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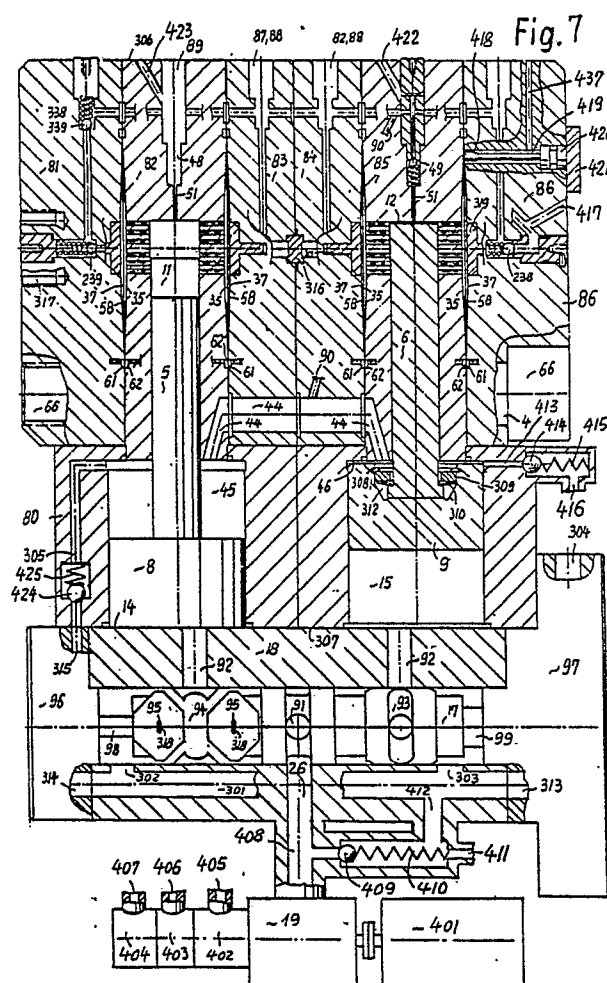
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54 **A device for the control of flow and a high pressure pump.**

57 A fluid motor (97) is set into the return flow of a hydraulic or pneuma-machinery. This fluid motor (97) has a relatively large consumption capacity to revolve at low speed, but it can be a low pressure motor. The motor (97) is utilized to revolve or oscilate one or more control devices which may be used to control the operation of the machinery with the return flow whereinto the fluid motor (97) is set. Specific additional matters are then proposed to secure the smoothly timed and reliable operation of the fluid motor and of the controller(s) which it drives.

This control arrangement with the fluid motor (97) in the return flow fluid line may be utilized to control the operation of a high pressure pump. This pump may have medial pressure (8, 9) and high pressure (5, 6) pistons, reciprocating in respective cylinders, as well as inner- and outer-chambers with deflectible separators (58) between these chambers in order that the outer chamber may contain a lubricitious fluid while the inner chamber can then contain a non-lubricative fluid, as for example, water.

The fluid motor (97) in the return fluid line may be replaced by another motor, for example, an electric motor with a reduction gear, to enforce a low speed operation of the control device(s). If the apparatus of the invention is a complete use of all details of the invention, a pump can provide a flow of water with pressures in excess of 30 000 psi.



A DEVICE FOR THE CONTROL OF FLOW AND A HIGH PRESSURE PUMP

FIELD OF THE INVENTION :

This invention relates to control mechanism which can make a pump in the field as well as in machining shops independent of electric or electronic controls. It also relates to high pressure pumps, for example, to such pumps, which can deliver a flow or flows of water with pressure in excess of 30 000 psi.

DESCRIPTION OF THE PRIOR ART :

For the supply of high pressure flows of water, commonly the so called "axial boosters" are used in which a piston which is driven by oil, driving a piston of smaller cross section for the supply of high pressure water out of a water containing chamber. The directional control of the piston(s) is then commonly done by electromagnetic solenoid valves.

Further, US Patent 4,374,874 of Albert Phillips, discloses a gear motor which is set into the ingoing flow of a controller.

