US00RE38239E

(19) **United States**
(12) **Reissued Patent**
Duncan

(10) **Patent Number: US RE38,239 E**
(45) **Date of Reissued Patent: Aug. 26, 2003**

(54) **AIR DRIVEN DIAPHRAGM PUMP**

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(21) Appl. No.: **09/566,416**

(22) Filed: **May 5, 2000**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **5,378,122**
Issued: **Jan. 3, 1995**
Appl. No.: **08/017,822**
Filed: **Feb. 16, 1993**

(51) **Int. Cl.**[7] **F04B 43/06**
(52) **U.S. Cl.** **417/395**; 417/413.1
(58) **Field of Search** .... 417/393, 394, 417/395, 412, 413 R

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(57) **ABSTRACT**

A double diaphragm pump having an air chamber housing centrally located between two pump chamber housings. The air chamber housing includes a center section and two outwardly facing concave discs. Each pump chamber housing includes a pump chamber shell mating with one of the discs with a flexible diaphragm therebetween. Check valve chambers and inlet and outlet passages associated with each pump chamber and with inlet and exhaust manifolds control flow through the pump. A solenoid actuated valve alternately directs air pressure to each of the two diaphragms for reciprocal pumping action. Inner pistons associated with the diaphragms include stops which limit pump stroke in each direction. The solenoid may be driven by conventional electronics on a timed stroke or responsive to flow considerations.

7 Claims, 3 Drawing Sheets

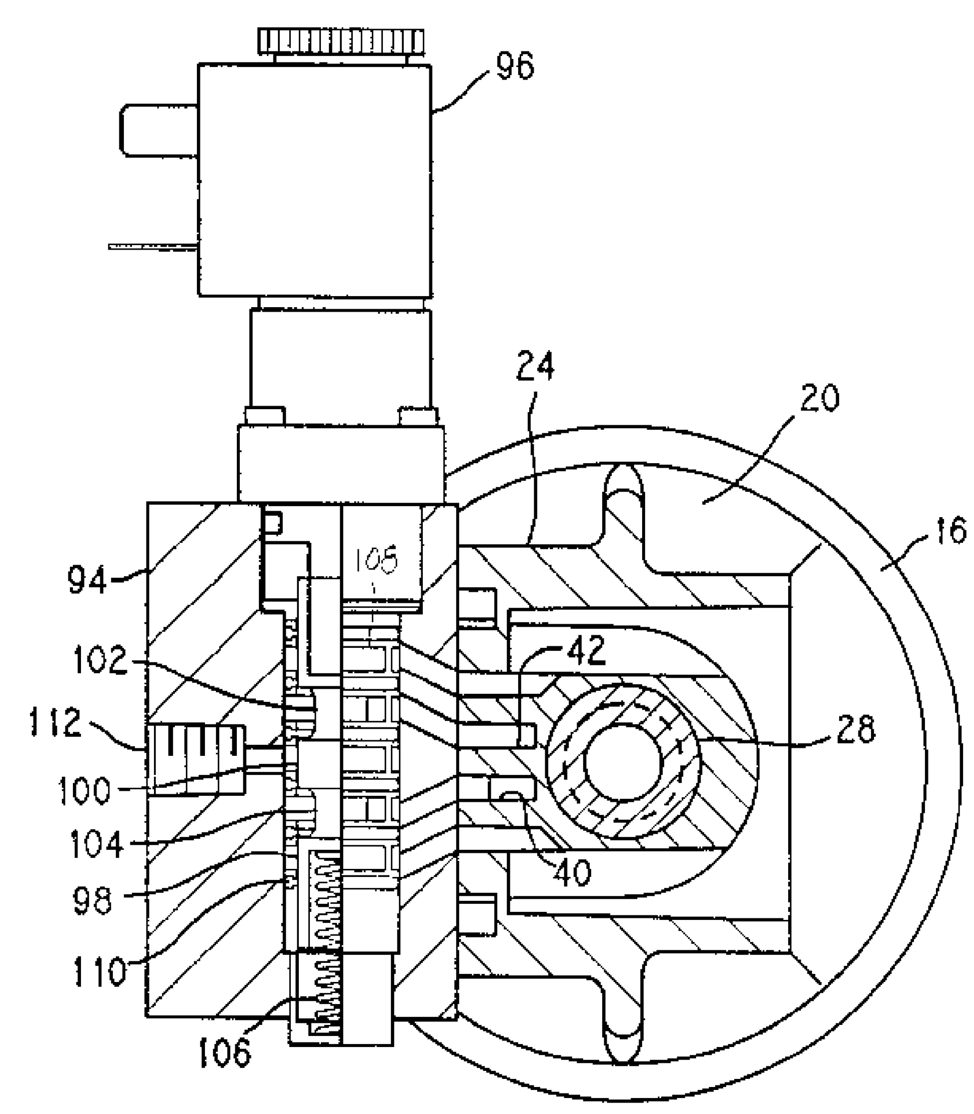

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FIG. 2.

