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PUMPING MECHANISM

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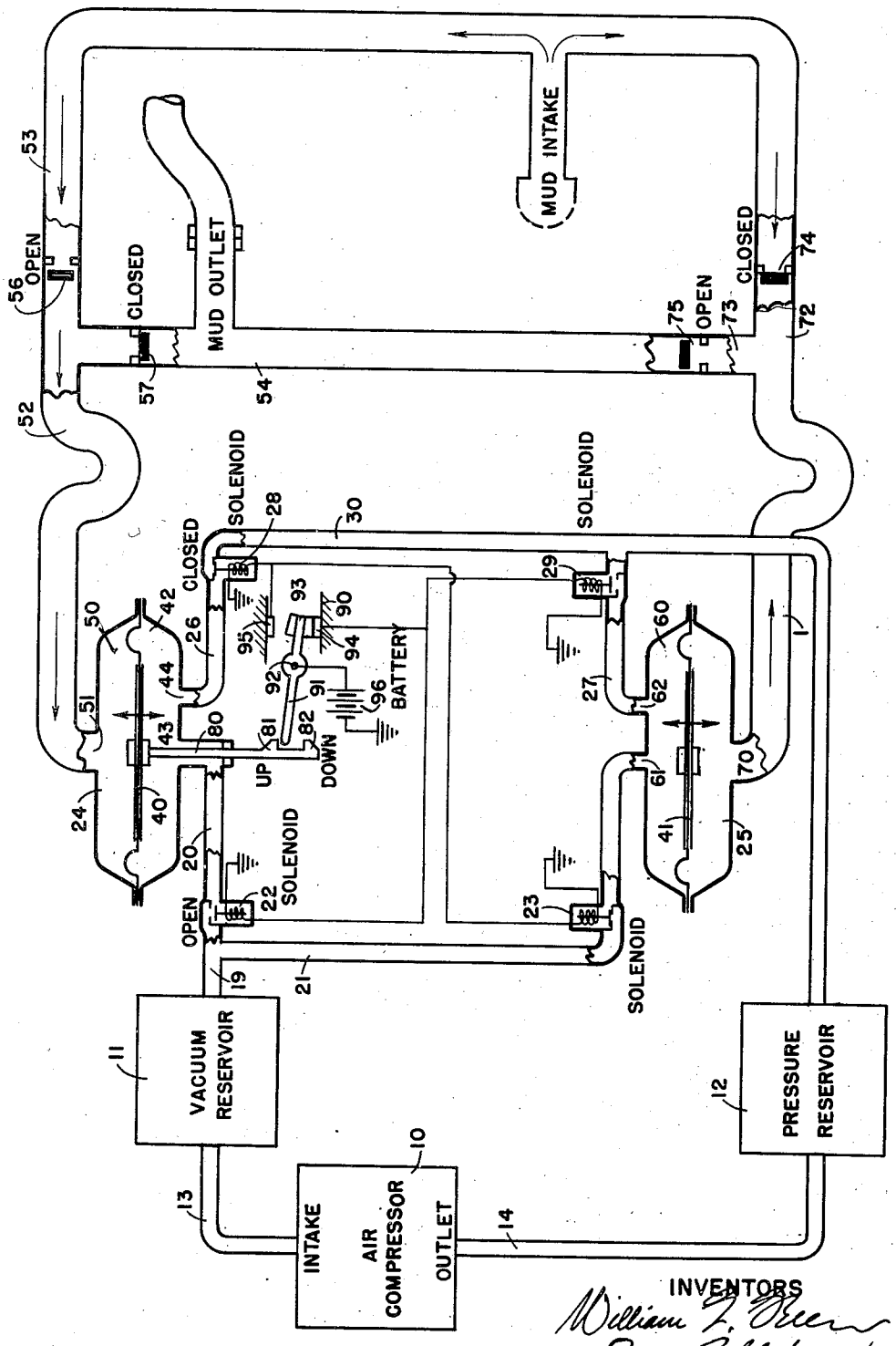

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PUMPING MECHANISM

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This invention relates to positive displacement pumps of the kind in which the displacing member is a metal bellows, diaphragm, or flexible wall which is hydraulically coupled to a prime mover by means of a suitable actuating or driving fluid.

