Oct. 23, 1962 E. C. COTTELL 3,059,584

ROTARY PUMPS AND COMPRESSORS

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FIG. 1

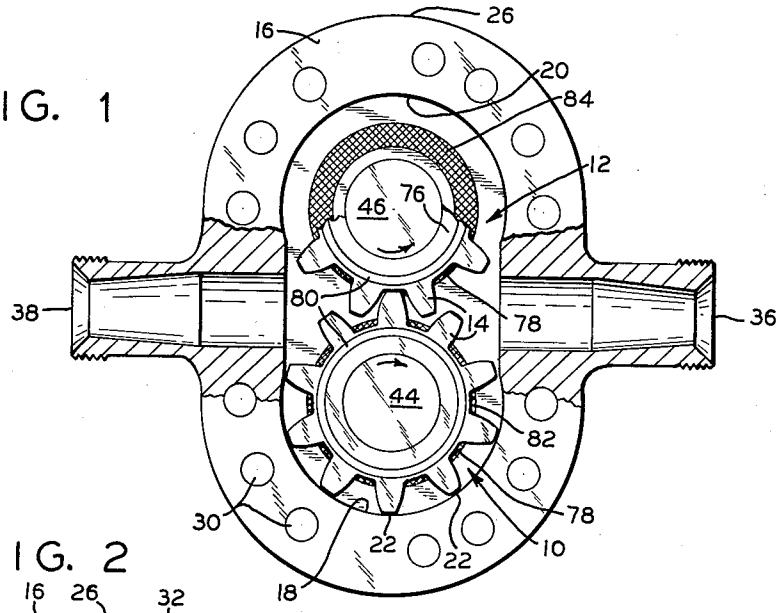

FIG. 2

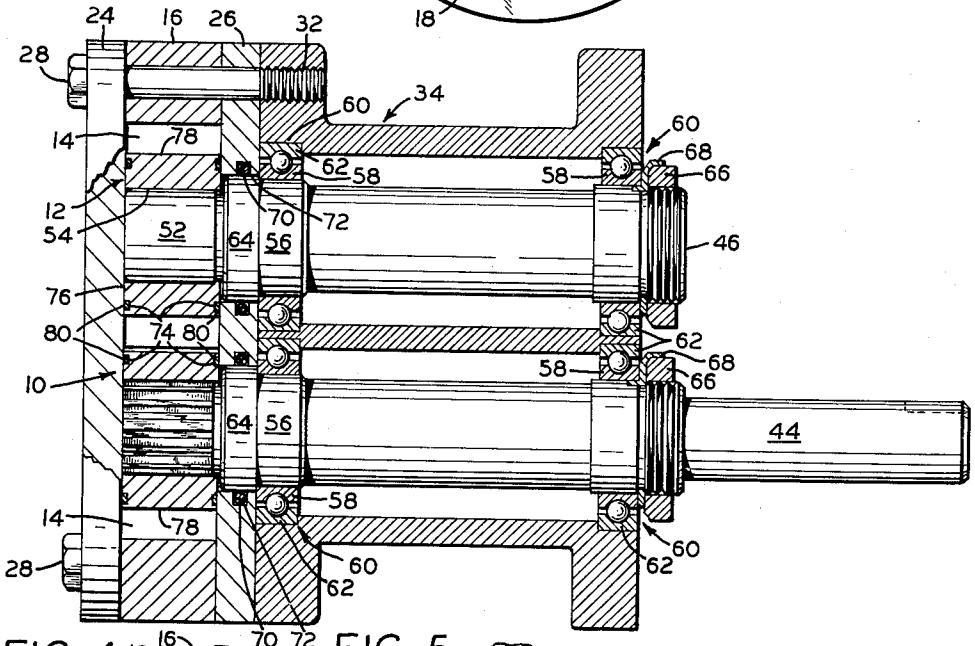

FIG. 4