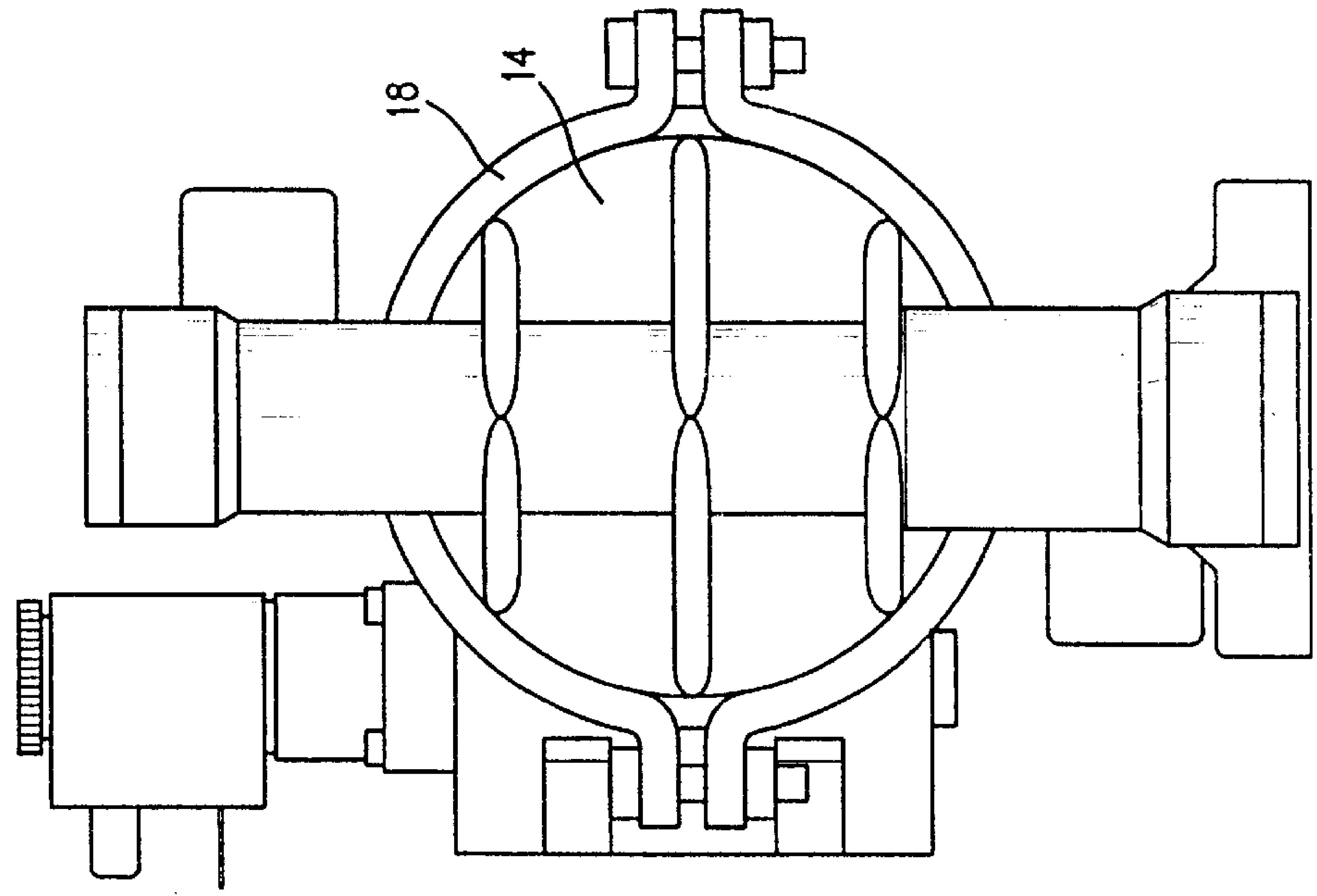
