Sept. 20, 1960 | A. C. SAMPIETRO | 2,953,096

DIAPHRAGM PUMP

Filed Jan. 15, 1957 | 2 Sheets-Sheet 1

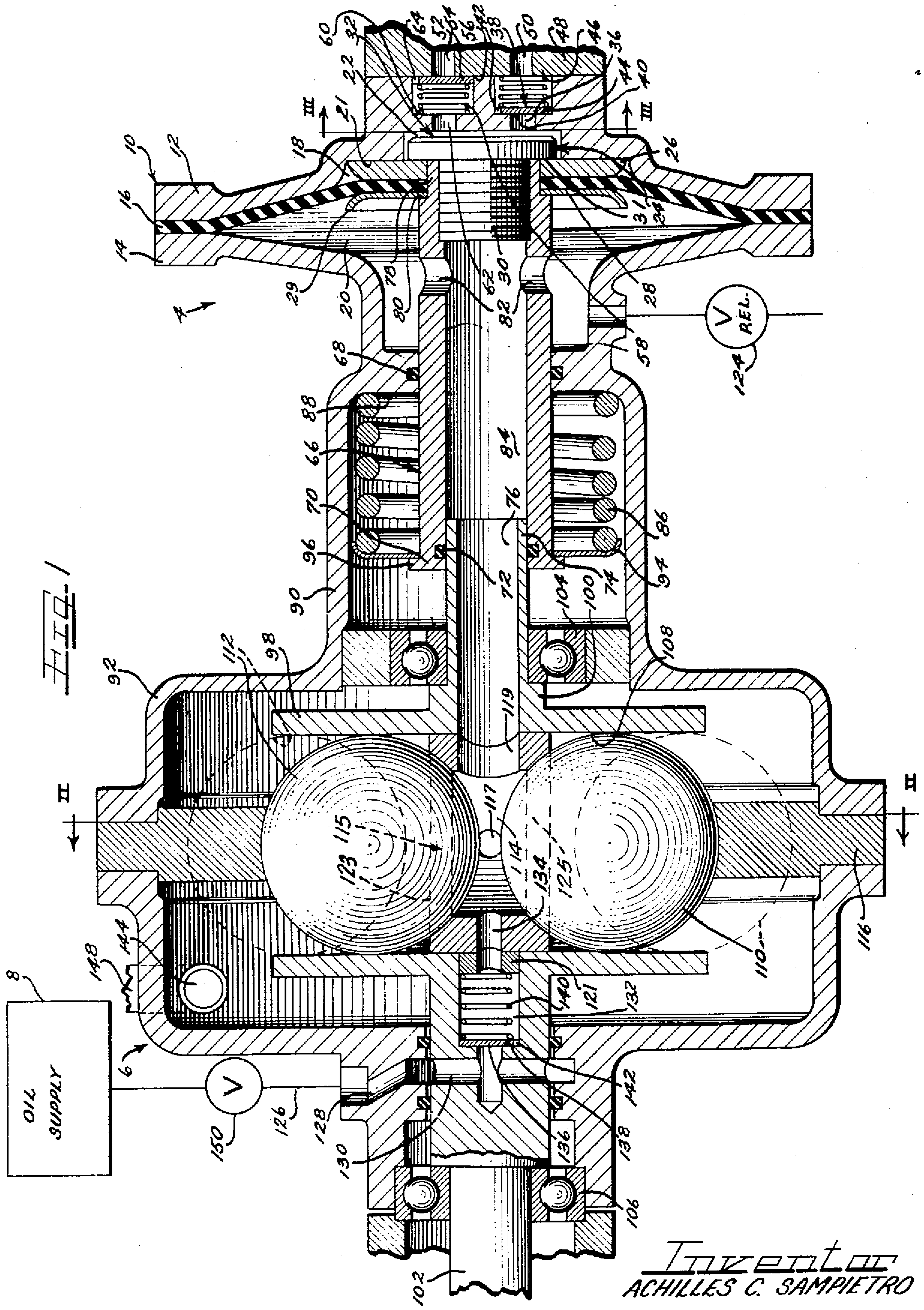

Fig. 1

Inventor
ACHILLES C. SAMPIETRO

