Jan. 21, 1964 L. W. KEIL 3,118,381

VARIABLE VOLUME CONSTANT PRESSURE PUMP

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FIG.2.

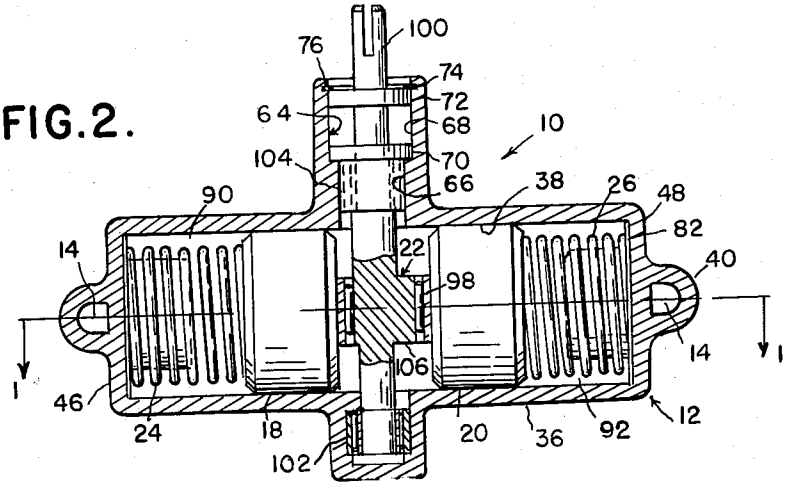


FIG.1.

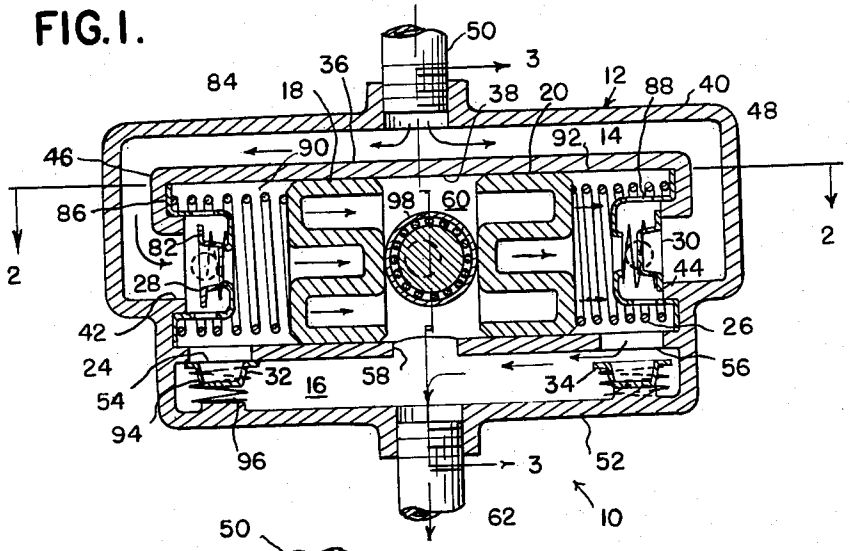
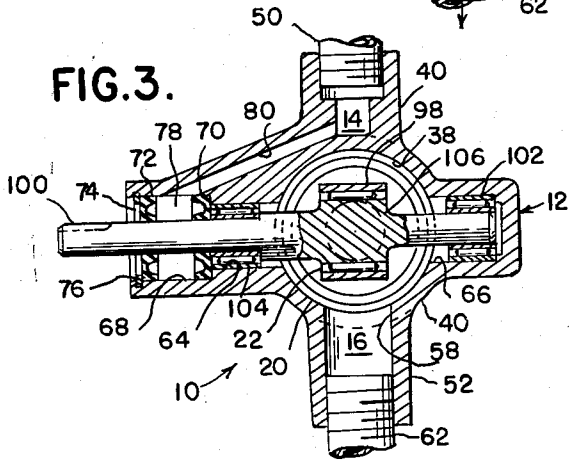


FIG.3.



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FIG. 5.

