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DIAPHRAGM PUMP

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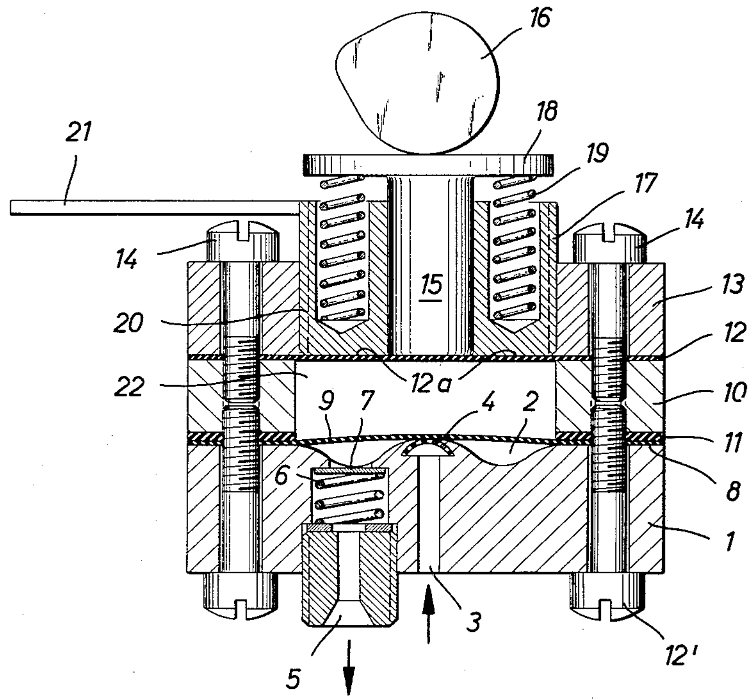

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DIAPHRAGM PUMP

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The present invention relates to a diaphragm pump.

It is well known to design diaphragm pumps with two resilient diaphragms between which an incompressible fluid medium is provided which serves as a transmission fluid. One of these diaphragms is moved by a rod or the like back and forth at a constant stroke in a direction transverse to its plane, for example, by means of an eccentric or crank drive. When the pump is not operated, the other diaphragm is spaced at a certain distance from a wall of the pump housing which is provided with one or more openings through which the respective medium to be conveyed by the pump is supplied thereto or discharged therefrom. Thus, a troughlike pump chamber is formed. If the first-mentioned diaphragm is moved, the other diaphragm will either approach or move away from the housing wall containing the inlet and outlet openings and draw or press the medium to be conveyed through the pipe lines connected to the pump, and will thus exert pumping impulses upon such medium. Both the intake and outlet lines of such pumps have to be provided with check valves. Since the stroke at which the first diaphragm is reciprocated is constant, the output of such a pump is likewise constant.

Such diaphragm pumps have several disadvantages, namely, first, that the pressure of the medium to be conveyed by the pump cannot exceed a certain value; second, that the output of such a pump can be changed only if the rate of speed of the crank or eccentric drive which reciprocates the first diaphragm is changed; and third, that two spring-loaded check valves have to be provided.

Although diaphragm pumps are also known which require only one check valve, these pumps operate with only one diaphragm and in such a manner that this diaphragm also serves as a means for shutting off the fluid inlet of the pump.

In diaphragm pumps which operate with only one diaphragm it is also known to support such diaphragm around the reciprocating member acting thereon so as to prevent the diaphragm from bulging too far outwardly. The capacity of these pumps may only be varied by varying the length of the stroke of the reciprocating member. Such stroke adjustment, however, has the disadvantage that it also changes the length of the intake and discharge periods.

It is the principal object of the present invention to provide a diaphragm pump which is generally of the first-mentioned type and operates with a constant stroke, but still permits the capacity and output of the pump to be varied independently of the rate of speed of the drive shaft thereof. Another object of the invention is to provide a two-diaphragm pump which overcomes the disadvantages of the above-mentioned and other previous diaphragm pump designs.