By Hill, Sherman, Meroni, Gross & Simpson Attys

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Fig. 2

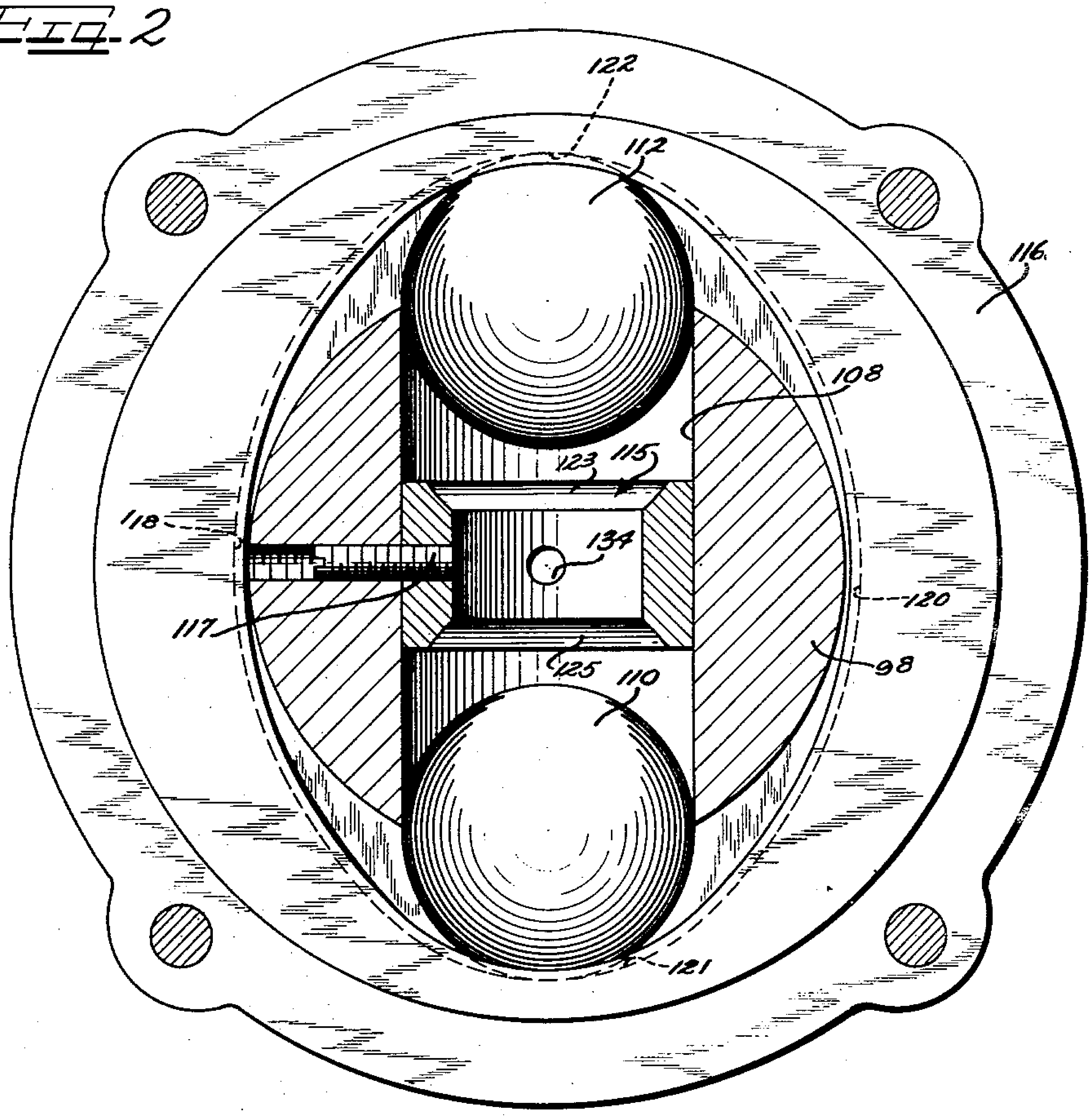
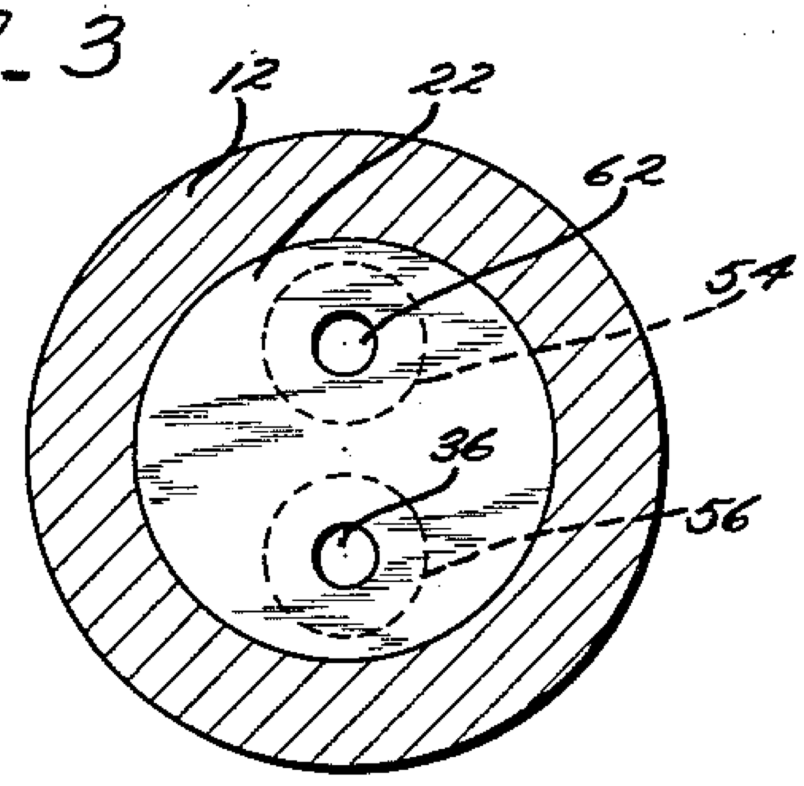


