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3,190,233

PUMPS

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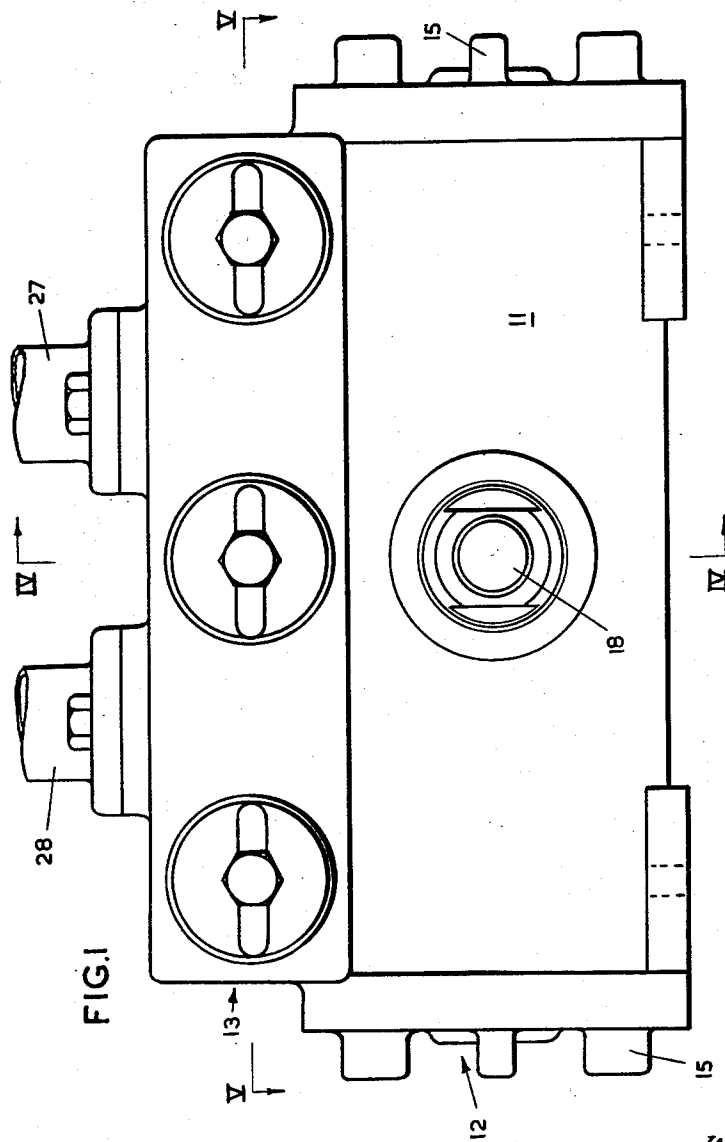


FIG. 1

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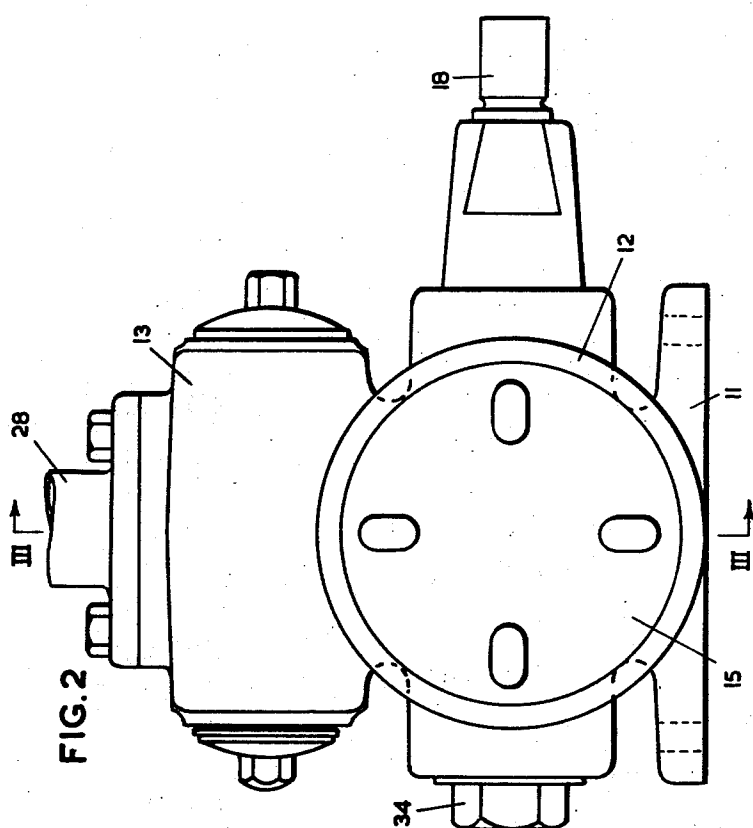
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5 Sheets-Sheet 2



