

June 9, 1964

O. ECKERLE ET AL

3,136,261

GEAR WHEEL PUMP

Filed Oct. 4, 1962

4 Sheets-Sheet 1

Fig. 1

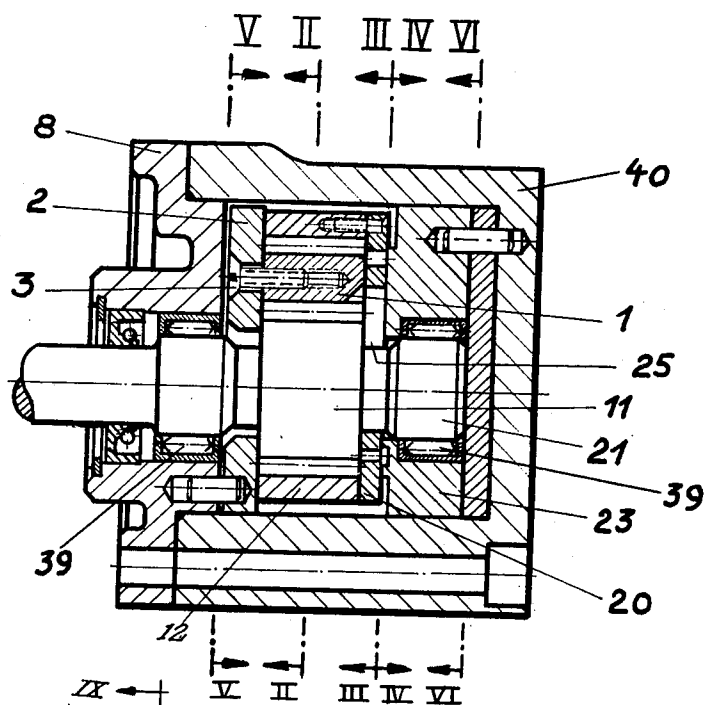
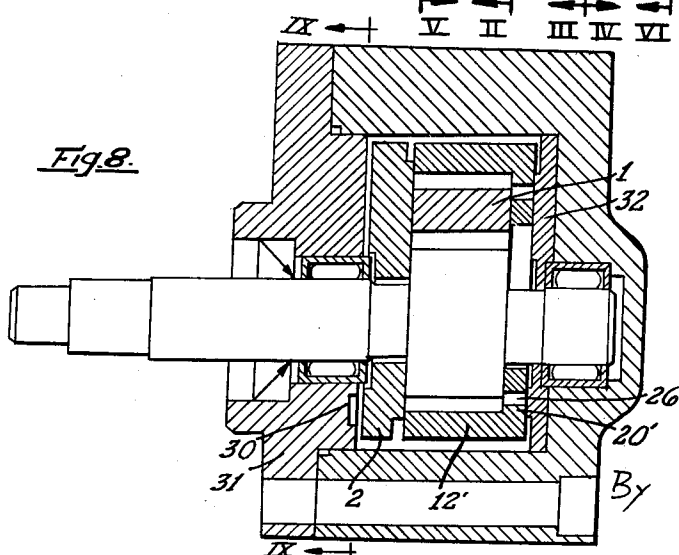