Fig. 3



Inventor
ACHILLES C. SAMPIETRO

By Hill, Sherman, Meroni, Gross & Simpson Attys

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DIAPHRAGM PUMP

Achilles C. Sampietro, Detroit, Mich., assignor to Thompson Ramo Wooldridge Inc., a corporation of Ohio

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6 Claims. (Cl. 103—44)

The present invention relates to improvements in fluid operated pumps wherein the operating fluid is completely isolated from the pumped fluid and to an improved combination of a diaphragm pump and reciprocating pump for supplying operating fluid to the diaphragm pump.

In greater detail, the present invention relates to a diaphragm pump employing a circular diaphragm clamped between a first pumping section of the casing and a second operating section with the diaphragm reinforced with metal parts so as to increase the effective displacement. The pumping section of the casing employs large valves having ports directly facing the metal reinforcement for the diaphragm to handle a considerable volume of fluid with high efficiency. The operating side of the diaphragm carries a coaxial tubular member slidably projecting through a seal in the casing wall with the tubular member being hollow and having ports communicating with the inside of the casing to receive a resurgent pulsating operating fluid to operate the diaphragm. The diaphragm is forced in its discharge stroke by pressurized operating fluid and is returned by a coil compression spring mounted coaxial with the tubular member.

Resurgent pulsating operating fluid is supplied by an operating pump having a rotor with a radial bore carrying radially opposed pumping members forced in the pumping stroke toward the intermediate pumping chamber by an annular encircling cam. Operating fluid is supplied to the pumping chamber through a non-return valve and the flow of fluid is controlled by a shut-off valve which permits termination of operation of the pump combination.