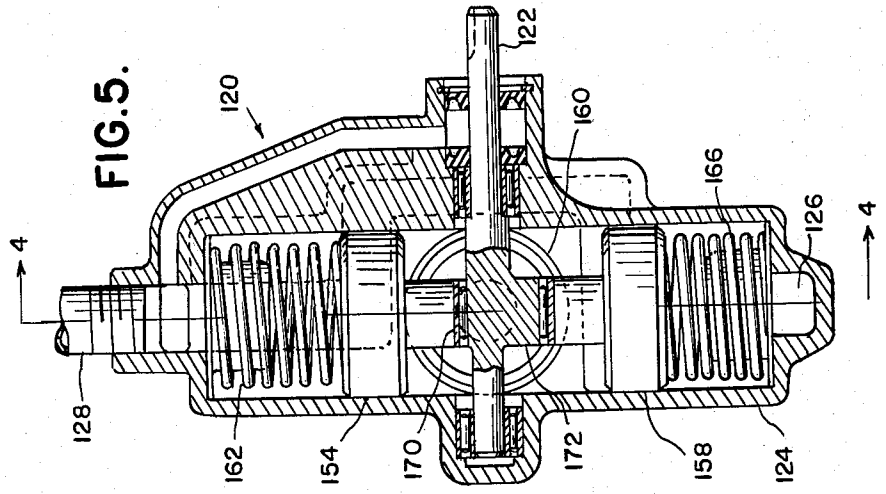
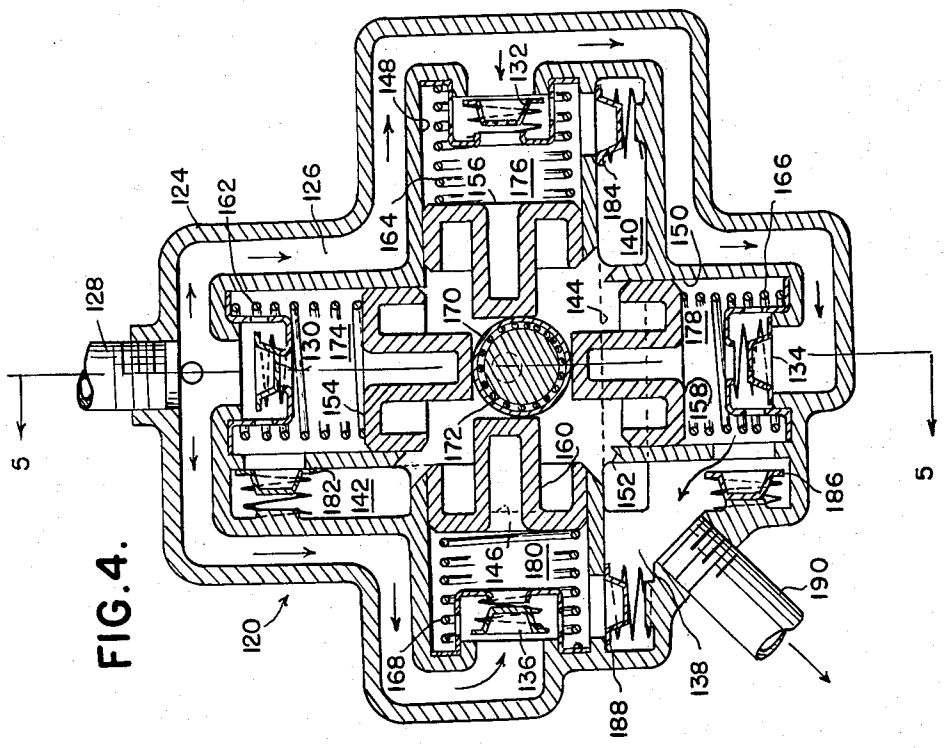


FIG. 4.



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FIG.6.