Fig. 8



Inventors
Otto Eckerle
Otto Becker

By Richard Lindt

June 9, 1964

O. ECKERLE ETAL

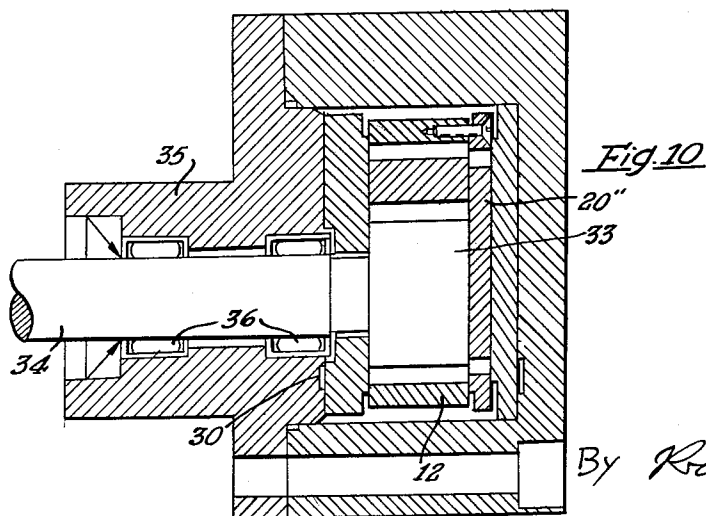
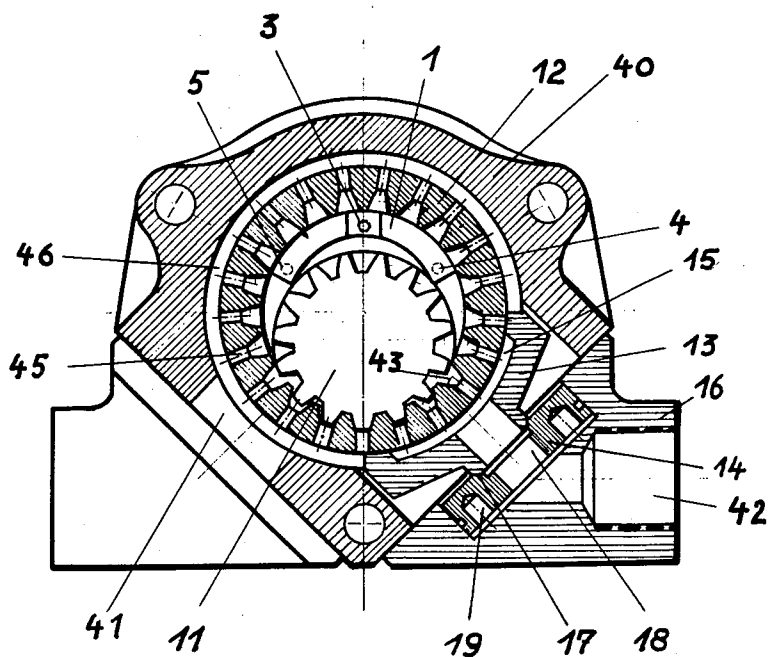
3,136,261

GEAR WHEEL PUMP

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4 Sheets-Sheet 2

Fig. 2



Inventors
Otto Eckerle
Otto Becker
By Richard Lund
Att

June 9, 1964

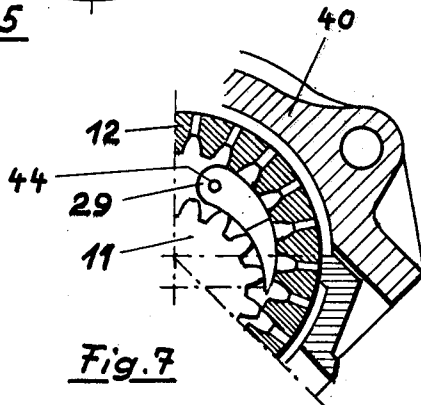
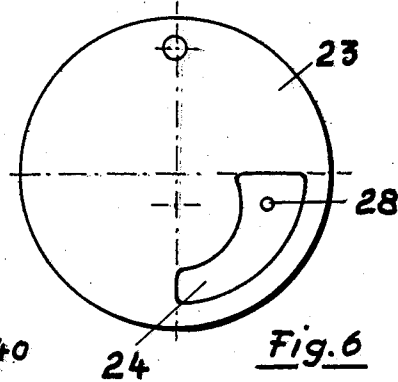
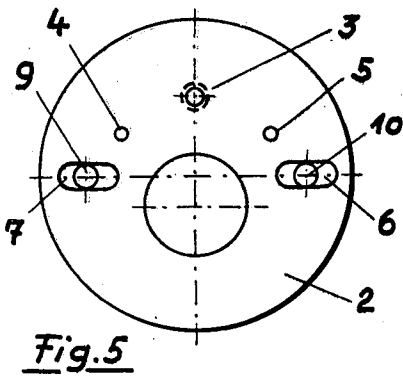
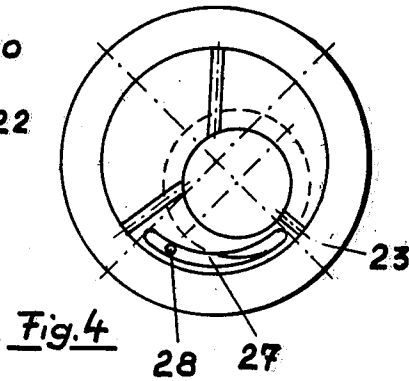
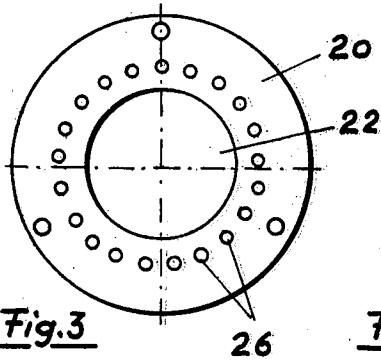
O. ECKERLE ETAL