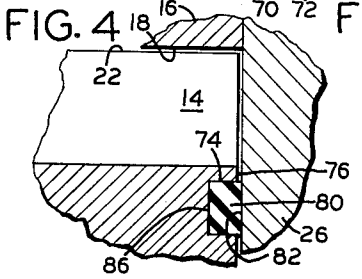

FIG. 5

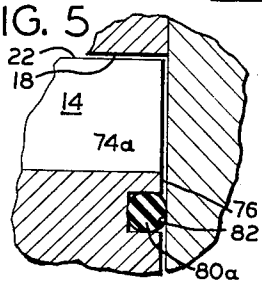

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FIG. 3

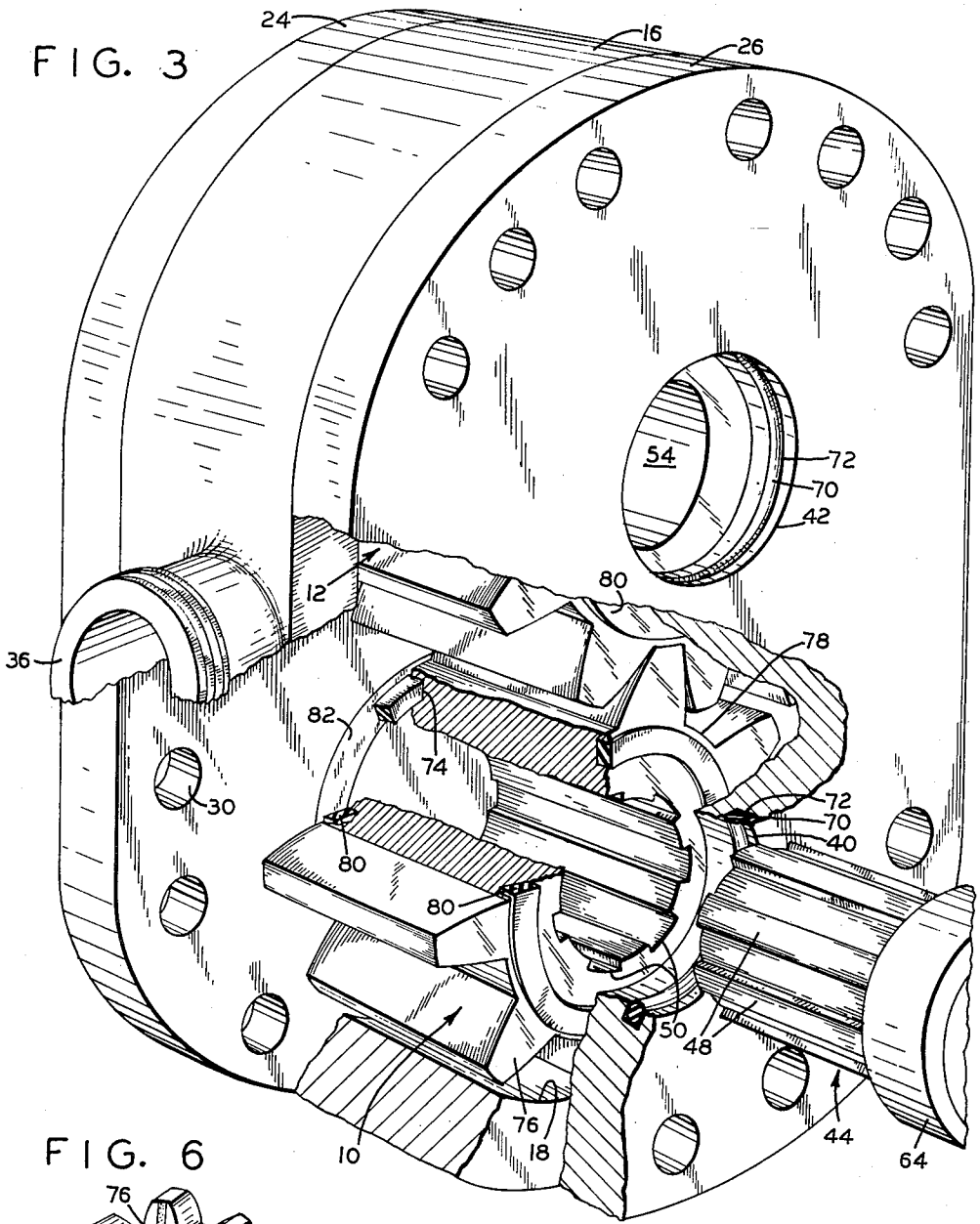
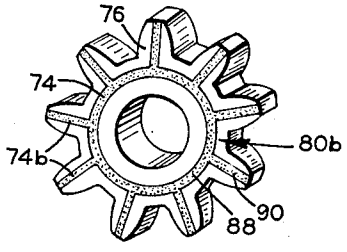