This prior art fails to provide a control mechanism for pressures in excess of 30 000 psi in flows of water and also fails to make the use of high pressure pumps possible in the field, where no electricity or electronics are available. Consequently, there exists a need for a control apparatus which can work in the field independently of electric and electronic devices. Further there remains a need for a compact pump which can pump water in excess of 30 000 psi.

SUMMARY OF THE INVENTION :

The first objet of the invention is to provide a control apparatus which is independent of electronic or electric devices and which is able to be applied to hydraulic- or pneumatic- machineries, as, for example, to hydraulic pumps, pneumatic compressors and the like.

The second object of the invention is to provide a high pressure pump which is capable to deliver a flow of fluid under high pressure, or deliver a plurality of such flows.

The third object of the invention is to provide a high pressure pump for the delivery of water or other non-lubricating fluid with pressures in excess

of thirtythousand pounds per square inch.

And, a further object of the invention is to supply those technological details which make the operation of the beforementioned objects of the invention reliably operable for a long time useful life.

BRIEF DESCRIPTION OF THE DRAWINGS :

The Figures illustrate some of the details of the invention and show in Fig. 1 a longitudinal sectional view through an example of a pump of the invention, in Fig.5 a respective cross sectional view, and in Figures 2 to 4 cross sectional views through the control valve 17 of Figure 1.

Figure 6 is a longitudinal sectional view through a device of the invention, while Figure 7 shows the same view of the same device, however, with some modifications, and Figure 8 shows a longitudinal sectional view through a pressure ratio valve which is preferred to be used in the device of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS :

In high pressure pumps, especially such which pumps non-lubricating fluid, like f.e water, and wherein the pressure exceeds more than one thousand atmospheres, two major problems appear:

a) The sealing of the membranes is difficult, results in leakage and the clamping bolts are subjected to alternating loads which reduce their life time;

b) The pumps run with high rotary revolutions if flanged onto electric motors whereby the valves and membranes have only several hundreds hours life time because of the many strokes at short time; and, when gears are provided between the electric motor and the pump, these gears are heavy and expensive because of the high power which is transferred through them.

The present invention overcomes these problems by using a control valve instead of the transmission between the driving motor and the pump. To make this effective, a small power reduction gear is provided between the driving motor and the control valve. To increase the sealing of the membranes and the life time of the clamping bolts, clamped and sealed circular portions as well as leakage collection recesses are provided in bodies which flank and clamp the membranes, while in a

plurality of chambers one gets high pressure when the other gets low pressure, through which, since the chambers are located axially of each other, the clamping bolts get at all times a uniform load, while alternating load is prevented.

These details of the invention are defined in the appended claims.

Medial pressure pump 19 has a shaft 20 provided with a reduction gear 21-22 to the thereby with lower speed revolved control valve 17. Pump 19 delivers medial pressure fluid of between 50 and 800 atmospheres via passages 26,27 to control valve 17. This control valve has high pressure passages and ports, numbered and defined by "H" which deliver the fluid from the passages 26,27 alternately to and into at least two cylinders 14,15,16 for driving pistons 8,5 and 9,6 or also 10,7 upwards in a delivery stroke to pump fluid, preferred oil, into the first or outer chambers 11,12,13 (Fig.1) or 135,235 (Fig.5). This delivery strokes press the membranes 58 (Fig.5) from the first or outer chambers into the second or inner chambers 137,237 (Fig.5) to press the high pressure fluid, f.e. water, out of the mentioned second chambers over outlet valves 139,239 after the fluid had entered them during the piston return strokes over 135,137 are subjected to high pressure when the chambers 235,237 are subjected to low pressure and vice versa. It is desired by this invention that the control valve should act so perfectly that no time lapse appears at the time of changing of pressure from chambers 135,137 to chambers 235,237 and vice versa. Then it is secured that the bolts 4 with their holding means 66 are at all times uniformly loaded with the stress which appears onto the bolts from the delivery strokes high pressure fluid in the respective chambers. Alternation to lower pressures are thereby prevented, the bolts 4 are subjected at all times to uniform internal elongation stresses, while alternating loads and stresses are prevented and the bolts obtain a long life, while at the same time the compression stresses of the sealing portions of the membranes and bodies also at all times remain under substantially equal and not alternately loaded compression stresses. Thereby they also obtain a long and reliable life time of operational perfectness.