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GEAR WHEEL PUMP

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4 Sheets-Sheet 3



Inventors
Otto Eckerle
Otto Becker
By Richard Lindberg

June 9, 1964

O. ECKERLE ETAL

3,136,261

GEAR WHEEL PUMP

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4 Sheets-Sheet 4

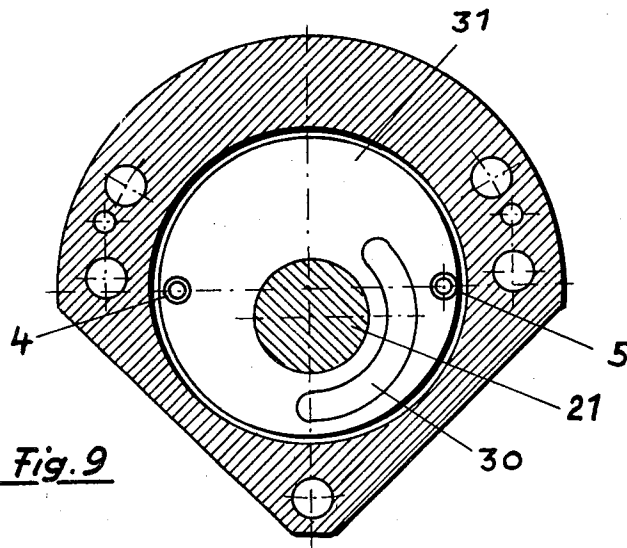


Fig. 9

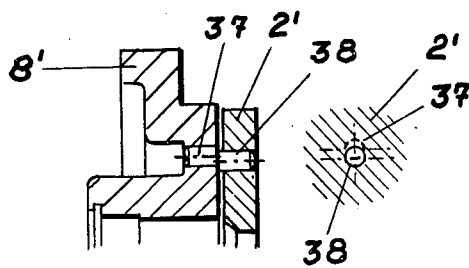


Fig. 11

Inventors
Otto Eckerle
Otto Becker
By Richard Ernst agt

1

3,136,261

GEAR WHEEL PUMP

Otto Eckerle, 3 am Bergwald, Malsch, Kreis Karlsruhe, Germany, and Otto Becker, Langensteinbach, Kreis Karlsruhe, Germany; said Becker assignor to said Eckerle

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14 Claims. (Cl. 103—126)

This invention relates to gear wheel pumps, and more particularly to gear wheel pumps of the type in which a circumferential portion of a gear wheel is in meshing engagement with an internally toothed gear ring of greater pitch diameter, whereby pressure chambers are formed between the engaged teeth of the gear wheel and the ring gear, and a fluid trapped between the teeth is compressed. A stationary sealing member in simultaneous sealing engagement with the gear wheel and ring gear is an essential element of such a pump.

Gear wheel pumps of the type described are employed for pumping fluids too viscous to be handled by centrifugal pumps, or for producing pressures higher than can be conveniently produced by other types of pumps. Both types of service are conducive to relatively rapid wear of all pump elements in contact with the pumped fluid. While wear may be retarded by suitable choice of materials of construction, the useful life of such pumps is relatively short. To lengthen it, complex sealing arrangements have been employed heretofore. They increase the first cost of the pump and its maintenance, and have not proved entirely satisfactory, being either so tight as to interfere with operation of the pump, or so loose as to permit leakage under unfavorable conditions of temperature.

The primary object of this invention is the provision of a pump of the type described in which wear of the several operative pump elements is balanced in such a manner that pressure tightness of the pump is not significantly affected by such wear, and the useful life of the pump is accordingly increased.

With this object and others in view, the invention in one of its aspects provides a pump in the housing cavity of which a gear wheel is rotated about a fixed axis by suitable drive means. An internally toothed ring gear of a pitch diameter greater than that of the gear wheel is in partial meshing engagement with the gear wheel so that a crescent shaped space is defined between the two meshing elements. A sealing member is arranged in the last-named space adjacent the meshed portions of the gear wheel and ring gear and simultaneously sealingly engages the toothed faces of the gear wheel and of the ring gear where they approach meshing engagement. Fluid initially trapped between the sealing member and the toothed faces is ultimately compressed in a pressure chamber formed when the toothed faces directly engage each other.

