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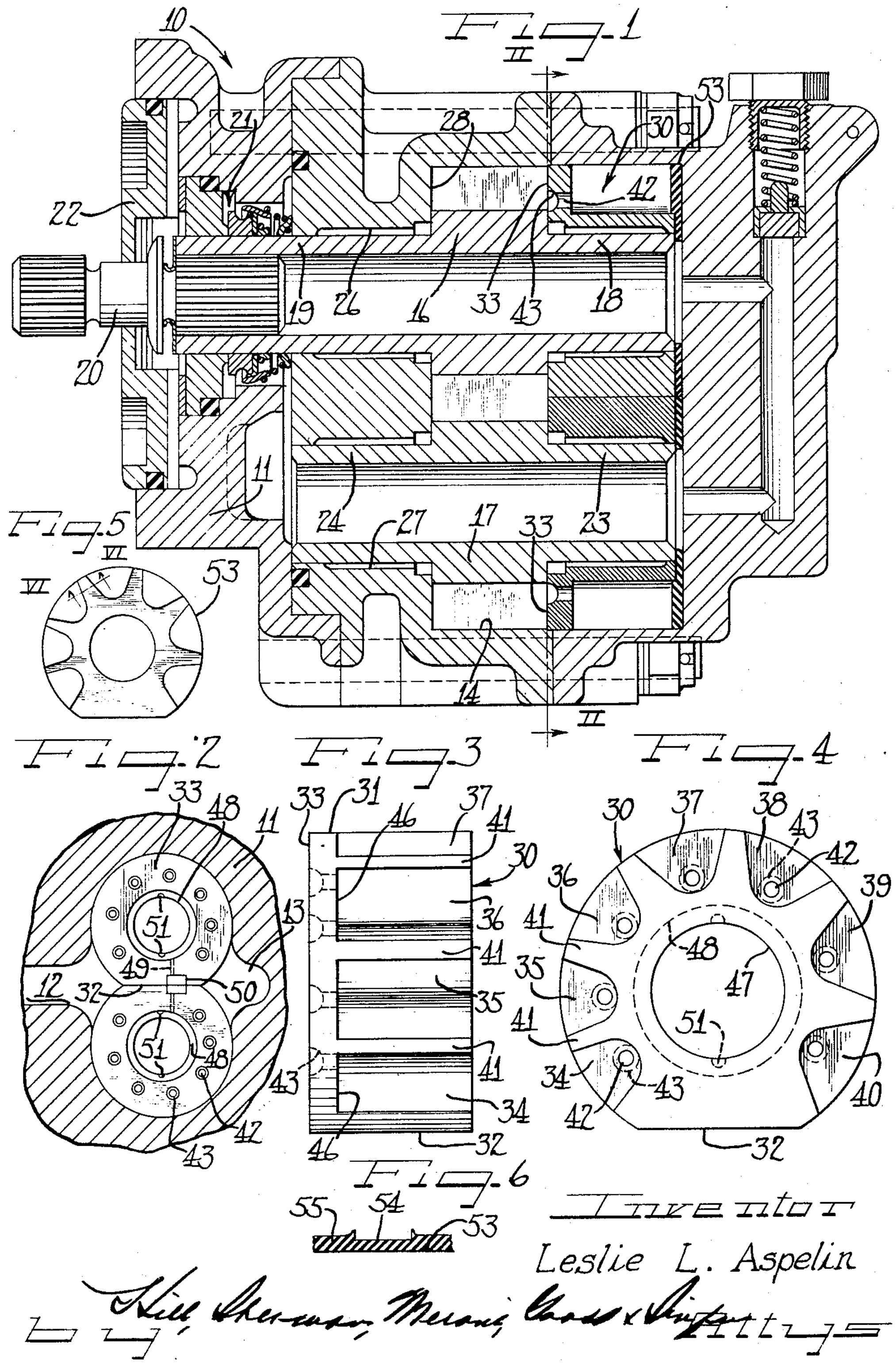

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GEAR RING BUSHING

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This invention relates generally to gear pumps and more particularly to a gear pump having a pressure loaded movable end plate means.