One object of the invention is to provide improved means for pumping liquids possessing characteristics which make them difficult to handle, such as high thixotropy, high abrasive contents and high or variable viscosities. It is well known to those versed in the art that the handling of such materials is accompanied by an undesirable amount of wear to all moving parts coming in contact with liquids of this character.

Another object of this invention is to provide an improved means and method of maintaining automatically a more constant pump discharge pressure when pumping into varying head pressures. The speed of the pumping operation adjusts itself automatically to varying pressures, viscosities and flow in a manner such that when the resistance to flow of the pumped liquid is great, the pump pumps relatively slowly, and as the resistance to flow decreases, the rate of pumping increases substantially in proportion. This automatic variation in the rate of pumping is achieved by a "self-synchronous" switching arrangement which is arranged in a manner such that the period of the pumping stroke is automatically determined by the resistance to flow of the pumped liquid.

Such a variation in the rate of pumping is desirable, since, for a given power (in this case the power of the air compressor), the maximum possible rate of pumping is secured for all conditions of the liquid. The arrangement is somewhat analogous to the provision of a continuously variable gear between the prime mover and the pump elements.

The self-synchronous switching arrangement, referred to above, makes the pump entirely self-contained and containing its own timing mechanism. It should be pointed out that the switching mechanism described, employing electrically operated solenoids could be replaced by valves directly operated by the positions of the diaphragms. In the embodiment herein described, however, it is preferred to employ the solenoid valves for reasons of flexibility.

An important object of the present invention is to provide a pump which supplies constant power to the pumped liquid, i. e., the speed of the pumping operation adjusts itself automatically to varying pressures, viscosities and flow in a manner such that when the resistance to flow of the

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pumped liquid is great, the pumps pump relatively slowly, and as the resistance to flow decreases the rate of pumping increases substantially in proportion. This automatic variation in the rate of pumping is achieved by a "self-synchronous" switching arrangement which is arranged in a manner such that the period of the pumping stroke is automatically determined by the resistance to flow of the pumped liquid.

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The accompanying drawings represent in a single figure by way of example a form of construction and application of the pump according to the invention as well as control devices used for its actuation.

In the form of construction shown in the drawing the pump comprises an air compressor 10 which is in communication with a vacuum reservoir 11 and a pressure reservoir 12 by means of connecting pipes 13 and 14 respectively. The pump may be a multiple acting type wherein the vacuum reservoir 11 is put into communication by means of a manifold 19 with separate pipe conduits 20, 21 with two chambers 24 and 25 respectively. The pipe conduits 20, 21 are controlled by means of valves 22, 23, said valves being of solenoidal type wherein a plunger is being actuated by a current passing through a solenoid cooperating with said plunger. The chambers 24 and 25 are also put in communication with the pressure reservoir 12 through pipes 26, 27 controlled by valves 28, 29 respectively and through a pipe 30 in a manner shown in the figure. In these chambers are mounted in a fluid tight manner two flexible and impermeable diaphragms 40 and 41 respectively, which subdivide each chamber in two separate compartments. The lower compartment 42 of the chamber 24 has its wall pierced with holes 43 and 44. Through the hole 43 it is in communication with the vacuum reservoir 11 by means of the pipe 20 under the control of the valve 22 and by means of the pipe 19. Through the hole 44 it is in communication with the pressure reservoir 12 by means of the pipe 26 under control of the valve 28, said pipe being continued by the pipe 30. The upper compartment 50 of the chamber 24 has its wall pierced with a hole 51 through which it is in communication with

the main conduit 52, which is subdivided into two separate conduits 53 and 54 that are under the control of the valves 56 and 57 respectively.

The upper compartment 60 of the chamber 25 has its wall pierced with holes 61 and 62. Through the hole 61 it is in communication with the vacuum reservoir 11 by means of the pipe 21 under the control of the valve 23 and by means of the pipe 19. Through the hole 62 it is in communication with the pressure reservoir 12 by means of the pipe 27 under the control of the valve 29, said pipe being continued by the pipe 30.

The lower compartment of the chamber 25 has its wall pierced with a hole 70 through which it is in communication with the main conduit 71 which is subdivided into two separate conduits 72, 73 that are under the control of the valves 74, 75 respectively.