The desired balanced wear of the several working elements of the pump is provided by two fluid pressure actuated devices. A first device employs a fluid actuated motor to urge the ring gear against the gear wheel in a radially extending direction. The sealing member is mounted on the pump housing in such a manner as to be movable in the latter direction, so that any wear in radial dimensions can be compensated for by movement of the sealing member and of the ring gear which is freely movable in the housing cavity responsive to the forces transmitted by the sealing member and the gear wheel.

A second device jointly urges the ring gear, gear wheel, and sealing member toward a housing wall in an axial direction, thereby causing these working elements to be uniformly worn down in their axial dimensions. The

2

tightness of the pump is unimpaired by wear, and there is no drop in output pressure during prolonged use.

The exact nature of this invention as well as other features and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawings in which:

FIG. 1 shows a first embodiment of the gear wheel pump of the invention in section on the axis of its drive shaft;

FIG. 2 shows the pump of FIG. 1 in radial section on the line II—II;

FIG. 3 shows a detail of the pump of FIG. 1 in radial section on the line III—III;

FIG. 4 shows another detail in section on the line IV—IV;

FIG. 5 is another detail view of the pump of FIG. 1 taken in radial section on the line V—V;

FIG. 6 shows an element of the pump of FIG. 1 in section on the line VI—VI;

FIG. 7 illustrates a pump of the invention largely identical with that shown in FIGS. 1 to 6, but modified in a detail, the view corresponding to that of FIG. 2;

FIG. 8 shows a different embodiment of the pump of the invention in axial section on its drive shaft;

FIG. 9 is a radially sectional view of the pump of FIG. 8 on the line IX—IX;

FIG. 10 is an axially sectional view of yet another pump according to the invention; and

FIG. 11 shows a modified detail of the pump of FIGS. 1 to 6 in section on the axis of the drive shaft.

Referring initially to FIG. 1 of the drawing, there is illustrated a high pressure pump for oil or other viscous liquids, the pump being seen in axial section. The working elements of the pump are enclosed in a housing consisting of a cup shaped bottom portion 40 and a cover 8 bolted to the bottom portion. A pressure disc 23 is arranged adjacent the housing bottom and axially slidable in the housing cavity. A drive shaft 21 is rotatable in the housing on bearings 39 respectively mounted in the cover 8 and the pressure disc 23.

A coaxial gear wheel 11 is integral with the shaft 21. It is in partial meshing engagement with an internally toothed ring gear 12 as better seen in FIG. 2. The ring gear is fastened to an annular plate 20 having a central opening through which the shaft 21 passes. The portion of the shaft radially aligned with the plate 20 has an annular groove 25 of a width greater than the axial thickness of the plate 20 so that the plate 20 may be partly received in the groove.

A sealing member 1 is interposed between those circumferential portions of the gear wheel 11 and the ring gear 12 which are spaced from each other. The sealing member 1 is fastened to a centrally apertured guide plate 2 by a screw 3.

The pump of FIG. 1 is shown in FIG. 2 in radial section on the line II—II. The cavity in the housing portion 40 has two connections to the outside, an inlet conduit 41 and an outlet conduit 42. The gear wheel 11 and ring gear 12 define therebetween an approximately crescent shaped space which is largely occupied by the sealing member 1. The sealing member is seen to consist of a central portion attached by the screw 3 to the guide plate 2, and of two terminal portions, each tapering to a sharp edge, and pivoted to the central portion by pins 3 and 4 respectively. The outer circular wall of the sealing member 1 has approximately the same diameter as the toothed face of the ring gear 12 and sealingly engages the ring gear. The terminal portions of the sealing member are internally curved in a circular arc having a diameter about equal to the outside diameter of the gear wheel 11. The terminal sealing member portions are interposed between the spaced face portions of the gear wheel 11 and

3

of the ring gear 12 closely adjacent the engaged portions. The engaging teeth of the two gear elements form pressure chambers 43. A radial conduit 45 communicating with the space between each pair of teeth in the ring gear 12 leads outward into an annular space 46 between the cylindrical external face of the ring gear and the housing portion 40.