More details are described in the claims and the claims are therefore considered to be a portion of the description of the invention and of its preferred embodiments.

In Figures 1 to 5, a pump drives sets of pistons against membranes which press against water, whereby water can be delivered with very high pressure. Since pistons of different diameters are used, medial pressure can drive the bigger diameter pistons, while the small diameter pistons then deliver a fluid under very high pressure. A rotary

control valve is provided before the pistons and a transmission between the primary pump and the control valve secures that the main pistons run relatively slowly in order to obtain a high life time of the intake and delivery valves of the high pressure stage.

The problem of the mentioned Figures is, however, that the transmission requires a construction together with the primary driving motor, for example, the electric motor.

The present invention overcomes this problem by providing a unit which can be mounted at any place inside of buildings and also outside in the field, or on vehicles, where a medial pressure fluid supply is available. This aim of the invention is obtained by the provision of a fluid motor which is set into the return flow from the cylinders to drive the control valve of the invention.

In Figs. 6 and 7 the medial pressure pistons 8,9 are reciprocable in cylinders 14,15, and they are connected, for example by referentials 308,309,310,312, to the high pressure pistons 5,6 which are reciprocable in high pressure cylinders 11,12 and which are driven by the mentioned medial pressure pistons 8 and 9, respectively.

The high pressure stage has inlets and outlets 238,239 and may have membranes 58 between neighboring first- and second- high pressure chambers 35,37 for different fluids. One of the fluids is commonly oil, while the other may be a non-lubricating fluid, like, f.e., water.

The high pressure stage is provided in housing 81 to 86, while the medial pressure stage is provided in housing portion 80. A controller housing 18 is mounted to the medial pressure housing 80 and this controller housing 18 contains the flow control valve 17, which is in the Figures illustrated as a rotary valve.

The device becomes connected, for example, by a pipe or hose to a source of medial pressure fluid. The medial pressure fluid enters through entrance passage 26 into or along the control valve 17, which, when it is in operation, leads the medial pressure fluid in succession first through passage 92 into cylinder 14, thereafter into cylinder 15 and then again into cylinder 14 to secure an upwards stroke of piston 8 when piston 9 strokes downward, and vice versa. Control ports 93 are the inlet ports of the rotary valve, while ports 94 are the return flow ports of the rotary valve 17. Thus, when a port 93 leads the medial pressure fluid to one of the cylinders 14 or 15, the outflow port 94 leads the lower pressure return fluid of of the respective cylinder 14 or 15, which has at that time the returning stroke piston 8 or 9 (downwards stroke = return stroke, upwards stroke = pressure fluid stroke).

The lower pressure fluid is, according to the

present invention, passed through passages 302,301 into the intake port 313 of a fluid motor 97, which is clutched directly or over a gear to the rotary control valve 17. When the return fluid flows through the fluid motor 97 it causes the shaft of this motor 97 to revolve, whereby the motor 97 revolves the control valve 17. The return fluid flows thereafter out of the fluid motor 97 through its outlet port 304. From there it is commonly passed back into the fluid tank.

The feature of this arrangement of the invention is, that no other drive means is required to revolve the control valve, since the motor 97 of the unit of the invention secures this action.

Important is, however, that the fluid motor 97 is set into the return fluid flow, because if it would be set into the intake flow before the intake port 26, it would be subjected to the medial pressure and would then have leakage and would have to be built for high pressure and strength. The inflow into the controller housing 18 would then be limited to the pressure capacity of the before-set motor. Thus, the fluid motor 97 must, according to the invention, be set into the return fluid line from the cylinders 14 and 15.

