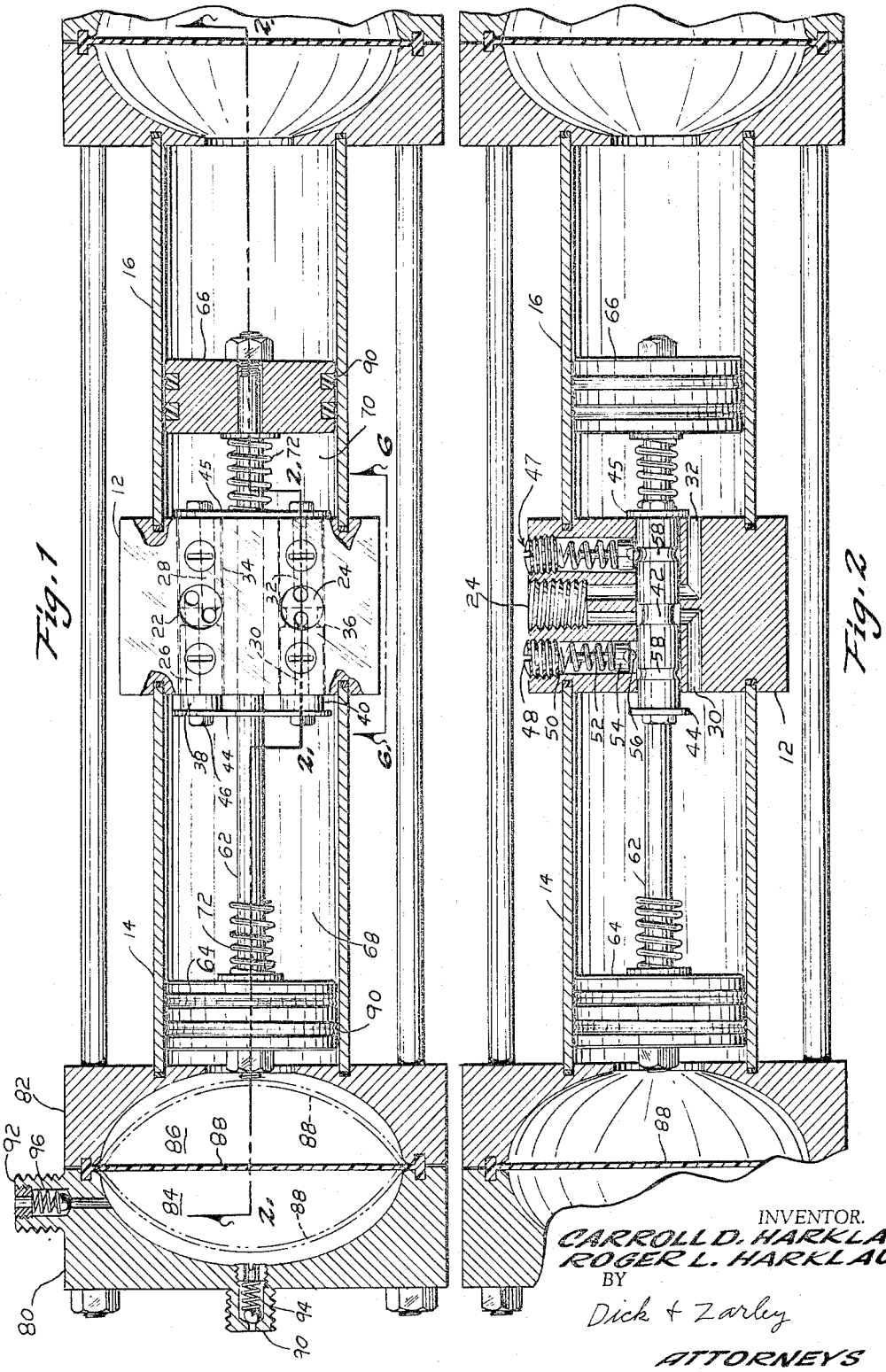
Oct. 4, 1966 C. D. HARKLAU ETAL 3,276,381

