Jan. 31, 1956 V. L. PARSEGIAN 2,732,807

DIAPHRAGM PUMP

Filed July 11, 1951 3 Sheets-Sheet 1

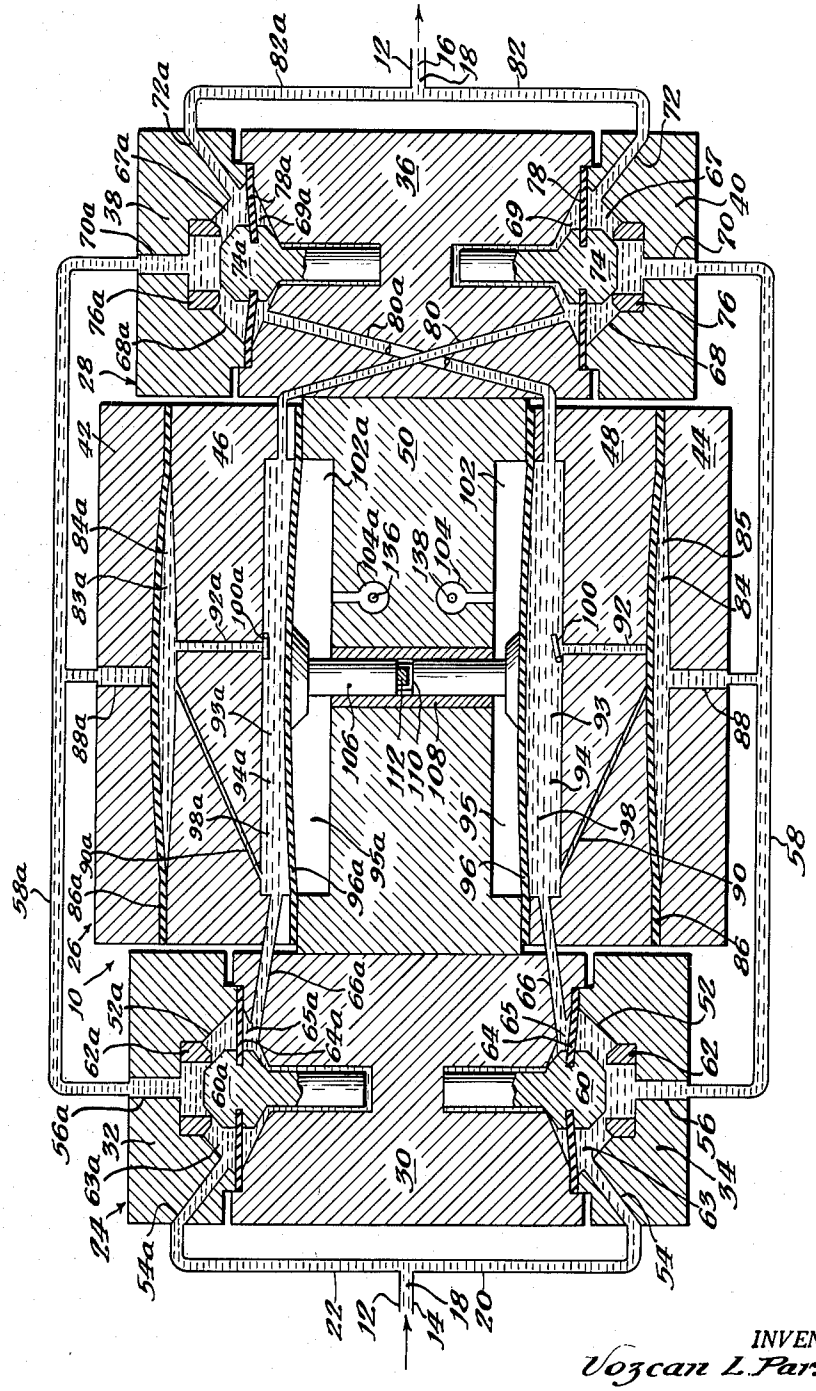

