

[54] AIR PRESSURE-ACTUATED
DOUBLE-ACTING DIAPHRAGM PUMP

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Related U.S. Application Data

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[52] U.S. Cl. 417/454, 92/128

[51] Int. Cl. F04b 21/06

[58] Field of Search 417/395, 404, 454; 92/128

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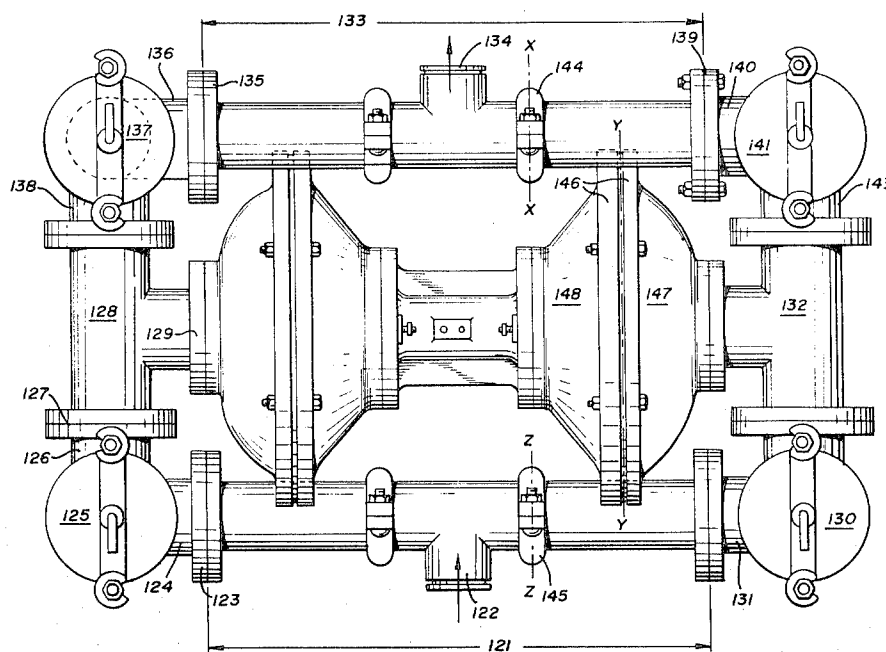
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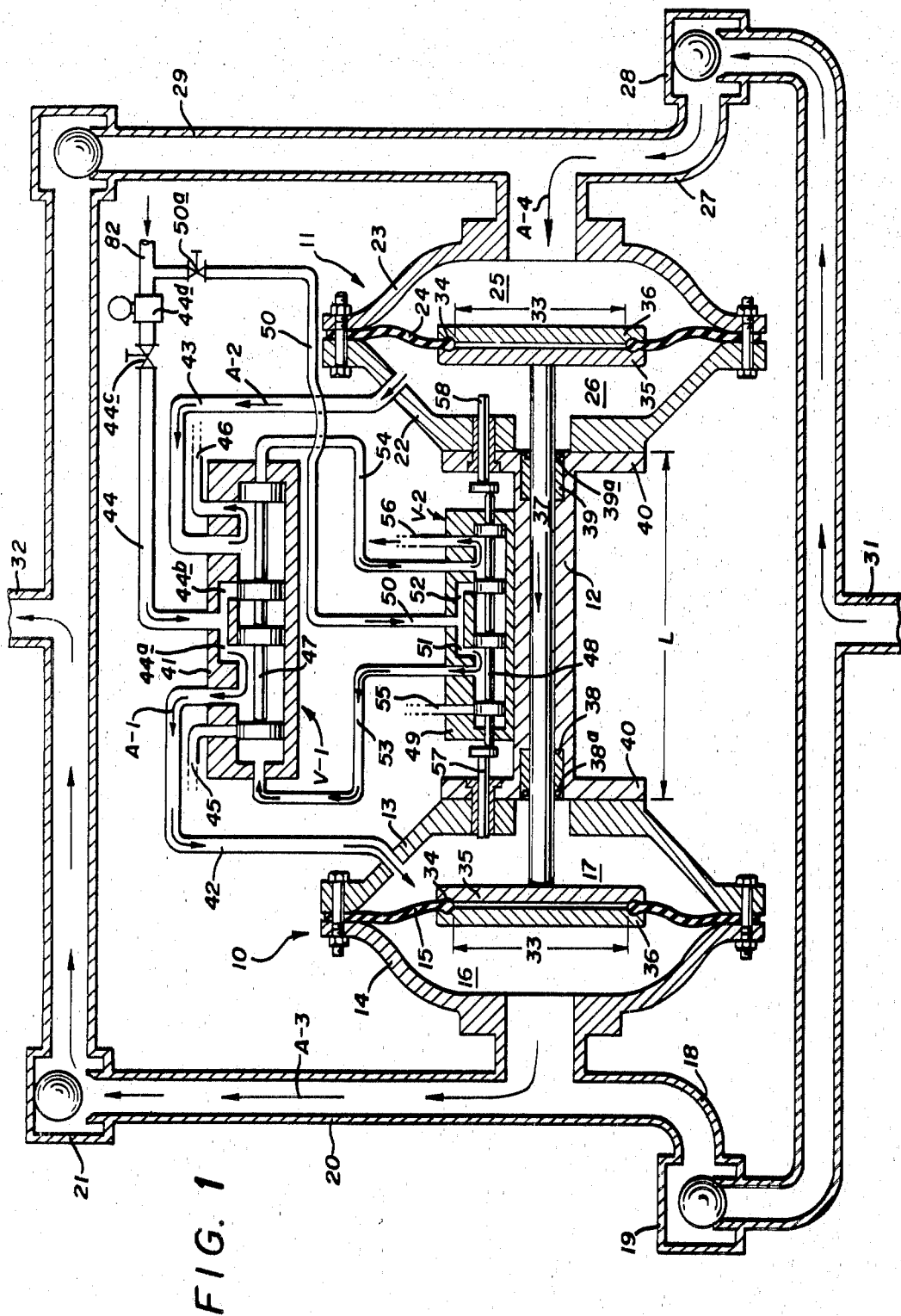
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ABSTRACT

A double acting pressure-actuated diaphragm pump comprising first and second housings each containing a pump diaphragm. An intermediate casing is provided for interconnecting the housings and containing common actuating means for the pump diaphragms. The first and second housings are mounted on a track structure with subassembly sections of the housings being retractable thereon to allow for selective inspection of the respective diaphragm portions of the first and second housings.