An abutment member 13 is radially movable in a portion of the annular space 46 adjacent the engaged portions of the gear elements 11, 12 and in the radially innermost portion of the outlet conduit 42 which is enlarged to permit free radial movement of the abutment member. The latter has a face opposite the external cylindrical face of the gear ring 12. The abutment member generally conforms to that external face but it has a recess 15 arranged sequentially to communicate with the radial conduits 45 during rotation of the gear ring 12. A cylindrical piston member 14 is sealingly slidable in another portion of the outlet conduit 42 in a direction which is radial with respect to the axis of the shaft 21, in abutting engagement with the abutment member 13. Cooperating annular face portions of the abutment member and of the piston member have an interface 17 of spherically curved shape and constitute a universal joint permitting the abutment member to follow movement of the ring gear 12 while maintaining contact with the piston member 14.

The portion of the outlet conduit in which the piston member 14 moves forms a cylindrical bore in a discharge nipple 16 fixedly attached to the housing portion 40. Recesses are provided in the piston member 14 to receive non-illustrated helical compression springs which normally urge the piston member and the associated abutment member 13 toward the ring gear 12 even in the absence of an actuating pressure fluid. A central passage 18 through the associated members 13, 14 connects the recess 15 with the outer portions of the outlet conduit 42.

FIG. 3 shows the annular plate 20 in a view taken on the line III—III in FIG. 1. The central opening in the plate 20 is substantially greater in diameter than the diameter of the shaft 21, and particularly of that portion of the shaft the diameter of which is reduced by the groove 25. Axial eccentric apertures 26 in the plate 20 are arranged in a circle to respectively communicate with the several radial conduits in the ring gear 12.

FIG. 4 is a view of the pressure disc 23 taken in the direction of the drive shaft axis on the section line IV—IV in FIG. 1. The radial face of the disc shown in FIG. 4 has a narrow, arcuately elongated recess 27 arranged to register with certain apertures 26 in the plate 20. The registering apertures are those which communicate with the radial conduits 45 in the meshing portion of the ring gear 12. An axial duct 28 passes from the recess 27 axially through the pressure disc 23. As seen in FIG. 6 which shows the opposite radial face of the pressure disc 23, the duct 28 terminates in a recess 24 on the opposite disc face. The cross section of the recess 24 in a radial plane is substantially greater than the corresponding cross section of the recess 27.

FIG. 5 shows the guide plate 2 as seen in an axial direction on the line V—V. The guide plate carries the screw 3 which attaches the center portion of the sealing member 1 to the plate 2, and the two pivot pins 4, 5 on which the terminal sealing member portions are hinged. The pins 4, 5 also secure the central sealing member portion against rotation on the screw 3. The guide plate 2 has two slots 6, 7 which are elongated in a common direction, not entirely radial with respect to the drive shaft which passes through an eccentric aperture in the guide plate 2, but having a substantial radial component. Movement of the guide plate 2 in the direction of the slots 6, 7 is guided by two guide pins 9, 10 which respectively engage the slots and are fastened in the housing cover 8. It will be appreciated that the aperture of the plate 2 is larger than the cross section of the shaft 21 thus permitting the movement of the plate 2 on the pins 9, 10.

4

The afore-described apparatus operates as follows:

The drive shaft 21 rotates the gear wheel 11 clockwise as shown in FIG. 2. Teeth of the gear wheel moving out of engagement with the teeth of the ring gear 2 and toward sealing engagement with one terminal portion of the member 1 draw fluid, such as oil, through the inlet conduit 41 into the annular space 46, and through the radial conduits 45 into the interstices between the teeth on the two gear elements 11, 12. When these teeth engage the sealing member 1, oil is trapped and carried in an arc along the sealing member 1 toward the free edge of the other terminal portion where the teeth of the gear elements 11, 12 again engage and form pressure chambers 43 of gradually decreasing volume, whereby the previously trapped oil is expelled through the radial conduits 45. In this portion of their path, the conduits 45 communicate with the recess 15 in the abutment member 14. The oil flows under positive pressure from the recess 15 through the central passage 18 and out of the outlet conduit 42.

Fluid tight sealing engagement of the several operating elements of the pump is ensured by two devices. One is best seen in FIG. 2. The abutment member 13 is acted upon by the pressure of the pumped liquid in the recess 15. This pressure is only partly balanced by the pressure of the liquid entering the pump to which the outer surfaces of the abutment member are exposed. The pressure on the walls of the recess 15 which urges the member to move radially away from the external face of the ring gear 12 is more than balanced by the pressure of the discharged liquid on the outer circular face of the cylinder member 14 so that the abutment member 13 urges the ring gear radially toward the gear wheel 11 and the sealing member 1 with relatively light pressure.

