

May 4, 1943.

W. T. TABB

2,318,128

FLUID TRANSFER APPARATUS

Original Filed Oct. 22, 1940

2 Sheets-Sheet 1

Fig. 1

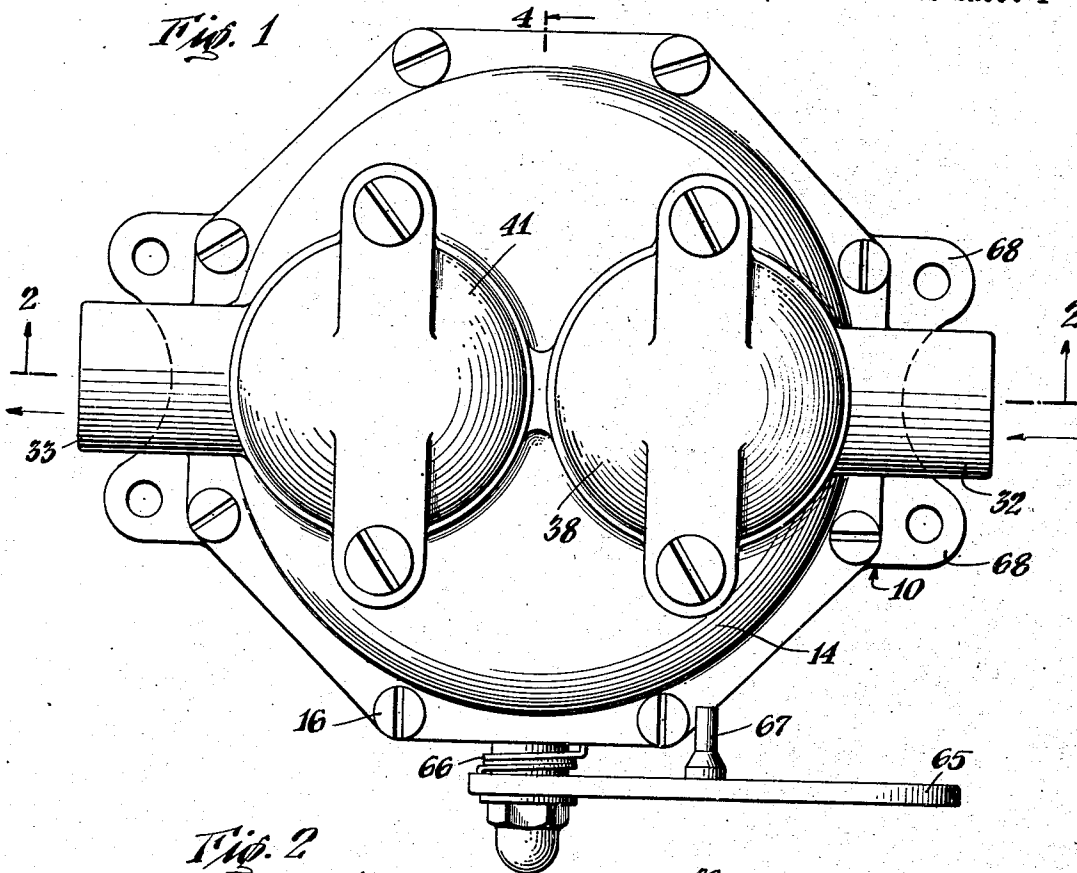
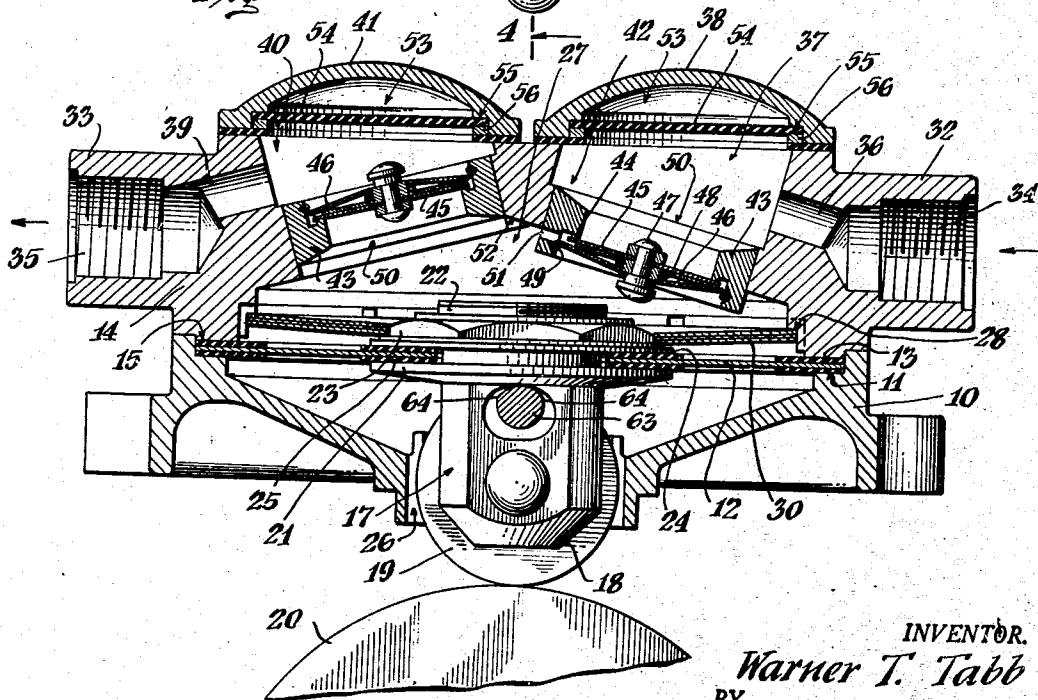