FIG. 6



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ROTARY PUMPS AND COMPRESSORS

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5 Claims. (Cl. 103—126)

This invention relates to an improved rotary pump or compressor having a member for positioning and sealing an impeller within a casing, and more particularly to a high pressure liquid gear pump incorporating such a member. Rotary pumps and compressors, in general, have wide application and are used to pump a great variety of fluids and semi-solids including lubricants, chemicals, food stuffs, gases and the like. Depending upon the type of material to be pumped, and a number of other factors such as temperature, pressure, viscosity and corrosiveness, the design of gear pumps, for example, may differ over a wide range. Within the wide range of applicable designs there are two basic types of gear pumps—the spur gear and the internal gear. As the spur gear pump is the most common of these, it is the type illustrated in the drawings and referred to hereinafter but it is to be understood that the present invention can be applied in rotary pumps and compressors of other design.

In the application and operation of rotary gear pumps, a number of problems have been encountered. A primary problem has been that of effectively retaining the side faces of the gears closely and uniformly spaced from the inner side walls of the pump casing. If the side faces of the gears are unevenly spaced from these casing walls, turbulence in the fluid moving through the pump is developed, and there is a resulting decrease in the efficiency of the pump. If either or both of the gear side faces are spaced too far from the inner side walls of the casing, there will be considerable back leakage across the side faces of the gears, which, of course, also results in decreased efficiency of the pump.

In the positioning and sealing of the gear within the casing, the problem of wear and friction is also encountered. In order to effectively seal against leakage across the side faces of the gear, some contact between the gear side faces and the casing side walls is necessary. It is at these points of contact that wear generally occurs on the gear side faces and the inner surface of the casing side walls. It is therefore very desirable, to reduce wear of these surfaces and enhance the efficiency of the pump in general, that there be as little friction as possible between the gear side faces and the casing side walls.

One method of centering the gears between the casing end walls is to secure the gear to its shaft and then further secure the shaft against axial movement relative to the casing. This method of centering the gear within the casing is quite expensive, for the tolerance between the gear side faces and its adjacent end wall surface must be very small to prevent any leakage and friction between the gear side face and its adjacent wall results in undue wear on both surfaces. The amount of time and labor required to disassemble and assemble such a gear pump is also increased as the gear must be released from its shaft in order to be withdrawn from the pump assembly.

The capability of being rapidly disassembled and reassembled is an extremely desirable feature in a pump used with food stuffs, chemicals and the like, in order to meet sanitary requirements. Particularly in the pumping of food stuffs, it is necessary that the pump be cleaned periodically and disassembly of the pump is generally required for a thorough cleaning operation. In the pumping of food stuffs and chemicals, it is also essential

that the positioning and sealing members be of a substantially chemically inert substance to avoid reactive contamination of the fluid pumped and for longer life of the positioning and sealing member.

Accordingly, it is a principal object of this invention to provide a rotary pump having positioning members at the side faces of the impellers for effectively centering the impellers axially within the pump casing.

Another object of the invention is to provide a rotary pump having positioning members of the above character which also function as pressure-sealing members across the side faces of the impellers and around the impeller shaft.

A further object of the invention is to provide in a rotary pump, impeller positioning and sealing members of the above character, having a low coefficient of friction and long wearing qualities.

Another object of the invention is to provide a rotary pump that can readily be disassembled, cleaned and reassembled wherein the impellers are positioned and sealed quickly and easily within the casing by positioning and sealing members of the above character.

A further object of the invention is to provide a rotary pump having positioning and sealing members of the above character which are substantially chemically inert to a great variety of foods and other chemicals.

Another object of the invention is to provide a rotary pump having sealing members of the above character that may be easily and inexpensively replaced.