PRIOR ART

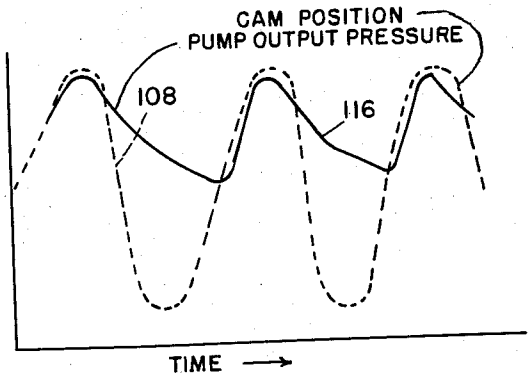
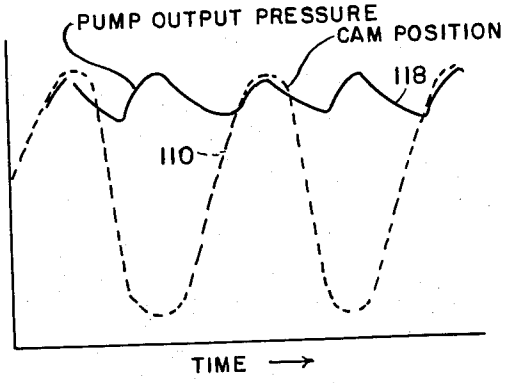


FIG.7.



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3,118,381
VARIABLE VOLUME CONSTANT PRESSURE PUMP

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5 Claims. (Cl. 103—38)

The invention relates to pumps and refers more specifically to a variable volume, constant pressure fluid pump which is especially constructed to more economically provide increased efficiency over a longer period of use.

In the past variable volume, constant pressure fluid pumps of the reciprocating piston type for military or commercial use in supplying fuel to reciprocating piston or turbo jet engines or the like have usually included a single piston driven through a variable stroke controlled by an accumulator which accumulator also regulates the pump output pressure to the limit of its capabilities between piston pumping strokes.

The variable volume, constant pressure fluid pumps of the past have often required multiple, eccentric, non-parallel bores therein. Further, in prior pump constructions the check valves, springs and similar elements therein have each been different.

It is one of the purposes of the present invention to provide an improved variable volume, constant pressure fluid pump requiring no separate accumulator.

Another object is to provide a variable volume, constant pressure fluid pump including a pumping piston operable to regulate the pump output pressure.

Another object is to provide a variable volume, constant pressure fluid pump including a housing having a piston reciprocally mounted therein operable to pump fluid from a fluid input chamber to a fluid output chamber within the housing on reciprocation thereof and means for applying the output pressure of the pump to the piston for limiting the stroke of the piston, and therefore the quantity of fuel pumped thereby to maintain a predetermined pump output pressure.

Another object is to provide a variable volume, constant pressure fluid pump including a housing, a fluid input chamber and fluid output chamber within the housing, a piston reciprocally mounted within a cylindrical bore in the housing, a pair of check valves communicating between the input chamber and the output chamber at one end of the cylindrical bore operable on reciprocation of the piston within the bore to provide for passage of fuel from the input chamber to the output chamber, means for reciprocating said piston within the cylindrical bore, means for biasing the piston away from said one end of the bore and means for permitting fluid communication between the other end of the bore and the fluid output chamber whereby the stroke of the piston and therefore the quantity of fluid pumped and the fluid output pressure are determined by the balance between the force of the biasing means and the output fluid acting on the piston.

Another object is to provide a variable volume, constant pressure fluid pump as set forth above wherein a plurality of fluid pumping units are provided in a single pump.

Another object is to provide a variable volume, constant pressure fluid pump which is simple in structure, economical to manufacture and efficient in use.

Other objects and feature of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating preferred embodiments of the invention, wherein:

FIGURE 1 is a sectional view of a fluid pump constructed in accordance with the invention taken substantially on the line 1—1 in FIGURE 2.

FIGURE 2 is a sectional view of the pump illustrated in FIGURE 1 taken substantially on the line 2—2 in FIGURE 1.

FIGURE 3 is a cross-sectional view of the pump illustrated in FIGURE 1 taken substantially on the line 3—3 in FIGURE 1.

FIGURE 4 is a sectional view of a modification of the pump illustrated in FIGURE 1 taken substantially on the line 4—4 in FIGURE 5.

FIGURE 5 is a sectional view of the modified pump structure illustrated in FIGURE 4 taken substantially on the line 5—5 in FIGURE 4.