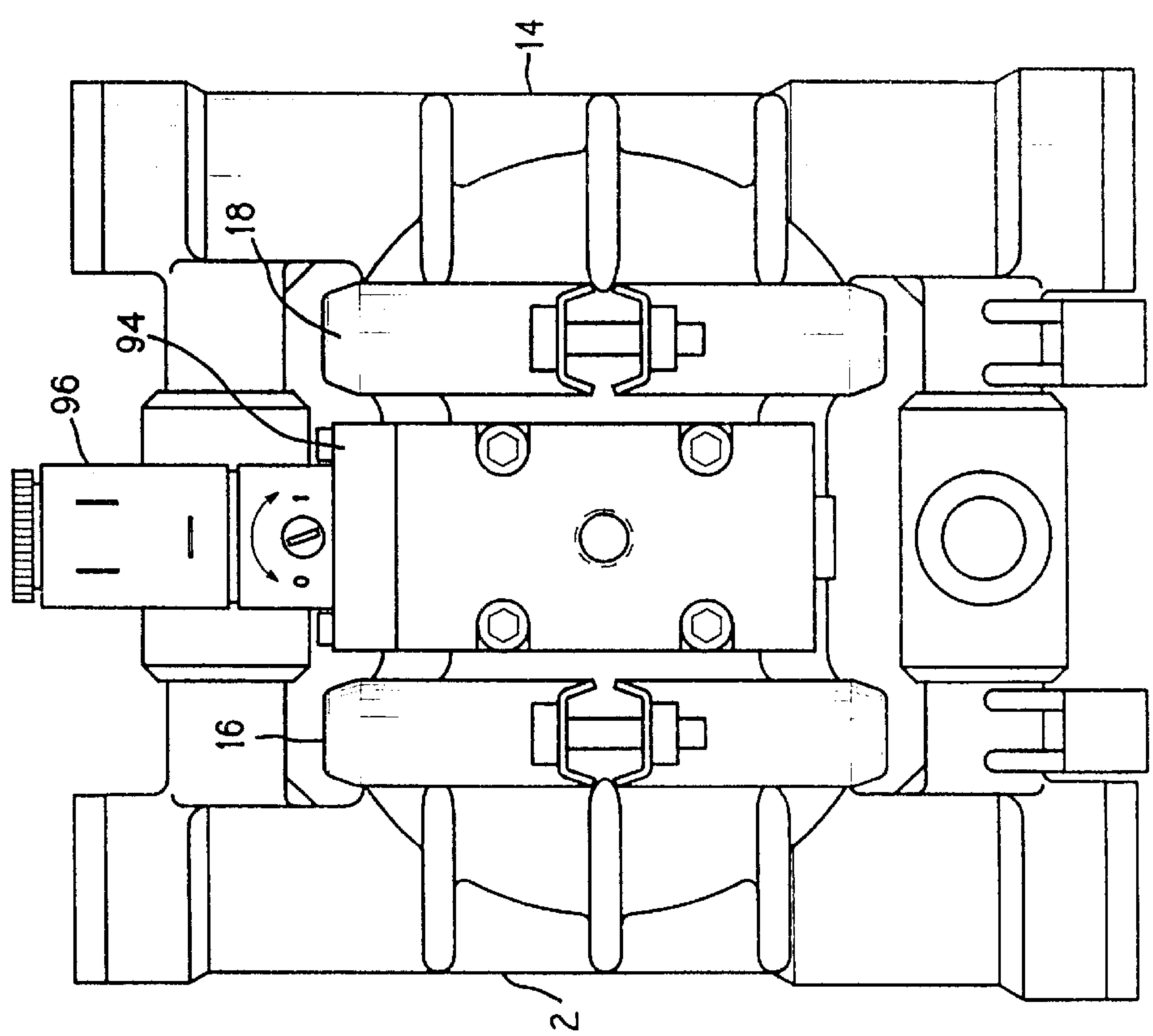