Fig. 2



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Fig. 3

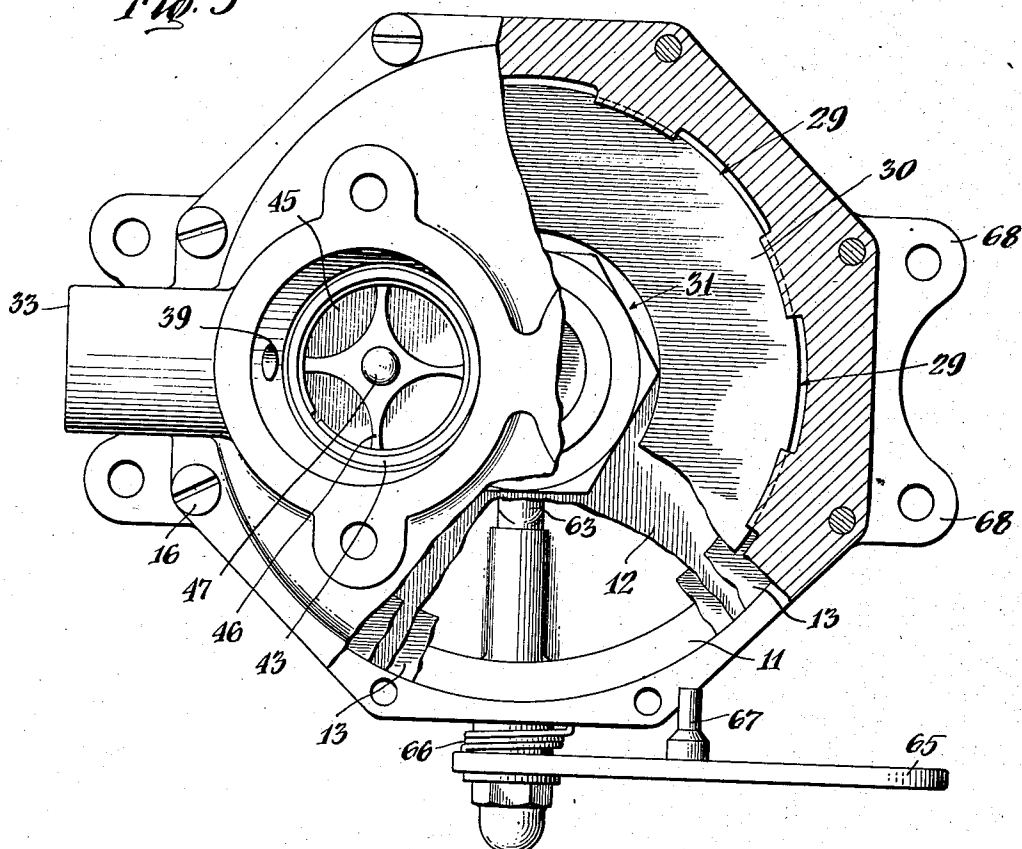
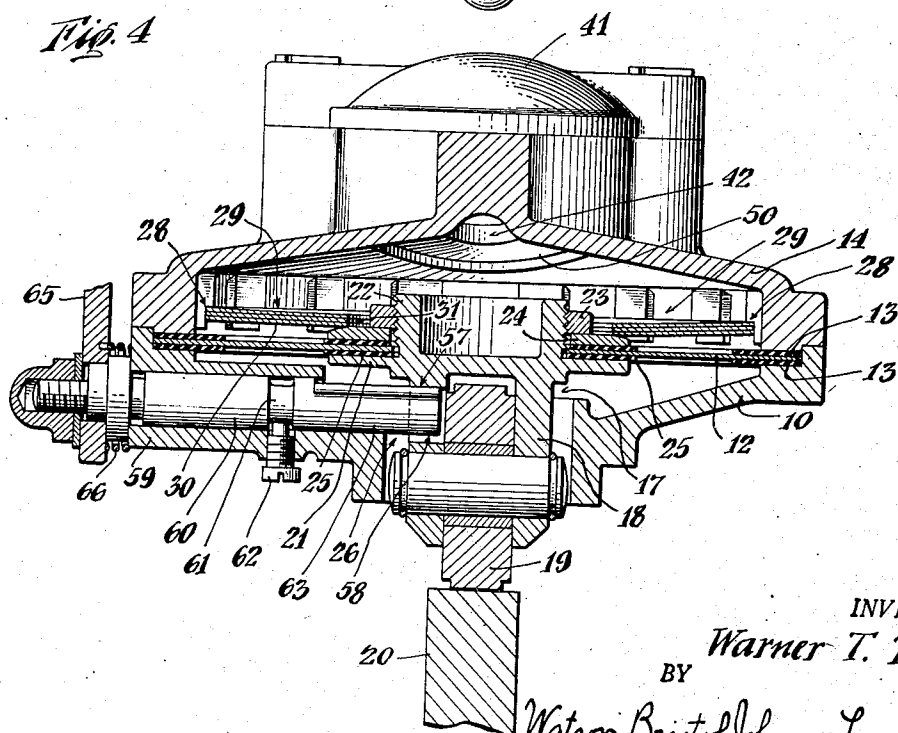


Fig. 4



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UNITED STATES PATENT OFFICE

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FLUID TRANSFER APPARATUS

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Original application October 22, 1940, Serial No.
362,179. Divided and this application March 17,
1942, Serial No. 435,118

6 Claims. (Cl. 103—207)

The present invention relates to fluid transfer apparatus and more particularly to pump apparatus adapted to effect transfer of fluids either liquid or gaseous for a variety of purposes, as disclosed in my parent application Serial No. 362,179, filed October 22, 1940, of which the present application is a division.

General objects of the invention are the provisions of such apparatus which is of simple and economical construction with minimization of leakage tendencies, requires little if any careful and costly machining and treating of cooperating parts frictional engagement between which is relatively minimized thus reducing tendency of wear which might eventually require replacements or repair, can be readily and easily assembled and disassembled, is efficient in operation to transfer fluid effectively at a relatively uniform rate, and is capable of efficient high frequency operation; and structural embodiments of such apparatus which can readily and economically be made and assembled in mass production while assuring efficient use and operation thereof.