7 Claims, 13 Drawing Figures





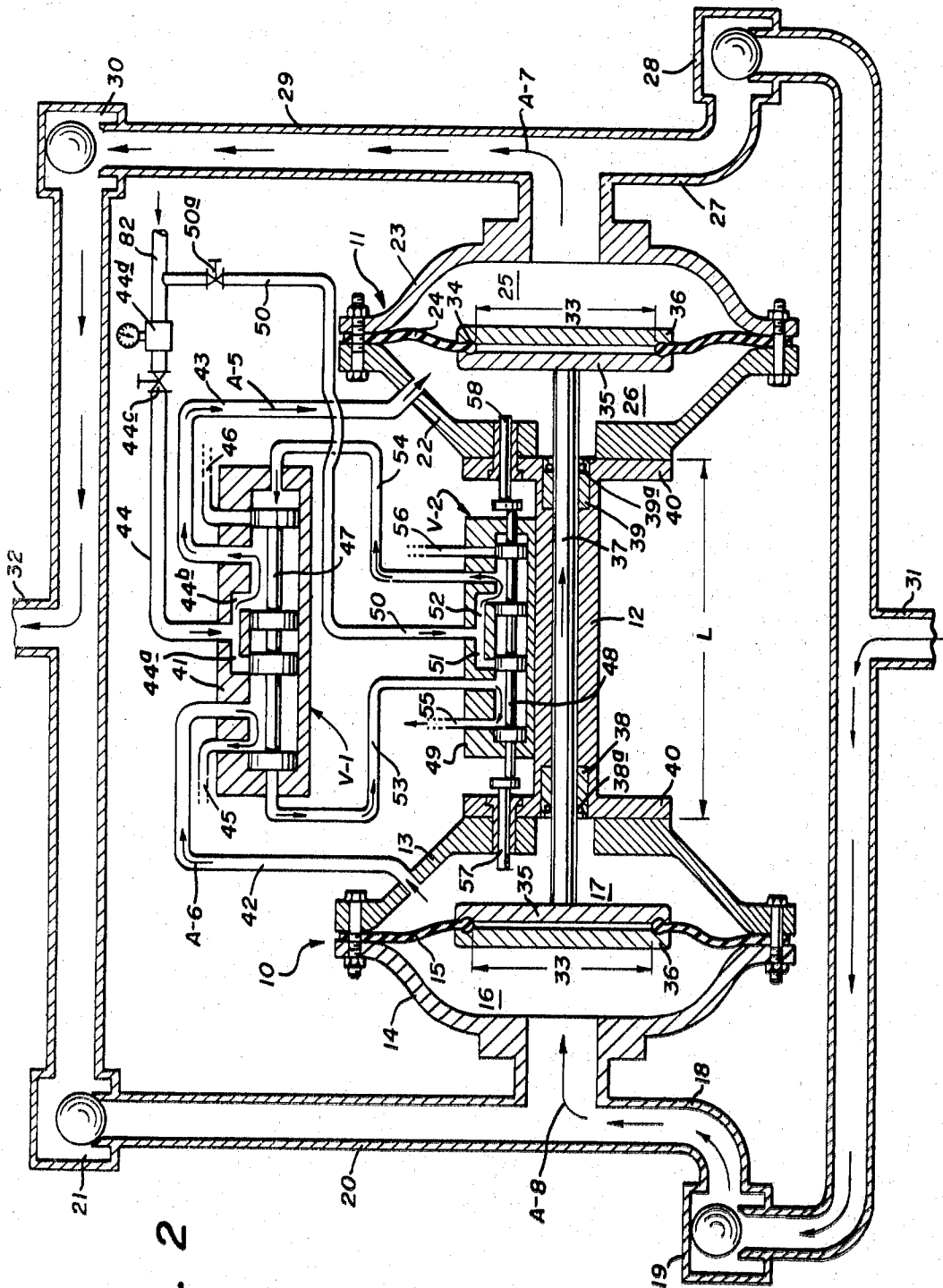


FIG. 2

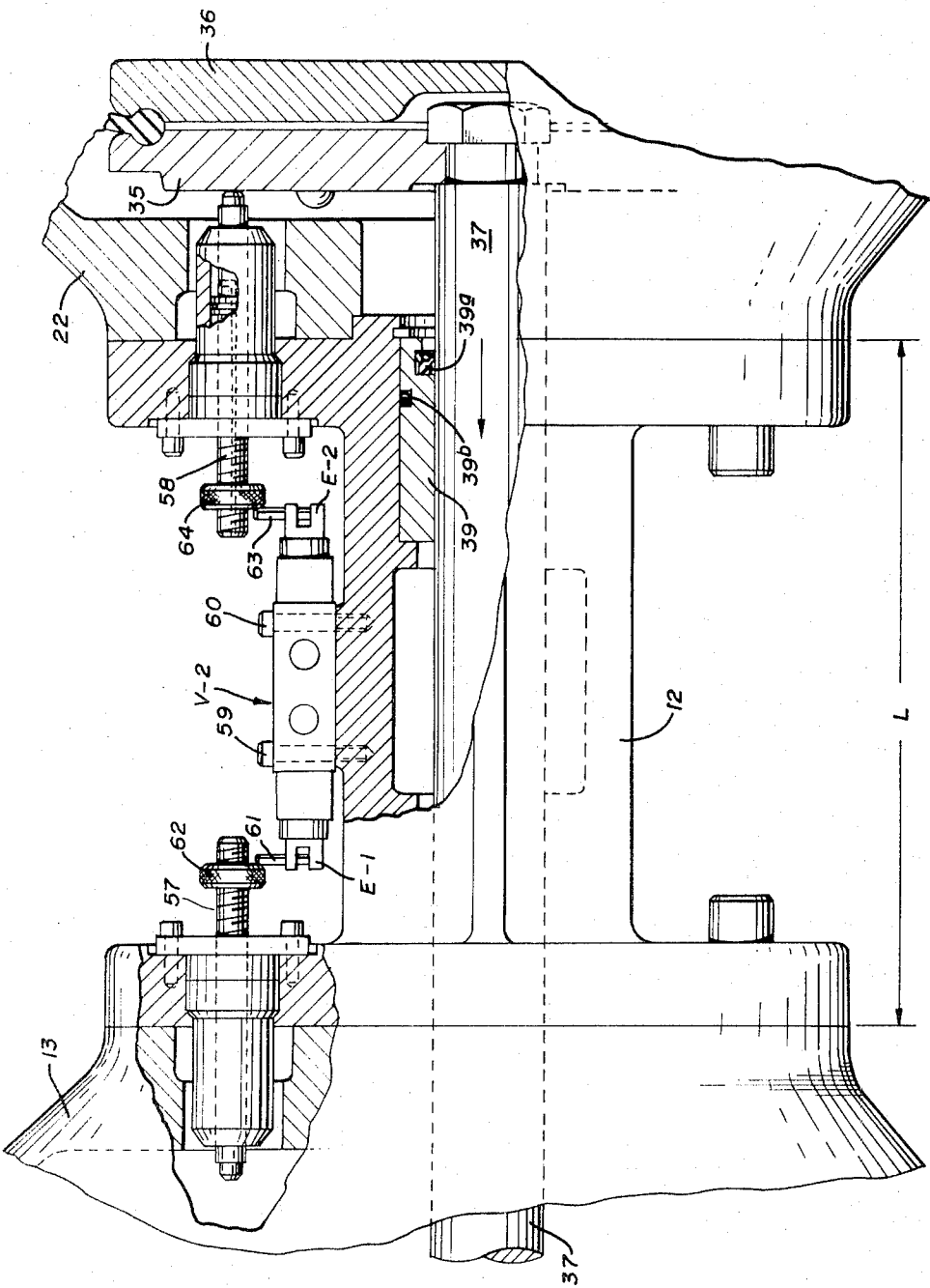


FIG. 3

FIG. 7

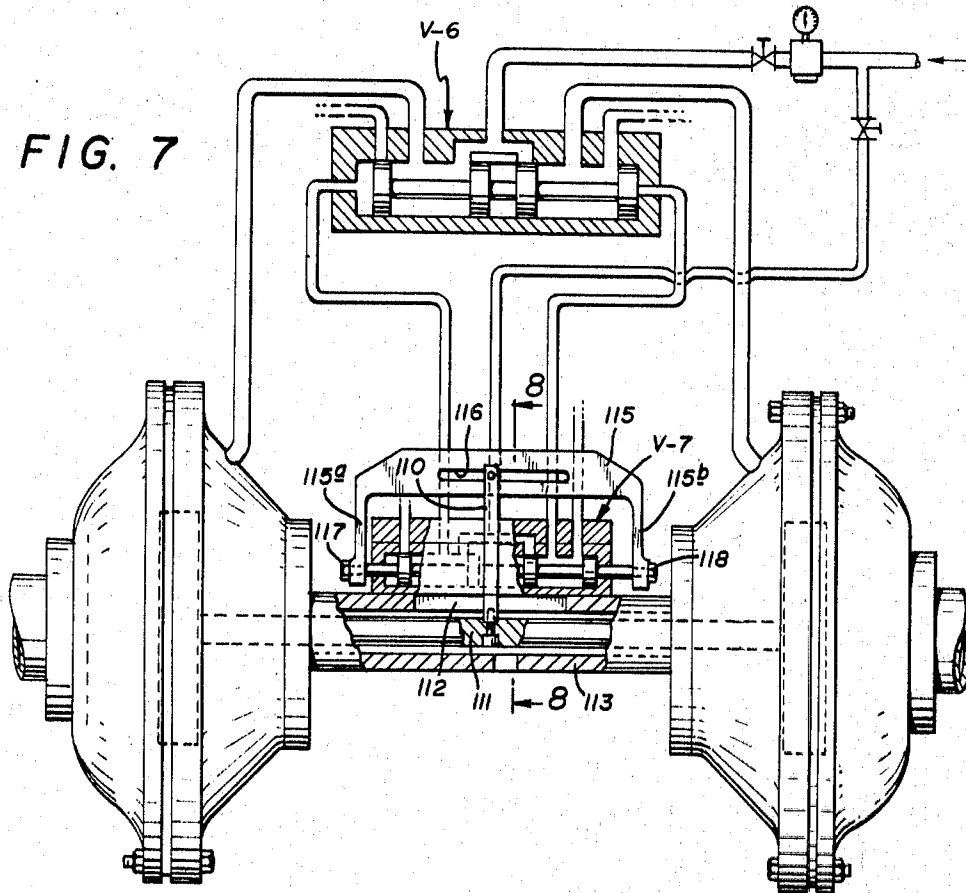


FIG. 4

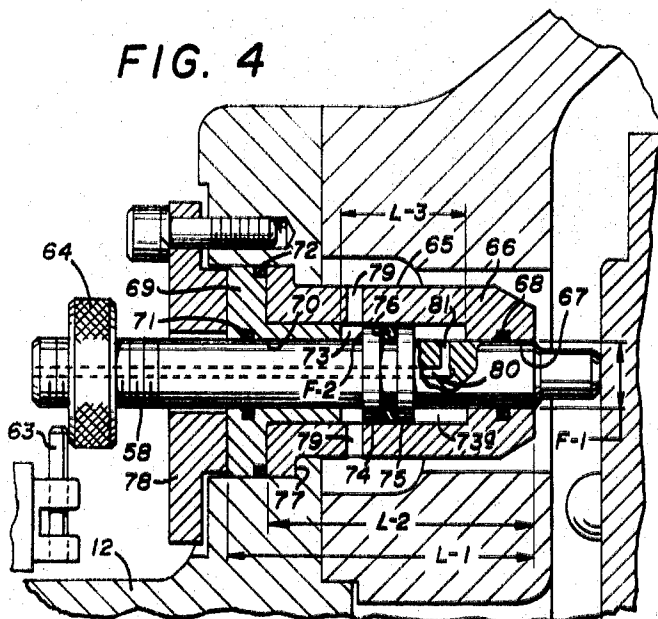
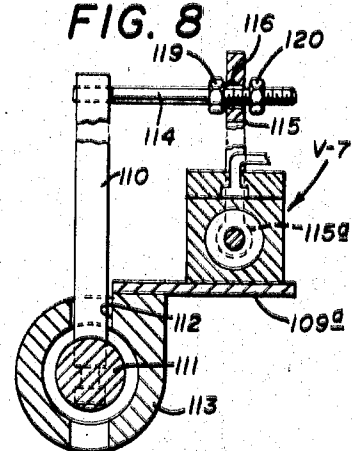


