United States Patent [19]
Sadler

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[45] July 10, 1973

[54] **PISTON TYPE PUMP**

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[21] Appl. No.: 716,271

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 530,027, Feb. 25, 1966, abandoned.

[52] U.S. Cl. 417/536
[51] Int. Cl. F04b 21/04
[58] Field of Search 230/184, 185; 103/171, 172; 417/534–537

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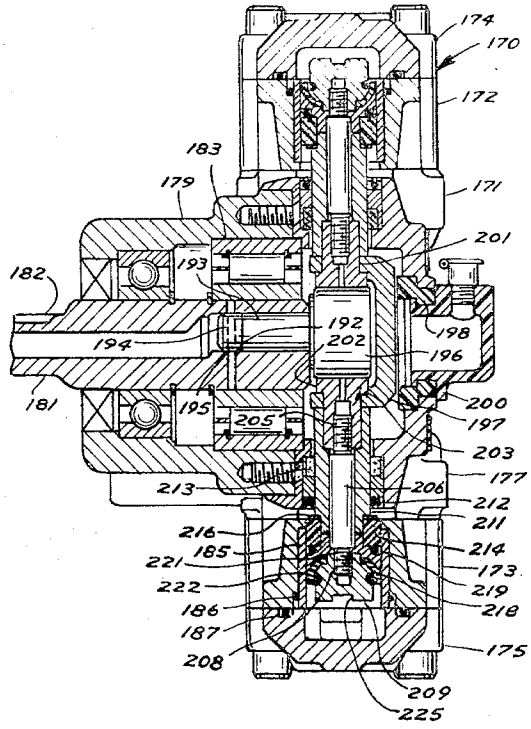
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[57] **ABSTRACT**

A positive displacement piston type pump having a drive housing portion and a pair of cylinder block housings secured to opposite faces of the drive housing, and a head secured over each of the cylinder block housings. Each cylinder block housing is provided with bores for forming a pumping cylinder, and also to retain the valves required for controlling the flow of fluids through the pump. The cylinder block housings therefore are provided with those individual components of the pump which are subject to the greatest wear, and therefore this arrangement enables a quick inter-change of components without requiring any substantial disassembly of the pump. Improved drive means are provided which enable the device to be operated under severe operating conditions, these components also being formed to provide ease of disassembly and servicing.