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5 Sheets-Sheet 3

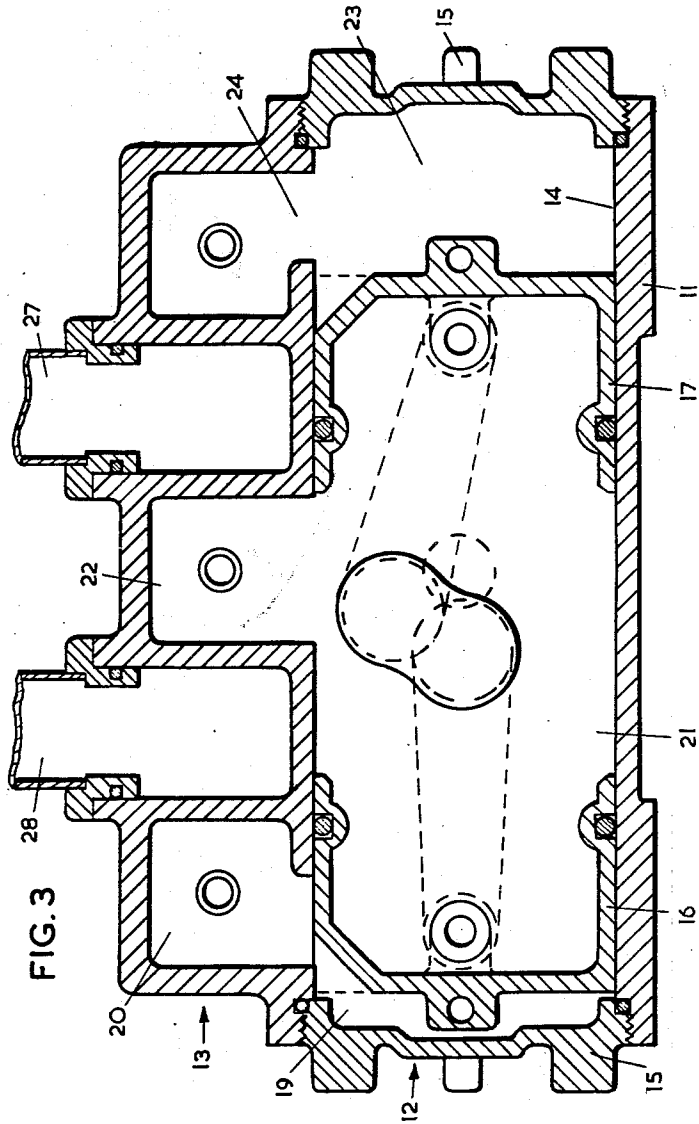


FIG. 3

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5 Sheets-Sheet 4

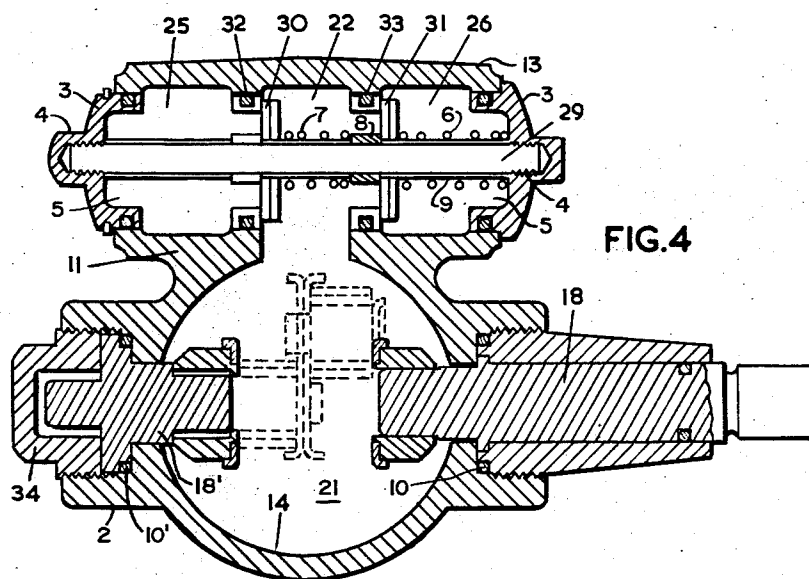


FIG. 4

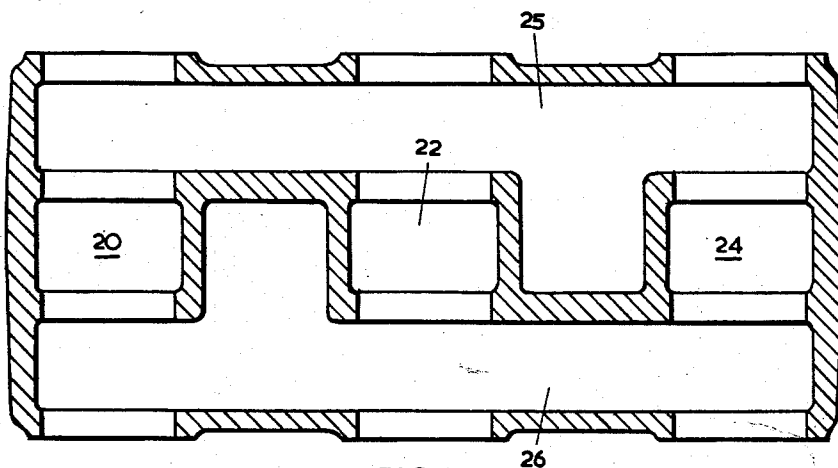


FIG. 5

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5 Sheets-Sheet 5

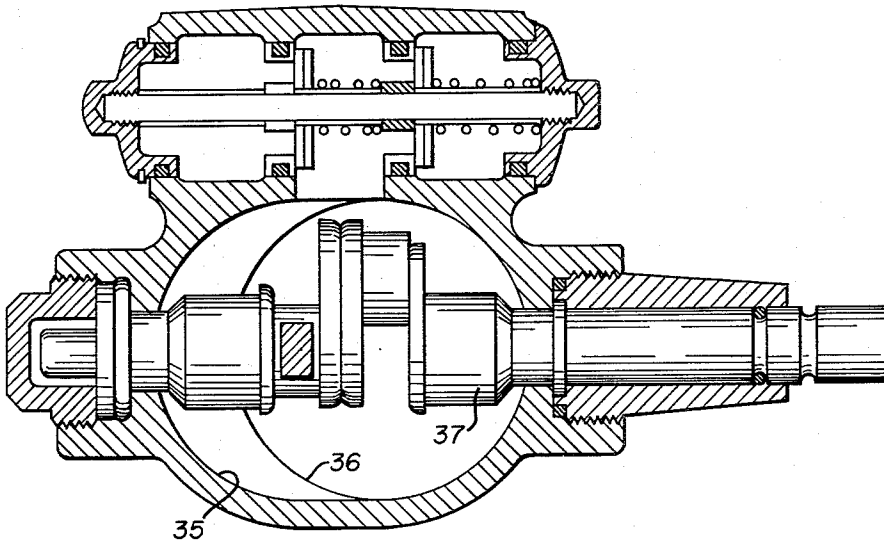


FIG. 6

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1

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Filed Mar. 5, 1963, Ser. No. 263,683
6 Claims. (Cl. 103-169)

This invention relates to pumps and particularly to reciprocating fluid (liquid or gas) pumps having one or more pairs of pistons mounted for reciprocation in a common cylinder.

In such pumps the pistons are normally operatively connected to a crank or eccentric in phase with one another or else 180° out of phase. This results in the one case in one of the pistons moving upon its induction or intake stroke over the same angle as the other piston moves upon its exhaust or output stroke, whilst in the other case the two pistons move over the same angles upon their respective intake and output strokes. Either of these prior arrangements therefore requires that a considerable driving force should be applied to the pistons by the crank over certain parts of the cycle of revolution of the crank, whilst at other points in the cycle very little or no driving force is required. This variation in the required driving force results in much higher wear of the working parts of the pump. Moreover, since the power to drive such a pump is normally applied in the form of a substantially constant torque, and this torque must always be greater than the maximum required to drive the piston over the part of the cycle where the loading is greatest, the power required is much greater than if the loading of the pistons were to be equal over the entire cycle of the crank. This disadvantage can, of course, be overcome to some extent by the use of a flywheel in the pump drive, but this can only result in a limited power saving, since the starting torque of the driving means has to be sufficient to overcome the inertia of the flywheel.