An object of the present invention is to provide an improved combination of a pump for supplying an operating fluid to drive a pump wherein the pumped fluid is completely isolated from the operating fluid.

Another object of the invention is to provide an improved diaphragm pump which has increased effective displacement and minimum clearance space and which is designed to permit the use of large valves and ports permitting the pump to handle a considerable volume of fluid with high efficiency.

Another object of the invention is to provide a pump combination for supplying a pulsating operating fluid to a fluid driven pump wherein the combination is mechanically balanced.

Another object of the invention is to provide an improved pump for supplying operating fluid to drive a fluid operated pump wherein the pumping operation can be terminated without stopping the mechanical operation of the operating pump.

A still further object of the invention is to provide an improved and more compact, efficient, and effective fluid driven pump, and a pump for supplying operating fluid.

Other objects and advantages will become more apparent in connection with the teaching of the principles and the features of the invention in the disclosure of the

preferred embodiment in the specification, claims and appended drawings, in which:

Figure 1 is a sectional view taken through the pump combination showing the spherical pumping members at the end of their discharge stroke;

Figure 2 is a sectional view taken along line II—II of Figure 1 but with the spherical pumping members moved to their position at the end of the intake stroke; and

Figure 3 is a sectional view taken along line III—III of Figure 1.

As illustrated in the drawings, the pump unit for pumping a fluid is illustrated as a diaphragm pump **4**, which is driven by an operating fluid and which completely isolates the operating fluid from the pumped fluid.

The operating pump for providing the pulsating intermittent flow of pressurized operating fluid is shown at **6**. The operating fluid may be oil or the like which is supplied from an oil supply member **8**, providing oil under a slight pressure to provide a continuous supply for the operating pump **6**.

The diaphragm pump will be first described in detail and comprises a casing **10** having a pumping section **12** which is on the pumping side of the pump and an operating section **14**, which is on the operating side of the pump. The casing sections are preferably circular and clamp between them a circular diaphragm **16**. The diaphragm separates the pumping chamber **18** within the pumping section **12** of the casing from the operating chamber **20**, within the operating section **14** of the casing. Thus the pumped fluid, which is handled on the pumping side **18** of the diaphragm is completely isolated from the operating fluid on the operating side **20** of the diaphragm.

The pumping section **12** of the casing is provided with a recess **21** which is centrally located and which leads to a smaller recess **22**, which is also centrally located. The recesses **21** and **22** receive a projection **24** extending from the face of the diaphragm **16** on the pumping side. This projection constitutes part of the reinforcement for the diaphragm.

The reinforcement consists of an annular plate **26** on the pumping side of the diaphragm, and on the opposite side of the diaphragm the plate **26** is backed by a similar lighter plate **28**. These plates are drawn together to be clamped to the diaphragm by the threaded end **30** of the holding member **32**. The holding member has an enlarged head **24**, which projects into the recess **22** of the casing section **12**. The head **24** substantially fills the recess **22** when the diaphragm is in the discharge position, as shown in Figure 1. The plate **26** also substantially fills the recess **21** when the diaphragm is in the discharge position, and there, therefore, is a minimum of clearance space when the diaphragm is in this discharge position.

The fluid pumped by the diaphragm pump **4** will be discharged from the recess **22** through a discharge port **36**. This recess port is relatively large and is positioned directly opposite the head **24** of the member **32**. The port **36** is provided with a non-return outlet valve **38**, which is relatively large and is positioned directly opposite the mouth of the port **36**.

The non-return valve is of a conventional type having a disc **40** with arcuate notches **42** arranged around its circular edge and the notches permit the flow of fluid past the disc **40** when it is forced from its seat **44** surrounding the port **36**. A coil compression spring **46** holds the valve plate **40** in place. The compression spring **46** bottoms on a plate **48** suitably connected to the end of the casing section **12** and which is provided with a delivery conduit **50** adapted to be suitably connected to a delivery line for conducting the pumped fluid away from the diaphragm pump **4**.

