Oct. 6, 1964 F. E. LA FLAME 3,151,804

VACUUM OPERATED PUMP

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Fig. 1

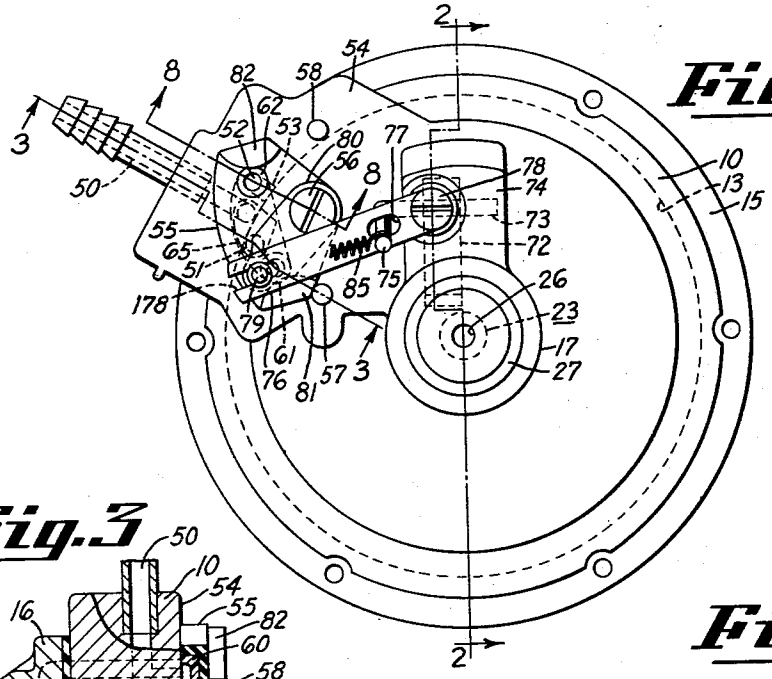


Fig. 3

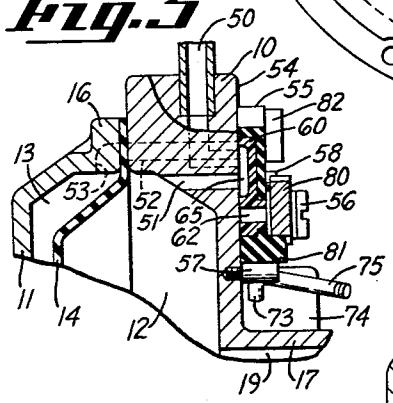


Fig. 4

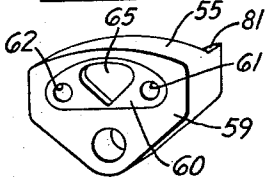


Fig. 2

Fig. 5

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Fig. 7

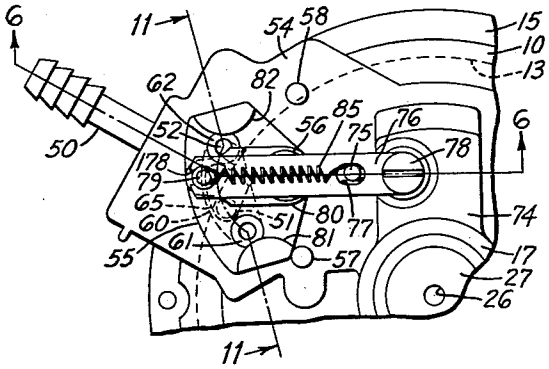
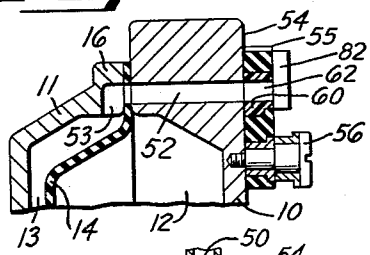