The conduits 52 and 71 are connected to the outlet through the pipe 54 and the conduits 52 and 71 are connected to the intake through the pipe 53.

In this case a double-acting operation is obtained, since the two diaphragms 40, 41 connected together exert alternately opposite actions in the chambers 24 and 25 of the respective bodies.

The diaphragm 40 is connected in its center portion to a rod 80 which is adapted to move up and down with the motion of the diaphragm. The lower portion of the rod has two members 81, 82 and is in operative engagement with a switch mechanism 90 which consists of a lever rod 91 pivotally mounted upon a fixed support 92 and provided at one of its extremities with a contact member 93. At convenient distances above and below the control member 93 are provided two fixed contact terminals 94 and 95 that are inserted into an electrical circuit energized by a battery 96 and including solenoidal coils for the actuation of the valves 22, 23, 28 and 29. The movable contact member 93 is actuated by the rod 80 in such a manner that when the rod 80 is in the "down" position an electrical connection is established between the movable contact member 93 and the fixed contact member 94.

The four solenoids actuating the valves 22, 23, 28 and 29 are connected to the electrical energizing circuit supplied by the battery 96 in a manner such that when the rod is in the "up" position, solenoids actuating the valves 22 and 29 become suddenly energized and their corresponding valves become open. In this position vacuum from the reservoir 11 is applied to the lower compartment 42 of the chamber 24 and pressure from the reservoir 12 is applied to the upper compartment 60 of the chamber 25. Because of the action of the vacuum and of the pressure, the diaphragms 40 and 41 are moved in a downward direction. It can be seen that when the diaphragm 40 is moved to the "down" position by a certain amount the rod will operate the switch 90 so as to throw it into a position that corresponds to deenergizing the solenoids actuating the valves 22 and 24 and energizing the solenoids actuating the valves 23 and 28; thus, when the rod 80 has completed its excursion in the downward direction, valves 22 and 29 close and valves 23 and 28 open. In this position corresponding to the end of the down stroke or rod 80, vacuum is applied to the lower compartment 42 of the chamber 24 and pressure is applied to the upper compartment 80 of the chamber 25, and the diaphragms 40 and 41 are forced upward. It can be seen that upon completion of upward stroke the switch 90 is again thrown and the cycle is repeated.

The action of the air compressor 10 in collaboration with the switch 40 and the rod 80 is such that the diaphragms 40 and 41 move in a reciprocating motion. Thus, the diaphragms move together, first in a downward direction, then stop, then move together in an upward direction as indicated by the arrows. Because at all times when pressure is applied to one of the diaphragms vacuum is applied to the other, the two diaphragms move in phase and this reciprocating motion continues as long as the air compressor is in operation.

The reciprocating motion referred to above causes alternate vacuum and pressure to appear in the pipes 52 and 71 in a manner such that when vacuum appears in 52 pressure appears in 71 and vice versa. The action of the clapper valves 56, 57, 79 and 75 is such that when the pipe 50 contains vacuum, valve 57 is closed and valve 56 is open and thus vacuum is communicated to the intake. When the pipe 72 contains pressure, valve 74 is closed and 75 is open, and thus the pressure is transmitted into the outlet. When the pipe 72 contains vacuum valve 75 is closed and 74 is open, and the vacuum is communicated to the intake.

It is seen, therefore, that the valves 56, 57, 74 and 75 act automatically so as to translate the alternate pressures and vacua in pipes 52 and 72 into a steady vacuum in the intake and a steady pressure in the outlet. This action is somewhat similar to the action of an electric full wave rectifier in which alternating current is translated into direct current. This action tends to produce a flow of mud between the intake and the outlet.

The nature and objects of the present invention having been thus described, what is claimed as new and useful and is desired to be secured by Letters Patent is:

1. In a mechanism for pumping a fluid, two reservoirs comprising a driving fluid, means operatively connecting said two reservoirs for maintaining a difference of the pressure of said fluid therebetween, two chambers, each of said chambers having a flexible diaphragm separating it into two compartments containing the delivery fluid and the driving fluid, respectively, a system of conduits connecting the compartment of each of the said chambers that contain the driving fluid with said two reservoirs, a plurality of valves operatively engaged with said system of conduits to control the motion of said fluid between said reservoirs and said chambers thereby causing corresponding displacements of said diaphragms, means for selective actuation of said valves in order to cause an alternate motion of said diaphragms, and a circulating system connected to the compartments of each of said two chambers that contain the delivery fluid, said circulating system being filled with said delivery fluid and comprising an input pipe and an output pipe, and a system of valves operatively engaged with said circulating system for providing a uniform motion of said delivery fluid in response to the alternate motion of said diaphragms.