To obtain a long life time of the valves 238,239 of the high pressure stage, the number of strokes of the pistons per unit of time should be small, resulting in a limited number of openings and closing of the mentioned valves, equal to the number of strokes of the pistons. Therefore, it is preferred that the fluid motor 97 is a low pressure motor, which then is inexpensive, but that the flow through volume through motor 97 per unit of revolution (commonly called CC/revolution) is 5 to 20 times higher than the inflow quantity of medial pressure fluid which passed into intake port 26 at the same unit of time. For example, if 40 liter per minute flow into port 26, and if the speed of the rotary valve shall be 200 Rpm, the consumption volume of the motor 97 should roughly be $40\ 000\ \text{CC}/200\ \text{rpm} = 200\ \text{CC}/\text{rev}$, meaning 200 cubic centimeter per revolution.

The rotary valve 17 may also be used to drive on its other end a fluid supply pump 96 for the upholding of a return push pressure in the medial chamber 44-46 to force the pistons downwards, when the ports 94 open the cylinders. A fluid line 305 may deliver this fluid from pump 96 into the medial chamber 44-46.

While Fig. 7 illustrates the same device as Figure 6, it shows a number of alternatives or features. For example, the pressure valve 425 with load 425 is set into fluid line 305 to act as a breaking means for the rotary valve to prevent sudden fluctuations or overspeed of the rotary valve. The valve 424 prevents such overspeed of valve 17 by forcing the pump 96 to work against

the set pressure of valve 424. Further, the pressure in the medial chamber 44-46 may be controlled by the overflow valve 414 of the mentioned medial chamber.

An important means and novelty is also the setting of the overflow valve 409, loaded by f.e. spring 410, in the intake fluid line 26 or 408 before the control valve 17. The valve 409 must have a passage 412 to the intake port 313 of fluid motor 97. This arrangement is important in order to get the overflow from the medial pressure pump 19 passed through the fluid motor 97 to let this motor revolve, if all medial pressure fluid flows over the overflow valve 409. If this important arrangement is not provided, the device of the invention would come to a stop at the entire time when the fluid supply flows over the overflow valve 409. If this safety valve 409 is set remote from the device of the invention onto the supply pump 19, a fluid passage must become set from the valve to the intake port of the fluid motor 97.

Figure 8 illustrates a pressure ratio valve, which is very helpful in the device of the invention. For example, the pressure in the medial chamber 44-46 should at all times be higher than the pressure in the intake port 313 to fluid motor 97, because otherwise the pistons 8,9,5,6 would not stroke downwards for the return stroke. The device would come to a stop. Or, if the pressure in the chambers 35 would at the intake stroke be higher than the pressure in inlet port 417, the chambers 37 would not take in fluid. The membranes 58 would then not be deflected and the pump would not deliver high pressure fluid.

Port 431 of the valve of Figure 8 should therefore be connected to the chamber or passage of the higher pressure of a neighboring portion, while the port 428 of Figure 8 should be connected to the lower pressure passage or chamber of the neighboring portions. Port 435 of Figure 8 should be connected to the pressure-less fluid tank or to a still lower pressure chamber of the device. If that is done, the lower pressure, if it increases to a dangerous degree, would move valve piston 432-433 of Figure 8 into the leftwards position (as shown in Fig. 8) to let the lower pressure fluid flow out through passages 434,436,435 in order to prevent a too high pressure in the lower pressure fluid. For that purpose the piston of Figure 8 is a differential piston in a differential cylinder with smaller and bigger diameter portions. The smaller portions being piston portion 432 and cylinder portion 430, while the bigger diameter portions are piston portions 433 and cylinder portion 427.

Pumps 402,403,404 with delivery ports 405,406,407 may be set if so desired to serve additional actions in the device.

More details of the invention are defined in the

appended claims and the claims are therefore considered to constitute a portion of the description of the preferred embodiments and of their objects or aims.

