SHAFT END MOUNTING FOR SEALING AND LOOP FORMING A PUMP DIAPHRAGM

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FIG. 3.

FIG. 4.
Shaft End Mounting for Sealing and Loop Forming a Pump Diaphragm

FIG. 7

FIG. 8

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This invention relates to diaphragm type pumps and, more specifically, to a sub-assembly used in such pumps, including a mounting stem, diaphragm, and retainer.

This application is a continuation-in-part of my application Serial Number 429,543, filed May 12, 1954, now patent No. 2,904,876.

It is well understood that in pumps of this kind service life depends in good measure upon the proper mounting of the diaphragm in the pump, and this, in turn, depends upon the amount of initial loop provided and proper pressure of the backing plates on the diaphragm to prevent any leakage between the diaphragm and the stem. This pressure, however, should be limited to avoid any stresses which might contribute to premature failure of the diaphragm. It is, therefore, desirable that the pressure between the backing plates during the assembly be carefully controlled.

Hereofore it has been common practice to assemble the backing plates and diaphragm on the stem of the pump by a spinning or forging operation to head-over the end of the stem into engagement with the uppermost of the backing plates. In this operation, the final sealing pressure obtained between the backing plates and the diaphragm will depend upon initial dimensions of the assembled parts as much as on the accuracy with which the spinning or forging operation is performed. In quantity production this sealing pressure cannot be accurately controlled.

It is the object of this invention to preset the desired amount of loop in the portion of the diaphragm extending outwardly from the backing plates and simultaneously with the assembly operation of the stem with the diaphragm and plates. This avoids any strain due to the action of the pump except that involved in the passage of the fluid and at the same time makes unnecessary the step of forming the loop when the pump is assembled.

According to this invention, the stem for the pump is provided with the usual reduced section for receiving the backing against the upper backing, whereby a substantial supporting shoulder is formed. The backing plates, however, are themselves modified from usual construction to provide oppositely facing, concave surfaces. In order to provide uniform pressure between the backing plates and the diaphragm, a novel keeper washer is forced into locked engagement with a tapered groove formed in the reduced end portion of the stem. This keeper washer is produced by deforming a flat washer into a conical shape.

To assemble the washer in securing relation with the groove in the stem, pressure is applied at the outer rim of the conical washer sufficient to exceed the yield point of the metal. As the washer begins to flatten under the pressure, the outer peripheral edge of its aperture grips with the taper of the groove on the stem. This requires a force of given amount, depending, of course, upon the dimensions and material of the washer. These variables can be chosen to assure the desired amount of sealing pressure necessary. It has been found that this force is relatively uniform once these variables are determined. After the gripping action takes place, the force necessary to flatten the washer diminishes rapidly, and a rocking action radially of the washer takes place acting as a lever against the upper backing plate.

When the force required again approaches the pressure at the yield point of the metal, the operation is discontinued.

The results achieved so far with this method using the described structure have produced uniform pressure and a stretching action on the diaphragm sufficient to provide the preformed amount of loop desired.

In the drawings:

FIG. 1 is an environmental view of one type of diaphragm pump;

FIG. 2 is an exploded view illustrating the arrangement of the parts for assembly with the stem;

FIG. 3 illustrates the position of the parts in the initial stages of assembly;

FIG. 4 illustrates the relation of the parts when finally assembled;

FIG. 5 is an enlarged sectional view of a pump diaphragm in an initial stage of assembly and in accordance with the invention;

FIG. 6 is an enlarged sectional view of the assembled stage of the pump assembly of FIG. 5;

FIG. 7 is an enlarged sectional view of a pump assembly in accordance with a modification of the invention;

FIG. 8 is an enlarged sectional view of the pump assembly of FIG. 7 in the assembled stage.

Referring to FIG. 1, a body casting 1 contains a pump housing 2 provided with a flange 3 for attachment to the engine. A pump operating lever 4 having a slidable shoe 5 is pivoted at 6 within the housing 2. Pump lever 4 operates a pair of diaphragm pumps generally indicated as 10 and 11. These pumps are of the type shown in the patent to Hollembeck, et al., No. 2,623,351, December 30, 1952.

The pump 11 has a valve casing 13 containing an inlet connection 14 and an outlet connection 15. The inlet connection 14 connects with a pump chamber 16 by way of a passage 17 controlled by an inlet check valve 18. Discharge from the pump chamber 16 is controlled by an outlet check valve 19 in the outlet passage 20.

Within the pump chamber 16 is a diaphragm assembly generally indicated as 25, which includes a reciprocal stem 26 operated from the pump arm 4 in one direction and the compression spring 27 in the opposite direction. The stem is secured to a diaphragm 36, which is, in turn, clamped at its peripheral edge between the pump body casing 1 and the valve casing 13. Any suitable securing means may be used to attach these parts together.