For attaining these objects, the present invention provides a pump which essentially consists of two diaphragms which are spaced from each other so as to form an intermediate chamber which is filled with an incompressible fluid, a plunger or the like which is adapted to act upon the first of the diaphragms to reciprocate the same, and an annular member which surrounds the plunger and is adjustable relative to the first diaphragm and in the direction of movement of the plunger for varying the capacity of the pump. The second diaphragm covers the actual pump chamber and is adapted to be pressed into the latter by the pressure of the plunger upon the first diaphragm, which pressure is transmitted to the second diaphragm by the incompressible fluid between the two diaphragms. When the annular adjusting member is set so as to engage with the first diaphragm in the released position of the latter, the second diaphragm will be pressed by the stroke of the plunger, transmitted through the fluid between the diaphragms into the pump chamber so as to fill the latter completely and thus to pump the entire amount of the medium to be conveyed through the single check valve. At such an adjustment, the pump therefore operates at its maximum capacity. On the other hand, when the annular adjusting member is set so as to be spaced at a certain distance from the first diaphragm when the latter is in its released position, the constant stroke of the plunger will only result in a partial compression of the second diaphragm into the pump chamber and thus in a reduced pumping capacity or output of the pump. The invention further provides an inlet opening of the pump chamber which is normally closed by the second diaphragm which is held under tension. This inlet opening will be opened by the action of the underpressure which is formed within the pump chamber during the return stroke of the plunger. The second diaphragm will then be lifted from the inlet opening so that the underpressure within the pump chamber will draw a new supply of the medium to be conveyed through the inlet into the pump chamber. Finally, the pump according to the invention comprises a spring in the single check valve which is made of a strength slightly greater than the pressure which has to be exerted by the plunger in order to deform the first diaphragm from its released position so that during the pumping stroke of the plunger, the fluid between the two diaphragms will first press or bulge the first diaphragm tightly against the annular adjusting member around the plunger, regardless of the particular adjustment of this member relative to the diaphragm. The check valve will therefore not open to permit the medium to be pumped out of the pump chamber until the plunger has depressed the central portion of the first diaphragm to such an extent that the pressure fluid, in turn, has pressed the annular portion of this diaphragm around the central portion tightly against the adjusting member.

In order to make the new pump as compact as possible, the invention further provides the reciprocating plunger with a flange at its outer end, while the spring or springs which act upon the plunger to maintain the same in engagement with the driving eccentric or crank are disposed at a point intermediate the flange and the annular adjusting member. According to a preferred embodiment of the invention, the annular adjusting member is for this purpose provided with an annular recess or a plurality of socket-like recesses for receiving and guiding the spring or springs which act upon the flange on the plunger.

Further objects, features, and advantages of the present invention will appear from the following detailed description thereof, particularly when read with reference to the accompanying drawing of one preferred embodiment of the invention.

Referring to the drawing, a lower housing part **1** of the pump is provided with a troughlike pump chamber **2**. A fluid inlet **3** extends centrally of chamber **2** and its inner end is covered by a small screen 4. The outlet 5 communicates with pump chamber 2 via a check valve which consists of a plate 7 which is acted upon by a spring 6. A diaphragm 9 is mounted within the plane formed by the upper surface 8 of housing part 1 and when in the released position, it rests upon screen 4 or is spaced at a small distance therefrom. Diaphragm 9 is clamped by means of bolts 12 between housing parts 1 and 10, one of which is preferably provided with a gasket ring 11. The other side of the annular housing part 10 carries a second diaphragm 12 which is similarly clamped in place by bolts 14 between part 10 and another housing part 13. While diaphragm 9 may be very thin, it is advisable to make diaphragm 12 of a greater thickness. Chamber 22 which is formed between the two diaphragms 9 and 12 is filled with a transmission fluid, for example, oil, so that a movement of diaphragm 12 will be transmitted to diaphragm 9 so as also to move the latter and press the same into pump chamber 2. For re-ciprocating diaphragm 12, the same is acted upon by one end of a plunger 15 which has a flange 18 at the other end which is in positive engagement with an eccentric 16, or a crank or the like which is driven by a suitable motor. Plunger 15 is slidably guided within an annular member 17, the lower surface of which covers the entire free circular remaining surface 12*a* of diaphragm 12 around plunger 15. The annular member 17 is further provided either with an annular recess or a plurality of socket bores in which one or more coil springs 19 are inserted which act upon flange 18 for maintaining plunger 15 in constant engagement with eccentric 16. The annular member 17 is also adjustable relative to housing part 13, for example, by being provided with outer screw threads 20 which engage with similar inner screw threads in the annular housing part 13. By turning member 17, it is thus possible to vary the distance between the lower surface of member 17 and diaphragm 12. Such adjustment may be facilitated by the provision of a handle 21 which is secured to member 17.