FIG. 8



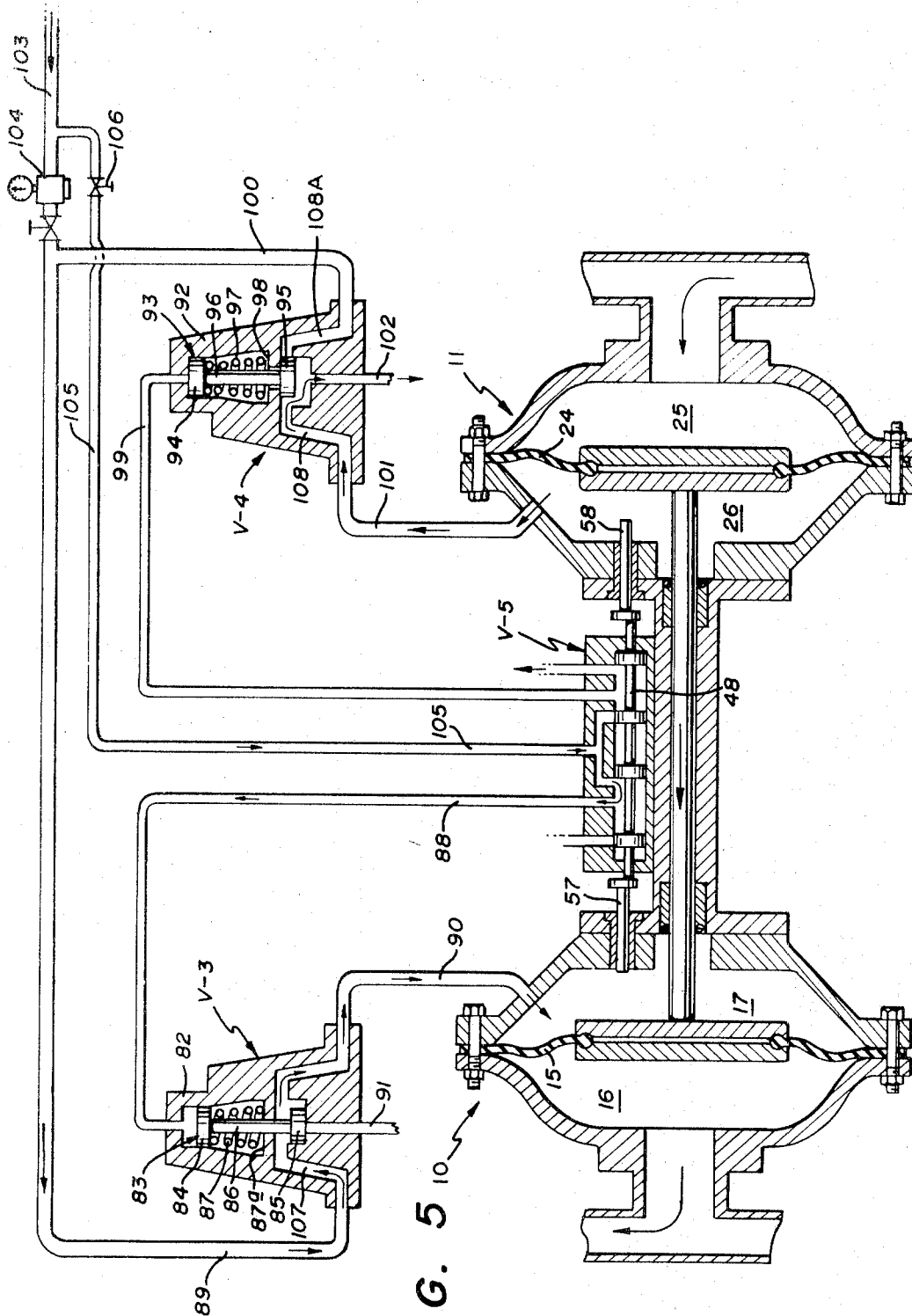
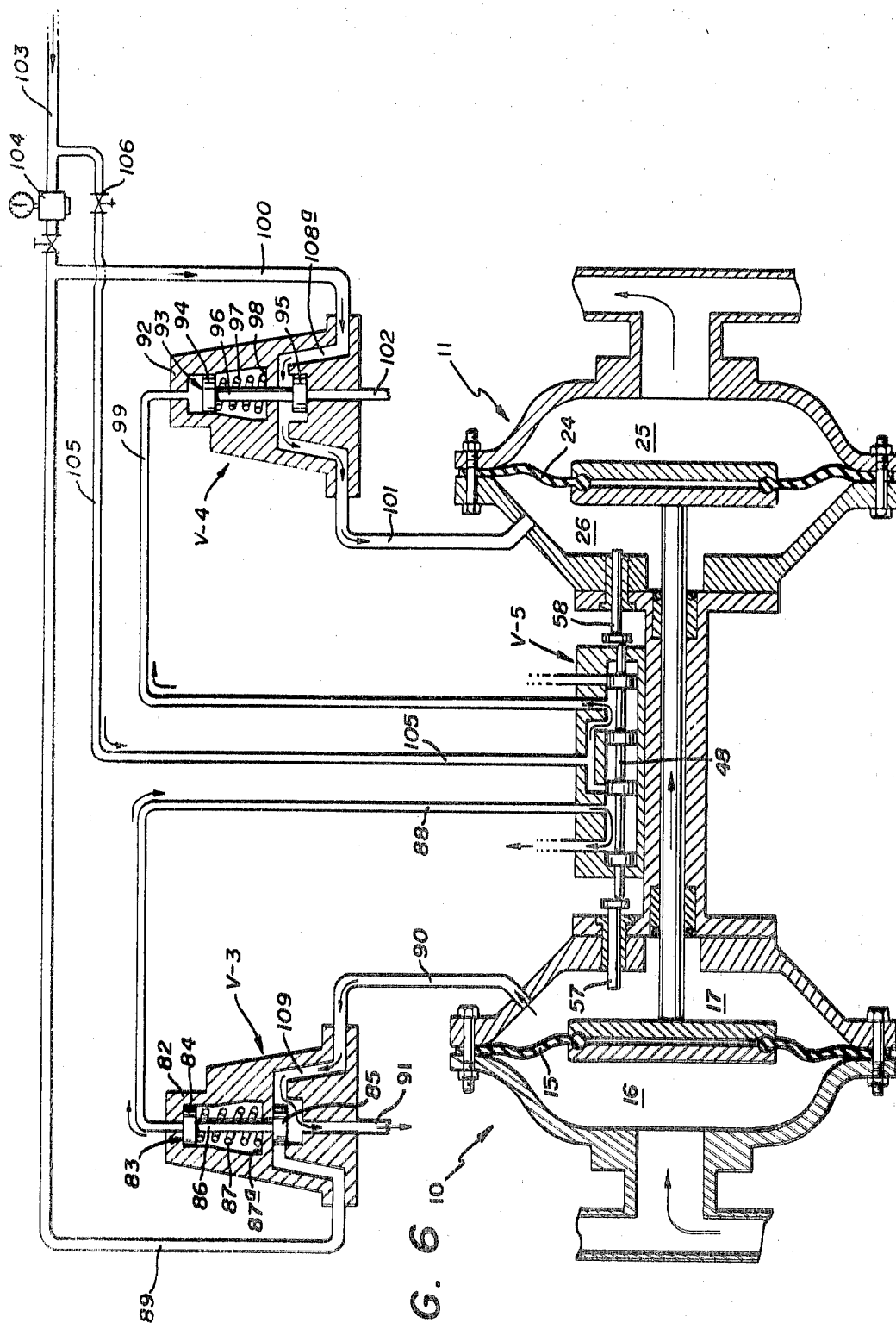