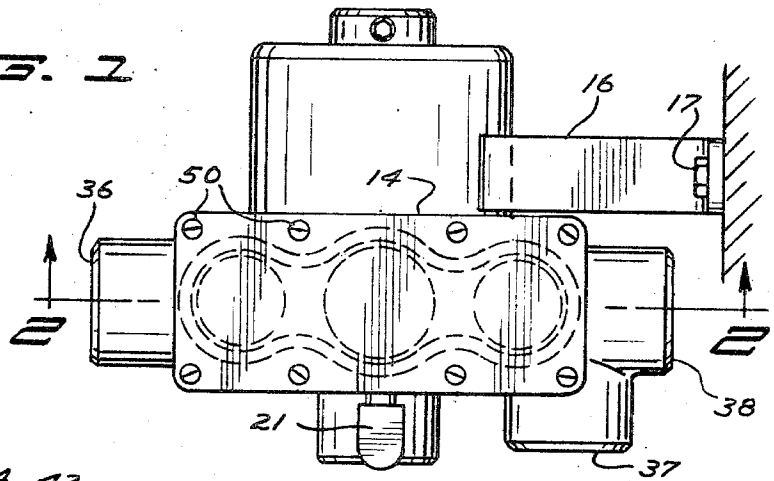
20 Claims, 10 Drawing Figures



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FIG. 1



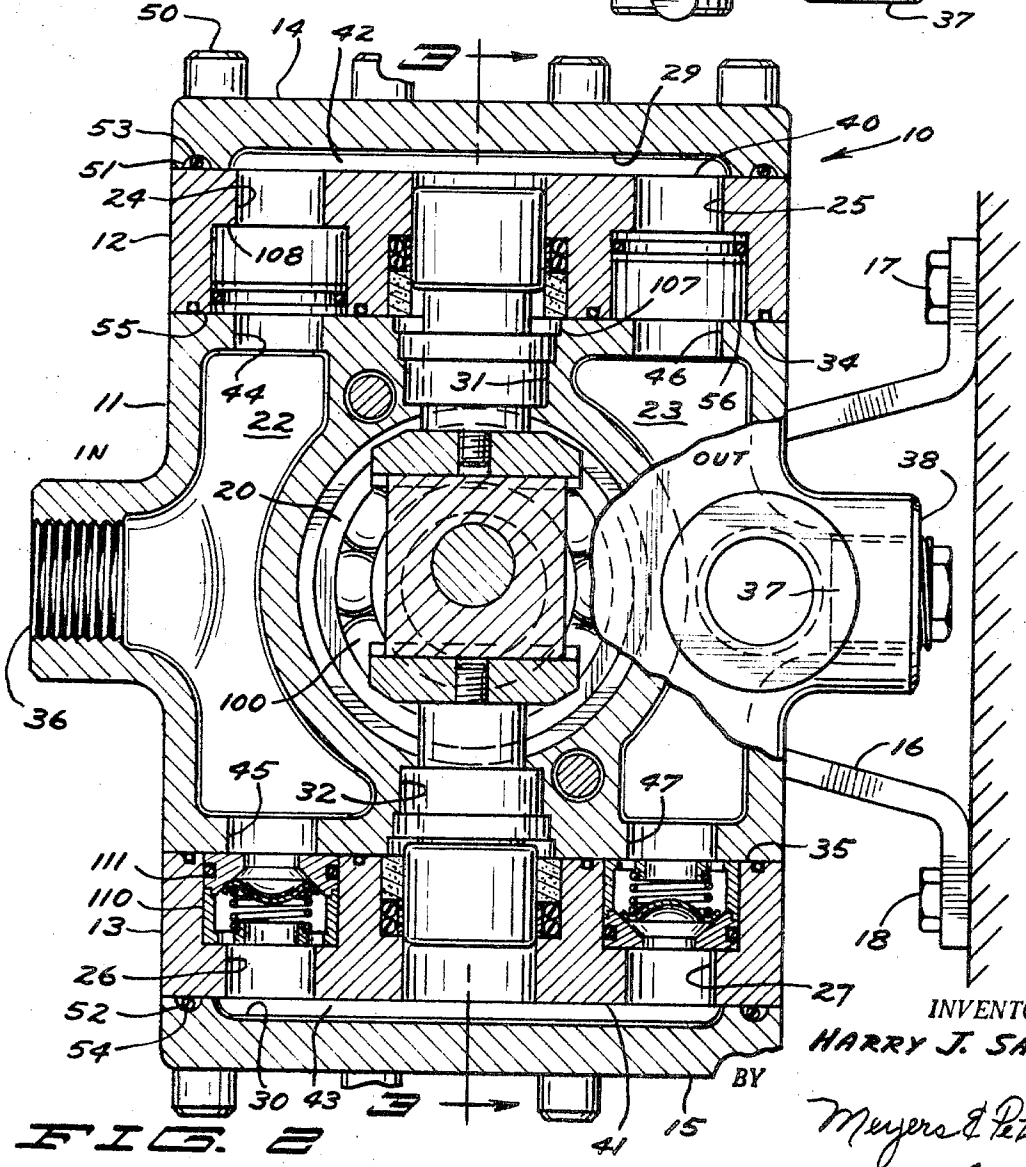


FIG. 2

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FIG. 3

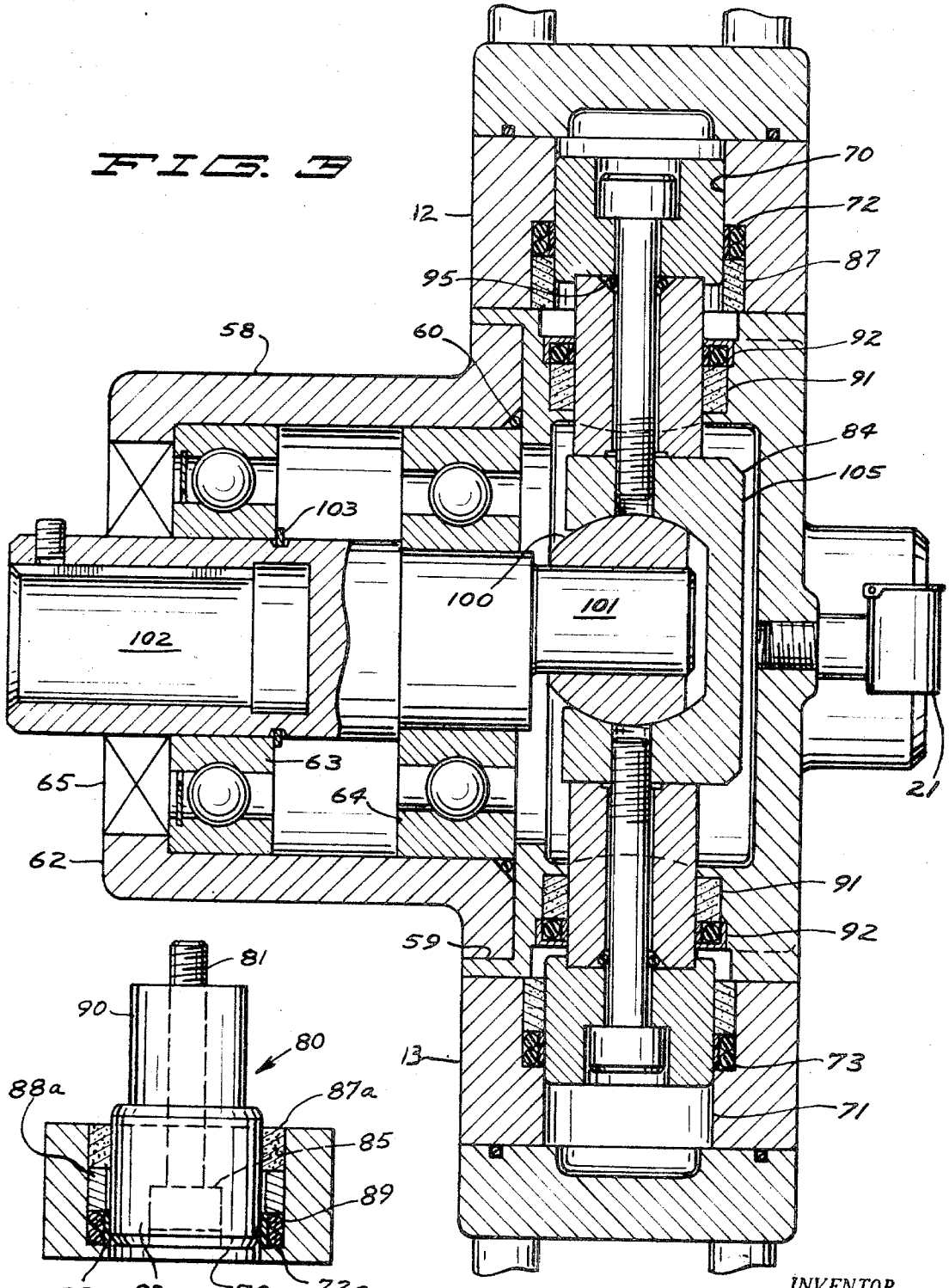


FIG. 4

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FIG. 5