The intake of pumped fluid into the diaphragm pump occurs when the diaphragm moves in its intake stroke toward the operating side of the casing, which is to the left, as shown in Figure 1. In this movement of the diaphragm, pumped fluid flows in through the line 52 which extends through the plate 48. The intake fluid flows past the valve disc 54 which is forced off its seat 56 against the urging of the coil compression spring 58. The coil compression spring bottoms on the shoulder 60 at the base of the bored valve chamber in the casing section 12, which leads to the smaller, but relatively large, intake port 62. The valve disc 54 is similar to the discharge disc 56, and has arcuate notches 64 around its peripheral edge to permit the flow of intake fluid.

For the purpose of guiding the diaphragm, for conducting the operating fluid to the operating chamber within the casing 10, and for providing a connecting means for the diaphragm reinforcing plates 26 and 28, a tubular member 66 is provided extending from the operating side of the diaphgram 16. The tubular member is mounted at the center of the circular diaphragm 16 and extends coaxial therefrom. The tubular member is slidably supported by a bearing with a seal 68 in the wall of the operating section 14 of the casing 10. The end 70 of the tubular member 66 carries an annular seal 72 which is slidably positioned between its inner face and the outer surface of a hollow hub 74, which forms the discharge conduit 76 for the operating fluid pump 6.

The opposite end 78 of the tubular member is reduced to provide a shoulder 80 against which seats the reinforcing plate 28. The reduced end 78 projects through the reinforcing plate 28, through an opening in the center of the diaphragm 16 and through the opposite reinforcing plate 26 and the diaphgram and plates are held in place by the base 31 of head 24 of the holding member 32, the threaded end of which is screwed into the interior of the tube 66, which carries mating female threads. The reduced end 78, therefore, provides a spacing element preventing the diaphragm 16 from being clamped too tightly between the plates 26 and 28.

The tubular member 66 is provided with lateral passageways 82 which communicate between the hollow interior 84 of the tubular member and the operating chamber 20, within the diaphragm pump casing 10. These passageways 82 permit the pulsations of operating fluid to flow into the chamber 20 to force the diaphragm assembly in its discharge stroke. The assembly is returned in its intake stroke by a coil compression spring 86. The compression spring bottoms against the area 88, which is part of the operating side 14 of the diaphragm pump casing 10 and which is on the interior of the cylindrical integral housing 90 which rigidly joins the diaphragm pump casing 10 and the operating pump casing 92. The coil compression spring 86 operatively acts on the diaphragm by bearing against an annular plate 94 which is held beneath a flange 96 on the end 70 of the tubular member 66.

The pump 6 for supplying the operating fluid will next be described in detail. The pump casing 92 houses a rotor 98, which has a hub 100 and a shaft 102 journaled respectively by bearings 104 and 106 within the housing 92. The shaft 102 leads to a prime mover or a driving member that turns the rotor 98 at the desired speed to give the frequency of operation of the diaphragm pump that is desired. With the arrangement illustrated, the frequency of movement of the diaphragm 16 is equal to twice the revolutions of the pump rotor 98, although this may be varied as will be understood with the description of the details of the pump 6.

The pump rotor 98 contains a smooth radial bore 108 extending through the rotor. Within this radial bore 108 of uniform diameter is carried a pair of pumping members 110 and 112. Although not limited in construction, the pumping members are preferably spherical in shape and fit snugly and slidably within the bore 108. A pumping chamber 114 is defined between the pumping balls 110 and 112 and the balls move together and apart to force fluid from the pumping chamber in the discharge stroke, and to take in fluid in the intake stroke. The pumping members 110 and 112 are shown together at the end of the discharge stroke in Figure 1, and apart at the end of the intake stroke in Figure 2.