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

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

For a better 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:

FIGURE 1 is an end view of a gear pump incorporating a preferred embodiment of the present invention with the end plate removed, the top gear being shown fragmentarily and the inlet and outlet fittings in section;

FIGURE 2 is a side view of a gear pump shown partially in section and incorporating a preferred embodiment of the invention;

FIGURE 3 is an enlarged partially exploded perspective view, partially in section, of the gear pump shown in FIGURES 1 and 2 with the drive shaft and cantilever frame removed;

FIGURE 4 is an enlarged fragmentary sectional view of a preferred embodiment with the sealing member as used in the present invention;

FIGURE 5 is an enlarged fragmentary sectional view of another embodiment with a sealing member that may be used in the present invention; and

FIGURE 6 is a perspective end view of a gear incorporating another embodiment of the invention.

In the following description, similar reference characters denote similar parts throughout the several views of the drawings.

The gear pump shown in FIGURES 1, 2 and 3 is of the spur gear type and utilizes closely meshing gears **10** and **12** closely surrounded by a casing **16** and end plates **24** and **26** which are fastened to the casing. Gear **10** is loosely fitted on a splined shaft **44** which is driven by a power source (not shown). Gear **12** is rotatably supported on a shaft **46** and is driven by the closely meshing gear **10**. As gear **10** rotates clockwise and gear **12** counterclockwise, the liquid is trapped between the gear

teeth 14 and the casing 16. The liquid is thus carried around the inner periphery of the casing 16 and since the gears are closely meshed, pressure built up by the rotating gears impels the liquid through outlet 38 on the discharge side of the pump.

In order to maintain pressure at the outlet, it is, of course, necessary that the end faces 22 of the gear teeth mesh as closely as possible with the root circle 78 of the opposing gear and that the inner surfaces 18 and 20 of casing 16 are in close clearance with gear end faces 22. The gear side faces 76 must be closely positioned adjacent the inner surface of end plates 24 and 26 to prevent the leaking back of liquid across the sides of the gears. Packing rings, such as O-ring seals 70 are also provided to prevent leakage from the pump around shafts 44 and 46.

In the gear pump shown in the drawings and embodying the present invention, there are provided annular positioning and sealing members 80 embedded in grooves 74 formed in the side faces 76 of the gears just inside the root circle 78 of the gears. These positioning and sealing members are made of a long-wearing, low friction material, and they preferably contact hardened polished or chromed surfaces 82 and 84 on the inner surfaces of end plates 24 and 26. The positioning and sealing members 80 retain the gears 10 and 12 in an equally and closely spaced relationship to the inner surfaces of end plates 24 and 26.

The positioning and sealing members 80 protrude slightly beyond the side faces 76 of the gears, as shown in FIGURES 3, 4 and 5, preventing contact between the gear side faces 76 and the end plates 24 and 26. As the positioning and sealing members have a low coefficient of friction they slide very easily on the smoothed surfaces 82 and 84 of end plates 24 and 26 as the gears rotate. Thus, by the use of such positioning and sealing members, wear on the side faces of the gears and on the inner surfaces of the end plates is substantially eliminated, the wear being taken up by the members themselves.

The problems encountered in centering the gears between the end plates of a gear pump are obviated by the positioning and sealing members of the present invention. For example, if the liquid that is being pumped is of such a nature that frequent cleaning of the pump is required, the reassembling of the pump may be accomplished quickly and easily. In a gear pump of the type illustrated, as shown in FIGURE 3, a cantilever frame or shaft housing 34 is provided (FIGURE 2) for rotatably supporting the shafts 44 and 46. By providing a pump with a cantilever frame, only end plate 24 need be removed in order to remove the gears and to clean the interior of the pump, or to replace the positioning and sealing members. Upon reassembly, the gears are self-positioning within the pump since they need only be slipped onto their respective shafts and end plate 24 bolted into position. The positioning and sealing members will retain the closely spaced relationship between the gear side faces and the end plates.

By retaining the gears in a closely spaced and axially centered relationship by sliding contact with the end plates 24 and 26, the efficiency of the pump is enhanced. It has been found that if the gears are not axially centered within the pump casing, a more turbulent flow of liquid in the pump results. This turbulence reduces the efficiency of the pump because such turbulence is induced in the liquid being pumped before the attainment of the critical velocity which would ordinarily cause turbulent flow of the liquid. Thus, the effect is a lowering of the critical velocity or Reynolds number for fluid flowing through the pump.

