March 15, 1966 K. V. ROBBINS 3,240,154

ROTARY PUMPS

Filed Nov. 1, 1963 4 Sheets-Sheet 1

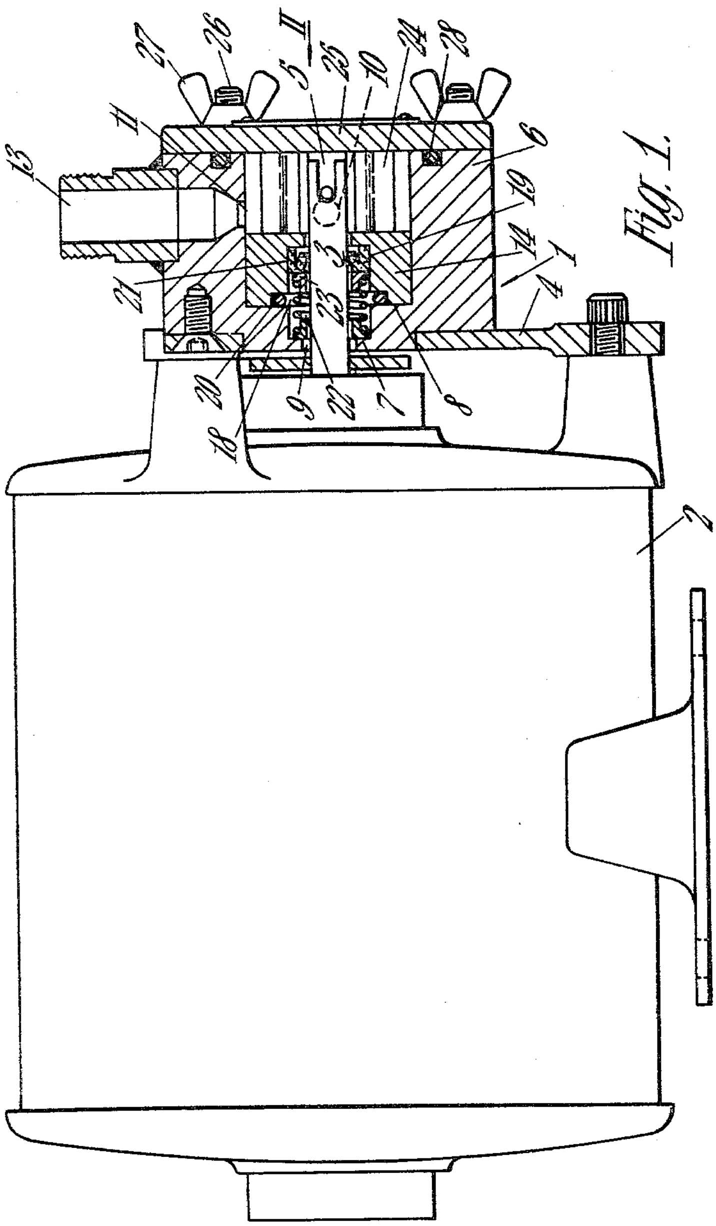

Fig. 1.

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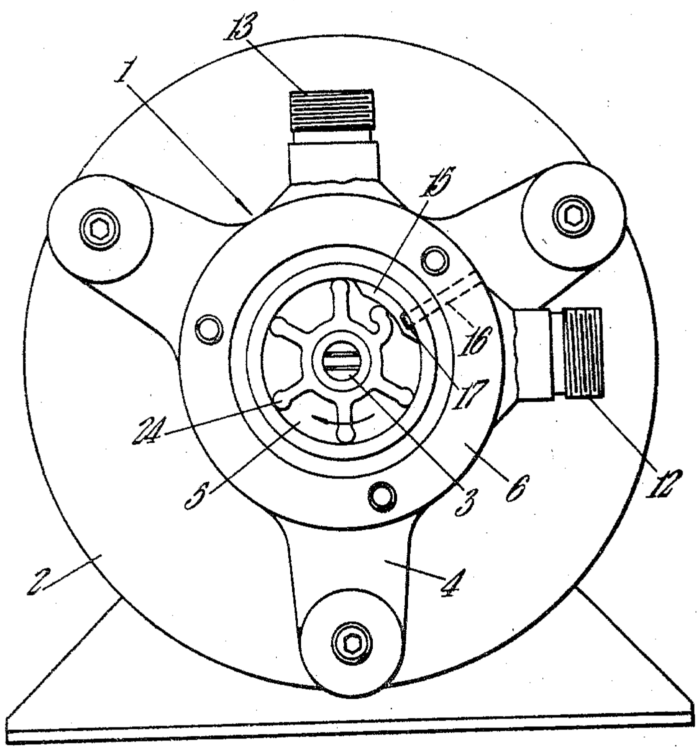