Claims

1.) A high pressure pump wherein pistons pump against a membrane which delivers high pressure fluid over an exit valve, characterized therein, that the membrane 58 is clamped between two neighboring bodies whereof one forms the chamber 35,135,235 on one end of the membrane and the other forms the chamber 37,137,237 which communicates to an inlet valve 138 and an outlet valve 139 on the other end of said membrane 58, wherein the membrane is of substantial circular configuration and clamped and sealed by a circular ring portion between said bodies radially outwards of said chambers, while leakage collection recesses 61,61 are formed radially outwards of said circular ring portion and the outer portion of said membrane is extended into the outwardly extending portions of said bodies.

2.) A high pressure pump of claim 1, which has at least two pistons 5,101,205,8,108,208,9,10 reciprocable provided in cylinders 11,12,13,14,15,16, a medial pressure supply pump 19 and a control valve 17 for the control of flow of fluid from said pump 19 alternately and in timed succession to one or another of said pistons, wherein an improvement provides that the rotary revolution speed reduction gear 21,22 is provided between the rotor or shaft 20 of said pump 19 and said control valve 17.

3.) The pump of claim 1, wherein an improvement provides that at least two sets of said membranes, chambers, ring portions and recesses are provided axially of each other, clamped together by bolts 4,66 and one of said chambers is subjected to high pressure fluid while the other of said chambers is subjected to low pressure fluid with said high pressure and low pressure timely succeeding alternately in said chambers, whereby said bolts are permanently subjected to uniform load of high pressure in one of said chambers and alternating loads of said bolts are prevented.

4.) In a fluid pressure device at least a pair of in cylinders reciprocable pistons with a rotary control valve in a controller housing before said cylinders and between an inlet port and passages to said cylinders, wherein a return flow passage is provided from said cylinders to a fluid motor to flow through said

fluid motor to revolve its shaft, and, wherein said shaft of said fluid motor is clutched at least indirectly to said rotary valve to revolve said rotary valve by the return fluid flow out of said cylinders.

5.) The device of claim 4, wherein a relief valve is provided on said inlet port and the rear of said relief valve is provided with a passage to the inlet port of said motor to pass the overflow of said relief valve into said motor.

6.) In a fluid flow device two neighboring working elements under pressure from two different pressures, wherein a differential piston is provided in a differential cylinder to be able to reciprocate therein,

wherein the ports on the ends of said differential cylinder are individually communicated to said two different pressures, an outlet port is provided between said differential cylinders and a passage is provided through the bigger portion of said differential piston, in order that the pressure of one of said two different pressures remains at all times below the higher pressure of said two different pressures.

7.) The pump of claim 1, wherein said rotary speed reduction gear is provided between an electric motor and said valve 17.

8.) The device of claim 4, wherein said rotary control valve is replaced by a pivoting or axially reciprocating valve.

9.) The device of claim 4, wherein said cylinders and pistons are replaced by at least one fluid motor which includes pivoting or revolving members.

10.) The device of claim 9, wherein said rotary control valve is replaced by a pivoting or axially reciprocating valve.

11.) In a fluid flow device, the provision of a flow controlling member, provided closely, but moveably, fitted in a surrounding housing with said housing having fluid ports which are open towards portions or neighborhoods of said controlling member,

wherein said controlling member is provided through a portion of its interior with a high pressure passage from an inlet to at least one control port, while at least one return flow control port of said controlling member is communicated by a passage along the radial outer portion of said flow controlling member towards a return port of said housing.