Even where pumps are to be manual instead of mechanically operated, these disadvantages still apply, since a pump in which the manual effort required varies over the cycle of the pump is more difficult to operate than one in which the effort called for is constant.

It is object of the present invention to provide a construction of pump which overcomes these disadvantages.

According to the invention a pump is provided having a pair of pistons mounted for reciprocation in a common cylinder in which each piston is connected by a single connecting rod to a common crankshaft at a phase difference such that the maximum driving torque required in respect of one of the pistons in coincidence with the minimum driving torque required in respect of the other of said pistons.

This condition may be obtained by connecting the pistons to a common crank shaft at a phase difference of approximately 60°.

In further accord with the invention a pump is provided having a pair of pistons reciprocable with a common cylinder, each piston being connected by a single connecting rod to a common crank shaft at a phase difference of approximately 60°, in which the phase between the pistons is utilized as an operative part of the pump in addition to the end spaces beyond each of the pistons and between this and the closed ends of the cylinder. Thus, in this construction of pump three separate operative cylinder spaces are provided. Two of these are the spaces lying between the outside faces of the pistons and the closed ends of the cylinders, and in each of these as the piston draws away from the cylinder end fluid is drawn into the space, whilst as the piston returns towards the cylinder end the fluid is expelled.

2

The third space is provided by that part of the cylinder between the two pistons, that is that part of the cylinder which will normally contain the crank mechanism. Since the pistons are connected to the crank out of phase the separation between them varies at different parts of the pump stroke. This results in a change of volume of this part of the cylinder and this change of volume may therefore be used to increase the pumping capacity of the pump whilst at the same time evening out the thrust which is required to drive it.

Utilizing this arrangement with the connecting rods from each of the pistons being connected to a common crank shaft as points separated by about 60°, a pump may be provided in which the driving torque required is substantially constant throughout the whole of its cycle.

The general construction of the pump and the manner of driving it may be the same as that which is conventionally utilized in constructions of apparatus of this kind.

Conveniently the valve assembly for use with a pump according to the invention may be arranged such that each of the three operative spaces within the cylinder is exposed to individual inlet and outlet valves which may be lightly spring-loaded into place and which when closed are held firmly against their seatings by the fluid pressure. Thus, from each of the operative regions of the cylinder a port in the cylinder wall may connect with a compartment in a valve chest. This compartment may be provided with two ports, one leading to a common inlet duct whilst the other leads to a common outlet duct, and each of these ports may be closed by a suitable form of valve which is normally held lightly in the closed position by a low rate spring (the exact rate of which will be chosen according to the characteristics of the liquid or gas to be pumped). During the suction or inlet stroke in the appropriate region of the cylinder, the inlet valve is lifted from its seat against the force of its spring by the suction or negative pressure created, whilst during this stroke the outlet valve is held very firmly in its seating by the same pressure differential. During the outlet stroke, the inlet valve is pressed firmly against its seating by the pressure of the outgoing fluid, whilst the outlet valve is lifted against the force of its spring.

With the foregoing and other objects in view which will appear as the description proceeds, the invention resides in the combination and arrangement of parts and in the details of construction hereinafter described and claimed, it being the intention to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention.

The invention is illustrated in the accompanying drawings, wherein:

FIGURE 1 is a side elevational view of a pump in accordance with this invention.

FIGURE 2 is a left hand end view.

FIGURE 3 is a vertical section on line III—III of FIGURE 2.

FIGURE 4 is a vertical section on line IV—IV of FIGURE 1.

FIGURE 5 is a horizontal section on line V—V of FIGURE 1.

FIGURE 6 is a vertical section comparable with FIGURE 4 and illustrating a modification of the pump.

As shown in FIGURE 3 of the drawings, a pump casing 11 is formed as a single casting with a lower or cylinder part 12 and an upper or valve chest part 13. In the lower part 12 is formed a cylinder 14 closed by end caps 15 and containing two pistons 16 and 17 arranged to be reciprocated by the rotation of a driving shaft 18 located transversely of the casing 11 on the axial center line of said common cylinder 14. The pistons 16 and 17

may be in the form of cups of nylon or a similar material and are connected to a common crankshaft mounted on the driving shaft 18, the connections to the common crank shaft being at a phase difference such that the maximum driving torque required in respect of one of the pistons is coincident with the minimum driving torque required in respect of the other of said pistons.