The operation of the diaphragm pump according to the invention is as follows:

If the eccentric 16 is rotated, for example, in a clockwise direction, plunger 15 will be reciprocated in accordance with the rate of speed of eccentric 16 and will thereby also reciprocate diaphragm 12 in a direction toward or away from diaphragm 9. Since chamber 22 between the two diaphragms is filled with oil or other fluid, an inward movement of plunger 15 and diaphragm 12 will be transmitted to diaphragm 9 to press the same into the trough-shaped pump chamber 2. If diaphragm 9 in its released position is slightly spaced from sieve 4, it will, when acted upon by the fluid in chamber 22, at first engage the sieve and then close and seal the inlet 3. Since the sealing surface is relatively small, the sealing action by diaphragm 9 will be secure. At the further inward movement of plunger 15 and diaphragm 12, diaphragm 9 will finally fill out the entire pump chamber 2 so that the respective medium therein will be conveyed through check valve 6, 7 and be discharged through outlet 5. At the return stroke of plunger 15, both diaphragms 9 and 12 will again return to the position illustrated in the drawing since they consist of resilient material. Such return stroke will result in an underpressure in pump chamber 2 so that the medium to be conveyed will be sucked through inlet 3 into pump chamber 2.

If the capacity or output of the pump is to be reduced to any smaller value than the maximum, when the adjusting member 17 is in the position as illustrated in the drawing, it is merely necessary to pivot handle 21 so as to increase the distance of the lower surface of member 17 from diaphragm 12. If plunger 15 is then again moved from the position shown in the drawing in the direction toward diaphragm 9, the latter will again at first close up the inlet 3. Since the tension of spring 6 of the check valve is made of such strength that the pressure exerted thereby upon plate 7 is greater than that of the pressure which is necessary to depress diaphragm 12, plate 7 will keep inlet 5 closed since pump chamber 2 is filled with the medium to be conveyed, for example, a liquid. Thus, the position of diaphragm 9 will at first not be changed. However, since plunger 15 depresses diaphragm 12 in the direction toward diaphragm 9, and since diaphragm 12 is spaced from the inner surface of the annular member 17, the pressure exerted by plunger 15 upon the fluid in chamber 22 will bulge diaphragm 12 outwardly around the lower end of plunger 15 and toward the retracted lower surface of member 17 until it engages with this lower surface. When plunger 15 is then further depressed, the pressure in chamber 22 will increase so that diaphragm 9 will then be pressed into pump chamber 2, but not to such an extent as to fill out pump chamber 2 completely. The capacity of the pump and the output thereof is therefore lower than that attained when the lower surface of the annular member 17 in the released position of diaphragm 12 directly engages with the latter, and it is so reduced in proportion to the amount of the withdrawal of member 17 from such full-capacity position by the operation of handle 21. The pump may therefore be easily adjusted to any capacity and output between zero and the maximum for which it has been designed.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. In a pump, in combination, a pair of elastic diaphragms; a support means supporting said diaphragms in spaced relation with respect to each other and defining with said diaphragms a closed chamber which is adapted to be filled with an incompressible fluid so that movement of one of said diaphragms toward the other will be transmitted through said fluid to said other diaphragm to enable the latter to perform a pumping action; reciprocating means located at the side of said one diaphragm opposite from said other diaphragm and cooperating with a first portion of said one diaphragm for reciprocating said first portion of said diaphragm through a predetermined stroke; and means cooperating with a second portion of said one diaphragm for adjusting the extent to which said second portion of said diaphragm can bulge from a rest position of said one diaphragm in a direction away from said other diaphragm so as to regulate the extent to which said other diaphragm is moved during said predetermined stroke of said reciprocating means and first portion of said one diaphragm.

