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PUMP

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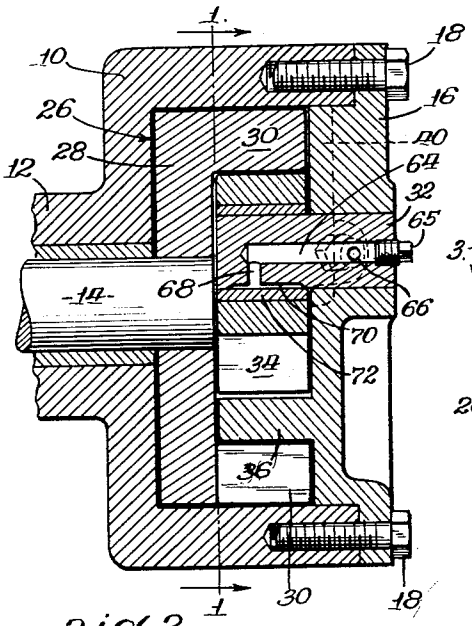



Fig. 2.

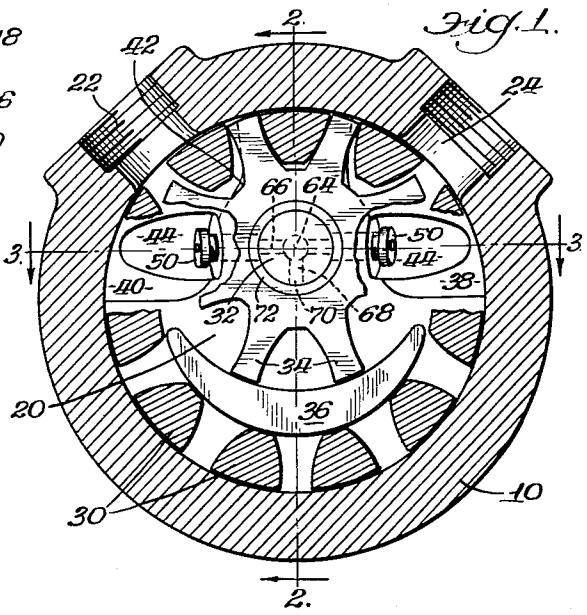



Fig. 1.

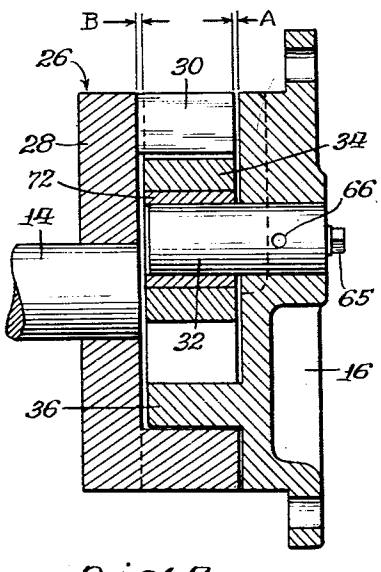



Fig. 4.

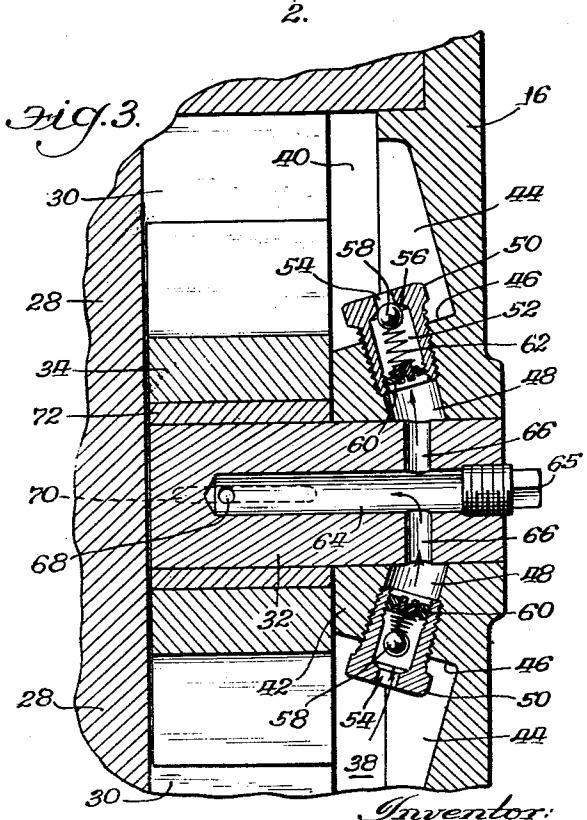



Fig. 3.

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# PUMP

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This invention relates to pumps and particularly to an arrangement for the pressurized self-lubrication and hydraulic balance of positive displacement rotary pumps.

It is the principal object of the invention to provide in a rotary pump a simplified arrangement for utilizing the pumped liquid at the developed pressure for the forced lubrication of certain rotary elements, and at the same time to provide hydraulic balance of the rotary parts involved. A further object of the invention is to provide the aforesaid self-lubrication and balance in a reversible pump independently of the direction of rotation.

