Sept. 6, 1966 B. L. RICH 3,270,680

PRESSURE LOADED GEAR PUMP

Filed Dec. 17, 1964 3 Sheets-Sheet 1

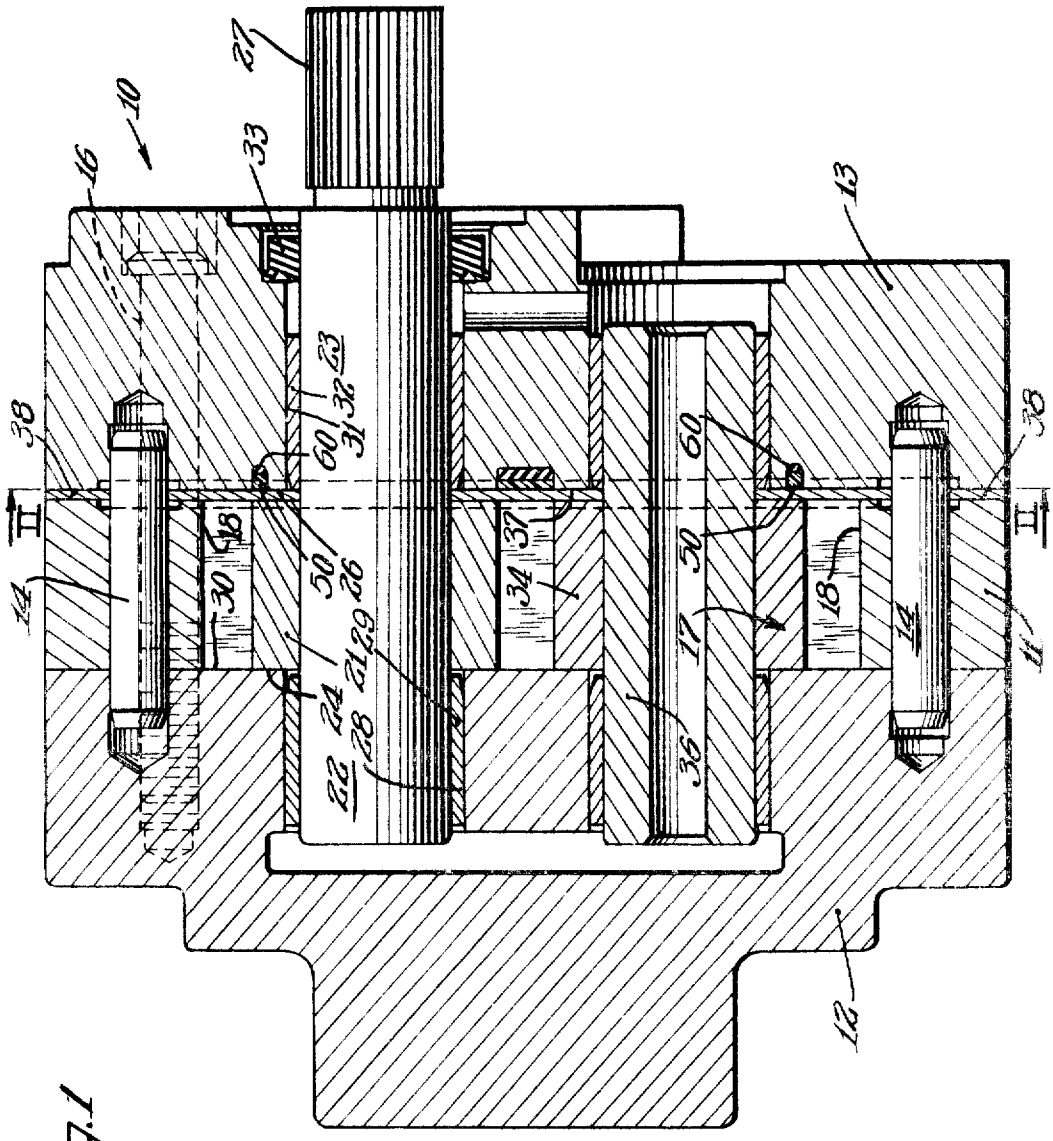

FIG. 1

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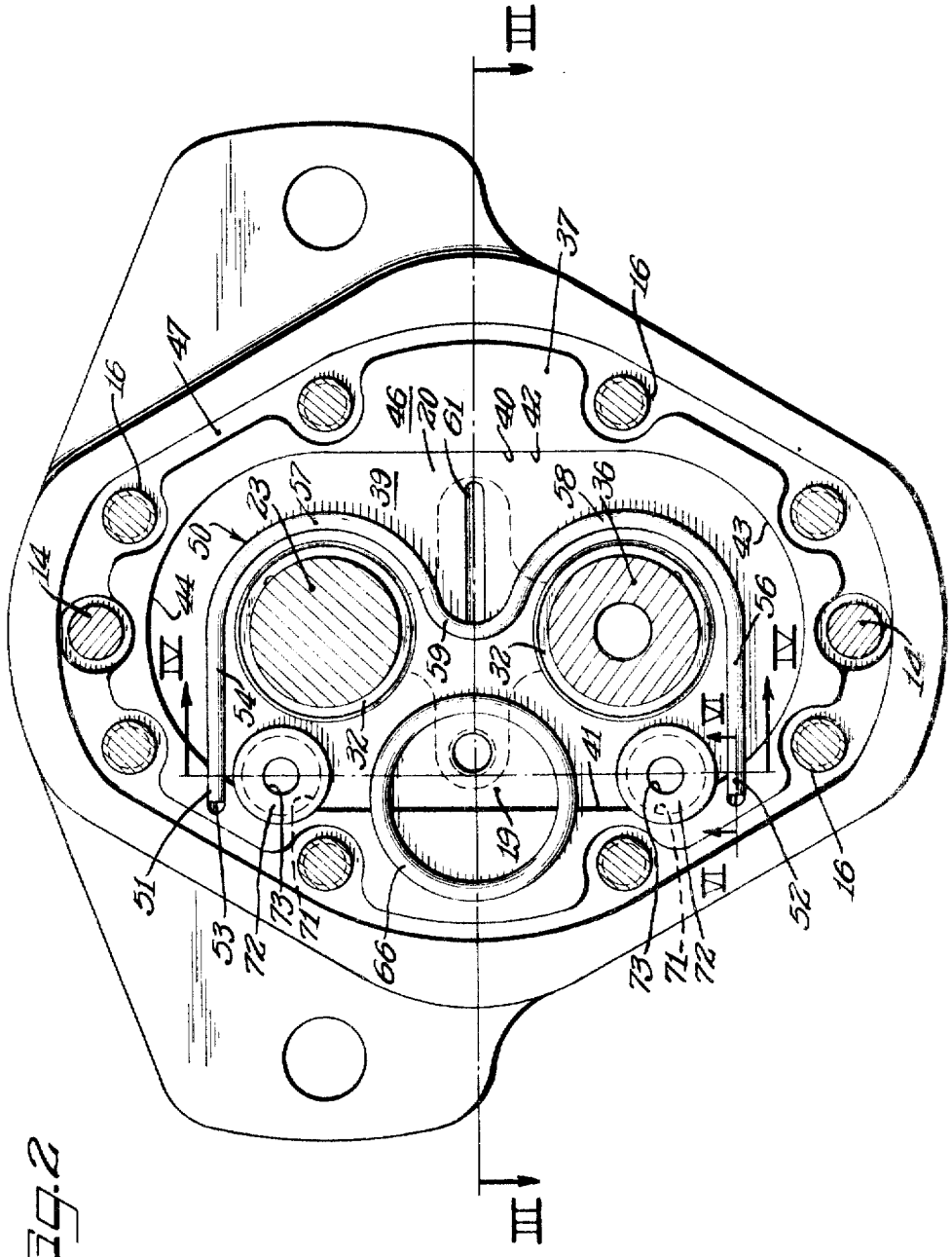