Fig. 1

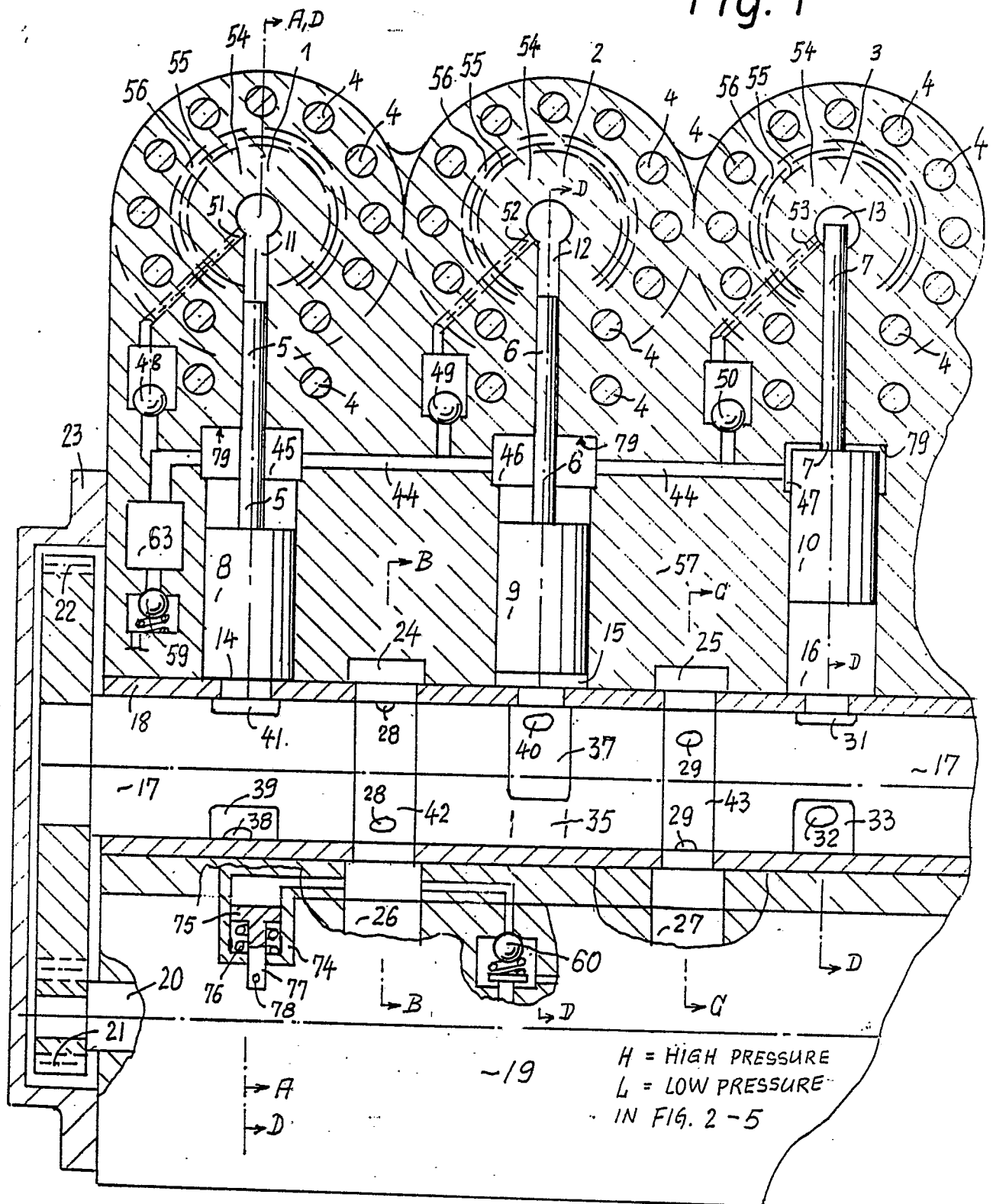


Fig. 2

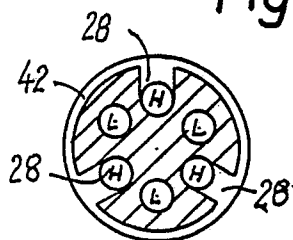


Fig. 3

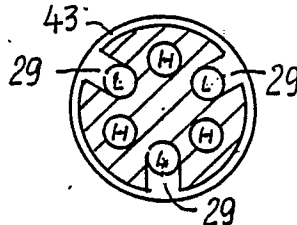
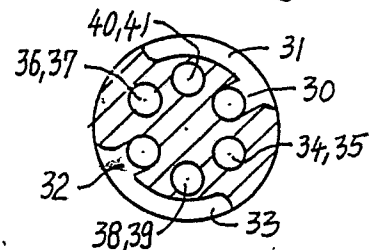