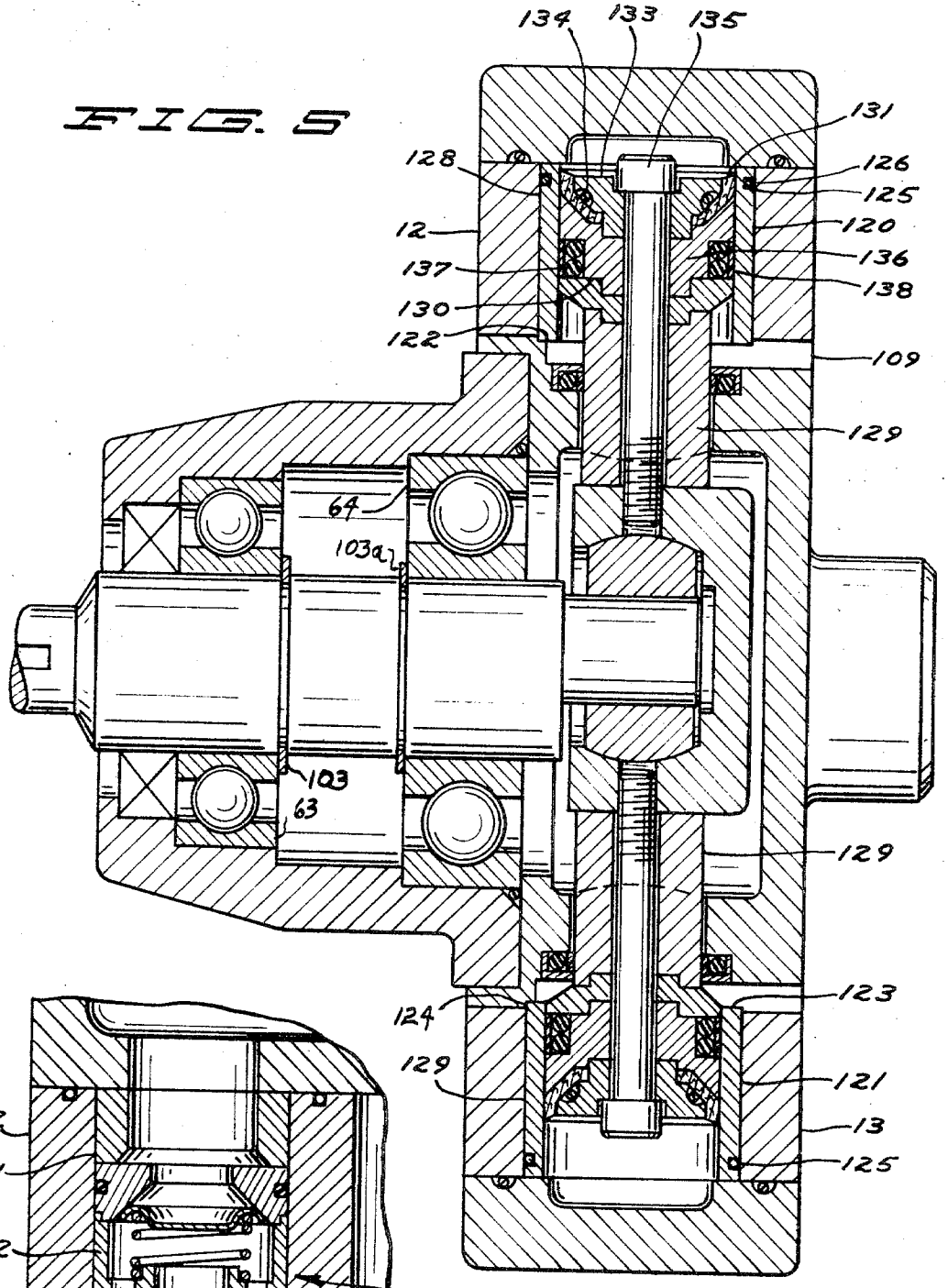


FIG. 6

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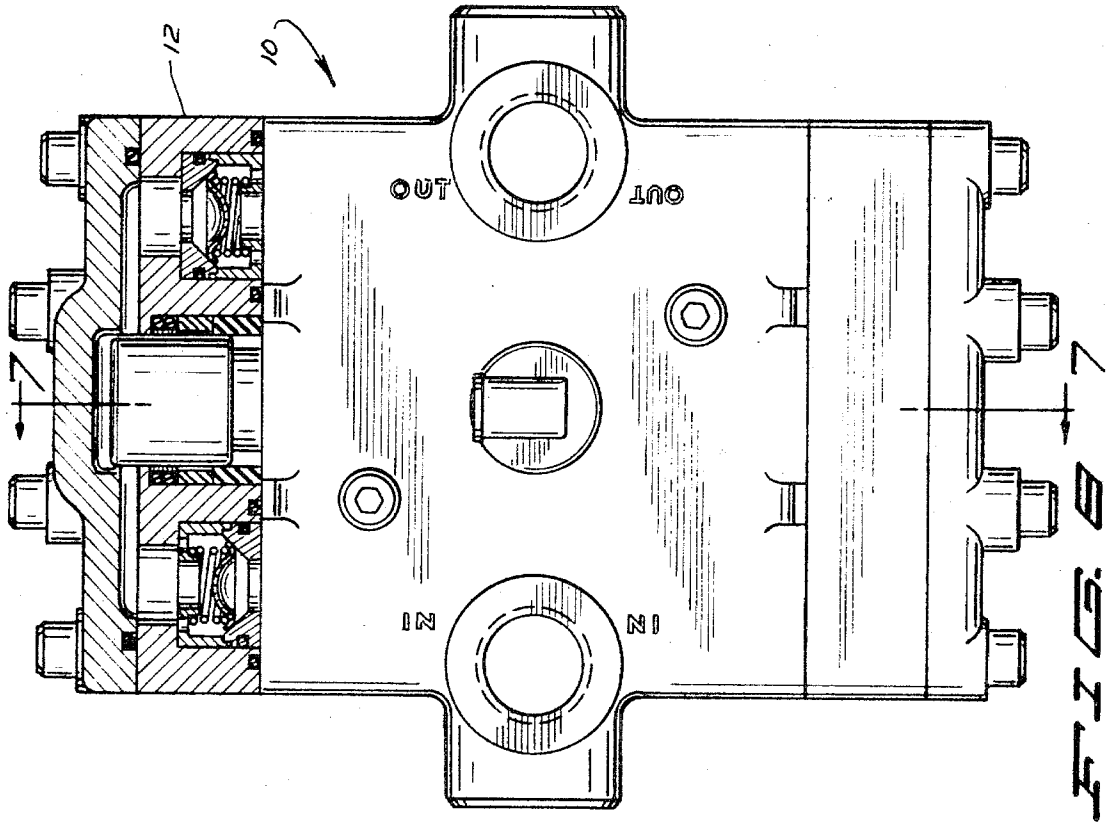


FIG. 6

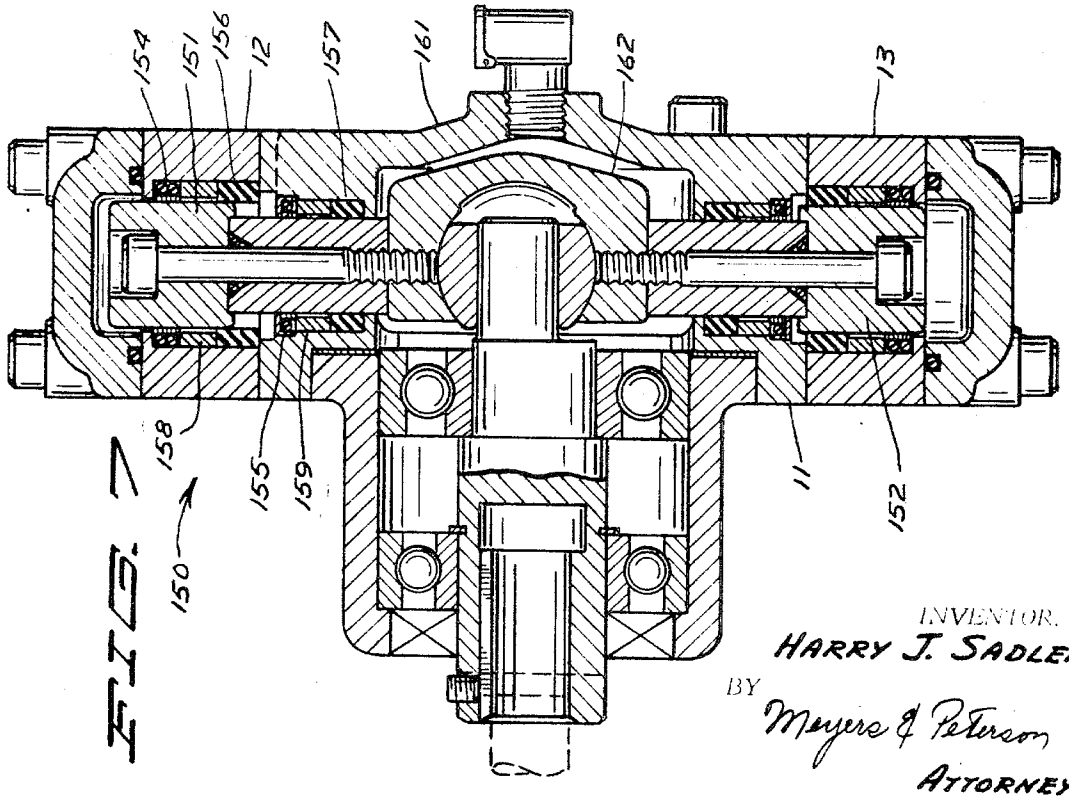


FIG. 7

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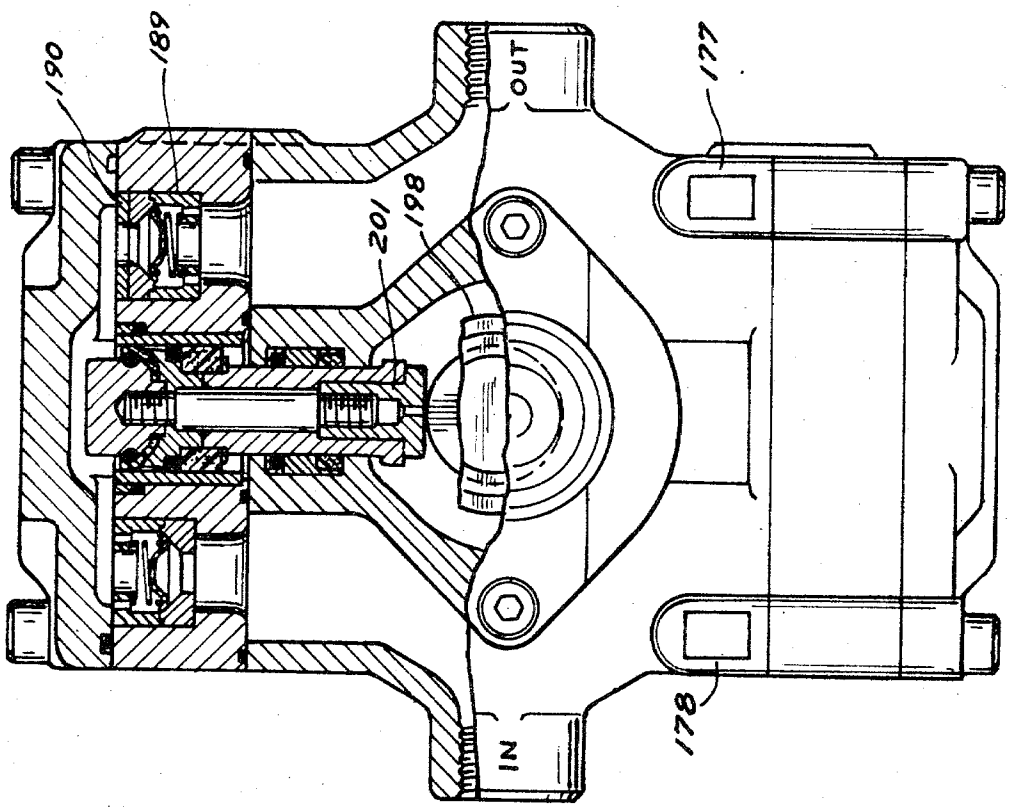