FIG. 1

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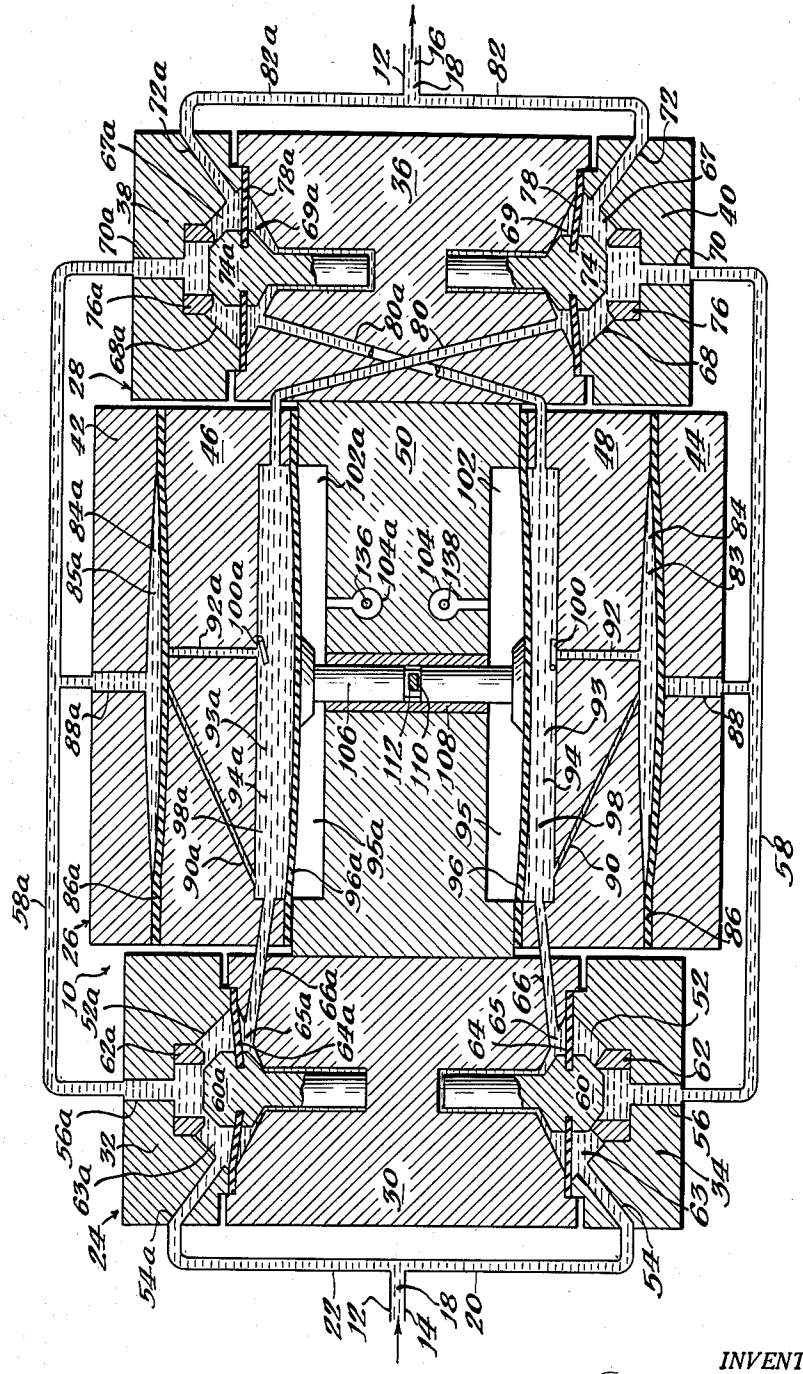