SWITCHING VALVE

Filed Feb. 27, 1964 2 Sheets-Sheet 1



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SWITCHING VALVE

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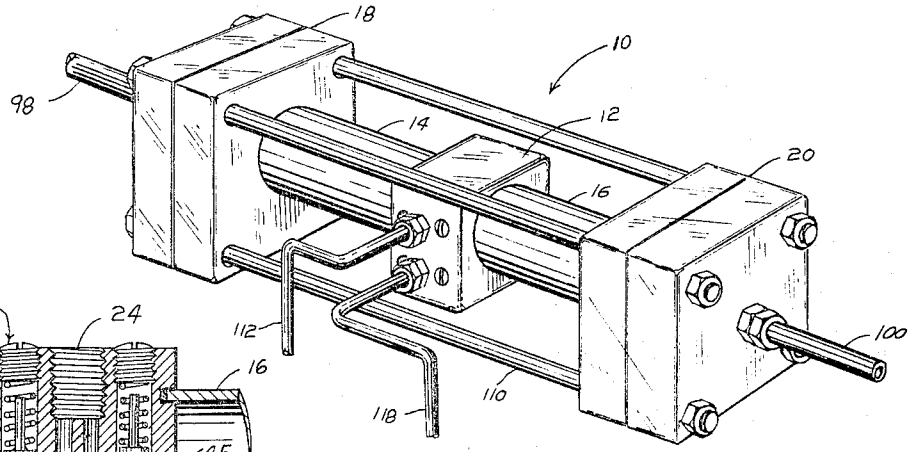

Fig. 3

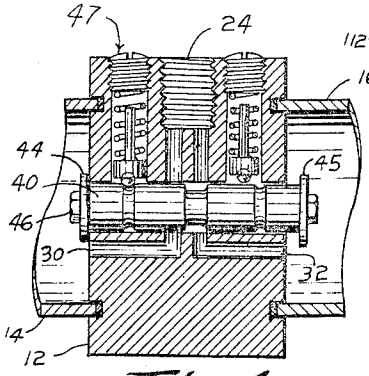

Fig. 4

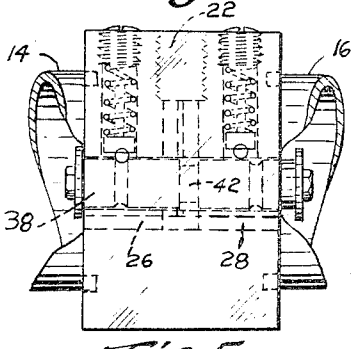

Fig. 5

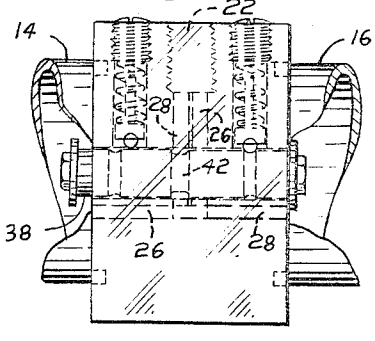

Fig. 6

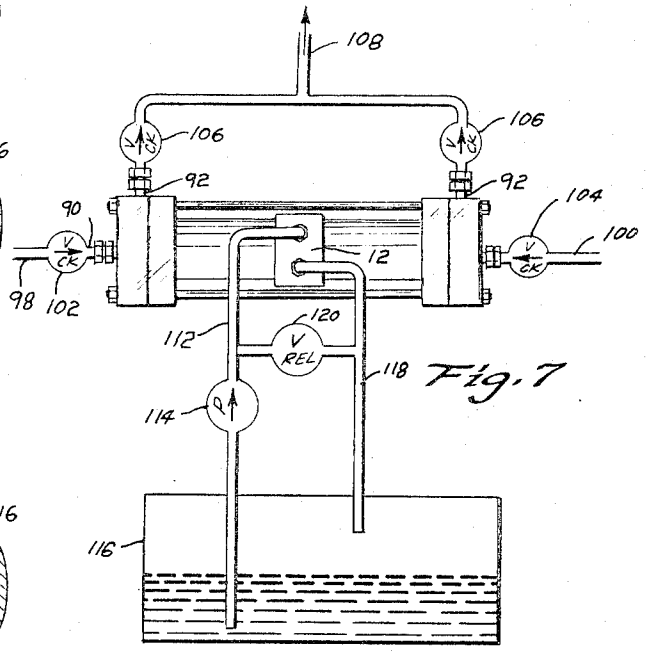

Fig. 7

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United States Patent Office 3,276,381 Patented Oct. 4, 1966

3,276,381

SWITCHING VALVE

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Filed Feb. 27, 1964, Ser. No. 347,906
8 Claims. (Cl. 103—44)

This invention relates to an automatic switching valve and in particular to a valve which is operated by fluid means. The switching valve of this invention has many diverse uses, but is particularly well suited for use as a pump prime mover.