FIG. 5



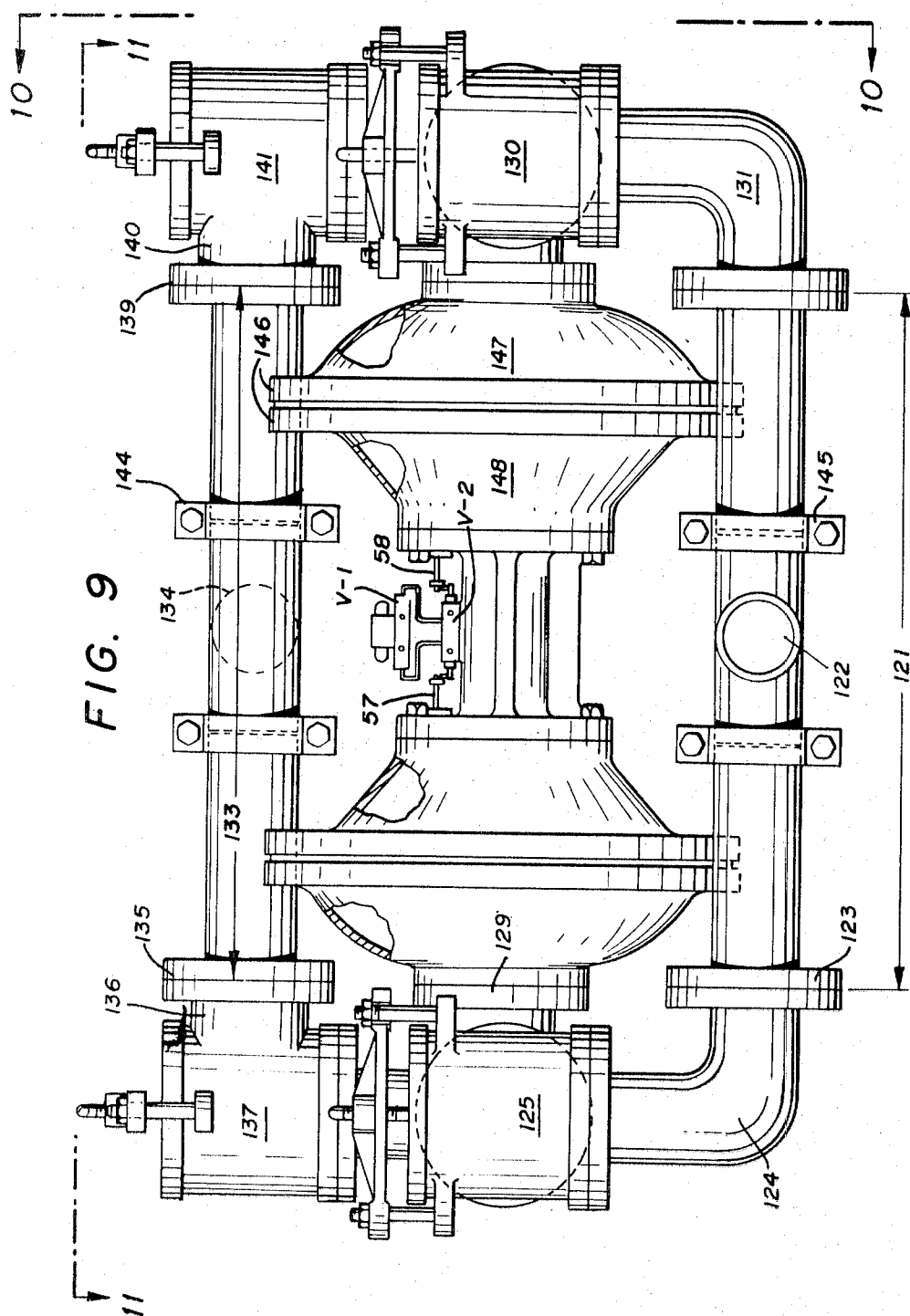


FIG. 10

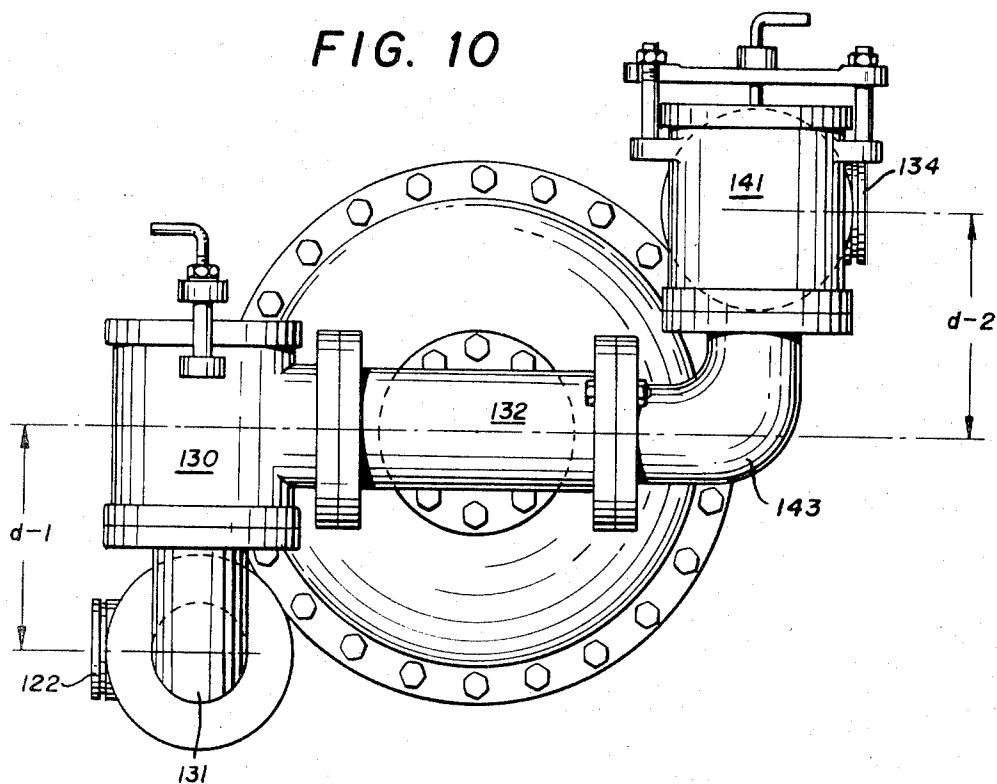
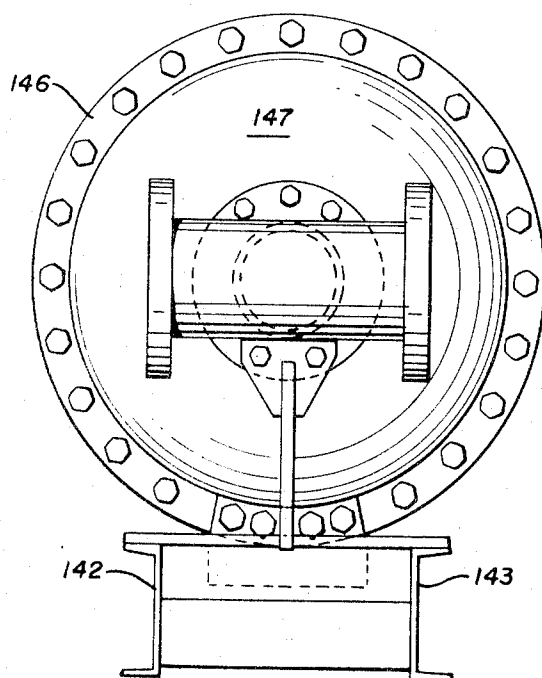
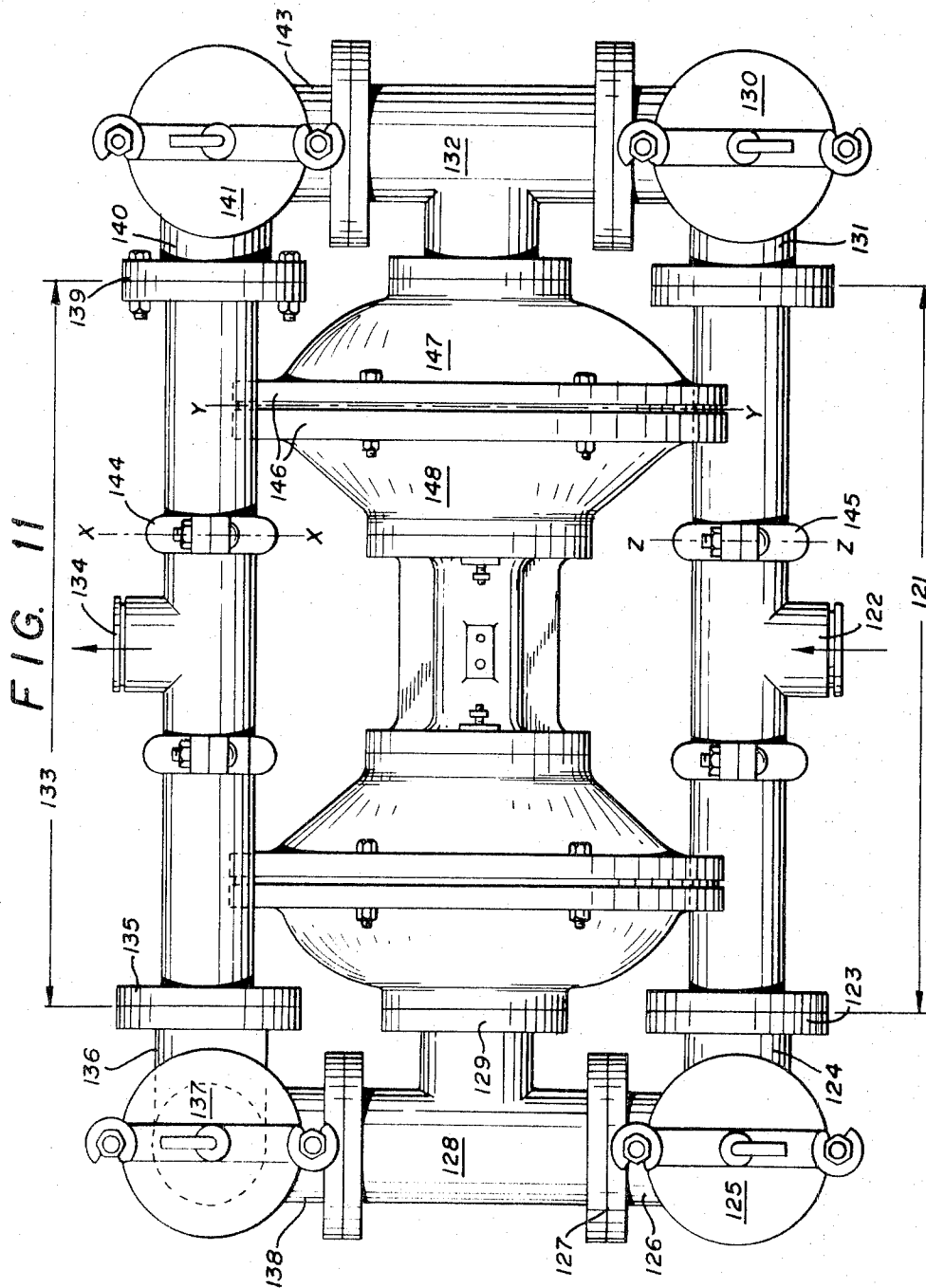
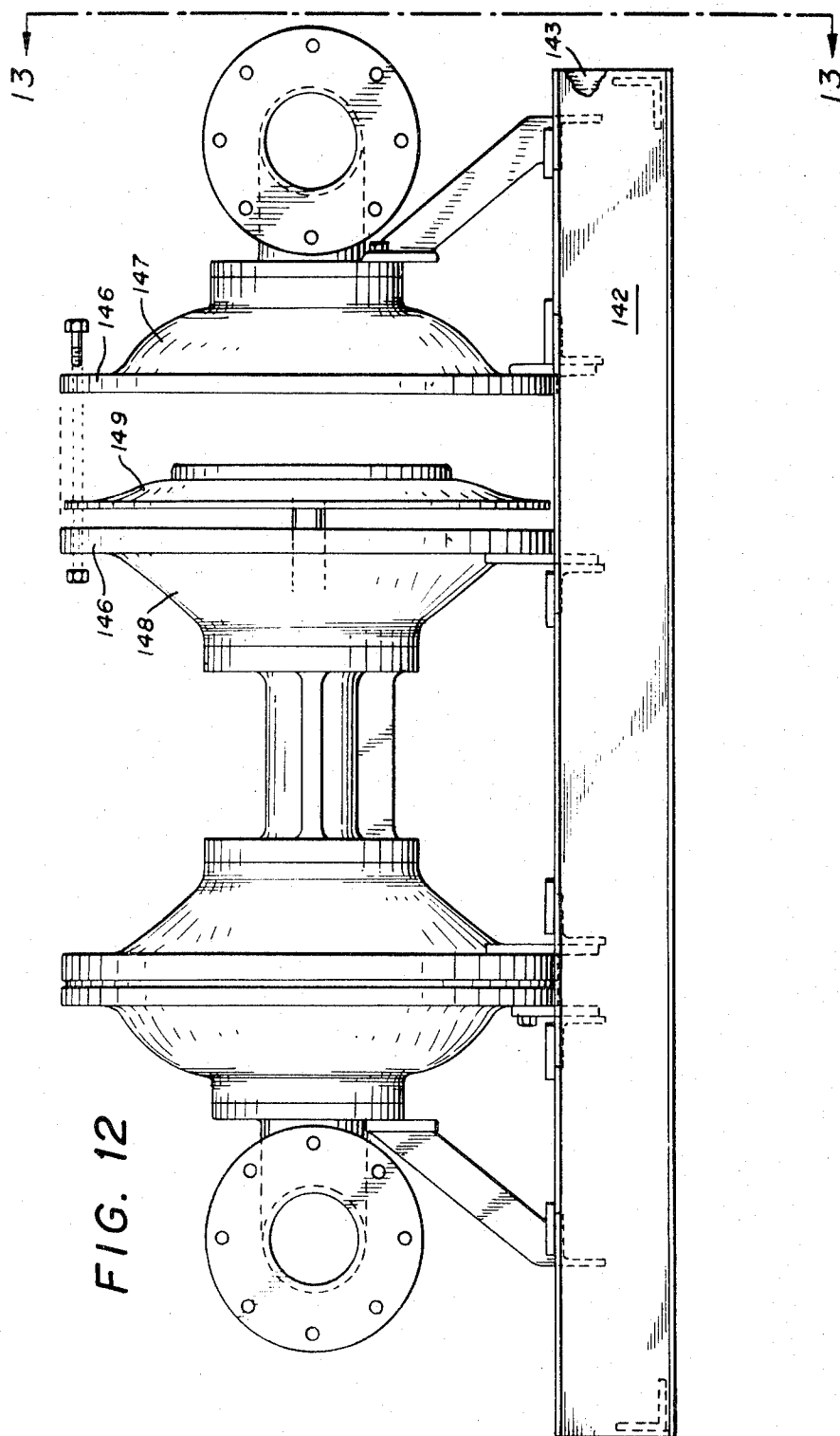


FIG. 13







AIR PRESSURE-ACTUATED DOUBLE-ACTING DIAPHRAGM PUMP

This is a division of application Ser. No. 365,936, filed June 1, 1973 which is a continuation of Ser. No. 161,465 filed July 12, 1971, now abandoned.

This invention relates to fluid pressure-actuated diaphragm pumps. In such pumps, the diaphragm is stress-compensated during the pumping or pump delivery stroke, because the pressure of a fluid medium or air is applied to the diaphragm to move the same against a pumping head.

A general object of this invention is to provide an improved fluid-pressure actuated pump capable of pumping effectively against a negative suction head. To this end, the invention proposes to utilize the fluid pressure medium as a positive means for effecting a pressure-assisted return — or pump suction stroke.

More in particular, a main object is to provide a high capacity double-acting diaphragm pump wherein the pumping stroke of one diaphragm coincides with the suction stroke of another diaphragm, and vice versa, and wherein a pressure fluid medium is applied not only for effecting the pump delivery stroke against a pumping head, but also for effecting the return — or suction stroke against a negative suction head, with an effective actuating — or control system provided for maintaining the pumping cycle.

Thus, it is a more specific object to provide a control system for maintaining the pumping cycle, which is simple, positive acting, and readily accessible as well as easy to adjust, preferably comprising standard sealed component actuating units that are individually available, and can be readily assembled and connected to the pump, and which when in place are readily accessible for inspection and adjustment.

Another object is that the control system should have simple means for adjusting the length and frequency of the pumping stroke, even while the pump is in operation.