The driving shaft 18 extending through the righthand side of the cylinder 14 as viewed in FIGURE 4 has opposed thereto in the lefthand side of the cylinder 14 a short shaft portion 18', this short shaft portion being coupled to the common crank shaft 18. The short shaft portion 18' is rotatably housed in a projection 2 of the cylinder casing 14, said projection 2 being closed by a closure plug 34. The space 19 to the left of the left hand piston communicates permanently with a chamber 20 in the valve chest 13 (see FIGURE 3), the space 21 between the pistons with a chamber 22, and the space 23 to the right of righthand piston 17 with a chamber 24.

Each of the three chambers 20, 22 and 24, when subjected in turn to a reduced pressure by the pistons, communicate with an inlet chamber 25, FIGURES 4 and 5, and when the three chambers 20, 22 and 24 are subjected in turn to pressure by the pistons they communicate with an outlet chamber 26.

The chamber 25 is permanently connected to an inlet pipe 27 and the chamber 26 is permanently connected to an outlet pipe 28.

The manner in which the chambers 20, 22 and 24 communicate with the inlet and outlet chambers 25 and 26 is determined by pressure operated valves.

There are six of these pressure operated valves, arranged in pairs, one pair for each of chambers 20, 22 and 24 and of each pair one valve communicates with chamber 25 and the other with chamber 26. Thus, there are three transverse fixed spindles, of which FIGURE 4 shows the spindle 29 pertaining to chamber 22. On each spindle are mounted two valve discs 30 and 31, spring-urged in the same direction, to the left as viewed in FIGURE 4, towards closure on respective seatings 32 and 33. The ends of each of the three transverse spindles, such as spindle 29, are screw threaded so that end caps 3, with correspondingly threaded end portions 4, can be screwed onto the spindles to seal circular openings 5 that lead into the chambers 20, 20 and 24 from both sides of the valve chest 13. The spring 6 that acts on the valve disc 31 is compressed between the valve disc 31 and the righthand end cap 3 shown in FIGURE 4. The spring 7 that acts on the valve disc 30 is compressed between the valve disc 30 and a collar 8 that is spaced from the righthand end cap 3 by a sleeve 9 on the spindle 29, the valve disc 31 sliding on the sleeve 9.

In operation, the driving shaft 18 is rotated to reciprocate the pistons 16 and 17 in an out-of-phase relationship such that not only the end spaces 19 and 23 but also the intermediate spaced 21 varies in volume. As the volume of a space is enlarged, incoming fluid pressure in chamber 25 opens the inlet valve (30 in the case of the intermediate space 21 and its chamber 22) against its spring pressure, to admit the fluid to the space. As the space contracts in volume, valve 30 closes and outlet valve 31 opens to discharge the fluid at a heightened pressure to the outlet chamber 26.

By this means a pump is provided in which a fluid, which may be a liquid or which may be a gas, is drawn into the chamber 25 through a supply conduit 27 and passed out from the outlet chamber 26 through an outlet conduit 28 at an almost completely steady rate, very little pulsation being apparent in the flow. Moreover, the torque required to drive the shaft 18 is almost exactly the same throughout the entire 360° of its cycle of revolution. Thus, a pump is provided which is very easily driven and which, if it is driven by a motor, requires a much lower power motor than would a conventional pump delivering the same volume of fluid at the same pressure. Where the pump is to be hand operated, a handle

carried upon the shaft 18 can be rotated with very much less fatigue than in the case of a conventional pump since the pressure which must be applied to the handle is constant throughout the cycle and does not vary.

Since the chamber 21 containing the cranks and bearings associated with the connecting rods is exposed to the fluid passing through the pump, these bearings should be made self-lubricating and it is desirable that a packing 10 should be provided to prevent the leakage of fluid through the bearing in which the shaft 18 is journaled.

It will be appreciated that the present design permits the quick removal of the valve units 29, 30 and 31 for cleaning of any stoppages which might occur, since it is only necessary for the lefthand cover of any of the three valve chambers 20, 22 and 24 to be removed whereupon, when the righthand cover of that chamber is removed, the whole valve system in that chamber can be withdrawn.

Moreover, since the valve chest 13 is above the cylinder 14 the need for a bleeder valve is avoided.

The closure plug 34 shown in FIGURE 4 can be removed to give access to the short shaft portion 18' so that the pump can be driven from either side.