Fig. 2.

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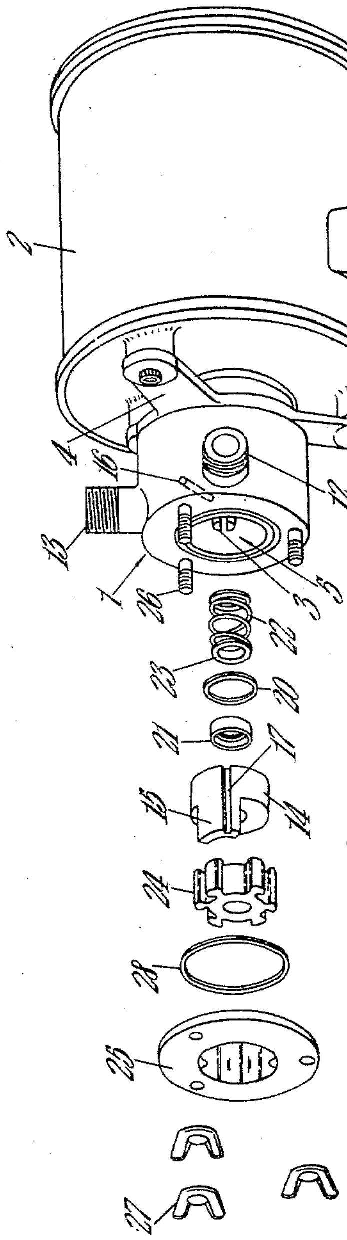

Fig. 3.

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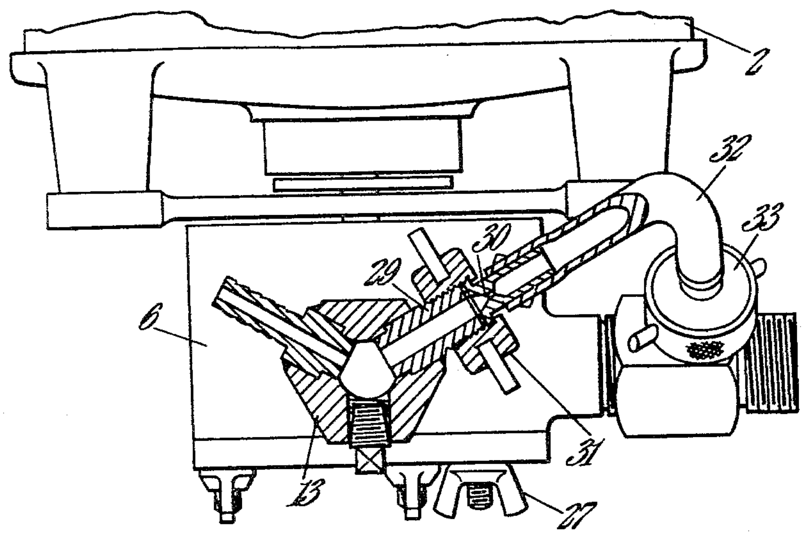


Fig. 4.

Fig. 5.