FIGURES 6 and 7 are graphs illustrating cam surface position and pump output pressure related to time in a prior art variable volume, constant pressure fluid pump and a variable volume, constant pressure fluid pump constructed in accordance with the invention as illustrated in FIGURES 1–3 respectively.

With particular reference to the drawings a specific embodiment of the present invention will now be disclosed.

The fluid pump, generally indicated 10, shown in FIGURES 1–3 includes the housing 12 having a fluid input chamber 14 and a fluid output chamber 16 therein. Pistons 18 and 20 are mounted in the cylindrical bore 38 in the housing 12 for reciprocation on rotation of the eccentric drive assembly, generally indicated 22. Springs 24 and 26 bias the pistons 18 and 20 respectively toward the eccentric drive means 22.

On reciprocation of the pistons 18 and 20 the check valves 28, 30, 32 and 34 permit passage of fluid from the input chamber 14 to the output chamber 16, as will be considered in more detail subsequently. The strokes of the pistons 18 and 20 are regulated by the output fluid pressure in chamber 16 acting in opposition to the springs 24 and 26 so that the pressure in the output chamber 16 is maintained substantially constant.

More specifically, the housing 12 includes the cylindrical portion 36 providing the interior cylindrical bore 38 in which the pistons 18 and 20 are reciprocally mounted. As shown best in FIGURE 2, the housing 12 further includes a portion 40 providing inlet chamber conduit 14 which includes valved orifices 42 and 44 at opposite ends 46 and 48 respectively, of the cylindrical portion 36 of the housing 12. An inlet pipe or conduit 50 is connected to the chamber 14 centrally of the cylindrical portion 36 of the housing 12, as shown best in FIGURE 1, and supplies fluid to the input chamber 14. Of course if the pump 10 is immersed in fluid to be pumped the portion 40 of the housing 12 forming the input chamber 14 would not be necessary.

The housing 12 further includes the portion 52 extending longitudinally of the cylindrical portion 36 to provide the fluid outlet chamber 16 which includes valve orifices 54 and 56 at the opposite ends thereof communicating with the opposite ends 46 and 48 of the cylindrical bore. The outlet chamber 16 further communicates through the opening 58 with the central portion 60 of the cylindrical bore 38 between the pistons 18 and 20. An outlet conduit or pipe 62 is connected to the output chamber 16 by convenient means such as screw threads to supply fluid from the pump to utilizing devices (not shown).

Housing 12 further includes a multi-diameter bore 64 extending transversely thereof including a smaller diameter portion 66 in which the eccentric drive means 22 is mounted as illustrated best in FIGURE 3. The enlarged diameter portion 68 of the multi-diameter bore 64 has a pair of sealing members 70 and 72 positioned therein in spaced apart relation also as best seen in FIGURE 3. The sealing member 72 is secured in position by a re-

taining ring 74 positioned within the annular groove 76 in housing 12.

The chamber 78 provided between the housing 12 and the spaced apart sealing members 70 and 72 communicates with the input chamber 14 by means of passage 80 in housing 12. Thus, any fluid leaking through the multi-diameter passage 64 past seal 70 is returned to the input side of the pump 10.

Each of the check valves 28 and 30 comprise hat-shaped members 82 biased toward the respective valve orifices 42 and 44 by a spring 84. The springs 84 are supported at their other end on hat-shaped members 86 at each end of the cylindrical bore 38 which are in turn held in position against the ends 46 and 48 of the cylindrical bore 38 by the springs 24 and 26 respectively. The hat-shaped members 86 are provided with openings 88 therein to permit fluid passing the hat-shaped members 82 to pass readily into the chambers 90 and 92 formed between the ends 46 and 48 of the cylindrical bore 38 and the pistons 18 and 20 respectively.

Check valves 32 and 34 each include hat-shaped sections 94 biased toward the valve orifices 54 and 56 by springs 96. The hat-shaped sections 94 and 82 and the springs 84 and 96 may be identical.