FIG. 10

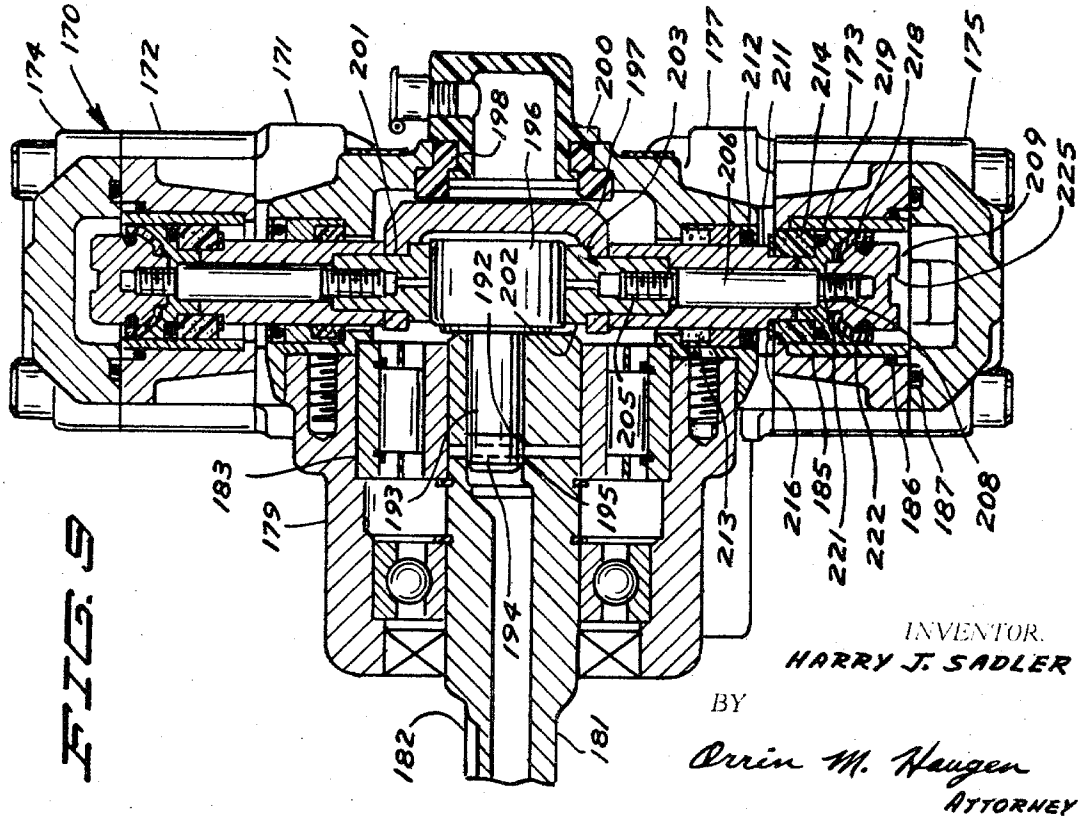


FIG. 9

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PISTON TYPE PUMP

This invention relates to pumps and more particularly to a pump of the piston type with positive displacement. The present application is a continuation-in-part of my co-pending application Ser. No. 530,027, now abandoned, filed Feb. 25, 1966, entitled "Piston Type Pump" and assigned to the same assignee as the present application, the prior co-pending application in turn having been an improvement over a certain application entitled "Piston Type Pump", Ser. No. 316,978, filed June 21, 1963, now U.S. Pat. No. 3,238,890.

The positive displacement piston type pump of the present invention is particularly adapted for use in a high-pressure, high-capacity application. The pump is capable of accomplishing this requirement while being light in weight and economical in construction. The structure of the pump includes a crankcase or drive housing portion, a pair of cylinder block housings secured to opposite faces of the drive housing and a head secured over each of the cylinder block housings. The cylinder block housing is provided with bores which either per se form or which are adapted to retain a pumping cylinder sleeve, and which are also adapted to retain the valves required for controlling the flow of fluid through the pump. The cylinder block housings therefore are provided with those individual parts of the pump which are subject to the greatest wear, and therefore this assembly arrangement enables a quick interchange of components without requiring any substantial disassembly of the pump. These features are accomplished without sacrificing the pressure, capacity, or efficiency of operation.

It is therefore a general object of the invention to provide a pump which is light in weight, economical in construction, readily servicable, and high in its efficiency of operation.

It is a further object of the present invention to provide a pump of the character described in which a dual piston arrangement is disposed substantially diametrically across a hollow body, and having an outer closed loop with a piston drive mechanism disposed therein and adapted for high-pressure operation, the drive mechanism being generally isolated from contact with the fluid being pumped.

It is yet a further object of the present invention to provide a pump structure having an improved arrangement for retaining valve and cylinder assemblies in place within the structure, which assemblies can be readily replaced or installed without requiring unusual tools, jigs, or the like.

It is yet a further object of the present invention to provide a pump structure which has a simple cast body, a pair of cylinder block assemblies for either forming per se or retaining a cylinder sleeve and for retaining the requisite valve assemblies, and a pair of cylinder heads which, when secured to the cylinder block assemblies retain the valves and cylinder sleeve parts in rigid and sealed relationship, this being accomplished without requiring internal fastening.

Another object of the invention is to provide an improved drive connection in one aspect of the invention for a high pressure pump which utilizes a drive means which can tolerate ordinary run-out errors on the drive shaft arrangement.

A still further object of the present invention is to provide a double-acting piston pump in which fluid flow passageways are arranged to provide smooth and efficient flow of fluid at a wide range of operating pressures.

Yet a further object of the present invention is to provide an improved stacking assembly or arrangement for the pistons employed in connection with the pump structure.

These and other objects and advantages of this invention will more fully appear in the following specification, made in connection with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIG. 1 is a top plan view of the pump and mounting assembly, and showing, in phantom, an outline of the valve and cylinder arrangement together with an outer sealing arrangement;

FIG. 2 is a vertical sectional view taken substantially along the lines and in the direction of the arrows 2—2 of FIG. 1, and showing the mounting arrangement in partially broken away form;

FIG. 3 is a vertical sectional view taken along the lines and in the direction of the arrows 3—3 of FIG. 2;

FIG. 4 is a detail sectional view of a piston and cylinder sleeve arrangement utilized in the apparatus shown in FIGS. 1–3;

FIG. 5 is a view similar to FIG. 2, and showing the details of construction of a somewhat modified form of pump;

FIG. 6 is a detail view of a somewhat modified form of cylinder arrangement construction, as contrasted to that form shown in the modification of FIG. 5;

FIG. 7 is a sectional view, preferably a vertical sectional view of a somewhat modified form of pump structure, this view being taken along the line and in the direction of the arrows 7—7 of FIG. 8;

FIG. 8 is an elevational view, partly in section, showing the arrangement of a cover-plate member, along with other features of a pump constructed in accordance with the features of the present invention;

FIG. 9 is a vertical sectional view of a modified form of pump prepared in accordance with the present invention, this view being taken along the line and in the direction of the arrows 9—9 of FIG. 10; and

FIG. 10 is a vertical sectional view of the structure shown in FIG. 9, this view being taken along the line and in the direction of the arrows 10—10 of FIG. 9.

With continued reference to the drawings and with particular attention directed to FIGS. 1 and 2, the pump housing is generally designated at 10, this housing comprising a central crankcase drive housing portion 11, and upper and lower cylinder block housings 12 and 13, with housing heads 14 and 15 being secured to and enclosing the cylinder block housing members. A mounting bracket 16 is provided for the pump housing 10, this bracket being provided with suitable holes for receiving the mounting bolts or screws 17 and 18. For convenience, as indicated in FIGS. 1 and 2, the hub or boss upon which the mounting bracket 16 is retained, may be received into the body of the pump at any of four positions, each being disposed 90° apart. This is possible since four symmetrical bolt holes are available for mounting purposes. The pump housing 10 is provided with a hollow closed loop passageway, this passageway surrounding the crankcase drive chamber shown at 20. The crankcase drive chamber 20 is sealed and provided with suitable lubricants for maintaining

the drive assembly in properly lubricated condition during use, an oil cup being shown at **21.**

The continuous passageway is made up of a plurality of individual segments or portions. The crankcase drive housing has a pair of laterally disposed segments or portions **22** and **23,** and each of the cylinder block housings or assemblies **12** and **13** have appropriately formed through-bores as at **24, 25, 26** and **27.** The heads **14** and **15** further define a continuation of the continuous passageway by means of the areas shown at **29** and **30** respectively.

The crankcase drive housing **11** has a central cylindrical bore formed therein, and including an upper segment **31** and a lower segment **32.** This cylindrical bore extends through the top surface **34** and the bottom surface **35.** In the form shown in the instant application, the bore portions **31** and **32** are formed along a single or common vertical axis which passes through the center of the medial crankcase drive chamber **20** within the closed loop housing. The bore portions **31** and **32** thus communicate between the endless passageway formed within the pump housing **10** and the crankcase drive chamber **20.**

The portion of the laterally disposed passageway shown at **22, 24** and **26** constitute the inlet passageway to the pump housing **10.** An internally threaded port **36** provides the inlet port to the pump housing. In a similar manner the laterally disposed portions of the endless passageway shown at **23, 25** and **27** constitute the outlet portion of the endless passageway, and a pair of internally threaded communicating ports **37** and **38** are provided as the outlet ports from the pump housing **10.** Each of the laterally disposed portions of the passageway as previously indicated, terminates at the outer surfaces of the oppositely disposed cylinder block assemblies, as at **40** and **41** in transverse portions **42** and **43** respectively. The passageway portion **22** terminates in a pair of ports **44** and **45,** these ports being of a certain predetermined diameter, which is somewhat less than the diameter of the bore portions **24** and **26** adjacent thereto. Similarly, the passageway portion **23** terminates in a pair of openings **46** and **47,** these openings likewise being of a diameter which is less than the adjacent extensions in the cylinder heads as at **25** and **27.**

The housing heads **14** and **15** are secured to the pump housing assembly, preferably to the crankcase drive housing by means of the cap screws **50—50** as shown in FIG. **1,** one or more of these screws being offset in order to aid in orientation of the cover. A continuous groove may be formed in these heads as at **51** and **52** to receive a continuous sealing gasket as at **53** and **54.** It will be observed that a lug portion **55** of the surface adjacent port **44** and lug portion **56** of the surface adjacent port **46** extends marginally over the passageway openings **24, 25, 26** and **27** for a purpose to be subsequently disclosed. It will be appreciated that the lower passageways are provided with similar marginal lug portions.