The sealing member 1 is capable of yielding to movement of the ring gear 12 to some extent by movement of the guide plate 2 on the pins 9, 10. The force required for actuating such movement is small, and the component of the pressure exerted by the abutment member 13 in the direction of elongation of the slots 6, 7 and transmitted to the plate 2 is sufficient when the angular relationship is as illustrated, that is, the angle between the directions of movement of the abutment member and of the plate 2 is of the order of 45°. The dimensional relationships necessary under specific operating conditions such as the viscosity of the fluid and the discharge pressure obtained will be readily selected by those skilled in the art. Regardless of the wear on the teeth of the gear elements 11, 12 and of the contact faces of the sealing member 1 which affects the dimensions of these operating members of the pump in a radial direction, no leakage will develop.

The second device built into the pump of the invention prevents leakage due to wear which decreases axial dimensions of the working members. Fluid under pressure is diverted in small amounts from the radial conduits 45 while in registry with the recess 15 through the associated eccentric apertures 26 (FIG. 3) in the plate 20 into the recess 27 of the pressure disc 23, and thence into the recess 24. Even while the disc 23 is in generally abutting engagement with the bottom of the cup-shaped housing portion 40, the axial pressure exerted by the fluid in the recess 24 more than balances that of the fluid in the recess 27, thus urging the disc 23 against the plate 20.

As shown in FIG. 1, the plate 20 is attached to the ring gear 12 and is in axially abutting engagement with the sealing member 1 and the gear wheel 11. It presses both geared elements 11, 12 against the plate 2. Any non-uniformity in the axial shortening of the gear wheel 11, the ring gear 12, and the sealing member 1 by wear will increase the axial pressure exerted by the disc 23 on the axially longer elements until these too are shortened and the pressure is uniformly distributed. Any significant imbalance of the axial dimensions of the working elements of the pump is prevented by this pressure device.

FIG. 7 shows an embodiment of the invention which

5

differs by one detail only from that shown in FIGS. 1 to 6 and described hereinbefore. The sealing member 1 is replaced by a sealing member 29 which is pivoted on the non-illustrated guide plate 2 by a pin 44. The sealing member 29 extends over only about one half of the circumference of the geared elements 11, 12 enveloped by the sealing member 1. The mode of operation of the apparatus of FIG. 7 is so closely similar to that described above, as not to require separate explanation.

In the embodiment of the invention illustrated in axial section in FIG. 8, and in section on the line IX—IX in FIG. 9, the cover 31 is formed with a recess 30 on its inner radial face adjacent the plate 2. Pressure fluid in the recess 30 axially urges the plate 2 toward the ring gear 12' which is integral with the plate 20'. Axial apertures 26 in the plate 20' admit fluid under pressure to a recess 27 in a disc 32.

The provision of the groove 25 in the shaft 21 of the apparatus illustrated in FIGS. 1 to 6 permits movement of the ring gear 13 and of the attached plate 20 to compensate for extensive wear without interference by the shaft 21, yet does not unduly reduce the diameter of the bearings 39. The embodiment of the invention shown in FIG. 10 is even more advantageous in this respect. Both bearings 36 of the shaft 34 are arranged in the pump housing cover 35. The plate 20'' on which the ring gear 12 is mounted thus is without central aperture. The plate 20'' provides a particularly reliable axial closure for the pressure space of the pump in which the gear wheel 33 rotates. In other respects, the embodiment of the invention shown in FIG. 10 is similar to those described hereinabove, and a more detailed description is not called for.

FIG. 11 illustrates an alternate method of fastening a guide plate 2' to a cover 8' of a pump otherwise identical with that illustrated in FIGS. 1 to 6. A pin having two longitudinal portions 37, 38 transversely offset relative to each other and respectively rotatably received in the cover 8' and the guide plate 2' permit adequate relative movement of the plate and the cover in the manner of the pins 9, 10 and slots 5, 6. The engagement between the plate 2' and the entire cylindrical outer face of the pin portion 37, and that between the cover 8' and the outer face of the pin portion 38 reduces the specific pressure at the respective interfaces, and increases the durability of a critically important portion of the apparatus.

It is a common feature of all illustrated embodiments of the invention that they automatically balance the wear of the several operating elements of the pump, and thus avoid leakages between them. The pumps of the invention are also distinguished by a particularly low noise level.