By locating the positioning and sealing members just inside the root circles of the gears, leakage across the side faces of the gears is greatly reduced. This is particularly true in a gear pump utilizing a cantilever frame as shown in FIGURE 2, as the shafts do not extend through end plate 24. Leakage across the side faces of the gears and across the ends of shafts 44 and 46 in a conventional pump would be considerable, but by retaining positioning and sealing members 80 of the present invention in close contact with the hardened polished or chromed surfaces 82 and 84 on both end plates 24 and 26, such leakage across the side faces of the gears and ends of the shafts is substantially prevented.

The positioning and sealing members 80 may be made of a variety of materials. "Teflon" (polytetrafluoroethylene) is preferred since it possesses the requisite toughness and low friction qualities. Such materials as "Viton" A, "nylon" or a sintered bearing material impregnated with Teflon may also be used for the positioning and sealing members.

As an alternate embodiment of the present invention, it should also be understood that the positioning and sealing members may be embedded into the end plates of the pump casing, and may contact chromed or polished surfaces on the gear side faces. The preferred embodiment, however, is that which is shown in FIGURES 1–4, as replacement of the positioning and sealing members is more easily accomplished when the members are carried by the gears themselves.

As seen in FIGURES 1, 2 and 3, the gear pump shown is generally comprised of a driving gear 10 and a driven gear 12, having their teeth 14 meshed with close clearance. Gears 10 and 12 are positioned within a casing 16 having curved inner surfaces 18 and 20 in close clearance with the end faces 22 of the teeth 14. The gears are enclosed by securing end plates 24 and 26 to casing 16 by bolts 28 passing through end plate 24, through holes 30 in the casing, through end plate 26 and into threaded holes 32 in the cantilever frame 34. Inlet and outlet ports 36 and 38 respectively, are integral with casing 16 as shown in FIGURE 1.

End plate 26 (FIG. 3) is provided with openings 40 and 42 to admit shafts 44 and 46 (FIG. 2) respectively for engagement with gears 10 and 12. Driving shaft 44 is provided with splines 48 which fit into corresponding axial grooves 50 in the bore of driving gear 10. As shown in FIGURE 2, the peripheral end surface 52 of shaft 46 and the mating bore 54 of driven gear 12 may both be smooth, since no torque is required to be transmitted between them, gear 12 being driven by gear 10.

As shown in FIGURE 2, shafts 44 and 46 are each provided with a pair of spaced collars 66 which are tightly fitted to the inner races 58 of ball bearing assemblies 60. The ball bearing assemblies 60 have their outer races 62 mounted in the cantilever frame 34. The shafts 44 and 46 are retained against axial movement from left to right as viewed in FIGURE 2, by shoulders 64 and against right to left movement by nuts 66 threaded onto the shaft. Keyed lock washers 68 prevent loosening of the nuts as the shafts rotate.

As shown in FIGURES 2 and 3, the packing O-rings 70 are retained in apertures 40 and 42 in end plate 26 within grooves 72. These O-rings contact shoulders 64 and provide pressure seals around shafts 44 and 46, preventing leakage through openings 40 and 42.

As best seen in FIGURE 3, gear 10 is provided with recessed annular grooves 74 in both of its flat side faces 76 just inside the root circles 78 of the gear. Into these grooves, annular positioning and sealing members 80 are inserted. The positioning and sealing members are preferably rectangular in cross section (FIG. 4) and made of a chemically inert, tough, low friction material such as nylon or Teflon. The positioning and sealing members protrude from the gear side faces 78 approximately .002 of an inch and contact chromed or polished surfaces 82 on end plates 24 and 26.

As shown in FIGURES 1 and 2, gear 12 is similarly provided with an annular positioning and sealing member 80 mounted in each of its side faces 76. The positioning and sealing members of gear 12 also protrude

approximately .002 of an inch from the gear side faces and contact polished or chromed surfaces 84 on end plates 24 and 26.