Within the pumping chamber is an insert 115 which is slid into the bore 108 before the spherical balls 110 and 112 are inserted. This insert 115 is cylindrical in shape and has a cylindrical interior which is tapered at the ends 123 and 125 to prevent interference with the balls 110 and 112 as they are pushed together. An intake passageway 134 extends out through one side of the insert and a discharge passageway 119 extends out the other side to communicate with the conduit 76. The insert is held in place by a threaded pin 117 screwed into the side of the rotor 98.

To cause reciprocation of the pumping members 110 and 112 toward and away from each other, they are surrounded by an annular cam 116, which is supported by being clamped between the sections of the pump housing 92. The annular cam 116 is shaped to have opposing surfaces 118 and 120 which force the pumping members 110 and 112 toward each other for 90° of rotation of the rotor 98, and these surfaces of the cam 116 widen toward the surfaces 121 and 122 which have a greater diameter between them to permit the pumping members 110 and 112 to move apart for the next 90° of rotation of the rotor 98.

As the pumping members 110 and 112 move together, fluid is forced out through the discharge port 119 and the discharge conduit 76 to operate the diaphragm 16. A pressure relief valve 124 is tapped into the operating chamber 20 in the casing 10 to relieve excessive pressures should they develop.

The pumping members are held against the inner surface of the annular cam 116 by centrifugal force as the pump rotates and this causes the pumping members to move outwardly on their intake stroke. This intake stroke, however, is aided and abetted by the action of the spring 86, which surrounds and is coaxial with the tubular member 66. This spring forces the diaphragm in its intake stroke and thereby forces the operating fluid back toward the pumping chamber 114 to aid in forcing the balls apart.

The pumping chamber 114 is kept filled with a supply of operating fluid by a fluid supply line 126. This line leads from the oil supply 8 and connects to the pumping chamber 114 through a passageway 128 through the pump casing 92, through radial bored holes 130 in the hub 102, through a non-return valve chamber 132 and through a communicating intake port 134, leading into the pumping chamber 114.

The non-return valve includes a disc plate 136 which is normally urged against its seat 138 by a coil compression spring 140 within the valve chamber 132. The disc plate has annular notches 142 around its peripheral edge to permit the flow of oil into the pumping chamber 114 whenever the disc is unseated. This occurs only when a drop in pressure occurs within the pumping chamber due to a lack of oil or operating fluid. The pressure drop or suction to draw in new oil is caused by the flanged edge 29 of plate 28 sticking the inside of the diaphragm pump casing section 14, whereupon the centrifugal force on the balls 110 and 112 sucks in new oil if the chamber 114 is not keep filled by oil returning from the diaphragm pump.

Small amounts of pumping fluid will be lost by leaking past the spherical pumping members 110 and 112 into the pump housing 92. This oil is drained off through a port 144 leading to a drain line 148 which connects to a reservoir for the oil supply 8.

The oil supply line 126 is provided with a shut-off valve 150 which operates to permit termination of operation of the pump assembly without stopping the rotation of the pump rotor 98. When the shut-off valve 150 is turned off to stop the flow of oil through the line 126, the leakage of oil from the pumping chamber into the pump casing **92** will not be replenished and, consequently, the diaphragm **16** will cease to operate. To again cause operation of the pump, the control valve **150** is merely opened providing a new supply of operating fluid.

In operation of the pump combination, the rotor **98** of the operating fluid pump **6** is rotated and the pumping members **112** and **110** will be reciprocated by the action of the annular cam **116**. The pumping chamber **114** between the pumping members **110** and **112** is kept filled with a supply of oil from the oil supply **8** as long as the shut-off valve **150** is open.

When the pumping members **110** and **112** are forced toward each other the pressurized operating fluid will flow through the delivery conduit **76**, through the tubular member **66** and into the operating chamber **20** of the diaphragm pump via the lateral openings **82** in the tubular member **66**. This will force the diaphragm **16** toward its discharge position and the pumped fluid will be forced out of the recess **22** in the section **12** of the diaphragm pump casing through the diaphragm pump discharge port **36**. The large port **36** and large discharge valve **38** will accommodate rapid movement of the diaphragm and a large volume discharge of pumped fluid.