With specific attention being directed to FIG. **3** of the drawings, it will be observed that a large boss **58** is provided in sealed relationship to the pump housing **10** and particularly with the crankcase drive housing **11.** A boss receiving bore is formed in the drive housing **11,** such as at **59,** and while any suitable gasket may be used, an "O" ring seal is preferably interposed between the boss **58** and the inner surface of the recessed area **59,** such as at **60.** The boss **58** is provided with a shoulder at **62** in order to locate the ball bearing assemblies **63** and **64,** this opening being sealed by a suitable seal member **65.**

At the upper and lower cylinder head assemblies **12** and **13,** there is provided a cylinder bore or cavity such as is shown at **70** and **71** in FIG. **3.** The bores **70** and **71** have a shouldered abutment portion **72** and **73,** for example.

A piston assembly **80** has a connecting rod **81** and a piston **82** disposed at one end thereof as shown in FIG. **4.** The cylinder bores **70** and **71** are preferably diametrically opposed as in the instant disclosure and identical piston assemblies **80** are disposed in bores **70** and **71.** The individual connecting rods **81** may be received in the cap or cross-head member **84** as shown in FIG. **3.** A rod head receiving counterbore ares **85** is formed on the outer surface of each of the pistons. Adjacent to the shouldered portion, such as at **72,** a guide and seal assembly are disposed. The guide and seal assembly includes a carbon guide ring member **87** and a second seal ring member **88,** ring member **88** being held snugly against the surface of piston **82** by means of a pair of "O" rings **89,** as indicated. The ring member **88** is preferably fabricated from a tough low friction material such as polytetrafluorethylene, which material may be molded to the form, as required. Polytetrafluorethylene is available commercially under the code name "Teflon".

To the rear of the piston **82,** and along the connecting rod **81,** an annular drive guide member **90** is disposed. The guide member **90** is suitably retained within the drive housing **11** by means of a carbon guide **91** and a suitable seal element **92.** The seal **92** is of similar construction to the ring **88,** and is normally of the type which will be self-retaining in the appropriate seat area within the bores **31** and **32.** In order to prevent seepage of the pumped fluid into the crankcase area, a suitable seal ring is provided at **95** between the connecting rod **81** and the annular member **92.**

The drive arrangement, as indicated, includes the cap **84** which receives the drive bearing **100** therein. As indicated, the member **100** is received on the eccentric crank pin **101,** which extends from the main drive shaft **102.** As indicated, the drive shaft **102** is journaled for rotation within the bearing members **63** and **64,** as previously described. Also, if desired, snap ring members are provided at **103,** for example to locate and prevent the movement of bearing **63.** (Snap ring **103a** may be utilized for similar purposes with bearing **64** as shown in FIG. **5,** for example.) The outer surface of the bearing **100** and the inner surface of the cap **84** are formed in a matching arcuately extending contour, which is convex and concave in axial cross-section respectively. Preferably, the origin of the arc lies along the axis of the eccentric pin **101.** Therefore, any ordinary distortions, misalignments, or run-out from the shaft **102** may be readily taken up in this drive arrangement, thus enabling the pump to operate at high efficiency under extremely high pressure conditions. A suitable lubricant may be provided in the chamber or crankcase area as at **105,** the lubricant being added through the oil cup **21** as illustrated. It will be appreciated, therefore, that the high efficiency and high pressure capabilities of the assembly are made possible, at least in part, by the arrangement of the piston drive assembly.

Ease of repair is made possible by the arrangement of the cylinders and valves in the upper and lower cylin-

der block assemblies 12 and 13. In this connection, each of the cylinders and valves is formed so as to extend between the opposed surfaces of the cylinder block assemblies or between an internal abutment and one such surface for the valves. The upper and lower portions of the drive housing 11 provides areas such as at 55, for retaining the piston guides in place. As indicated, the opposite ends of the valves are in abutment with the opposed outer surfaces of the drive housing 11 adjacent the ports 44, 45, 46 and 47 and the inner shoulders of the bores 24, 25, 26 and 27 as at 108, for example. In order to resist the tendency of leaking fluid to flow into the crankcase housing 105, a vent opening may be provided which communicates between the area adjacent the juncture of the drive housing 11 and the cylinder block assemblies 12 and 13 such as shown at 109 in FIG. 5. Thus, any leakage will be permitted to pass directly to the atmosphere without contaminating the lubricant retained within the crankcase 105.

The arrangement of the individual valves is similar to the structure of the valves shown in the aforementioned U. S. Pat. No. 3,238,890. With particular attention being directed to FIG. 2, it will be seen that each individual valve assembly is sealed from the environment with sealing rings disposed in grooves, as at 111 circumscribing the valve assemblies therein, each of the annular grooves 111 being provided with a suitable O-ring for effecting a seal against the abutting surface.

In the operation of the pump, the fluid to be pumped enters the inlet 36 and when the shaft 102 is rotated, the piston assembly 80 will be reciprocated to cause alternate flow of fluid into the respective cylinder sleeves 70 and 71, and ejection thereof when the piston assembly reverses its direction. The fluid is discharged from the pump through the outlet 37 and 38, this occurring for each half-revolution of the shaft 102. Since the roller member 100 has a convex bearing surface, it is not essential that the cap member 84 be machined to a high degree of accuracy. Slight misalignment will be automatically compensated for by the character of the contacting surfaces. Also, the applied stress is uniformly distributed over a broad area, and there is no danger of acquiring only point or line contact under any normal operating conditions. Since the crankcase area 105 is effectively isolated from the individual passageways and pumping cylinders, and since a venting arrangement may be provided, there is no risk of material leaking from the pump and into the drive parts. The surface of the drive mechanism may be lubricated upon each revolution by immersion in the lubricant in the crankcase.

The arrangement shown in the pump illustrated in FIGS. 1–4 permits the use of materials having a composition which will be compatible with the fluid being pumped. For example, corrosive or abrasive materials may be pumped in this system, suitable materials of construction being employed. In addition, it will be observed that the pumping piston is essentially free of moving parts or flexing seals, and thus the drive is enhanced when difficult-to-handle materials are being pumped. In this regard, it will also be observed that the entire pumping piston may be fabricated from a material which is resistant to wear, and accordingly any degree of hardness may be employed for the materials of construction for the piston per se.

As a further advantage of this structure, it will be observed that the central cylinder block members may be fabricated using powdered metallurgical operations. This capability will obviously render the cost of the part substantially less than the cost of the part which must be carefully machined.

Turning now to the structures shown in FIGS. 5 and 6, it will be observed that the structure is somewhat different from that of the modification shown in FIGS. 1–4, particularly in the arrangement of the cylinder bore and the valve structure. At the upper and lower cylinder block assemblies 12 and 13, there is provided a cylinder sleeve such as is shown at 120 and 121. The sleeves 120 and 121 have a shouldered abutment with the opposed surfaces 122 and 123 of the drive housing, the outer terminal edge of the sleeves being received in a recessed groove area as at 124, for example. A groove 125 is formed annularly around each of the sleeves 120 and 121, and a seal such as "O" ring 126 is positioned therein for making a pressure-tight connection between the sleeves 120 and 121 and the bores 128 and 129 formed within the cylinder block assemblies 12 and 13 respectively. As indicated in detail in FIGS. 5 and 6, the individual sleeve members 120 and 121 may be provided with skirt extensions which project slightly into the drive housing, such as at 123 as previously indicated.