It should be understood of course that the foregoing disclosure relates to only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. In a gear wheel pump, in combination:
 - (a) a housing defining a cavity therein;
 - (b) a gear wheel rotatable in said cavity about a fixed axis;
 - (c) an internally toothed ring gear in said cavity, the pitch diameter of said ring gear being greater than that of said gear wheel, respective circumferential portions of said gear wheel and of said ring gear being in meshing engagement, and the remainders of the circumferences of said gear wheel and of said ring gear defining therebetween a crescent shaped space;
 - (d) drive means for actuating rotation of said gear wheel in a predetermined direction;

6

(e) a sealing member in said space adjacent said meshingly engaged portions and in simultaneous sealing engagement with said gear wheel and said ring gear, said sealing member being movable in a radially extending direction with respect to said axis;

(f) first pressure means for urging said ring gear toward said gear wheel in said radially extending direction; and

(g) second pressure means for jointly urging said ring gear, said gear wheel, and said sealing member toward a portion of said housing in an axial direction.

2. In a pump as set forth in claim 1, said housing including inlet means for admitting a fluid to said space, and outlet means, said engaged portions defining therebetween at least one pressure chamber, and said outlet means communicating with said pressure chamber for discharging said fluid from said housing under pressure, said first pressure means including pressure fluid operated motor means operatively connected to said ring gear for urging the ring gear to move toward said gear wheel in said radially extending direction, and communicating with said outlet means for actuation by said fluid under pressure.

3. In a pump as set forth in claim 2, a pressure disc member axially movable in said cavity, a portion of said housing axially spaced from said pressure disc defining with the latter a substantially closed pressure space, said pressure space communicating with said outlet means for admission of fluid under pressure, said pressure disc being operatively connected to said ring gear, said gear wheel, and said sealing member for urging the same in a direction axially away from said pressure space under the pressure of the admitted fluid.

4. In a pump as set forth in claim 3, said ring gear being movable in said cavity and free to assume a position in a radial plane responsive to forces transmitted thereto by said gear wheel, by said sealing member, and by said first pressure means.

5. In a pump as set forth in claim 3, guide means on said housing for limiting movement of said sealing member to a path having a component which is radial with respect to said axis.

6. In a pump as set forth in claim 5, said guide means including a guide member movably secured to said housing and fastened to said sealing member.

7. In a pump as set forth in claim 6, said guide means further including pivot means interposed between said guide member and said sealing member.

8. In a pump as set forth in claim 3, said drive means including a shaft coaxially fastened to said gear wheel and journaled in said housing, an annular plate member fastened to said ring gear and formed with a central opening, said shaft passing through said opening, and said pressure disc abuttingly engaging said plate member.

9. In a pump as set forth in claim 8, said shaft being formed with an annular groove axially aligned with said plate member, and of an axial width greater than the axial thickness of said plate member.

10. In a pump as set forth in claim 8, said gear wheel being integral with said plate member.

11. In a pump as set forth in claim 8, said pressure disc having a face opposite said plate member and being formed with a recess in said face, said plate member being formed with a plurality of eccentric apertures therethrough, said apertures communicating with said pressure chamber and with said recess during respective portions of each revolution of said ring gear, said pressure disc being formed with a duct connecting said recess with said pressure space.

12. In a pump as set forth in claim 3, said housing being formed with a cylinder bore, said motor means including a piston member sealingly movable in said cylinder bore, an abutment member engaging said ring gear,

universal joint means interposed between said piston member and said abutment member, said cylinder bore communicating with said outlet means for movement of said abutment member toward said ring gear under the pressure of the fluid in said outlet means.

13. In a pump as set forth in claim 3, said ring gear having an external face, said motor means including a piston member movable in said outlet means in the direction of fluid flow therethrough, and sealingly engaging said housing; an abutment member having an abutment face; and universal joint means interposed between said piston member and said abutment member, said abutment member being formed with a recess in a portion of said face thereof, the remainder of said abutment member face sealingly engaging said external face of said ring gear, said ring gear being formed with a conduit therethrough connecting said pressure chamber with said external face for passage of fluid under pressure from said pressure

chamber to said recess, said abutment member, universal joint means, and piston member being formed with respective communicating passages for passing said liquid from said recess through said outlet means.

14. In a pump as set forth in claim 13, said piston member being of circular cross section.

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