Fig. 4



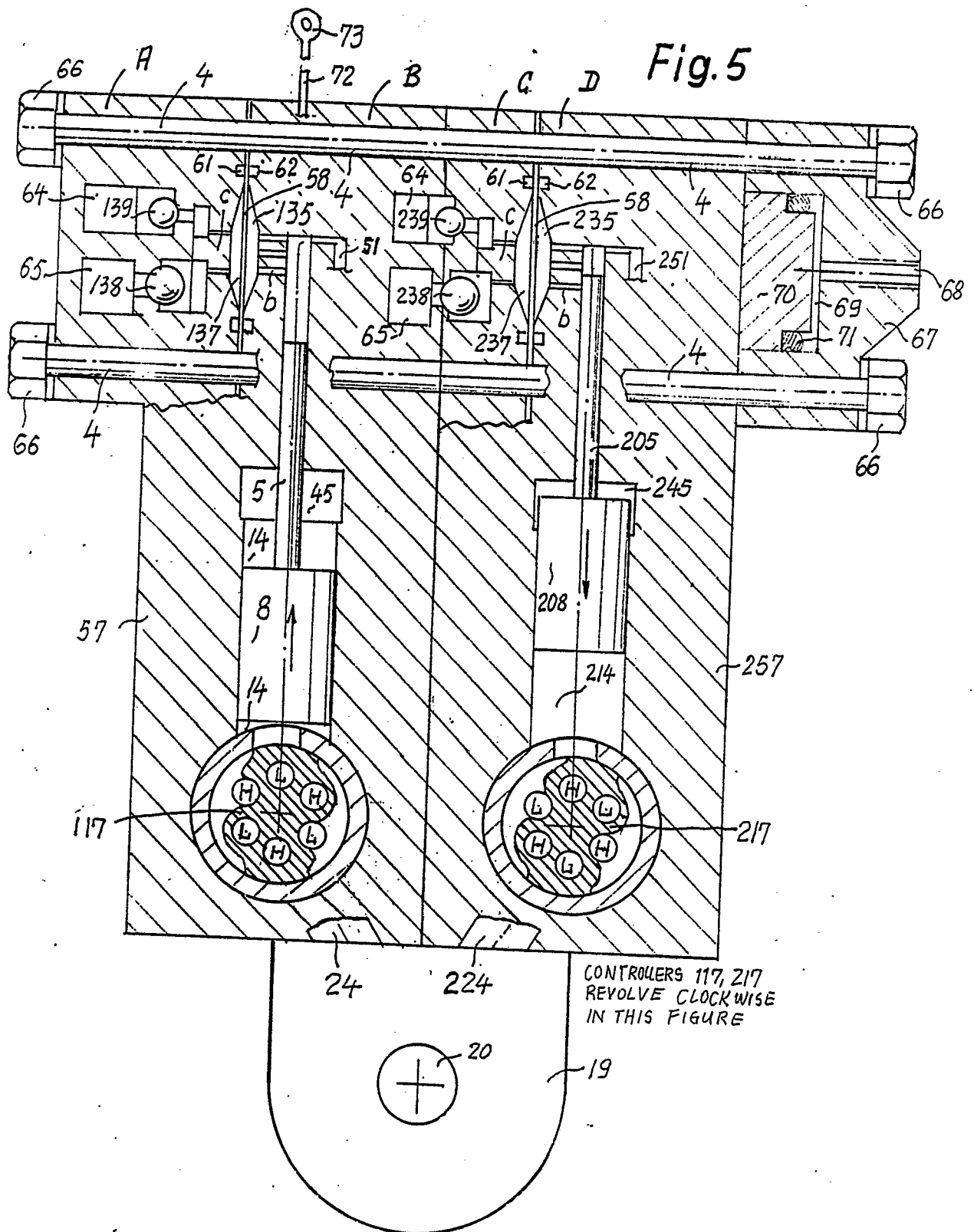


Fig. 6