The drive arrangement for the individual pistons in FIG. 5 are the same as that which has previously been indicated in the apparatus in the modification shown in FIGS. 1–4, it being noted that the annular drive members 129—129 are formed at their free ends to receive the piston assemblies therein. A piston backing plate 130 is in position at the free end of each of the annular drive members 129—129, and a piston cup 131 is in turn positioned upon the backing plate. A piston cup spreader 133 is then placed over the piston cup 131 and the spreader 133 is provided with a circumferential groove and O-ring cup spreader 134 as shown. The head portion 135 of the connecting rod is used to retain the piston assembly in its desired configuration, the opposite end of the rod being threadably received within the cap member 84. A groove 136 is formed in the forward portion of the backing plate 130, this groove being adapted to receive the O-rings 137 therein. A Teflon guide ring is provided at 138 in order to enhance the operational qualities of the piston assembly. The members 129 are provided between the cap 84 and the backing plate 130 in order to aid the axial position of the piston assembly, the piston assembly being received in the member 129 along a recess area. Suitable seals are provided at 92 in order to prevent the flow of pumped fluid into the crankcase area. If desired, the guide arrangement as shown in FIG. 3, that is, the carbon guides 87, may be suitably employed in connection with guiding both the piston assembly or the member 129 in its motion within the apparatus. Therefore, it will be appreciated that the seal area along the driving mechanism may be provided with suitable spacers between the seal member per se and the relatively hard guide member.

The valve arrangement shown at 140 in FIG. 6 is identical in each respect to the valve arrangement shown in FIG. 2, it being observed that the valve member 140 has a body portion which is formed in two segments 141 and 142, which segments extend from one surface to the other, along the entire thickness of the cylinder block members 12 and 13, block 13 being selected in the view of FIG. 6.

Particular attention is now directed to FIGS. 7 and 8 of the drawings wherein a somewhat modified version of the pump is shown. While essentially, the modification has the characteristics and structural features previously presented, there are some differences in structure which may be of importance in the concepts involved. The pumping system generally designated **150** utilizes a pair of opposed pistons **151** and **152** which are operated in the manner previously discussed in connection with the apparatus of FIGS. **1–6.** The guide, seal, and cover arrangements are somewhat different, however. As previously indicated, seals are provided at **154** and **155,** the former being the piston area, the latter being in the drive or guide area. A carbon guide for the piston is shown at **156,** and a corresponding guide for the backing member is shown at **157.** Spacers are employed at **158** and **159** in order to separate the seal area from the guide area. In this concept, it is possible to separate wear portions caused by contact with the guides **156** and **157** from encountering the surfaces of the seal areas **154** and **155.**

In another feature, it is noticed that the cap or cover member is recessed, thus permitting the piston elements **151** and **152** to actually enter into the cover area or chamber. This arrangement provides for a shorter overall pump dimension, without otherwise affecting the operation of the unit.

Particular attention is now directed to the central drive portion of the pump, particularly at **161,** wherein a blister effect is shown in the cover member. The blister effect is to permit the ultimate rotation of the eccentric cross-head bearing **100** about its central axis by 90° while being actually physically removed from the assembly. Thus, by merely separating the boss from the crankcase member, it is possible to rotate this cross-head member **100** about its axis by an arcuate distance of 90° and thereby remove it physically from the assembly. This is accomplished without unusually disturbing the arrangement of the driving member secured to the eccentric portion of the drive shaft. Thus, the eccentric bearing **100** may be quickly removed from the body.

With attention now being directed to the modification illustrated in FIGS. **9** and **10,** it will be observed that the pump structure generally designated **170** is provided with a central crankcase drive housing portion **171,** and upper and lower cylinder block housings **172** and **173** with housing heads **174** and **175** being secured to and enclosing the cylinder block housings. This structure is essentially the same as that shown in the embodiment of FIGS. **1** and **2,** with the possible exception of the provision of a pair of clamping lugs such as at **177** and **178,** these lugs permitting clamping pressure to be applied against the central crankcase drive housing portion whenever servicing is indicated.

As is conventional in pumps of this type, a large boss **179** is provided which is designed to be received in sealed relationship to the pump housing **170,** and particularly in such relationship with the crankcase drive housing **171.** As is indicated, a boss receiving bore is formed in the crankcase drive housing **171,** in a manner similar to that provided in the apparatus shown in FIGS. **1** and **2.** The boss **179** is adapted to receive the drive shaft **181** in sealed relationship therewith, the drive shaft being provided with a keyway **182** for imparting rotational motion from a drive source to the shaft **181.** The bearing assemblies utilized in this assembly for the drive shaft **181** are substantially similar in all respects to those bearing assemblies utilized in connection with the previous embodiments disclosed, with the possible exception, however, of a roller bearing member **183** being utilized along the inner portion of the shaft **181.** For best results, the bearing member **183** is open-ended, in order to permit lubricant to freely flow on both sides of that bearing.

The arrangement of the various passageways, the valves disposed therein, and other basic features of the housing members are substantially similar to those shown in the embodiments of FIGS. **1–9,** and no further detailed explanation is believed necessary here. In this regard, the modification illustrated in FIGS. **9** and **10** utilizes a sleeve insert member **185** for the pumping cylinders, which member is held in place by a sealing ring **186** and a locking ring **187.** Another feature is illustrated in FIG. **10** of the drawings wherein the outlet valve member **189** is provided with a polarizing disc or washer member **190** to assist the individual servicing the equipment to perform a proper re-assembly.

The drive mechanism is illustrated in detail in FIG. **9.** The shaft **181** is provided with an eccentric bore as at **192** for receiving drive pin **193.** Pin **193** is provided with a diametrical bore **194** to accommodate locking pin member **195** therein, pin **195** being provided to retain the member **193** in desired axial disposition. The free end of pin **193** is received within the interior confines of the drive bearing **196,** bearing **196** preferably being, for purposes of handling heavy loads, a needle or roller bearing. A yoke **197** is provided in generally circumscribed relationship about the exterior of bearing member **196.** Thus, for purposes of operation, bearing **196** operates as a cam roller bearing driving the individual cylinder stacks in their reciprocatory up-and-down motion.

Since this unit is capable of operating at sustained high pressures, a low friction face bearing or abutment member **198** is provided for guiding and retaining the yoke **197.** Although metals such as steel or brass may be used, abutment member **198** is preferably fabricated from nylon or molded polytetrafluorethylene and is disposed in close tolerance to the outer face of yoke **197** and has an abutment surface disposed along the path generated by the eccentric path of the periphery of cam bearing **196.** Thus, controlled disposition of the yoke **197** is possible, and there is accordingly a substantial elimination of any tendency of the yoke **197** to wander during its reciprocatory motion. Abutment plate **198** is preferably in the form of a ring, thereby proving a maximum contact surface for the face of yoke **197.** Appropriate seals **200** are placed adjacent the abutment member **198** to retain lubricant and seal the crankcase from the atmosphere.

Turning now to a discussion of the arrangement of the stack comprising the pumping cylinders, a cam follower member **201** is provided having a face with a hexagonal configuration as at **202** in order to appropriately lock the arrangement within the confines of the yoke **197,** particularly as at **203.** The cam follower **201** may be fabricated from any desirable wear-resistant material, compatible with the outer surface of the outer race of the cam roller bearing **196.** Cam follower **201** is provided with an internal bore as at **205** in order to threadably receive the threaded stack carrying member **206.** Stack carrying member **206** terminates in a threaded portion **208,** which is ultimately received in the threaded bore formed in the piston head member **209.**

The stack further comprises a spacer sleeve member 211 which is disposed at its inner end in contact with the outer surface of yoke 197. A counterbore formed within sleeve 211 is adapted to receive the cam follower 201, as indicated. Seals 212 and guides 213 are provided between the inner surface of the bore formed in the crankcase portion 171, as indicated, the seal and the guide appropriately contacting the outer surface of sleeve 211. A second guide 214 is provided at the outer end of sleeve 211, preferably adjacent the washer pad 216, pad 216 being arranged and retained along the axis of sleeve 211. Disposed axially outwardly of guide 214 is a ring of molded polytetrafluorethylene such as at 218, this ring being held in expanded disposition by the inwardly disposed "O" ring 219. This portion of the assembly is held radially outwardly from the expander member 221, which expander member receives an expandable piston cup member 222 in operative relationship with the outer portion thereof. Examples of similar piston cup assemblies and cup backing assemblies are illustrated in U. S. Pat. No. 3,343,844, John Leschisin, which patent is assigned to the assignee of the present invention.