FIG. 1.



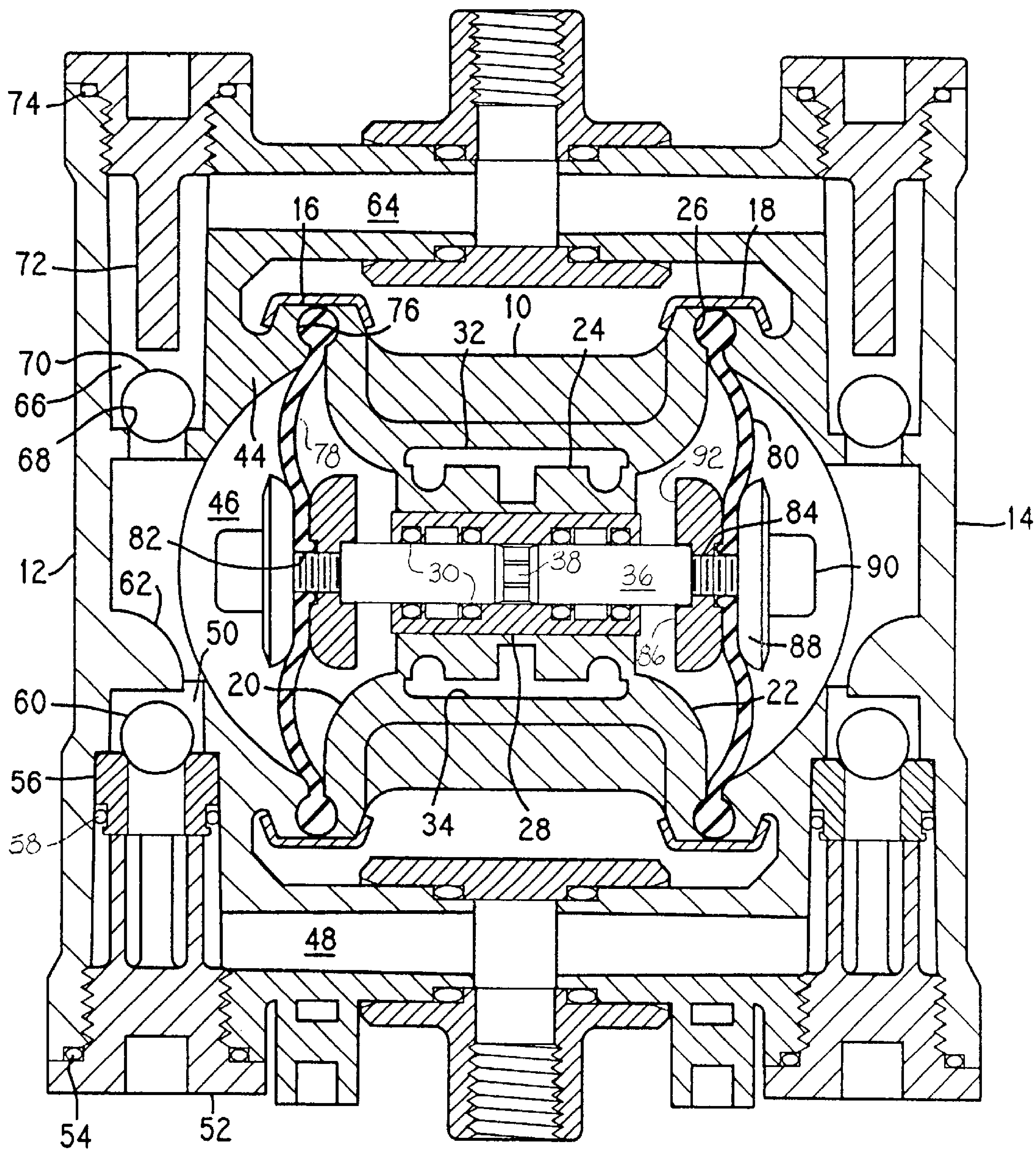


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FIG. 3.