2. In a pump, in combination, a pair of elastic diaphragms; support means supporting said diaphragms spaced from each other and defining with said diaphragms a closed chamber adapted to be filled with an incompressible fluid for transmitting movement of one diaphragm toward the other to said other diaphragm for moving the latter along pumping strokes; a reciprocating plunger having a top dead center position engaging said one diaphragm when the latter is in a rest, substantially planar position, said plunger reciprocating toward and away from said diaphragms along strokes of predetermined length and said one diaphragm having a portion extending laterally beyond said plunger; adjustable limiting means located alongside of said plunger opposite said portion of said one diaphragm and adjustably carried by said support means for movement toward and away from said portion of said one diaphragm to define with the latter a space extending axially along said plunger and having a length along the axis of the latter determined by the adjusted position of said limiting

means, the latter having an end position engaging said portion of said one diaphragm when the latter is in said rest position thereof, whereby when said limiting means is in said end position thereof it will prevent said one diaphragm from bulging away from said other diaphragm to provide the maximum stroke of the latter during reciprocation of said plunger while when said limiting means is spaced from said one diaphragm when the latter is in its rest position said portion of said one diaphragm can bulge toward said limiting means in a direction opposite to the direction of movement of said plunger toward said other diaphragm so that the latter will be moved to a lesser extent than when said limiting means is in said end position thereof.

3. In a pump as recited in claim 2, a wall connected to said support means and cooperating with said other diaphragm to form a pumping chamber therewith, said wall being formed with a discharge passage; and a non-return valve located in the latter passage and having a spring strong enough to prevent opening of said non-return valve until after said one diaphragm has bulged toward said limiting means into engagement with the latter when said limiting means is in a position other than its ends position.

4. In a pump, in combination, a pair of elastic diaphragms; support means supporting said diaphragms spaced from each other and defining with said diaphragms a closed chamber adapted to be filled with an incompressible fluid for transmitting movement of one of said diaphragms toward the other to said other diaphragm, said support means having an annular wall portion located along the periphery of said one diaphragm and extending from said one diaphragm away from said other diaphragm; a reciprocating plunger surrounded by and spaced from said annular wall portion of said support means for engaging and reciprocating a portion of said one diaphragm; a ring located in the space between said plunger and annular wall portion of said support means and having an end surface directed toward said one diaphragm and extending completely across said space; and means cooperating with said ring and support means for adjusting the position of said ring along the axis of said plunger.

5. In a pump as recited in claim 4, said means for adjusting the position of said ring along the plunger axis being in the form of a threaded connection between said ring and said annular wall portion of said support means.

6. In a pump as recited in claim 4, said plunger having at its end distant from said one diaphragm a flange overlapping and spaced from said ring; reciprocating means cooperating with the latter end of said plunger for reciprocating the latter.

7. In a pump as recited in claim 6, said reciprocating means including a cam for moving said plunger toward said diaphgrams and at least one spring between said ring and flange maintaining said plunger in engagement with said cam and moving said plunger in a direction away from said diaphragm.

8. In a pump as recited in claim 4, a wall connected to said support means and cooperating with said other diaphragm to form a pumping chamber therewith; and non-return valve means carried by said wall and forming part of a discharge passage of the pump, said valve means including a spring strong enough to prevent opening of said valve means and until said one diaphragm has bulged around said plunger toward said ring.

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