Fig. 8



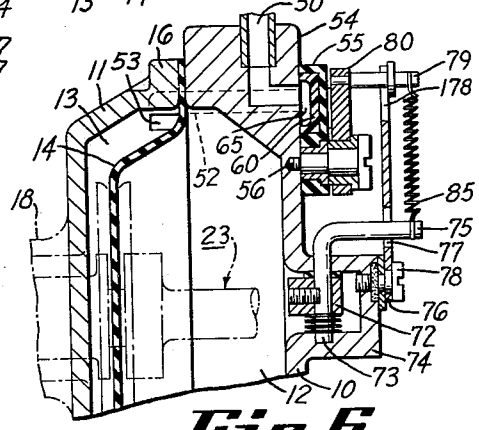


Fig. 6

Fig. 9

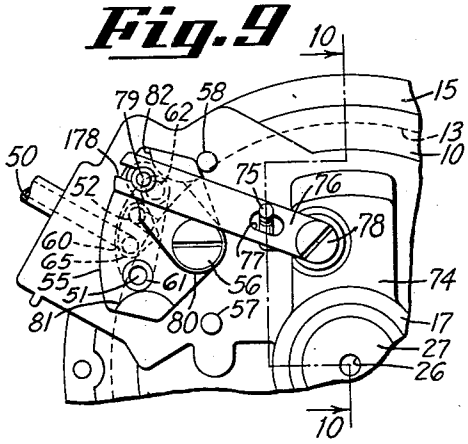


Fig. 11

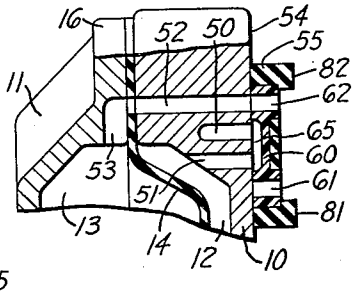
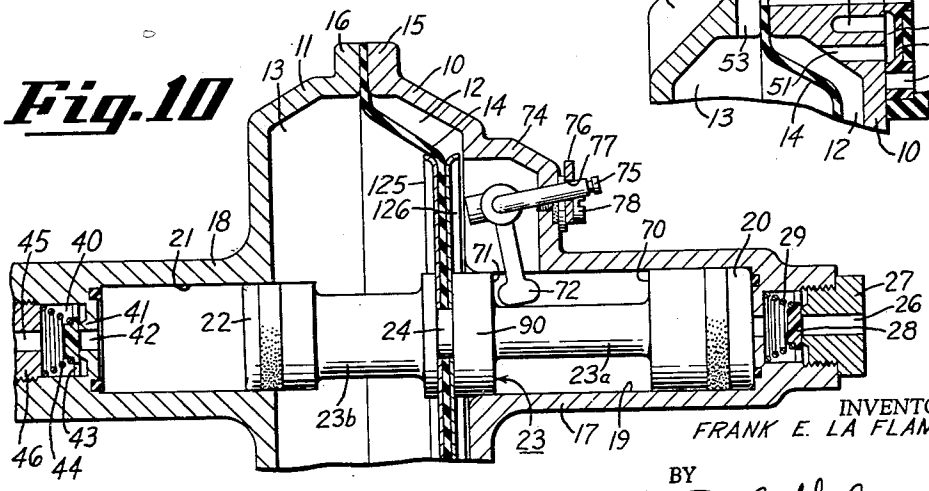


Fig. 10



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3,151,804

VACUUM OPERATED PUMP

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Filed June 29, 1961, Ser. No. 120,642
2 Claims. (Cl. 230—52)

This invention relates to a vacuum operated pump that is particularly useful in compressing air for use in air pressure actuated devices.

An object of the invention is to provide a vacuum operated fluid pump, particularly of the diaphragm operated type, wherein the pump is provided with a pair of opposed coaxially aligned pistons and cylinders with the cylinders and pistons being valved in a manner that the pump can compress fluids in two stages with the fluid compressed in the first stage being delivered to the second stage through an axial passage provided in the piston rod that connects the pistons together and also connects the pistons to the diaphragm of the pump, the valving between the first stage compression and the second stage compression consisting of a single valve member that performs the function of the discharge valve for the first stage compression cylinder and an inlet valve for the second stage compression cylinder, the single valve member being located in the passage that is provided through the piston rod, and more specifically is located at a juncture between two parts of the piston rod that are separable and retain the diaphragm of the pump between the parts of the piston rod, the juncture portion of the piston rod being provided with the valve chamber that receives the single valve element herebefore mentioned.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is an elevational view of a pump incorporating features of this invention.

FIGURE 2 is a cross sectional view taken along line 2—2 of FIGURE 1.

FIGURE 3 is a partial cross sectional view taken along line 3—3 of FIGURE 1 to illustrate the valving for operating the pump.