As previously indicated, the pistons 18 and 20 which are shaped as shown in FIGURES 1 and 2, are reciprocally mounted in the cylindrical bore 38. The pistons 18 and 20 at one limit of their movement are biased into engagement with the driving bearing assembly 98 of the drive means 22 of pump 10 by the springs 24 and 26 respectively. As shown the springs 24 and 26 abut at their opposite ends the hat-shaped sections 86 positioned at the opposite ends 46 and 48 of the cylindrical bore 38 and one side of the pistons 18 and 20 respectively.

The drive means 22 comprises the shaft 100 which may be rotated by a convenient means such as the engine to which the fuel or fluid is being supplied by the pump. Shaft 100 is mounted in the multi-diameter bore 64 by means of bearings 102 and 104. The shaft 100 includes the eccentric portion 106 within the cylindrical portion 36 of the pump housing 12. The drive bearing assembly 98 is mounted on the eccentric portion 106 of the shaft 100 and is therefore also eccentric with respect to the shaft 100. As previously indicated, the seals 70 and 72 in conjunction with passage 80 are provided to return fluid from the output chamber 16 leaking along the shaft 100 to the input chamber 14.

In operation, on rotation of shaft 100 the eccentrically mounted drive bearing assembly 98 engages the pistons 18 and 20 to cause reciprocation thereof in conjunction with the springs 24 and 26 biasing the pistons 18 and 20 respectively toward the drive bearing assembly 98. In normal operation the pistons 18 and 20 will be out of engagement with the drive bearing assembly 98 during a portion of the rotation of shaft 100 as a result of the forces acting on the pistons due to the fluid in the chambers 90 and 92 together with the forces exerted on the pistons 18 by the springs 24 and 26 being equal to the force exerted on the pistons by the fluid pressure in the output chamber 16 and the central portion of the cylindrical bore 36.

Thus for example, on movement of the piston 20 to the right in FIGURE 1 in opposition to the bias applied thereto by spring 26 due to contact of the piston 20 with the driving bearing assembly 98, fluid previously taken into chamber 92 through check valve 30 will be forced out of chamber 92 through check valve 34 and into the output chamber 16. The fluid thus pumped into the output chamber 16 produces a predetermined pressure in the output chamber 16 depending on the amount of fluid pumped and the demand on the pump by the utilizing devices. Thus, on further rotation of the shaft 100 the piston 20 will move to the left as permitted by the driving bearing assembly 98 only until the force exerted on the piston due to the pressure in the output chamber 16 is equal to the force exerted on the piston due to the fluid pressure in the chamber 92 and the spring 26.

When the forces acting on the piston 20 are in equilibrium the continued rotation of the shaft 100 and movement of the driving bearing assembly away from the piston 20 will not produce further leftward movement of the piston 20. Therefore, if the pump output pressure is low it will be seen that the piston 20 will move farther to the left on the return stroke and on subsequent strokes will pump more fuel than if the pump output pressure were higher whereby the pump output pressure is regulated. Further, it will be obvious from the above consideration of the operation of the pump that should the pistons 18 stick that the pistons 20 would compensate therefor by taking a longer pumping stroke to maintain a desired pump output pressure within the capabilities of the pistons 20.

Thus, it will be seen that the piston 20 performs a plurality of functions in that it acts as a pumping piston, a pressure regulator and an accumulator. That is to say, in addition to independently pumping fuel the spring loaded piston independently regulates output pressure in the system to provide accumulator action.

The operation of the piston 18 is of course exactly the same as that of the piston 20 with the obvious exception that the piston 18 is in a pumping stroke when the piston 20 is in a suction stroke since the pistons tend to move in the same direction.

With particular reference to the graphs of FIGURES 6 and 7 it will be seen that the pump illustrated in FIGURES 1–3 is much more efficient than the prior art pumps wherein a single piston and accumulator have been used. In the diagram of FIGURES 6 and 7 time is indicated as the ordinant and eccentric position and pump output pressure are indicated by the dotted lines 108 and 110 and the solid lines 116 and 118 respectively.

Thus, as indicated in FIGURE 6, the output pressure from a prior art pump using a single piston and an accumulator included substantial pressure ripple as indicated by the deep valleys outlined by the solid line 116. With the output from the pump of FIGURE 1 such ripples in the output pressure are substantially reduced as shown by solid line 118 since a pumping stroke is produced twice as often by the two pistons 18 and 20.