More specific objects of the invention are the provision of such apparatus characterized by a pump chamber formed by cooperation of a casing and a diaphragm having lateral rigidity and certain spring characteristics with diaphragm biasing leaf-like spring structure having certain spring characteristics mounted in the chamber in a manner to provide certain net spring characteristics for combined diaphragm and spring construction; and to provide such apparatus wherein the mounting and characteristics of said diaphragm structure are such that an outwardly projecting diaphragm operating member mounted on the diaphragm is properly and efficiently guided in its operation without necessitating use thereof of bearing supports or like guiding means which might tend to introduce undesirable problems of construction, manufacture and wear; and which assure efficient operation of said apparatus by mechanical means that may tend in operation to flex said diaphragm only inwardly.

Another object of the invention is the provision in such apparatus of suitable fluid passages past a diaphragm biasing spring disc structure within the pump chamber of such a diaphragm pump, either through the diaphragm or around the periphery thereof, which assures efficient use and operation thereof.

A still further object of the invention is to provide such diaphragm apparatus of such construction as to permit easy and economical pro-

vision of simple and effective priming means, manually operable if desired, which requires no particular provision of packing to prevent leakage, which can be simply mounted and demounted without affecting assembly of other parts, and which can be manipulated effectively to discontinue transfer operation of the pump apparatus without disturbing mechanical means effecting such transfer operation.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of one embodiment of the apparatus of the present invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a top plan view of the structure shown in Figs. 1 and 2 but with parts removed and broken away; and

Fig. 4 is a sectional view taken on line 4—4 of Fig. 1.

Various diaphragm pump structures have been proposed for use in transferring fluids, both gaseous and liquid. For example, such structures have been proposed for use in both mechanical and electrical gasoline injection systems as well as for use in fuel supply systems of internal combustion engines of the Diesel type, oil burners and the like. Many of such structures, however, have been of such construction as to require extremely careful and costly machining and fitting of parts, treating of material to harden frictionally engaging parts, and costly and frequently inefficient provisions of packing to prevent leakage; and have been complicated making assembly and disassembly difficult, subject to wear of frictionally engaging parts making repair or replacement of parts eventually necessary, and inefficient and non-uniform in operation. Further, such structures have been such as to make their use in systems requiring high speed operation, for example fuel supply systems for internal combustion engines, extremely uncertain and unsuitable.

These and other difficulties are efficiently alleviated by the apparatus of the present invention

which has been found to be highly satisfactory for use, by way of example, in fuel supply systems for Diesel engines. The diaphragm pump structure of the invention has no working parts characterized by frictional engagement of guiding bearings, other than a roller, if desired, used as a cam follower to impart movement to a diaphragm operating member or rod. The diaphragm operating member is preferably anchored to the diaphragm to project outwardly therefrom free from any bearing support. It is guided in its operation solely by the diaphragm having lateral rigidity mounted with peripheral portions thereof seated on a casing cooperating with the former to form a chamber. A leaf-like spring structure is mounted in the chamber with outer portions thereof rigidly supported by the casing and forms a biasing abutment for the central portion of the diaphragm structure to obtain the desired biasing action. The diaphragm structure has certain spring characteristics as does the spring structure and these are so correlated as to give net spring characteristics for the combined spring and diaphragm structures as to make for desired action.

Provision is made for manually or otherwise priming the apparatus. This is accomplished by means exterior of the chamber whereby necessity for packing and tendency of leakage are eliminated. Suitable mechanism permits raising or moving inwardly the diaphragm operating member. Preferably a member or shaft is rotatably mounted on the apparatus exteriorly of the chamber preferably on a base member supporting the diaphragm and casing. The inner end thereof may be provided with a cam or the like or so shaped as to engage means such as a shoulder on the operating rod to impart to the latter the desired movement when the priming member or shaft is rotated. When operating the apparatus by a cam with the outer end of the operating rod biased to the external surface thereof to act as a cam follower the priming mechanism may be utilized to arrest fluid transfer operation of the apparatus merely by rotating the shaft and holding it in rotated position to raise the cam follower free from the cam and hold it in raised position.