2. In a mechanism for pumping fluids, two reservoirs comprising a driving fluid, means operatively connecting said two reservoirs for maintaining a difference of pressure of said fluid therebetween, a chamber provided with a movable member separating it into two compartments containing the delivery fluid and the driving fluid, respectively, a system of conduits connecting the

compartment of said chamber that contains the driving fluid with said two reservoirs, a plurality of valves operatively engaged with said system of conduits to control the motion of said fluid between said reservoirs and said chamber thereby causing corresponding displacements of said movable member, means responsive to the displacements of said movable member for selective actuation of said valves in order to cause an alternate motion of said member, and a circulating system connected to the compartment that contains the delivery fluid, said circulating system being filled with said delivery fluid and comprising an input pipe and an output pipe, and a system of valves operatively engaged with said circulating system for providing a uniform motion of said delivery fluid in response to the alternate motion of said movable member.

3. In a mechanism for pumping a delivery fluid, two reservoirs comprising a driving fluid, means operatively connected to said two reservoirs for maintaining a difference of pressure of said fluid therebetween, a chamber provided with a flexible diaphragm separating it into two compartments containing the delivery fluid and the driving fluid, respectively, a system of conduits connecting the compartment of said chamber that contains the driving fluid with said two reservoirs, valves operatively engaged with said system of conduits to control the motion of said fluid between said reservoirs and said chamber thereby causing corresponding displacements of said diaphragm, means responsive to the displacements of said diaphragms for selective actuation of said valves in order to cause an alternate motion of said diaphragm, and a circulating system connected to the compartment that contains the delivery fluid, said circulating system being filled with said delivery fluid and comprising an input pipe and an output pipe, and a system of valves operatively engaged with said circulating system for providing a uniform motion of said delivery fluid in response to the alternate motion of said diaphragms.

4. In a mechanism for pumping a delivery fluid, two reservoirs comprising a driving fluid, means operatively connected to said two reservoirs for maintaining a difference of pressure of said fluid therebetween, two chambers, each of said chambers having a movable member separating it into two compartments containing the delivery fluid and the driving fluid, respectively, a system of conduits connecting the compartment of each of the said chambers that contain the driving fluid with said two reservoirs, a plurality of valves operatively engaged with said system of conduits

to control the motion of said fluid between said reservoirs and said chambers thereby causing corresponding displacements of said movable member, means responsive to the displacements of at least one of the said members for selective actuation of said valves in order to cause an alternate motion of said member and a circulating system connected to the compartments of each of said two reservoirs that contain the delivery fluid, said circulating system being filled with said delivery fluid and comprising an input pipe and an output pipe, and a system of valves operatively engaged with said circulating system for providing a uniform motion of said delivery fluid in response to the alternate motion of said movable members.

5. In a mechanism for pumping a delivery fluid, two reservoirs comprising a driving fluid, means operatively connected to said two reservoirs for maintaining a difference of pressure of said fluid therebetween, two chambers, each of said chambers having a flexible diaphragm separating it into two compartments containing the delivery fluid and the driving fluid, respectively, a system of conduits connecting the compartment of each of the said chambers that contain the driving fluid with said two reservoirs, a plurality of valves operatively engaged with said system of conduits to control the motion of said fluid between said reservoirs and said chambers thereby causing corresponding displacements of said diaphragms, means responsive to the displacements of at least one of the said diaphragms for selective actuation of said valves in order to cause an alternate motion of said diaphragms, and a circulating system connected to the compartments of each of said two reservoirs that contain the delivery fluid, said circulating system being filled with said delivery fluid and comprising an input pipe and an output pipe, and a system of valves operatively engaged with said circulating system for providing a uniform motion of said delivery fluid in response to the alternate motion of said diaphragms.

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