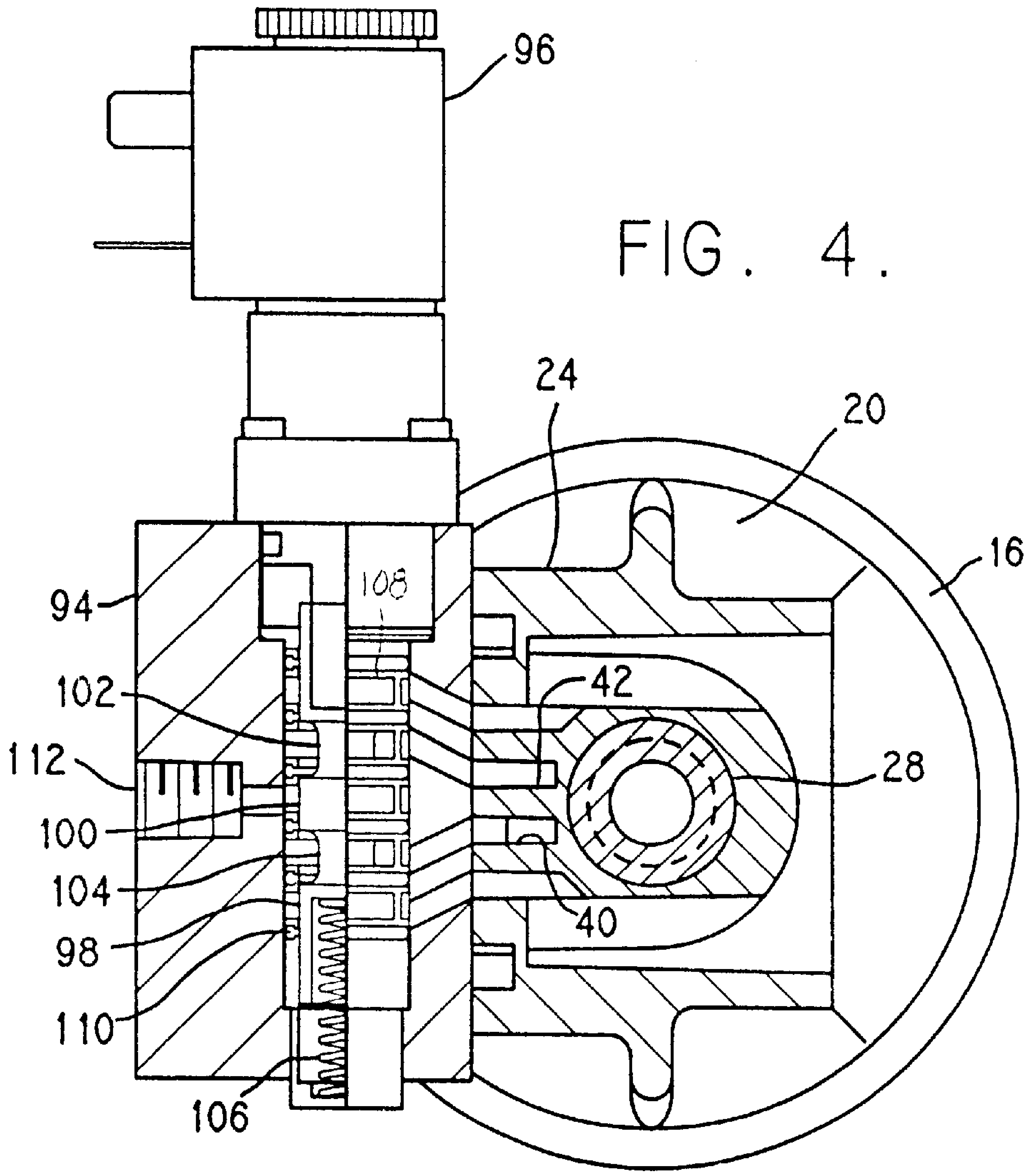

FIG. 4.