To attain the foregoing objectives, the invention provides a double-acting diaphragm pump which comprises a pair of cooperating diaphragm pump units or component pumps coaxially arranged and connected rigidly to one another. Each component pump has a diaphragm dividing the pump housing into a pumping- or pump delivery chamber provided with a valved intake- or suction connection and with a valved discharge connection, and a pump actuating chamber provided with a connection for supplying a fluid pressure medium, as well as for venting the chamber.

The two component pumps are spaced from each other by an intermediate or interposed coaxial connecting member rigidly flange connected to the pumps, with the two actuating chambers facing each other, and the two pumping chambers facing in opposite directions.

Each of the diaphragms has a central rigid portion as in the form of a pair of circular clamping plates. An actuating rod rigidly interconnects the centers of the two diaphragms, so that the pumping stroke of the one diaphragm will coincide with the pump suction — or pump filling stroke of the other diaphragm, and vice versa. The connecting rod is longitudinally guided in the interposed connecting member, and in sealing relationship to either one of the adjacent pump-actuating chambers.

A control or actuating valve system for moving the diaphragms through the pumping cycle, communicates with the two actuating chambers, and has a pressure fluid supply connection. A control member when moved to one position causes the control system to admit pressure fluid into the first actuating chamber, while allowing the second actuating chamber to be vented, and when moved to the opposite position causes said system to admit pressure fluid into said second actuating chamber, while allowing the first actuating chamber to be vented. The movement of the control member between end positions is effected by the reciprocating movements of the diaphragm assembly.

In a preferred embodiment, an auxiliary — or pilot valve unit having a plug valve member, is mounted on said connecting member of the pump structure. The pilot plug valve member through air pressure actuates the plug valve member of a main control valve unit which in turn admits air pressure to the actuating chambers in alternation. The pilot plug valve member is reciprocated by the movements of the diaphragm assembly.