FIG. 2

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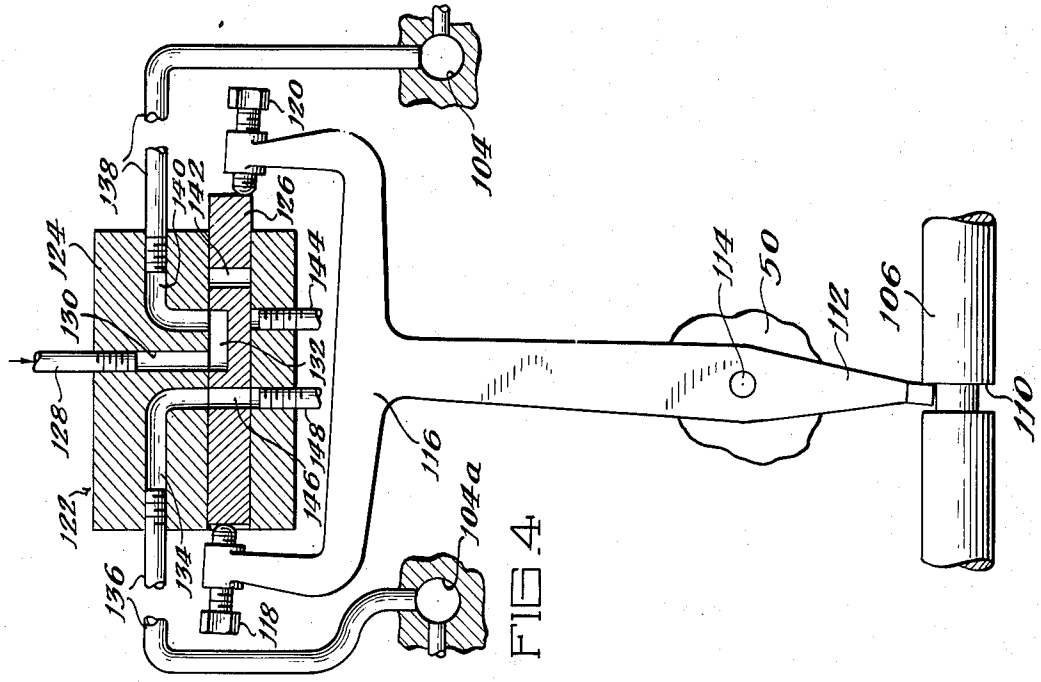

FIG. 4

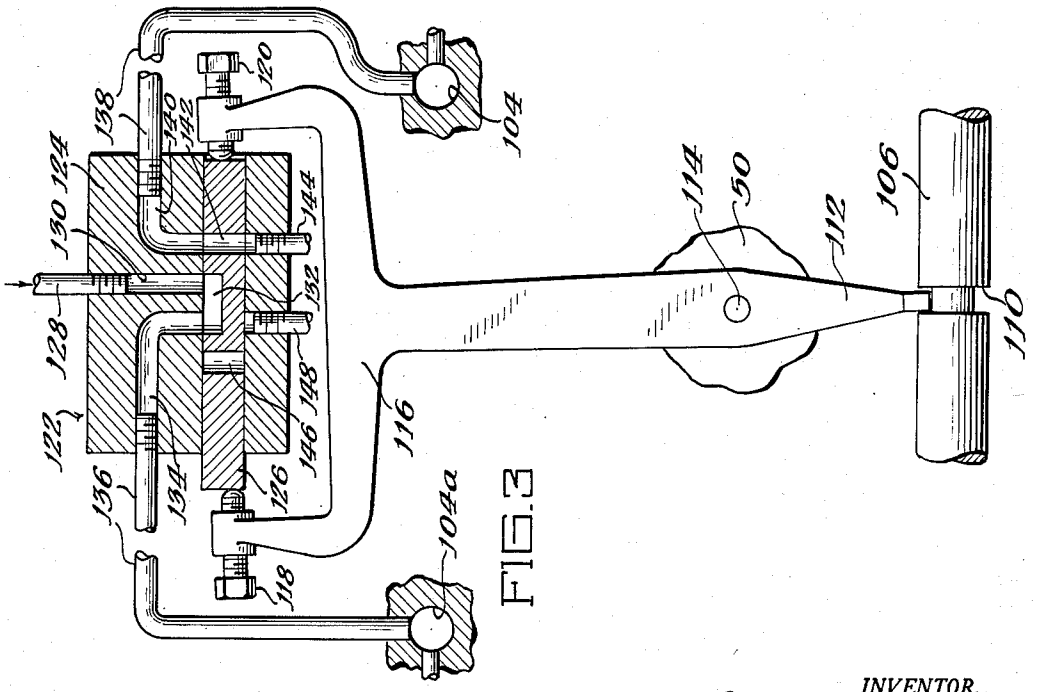

FIG. 3

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DIAPHRAGM PUMP

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7 Claims. (Cl. 103—152)

This invention relates to pumps and in particular it pertains to diaphragm pumps.

The pump of the present invention is particularly well designed for the handling of highly corrosive radioactive liquids and provides accurate metering that is reproducible over an extended period of time.