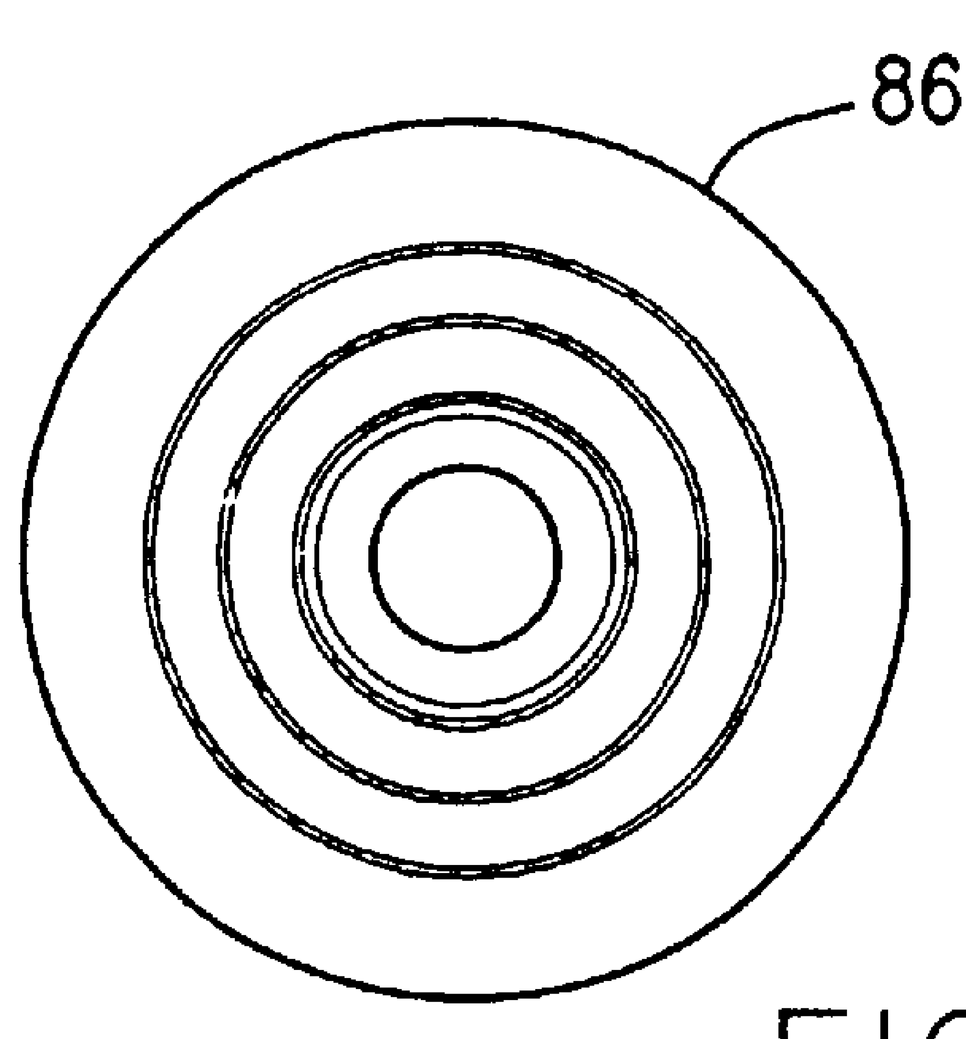

FIG. 5.

AIR DRIVEN DIAPHRAGM PUMP

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The field of the present invention is control mechanisms for air driven diaphragm pumps.

Pumps having double diaphragms driven by compressed air directed through an actuator valve are well known. Reference is made to U.S. Pat. Nos. 5,169,296; 4,247,264; U.S. Pat. Des. Nos. 294,946; 294,947; and 275,858, all issued to James K. Wilden, the disclosures of which are incorporated herein by reference. An actuator valve operated on a feedback control system is disclosed in U.S. Pat. No. 3,071,118 issued to James K. Wilden, the disclosure of which is also incorporated herein by reference. This feedback control system has been employed with the double diaphragm pumps illustrated in the other patents.

Such pumps include an air chamber housing having a center section and two concave discs facing outwardly from the center section. Opposing the two concave discs are pump chamber housings. The pump chamber housings are coupled with an inlet manifold and an outlet manifold through ball check valves positioned in the inlet passageways and outlet passageways from and to the inlet and outlet manifolds, respectively. Diaphragms extend outwardly to mating surfaces between the concave discs and the pump chamber housings. The diaphragms with the concave discs and with the pump chamber housings each define an air chamber and a pump chamber to either side thereof. At the centers thereof, the diaphragms are fixed to a control rod which slidably extends through the air chamber housing.

Traditionally, actuator valves associated with such pumps have included feedback control mechanisms including a valve piston and airways on the control rod attached to the diaphragms. Air pressure is alternately generated in each air chamber according to control rod location, driving the diaphragms back and forth. In turn, the pump chambers alternately expand and contract to pump material therethrough. Such pumps are capable of pumping a wide variety of materials of widely varying consistency.

Turning to the area of reciprocating power, various reciprocating devices have been known to use a constant supply of air pressure and a solenoid valve to provide an alternating flow of air for driving the reciprocating motions. Such devices may require any number of mechanisms for timing of the strokes including feedback control as well as simple set interval actuation.

SUMMARY OF THE INVENTION

The present invention is directed to an air driven double diaphragm pump employing an actuator valve which provides alternating pressure to the diaphragms independently of the stroke position of the pump. In association with reciprocal control, pistons act to limit the stroke of the double diaphragms to accomplish desired pumping characteristics.

Accordingly, it is an object of the present invention to provide an improved air driven diaphragm pump. Other and further objects and advantages will appear hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a pump of the present invention.

FIG. **2** is a side view of a pump of the present invention.

FIG. **3** is a cross-sectional elevation taken along the centerline of the pump.

FIG. **4** is a cross-sectional view taken centrally through the pump center section and actuator valve.

FIG. **5** is a plan view of an inner piston of the pump.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning in detail to the drawings, an air driven double diaphragm pump is illustrated. The pump itself is found to be in three principal structural pieces, an air chamber housing **10** and two pump chamber housings **12** and **14**. Clamp bands **16** and **18** hold these components together.