Other objects and advantages of the invention will become apparent from the following description and the accompanying drawings, which illustrate the application of the invention to a gear pump of the internal gear type.

FIGURE 1 is a sectional view of the aforementioned pump taken perpendicularly to the pump axis (on the line 1—1 of FIG. 2), and having certain parts partially broken away for clarity of illustration;

FIGURE 2 is a sectional view through the rotary axis of the pump, taken on the line 2—2 of FIG. 1;

FIGURE 3 is an enlarged fragmentary sectional view of the pump taken on the line 3—3 of FIG 1; and

FIGURE 4 is a partial sectional view similar to FIG. 2 but with the pump housing removed to facilitate reference to the moving parts of the pump, particularly in connection with the hydraulic balance achieved by the disclosed pressure-lubrication system.

Referring particularly to FIGS. 1 and 2, the illustrated gear pump comprises a pump housing including a cup-shaped casing **10** which has a central bearing **12** suitably bushed to journal an input drive shaft **14**, and is closed at the side opposite the bearing **12** by a head or cover plate **16** secured to the casing by means of cap screws **18** or the like. As indicated, the two-part housing may be of cast construction suitably machined for assembly and for proper fit with parts yet to be described.

The cover plate **16**, to which detailed reference will later be made, forms with the casing **10** a cylindrical pumping chamber **20** in which the rotary pump parts operate to draw liquid into the housing through one radially extending opening **22** in the casing **10** and expel it from the chamber through a similar radially extending outlet opening **24**, or vice versa, after traveling a generally peripheral path of about 270 degrees through the housing. As will later appear, the pump is reversible in character, operating equally well in either direction of rotation.

Securely fitted on the end of the drive shaft **14** within the pump housing is an internal gear or rotor **26** which consists essentially of a heavy circular disk **28** having axially extending peripheral projections **30** formed as internal gear teeth. The cover plate **16** of the pump is provided with a stub shaft **32** which extends axially into the pump chamber eccentrically to the input shaft **14** and forms a journal for an idler gear **34** which is disposed in meshing engagement with the teeth **30** of the rotor **26** (as shown in FIG. 1). A crescent-shaped projection **36**, formed integrally with the cover plate **16**, extends into the pump chamber in the space between the two gears, with its end face in close proximity to the inside face of the motor **26**. The inner and outer surfaces of



the crescent-shaped member **36** are circular arcs on the centers respectively of the idler **34** and the rotor **26**, and are wiped by the teeth of those gears when the pump is in operation.

Referring to FIGURE 1, it will thus be understood that when the rotor **26** is driven in a counter-clockwise direction, the internal idler **34** is driven thereby in the same direction, drawing liquid into the pump housing through the inlet opening **22** into the increasing spaces between the disengaging teeth of the two gears, and conveying it toward the outlet opening **24**, where the reengaging teeth of the gears expel the liquid from the pump housing under pressure through the outlet opening **24**.

The high pressure and low pressure zones of the pump are separated from each other by the engaged gear teeth and by the closeness of the fit between the inner faces of the two gears and between their outer faces and the pump housing, as well as by the close peripheral fit of both gears with the walls of the pump chamber and the crescent **36** which fills the eccentric space between the two gears.

The illustrated clearances are exaggerated for clarity of illustration, but are maintained sufficiently close in actual operation that no appreciable amount of liquid is bypassed by leakage between the high and low pressure zones through the running clearances.

In the illustrated pump, the idler gear **34** is lubricated and balanced axially on its supporting shaft **32** by the pumped liquid which is delivered from the high pressure side of the pump to the journal of the idler gear **34** through a system of channels and valves which operates effectively regardless of the direction of rotation of the pump.

For this purpose the inside face of the cover plate **16** is relieved in two areas **38** and **40** respectively adjacent the two ports **22** and **24** of the pump casing **10**, leaving an intermediate barrier against which the close fit of the outer faces of the two gears is maintained, and which also provides a boss **42** in which the stub shaft **32** is securely maintained by a press fit. The relief of the inside face of the cover plate **16** provides an enlargement of the low and high pressure areas within the pump chamber.

Within each relieved area **38** and **40** of the cover plate **16**, there is further formed a recess **44**, the purpose of which is to provide a flat surface **46** on the boss for the stub shaft **32** through which to bore passageways **48** generally radially, through the boss **42** but at a slight angle to the axis of the stub shaft **32**. Each of the passageways **48** is tapped to receive the threaded body of a spring-and-ball check valve **50** which is designed to pass liquid only radially inwardly through the passageways **48**.

As indicated particularly in FIGURE 3, the body of the check valve **50** may be hollow, its inner space **52** communicating with the pump chamber through a small passage **54** having a conical seat **56** which is normally closed by a ball valve element **58**. The opposite or inner end of the valve chamber **52** is provided with interior threads to receive a plug **60** which forms a seat for the valve spring **62**, and which may be adjusted axially of the valve body to adjust the pressure at which the valve opens. A small opening in the center of the plug **60** completes the channel from the stub shaft to the pump chamber.