It has been determined that developed pressures around the periphery of a rotary fluid displacement means of a gear pump vary as a function of the rotational speed of the pump and as a function of the discharge pressure. Accordingly, with a pressure loaded gear pump of the type using pressure loaded movable end plate means, the total force tending to separate the mating gear and end plate and the line of action of that force tends to change with the speed of rotation of the gear impeller. To provide a loading force acting on the movable end plate which will be equal and opposite to a varying load, it would be necessary to change not only the quantitative value of the loading force, but it would also be necessary to apply such force at different locations.

According to the principles of the present invention, these objectives are satisfied by the provision of a gear pump bearing end plate means having an irregularly shaped back surface or non-friction surface which forms together with means including a portion of the housing of the pump a plurality of circumferentially spaced localized confined pressure control chambers. Each chamber communicates with the friction side of the end plate means at a point axially opposite the corresponding pressure control chamber, thereby to progressively vary the quantitative value of pressure force in the circumferentially spaced pressure control chambers and thereby varying the amount of thrust acting upon the end plate means from the inlet to the outlet.

Furthermore, it is contemplated according to the present invention to vary the effective motive surfaces of each respective pressure control chamber in such a manner that the loading force acting on the end plate means varies from a minimum on the inlet side of the pump to a maximum at the outlet side of the pump.

It is an object of the present invention, therefore, to provide an improved pressure loaded gear pump.

Another object of the present invention is to provide a loading force on movable end plate means for a pump which will be equal and opposite to a varying load developed in the pumping cavity.

Yet another object of the present invention is to provide a pump in which end plate means are subjected to different quantitative values of loading force and in which the loading force is, in effect, applied at different locations depending upon the operating conditions existing within the pump.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheet of drawing in which a preferred structural embodiment of a pressure loaded gear pump incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

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Figure 1 is a cross sectional view of a pressure loaded gear pump incorporating a bearing end plate means provided in accordance with the principles of the present invention;

Figure 2 is a cross sectional view reduced in size and fragmentary in part taken substantially on line II—II of Figure 1;

Figure 3 is an elevational view of a bearing end plate means provided in accordance with the principles of the present invention;

Figure 4 is an end elevational view of the bearing end plate means of Figure 3;

Figure 5 is an end elevational view of the sealing member provided in accordance with the principles of the present invention and;

Figure 6 is a fragmentary cross sectional view enlarged in size and taken substantially on line VI—VI of Figure 5.

As shown on the drawings:

The pump of the present invention is indicated generally at **10** and includes a casing or housing **11** having an inlet **12** and an outlet **13**. Rotary fluid displacement means operate in a pumping cavity **14** to move fluid from the inlet **12** to the outlet **13** and in this particular pump take the form of a pair of intermeshing gears including a driver gear **16** and a driven gear **17**.

The driver gear **16** has a first gear shaft extension **18** and a second gear shaft extension **19** which projects out of the housing or casing **11** and which is splined to a driving member **20** adapted to be connected to a source of power. The usual bearing and seal assembly **21** is interposed between the housing or casing **11** and the gear shaft extension **19** and is retained in place by a cover member **22** attached to the casing **11**. It will be understood that O ring sealing members and recesses for receiving same may be incorporated throughout the pump for effecting seals between related adjoining surfaces established by the pump components.

The driven gear **17** has a first gear shaft extension **23** and a second gear shaft extension **24**. The gear shaft extensions **19** and **24** are journalled in a corresponding pair of bearing surfaces indicated at **26** and **27** respectively provided by the casing **11**. That portion of the casing **11** also provides a radially extending sealing surface **28** which engages and seals against and adjoining side face of each corresponding gear **16** and **17**.

At the opposite side of the gears **16** and **17**, the movable pressure loaded bearing end plate means of the present invention are provided, each gear **16** and **17** having a bearing end plate member **30** associated therewith.