For explanation of the invention reference is made to the accompanying drawings, wherein:

Figure 1 is a schematic view showing the phase of operation of a double-acting pump in which one chamber has completed the suction stroke while the other chamber has completed the pumping stroke;

Figure 2 is a schematic view similar to Figure 1 in which the chambers are reversed in phase;

Figure 3 is a vertical view partly in section of a rocker arm and an air-distributing valve showing their positions when the pump is in the phase shown in Figure 1; and

Figure 4 is the same as Figure 3 except that it corresponds to the phase of the pump shown in Figure 2.

In Figures 1 and 2, a pump generally indicated at 10 is shown disposed in a pipe line 12 between a point 14 of low pressure and a point 16 of high pressure. As a liquid 18 being pumped passes the point 14 of low pressure, half of it moves through a branch 20 and the other half moves through a branch 22.

The moving parts of the pump are contained within three interconnected housing units generally indicated at 24, 26 and 28. The housing unit 24 at the intake end of the pump consists of a central section 30 and two end sections 32 and 34. Similarly at the exhaust end of the pump 10 the housing unit 28 consists of a central section 36 and two end sections 38 and 40. The central housing unit 26 comprises two outer housings 42 and 44, two intermediate housings 46 and 48, and a central housing 50.

Since the pump 10 is a double-acting pump having two halves that operate alternately, the remainder of the pump will be described by identifying the various parts on one side of an imaginary line between the point 14 of low pressure and the point 16 of high pressure. Corresponding parts on the other side of said line will be given the same reference number plus the letter "*a*."

The end section 34 fits against the central section 30 to form an intake valve chamber 52 having an inlet 54 and an outlet 56 disposed in said end section. The inlet 54 connects with the branch 20 of the pipe 12 while the outlet 56 connects with a pipe 58. Centrally disposed within the chamber 52 is a valve body 60 that is normally sustained in a closed position against a valve seat 62 by a diaphragm 64. The periphery of the diaphragm 64 is secured between the central section 30 and the end section 34, dividing the chamber 52 into two portions 63 and 65 adjacent sections 34 and 30, respectively. Portion 63 has been described as having the valve inlet 54 and the valve outlet 56, and the portion 65 communicates with a conduit 66.

At the exhaust side of the pump 10 the end section 40 fits against the central section 36 to form an exhaust

valve chamber 68. Generally, said chamber is identical with the intake valve chamber 52 just described, comprising a valve inlet 70, a valve outlet 72, a valve body 74, a valve seat 76, a valve disphragm 78 and a conduit 80. The diaphragm 78 partitions the chamber 68 into portions 67 and 69 adjacent sections 40 and 36, respectively. Portion 67 communicates with the inlet 70 and the outlet 72, and portion 69 communicates with a conduit 80. The valve inlet 70, in turn, communicates with the pipe 58 and the valve outlet 72 communicates with a branch 82 of the pipe 12.

Between the outer housing 44 and the intermediate housing 48 is formed a pump chamber 84 which is partitioned by a diaphragm 86, serving as a piston therein. One portion 83 of the chamber 84 (Figure 2) is disposed between the diaphragm 86 and the intermediate housing 48, while a portion 85 (Figure 1) is disposed between said diaphragm and the outer housing 44. Connected to the portion 85 is a single entry 88 passing through the outer housing 44 and connecting said chamber with the pipe 58. On the other side are disposed a restricted passage 90 and a passageway or passage 92 communicating with the portion 83. A "restricted passage" as used herein and in the claims refers to a passage having a flow resistance which is high relative to that of the other passages communicating with the respective chambers in the fluid system. Both passages 90 and 92 connect the pump chamber 84 with a compartment 94 which is disposed between the intermediate housing 48 and the central housing 50. A diaphragm 96 partitions the compartment 94 into portions 93 and 95 adjacent the housings 48 and 50, respectively.

The portion 65 of the intake valve chamber 52 and the portion 69*a* of the exhaust valve chamber 68*a* are connected to the portion 93 of the chamber 94 by means of the conduit 66 and the conduit 80*a*, respectively. A hydraulic fluid 98 completely fills the portion 93 of the compartment 94 together with the conduits 66 and 80*a*, the passages 90 and 92 and the valve portions 65 and 69*a*. In the passage 92 is disposed a self-actuated one-way valve 100 that permits passage of the hydraulic fluid 98 only from the pump chamber 84 to the compartment 94 and not in the opposite direction. Such a valve, shown schematically in the drawings, may be a flap valve or any other type of one-way check valve well known in the art.