Referring to the drawings like numerals refer to like parts throughout. A base member or plate 10 is provided with an annular seat 11 upon which seats the periphery of a diaphragm 12. The diaphragm 12 may comprise one or more laminae of sheet steel and preferably has a gasket ring 13 located on either side of the periphery thereof. A casing 14 of general cup-shape and preferably domed at the top has an annular seating surface 15 adapted to cooperate with the seat 11 on the base 10 to clamp the diaphragm 12 and gaskets 13, 13 therebetween in a fluid-tight manner, suitable screws 16—16 being used to clamp the parts together.

An operating member or a rod 17 is anchored centrally to the diaphragm 12 to project outwardly therefrom. This member preferably comprises a fork 18 between the legs of which is rotatably mounted a roller 19 constituting a cam follower adapted to ride on the outer surface of a cam 20. A flange 21 at the base of the operating member 17 provides a bearing shoulder for a central portion of the diaphragm 12 and an inner stud end 22 thereof projects through a central aperture in the diaphragm 12 and is externally threaded to receive a nut 23 between which and the flange 21 is clamped the diaphragm struc-

ture with an interposed washer 24 and suitable gasket rings 25, 25.

The base member 10 is provided centrally with a hole 26 larger than the operating rod 17 and the roller 19 carried thereby to permit without contact free reciprocation of the latter therethrough.

The diaphragm 12 and the casing 14 cooperate to provide a pump chamber 27 on the side walls of which are formed a plurality of circumferentially spaced seats 28—28 providing a plurality of intermediate fluid passages 29—29 past the seats 28—28. A diaphragm biasing leaf-like spring structure 30, preferably formed of one or more laminae of sheet steel of disc configuration is mounted in the chamber 27 with its periphery supported on the seats 28—28 preferably with at least small lateral clearance. This spring structure 30 is provided with a central aperture 31 which engages over the inner end 22 of the operating rod and the structure mounted thereon preferably receiving the nut 23 with at least small lateral clearance at points of greatest lateral dimension with the portions adjacent the aperture bearing against the washer 24 to form a biasing abutment for the diaphragm structure.

This spring structure 30 may be cupped and positioned as shown in the drawings. Obviously the position of the spring structure 30 may be reversed provided the seats 28—28 and the diaphragm structure or anchorage structure of the operating rod are suitably altered to accommodate such reversal. The position and shape of the spring structure will be largely dictated by the results desired, the dimensions such as relation of thickness of spring structure to diameter, degree of initial cupping, etc. For some purposes substantially flat disc spring structure may be desirable, such as where the diaphragm is to be flexed in opposite directions from an intermediate neutral position which may be determined by a substantially flat diaphragm in the assembly when not stressed. Equalization of such travel results in the least strain on the diaphragm. The use of a flat spring structure assures compactness of pump construction.

A flat or initially uncupped diaphragm, such as that shown by way of example in the drawings, has certain well defined characteristics as a spring in and of itself. These are such as may tend to result in excessive pressure of the cam follower against the cam in the positions of maximum flexure of the diaphragm, such as the innermost position of the diaphragm and associated parts of the structure shown in the drawings. Further in such a structure those characteristics may tend to prevent the cam follower from effectively following the cam in the outermost position of the diaphragm. The plotted curve of those diaphragm characteristics is found to be of great curvature indicating that the rate of change of positive and negative pressures may be of an objectionable degree under certain conditions making it advisable to use very small diaphragm deflections.

This may be compensated for or effectively corrected by the use of an initially cupped spring which has a reverse spring characteristic curve. Net spring characteristics of the combination of such diaphragm and spring structure can thus be obtained which will assure approximately uniform pressure of the cam follower on the cam. Even a less pressure in the innermost position of the diaphragm than in the neutral or outermost positions thereof, or greater pressure in the latter position than when in the neutral position,

may be attained by proper predetermined combinations. Thus the spring rigging of the present pump construction while making for simple and compact pump construction assures long life for the diaphragm and its operating mechanism and efficient pump performance with the use of diaphragm and biasing spring structure of simple design.