Features of the invention lie in the valve arrangement of the control system, as well as in the construction and arrangement of the means for actuating the control system from the reciprocations of the diaphragm assembly.

Other features lie in the relationship of parts, and in the manner of their assembly to constitute the pump unit, in such a way that inspection or replacement of the diaphragm is facilitated, without the need to disconnect the pump intake — and pump delivery connections.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is illustrative and not restrictive. The scope of the invention is defined by the appended claims rather than by the description preceding them, and all embodiments which fall within the meaning and range of equivalency of the claims are therefore intended to be embraced by those claims.

FIGS. 1 and 2 schematically illustrate the pumping cycle of a double-acting diaphragm pump, showing one embodiment of the valve arrangement in the control system.

FIG. 3 is an enlarged fragmentary side view of the intermediate section of the pump structure, showing its relationship to the control system, exemplifying a pair of pusher pins for actuating the system from the movements of the diaphragm assembly.

FIG. 4 is a further enlarged longitudinal sectional detail view of one of the pusher pins, including means for sealingly mounting the same in the associated pump actuating chamber.

FIG. 5 and 6 schematically illustrate the pumping cycle corresponding to FIGS. 1 and 2 respectively, showing another embodiment of the valve arrangement.

FIG. 7 schematically illustrates a pump control system similar to FIGS. 1 and 2, with other motion transmitting means effective between the diaphragm assembly and control system.

FIG. 8 is a cross-sectional view taken on line 8—8 in FIG. 7.

FIG. 9 is a side view of the pump structure and pipe assembly, structurally more fully implemented.

FIG. 10 is an end view taken on line 10—10 of the assembly of FIG. 9.

FIG. 11 is a plan view taken on line 11—11 of the assembly in FIG. 9.

FIG. 12 is a side view of the pump structure, supported on tracks, illustrating the feature of accessibility of diaphragms.

FIG. 13 is an end view taken on line 13—13 in FIG. 12.

A fluid pressure-actuated double-acting diaphragm pump in the sense of this invention is a pump wherein two pump bodies are rigidly interconnected in coaxial relationship. A diaphragm divides the housing of each pump body into a pumping chamber and pump actuating chamber. An actuating rod interconnects the centers of the two diaphragms so that, when a fluid pressure medium or air pressure is admitted alternately into the actuating chambers, the pump filling stroke of one diaphragm will coincide with the pump delivery stroke of the other diaphragm. A control system timed by the reciprocations of the diaphragms and actuating rod admits the fluid pressure medium into the actuating chambers in a manner to maintain the continuity of the pumping cycle or pumping operation.

According to the several embodiments herein shown, this double-acting pump is equipped with a control system wherein a control member is movable to one position causing the pressure fluid to be admitted into one of the actuating chambers, while the other actuating chamber is being vented, and movable to the opposite position causing the respective flow directions to be reversed. Motion transmitting means are provided for actuating said control member by the reciprocations of the diaphragms and actuating rod.

Referring to the embodiment of FIGS. 1 & 2, the pump structure itself comprises a pair of pump bodies 10 and 11, and a flanged connecting member 12 of the length L rigidly interconnecting the pump bodies in coaxial and symmetrical relationship to one another. The pump housing of the first pump body 10 consists of two housing sections 13 and 14 bolted together, and having confined between a first diaphragm 15 dividing this housing into a pumping — or pump delivery chamber 16 and a pump actuating chamber 17. The pumping chamber has an intake connection 18 provided with a check valve unit 19, and a discharge connection 20 provided with a check valve 21.

Similarly, the pump housing of the second pump body 11 comprising two housing sections 22 and 23 having confined between them a second diaphragm 24 dividing this housing into a pumping chamber 25 and a pump actuating chamber 26. The pumping chamber has an intake connection 27 provided with intake valve 28, and a discharge connection 29 provided with check valve 30.

A common pump intake 31 is provided for the two intake connections 18 and 27, while a common pump discharge 32 is provided for two discharge connections 20 and 29.

Each diaphragm has a central opening 33 provided with an annular bead or beaded edge portion 34 tightly secured between a pair of circular clamping plates 35 and 36. The centers of the two pairs of clamping plates in turn are rigidly interconnected by an actuating rod 37 the longitudinal reciprocating movement of which

is guided in a pair of bearings 38 and 39 located in the respective ends of the intermediate connecting member 12. These bearings are provided with pressure seals 38^a and 39^a respectively, effective together with a sealing ring 39^b against the pump actuating air pressure to be applied to the actuating chambers 17 and 26. Each end of the connecting member 12 has a flange connection 40 with the adjoining pump housing section adjacent to the respective actuating chamber.

A control system will admit air pressure to the actuating chambers in alternation, so that the delivery stroke of one diaphragm will coincide with the pump intake stroke of the other diaphragm.

One embodiment of such a control system for maintaining the pumping cycle is as follows by reference to FIGS. 1 and 2 illustrating the respective phases of the pumping cycle:

This control system comprises a main control valve unit v-1 operable to admit air pressure to the respective actuating chambers, and an auxiliary — or pilot valve unit V-2 controlling the operation of the main valve unit, and in turn actuated by the reciprocation of the diaphragms and actuating rod.

The control valve unit V-1 is in the form of a plug valve unit having a valve housing 41 operatively connected to the two actuating chambers by way of pipe conduits 42 and 43 respectively. This valve housing has an air pressure supply connection 44 at the center, communicating with a pair of branch passages 44^a and 44^b in the housing. A pair of vent connections 45 and 46 are provided at the ends of this valve housing. A plug valve member 47 is longitudinally shiftable in the valve housing, so that when moved to the right hand end position shown in FIG. 1, it closes branch passage 44^b while admitting air pressure into the left hand actuating chamber 17 from the supply connection 44 through passage 44^a in the housing, and from there through pipe 42 into the actuating chamber, all as indicated by the path of flow arrows A-1. Simultaneously with the closing of branch passage 44^b, the plug valve member opens a vent connection to the other actuating chamber 26, as indicated by the path of flow arrows A-2, namely by way of pipe 43 leading to the valve housing, and vent 46 leading from the valve housing to the atmosphere.

Thus, air pressure will move the diaphragm 15 through the pump delivery stroke, as indicated by the path of flow arrows A-3 through the discharge check valve unit 21. The concurrent pump filling stroke of diaphragm 24 is indicated by the path of flow arrows A-4, through the intake check valve 28.

The main plug valve member 47 when shifted to the FIG. 2 position, closes the branch passage 44^a, while admitting air pressure into the right hand actuating chamber 26, supplied from pipe 44 through branch passage 44^b of the valve housing, and then into the actuating chamber 26, all as indicated by the path of flow arrows A-5. Simultaneously with the closing of branch passage 44^a the plug valve member opens a vent connection to the left hand actuating chamber 17, as indicated by the path of flow arrows A-6, this by way of pipe 42 leading to the valve housing, and vent 45 from the valve housing to the atmosphere. In this condition, air pressure will move the diaphragm 24 through the pump delivery stroke, with pump delivery indicated by flow arrows A-7, through the delivery check valve 30. The concurrent pump filling stroke of diaphragm 15 is

indicated by the path of flow arrows A-8, through the intake check valve 19.

The foregoing operation of the main plug valve unit V-1 is controlled by the pilot valve unit V-2 which causes the shifting of the main plug valve member 47, but which itself is actuated by the reciprocations of the diaphragms and actuating rod.

The pilot valve unit has a plug valve member 48 extending co-directional with the actuating rod, and longitudinally shiftable in a valve housing 49 detachably mounted upon the intermediate member 12. This valve housing has an air pressure supply connection 50 at the center, communicating with a pair of branch passages 51 and 52, and also has a pair of transfer pipes 53 and 54 communicating with the respective ends of the main control valve V-1. Furthermore, vent connections 55 and 56 are provided at the respective ends of pilot valve housing 49.

With the pilot valve unit V-2 thus located between the two valve bodies, and the valve member 48 thereof extending parallel to the actuating rod, the shifting of the valve member, according to one embodiment, is effected by a pair of oppositely arranged pusher pins 57 and 58 engaging respective ends of the valve member. The pusher pins extending parallel to the actuating rod, are slidable longitudinally in the wall of the respective pump housings, and are mounted in pressure-sealed relationship therewith, in a manner furthermore to be described below and in connection with the detail showing thereof in FIG. 4. At the end of each pumping stroke, as effected by the main valve unit V-1, the clamping plates of a respective diaphragm will through the associated pusher pin move the pilot valve member between the end positions shown in FIGS. 1 and 2, thereby maintaining the continuity of the pumping operation described as follows:

In the condition of FIG. 1, the actuating rod 37 is shown during its movement to the left, with both the pilot valve member 48 and the main valve member 47 in their right hand end position. This represents the condition where the pilot air supply from pipe 50 acting through passage 51 and transfer pipe 53 has moved the main plug valve member 47 to the right hand end position. Thus, the main air supply from pipe 44 through passage 44^a and transfer pipe 42 will act upon the left hand diaphragm during the pump delivery stroke coinciding with the pump intake stroke of the right hand diaphragm. It will be understood that during this pumping stroke to the left, the right hand actuating chamber 26 is being vented through transfer pipe 43 and exhaust 46 of control valve V-1, while the right hand end of valve V-1 is vented through pipe 54 and through the pilot valve V-2.