The portion 95 of the compartment 94 is filled with compressed air 102 that enters and leaves said chamber through a manifold 104. The transmitted pressure is alternately applied through the manifold 104 and 104*a*. Although air is used, any fluid may be used to transmit pressure to the diaphragms.

Through the center of the central housing 50 is a connecting shaft 106 extending in a direction normal to the diaphragms 96 and 96*a* to which the ends of said shaft are respectively attached. The diaphragms 96 and 96*a* thus move simultaneously in the same direction. Around that portion of the shaft 106 within the central housing 50 is a sleeve bearing 108 that serves to seal the compartment 94 from the compartment 94*a*. Centrally of the shaft 106 is an annular notch 110, more clearly shown in Figures 3 and 4. This notch serves to accommodate the lower end of a rocker arm 112 that will be explained below in reference to Figures 3 and 4.

It is to be pointed out that the pump 10 contains two closed hydraulic systems which are separate and independent of each other, namely, the system filled by the hydraulic fluid 98 and the system filled by the hydraulic fluid 98*a*. The system filled by the latter fluid includes the chamber portion 93*a*, the conduits 66*a*, and 80, the passages 90*a* and 92*a*, together with the pump chamber 84*a*, the intake valve chamber 65*a* and the exhaust valve

chamber 68. The necessity for separate hydraulic systems will be further set forth in the description of the operation of the pump 10.

Inasmuch as the pump 10 is operated pneumatically, means for alternating the air pressure between the manifolds 104 and 104a is provided as shown in Figures 3 and 4 which illustrate the same device in positions corresponding to those illustrated in Figures 1 and 2, respectively. Referring to Figures 3 and 4, the rocker arm 112 is a first-class lever pivoted to the central housing by a pin 114 with the lower end of the rocker arm 112 disposed in the annular notch 110 on the shaft 106. The upper end of the arm 112 incorporates a yoke 116 having set screws 118 and 120 mounted in each side. Within the yoke 116 is a distributing valve generally indicated at 122 which reverses the direction of the air pressure between the manifolds 104 and 104a. The distributing valve 122 comprises a stationary block 124 in which is disposed a reversible slide 126. Incoming air from a source, not shown in the drawing, enters at the top through a pipe 128 connecting with a channel 130 in the block 124. In the position shown in Figure 3, the slide 126 directs air through a notch 132 in said slide to a duct 134 that connects with a conduit 136 leading to the manifold 104a. Simultaneously the air leaving the manifold 104 passes through a conduit 138 that communicates with a duct 140 which is aligned with an aperture 142 in the slide 126, permitting the air to exhaust through an outlet 144. Manifestly, as the arm 112 rocks on the pinion 114, the reversible slide 126 moves between the positions shown in Figures 3 and 4. As a result the air entering through the channel 130 is directed by the notch 132 into the duct 140 (Figure 4) and through the conduit 138 to the manifold 104. Meanwhile the air 102 is exhausted through the manifold 104a and passes through conduit 136, the duct 134, an aperture 146 in the slide 126 and into the atmosphere through an exhaust outlet 148.

Operation

Operation of the pump 10 depends primarily upon the alternate reciprocation of the diaphragms 86 and 86a. By simultaneous suction and pumping strokes these diaphragms alternately move the liquid 18 being pumped from the point 14 to the point 16 through the pipes 58 and 58a, as shown by the arrows in Figures 1 and 2 at the point 14. In Figure 1, the diaphragm 86 is disposed against the intermediate housing 48 at the completion of the suction stroke. During this stroke said diaphragm has moved across the chamber 84 (to the position shown), the intake valve outlet 56 being open and the exhaust valve inlet 70 being closed. Simultaneously the diaphragm 86a has moved across the chamber 84a (to the position shown) pumping out the liquid 18 being pumped. During this pumping stroke the intake valve inlet 54a is closed and the exhaust valve outlet 72a is open. In Figure 2 the diaphragms 86 and 86a are shown at the completion of their next half-cycle; that is, the diaphragm 86 is shown at the completion of its pumping stroke while the diaphragm 86a is shown at the completion of its suction stroke.