In order to illustrate the details of this sub-assembly, the drawings show an exploded view in FIG. 2 with the parts arranged in the manner to be assembled upon the stem 26. Turning to this figure, the stem 26 is illustrated as cylindrical with a reduced end portion 35 forming a supporting shoulder 36. Formed in the upper end of the reduced portion 35 is a groove 37 with a double taper. The groove 37 is intentionally designed so that the widest shoulder with the gradual taper faces the shoulder 36.

The elements which are assembled on the stem 26 include a plain washer 39, a lower backing plate 40, diaphragm 30, sealing washer 41, upper backing plate 42, upper backing washer 43, and the conical keeper washer 45.

In the assembly of the parts above enumerated, the washers, backing plate, diaphragm, and keeper are assembled upon the stem as shown in FIG. 3. As will be noted in this figure, the backing plates are dished slightly, and it has been found that preferably this concavity should be 0.012 to 0.020 of an inch. The keeper washer 45 is a plain flat washer pressed into conical form. The sub-assembly with the parts arranged in the manner described mounted in a holder 48 are inserted in a press of any desired type which will indicate the pressure applied. The press member 49 is a die having a cavity 50 deep enough to receive the keeper washer 45, and is of a diam-
eter at the bottom of the cavity the same as the original diameter of the keeper washer 45 before the coning operation. The sides 51 of the cavity 50 preferably have about a 5° taper.

In the assembly operation, as pressure is applied by the die 49 with the sub-assembly 25 suitably mounted in the holder 48 on the anvil of the press, the conical washer moves down to the groove 37 and the backing plates are flattened to tension the diaphragm. Pressure then increases until the yield point in the metal of the washer 45 is reached thereby causing the size of the aperture in the washer to be decreased. This pressure will be sufficient to flatten the washer and cause the outer edge of its aperture to contract and grip the tapered shoulder of the groove 37. During the compression of the washer 45, the action of the backing plates to stretch the diaphragm centrally in a radial direction is completed. This forms the desired looping necessary to accommodate the stroke of the pump.

After the yield point of the washer 45 is reached, the pressure necessary to flatten the washer suddenly decreases and, as the washer flattens, it acts as a lever pivoting about the outer edge of its aperture, which is in gripping engagement with the groove. The press operation is continued until the pressure necessary to continue the flattening of the washer approaches that required at the yield point of the metal, at which point the washer appears as shown final position 45.

The sub-assembly 25 is then complete and ready for assembly in the pump. The small sealing washer 41 has been found to be desirable because, during the radial stretching of the diaphragm 30, the aperture receiving the stem 35 is enlarged and, without the sealing washer, a space would be left to permit leakage around the stem. The sealing washer fills this space and prevents leakage.

It has been found that this invention provides uniform results in spite of minor variations in thickness of the parts. These variations can be accommodated by the latitude provided on the shoulder 37 for receiving the keeper washer 45.

In FIG. 1 there is disclosed an assembled pump. It is noted that the pump spring 27 holds the diaphragm 30 downwardly, such that the central portion of the diaphragm is substantially below the level of its peripheral portions, which are clamped between the pump body housing members 1 and 13. In the assembly of the pump, the members 1 and 13 are brought together with their flanges oppositely disposed and with the periphery of the diaphragm 30 contacting these flanges. If the assembler makes a flat diaphragm, it is necessary to clamp the peripheral portions of the diaphragm between the flanged portions of the pump housing elements 1 and 13 and depend upon spring 27 to maintain the desired configuration of the diaphragm. This procedure results in considerable difficulty inherently experienced in bending a flat diaphragm member into a dish or conical configuration. The shaping of a flat diaphragm by spring 27 causes a distortion of the diaphragm and results in an unwanted stretching of the diaphragm which sets up uneven stresses in the diaphragm material during pump operation. Also, the considerable displacement of the diaphragm by spring 27 may result in wrinkling of the diaphragm at its periphery where it is clamped between the flanged portions of the housing members 1 and 13. Such wrinkles tend to provide leaks allowing air to pass into the pump irrespective of the pressure with which the housing elements 1 and 13 may clamp the diaphragm.

In accordance with this invention, then, the diaphragm 30 is given a preset, so that when assembled into the pump, it has a dished or a frusto-conical configuration, which minimizes the difficulties experienced with a flat diaphragm. One type of diaphragm, which may be used with this invention, is that formed from a cotton fabric, such as heavy duck material, which is coated on both sides with a layer of buna rubber having portions extending through the woven cotton fabric and connecting the rubber layers together. When a diaphragm of this type, or one made entirely of buna rubber, if appropriate, is assembled in the manner described, the two opposite surfaces of the diaphragm extending beyond the peripheral portions of the respective backing plates 40 and 42 become compressed and the center portion of the diaphragm is stretched, as shown in FIG. 4. The backing plates 40 and 42 are tightly clamped together. This compression of diaphragm surfaces forces the diaphragm 30 to assume a dished configuration which may extend in either direction from the clamped center portion of the diaphragm. For example, in FIG. 4 there is disclosed a substantial dishing of the diaphragm in an upward direction. The diaphragm is thus preset with a substantially frusto-conical or concave configuration.