The stub shaft **32** is bored axially from its outer end to provide a central passage **64** extending to within a short distance of its inner end, and the outer end of the bore is tapped to receive a threaded plug **65**. The stub shaft **32** is also bored diametrically near its outer end to provide a direct passage **66** between the central bore **64**

and the two chambers **48** in the boss **42**, and radially near its inner end to provide a passage **68** between the central shaft passage **64** and the surface of the journal for the idler gear **34**. As shown particularly in FIGURE 2, the surface of the journal is grooved at the outer end of the radial bore **68**, the groove **70** extending axially of the journal in both directions from the radial bore **68**, but not fully to the ends of the journal. The idler gear **34** is provided with a bushing **72** of sufficient length to extend axially beyond the groove **70** in both directions as shown in FIGURE 2.

In the operation of the pump, assuming again a counter-clockwise direction of rotation as seen in FIGURE 1, the right hand side of the pump is the high pressure zone and the left hand side the low pressure zone. By the same token, the check-valve in the high pressure zone **38** is opened by the pumped liquid which is delivered through the aforementioned channels to the journal for the idler gear **34** to lubricate the engaged surfaces of the stub shaft **32** and the bushing **72** of the gear. The high pressure liquid is prevented from direct access to the low side of the pump by the opposite check-valve in the low pressure zone **40**.

The running clearance between the bushing **72** of the idler gear and the journal surface of the stub shaft **32**, while throttling the flow of liquid through the lubrication system sufficiently to maintain the liquid in the bearing at a pressure approaching the pump delivery pressure, nevertheless permits escape of the pumped fluid from the ends of the bushing **72** to both faces of the idler gear **34**, which are disposed in close proximity to the inner face of the cover plate **16** and the inner face of the rotor gear **26** respectively. The running clearances between those faces are shown in exaggerated form in FIGURE 4 as spaces A and B, and it will be apparent that pumped liquid escaping in both directions from the idler gear journal finds access to the aforementioned clearance spaces. In the spaces A and B the liquid escaping from the journal lubricates the faces of the relatively moving parts, providing by pressurized flow a film of liquid which maintains the idler gear **34** in a state of floating balance between the rotor gear **26** and the face of the cover plate **16**. Inasmuch as the contact areas between the hub portion of the idler gear **34** and the adjacent surfaces of the rotor gear **26** and the cover plate **16** are substantially the same, axial movement of the idler gear in either direction momentarily increases the pressure in the liquid film on the advancing side of the idler, creating a momentary imbalance in the axial forces on the idler which moves the idler back toward a more central position on the journal.

When the direction of rotation of the pump is reversed, the operation of the self-lubrication and balancing system remains essentially the same with the exception that the check-valve which was previously open is now closed, and that which was closed is now opened. The direction of flow of pumped liquid through the stub shift **32** and the journal of the idler gear **34** remains the same in both instances.

In the above-described system, the idler journal is constantly lubricated and cooled, and the idler gear is buffered on both faces by a film of the pumped liquid which prevents galling and seizure at the contact surfaces of the relatively moving parts. As a result, pump maintenance is materially reduced and the useful life of the pump is greatly extended.

Features of the invention believed new and patentable are set forth in the appended claims.

I claim:

1. In a reversible gear pump, a pump housing, a driving gear journalled in the housing, a smaller idler gear within and in meshing engagement with said driving gear, said idler gear being journalled eccentrically to said driving gear on a shaft fixed in the wall of said housing and being formed so as to provide a clearance space adjacent each face of said idler gear, said housing having a crescent-shaped projection extending into the eccentric space between said two gears, said gears dividing said pump into high and lower pressure zones, said housing and shaft having formed therein at least one continuous communicating passageway extending from said high pressure zone regardless of the direction of rotation of the pump to a point on said journal which is midway between the high and low pressure zones of the pump on the side of the journal which is farthest from the full meshing point of the gears and extending through said idler gear journal and into said clearance spaces adjacent said idler gear faces so as to fill said clearance spaces, a portion of the pumped liquid being thereby continuously diverted under maximum pump pressure to the journal and equally to the idler gear faces irrespective to the direction of rotation of said gears so as to lubricate and cool the journal and provide axial balance for said idler gear, a portion of the length of said passageway being at and enclosed within the surface of said shaft, and a check valve in said passageway permitting liquid to flow only from the high pressure zone to the journal.

2. A reversible gear pump as set forth in claim 1, wherein said one continuous communicating passageway comprises a first transverse passage in said idler gear shaft, an axial passage in said idler shaft in communication with said first transverse passage, a second transverse passage in said idler gear shaft generally midway of said idler gear, and a groove extending lengthwise along the periphery of said idler gear shaft and having communication with said second transverse passage, said groove terminating at its opposite ends at positions inwardly of the ends of the journal on said shaft for said idler gear.

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