By alternating the air pressure between the compartment portions 95 and 95a, the diaphragms 96 and 96a are actuated. As air pressure is increased in the portion 95, the diaphragm 96 is displaced against the hydraulic fluid 98. The immediate effect is to transmit the pressure thereby created through the fluid 98 to the valve portions 65 and 69a which are thereby closed. Less immediate is the movement of the fluid 98 via the restricted passage 90 to the chamber portion 83, the check valve 100 being closed. As the fluid 98 fills the chamber portion 83, the diaphragm 86 moves across said chamber (to the position shown in Figure 2) performing the pumping stroke and forcing the liquid 18 being pumped through the exhaust valve chamber 68. While the above events transpire the diaphragm 86a in the pump chamber 84a is undergoing a suction stroke, whereby said chamber is being filled with the liquid 18 being pumped. This is made possible by exhausting the air 102a in the compartment 94a, permitting the diaphragm 96a therein to be drawn by the connecting shaft 106 to the position shown in Figure 2. In turn the resulting pressure release on the hydraulic fluid 98a opens the valve chambers 63a and 67. The check valve 100a permits free flow of the hydraulic fluid 98a from the chamber 83a to the chamber 93a.

As the connecting shaft 106 approaches that position, shown in Figure 2, it reverses the reversible slide 126 in the distributing valve 122 to the position shown in Figure 3. In this manner the compressed air 102 is again directed into the manifold 104a, permitting the air 102 to exit through the manifold 104. Inasmuch as this reversal immediately causes the two hydraulic systems to reverse their pressures, the intake and exhaust valves again assume the positions shown in Figure 1 and the diaphragms 86 and 86a ultimately move to the positions shown in the same figure.

Where necessary it is possible to adjust the movement of the shaft 106 with respect to the reversible slide 126, by adjusting the set screws 118 and 120.

Since certain changes can be made in the foregoing device and different embodiments may be employed in practicing the invention, it is intended that all matters shown in the accompanying drawings and described hereinbefore shall be interpreted as illustrative only and may be modified without departing from the intended scope of the invention.

What is claimed is:

1. A pump comprising a housing having two pump chambers, a first diaphragm in each chamber, an intake diaphragm valve coupled to each chamber on one side of said diaphragm, an exhaust diaphragm valve coupled to each chamber on the same side of said diaphragm, a passageway and a restricted passage of lesser diameter than the passageway in the housing and connected to each chamber on the opposite side of said diaphragm, a one-way valve in each passageway adapted to admit fluid from the chamber, a compartment connected to each pair of passages and passageways, a second diaphragm in each compartment, a connecting shaft attached to the second diaphragms on the sides opposite the passage and passageway, a first conduit coupling each intake valve to the compartment that is connected to its corresponding chamber, a second conduit coupling each exhaust valve to the compartment that is connected to the opposite chamber, said conduits entering the compartments on the same side of the second diaphragm as the passage and passageway, a hydraulic fluid in each compartment, compressed air means for reciprocating the second diaphragms alternately, said compressed air means including an air distributing valve attached to the connecting shaft and having an inlet and a first outlet and a second outlet, a third conduit and a fourth conduit connecting the first outlet and a second outlet of the air distributing valve to the compartments on the same side of the second diaphragms as the connecting shaft, said conduits not being connected, and said one-way valves adapted to permit movement of the fluid from the chamber to the compartment.

2. A pump comprising a housing having two pump chambers, two compartments, two restrictive passages, two passageways, one passageway and one passage connecting one chamber to one compartment and the other passage and passageway connecting the other chamber to the other compartment, a first diaphragm in each chamber, a second diaphragm in each compartment, an intake diaphragm valve coupled to each chamber on the side of the diaphragm opposite said passage, an exhaust diaphragm valve coupled to each chamber on the same side of the diaphragm, a connecting shaft in the housing attached to the second diaphragms on the sides opposite

the passage, a hydraulic fluid in each compartment, a check valve in each passageway, said check valve being adapted to admit fluid to the compartment, a first conduit coupling each intake valve to the corresponding compartment on the side of the diaphragm opposite the shaft, a second conduit coupling each exhaust valve to the compartment of the opposite chamber, said conduits entering the compartments on the side of the second diaphragm opposite the shaft, an air distributing valve connected to the shaft, compressed air means for reciprocating the second diaphragms alternately, and the housing having air ports connecting the compartments on the shaft sides of the diaphragms with the air valve.