The casing 14 is provided with a pair of opposed bosses 32 and 33 having respectively internally threaded recesses 34 and 35 to receive fluid supply and delivery conduits. The recess 34 communicates through the passage 36 with a fluid passage chamber 37 closed at the top by a removable cap 38 on the inlet side and a similar passage 39 communicates with a similar chamber 40 closed by a similar cap 41 on the outlet side. The chambers 37 and 40 constitute the inner ends of the inlet and outlet fluid passages communicating with the pump chamber 27 through suitable valve structure located therein. These valves preferably are of the check valve type so mounted in their respective chambers as to permit fluid to flow into the pump chamber 27 from the inlet side and fluid to flow out of the pump chamber on the outlet side, as indicated in the drawings.

The check valve 42 in the inlet chamber 37, as is more fully described in my copending application Serial No. 362,180, filed October 22, 1940, comprises a sleeve-like cage 43 having a seat 44 formed thereon against which is biased a valve plate 45 by a leaf-like spring structure 46 centrally apertured to receive a stud structure 47 preferably anchored to the valve plate 45, with spacing means 48 interposed between the valve plate structure 45 and the spring structure 46 to form opposed abutments whereby the valve plate can be biased to its seat and the parts of the valve assembled in the cage 43 by a split-ring 49 seated within a groove in the cage 43 and bearing against peripheral portions of the spring structure 46. The base of the cage 43 is machined out at 50 to form a tapered throat for the valve port. The check valve in the outlet chamber 40 is similar in construction to the check valve in the inlet chamber 37.

Pulsation eliminators may be provided in the inlet and outlet passages by forming recesses 53, 53 in the caps 38 and 41 and trapping a body of air therein by flexible diaphragms 54, 54 of resilient material, such as neoprene, each held in position on an annular seat 55 by a press-fitted ring 56.

For the purposes of moving the operating rod 17 axially for hand priming or the like a shoulder 57 is provided thereon by forming a hole 58 through one leg of the roller fork. A radially extending boss 59 on the base 10 is bored to receive rotatably a shaft 60 having a circumferential groove 61 in which the end of a pin or set screw 62 seats to hold the shaft in position. The inner end 63 of the shaft 60 is machined off on the top side thereof to form a pair of camming portions 64, 64 one of which is adapted to bear against the shoulder 57 when the shaft 60 is rotated in a clockwise or counter-clockwise direction thereby to lift the operating rod and flex the diaphragm inwardly against the biasing spring so as to raise the cam roller 19 from the cam 20. An operating arm 65 is keyed to the shaft 60 for rotating it and a coil spring 66 around the end of the shaft 60 having one end thereof anchored to the base member 10 and the other end thereof anchored to the arm 65 assures return of the arm 65 to a disengage position deter-

mined by a stud 67 bearing against the edge of the casing 14.

By way of example the transfer pump of the present invention may be mounted by means of mounting ears 68—68 on the base member 10 upon the case of a high pressure injecting apparatus for feeding fuel to a Diesel engine. Such injecting apparatus may comprise a plurality of high pressure injecting pump devices, one for each cylinder of the engine, all operated by a common cam. The circumferential surface of this cam may be provided with lobes equal in number to the number of high pressure injecting devices so that each revolution of the cam, such as 20, will result in a number of complete transfer pump cycles equal to the number of high pressure injecting devices each of which is operated during one cam revolution. Such operation obviously will be of very high frequency and it has been found that the apparatus of the present invention with the provision of diaphragm travel of about .0125" on each side of the neutral position will perform its functions under such conditions in a highly satisfactory manner. It will further be noted that with such a mounting of the device all of the parts thereof can easily and readily be assembled from the top.