Referring now to FIGURE 4, it will be seen that the positioning and sealing member 80 is tightly fitted in groove 74 and is prevented from further movement into groove 74 by contact with the bottom surface 86 of the groove. Thus, as the bolts 28 (FIG. 2) are tightened to secure end plate 24, the positioning and sealing members 80 are forced into close sliding contact with the adjacent chromed or polished surfaces 82 and 84.

FIGURE 5 illustrates another embodiment of the invention in which the positioning and sealing members 80*a* may be round in cross section and capable of some deformation as bolts 28 are tightened drawing end plates 24 and 26 (FIG. 2) closer together. Such deformation of the positioning and sealing member 80*a* compresses the member within its grooves 74*a*, this compressibility resulting in an urging of the positioning and sealing member 80*a* against the polished or chromed surface 82 on the surface of the end plate.

FIGURE 6 illustrates another embodiment of the invention in which the positioning and sealing member 80*b* has an annular central portion and radially extending portions 90 which are integral with the central portion. In addition to the annular groove 74 which is formed in the side face of the gear, a radially extending groove 74*b* is milled into the side face of each gear tooth 14. The radially spoked positioning and sealing member 80*b* of this embodiment may then be fitted into the annular and radial grooves to closely contact and slide on the adjacent chromed or polished surface of the end plate.

From the foregoing description it can readily be seen that the utilization of a gear pump embodying the present invention will result in increased efficiency due to the axial centering of the gears and the reduction of pressure loss across the end faces of the gears. The positioning and sealing members also perform a secondary sealing function by sealing off the pump shafts from the liquid in the pump, thus preventing leakage around the shafts. The positioning and sealing members herein described are inexpensively manufactured and can be replaced easily and inexpensively when worn. By utilizing the positioning and sealing members to axially center the gears and to seal across the end faces of the gears, metal to metal contact between the gears and pump chamber is avoided, thus contributing substantially to the serviceable life of the pump.

The positioning and sealing members may be formed from a variety of materials depending upon the application to which the pump is to be put. In some applications, resistance to corrosion and chemicals will be a limiting factor in the selection of materials from which to form the positioning and sealing members. For general purposes, it has been found that Teflon possesses the requisite toughness, durability, low coefficient of friction and the quality of being inert to a great variety of chemicals, making Teflon an ideal material for the positioning and sealing members.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the scope of the invention, 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.

I claim:

1. A rotary gear pump comprising a pair of closely meshing gears, one of said gears being a driving gear and the other of said gears being a driven gear, the axes of rotation of said gears being spaced and fixed relative to each other, a casing surrounding said gears, said casing being provided with an inlet and an outlet and side walls, the inner surfaces of the side walls making up said casing being parallel to, equally spaced from and closely adjacent the side faces of said gears, a driving shaft extending through a first opening in only one of said walls to engage and to rotate said driving gear, said driving gear being free to slide on said driving shaft, a guide shaft extending through a second opening in said one of said walls to engage said driven gear, said driven gear being free to slide on said guide shaft, said driving shaft and said guide shaft being disposed coaxially with respect to said driving gear and said driven gear, respectively, guide means exterior of said casing and said side walls for fixedly supporting said driving shaft and said guide shaft and annular resilient positioning and sealing means provided in contact with and between both side faces of each of said gears and said side walls to prevent contact between the side faces of said gears and said side walls and to equally space said gears from said side walls, said positioning and sealing means being made of long-wearing, low friction material and maintaining at all times the aforesaid parallel spaced relationship between both sides of said gears and said side walls.

2. A rotary gear pump in accordance with claim 1 wherein the side faces of said gears are provided with annular grooves into which said positioning and sealing means are fitted.

3. A rotary gear pump in accordance with claim 1 wherein said guide means comprises a housing adapted to rigidly and rotatably support said driving shaft and said guide shaft and means fastening said housing to the outer surface of said one of said side walls.

4. A rotary gear pump in accordance with claim 1 wherein an O-ring seal is provided on said driving shaft and on said guide shaft to effect a fluid tight seal between said driving shaft and said first opening and between said guide shaft and said second opening, respectively, in one of said side walls.

5. A rotary gear pump in accordance with claim 1 wherein means are provided to secure said driving shaft and said guide shaft against axial movement relative to said casing.

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