At the end of the stroke to the left, the clamping plate of the right hand diaphragm will engage pusher pin 58 causing the same to move the pilot valve member 48 to the opposite or left hand end position shown in FIG. 2, thus admitting pilot air pressure through pipe 54 to the right hand end of the main valve housing, which pressure moves the main valve member to its left hand end position.

This condition reverses the pumping stroke, in that air pressure is now admitted to the right hand actuating chamber 26 from the main air pressure supply pipe 44 through the valve and transfer pipe connection 43. At the end of this movement of rod 37 to the right, the clamping plate of the left hand diaphragm 15 will

through pusher pin 57 shift the pilot valve member back to its FIG. 1 right hand end position, thus initiating the next following operation cycle. It will be understood that during the pumping stroke to the right in FIG. 2, the left hand actuating chamber 17 is vented through pipe 42 and through the main valve unit V-1, while the left hand end of main valve V-1 is vented through pipe 53 and through the pilot valve unit V-2.

The intermediate portion of the pump in FIG. 3 provides a more detailed showing of the mounting of the pilot valve unit v-2 in relation to the associated pusher pins. In this arrangement, a pair of screw bolts 59 and 60 indicate the manner in which this valve unit is detachably fixed to the intermediate connecting member 12. The left hand end E-1 of the pilot plug valve member in this valve unit through finger 61 contacts an adjustable stop nut 62 on pusher pin 57. Similarly, the right hand end E-2 of the plug valve member through finger 63 contacts an adjustable stop nut 64 on pusher pin 58.

The proper timing of the control system is readily attainable by adjusting the stop nuts 62 and 64 upon the threaded inner end portions of the respective pusher pins. The effective length of the pumping stroke is also adjustable by the setting of the stop nuts on the pusher pins, so that the pump can be operated, for example, either at higher frequencies of the pumping cycle with a shorter stroke, or at lower frequencies with a longer pumping stroke.

As previously indicated, the pusher pins 57 and 58 are mounted in sealing relationship to the respective pump housing sections, effective against the operating air pressure applied to the actuating chambers 17 and 26.

A pressure-sealed mounting of the pusher pins is shown in the enlarged detail FIG. 4. Accordingly, the pusher pin 58 is slidable in a holder 65 also designated by its length L-1. This holder comprises a part 66 of length L-2 providing a first guide bearing surface 67 interrupted by a first sealing ring 68, and part 69 in the form of a flanged bushing fitted into part 66, and providing a second guide bearing surface 70 interrupted by a second sealing ring 71. A third sealing ring 72 is effective between parts 66 and 69 and the surrounding flanged member 12. The distance between the two guide bearing surfaces 67 and 70 defines the length L-3 of an annular chamber 73 surrounding the pusher pin. Slidably fitted into this chamber are a pair of annular shoulder portions 74 and 75 provided upon, or integral with the pusher pin, with a fourth sealing ring 76 provided between the two shoulder portions. The assembly of parts 66 and 69 containing the pusher pin is seated upon a shoulder 77 in the flanged end of member 12, and held in place by a retainer flange 78 bolted to said flanged end.

In the mounting of this pusher pin, provision is made for the air pressure acting upon the end face area F-1 of the pusher pin to be balanced by the air pressure acting through ports 79 upon the annular area F-2 of shoulder portion 74. Furthermore, an axial bore 80 in the pusher pin communicates through a radial passage 81 with dead space 73^a of chamber 73, providing a vent connection with the atmosphere.

When mounted in the manner of FIG. 4 the pusher pins are easily and smoothly movable in both directions together with the associated pilot valve member, irre-

spective of the pressure differential between the air pressure in the actuating chambers 16 and 25 and the outer atmosphere.

The air pressure supply for operating both the pump and the valves of the control system, is represented by the main air pressure supply line 82. The branch pipe 50 through hand operated valve 50^a provides the air pressure whereby the pilot valve V-2 actuates the main control valve V-1. The branch pipe 44 supplies the air pressure whereby the main control valve V-1 controls the operation of the actuating chambers 17 and 26. Aside from a hand controlled valve 44^c the pipe 44 also has a constant pressure valve 44^a whereby a desired pressure can be maintained automatically in the actuating chambers 17 and 26. Changes in the pumping speed can be effected by changing the settling of the constant pressure valve.

In another embodiment according to FIGS. 5 and 6, the single control valve V-1 of FIGS. 1 and 2 is replaced by a pair of identical control valve units V-3 and V-4, while the arrangement and operation of the pilot valve unit V-5 is identical to those of valve unit V-1 in FIGS. 1 and 2.

The control valve unit V-3 comprises a valve housing 82 wherein a vertical plug valve member 83 has upper and lower enlarged cylindrical end portions or plugs 84 and 85 respectively, interconnected by a stem 86. A compression coil spring 87 surrounding the stem is confined between the upper plug 84 and a shoulder 87^a formed by the valve housing. The upper end of this valve housing has a pipe connection 88 with pilot valve unit V-5 (functionally corresponding to pipe 53 in FIGS. 1 and 2), and cooperating with the upper end of plug valve member 83. The bottom portion of the valve housing is connected to an air supply pipe 89, as well as to a transfer pipe 90 leading to the left hand pump actuating chamber 16. Between these two pipe connections the valve housing has a bottom vent opening or connection 91 cooperating with the lower end of plug valve member 83.

Similarly, valve unit V-4 comprises a valve housing 92 wherein a vertical plug valve member 93 has upper and lower enlarged cylindrical end portions or plugs 94 and 95 interconnected by a stem 96. A compression coil spring 97 surrounding the stem is confined between the upper plug 94 and a shoulder 98 formed by the valve housing. The upper end of this valve housing has a pipe connection 99 with pilot valve unit V-5 (functionally corresponding to pipe 54 in FIGS. 1 and 2), and cooperating with the upper end 94 of plug valve member 93. The bottom portion of this valve housing is connected to an air supply pipe 100, as well as to a transfer pipe 101 leading to the right hand pump actuating chamber 26. Between these two pipe connections the valve housing has a bottom vent opening or connection 102 cooperating with the lower end 95 of plug valve member 93.

The two air supply pipes 89 and 100 are branches of a main air supply pipe 103 which has an automatic pressure control valve 104 for setting the operating pressure in the two pump actuating chambers 17 and 26. A third branch pipe 105 supplied the line air pressure to the pilot valve V-5, and may have a hand operated valve 106.

In the condition of FIG. 5 of the pumping cycle (functionally corresponding to the condition of FIG. 1), the pilot valve member 48 has been moved to the

right hand end position by the clamping plate of the left hand diaphragm 15 acting through pusher pin 5. Thus, air pressure from pipe 105 acting through pilot valve V-5 and through pipe 88 will have moved the main valve member 83 against the spring pressure to the lower end position closing the exhaust or vent connection 91, while opening a passage 107 allowing air pressure to pass therethrough into the left hand actuating chamber 17.

At the same time, the opposite right hand actuating chamber 26 is vented through pipe 101 and passage 108 in valve housing 92, while valve member 96 is spring-urged into the upper end position closing the air pressure supply from pipe 100. The upper end of valve housing 92 is vented through pipe 99 and through the pilot valve unit V-5.

At the end of the left ward pumping stroke resulting from the condition of FIG. 5, the clamping plate of the right hand diaphragm 24 will through pusher pin 58 move the pilot valve member 48 to the FIG. 6 left hand position, thereby reversing the respective flow directions in the system, as indicated by the various flow arrows therein. Consequently, air pressure is admitted from supply pipe 100 and through passage 108^a in valve unit V-4 to the actuating chamber 26, causing the diaphragm assembly to be moved to the right.

At the same time, the opposite left hand actuating chamber 17 is being vented through pipe 90 and passage 109 in valve unit V-3, since the spring 87 will have moved the valve member 86 to the upper end position closing vent connection 88 open through the pilot valve, while also opening a vent connection from the actuating chamber 17 through pipe 90 and through passage 109 in valve unit V-3.

At the end of the pumping stroke resulting from the condition of FIG. 6, the clamping plate of the left hand diaphragm 15 will again through pusher pin 57 move the pilot valve member back to the right hand end position, thus to initiate the next pumping cycle.

In another embodiment of the control valve system as shown in FIGS. 7 and 8, the combination of a main control valve unit V-6 and a pilot valve unit V-7 is the same structurally and functionally as the one in FIGS. 1 and 2. The difference lies in the provision of the motion transmitting means whereby the movements of the pilot valve member are derived from the diaphragm assembly, and which require the pilot valve unit V-7 to be mounted on a laterally overhanging bracket 109^a.

As shown in FIGS. 7 and 8, these motion-transmitting means comprise an upright stem 110 extending from the actuating rod 111 through a slot 112 formed in the surrounding connecting member 113, so that the stem will move back and forth in the slot together with the actuating rod. A finger 114 extends from the upper end of the stem horizontally across the pump axis, and across and above the pilot valve unit V-7.