The air chamber housing **10** is shown to include two outwardly facing concave discs **20** and **22** which are integrally formed with a center section **24**. The discs **20** and **22** extend outwardly to a circular periphery having a form compatible with one of the clamp bands **16** and **18**. A circular recess **26** accommodates the periphery of a diaphragm. The center section **24** includes a bushing **28**. The bushing **28** includes artifacts of an air driven reciprocating control valve. A plain bushing with a single O-ring **30** would suffice. Additional O-rings and passages are illustrated which are unnecessary in this embodiment. Exhaust passages **32** and **34** vent air from the air chambers.

Located in the bushing **28** is a control rod **36**. The control rod **36** is slidably arranged and need not include the central passage **38** for purposes of this embodiment. Referring specifically to FIG. **4**, the center section **24** is shown to include supply passages **40** and **42**. The supply passage **40** extends through the concave disc **20** while the supply passage **42** extends through the concave disc **22** in the opposite direction.

The two pump chamber housings **12** and **14** may be identical. Each housing **12** and **14** includes a pump chamber shell **44** defining a pump chamber **46**. Extending from the pump chamber shell **44** is an inlet passage **48** and an inlet check valve chamber **50**. The inlet passages, in association with a T-coupling, form an inlet manifold.

Contained within the inlet passage **48** and the inlet check valve chamber **50** is a spacer **52** threadably attached to one of the housings **12** and **14** with the junction sealed by an O-ring **54**. The spacer **52** positions a valve seat **56** with an O-ring **58** preventing bypass of the controlled passage. A ball valve **60** cooperates with the valve seat **56** to form a one-way valve. A stop **62** retains the ball valve **60** in position.

Also extending from the pump chamber shell **44** is an outlet passage **64** and an outlet check valve chamber **66**. The outlet passages, in association with another T-coupling, form an outlet manifold. The outlet check valve chamber **66** includes a seat **68**. A ball valve **70** cooperates with the seat **68** to provide a one-way check valve. A stop **72** extends into the outlet check valve chamber **66** to retain position of the ball valve **70**. The stop **72** is threadably fixed within the outlet passage **64** and includes an O-ring **74** to insure proper sealing.

The two pump chamber housings **12** and **14** also include a circular recess **76** to receive the periphery of the diaphragms. The outer portion of the pump chamber shell **44** is circular and adapted to cooperate with one of the clamp bands **16** and **18**.

Two diaphragms **78** and **80** are retained within the circular recesses **26** and **76** about their periphery. The diaphragms may be of conventional construction for air driven diaphragm pumps, defining with the concave discs **20** and **22** and the pump chamber shells **44** and air chamber and a pump chamber on either side of each diaphragm **78** and **80**. Each diaphragm **78** and **80** includes a center opening **82** for anchoring to the control rod **36**. The control rod **36** includes a threaded portion **84** at each end thereof. At each end, an inner piston **86** and an outer piston **88** cooperate to retain each of the diaphragms **78** and **80**. A nut **90** is threaded onto the control rod **36** at each end to retain the pistons **86** and **88**.

The inner pistons **86** each include a stop surface **92** which is positioned to abut against the center section **24** to define the limits of the stroke of the control rod **36**. The inner pistons **86** may be available in varying thicknesses to accommodate different pump characteristics.

Associated with the air driven diaphragm pump is an actuator valve **94**. In the present embodiment, the actuator valve **94** operates independently of the stroke position of the control rod **36**. A solenoid **96** controls the valve **94**. Conventional electronic control may be employed to reciprocate the valve **94** through the solenoid **96** on a timed basis, on a pump flow basis, on a flow pressure basis or on external controls and circumstances.

The actuator valve **94** is shown to include a piston **98** having a central land **100** and two circumferential passages **102** and **104**. A spring **106** biases the piston **98** in a first direction to cooperate with the solenoid **96**. Spacers **108** with O-rings **110** therebetween prevent communication axially along the valve. An inlet **112** receives a constant pressurized source of air. Supply passages **40** and **42** are alternately communicated with the inlet **112** depending on the position of the piston **98**. Alternatively, the supply passage of the supply passages **40** and **42** which is not in communication with the inlet **112** is in communication with its respective exhaust passage of the exhaust passages **32** and **34**. Thus, as one air chamber is being filled, the other air chamber is allowed to exhaust. Through reciprocation of the solenoid, the pump is alternately driven in one direction or the other until it stalls against a stop surface **92** of one of the inner pistons **86**.