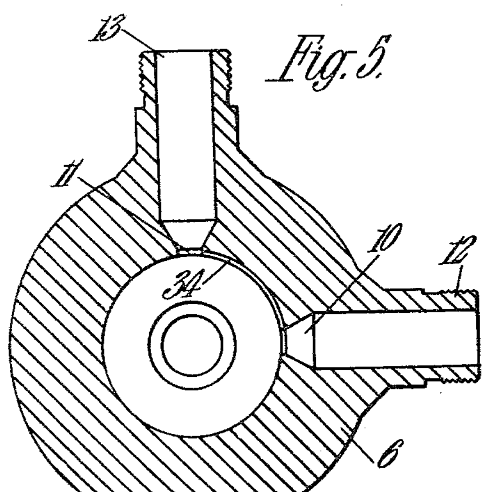
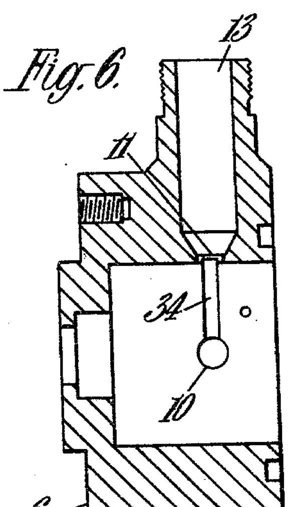


Fig. 6.



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3,240,154
ROTARY PUMPS

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8 Claims. (Cl. 103—117)

This invention relates to rotary positive displacement pumps of the type wherein the pumping action is effected by a flexible vaned impeller which is rotated by an impeller shaft in a chamber of substantially circular section, formed in the pump body, liquid being introduced to, and delivered from the chamber, circumferentially, by suction and delivery ports which are angularly spaced apart around the chamber circumference.

The above type of pump commonly employs an offset segment, which comprises an inner member of relatively small radial extent attached to, and formed integrally with the peripheral wall of the pump chamber, and located between the delivery port and the suction port when considered in the direction of rotation of the impeller. The action of the offset segment is to flex and radially compress the impeller vanes as each of these encounter the segment (after traversing the delivery port) and the subsequent release of the vanes, as each of these leaves the segment in the region of the suction port with a whip-like action, enhances the suction effect at this port and consequently enhances the overall pumping action.

In addition to the active parts mentioned above sealing means are provided between the rotating impeller shaft, and the stationary pump body to prevent liquid escaping from the pump chamber, the sealing means commonly being in the form of annular shaft seals, housed in the pump body.

Pumps of this type are particularly useful for handling organic liquids such as for example beer, milk or other foodstuffs, and when employed for this purpose it is desirable that all the pump components be readily accessible for the purpose of cleaning.

It is an object of the present invention to provide an improved pump of the above type, which may be quickly and easily stripped and reassembled even by unskilled labour, normally without the use of tools.

The invention consists in a rotary positive displacement pump of the type indicated wherein the sealing means for one end of the pump chamber and the offset segment are displaceable, the sealing means at least being carried on a displaceable seal housing slidable axially on the impeller shaft, and the arrangement being such that said seal housing, the offset segment, and the impeller which latter is axially slidable on the impeller shaft, are readily withdrawable from the opposite end of the chamber after removal of a cover plate.

The invention further consists in a rotary positive displacement pump of the type indicated in which the sealing means for one end of the pump chamber, and the offset segment are separable from the pump body, the sealing means at least being carried by a displaceable seal housing axially slideable on the pump impelled shaft for positioning within the pump chamber, access to which is attained through an opening in the end of the chamber remote from the seal housing end, a cover plate, sealing means and attachment means being provided for said opening such that for assembling the pump, the seal housing, segment and pump impeller may be successively slid into position within the chamber and the cover plate attached, locating means being provided for circumferentially locating the offset segment between the suction and delivery ports, whilst for stripping the pump, the cover plate may be removed whereupon all the pump components are readily accessible for successive withdrawal.

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According to one form of the invention as set out in the preceding paragraph, a helical thrust spring is provided for positioning around the impeller shaft between the seal housing and an end abutment formed in the pump body, the action of which, when the pump is assembled is to exert axial pressure on the seal housing and the adjacent impeller and thus effect an enhanced pressure sealing effect between the remote end of offset segment and the end cover plate. Furthermore, on stripping of the pump, the thrust spring serves to move the seal housing, and impeller towards the open end of the pump chamber which facilitates their removal. It has also been found that if the seal housing carries an annular shaft seal in a recess to the side on which the thrust spring acts, and if a spring of diameter about equal to that of the shaft seal is employed (so that the spring may act directly on the shaft seal), an improved sealing effect is obtained by this seal.