Detailed description of a single bearing end plate member **30** will suffice for both of the bearing end plate members and in this connection, reference may be had to the enlarged details shown in Figures 2, 3 and 4.

Each of the bearing end plate members **30** comprises a generally cylindrical spool-type bushing member having a generally circular outer periphery **31**. A chordal flat portion **32** (Fig. 2) establishes an abutment joint between a pair of the adjoining members **30**, **30**.

Each bushing **30** has a friction side or a sealing surface **33** which is adapted to engage and seal against the adjoining side face of a corresponding gear **16** or **17**.

Each bushing **30** also has an irregularly shaped non-friction side which together with means including a portion of the housing or casing **11** forms a plurality of circumferentially spaced localized and confined pressure control chambers herein numbered serially **34**, **35**, **36**, **37**, **38**, **39** and **40**.

In cross section, or, in viewing the bushing **30** from the rear, it will be noted that the configuration of the bushing **30** on the non-friction side resembles a star, there being a plurality of circumferentially spaced fingers each indicated at **41** which are interposed between each respective pair of pressure control chambers **34—40**.

The pressure control chambers **34—40** being circumferentially spaced, lie axially opposite corresponding areas on the friction side or sealing surface **33** of the bushing **30** subjected to varying loads in the pumping cavity **14** of the pump **10**. These varying pressure loads increase progressively in the pumping cavity **14** from a minimum at the inlet side of the pump adjacent the inlet **12** to a maximum on the outlet side of the pump adjacent the outlet **13**. Moreover, when the speed of rotation of the gears **16** and **17** is increased, the line of action of the pressure force tends to change.

In accordance with the principles of the present invention, the quantitative value of the loading force is not only changed but, is in effect, applied at different locations because each respective pressure control chamber **34—40**, inclusive, is separately communicated to an axially opposite portion of the pumping cavity **14** by a passageway extending axially through the bushing **30**. Each of the passageways, for the sake of convenience, is indicated by the same reference numeral **42**. The passageways **42** constitute generally cylindrical openings or bores and may be counterbored as at **43** at the sealing surface **33**.

The present invention further contemplates that the pressure control chambers **34—40** be provided in an increasing number from the inlet to the discharge side of the pump. Thus, the degree of concentration is calculated to approximate the generated pressure gradient of the working fluid within the pumping cavity **14**. Furthermore, it is contemplated by the present invention that the width of the respective projections or fingers **41** be progressively changed to increase the respective areas of the motive surfaces at the bottom of the respective pressure control chambers **34—40**. In Fig. 3, the motive surfaces are indicated by the reference numeral **46**. In Fig. 4, it will be noted that the fingers **41** become progressively narrower, thereby proportionately increasing the amount of exposed area from the inlet to the outlet sides of the pump.

Each bushing **30** has a bore extending therethrough providing a bearing surface **47** for journalling a corresponding one of the gear shaft extensions **18** and **23**. In the sealing surface **33**, there is provided a counterbored recess **48** which lies circumjacent the bearing surface **47**. Pressure generated by the pump is communicated to the counterbored recesses **48** by a passageway **49** extending between the recesses **48** and a trapping relief **50** formed on the discharge side of each respective bushing **30**. The bearing surface **47** of each bushing **30** is further characterized by one or more axially extending grooves **51** communicating with the counterbored recess **48**, thereby to flood the bearing surface **47** with a coolant and lubricant.

In order to seal the pressure control chambers **34—40** and in order to initially load the bushing **30** into sealing engagement with the gears **16** and **17**, a resilient and elastic sealing disk **53** is interposed between each bushing and the back adjoining wall of the casing **11**. As shown in Fig. 6, the face of the seal ring **53** adjoining each bushing **30** may be provided with circumferentially spaced radially extending grooves **54** adapted to receive and seat corresponding fingers of projections **41**, thereby providing projecting portions **55** which form lips extending into each corresponding pressure control chamber **34—40**. The grooves **54** not only promote efficient sealing, but also prevent relative rotation between the parts of the pump.