In addition, since the output pressure does not vary as much in the pump illustrated in FIGURES 1–3 it will be understood that each piston will have to pump less fluid per stroke and the movement thereof will therefore be reduced. With the pump structure disclosed therefore a longer pump life may be expected since less movement of the individual pistons is required to supply the same quantity of pumped fuel.

In addition, with the pump structure illustrated in FIGURES 1–3 it will be particularly noted that the pistons are duplicates of each other and that the bores of the pump are for the most part substantially straight through bores whereby production of the pump is greatly simplified and cost thereof is reduced. Further reduction in cost is of course provided since a separate accumulator is not needed.

The elimination of the accumulator as indicated above also improves the reliability of the fluid pump since the prior known accumulators were not positively driven and were subject to sticking which would produce substantial failure of the pump. With the present pump construction should one piston stick the other piston would immediately compensate for the stuck piston to the limit of its pumping capacity so that in addition to being more reliable, less expensive and more efficient than prior pump structures, the pump structure illustrated in FIGURES 1–3 is provided with an inherent built-in safety feature.

A modification 120 of the pumping structure illus-

trated in FIGURES 1–3 is disclosed in FIGURES 4 and 5. The modified pump structure **120** differs from the pump structure of FIGURES 1–3 primarily in that a second set of pumping pistons have been added thereto so that four separate complete pumping strokes are provided during each revolution of the shaft **122**.

The efficiency and reliability as well as the capacity of the pump of FIGURES 4 and 5 is thus increased over the pump illustrated in FIGURES 1–3. That is to say, there will be less ripple in the output pressure from the pump **120** than there will be in the output of pump **10**, as shown in FIGURE 7, and should one or two of the pistons in the pump **120** become stuck the other pistons would compensate for the non-active piston to the limit of their ability.

The pump structure **120** includes the housing **124** having the input chamber **126** therein communicating with the input conduit **128** and with each of the input check valves **130**, **132**, **134** and **136**. Housing **124** further includes the output chamber **138** in communication with output chambers **140** and **142** through conduits **144** and **146** respectively and with the crossed cylindrical bores **148** and **150** also formed in the housing **124** through the passage **152**. Pistons **154**, **156**, **158** and **160** shaped as shown in FIGURES 4 and 5, are mounted for reciprocation in the cylindrical bores **148** and **150** as illustrated. The springs **162**, **164**, **166** and **168** are provided to bias the pistons **154**, **156**, **158** and **160** respectively toward the bearing assembly **170** mounted on the eccentric portion **172** of the shaft **122**.

The operation of the modified pump of FIGURES 4 and 5 is entirely analogous to the operation of the pump illustrated in FIGURES 1–3. Thus, on a single complete rotation of the shaft **122** the pistons **154**, **156**, **158** and **160** each go through a complete cycle of reciprocation to draw fuel from the input conduit **128** and input chamber **126** into the chambers **174**, **176**, **178** and **180** through the input check valves **130**, **132**, **134** and **136** respectively and to subsequently force fuel out of the chambers **174**, **176**, **178** and **180** through the output check valves **182**, **184**, **186** and **188** respectively into the output chamber **138** and output conduit **190**.

In such operation the stroke of each of the pistons **154**, **156**, **158** and **160** will as before be limited by the balance between the fixed force of the springs **162**, **164**, **166** and **168**, the fluid pressure in chambers **174**, **176**, **178** and **180**, and the output fluid pressure in the output chamber **138**. As indicated above however, the ripple in the output pressure will be reduced with the pump illustrated in FIGURES 4 and 5 and the safety factor due to compensation of the remaining pistons for any pistons which become inoperative will be increased.

While one embodiment of the present invention has been considered in detail and one modification thereof has been disclosed, it will be understood that other embodiments and modifications of the invention are contemplated. Thus for example, it will be understood that a pump as shown in FIGURES 1–3 may include a number of cylinder banks engaged by separate eccentric cams on a common shaft driven by a single motor. It is therefore the intention to include all such embodiments and modifications defined by the appended claims within the scope of the invention.