The pump may be close coupled to an electric motor, in which case the pump body has a flange formed at the thrust spring end of the housing, for bolting to the motor framework, the motor shaft serving also as the pump impeller shaft. Alternatively, the pump may be an independent unit, having a separate shaft, a bare extension of which projects from the thrust spring end of the pump housing which is provided with its own shaft bearings, bearing housing and body bracket.

The invention will now be described by way of an example with reference to the accompanying drawings in which

FIGURE 1 is a side elevation partly in section of a pump close coupled to an electric driving motor,

FIGURE 2 is an end elevation of the pump-motor combination in the direction of the arrow II on FIGURE 1, and with the pump end cover plate removed.

FIGURE 3 is an exploded perspective view of the combination,

FIGURE 4 is a fragmentary plan view of a motor and pump combination showing, partly in section, the fitting of an external recirculatory by-pass between the pump section and delivery branches, and

FIGURES 5 and 6 are sectional elevations through a pump body incorporating an internal recirculatory by-pass between the suction and delivery ports.

Referring now more particularly to FIGURES 1 to 3, a rotary pump generally indicated at **1** of the flexible, vaned rotary impeller type, is designed for close coupling to a suitable electric motor **2**, the extended shaft **3** of which forms the pump impeller shaft, and to this end, one end of the pump body is provided with a flange **4** for bolting to the motor framework.

A cylindrical chamber **5** is formed in the pump body **6**, such that when it is bolted to the motor, the chamber is co-axial with the motor shaft extension **3** (hereinafter referred to as the impeller shaft), the length of which is sufficient to extend to just short of that end of the chamber, which is completely open. The opposite end of the chamber (i.e. the motor end) is provided with two reduced diameter shoulders **7** and **8** (see FIG. 1) the purpose of which will be described, and an end opening **9** through which the impeller shaft **3** projects. The chamber **5** is also provided with a pair of longitudinally co-planar, circumferentially spaced ports **10** and **11**, for attachment to suction and delivery branches **12** and **13** respectively.

A seal housing **14** distinct from the pump body **6** is provided for the motor end of the chamber, and this comprises a cylindrical disc of external diameter equal to that of the pump chamber, so as to be a sliding fit therein, and having an internal bore for sliding on the impeller shaft. Formed integrally with and to one side of this housing is the pump offset segment **15** which comprises an insert member suitable for lining the chamber **5**, and of circumferential extent sufficient to extend from the delivery port **11** to the suction port **10** when considered in the direction of impeller rotation, while being of sufficient length, that when the seal housing is positioned in the chamber (see FIG. 1), to abut against the larger diameter **8** of the two above mentioned shoulders, the segment extends substantially to the open end of the chamber. Locating means in the form of a circular section dowel **16** projecting into chamber **5**, to cooperate with a groove **17** in the offset segment **15**, is provided to ensure correct angular positioning and positive location of the segment, between the ports. The seal housing **14** further, is provided with recesses **18** and **19** to accommodate an annular O-ring type seal **20**, as well as an annular shaft seal, **21**, on the side remote from the offset segment.

The recess in the in the pump chamber which is formed by the smaller of the above-mentioned shoulders **7**, is of such a diameter as to accommodate an axial spring **22** around the shaft, the diameter of which is equal to that of the shaft seal **21**, against which the spring abuts through an affixed interposed pressure plate **23**. The spring may alternatively be of large diameter so as to abut against the seal housing instead of directly against the seal, but the seal-abutting arrangement is preferred.

A flexible vaned impeller **24** made of rubber, synthetic rubber, plastic or other suitably flexible material is provided, and has a central hole for mounting on the impeller shaft. The impeller length is such that when in position in the chamber immediately adjacent the seal housing, and with the or each vane which is in the angular region of the offset segment being radially compressed thereby, it extends substantially to the open end of the chamber. The impeller has any suitable means associated therewith for allowing axial sliding on the impeller shaft, whilst constraining same to rotate with the impeller shaft.