The diaphragm is moved in a reverse direction for the intake of fluid past the intake valve plate **54** and through the intake port **62**. The intake movement of the diaphragm is occasioned by action of the coil compression spring **86** which urges the tubular member **66** to slide to the left as is shown in Figure 1. This intake movement of the diaphragm plus centrifugal force on the pumping members **110** and **112** causes the operating fluid to flow back into the pumping chamber **114** to be ready for a succeeding pulsation to move the diaphragm in its next discharge movement.

Thus, it will be seen that I have provided an improved pump combination which meets the objectives and advantages hereinbefore set forth. The diaphragm incorporates metal reinforcing plates to increase its effective displacement and has enlarged ports stationed in the recessed portion of the casing with enlarged control valves to permit the pump to handle a considerable volume of fluid with high efficiency.

The pump for supplying the operating fluid is simple in nature and reliable and well-adapted to use with the diaphragm pump. Together the combination provides an effective, efficently operating pump which permits pumping fluid without endangering the mixing of the operating fluid and the pumped fluid.

It is to be noted that the machine is mechanically balanced and that vibrations due to the oscillation of the diaphragm and its assembled parts are centrally located with respect to the pump rotor. Since the diaphragm is coaxial in location with respect to the pump axis, the mechanism will be well balanced and unwanted torque forces will not be established to cause unnecessary wear on the parts or to cause vibration or loosening of mountings in the pump assembly.

Operational control of the mechanism is simply applied without terminating the drive of the pump rotor, thereby making it unnecessary to provide a clutch mechanism. This is accomplished by merely closing the supply valve which terminates operation of the diaphragm pump through failure of the supply of operating fluid.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiment of my invention, but it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. In a fluid operated pumping assembly wherein the operating fluid is completely isolated from the fluid pumped, the combination comprising a diaphragm pump to handle a pumped fluid, an operating pump to handle an operating fluid for operating the diaphragm pump, the diaphragm pump including a casing having an operating side and a pumping side, said casing having a recess in the interior and on the pumping side, a diaphragm extending across the interior of the casing and separating said sides, a projection on the diaphragm projecting into said recess to reduce the clearance when the diaphragm is in discharge position against the pumping side within the casing, and control valves for intake and discharge of the diaphragm pump located within said recess to be close to the diaphragm in discharge position, said operating pump including a rotor having a radial bore, pumping members slidably positioned in the bore, an operating fluid supply conduit leading into the pumping chamber between the pumping members, a non-return valve in the conduit permitting operating fluid to be supplied to the pumping chamber, a cam surrounding the pumping members to cause them to reciprocate, means to cause relative rotation between the cam and the pump rotor to cause an intermittent fluid surge to operate the diaphragm, and a discharge conduit communicating between the pumping space between the pumping members.

2. In a fluid operated pumping assembly wherein the operating fluid is completely isolated from the fluid pumped, the combination comprising a diaphragm pump to handle a pumped fluid, an operating pump to handle an operating fluid for operating the diaphragm pump, the diaphragm pump including a casing having an operating side and a pumping side, a diaphragm extending across the interior of the casing and separating said sides and movable against the operating side in intake position and against the pumping side in discharge position, and control valves for the intake and discharge of the diaphragm pump located on the pumping side of the casing, said operating pump including a rotor having a radial bore, pumping members slidably positioned in the bore, an operating fluid supply conduit leading into the pumping chamber between the pumping members, a non-return valve in the conduit permitting operating fluid to be supplied to the pumping chamber, a cam surrounding the pumping members to cause them to reciprocate, means to cause relative rotation between the cam and the pump rotor to cause an intermittent fluid surge to operate the diaphragm, a discharge conduit communicating between the pumping space between the pumping members, and means to return the diaphragm to intake position after being forced to discharge position by the operating fluid whereby the fluid urges the pumping members away from the pumping chamber to fill the chamber for a new delivery stroke.