It is one of the objects of this invention to provide a switching valve which may be used as a pump wherein the valve assembly is completely isolated from the material being discharged by the pump.

Another object of this invention is to provide a switching valve which may be used as a pump wherein diaphragm means separates the valve from the fluid material being discharged.

Accordingly, it is another object of this invention to provide a switching valve for use in a pump machine wherein all types of fluid materials may be pumped.

Also, it is an object of this invention to provide a switching valve used in a pump combination wherein extremely high pressures may be created at the point of discharge.

A still further object of this invention is to provide a switching valve having a minimum number of moving parts.

A particular object of this invention is to provide a switching valve having a pair of pistons connected to a movable shaft which extends into a pair of cylinders wherein as the shaft moves the full length of its stroke in either direction, the direction of flow of fluid into each of the cylinders is reversed thereby assuring continuous uninterrupted operation of the switching valve.

Another particular object of this invention is to provide an airless pump for spraying paint or the like.

Another particular object of this invention is to provide a pump which will develop sufficient pressure to move liquid cleaning solutions in lieu of gas or steam materials.

A still further object of this invention is to provide a switching valve which may be operated by either a liquid or a gas pressure source.

A further object of this invention is to provide a switching valve which is simple in design, economical to manufacture and refined in appearance.

This invention consists in the construction, arrangements, and combination of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in the claims, and illustrated in the accompanying drawings, in which:

FIG. 1 is a side elevation view, partially in cross-section of the switching valve pump illustrated in FIG. 3;

FIG. 2 is a cross-sectional view taken along line 2—2 in FIG. 1;

FIG. 3 is a perspective view of the switching valve pump;

FIG. 4 is a fragmentary cross-sectional view similar to FIG. 2, but of only the valve body with the spools moved to their righthand position;

FIG. 5 is a fragmentary plan view of the valve body only and showing in phantom the inlet passageway and the associated spool moved to its righthand position permitting communication with the lefthand cylinder chamber;

FIG. 6 is a view similar to FIG. 5 but showing the spool associated with the inlet passageway moved to its lefthand position to permit communication with the righthand cylinder chamber; and

FIG. 7 is a schematic view of the switching valve used in a pump system.

The switching valve mechanism of this invention is shown in FIG. 3 in a pump combination referred to generally by the reference numeral **10**. Basically, the pump **10** comprises a valve head **12** having oppositely disposed cylinders **14** and **16** on two sides thereof. At the outer ends of the cylinders **14** and **16**, head assemblies **18** and **20** are respectively secured.

The valve body **12**, as shown in FIG. 1, is provided with an inlet passageway **22** and an outlet passageway **24**. Extending from the inlet passageway **22** in opposite directions into the cylinders **14** and **16** respectively are passageways **26** and **28**. Similarly, the outlet passageway **24** has a passageway **30** extending into the cylinder **14** and a passageway **32** connecting with the cylinder **16**. Intersecting the passageways **26** and **28** is a bore **34** which is parallel to a bore **36** intersecting the passageways **30** and **32**. Received in the bores **34** and **36** are spool members **38** and **40** respectively. These spools are identical in construction and are cylindrical in cross-section having an annular center groove **42** which is adapted to communicate in the case of the spool **38**, with the passageways **26** and **28** while the groove **42** in the spool **40** alternates in communication with the passageways **30** and **32**. The outer ends of the spools **38** and **40** are connected by plate elements **44** and **45** which are held to the spool ends by cap screws **46**. Since the length of the spools **38** and **40** is greater than the corresponding dimension of the valve body **12**, the spools **38** and **40** may move in either direction until one of the plate elements **44** or **45** makes contact with the adjacent side of the valve body **12**. As is seen in FIG. 1, when the spools **38** and **40** are moved to the left, the inlet passageway **22** is placed in communication with the passageway **28** leading to the righthand cylinder **16** and the outlet passageway **24** is similarly placed in communication with the passageway **30** leading to the lefthand cylinder **14**. Accordingly, when the spools **38** and **40** are moved to the right, as shown in FIG. 4, the outlet passageway **24** is placed in communication with the passageway **32** leading to the righthand cylinder **16** and, although not specifically shown, is obvious from FIG. 1 that the inlet passageway **22** is in communication with the passageway **26** leading to the lefthand cylinder **14**.