A cover plate **25** is provided for the open end of the chamber, the pump body at this end being formed into a flange to which the plate may be attached by bolts **26** and wing nuts **27**, an O-ring type seal **28** being positioned between the flange and cover plate.

It will be appreciated from the foregoing description that assembly and stripping of the pump are extremely simple operations, and normally no tools are required for either, thus allowing for a simplified cleaning procedure for all the pump components.

To assemble the pump, (the body **6** being bolted to the motor framework) it is merely necessary to insert the thrust spring **22**, slide the seal housing **14** (with seals **20** and **21** in place) and impeller **24** into place, compress the relative impeller vane or vanes to clear the offset segment **15**, exert pressure against the spring thrust, position the open end O-ring seal **28** and attach the end plate **25** by screwing up the wing nuts **27** by hand.

For stripping the unit it is merely necessary to loosen the wing nuts and remove the end plate, whereupon the action of the thrust spring pushes the impeller and offset segment partially out of the open end of the chamber for removal. It will thus be seen that, by being attached to the seal housing, the offset segment also serves a secondary purpose as finger gripping means which facilitates the removal of the seal housing and associated seals and dispenses with the necessity of providing tools to remove the internal seals.

With rotary vane pumps of the type herein described it is important to ensure a continuous supply of liquid into the suction branch **13**. If this is not done, dry-running will quickly occur as the mechanism relies entirely upon the liquid being pumped for lubrication of the impeller and seals. Depending on various factors, the pump may be run for very short periods in a dry state, but, in many applications, it is advisable to guard against accidental dry-running, particularly where it is possible that this may continue for a sustained period.

To prevent dry-running a re-circulatory by-pass from the delivery port **11** to the suction port **10** of the pump may be provided. This pre-supposes there is liquid on the delivery side of the pump, as is to be expected under most conditions of operation. A recirculatory by-pass may be either incorporated within the pump body as shown in FIGURES 5 and 6 or fitted as an external accessory as shown in FIGURE 4.

FIGURES 5 and 6 show a by-pass in the form of a groove **34** formed internally of the pump body **6** and connecting to outlet port **11** to the inlet port **10**. Depending on the cross sectional area of the by-pass, a percentage of liquid will be constantly re-circulated, both with and without a normal supply of liquid into the suction inlet of the pump. With these arrangements, however, due to heating up within the pump when relying solely on the liquid being re-circulated, there will be a tendency for this to evaporate more rapidly than when the re-circulation is effected by means of an external by-pass. It also follows that the pumping action of the impeller tends to impede the return of liquid through the internal by-pass and, for these two reasons, internal bypass of the types described are only suitable where limited periods of dry-running are likely to occur.

If dry-running is likely to take place for lengthy periods, it is preferable to utilise an external by-pass and FIGURE 4 shows details of suitable design. A nozzle **29** leading from the delivery and having a restricted bore **30** is connected by a hand nut **31** to a flexible tube **32** which in turn is connected by a hand nut **33** to the pump suction branch **12**.

More particularly in the case of the externally mounted by-pass, there is the additional advantage that this acts as a pressure relief valve, and, depending on the cross sectional area of the restriction **30** within the by-pass, it is possible to limit the maximum pressure against which the pump can be required to operate. As the pump is of the positive replacement type, this offers the additional advantage of avoiding damage to the impeller and mechanism, due to operating the pump against an excessive pressure. Normally, however, the cross sectional area of the restriction within the by-pass would be set so as to allow betwen 5% and 15% of the liquid being pumped to be re-circulated.

Also the designs of both the internal and external by-passes permit of easy cleaning, thereby following the sanitary construction of the pump.

Various modifications are possible within the scope of the invention, for example the impeller shaft may extend through the end cover plate, suitable seal and bearing means being provided. Furthermore, as mentioned above, the pump may be produced as a distinct entity with an independent shaft and a suitable cover plate and shaft bearing at the motor end. Also, the pump may be provided with more than one offset segment, these being circumferentially spaced around the chamber. The additional segment, and even the original one, may furthermore, instead of being attached to the seal housing, be loose or be attached to the open end cover plate.

The invention is illustrated in the accompanying drawings.