The thickness of the inner pistons **86** may be selected to provide varying pump performance characteristics. For example, thick inner pistons **86** would act to minimize pressure surges. The thinner inner pistons **86** would maximize flow. Where each side is intended for a different pumping function, the inner pistons **86** may be of different thicknesses to accomplish different results. Finally, empirical selection of the thickness for each inner piston **86** would define a specific quantity of flow per stroke such that the pump itself may be used to accurately measure volumes.

Thus, an air driven diaphragm pump controlled by a solenoid, valve with controlled stroke length has been disclosed. While embodiments and applications of this invention have been shown and described, it would be apparent to those skilled in the art that many more modifications are possible without departing from the inventive concepts herein. The invention, therefore is not to be restricted except in the spirit of the appended claims.

What is claimed is:

1. An air driven double diaphragm pump comprising

an air chamber housing having a center section and two outwardly facing concave discs rigidly positioned to either side of said center section;

two pump chamber housings fixed to said air chamber housing and mating with said two outwardly facing concave discs about the periphery thereof, respectively;

a control rod slidably extending through said center section of said air chamber housing and extending concentrically through said two outwardly facing concave discs;

two diaphragms concentrically fixed to the ends of said control rod, respectively, and extending outwardly to the mating peripheries of said two outwardly facing concave discs and said two pump chamber housings, respectively;

two pistons on said control rod between said two diaphragms and said air chamber housing, respectively, each piston including a stop facing said air chamber housing to abut against said air chamber housing to define the extent of slidable movement of said control rod;

an actuator valve [coupled with] *immediately attached to* said air chamber housing *and including an air inlet and an actuator piston* to provide alternating pressure to said diaphragms independently of the position of said control rod.

2. The pump of claim **1** wherein said actuator valve is a solenoid valve.

3. The pump of claim **2** wherein said solenoid valve includes timed alternation of pressure to said diaphragms.

4. An air driven double diaphragm pump comprising

an air chamber housing having a center section and two outwardly facing concave discs rigidly positioned to either side of said center section;

two pump chamber housings fixed to said air chamber housing and mating with said two outwardly facing concave discs about the periphery thereof, respectively;

a control rod slidably extending through said center section of said air chamber housing and extending concentrically through said two outwardly facing concave discs;

two diaphragms concentrically fixed to the ends of said control rod, respectively, and extending outwardly to the mating peripheries of said two outwardly facing concave discs and said two pump chamber housings, respectively;

two pistons on said control rod between said two diaphragms and said air chamber housing, respectively, each piston including a stop facing said air chamber housing to abut against said air chamber housing to define the extent of slidable movement of said control rod;

an actuator valve attached to said air chamber housing and including an air inlet and an actuator piston to provide alternating pressure to said diaphragms independently of the position of said control rod, said actuator piston having two positions, a first position with said air inlet in communication with one of said two outwardly facing concave discs and a second position with said air inlet in communication with the other of said two outwardly facing concave discs.

5. The pump of claim 4, said actuator valve being a solenoid valve.

6. The pump of claim 4, said solenoid valve includes timed alternation of pressure to said diaphragms.

7. An air driven double diaphragm pump comprising

an air chamber housing having a center section and two outwardly facing concave discs rigidly positioned to either side of said center section;

two pump chamber housings fixed to said air chamber housing and mating with said two outwardly facing concave discs about the periphery thereof, respectively;

a control rod slidably extending through said center section of said air chamber housing and extending concentrically through said two outwardly facing concave discs;

two diaphragms concentrically fixed to the ends of said control rod, respectively, and extending outwardly to the mating peripheries of said two outwardly facing concave discs and said two pump chamber housings, respectively;

two pistons on said control rod between said two diaphragms and said air chamber housing, respectively, each piston including a stop facing said air chamber housing to abut against said air chamber housing to define the extent of slidable movement of said control rod;

an actuator valve attached to said air chamber housing and including an air inlet, an actuator piston and a spring, said actuator piston providing alternating pressure to said diaphragms independently of the position of said control rod and having two positions, a first position with said air inlet in communication with one of said two outwardly facing concave discs and a second position with said air inlet in communication with the other of said two outwardly facing concave discs, said actuator valve being a solenoid valve, said spring biasing said actuator piston toward said first position, said actuator piston being in said second position with actuation of said solenoid valve.

* * * * *