In operation, the arrangement described is of particular utility because the separate pressure control chambers **34—40** having motive surfaces of varying areas and communicating with separately spaced portions of the pumping cavity **14** operate to provide a loading force acting on the bushings **30** which is equal and opposite to a varying load and which varies not only quantitatively but also varies insofar as the effective point of load concentration is concerned.

Although various minor structural modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A pressure loaded bearing end plate bushing for a gear pump comprising a friction side and a non-friction side, means on said non-friction side of said bushing forming a plurality of confined localized alternately circumferentially spaced fingers and areas, the areas increasing progressively in number from the inlet to the outlet sides of the pump and the fingers decreasing progressively in size, whereby to provide a greater effective total area of said localized areas on the outlet side of the pump, and passage means in said bushing extending from each respective one of said areas axially into said friction side of said bushing to communicate the same varying pressure forces acting on the friction side of the bushing to the corresponding localized areas on the non-friction side of the bushing.

2. In a high pressure pump, a housing having an inlet and an outlet and providing a pumping cavity, and end plate means for said cavity in said housing, said end plate means having an irregularly shaped back surface forming together with means including a portion of said housing a plurality of circumferentially spaced localized confined pressure control chambers, a finger interposed between each respective pair of chambers, the number of chambers increasing and the width of the fingers decreasing towards the outlet side of the pump, and a corresponding plurality of passages in said end plate means communicating each respective chamber to said cavity at a point axially opposite the corresponding chamber, thereby to vary progressively the loading force on said end plate means from the inlet side of the pump to the outlet side of the pump in degree to approximate the generated pressure gradient in the pumping cavity.

3. In a high pressure pump as defined in claim 2, a flexible sealing member interposed between said housing and said end plate means having a plurality of face segments corresponding in size and shape to said chambers to seal said chambers.

4. In a high pressure pump, a housing having an inlet and an outlet and providing a pumping cavity, rotary fluid displacement means in said pumping cavity for moving fluid from said inlet to said outlet, said housing having a second cavity adjoining said pumping cavity and being of a complementary size and shape, bearing end plate means in said second cavity for sealing and engaging against an adjoining side face of said rotary fluid displacement means, said bearing end plate means having a friction side forming a sealing surface for engaging an adjoining side face of the rotary fluid displacement means and a non-friction side, said non-friction side being star-shaped in configuration and having integral therewith a plurality of alternately circumferentially spaced radially extending finger projections and pressure control chambers, and separate passageways for each chamber extending through said bearing end plate means and intersecting said friction side for communicating varying pressures to said pressure control chambers, thereby to progressively vary the loading force acting on the bearing end plate means from the inlet to the outlet side of the pump for balancing the unequal pressure forces in the pumping cavity.

5. In a high pressure pump, a housing having an inlet and an outlet and providing a pumping cavity, a second cavity adjoining said pumping cavity and being of a complementary size and shape with respect thereto, bearing end plate means in said second cavity having a fric-

tion side providing a sealing surface for engaging and sealing against an adjoining side face of rotary fluid displacement means in said pumping cavity, said bearing end plate means having a non-friction side characterized by the formation thereon of a plurality of alternately circumferentially spaced radially extending finger projections and pressure control chambers in said bearing end plate means, and a flexible sealing member interposed between said housing and said bearing end plate means having a face particularly characterized by the formation thereon of a plurality of face segments fitting in said pressure control chambers to effect a seal of each chamber with respect to said housing, and means communicating pressure generated by said pump into said pressure control chambers.

6. In a high pressure pump as defined in claim 5, each respective pressure control chamber having motive surfaces of size increasing in effective motive surface area towards the discharge side of the pump, thereby to approximate the pressure gradient in the pumping cavity.

7. In a high pressure pump as defined in claim 5, said pressure control chambers being disposed in an order of increasing number from the inlet to the discharge side of the pump and the corresponding interposed finger projections decreasing in width, thereby to increase the total loading force of the bearing end plate means towards the discharge side of the pump.

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