3. In a fluid operated pumping assembly wherein the operating fluid is completely isolated from the fluid pumped, the combination comprising a diaphragm pump to handle a pumped fluid, an operating pump to handle an operating fluid for operating the diaphragm pump, the diaphragm pump including a casing having an operating side and a pumping side, a diaphragm extending across the interior of the casing and separating said sides and movable against the operating side in intake position and against the operating side in discharge position, and control valves for the intake and discharge of the diaphragm pump located on the pumping side of the casing, said operating pump including a rotor having a radial bore, pumping members slidably positioned in the bore, an operating fluid supply conduit leading into the pumping chamber between the pumping members, a non-return valve in the conduit permitting operating fluid to be supplied to the pumping chamber, a cam surrounding the pumping members to cause them to reciprocate, means to cause relative rotation between the cam and the pump rotor to cause an intermittent fluid surge to operate the diaphragm, a discharge conduit communicating between the pumping space between the pumping members, and a flow control valve in the operating supply conduit whereby

the supply of operating fluid may be cut off to deprive the pumping members of fluid for their discharge stroke to terminate operation of the diaphragm pump with continued relative rotation of the operating pump rotor.

4. In a fluid operated pumping assembly wherein the operating fluid is completely isolated from the fluid pumped, the combination comprising a diaphragm pump to handle a pumped fluid, an operating pump to handle an operating fluid for operating the diaphragm pump, the diaphragm pump including a casing having an operating side and a pumping side, a diaphragm extending across the interior of the casing and separating said sides and movable against the operating side in intake position and against the pumping side in discharge position, and control valves for the intake and discharge of the diaphragm pump located on the pumping side of the casing, said operating pump including a rotor having a radial bore, pumping members slidably positioned in the bore, an operating fluid supply conduit leading into the pumping chamber between the pumping members, a non-return valve in the conduit permitting operating fluid to be supplied to the pumping chamber, a cam surrounding the pumping members to cause them to reciprocate, means to cause relative rotation between the cam and the pump rotor to cause an intermittent fluid surge to operate the diaphragm, a discharge conduit communicating between the pumping space between the pumping members and said operating side of the diaphragm pump casing, and a pressure relief valve in the discharge conduit to relieve excess delivery pressure between the operating pump and diaphragm pump.

5. In a fluid operated pumping assembly wherein the operating fluid is completely isolated from the fluid pumped, the combination comprising a diaphragm pump to handle a pumped fluid, a rotary pump to handle an operating fluid for operating the diaphragm pump, the diaphragm pump including a casing having an operating side and a pumping side, a diaphragm extending across the interior of the casing and separating said sides, said operating pump enclosed in a housing and mounted to rotate coaxially with the center of said diaphragm, a discharge conduit between the rotary operating pump and the diaphragm pump, and means rigidly connecting the operating pump housing and the diaphragm pump casing whereby vibrations of the diaphragm pump will be transmitted along the axis of the rotary pump.

6. A fluid operated pumping assembly wherein operating fluid is completely isolated from a pumped fluid comprising in combination a diaphragm pump for pumping a pumped fluid, an operating pump for pumping an operating fluid for actuating the diaphragm pump, said diaphragm pump including a casing with a chamber therein having an operating side and a pumping side, a diaphragm extending across the chamber of the casing and separating said operating side and pumping side and movable toward the operating side in intake position and toward the pumping side in discharge position, and flow control valves for the intake and discharge of the diaphragm pump located to communicate with the pumping side of the casing, and said operating pump including a rotor member having a radially extending bore therethrough, pumping members slidably positioned in said bore to move together and apart in opposed relationship and force operating fluid from said bore and forming a pumping chamber between them, operating means operatively connected to said pumping members to cause them to reciprocate together and apart in said bore, and a pump discharge conduit communicating between said pumping chamber between the pumping members and the operating side of said diaphragm whereby said diaphragm is positively moved toward pumping position by a movement of said pumping members toward each other and is permitted to move toward intake position when said pumping members move apart.

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