As previously indicated, the piston stack terminates in a head member 209. Head 209 is slotted as at 225 in order to permit ease of disassembly or assembly of the piston stack.

In its operation, this improved stacking assembly, particularly when utilized in combination with a centrally disposed driving yoke, which yoke is arranged in its proper axial disposition by a low friction abutment member, extended periods of operation at high pressures, high capacities, and the like may be undertaken. The device may appropriately be utilized under a variety of operating conditions without risk or danger of mechanical failure.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. A piston type pump comprising:

a. a crankcase drive housing portion having a pair of opposed flat surfaces, a cylindrical bore extending through said drive housing portion and communicating with the medial open portion of said drive housing, said medial open portion constituting a lateral drive receiving enlargement disposed at an intermediate portion of said bore, at least two laterally disposed passageways each extending through said opposed flat surfaces disposed on opposite sides of said cylindrical bore, an inlet port communicating with one of said passageways and an outlet port communicating with the other of said passageways, each of said passageways having a certain predetermined diameter at said opposed flat surfaces;

b. at least two cylinder block housings each having inner and outer opposed flat surfaces secured to said drive housing along opposed surfaces of said drive housing, each of said cylinder block housings having a cylindrical extension bore disposed coaxially with the cylindrical bore formed in said drive housing and with a diameter at least equal to the diameter of said cylindrical bore, a piston received in each of said cylindrical extension bores, a reciprocating drive means coupled to each of said pistons, a pair of substantially laterally disposed extension passageways extending through each of said cylinder block housings, each extension passageway having a drive housing abutting portion disposed in continuation with and communicating with one of the laterally disposed passageways of said drive housing, an inlet valve assembly inserted in one of said extension passageways within each cylinder block housing, and an outlet valve assembly inserted in the other of said extension passageways within each cylinder block housing;

c. a housing head secured over the cylinder bore and each of said laterally disposed extension passageways along the outer flat surface of the cylinder block housing, each housing head having a flat forward area along and adjacent portions of the periphery thereof and a rearwardly recessed area inscribed within said flat forward area and providing communication between said pair of passageways and said cylindrical bore; and

d. each laterally disposed extension passageway having a counter-bore portion with shoulders abutting said inlet and outlet valve assemblies at marginal portions thereof whereby said counter-bore shoulders and one cylinder block contacting surface selected from said opposed flat surface and said flat forward area cooperate to hold the valve assemblies in their inserted positions within said cylinder block housing without additional fastening means.

2. The structure set forth in claim 1 wherein each of said valve assemblies includes a resilient ring extending about its periphery for effecting a seal with its particular passageway.

3. The structure set forth in claim 1 in which said valve assemblies are each constructed of two outer parts interfitted to provide a unit, one of said parts having a valve seat, and said unit further including a spring biased poppet engageable with said seat.

4. The structure as set forth in claim 1 being particularly characterized in that said drive means comprises a drive shaft journaled for rotation within said housing, an eccentric crank pin projecting from the end of said shaft, roller means on said crank pin, a cross-head yoke member having an inner surface circumscribing said roller and having connecting rods removably coupling said cross-head yoke member to each of said pistons, the outer surface of said roller and the inner surface of said cross-head yoke member having substantially matching arcuately formed contours, the contours being convex and concave respectively in axial cross section.

5. The structure of claim 1 being particularly characterized in that seal means are provided along the mating opposed surfaces between said drive block and said cylinder block about the periphery of each of said laterally disposed passageways.

6. The structure as set forth in claim 1 being particularly characterized in that guide means are provided within said drive housing portion for guiding the reciprocatory action of said pistons.

7. A piston type pump comprising:

a. a housing defining a closed loop and having an endless passageway formed therein, said closed loop surrounding an inner crankcase cavity, an inlet communicating with said endless passageway, an outlet spaced from said inlet and also communi-

cating with said endless passageway, a pair of open-end cylinders lying mutually in spaced relation between said inlet and said outlet, each communicating with said endless passageway and with said inner open space, said cylinders being substantially diametrically opposed, a piston reciprocably positioned in each of said cylinders; and

b. a drive shaft journaled for rotation within said housing, an eccentric crank portion along said shaft, self-aligning drive bearing means on said crank portion, a cross-head having an inner surface circumscribing a substantial portion of the periphery of said self-aligning drive bearing means with an open segment along one surface thereof to receive said drive bearing means and having connecting rods coupling said cross-head to each of said pistons, the outer surface of said self-aligning drive bearing means and the portions of the inner surface of said cross-head directed generally toward said cylinders having substantially matching arcuately formed contours, the said contours being convex and concave respectively in axial cross section, and a recessed zone formed along the closed yoke portion of said inner surface for receiving said drive bearing means while at an angular disposition shifted an arcuate distance of 90° from its normal position.

8. The piston type pump as defined in claim **1** being particularly characterized in that each of said pistons is coupled to said reciprocating drive means by a cam follower means, a centrally disposed drive yoke coupling said cam follower means, one to another, and a central shaft disposed coaxially with said pistons and cam follower means for threadably coupling each of said pistons to its associated cam follower means.

9. A piston type pump comprising:

a. a housing defining a closed loop and having an endless passageway formed therein, said closed loop surrounding an inner crankcase cavity, an inlet communicating with said endless passageway, an outlet spaced from said inlet and also communicating with said endless passageway, a pair of open-end cylinders lying mutually in spaced relation between said inlet and said outlet, each communicating with said endless passageway and with said inner open space, said cylinders being substantially diametrically opposed, a piston reciprocably positioned in each of said cylinders;

b. a drive shaft journaled for rotation within said housing, an eccentric crank portion along said shaft; and

c. means including resilient seal means and relatively rigid guide means disposed within said cylinders to contact the surface of said pistons for isolating said pistons within each of said cylinders, said means further including spacers between said seal means and said guide means, the axial length of said spacers being in excess of the length of the reciprocable stroke provided said pistons by said eccentric crank portion.

10. A piston type pump comprising:

a. a housing defining a closed loop and having an endless passageway formed therein, said closed loop surrounding an inner crankcase cavity, an inlet communicating with said endless passageway, an outlet spaced from said inlet and also communicating with said endless passageway, a pair of open-end cylinders lying mutually in spaced relation between said inlet and said outlet, each communicating with said endless passageway and with said inner open space, said cylinders being substantially diametrically opposed, a piston reciprocably positioned in each of said cylinders;

b. a drive shaft journaled for rotation within said housing and terminating in an eccentric drive cam means with a drive surface, cam follower means having means coupling to each of said pistons, and a coupling yoke with an axis generally transverse to the axis of said drive shaft and having an inner surface disposed adjacent said drive cam and an outer surface, the yoke being arranged generally axially outwardly of said drive shaft and being coupled to each of said cam follower means; low friction abutment ring means having a central ring axis which is generally parallel to the axis of said drive shaft arranged immediately adjacent the outer surface of said yoke for controlling the axial disposition of said yoke during reciprocation thereof, said low friction abutment ring means having an annular abutment surface arranged generally parallel to the axis of said coupling yoke, said abutment surface being generally commensurate with the pattern generated by the drive surface of the eccentric drive cam means.

11. The piston type pump as defined in claim **10** being particularly characterized in that said low friction abutment ring means is fabricated from a composition selected from the group consisting of nylon and molded polytetrafluorethylene.