FIGURE 4 is a perspective view of the valve element that controls operation of the pump.

FIGURE 5 is an elevational view of an insert element used in the valve element shown in FIGURE 4.

FIGURE 6 is a cross sectional view taken along line 6—6 of FIGURE 7 illustrating a part of the operating mechanism for the control valve of the pump.

FIGURE 7 is a partial elevational view of the pump similar to FIGURE 1 but with the valve operating mechanism illustrated in a position in which it is ready to move from the position shown in FIGURE 1 to the position shown in FIGURE 9.

FIGURE 8 is a cross sectional view taken along line 8—8 of FIGURE 1 illustrating certain of the valve passages for the pump.

FIGURE 9 is a partial elevational view similar to FIGURE 1 wherein the valve operating mechanism has been moved to its opposite position.

FIGURE 10 is a cross sectional view taken along line 10—10 of FIGURE 9.

FIGURE 11 is a cross sectional view taken along line 11—11 of FIGURE 7 illustrating the porting for operating the pump.

In this invention the pump comprises a first housing member 10 and a second housing member 11 that co-

operate to form a closed chamber that is divided into two compartments 12 and 13 by means of a flexible diaphragm 14 having its periphery secured between the flanged portions 15 and 16 of the respective housing members.

The housing 10 has a first cylinder 17 formed as an integral part thereof while the housing 11 has a second cylinder 18 formed as an integral part of the housing 11.

The cylinder bore 19 of cylinder 17 receives a piston 20 while the cylinder bore 21 of the cylinder 18 receives the piston 22. The pistons 20 and 22 are connected together by a piston rod means 23 that is formed of the two parts 23*a* and 23*b*, part 23*b* having a threaded end portion 24 received in a mating threaded portion in the part 23*a*. The threaded portion 24 extends through a central opening in the diaphragm 14 and a pair of diaphragm clamping plates 125 and 126 are retained on opposite sides of the diaphragm between the parts 23*a* and 23*b* of the piston rod 23.

The threaded end portion 24 of the piston rod part 23*b* is received within the enlarged cylindrical portion 90 provided on the piston rod part 23*a*. The threaded portion 24 has a recess chamber 91 that forms a valve chamber for a single valve member hereinafter more fully described.

A piston rod bore or passages 35*a* extends through the piston rod portion 23*a* while a corresponding axial passages 35*b* extends through the piston rod portion 23*b*, the axial passages 35*a* and 35*b* together with the valve chamber 91 forming an axial passage that extends through the piston rod portion as well as the pistons attached thereto.

The cylinder 17 has a first valve chamber 25 that also includes a fluid inlet port 26 provided in the fitting 27. The inlet port 26 is closed by a first valve member 28 retained on its seat on fitting 27 by the compression spring 29. The valve chamber 25 is open to the cylinder bore 19 so that movement of the piston 20 in a leftward direction, as viewed in FIGURE 2, will draw air in through the inlet port 26.

At the separable juncture between the piston rod portions 23*a* and 23*b* the valve chamber 91 has a valve member 31 seated on a valve seat 32 by a compression spring 33, the seat 32 being provided at the end of the axial passage portion 35*a*. With the axial passage portion 35*a* being connected with the cylinder bore 19, the valve member 31 acts as a discharge valve for pressurized fluid from the cylinder bore and also acts as an inlet valve for delivery of pressurized fluid for the passage 35*b* for delivery into the cylinder bore 21. The separable attachment of the piston rod portions 23*a* and 23*b* therefore provide a means at the juncture between these portions for attachment thereof to the diaphragm providing a valve chamber to receive a single valve element that can perform the dual functions of discharge valve for the cylinder bore 19 and of inlet valve for the cylinder bore 21.

The cylinder 18 has a third valve chamber 40 that has a fitting member 41 provided with a discharge port 42 from cylinder bore 21 that is closed by a valve member 43 as held on the seat on the member 41 by the compression spring 44, valve member 43 allowing fluid under pressure to pass from the cylinder chamber 21 into the conduit passage 45 provided in fitting 46 when the piston 22 moves in a lefthand direction, as viewed in FIGURE 2.