In operation when the operating rod is lifted upwardly by a cam the resultant inward flexing of the diaphragm against the biasing action of the spring structure minimizes the space of the pump chamber and when the cam permits the operating rod to be moved outwardly by the biasing spring structure partial vacuum is created in the pump chamber producing a differential in pressure on opposite sides of the inlet valve sufficient to open the same and cause fluid to flow into the pump chamber. When the operating rod is again moved inwardly the inlet valve automatically closes, and pressure built up in the pump chamber by inward flexing of the diaphragm causes the outlet valve to unseat and fluid to be delivered through the outlet passage from the pump chamber. When the biasing spring structure is again permitted to move the diaphragm outwardly the outlet valve automatically closes and the cycle is then repeated. The pump apparatus may be manually primed by flexing the diaphragm inwardly and outwardly a number of times, which can be accomplished by pulling on the priming arm, releasing it and repeating the operation. Operation of the transfer pump may be arrested by pulling on the priming arm and holding it.

It will thus be seen that the objects set forth above are efficiently attained by apparatus of the present invention and since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Fluid transfer apparatus comprising, in combination, a base member, a casing, a flexible diaphragm peripherally mounted on said casing

to form therewith a pump chamber, an operating member mounted on said diaphragm and projecting outwardly through said base member free from any bearing support and having a mechanical diaphragm-flexing mechanism-engaging portion, an engaging shoulder on the side of said operating member, and a manually rotatable shaft mounted transversely on said base member with its inner end shaped to engage the shoulder and move said operating member axially when said shaft is rotated.

2. Fluid transfer apparatus comprising, in combination, a base plate, a casing, a flexible diaphragm peripherally supported between said plate and said casing to form with the latter a pump chamber, an operating rod mounted on said diaphragm and projecting outwardly through a hole in said base plate free from any bearing support and terminating in a cam follower for mechanically flexing operation of said diaphragm, resilient means biasing said diaphragm outwardly axially of said rod, a shoulder on the side of said rod, a rotatable shaft mounted transversely on said base plate with its inner end shaped to engage said shoulder and move said rod axially inward to a cam-disengaging position when said shaft is rotated, and means to permit manual rotation of said shaft.

3. Fluid transfer apparatus comprising, in combination, casing structure, flexible diaphragm structure mounted on said casing structure to form therewith a pump chamber, an operating member adapted to flex said diaphragm for pumping action and having a mechanical diaphragm-flexing mechanism-engaging portion, an engaging shoulder provided on said operating member by the formation of a transversely extending slot therein, and a shaft rotatably mounted on said casing structure and having an eccentric end portion received in the slot to engage said shoulder for moving said operating member axially when said shaft is rotated.

4. Fluid transfer apparatus comprising, in combination, casing structure, flexible diaphragm structure mounted on said casing structure to form therewith a pump chamber, resilient means

biasing said diaphragm structure outwardly, an operating member adapted to flex said diaphragm inwardly for pumping action, an engaging shoulder provided on said operating member by the formation of a transversely extending slot therein, and a shaft rotatably mounted on said casing structure and having an eccentric end portion received in the slot to engage said shoulder for moving said operating member axially inwardly when said shaft is rotated.

5. Fluid transfer apparatus comprising, in combination, casing structure, flexible diaphragm structure mounted on said casing structure to form therewith a pump chamber, resilient means biasing said diaphragm structure outwardly, an operating member adapted to flex said diaphragm inwardly for pumping action, an engaging shoulder provided on said operating member by the formation of a transversely extending slot therein, and a cylindrical shaft transversely mounted in a rotatable manner on said casing structure with a side of the inner end thereof flattened off to provide a camming shoulder received in the slot to engage said first mentioned shoulder for moving said operating member axially inwardly when said shaft is rotated.

6. Fluid transfer apparatus comprising, in combination, a base plate, a casing, a flexible diaphragm peripherally supported between said plate and said casing to form with the latter a pump chamber, an operating rod mounted on said diaphragm and projecting outwardly through a hole in said base plate and terminating in a cam follower, resilient means biasing said diaphragm outwardly axially of said rod, an engaging shoulder provided on said rod by the formation of a transversely extending slot therein, a cylindrical shaft transversely mounted in a rotatable manner on said base plate, said shaft having a side of the inner end thereof received in the slot and flattened off to provide a camming shoulder adapted to engage said first mentioned shoulder for moving said rod axially inwardly when said shaft is rotated, and means to rotate said shaft.

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