By engaging a bridge member 115, the finger 114 extending through horizontal slot 116 will move the pilot valve member between respective end positions each time the finger 114 reaches a respective end of the slot. The depending shanks 115^a and 115^b of the bridge member engage respective ends of the valve member secured by respective set nuts 117 and 118. The length of the pumping stroke may be varied by the provision of adjustable end steps or abutment (not shown) on bridge member 115, cooperating with finger 114. A

pair of nuts 119 and 120 on finger 114 maintain the bridge member in the proper upright position.

FIGS. 9 to 13 further illustrate practical features embodied in the structural implementation of a pump operable in the manner of the pumping cycle shown in the schematic FIGS. 1 and 2.

In this practical embodiment, referring to FIGS. 9 and 10, a horizontal intake pipe 121 extends along one side of the pump at a low level a distance $d-1$ below the axis of the pump, and having a lateral intake opening 122 equidistant from its ends. The left hand end of this intake pipe has a flanged connection 123 with an elbow member 124 which has an upwardly directed leg which in turn is flange-connected to the underside of a first ball valve unit 125. A lateral neck 126 of this ball valve unit located at the level of the pump axis, has a flange connection 127 with a first short horizontal pipe member 128 extending transversely of the pump axis, and having a horizontal lateral neck concentric with the pump axis and flange-connected at 129 to the adjoining left hand outer end of the pump.

The opposite or right hand end of intake pipe 121 is connected to a second intake ball check valve unit 130 through an elbow member 131, in a manner similar and symmetrical to the first ball check valve unit 125. A second horizontal transverse pipe member 132 connects this ball check valve 130 with the right hand end of the pump similar and symmetrical to the opposite or first transverse pipe member 128.

Along the opposite side of the pump, at a high level a distance $d-2$ above the pump axis, extends a horizontal discharge pipe 133 having a lateral discharge opening 134 equidistant from its ends. The left hand end of this discharge pipe has a flange connection 135 with the lateral neck 136 of a first discharge ball check valve unit 137 the bottom of which is connected through an elbow member 138 to the first transverse horizontal pipe member 128. The opposite or right hand end of the discharge pipe has a flange connection 139 with the lateral neck 140 of a second discharge ball check valve unit 141 the bottom of which in turn through an elbow member 143 is connected to the second transverse horizontal pipe member 132.

The pump unit shown in FIGS. 9 to 11 is mounted and supported in a practical manner illustrated in FIGS. 12 and 13, whereby the inspection of the two diaphragms is greatly facilitated.

To that end, the pump unit is supported upon a pair of parallel supporting beams or steel profiles shown in the form of channel irons 142 and 143. For example, in order to inspect the diaphragm in the right hand pump body, a simple procedure is merely to disconnect the quick-detachable couplings 144 and 145, as well as to disconnect the flanges 146 of the associated pump housing sections 147 and 148. The assembly of parts thus disconnected are to the right of the severing lines X-X, Y-Y and Z-Z indicated in the plan view of FIG. 11. This assembly may then be slid outwardly away while supported on the beams, thereby exposing the diaphragm 149 in the manner illustrated in FIGS. 12 and 13.

The control valve unit V-1 in FIGS. 1 and 2 is available from Mac Valves Inc., Detroit, Michigan, Model No. 2733. The pilot valve V-2 in the same embodiment is available from Mac Valves Inc., Detroit, Mich., Model No. 1808-1-08.

The two identical air pressure actuated control valve units V-3 and V-4 in FIGS. 5 and 6 are available from Mac Valves Inc., Detroit, Mich., Model No. 4444.

I claim:

1. A double-acting pressure-actuated diaphragm pump having a horizontal pump axis, which comprises

a first pair of housing sections bolted to each other to constitute a first pump housing,

a first pump diaphragm interposed between said housing sections, and dividing the housing into a first pumping chamber having first intake- and discharge connections directed away from one another, and a first actuating chamber having an opening concentric with the diaphragm,

a second pair of housing sections bolted to each other to constitute a second pump housing,

a second pump diaphragm dividing said second pump housing into a second pumping chamber having second intake- and discharge connections directed opposite to each other, similar to said first intake- and discharge connections, and a second actuating chamber having an opening concentric with the diaphragm,

a tubular connecting member rigidly interconnecting said pump housings in axially aligned relationship, and so that said first and second actuating chambers are located adjacent to each other, and that the pump housing assembly is constituted of a pair of inner housing sections defining the respective actuating chambers, and a pair of outer housing sections defining the respective pumping chambers,

an actuating rod interconnecting said first and second diaphragms, coaxial with the pump axis and guided in said connecting member in sealing relationship with each end thereof, providing a double diaphragm assembly whereby the pump delivery stroke of one diaphragm will coincide with the pump intake stroke of the other diaphragm,

said pump consisting of an intermediate section comprising said connecting member and associated inner housing sections,

a first disconnectible subassembly unit comprising the first outer housing section, a first upright intake check valve having a lateral discharge neck connected to said outer housing section, and having a bottom intake neck extending parallel to the pump axis, and towards the opposite end of the pump, and a first upright discharge check valve having a bottom intake neck connected to said outer housing section, and having a lateral discharge neck extending parallel to the pump axis and towards said opposite end of the pump,

a second disconnectible subassembly unit opposite to said first subassembly unit, which comprises the second outer housing section, a second upright intake check valve having a lateral discharge neck connected to said outer housing section, and having a bottom intake neck extending parallel to the pump axis and towards the opposite end of the pump, and a second upright discharge check valve having a bottom intake neck connected to said outer housing section, and a lateral discharge neck extending parallel to the pump axis and towards said opposite end of the pump,

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a first intermediate pipe header detachably interconnecting the intake necks of the first and second intake check valves, and having intake means for both said intake valves,

and a second intermediate pipe header detachably interconnecting the discharge necks of the first and second discharge check valves, and having discharge means for both said discharge valves, and track structure for supporting said first and second subassembly units, when disconnected from said intermediate section, and retracted to allow for inspection of the respective diaphragms.

2. The pump according to claim 1, wherein said first intermediate pipe header comprises an intermediate section including said pump intake means, one end section connected to said first intake valve, and having a quick detachable coupling connecting its inner end with the adjacent end of said intermediate section, and another end section connected to said second intake valve, and having a quick detachable coupling connecting its inner end with the adjacent end of said intermediate section,

and wherein said second intermediate pipe header comprises an intermediate section including said pump discharge means, one end section connected to said first discharge valve, and having a quick detachable coupling connecting its inner end with the adjacent end of said second intermediate section, and another end section connected to said second discharge valve, and having a quick detachable coupling connecting its inner end with the adjacent end of said intermediate section.

3. The diaphragm pump according to claim 1, wherein said intake pipe header is spaced downwardly from the pump axis by means of elbow members connecting the bottom inlet openings of the inlet check valves with the respective adjacent ends of said first intermediate pipe header, and wherein said discharge pipe header is spaced upwardly from the pump axis by means of elbow members connecting the bottom inlet openings of the discharge check valves with the respective outer housing sections.

4. The diaphragm pump according to claim 1, wherein said connecting member has end flanges detachably connected to the associated inner housing sections, said flanged member having a concentric recess at each end, and sealing means contained in the respective recesses.

5. The pump according to claim 1, with the addition of, a control valve system for maintaining the operating

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cycle of the pump, operatively connected to said first and second actuating chambers, and having a pressure fluid supply connection, and a control member movable to one end position effective to allow said control system to admit pressure fluid to the first of said actuating chambers, while allowing the second actuating chamber to be vented, and movable to the opposite position effective to allow said control system to admit pressure fluid to the second actuating chamber, while allowing said first chamber to be vented, in the course of a pumping cycle,

and actuating means for moving said control member between said end positions substantially in synchronism with the reciprocations of the diaphragm assembly, thereby maintaining the pumping cycle.

6. The diaphragm pump according to claim 5, wherein said transmitting means comprise,

a first pusher pin parallel to said actuating rod, and mounted in the adjacent inner housing section in sealing relationship therewith, and adapted to transmit movement of the diaphragm assembly to said control member of the control valve system so as to move the same in one direction at the end of one stroke of the pumping cycle,

and a second pusher pin parallel to said actuating rod, and mounted in the opposite inner housing section, and adapted to transmit movement of the diaphragm assembly to said control member of the control valve system, so as to move the same in one direction at the end of the next stroke of the pumping cycle.

7. The diaphragm pump according to claim 5, wherein said control system comprises

fluid pressure-actuated main control valve means communicating with said actuating chambers, and operable to admit pressure fluid to said actuating chambers and venting said chambers in alternation,

and a fluid-actuated pilot plug valve unit mounted in fixed relationship to said connecting member, parallel to said actuating rod, and having a longitudinally reciprocable pilot plug valve member interposed between, and actuated by said pusher pins, so that reciprocating movement imparted by said pusher pins to said pilot valve member parallel to said actuating rod will cause said main control means to operate the pumping cycle.

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