It will be noted that all three valve members 28, 31 and 43 are positioned on the axis of the cylinders 18 and 17 and coaxial therewith and that all of the valves open in one common direction and close in the opposite common direction so that fluid flow is unidirectional from the inlet 26 to the discharge conduit 45 in compressing

fluid in stages, first in the cylinder bore 19 and thence in the cylinder bore 21 in the reciprocating stroke of the pistons 20 and 22. The arrangement provides for a pump having all of the flow passages contained within the pump so that no exterior conduits will be necessary to conduct pressurized fluid from the first stage compression chamber 19 to the second stage compression chamber 21 and also provides for a minimum number of valves in controlling the flow of fluid from the first stage chamber 19 to the second stage chamber 21, thereby reducing the overall cost of the pump.

The pistons 20 and 22 are reciprocated in their respective cylinder bores by means of the diaphragm 14 as it moves from a position shown in FIGURE 2 to a position shown in FIGURE 10, the compartments 12 and 13 being connected alternately with a vacuum or subatmospheric pressure source while the opposite compartment is connected with atmosphere to obtain thereby a pressure differential at opposite sides of the diaphragm effective alternately to drive the diaphragm 14 in a left-hand direction when chamber 12 is open to atmosphere and compartment 13 is connected with a vacuum source and then to drive the diaphragm in a right-hand direction to a position shown in FIGURE 10 when compartment 13 is at atmosphere pressure and compartment 12 is connected with the vacuum source.

The housing member 10 has a port 50 adapted for connection with a source of vacuum or subatmosphere pressure, such as the vacuum manifold on an internal combustion engine of an automotive vehicle. The housing 10 is also provided with two ports 51 and 52 positioned equidistantly at each side of the vacuum port 50, port 51 being connected with compartment 12 and port 52 being connected with compartment 13 by means of a port extension 53 provided in the housing member 11, as shown in FIGURE 11.

The housing member 10 has a planar face 54 on which a valve member 55 is positioned as pivotally mounted thereon on a pivot screw 56, as shown in FIGURE 6. The valve member 55 is preferably of a semi-hard rubber material so that it will not produce undesired clicking noise when engaging the stops 57 and 58 in movement alternately from the position shown in FIGURE 1 to that shown in FIGURE 9 in a manner hereinafter described. To reduce the friction of movement of the planar face 59 of the valve 55 over the planar surface 54 of the housing member 10, an insert member 60, more specifically shown in FIGURE 5, is placed in the valve member 55, the insert being formed of "Teflon" or other suitable self-lubricating plastic material or "Nylon." The insert member 60 has a pair of ports 61 and 62 that also provide ports through the valve member 55, as shown in FIGURE 11. These ports 61 and 62 are adapted to align alternately with the ports 51 and 52 in the housing wall and thereby alternately connect the chambers 12 and 13 with atmosphere.

The insert member 60 also has a recessed chamber 65 that communicates with the vacuum or subatmosphere port 50 in the housing wall and is adapted to alternately connect the port 50 with the port 51 as shown in FIGURE 11 when the valve member 55 is in the position shown in FIGURE 1, or to connect the port 50 with the port 52 when the valve member 55 is in the position as shown in FIGURE 9, and thereby alternately connect chambers 12 and 13 with the vacuum or subatmosphere port 50. From FIGURE 11 it will be apparent that when chamber 12 is connected with the subatmosphere port 50, chamber 13 will be connected with atmosphere, and that when the valve member 55 shifts to its opposite position, that chamber 13 will then be connected with the subatmosphere or vacuum port 50 while chamber 12 is connected with atmosphere and thereby alternately effect a pressure differential at opposite sides of the diaphragm 14 to alternately move it from the position shown in FIGURE 2 to the position shown in FIGURE 10 and thereby reciprocate the pistons 20 and 22 in their respective cylinders 19 and 21.

The valve member 55 is shifted alternately from the position shown in FIGURE 1 to the position shown in FIGURE 9 by a mechanism that is actuated by reciprocable movement of the piston 20.

The piston 20 has radial annular shoulder portions 70 and 71 that engage a finger member 72 secured on a rock shaft 73 pivotally mounted in the extension 74 of the housing member 10 as shown in FIGURE 6. Thus the end portion 75 of the rock shaft 73 oscillates from a position shown in FIGURE 1 to a position shown in FIGURE 9 as the shoulder portions 70 and 71 alternately engage the finger 72 and move it from the position shown in FIGURE 2 to the position shown in FIGURE 10.