I claim:

1. A rotary positive displacement pump comprising a pump body, a cylindrical pumping chamber formed in said body, an opening at one end of said chamber, an end wall at the other end of said chamber, circumferentially spaced inlet and outlet ports in said body leading into said chamber, an impeller shaft extending axially into said chamber, through said end wall, a flexible-vaned impeller slidably mounted on said shaft in said chamber for removal through said opening, means constraining said impeller to rotate with said shaft, a seal housing in said chamber between said impeller and said end wall, said seal housing being slidable on said shaft for manual removal from said chamber through said opening, first sealing means carried by said seal housing for minimizing the escape of liquid being pumped from said other end of said chamber, an offset segment positioned against the walling of said chamber for flexing said impeller vanes as said vanes rotate between said inlet and outlet ports, said offset segment being removable from said chamber through said opening, a cover plate releasably attached to the body to close said opening, and second sealing means interposed between said cover plate and said body.

2. The pump according to claim 1, wherein said offset segment is fixedly attached to said seal housing.

3. The pump according to claim 2, wherein said offset segment is formed integrally with said seal housing.

4. The pump according to claim 1 and including a helical thrust spring slidably mounted on said impeller shaft between said seal housing and said end wall and urging said seal housing towards said opening.

5. The pump according to claim 4, wherein said seal housing has a recess around said shaft and facing said end wall and said first sealing means includes an annular shaft seal in said recess, said spring abutting against said shaft seal.

6. In a rotary positive displacement pump having a body member formed with a cylindrical pumping chamber, an opening at one end of said chamber, an end wall at the opposite end of said chamber, an impeller shaft projecting into said chamber through said end wall, an impeller in said chamber slidably mounted on said shaft for removal from said chamber through said opening, means containing said impeller to rotate with said shaft, a cover plate closing said opening, and circumferentially spaced inlet and outlet ports leading to the chamber through the body member, the combination of a seal housing in said chamber slidably mounted on said impeller shaft against said end wall for manual removal from said chamber through said opening, and sealing means carried by said seal housing for minimizing escape of liquid from said opposite end of the chamber during pumping.

7. A rotary positive displacement pump comprising a body member, a cylindrical pumping chamber formed in said body member, an opening at one end of said chamber, an end wall at the other end of said chamber, circumferentially spaced inlet and outlet ports in said body member leading into said chamber, an impeller shaft extending axially into said chamber through said end wall, a flexible-vaned impelled slidably mounted on said shaft in said chamber for removal through said opening, said impeller being constrained to rotate with said shaft, a combined seal housing and offset segment member in said chamber having a seal housing portion between said impeller and said end wall and an offset segment portion against the walling of said chamber for flexing said impeller vanes as said vanes rotate between said inlet and outlet ports, said combined member being slidably mounted on said shaft for removal from said chamber through said opening, first sealing means at said other end of said chamber for minimizing escape of liquid therefrom during pumping, a cover plate releasably attached to the body member to close said opening, and second sealing means interposed between said cover plate and said body member.

8. A rotary positive displacement pump comprising a body member, a cylindrical pumping chamber formed in said body member, an opening at one end of said chamber, an end wall at the other end of said chamber, circumferentially spaced inlet and outlet ports formed through said body member and leading into said chamber, an impeller shaft extending axially into said chamber through said end wall, a flexible-vaned impeller slidably mounted on said shaft in said chamber for removal through said opening, means constraining said impeller to rotate with said shaft, a combined seal housing and offset segment member in said chamber having a seal housing portion between said impeller and said end wall and an offset segment portion projecting from said seal housing portion and lying against the walling of said chamber for flexing said impeller vanes as said vanes rotate between said inlet and outlet ports, said combined member being slidably mounted on said shaft for manual removal from said chamber through said opening, a recess in said seal housing portion of said combined member, said recess surrounding said shaft and facing said end wall, an annular shaft seal in said recess, a helical thrust spring surrounding said shaft and interposed between said seal and said end wall and urging said combined member towards said opening, a cover plate releasably attached to the body member to close said opening, sealing means interposed between said cover plate and said body member, and means external to the pumping chamber for rotating said impeller shaft.

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