A quartet of detent assemblies **47** are provided in the valve body **12** and include two on each side of the inlet passageway **22** and the outlet passageway **24** for engagement with annular grooves **58** in the spools **38** and **40**. Each of the detent assemblies **47** include a set screw **48** in bearing engagement with a spring **50** which embraces one end of a pin **52**. The pin **52** has a head portion **54** which seats on a detent ball element **56**. The ball element **56** is adapted to move from engagement with the outer cylindrical surface of the spools **38** and **40** to a position within the annular grooves **58**. When the spools **38** and **40** are moved to the lefthand position, the righthand detents **43** are in engagement with the annular grooves **58** in each of the spools **38** and **40** while the lefthand detents **47** are displaced from engagement with the adjacent groove **58**. When the spools **38** and **40** are moved to their righthand position, as shown in FIG. 4 for instance, the reverse situation exists wherein the lefthand detents **47** are in locking engagement with the grooves **58** and the righthand detents are rendered inoperative as they ride on top of the spools **38** and **40**.

A piston shaft **62** is movably mounted in the valve **10** and extends into the cylinders **14** and **16** through the plates **44** and **46**. A piston **64** is mounted on the shaft in the cylinder **14** and a piston **66** in the cylinder **16**. Between the inner face of the piston **64** and the valve body **12** a chamber **68** is formed in the cylinder **14** and simi-

larly a chamber **70** is formed in the cylinder **16** between the inner face of the piston **66** and the outer face of the valve body. Also disposed against the inner face of each of the pistons **64** and **66** is a coil spring **72** which is adapted to bear against the adjacent plate element **44** or **45**. For instance, as shown in FIG. 1, when the force between the spring **72** and the plate element **45** reaches a level sufficient to overcome the detent **47** resistance with the spools **38** and **40**, the spools will be moved away from the opposing spring **72**.

The head assemblies **18** and **20** are similar in construction and each comprise half sections **80** and **82** with cavities **84** and **86** formed therein respectively and separated by a diaphragm element **88** secured between the half sections **80** and **82**. The diaphragm element **88** completely seals the two cavities **84** and **86** from each other. The cavity **86** is adapted to be filled with fluid similar to that used in the chambers **68** and **70** of the cylinders **14** and **16**, although it is contemplated that sealing rings **90** on each of the pistons **64** and **66** will eliminate leakage of oil or the like past the pistons. The outer half **80** of the head assemblies is provided with a material inlet port **90** and outlet port **92**. The ports **90** and **92** are provided with check valves **94** and **96** respectively which permit respectively only the admittance and discharge of fluid from the cavity **84**.

As shown in FIG. 7, each of the head assemblies **18** and **20** are connected to a material source by conduits **98** and **100**. Each of the conduits are provided with check valves **102** and **104** respectively. Each of the discharge ports **92** are connected through check valves **106** to a common conduit **108**.

Four head bolts **110**, one at each corner of the head assemblies **18** and **20**, extend the full length of the pump **10** as shown in FIG. 3 and serve to clamp the mating half sections **80** and **82** together thereby holding therebetween the diaphragm **88**. Also the head bolts **110** secure the head assemblies **18** and **22** to the outer ends of the cylinders **14** and **16** respectively.

The inlet conduit **22** of the valve head **12** is connected by a pipe **112** to a pump **114** which in turn is in communication with an oil sump or the like **116**. The outlet passageway **24** is in turn connected by a pipe **118** which extends into the oil sump **116**. An oil pass pressure release valve **120** is disposed between the pipes **112** and **118**.