3. A pump comprising means forming a pump chamber, a movable wall dividing the chamber into a first compartment and a second compartment, an intake valve connected to the first compartment of the chamber, an exhaust valve connected to the first compartment of the chamber, and means including a hydraulic fluid system connected to the second compartment of the chamber and to the valves for reciprocating the wall and for alternately opening and closing the valves, the last mentioned means further including a restricted passage, a passageway, and a one-way valve associated with said passageway for delaying the pumping stroke of said wall with respect to the movement of said valves.

4. A pump comprising means forming a pump chamber, a diaphragm dividing the chamber into a first compartment and a second compartment, an intake valve connected to the first compartment of the chamber, an exhaust valve connected to the first compartment of the chamber, and means including a hydraulic fluid system connected to the second compartment of the chamber and to the valves for reciprocating the diaphragm and for alternately opening and closing the valves, the last mentioned means further including a restricted passage for delaying the pumping stroke of said diaphragm with respect to the movement of said valves.

5. A pump comprising a housing having a first pump chamber and a second pump chamber, a first diaphragm in each chamber, first and second intake valves connected to the first and second chambers, respectively, on one side of said diaphragms, first and second exhaust valves connected to the first and second chambers, respectively, on the same side of said diaphragms, a passageway and a restricted passage of lesser diameter than the passageway in the housing and connected to each chamber on the opposite side of said diaphragms, a one-way valve in each passageway adapted to admit fluid from the chambers, a compartment in the housing connected to each pair of passages and passageways, a second diaphragm in each compartment, a hydraulic fluid in each compartment and chamber between said diaphragms, and means including alternating pressure mediums for producing reciprocation of the second diaphragms alternately, such reciprocation acting through the hydraulic fluid to open and close the first intake valve and the second exhaust valve alternately with the first exhaust valve and the second intake valve, said one-way valve adapted to permit movement of the fluid from the chamber to the compartment.

6. A pump comprising a housing having a first pump chamber and a second pump chamber, a first diaphragm in each chamber, first and second intake valves connected to the first and second chambers, respectively, on one side of said diaphragms, first and second exhaust valves connected to the first and second chambers, respectively, on the same side of said diaphragms, a passageway and a restricted passage of lesser diameter than the passageway in the housing and connected to each chamber on the opposite side of said diaphragms, a one-way valve in each passageway adapted to admit fluid from the chambers, a compartment in the housing connected to each pair of passages and passageways, a second diaphragm in each compartment, a connecting shaft slidably disposed between the second diaphragms on the side opposite the passage and passageway, a hydraulic fluid in each compartment and chamber between said diaphragms, and means including alternating pressures for producing reciprocation of the second diaphragms alternately, such reciprocation acting through the hydraulic fluid to open and close the first intake valve and the second exhaust valve alternately with the first exhaust valve and the second intake valve, said one-way valve adapted to permit movement of the fluid from the chamber to the compartment.

7. A pump comprising a housing having a first pump chamber and a second pump chamber, a first diaphragm in each chamber, first and second intake diaphragm valves connected to the first and second chambers, respectively, on one side of said diaphragms, first and second exhaust diaphragm valves connected to the first and second chambers, respectively, on the same side of said diaphragms, a passageway and a restricted passage of lesser diameter than the passageway in the housing and connected to each chamber on the opposite side of said diaphragms, a one-way valve in each passageway adapted to admit fluid from the chambers, a compartment in the housing and connected to each pair of passages and passageways, a first conduit connecting each intake diaphragm valve to the compartment that is connected to its corresponding chamber, a second conduit connecting each exhaust diaphragm valve to the compartment that is connected to the opposite chamber, a second diaphragm in each compartment, a connecting shaft slidably disposed between the second diaphragms on the side opposite said passage and passageway, a hydraulic fluid in each compartment and chamber between each pair of first and second diaphragms, and means including alternating pressure mediums for producing reciprocation of the second diaphragms alternately, such reciprocation acting through the hydraulic fluid to open and close the first intake valve and the second exhaust valve alternately with the first exhaust valve and the second intake valve, said one-way valve adapted to permit movement of the fluid from the chamber to the compartment.

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