The end portion 75 of the rock shaft 73 extends through a lever 76 through a slot 77, lever 76 being pivoted on housing portion 74 by means of a pivot screw 78. Thus the lever 76 is oscillated about the pivot 78 from the position shown in FIGURE 1 to the position shown in FIGURE 9 in accordance with oscillation of rock shaft 73.

The free end of the lever 76 has a slot 178 through which a pin 79 extends from the secondary level 80 that is carried on the pivot screw 56 which also supports the valve member 55 as shown in FIGURE 6. Oscillation of the lever 76 by the rock shaft 73 also occasions oscillation of the intermediate member 80 about the pivot screw 56 from the position shown in FIGURE 1 to the position shown in FIGURE 9. A compression spring 85 extends between the end portion 75 of the rock shaft and the pin 79 mounted on the intermediate member 80, so that as the lever 76 moves from the position shown in FIGURE 1 through a position shown in FIGURE 7, the spring 85 moves over the axis center of the pivot screw 56 resulting in the snap action movement of the intermediate member 80 to engage the valve 55 and move it rapidly from the position shown in FIGURE 1 to the position shown in FIGURE 9 and to thereby reverse the porting of the chambers 12 and 13 in the manner heretofore described.

The intermediate member 80 is adapted to engage the stop lugs 81 and 82 provided at opposite sides of the valve 55 when oscillating the valve member between the positions shown in FIGURE 1 and FIGURE 9 as the member 80 is carried alternately back and forth by the lever 76.

While the embodiment of the present invention as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a two-stage pump, in combination, a housing having first and second portions joined to form a chamber, a flexible diaphragm extending transversely of said chamber and having the outer periphery thereof in sealing engagement with the junction of said housing portions for dividing said chamber into two compartments, said housing including two cylinder means one at each of opposite sides of the diaphragm, a piston in each of said cylinders, each of said pistons having a piston rod portion extending into engagement with one side of said diaphragm, one of said piston rod portions extending through said diaphragm into an attachment juncture with the other of the piston rod portions, said diaphragm being retained between said piston rod portions in the central area of the diaphragm, one of said piston rod portions having a valve chamber therein at the attachment juncture thereof, generally aligned passage means extending through said piston rod portions from each of opposite sides of said valve chamber and through each of said pistons for fluid connection of said valve chamber with both of said cylinders, a single valve member in said valve chamber providing the dual function of a discharge valve for one of said cylinders and an inlet valve for the other of said cylinders for control of discharge of pressurized fluid from said one cylinder into said other

cylinder, and control means actuated by one of said pistons for alternately and oppositely connecting said compartments to sources of high and low pressure for causing said diaphragm to effect reciprocation of said pistons.

2. A vacuum operated pump comprising in combination, a housing having first and second portions joined to form a chamber, a flexible diapragm extending transversely of said chamber and having the outer periphery thereof in sealing engagement with the juncture of said housing portions for dividing said chamber into two compartments, each of said housing portions including a cylinder means thereon in communication with one of said compartments, one of said cylinder means having a greater displacement than the other of said cylinder means, means for interconnecting said housing portions to locate said cylinder means in close axial alignment, piston means in each of said cylinder means, said piston means in said larger displacement cylinder means having a diameter greater than that of the other piston means, piston rod means connecting said piston means, means for connecting said piston rod means in sealing engagement at the outer periphery thereof with said diaphragm for movement therewith, the larger displacement cylinder means having a valve inlet port, the other of said cylinder means having a valved discharge port, said pistons and piston rod means having a passage extending axially therethrough for communicating said cylinder means, said passage having a single valve means therein providing

the dual function of a discharge valve for said larger diameter means and an inlet valve for said other cylinder means for controlling pressurized fluid flow between said cylinder means, each of said housing portions having a port therein for connecting each of said housing compartments to atmosphere, means forming an additional port in said housing adapted to communicate each of said compartments with a subatmospheric source of pressure, and valve means for alternately connecting said additional port with one of said compartment ports while leaving the other of said compartment ports exposed to atmosphere to produce a pressure differential across said diaphragm acting in alternate directions thereon for producing reciprocation of said piston means in said cylinder means through said piston rod means for producing a two-stage compression of fluid from the inlet port means to the outlet port means therein.

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