It should be noted that the end covers 15 may be of the flanged type with sealing rings between each flange and the cylinder casting 11, but to reduce cost the end covers 15 are preferably threaded plug type closures, as shown, with the sealing ring sandwiched between the end of the cover 15 and the wall of a counterbase in the cylinder casting 11. This ensures that any grease used to protect the screw thread of the end caps 15 does not contaminate the fluid being pumped since the grease is outside the sealing ring.

It will be appreciated that the actual construction of the pump may be varied considerably from the specific construction which is shown in the drawings without departing from the invention. In particular, the two halves of the cylinder in which the two pistons move may conveniently be offset as illustrated in FIGURE 6 so that the connecting rods may be straight and not cranked, thereby lowering the loading upon the various pivotal connections and reducing the tendency of the pistons to twist out of alignment with the cylinder bores. In FIGURE 6 the two halves of the cylinder are indicated by the numerals 35 and 36 respectively and the crank shaft is indicated by the numeral 37.

The pump may be made in any desired materials and in any desired size. It will be appreciated that where it is intended for use with gases or fluids of low viscosity, the spring rates controlling the valves will need to be considerably different from those which will be required where the pump is used with relatively viscous liquids.

Having thus described my invention, what I claim is:

1. A pump having a cylinder with closed ends in a common casing with a valve chest, a pair of pistons reciprocable within said cylinder, a crank shaft in said cylinder between said pistons, connecting rods connecting each of said pistons to said crank shaft at a phase difference of approximately 60°, the space within said cylinder between the pistons being sealed and comprising an operative part of the pump in addition to the end spaces beyond each of the pistons and the closed ends of said cylinder, access ports in said common cylinder establishing communication between said valve chest and said common cylinder, pressure operated valves controlling said access ports, and wherein said common casing is completely sealed except for said valved access ports.

2. A pump having two cylinders arranged in oppositely disposed relation with axes parallel, a crank shaft in said pump between said cylinders, a piston mounted for reciprocation in each of said cylinders, straight connecting rods connecting said pistons with said crank shaft, said cylinders being offset to such a degree as to allow the use of said straight connecting rods extending between said crank shaft and the centers of said pistons, a valve chest positioned adjacent said two cylinders and access ports in

5

said two cylinders establishing communication therewith, pressure operated valves in said access ports and wherein said two cylinders and casing are completely sealed except for said access ports.

3. A pump having a common cylinder, a pair of pistons mounted for reciprocation in said common cylinder at a phase difference such that the maximum driving effort required in respect of one of said pistons is coincident with the minimum driving effort required in respect of the other of said pistons, and wherein the space between the pistons is sealed and operative as a pumping space in addition to spaces beyond the pistons within the cylinder, a common crank shaft within said pump intermediate the pistons, and a pair of connecting rods respectively connecting said pistons to said crank shaft at said phase difference, a valve chest disposed alongside said common cylinder, and three access ports in the wall thereof each serving as a common inlet and outlet connection between a respective one of the pumping spaces and the valve chest, pressure responsive valves in each of said three access ports.

4. A pump according to claim 3 and wherein said phase difference is equal to 60°.

5. A pump according to claim 3 and wherein said valve chest has a common inlet compartment and a common outlet compartment and wherein said pressure responsive valves comprise a pressure-operated inlet valve associated with each of said chambers and serving to establish communication between a respective one of said chambers and said common inlet compartment within the valve chest, and a pressure-operated outlet valve associated with each of said chambers and serving to establish communication between a respective one of said chambers and said common outlet compartment at appropriate times during a pumping cycle.

6. A pump according to claim 3 wherein said valve chest has a common inlet compartment and a common

6

outlet compartment and wherein said pressure operated valves comprise a pressure-operated inlet valve associated with each of said chambers and serving to establish communication between a respective one of said chambers and said common inlet compartment within the valve chest, and a pressure-operated outlet valve associated with each of said chambers and serving to establish communication between a respective one of said chambers and said common outlet compartment at appropriate times during a pumping cycle, three static spindles arranged within the valve chest transversely of the cylinder, each of the spindles passing through a respective one of said chambers, a pair of valve discs slidable on each of said spindles and respectively constituting said inlet valve and said outlet valve, spring means urging each of said valve discs into a closed position, and end caps removable from without and detachably receiving the ends of each of said spindles, so that said valves can be easily withdrawn from the valve chest when desired.

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