the openings 91 and 95, is prevented.

Inasmuch as the pump, above described, is utilized to deliver fluid at high pressures, a relatively small portion of the fluid does escape between each piston 56 and its cooperating sealing ring 45 to its respective inner channel 48 during the pressure stroke of each piston. The channels 48 and 49, together with their connecting passages 50 communicating with the relatively low pressure inlet manifold chamber 22, fluid escaping outwardly past the sealing rings 45 is delivered back to the low pressure side of the pump. The sealing rings 46 are effective to prevent lubricant from escaping from the chamber 7 to the fluid return channels 48, due to the fact that the pressure within the chamber 7 is substantially atmospheric. The O-rings 47 between the channels 48 and the sealing rings 46 provide an effective seal against the fluid in the channels 48 from escaping to the chamber 7.

While we have shown and described a preferred embodiment of our pump structure, it will be understood that the same is capable of modification, and that modification may be made without departure from the spirit and scope of the invention as defined in the claims.

What we claim is:

1. In a fluid pressure apparatus including, a cylinder block, a piston mounted for reciprocatory movements in said cylinder block, and a shaft journaled for rotation in said block in spaced parallel relation to said piston and having a crank portion disposed at an oblique angle to the axis of rotation of said shaft; a wobble member, means journalling said wobble member on said crank portion, said wobble member defining a radially out-

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wardly opening generally cylindrical recess, the axis of said recess being tangent to a circle substantially concentric with said shaft, a generally cylindrical wrist pin journaled in said recess for oscillatory movements on the axis of said recess and having a transverse opening through its central portion, a piston pin extending through a transverse opening in said piston and said opening in the wrist pin and rotatable and axially slidable in one of said openings, and stop elements on said wrist pin and engaging spaced portions of said wobble member to positively hold said wrist pin against axial movement in said recess whereby to lock said wobble member against common rotation with said shaft, said stop elements comprising a pair of radially outwardly projecting circumferential flanges, one on each end of said wrist pin, said flanges each engaging an adjacent wall portion of said wobble member at an opposite end of said recess to limit axial movement of said wrist pin in a different direction.

2. In a fluid pressure apparatus including, a cylinder block, a central shaft journaled for rotation in said block and having a crank portion at one end disposed at an oblique angle to the axis of rotation of the shaft, and a plurality of circumferentially spaced pistons mounted for reciprocatory movement in said block in spaced parallel relation to said shaft; a wobble member, means journalling said wobble member on said crank portion of the shaft, said wobble member including a plurality of circumferentially spaced radially outwardly projecting lugs, said lugs each defining a radially outwardly opening generally cylindrical recess, the axes of said recesses being tangent to a circle substantially concentric with said shaft, a plurality of generally cylindrical wrist pins and each journaled in a different one of said recesses for oscillatory movements on the axis of its respective recess and each having a transverse opening through its central portion, a plurality of piston pins and each mounted on a different one of said pistons and each extending through the opening in a different one of said wrist pins and rotatable and axially slidable in said opening, and stop means on one of said wrist pins engaging opposite sides of its respective one of said lugs and positively holding said one of the wrist pins against axial movement in its respective lug, whereby said wobble member is held against common rotary movement with said shaft, said wrist pin having said stop means thereon being provided with a pair of flat sides which are disposed in diametrically opposed parallel relationship to each other, the distance between said flat sides being less than the diameter of the opposed arcuate surfaces between said flat sides and less than the distance across the radially outer portion of its respective recess in said wobble member, whereby to facilitate radially inward insertion of said wrist pin into the recess, the transverse opening in said wrist pin being normal to the flat sides thereof, whereby when the piston pin cooperating therewith is received in said opening, said wrist pin is held thereby against rotation to the extent sufficient to permit radially outward movement thereof from said recess, said stop means comprising circumferentially extended radial flanges on opposite ends of said wrist pin.

3. In a fluid pressure apparatus including, a cylinder block, a central shaft journaled for rotation in said block and having a crank portion at one end and disposed at an oblique angle to the axis of rotation of the shaft, and a plurality of circumferentially spaced pistons mounted for reciprocatory movement in said block in spaced parallel relation to said shaft; a wobble member, means journalling said wobble member on said crank portion of the shaft, said wobble member including a plurality of circumferentially spaced radially outwardly projecting lugs, said lugs each defining a radially outwardly opening recess having a generally cylindrical inner end, the diameter of said generally cylindrical inner ends being greater than the width of said recesses radially outwardly thereof and having axes tangent to a circle substantially concentric with said crank portion of the shaft, a plurality of gen-

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erally cylindrical wrist pins and each journaled in the generally cylindrical inner end portion of a different one of said recesses for oscillatory movements on the axis of its respective inner end recess portion and each having a pair of flat parallel sides in diametrically opposed relation to each other, the distance between said flat sides being less than the diameter of the opposed cylindrical surfaces between said flat sides and less than the width of its respective recess radially outwardly of the inner generally cylindrical end thereof, whereby each wrist pin may be inserted radially inwardly into its respective recess, each wrist pin defining a transverse opening through the central portion thereof on an axis normal to the flat sides thereof, a plurality of piston pins and each mounted on a different one of said pistons and each extending through the opening in a different one of said wrist pins when said wrist pins are received in the generally cylindrical inner end portions of their respective recesses to hold said wrist pins

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against rotation to the extent sufficient to permit radially outward movement thereof from said recesses, and means on one of said wrist pins holding said wobble member against common rotary movement with said shaft.

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