The drawings and the foregoing specification constitute a description of the improved variable volume constant pressure pump in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention.

What I claim as my invention is:

1. A constant pressure, variable volume fluid pump comprising a housing having an open ended bore therein, a piston reciprocally mounted in each end of the bore, a drive shaft extending transversely of the bore centrally thereof journaled for rotation in the housing at opposite sides of the bore and having an eccentric portion located centrally of the bore engageable with the pistons in the bore, spring means operable between the ends of the bore and the pistons urging the pistons into engagement with the eccentric portion of the shaft so that the pistons are reciprocated on rotation of the shaft, an input chamber in the housing extending parallel to and adjacent the bore and terminating in portions at the ends of the bore extending transversely of and communicating with the ends of the bore, input check valves positioned over the ends of the bore between the bore and input chamber for permitting flow of fluid only from the input chamber to the bore, an output chamber extending parallel to and adjacent the bore, an opening in the housing for communication between the output chamber and the central portion of the bore and other openings in the housing for communication between the opposite ends of the output chamber and the corresponding opposite ends of the bore and output check valves positioned over the other openings for permitting fluid flow only from the ends of the bore into the output chamber.

2. A constant pressure, variable volume fluid pump comprising a housing having a pair of open ended bores therein extending perpendicularly to each other and intersecting centrally, a separate piston reciprocally mounted in each end of each of the bores, resilient means operable between the ends of the bores and the pistons for urging the pistons inwardly of the bores, a drive shaft journaled for rotation in the housing and extending substantially perpendicularly to and transversely of each of the bores including an eccentric portion located within the intersection of the bores engageable with the individual pistons therein for reciprocating the pistons in conjunction with the resilient means on rotation of the drive shaft, an intake chamber extending in substantially the plane of the longitudinal axes of the bores in communication with the ends of each of the bores, input check valves over the ends of each of the bores between the input chamber and the bores for permitting fluid flow only from the input chamber into the bores, an output chamber in communication with the opposite ends of each of the bores and with the bores centrally thereof and check valves positioned between the ends of the bores and the output chambers for permitting fluid flow only from the ends of the bores into the output chamber.

3. Structure as set forth in claim 2 wherein the drive shaft extends out of the housing and including a recess in the housing surrounding the output shaft, a pair of seals sleeved over the shaft within the recess in the housing in axially spaced apart position forming a chamber with the housing and shaft, and a passage in the housing between the chamber formed between the seals, shaft and housing and the input chamber.

4. A constant pressure, variable volume fluid pump comprising a housing having a bore therein, a piston reciprocally mounted in each end of the bore, a rotatable drive shaft extending transversely of the bore and having an eccentric portion engageable with the pistons in the bore, resilient means operably engaged with the pistons for urging the pistons into engagement with the eccentric portion of the shaft so that the pistons are reciprocated on rotation of the shaft, an input chamber in the housing communicating with the ends of the bore, input check valves positioned at the ends of the bore between the bore and input chamber for permitting flow of fluid from the input chamber only into the bore, an output chamber in the housing, an opening in the housing for communication between the output chamber and the central portion of the bore and other openings in the housing for communication between the output chamber and the ends of the bore and output check valves positioned over the other openings for permitting fluid flow from the ends of the bore only into the output chamber.

5. A constant pressure, variable volume fluid pump

comprising a housing having a pair of bores therein intersecting centrally, a separate piston reciprocally mounted in each end of each of the bores, resilient means operably engaged with the pistons for urging the pistons inwardly of the bores, a rotatable drive shaft extending transversely of each of the bores including an eccentric portion located within the inner section of the bores engageable with the individual pistons therein for reciprocating the pistons in conjunction with the resilient means on rotation of the drive shaft, an intake chamber in communication with the ends of each of the bores, input check valves at the ends of each of the bores between the input chamber and the bores for permitting fluid flow from the input chamber only into the bores, an output chamber in communication with the ends of each of the bores and with the bores centrally thereof and check valves positioned between the ends of the bores and the output chamber for permitting fluid flow from the ends of the bores only into the output chamber.

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