12. A piston type pump comprising:

a. a crankcase drive housing portion having a pair of opposed flat surfaces, a cylindrical bore extending through said drive housing portion and communicating with the medial open portion of said drive housing, said medial open portion constituting a lateral drive receiving enlargement disposed at an intermediate portion of said bore, at least two laterally disposed passageways each extending through said opposed flat surfaces disposed on opposite sides of said cylindrical bore, an inlet port communicating with one of said passageways and an outlet port communicating with the other of said passageways, each of said passageways having a certain predetermined diameter at said opposed flat surfaces;

b. at least two cylinder block housings each having inner and outer opposed flat surfaces secured to said drive housing along the opposed surfaces of said drive housing, each of said cylinder block housings having a cylindrical extension bore disposed coaxially with the cylindrical bore formed in said drive housing with a diameter at least equal to the diameter of said cylindrical bore, a piston received in each of said cylindrical extension bores, reciprocating drive means coupled to each of said pistons, a pair of substantially laterally disposed extension passageways extending through each of said cylinder block housings, each extension passageway having a drive housing abutting portion disposed in continuation with and communicating with one of the laterally disposed passageways of said drive housing, an inlet valve assembly inserted in one of said extension passageways within each cylinder block housing, and an outlet valve assem-

bly inserted in the other of said extension passageways within each cylinder block housing;

c. a housing head secured over the cylinder bore and each of said laterally disposed extension passageways along the outer flat surface of the cylinder block housing, each housing head having a flat forward area along and adjacent portions of the periphery thereof and a rearwardly recessed area inscribed within said flat forward area and providing communication between said pair of passageways and said cylindrical bore;

d. each laterally disposed extension passageway having a portion abutting said inlet and outlet valve assemblies at marginal portions thereof whereby to hold the valve assemblies in their inserted positions within said cylinder block housing without additional fastening means; and

e. said drive means comprising a drive shaft journaled for rotation within said housing, an eccentric crank pin projecting from the end of said shaft, roller means on said crank pin, a cross-head yoke member having an inner surface circumscribing said roller and having connecting rods removably coupling said cross-head yoke member to each of said pistons, the outer surface of said roller and the inner surface of said cross-head yoke member having substantially matching arcuately formed contours, the contours being convex and concave respectively in axial cross section, each arcuately formed contour having a substantially common origin disposed along the axis of said crank pin and a recessed zone formed along the closed axially extending face of said yoke member for receiving said roller means within said yoke with said roller means disposed at an arcuate distance of 90° from its normal driving position.

13. A piston type pump comprising:

a. a crankcase drive housing portion having a pair of opposed flat surfaces, a cylindrical bore extending through said drive housing portion and communicating with the medial open portion of said drive housing, said medial open portion constituting a lateral drive receiving enlargement disposed at an intermediate portion of said bore, at least two laterally disposed passageways each extending through said opposed flat surfaces disposed on opposite sides of said cylindrical bore, an inlet port communicating with one of said passageways and an outlet port communicating with the other of said passageways, each of said passageways having a certain predetermined diameter at said opposed flat surfaces;

b. at least two cylinder block housings each having inner and outer opposed flat surfaces secured to said drive housing along the opposed surfaces of said drive housing, each of said cylinder block housings having a cylindrical extension bore disposed coaxially with the cylindrical bore formed in said drive housing with a diameter at least equal to the diameter of said cylindrical bore, a piston received in each of said cylindrical extension bores, a reciprocating drive means coupled to each of said pistons, a pair of substantially laterally disposed extension passageways extending through each of said cylinder block housings, each extension passageway having a drive housing abutting portion disposed in continuation with and communicating with one of the laterally disposed passageways of said drive housing, an inlet valve assembly inserted in one of said extension passageways within each cylinder block housing, and an outlet valve assembly inserted in the other of said extension passageways within each cylinder block housing;

c. a housing head secured over the cylinder bore and each of said laterally disposed extension passageways along the outer flat surface of the cylinder block housing, each housing head having a flat forward area along and adjacent portions of the periphery thereof and a rearwardly recessed area inscribed within said flat forward area and providing communication between said pair of passageways and said cylindrical bore;

d. each laterally disposed extension passageway having a portion abutting said inlet and outlet valve assemblies at marginal portions thereof whereby to hold the valve assemblies in their inserted positions within said cylinder block housing without additional fastening means; and

e. venting means being provided along said opposed surfaces of said drive housing portion which extend between the base of said piston receiving bores and the exterior of said pump housing at a point adjacent the base of a piston in bottom dead-center disposition.

14. A piston type pump comprising:

a. a crankcase drive housing portion having a pair of opposed flat surfaces, a cylindrical bore extending through said drive housing portion and communicating with the medial open portion of said drive housing, said medial open portion constituting a lateral drive receiving enlargement disposed at an intermediate portion of said bore, at least two laterally disposed passageways each extending through said opposed flat surfaces disposed on opposite sides of said cylindrical bore, an inlet port communicating with one of said passageways and an outlet port communicating with the other of said passageways, each of said passageways having a certain predetermined diameter at said opposed flat surfaces;

b. at least two cylinder block housings each having inner and outer opposed flat surfaces secured to said drive housing along the opposed surfaces of said drive housing, each of said cylinder block housings having a cylindrical extension bore disposed coaxially with the cylindrical bore formed in said drive housing with a diameter at least equal to the diameter of said cylindrical bore, a piston received in each of said cylindrical extension bores, a reciprocating drive means coupled to each of said pistons, a pair of substantially laterally disposed extension passageways extending through each of said cylinder block housings, each extension passageway having a drive housing abutting portion disposed in continuation with and communicating with one of the laterally disposed passageways of said drive housing, an inlet valve assembly inserted in one of said extension passageways within each cylinder block housing, and an outlet valve assembly inserted in the other of said extension passageways within each cylinder block housing;

c. a housing head secured over the cylinder bore and each of said laterally disposed extension passageways along the outer flat surface of the cylinder

block housing, each housing head having a flat forward area along and adjacent portions of the periphery thereof and a rearwardly recessed area inscribed within said flat forward area and providing communication between said pair of passageways and said cylindrical bore;

d. each laterally disposed extension passageway having a portion abutting said inlet and outlet valve assemblies at marginal portions thereof whereby to hold the valve assemblies in their inserted positions within said cylinder block housing without additional fastening means; and

e. each of said pistons being coupled to a reciprocating drive means by a cam follower means, a centrally disposed drive yoke coupling said cam follower means, one to another, and a central shaft disposed coaxially with said pistons and cam follower means for threadably coupling each of said pistons to its associated cam follower means, the outer surface of each of said pistons having a slot formed therein to assist in arcuate rotation of said pistons.

15. A piston and yoke assembly for a fluid pump having a pair of longitudinally spaced cylinder means disposed on a common axis and a drive shaft journaled on an axis disposed between said cylinder means and normal to said common axis, and eccentric drive means on said shaft, said assembly comprising:

a. a rigid generally U-shaped yoke comprising an elongated relatively soft metallic strap bent to form a generally flat body portion extending generally parallel to said common axis and a pair of opposed parallel side portions at the opposite ends of, and normal to, the body portion, said side portions having aligned openings therethrough generally on said common axis;

b. a pair of opposed relatively hard bearing shoes each having a head disposed between said yoke side portions and abutting an adjacent one of said side portions, and a shank received in an adjacent one of said openings, said heads having opposed flat parallel wear surfaces for engagement with said eccentric drive means;

c. a pair of tubular piston rods mounted and guided in said cylinder means and having inner ends each receiving an adjacent one of said bearing shoe shanks and abutting the adjacent yoke side portion opposite the adjacent bearing shoe head, and outer ends;

d. piston means on the outer ends of said piston rods; and

e. a pair of anchoring screw means each extending axially through a different one of said piston means and a cooperating piston rod, and each having screw-threaded engagement with an adjacent bearing shoe shank, whereby to releasably anchor said yoke, bearing shoes, piston rods and the piston means together.

16. The piston and yoke assembly for a fluid pump as defined in claim **15** wherein each of said cylinder means includes a sleeve insert member.

17. The piston and yoke assembly for a fluid pump as defined in claim **15** wherein said eccentric drive means comprises a bearing member having an outer race and being mounted upon said drive shaft eccentrically to the central axis of said drive shaft and wherein said outer race is in contact with the said opposed flat parallel wear surfaces of said bearing shoes.

18. The piston and yoke assembly for a fluid pump as defined in claim **15** wherein said piston and yoke assembly is mounted within a pump body and wherein said eccentric drive means is disposed within a central crankcase portion of said pump body.

19. The piston and yoke assembly for a fluid pump as defined in claim **18** wherein seal elements are disposed within said pump body and circumferentially engage said piston rods.

20. The piston and yoke assembly for a fluid pump as defined in claim **16** being particularly characterized in that each of said piston means includes cup means in engagement with the inner periphery of said sleeve insert member.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,744,936 Dated July 10, 1973

Inventor(s) Harry J. Sadler

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 15, line 30, Claim 15, "relatively soft metallic strap bent to form" should read -- metallic structure having --.

Signed and sealed this 27th day of November 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

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