FIGS. 5 and 6 are enlarged views of a diaphragm sub-assembly similar to that shown in FIGS. 3 and 4. Like reference numerals are used to designate parts identical to those shown in FIGS. 3 and 4. The reciprocal pump stem 26, however, is formed with a threaded end 60 at the outer end of the reduced portion 35'. This is to accommodate a nut 62 for assembling the diaphragm assembly parts. FIG. 5 discloses the dished backing plates 40 and 42 in an exaggerated manner to more diagrammatically point out the invention.

FIG. 6 exaggeratedly illustrates the effect produced when the parts are assembled and as the nut 62 is tightened onto the shaft end 35'. As described above, the rubber surfaces of the diaphragm 30 extending beyond plates 40 and 42 are compressed by the outwardly moving rims of plates 40 and 42. This results in slight bunching of the rubber material of the diaphragm surfaces adjacent to the rims of the respective plates 40 and 42, as illustrated by the fillet portion 63 in FIG. 6. Thus, with the diaphragm surfaces beyond plates 40 and 42 under compression, the diaphragm itself becomes dished or frusto-conically shaped, as the diaphragm is.

As schematically illustrated in FIG. 1, a diaphragm 30, having a preset prior to assembly into the pump, will have its peripheral portion extend outwardly at an angle from the backing plates 40 and 42, as is indicated by the dotted line portion 64. Thus, in the assembly of the preset diaphragm into the pump of FIG. 1, the procedure merely requires the bending of peripheral edge of diaphragm 30 downwardly to be clamped between the flange and body members 1 and 13. This results in a minimum of distortion in the assembly of the pump part and enables the diaphragm to be inserted without undue wrinkling and the like of the fabric portion of the diaphragm.

A flat, planar diaphragm, which is assembled into the pump assembly, must be first dusted and then have its peripheral portions bent backward as described above and as shown in FIG. 1. If the diaphragm is not preset, this distortion of the assembled diaphragm is one which tends to force stem 26 against the pump spring 27. That is, a diaphragm not having a preset would tend to assume a position in the plane between the flanges of the pump body portions 1 and 13. This urges the stem 26 against the pressure of spring 27. During the operation, then, of the pump at high speed, a flat diaphragm opposes spring 27 and lessens the return stroke of the spring, such that the intake stroke of the pump under urging of spring 27 is thus weakened. A preset diaphragm eliminates this difficulty and has a minimum opposition to spring 27, such that at high speed the short return stroke of the spring is not unduly lessened.

FIGS. 7 and 8 schematically disclose another modification of the pump diaphragm assembly, in which, instead of both of the backing plates being slightly concave, only one of the plates 40 has a concavity. The other backing plate 56 may be flat, so that when the diaphragm assembly parts are assembled onto the stem 35, the peripheral portion of the plate 40 is moved outwardly to compress the rubber surface portions of diaphragm 30 causing this
surface of the diaphragm to become compressed. This results in a presetting of the diaphragm into a dish or frusto-conical configuration as schematically shown in FIG. 8.

In FIGURE 7, N1 and N2 indicate points on plates 58 and 40, respectively which are equidistant from the common center axis of the two plates. The tilt of line N2 from the vertical indicates roughly the concavity of plate 40. In FIGURE 8, when the pump stem has been assembled, by the tightening of nut 62, plate 40 is flattened out and, as indicated, N2 is aligned with N1 showing the radial movement of the rim of plate 40, outwardly. This compresses the surface of diaphragm 30 in contact with plate 40 and extending beyond the periphery of the plate 40. The result is the presetting of the diaphragm as shown.

Although the invention has been disclosed using backing plates of concave configuration to form a preset diaphragm, it is also clear to those skilled in the art that other structures for producing a preset diaphragm are possible.

A structure has been described which will fulfill the objects of the invention above stated, but it is contemplated that other modifications will occur to those skilled in the art which come within the spirit of the invention as defined by the appended claims.

I claim:

1. A pump comprising a housing, a resilient diaphragm sealed at its peripheral edge within and across said housing forming a pump chamber between said diaphragm and said housing, a first backing plate having a concave surface defining a marginal rim, said backing plate being positioned against one side of the diaphragm and at the center thereof, a second backing plate on the opposite side of said diaphragm having its peripheral portion overlying said marginal rim of said first backing plate, means clamping said first and second backing plates together about their axial portions to simultaneously grip the diaphragm therebetween, said clamping means being adapted to flatten the first concave plate, whereby said marginal rim of said first backing plate is urged radially under compression to distort the diaphragm outwardly from its axis to form an annular fillet in the diaphragm structure outwardly of and adjacent to the compressed area of the backing plates and outwardly of said marginal rim of the first backing plate to thereby form a dish-shaped configuration of the diaphragm.

2. The structure of claim 1 characterized in that the second backing plate is formed convex at its medial portion to define a marginal rim directly overlying the marginal rim of the first backing plate to grip and retain the distorted diaphragm as the plates are medially compressed by said clamping means.

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