Before beginning operation of the pump **10**, the cylinder chambers **68** and **70** are filled with oil or the like. Also the cavities **86** are similarly filled with a fluid such as oil. Thus, when the piston **64**, as shown in FIG. 1, is to its far left position, the oil in the cavity **86** will force the diaphragm **88** to its lefthand dash line position. On the other hand, when the shaft **62** moves to its far right position (not illustrated) the diaphragm **88** will move to its right-hand dash line position. Each of the material inlet ports **90** are placed in communication with a source of material products such as paint of the like.

As the pump **114** begins to force oil from the sump **116** through the pipe **112** into the inlet passageway **22** of the valve **12**, the oil will move into the passageway **28** and thus into the chamber **70** of the right-hand cylinder **16**. Consequently, the piston **66** will be forced to the right and the piston **64** will force oil from the chamber **68** into the passageway **30** and thence into the outlet passageway **24** into the pipe **118** where it is returned to the oil sump **116**. Also, as the pistons **64** and **66** move to the right, the diaphragm **88** will move to its right-hand dash line position thereby permitting paint material or the like to enter the inlet port **90** and fill the now enlarged cavity **84**. Once the shaft **62** has moved to its far right position, the spring **72** in the cylinder **14** will come into bearing engagement with the plate element **44** interconnecting the plungers **38** and **40** and upon reaching a predetermined pressure will instantaneously dislodge the spools **38** and **40** from engagement with the detent balls **56** (FIG. 2)

whereby the spools in a fraction of a second move to the far right position as shown in FIG. 4. The movement of the spools to the right-hand position reverses the flow of fluid to and from the chambers **68** and **70** whereby oil is pumped through the inlet passageway **22** (FIG. 5) and thence to the passageway **26** leading to the left-hand. cylinder chamber **68**. The chamber **70** is now placed in communication with the discharge passageway **24** by the passageway **32** (FIG. 4). Thus as the pump **114** forces the piston **64** to the left the diaphragm **88** is moved to its left-hand dash line position of FIG. 1 and in turn forces the paint material or the like up through the discharge port **92**. Similar operation occurs in the right-hand head assembly **20** as has been described with respect to the left-hand assembly **18**. And, therefore, continuous material pressure is maintained in the outlet conduit **108** with the exception of very momentary pulsations as the pistons and shaft reverse their direction of movement as the spools **38** and **40** are actuated to reverse the flow of oil into and from the cylinder chambers **68** and **70**.

When non-corrosive material products are being pumped the diaphragm element **88** may be made of rubber or the like material. However, other suitable materials may be used as required for a particular job. It is noted that all of the moving parts, namely the pistons and the spools **38** and **40**, are continuously being lubricated since they are completely immersed in an oil solution.

It is to be understood that the pistons **64** and **66** may be coupled in any suitable manner to any other system in lieu of the diaphragm arrangement shown as an embodiment of the present invention.

Should, for example, the discharge pipe **108** be closed while the top **114** is operating, the oil bypass valve **120** (FIG. 7) would function to permit oil to flow directly into the pipe **118** and back into the oil sump thereby preventing damage to the pump unit **10**.

Some changes may be made in the construction and arrangement of our switching valve without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claims, any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

We claim:

1. In a switching valve, comprising,
- a valve body,
- a cylinder disposed on one side of said valve body,
- a cylinder disposed on the opposite side of said valve body from said first cylinder,
- a head assembly for and separate from each of said cylinders and being disposed at the outer end of each of said cylinders from said valve body,
- a plurality of detachable rods interconnecting said head assemblies whereby said valve body is held between the inner ends of said cylinders,
- a movable shaft extending through said valve body into each of said cylinders,
- a piston in each of said cylinders and connected to the adjacent end of said shaft,
- a chamber formed in each of said cylinders between said pistons and said valve body,
- inlet means adapted to be in communication with each of said chambers,
- outlet means adapted to be in communication with each of said chambers,
- means for simultaneously opening the inlet means to one chamber and the outlet means to the other chamber, and said last mentioned means adapted to simultaneously open the inlet means to the other chamber and the outlet means to said first chamber.

2. The valve of claim **1** and said inlet means is in communication with a fluid supply, a pump means is provided for supplying fluid from said fluid supply to said chambers through said inlet means, and said outlet means is in communication with said fluid supply whereby said

fluid at times is discharged from said chambers into said fluid supply through said outlet means.

3. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and
each of said cylinders having a diaphragm therein disposed outwardly of the outer sides of each of said pistons, and the outer side of each piston and the adjacent diaphragm defining a chamber, said chamber containing fluid.

4. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the

other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and
each of said cylinders having a diaphragm therein disposed outwardly of the outer sides of each of said pistons, and the outer side of each piston and the adjacent diaphragm defining a chamber, said chamber containing fluid, means adjacent each of said diaphragms to form an outer chamber on the opposite side thereof from said piston, each of said outer chambers having a fluid inlet and an outlet means whereby as said pistons move towards their adjacent diaphragms said fluid in said outer chambers is forced out said outlet means connected thereto and as said pistons move away from the adjacent diaphragms said outer chambers are filled with fluid through said inlet means connected thereto.

5. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and
each of said cylinders having a diaphragm therein disposed outwardly of the outer sides of each of said pistons, and the outer side of each piston and the adjacent diaphragm defining a chamber, said chamber containing fluid, means adjacent each of said diaphrams to form an outer chamber on the opposite

side thereof from said piston, each of said outer chambers having a fluid inlet and an outlet means whereby as said pistons move towards their adjacent diaphragms said fluid in said outer chambers is forced out said outlet means connected thereto and as said pistons move away from the adjacent diaphragms said outer chambers are filled with fluid through said inlet means connected thereto, the outlet means of said outer chambers are connected to a common discharge passageway.

6. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and
a head assembly is provided at the outer end of each cylinder, a diaphragm in each of said head assemblies forming a pair of cavities on opposite sides thereof, one of said cavities being in direct communication with the outer end of the adjacent cylinder, and the other cavity having a material inlet port and a material outlet port.

7. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber

and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and
a head assembly is provided at the outer end of each cylinder, a flexible diaphragm in each of said head assemblies forming a pair of cavities on opposite sides thereof, one of said cavities being in direct communication with the outer end of the adjacent cylinder, and the other cavity having a material inlet port and a material outlet port, said material inlet port being in communication with a material supply and the outlet port of each head assembly being connected to a common discharge conduit.

8. In a switching valve, comprising,
a valve body,
a cylinder disposed on one side of said valve body,
a cylinder disposed on the opposite side of said valve body from said first cylinder,
a movable shaft extending through said valve body into each of said cylinders,
a piston in each of said cylinders and connected to the adjacent end of said shaft,
a chamber formed in each of said cylinders between said pistons and said valve body,
inlet means in said valve body in communication with each of said chambers,
outlet means in said valve body in communication with each of said chambers,
a first valve means for alternately breaking communication between said outlet means and one chamber and said outlet means and the other chamber,
a second valve means for alternately breaking communication between said inlet means and one chamber and said inlet means and said other chamber,
actuating means for simultaneously actuating said first and second valve means to a first position for placing said one chamber in communication with said inlet means and closing said one chamber to communication with said outlet means, and also simultaneously placing the outlet means in communication with the other chamber while closing the inlet means to communication with said other chamber, and to a second position wherein simultaneously said one chamber is placed in communication with said outlet means and said one chamber is closed to communication with said inlet means, and also simultaneously said other chamber is placed in communication with said inlet means and said other chamber is closed to communication with said outlet means,
spring biased detent means in engagement with each of said first and second valve means when in said first and second positions to yieldingly limit movement of said first and second valve means between said first and second positions, and

a head assembly is provided at the outer end of each cylinder, a flexible diaphragm in each of said head assemblies forming a pair of cavities on opposite sides thereof, one of said cavities being in direct communication with the outer end of the adjacent cylinder, and the other cavity having a material inlet port and a material outlet port, said material inlet port being in communication with a material supply and the outlet port of each head assembly being connected to a common discharge conduit, and said chambers in said cylinders and said first cavity of each head assembly containing a fluid whereby as said pistons move in one direction towards one head assembly said material is forced out the outlet port

of the adjacent cavity by the diaphragm in said one head and when said pistons move in the opposite directions towards the other head assembly the material in the other head is forced out by its diaphragm through said outlet port in the associated cavity.

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