Fig. 2

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PRESSURE LOADED GEAR PUMP

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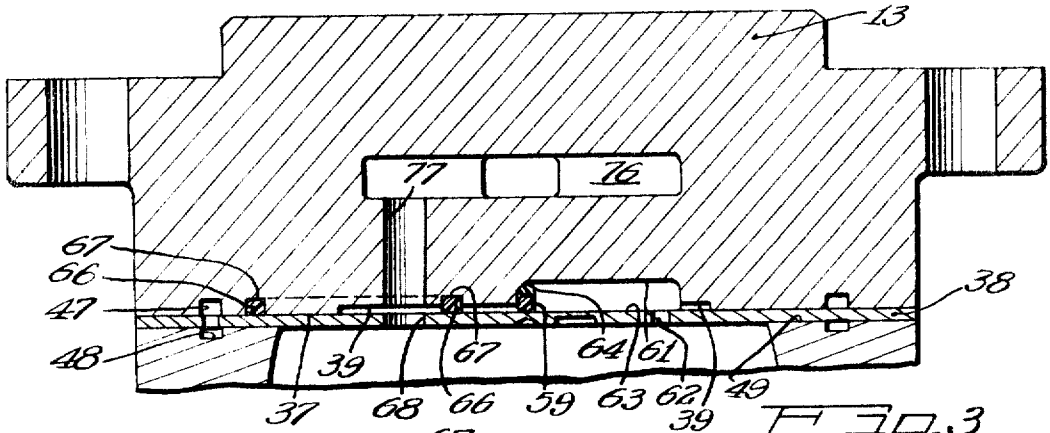

Fig. 3

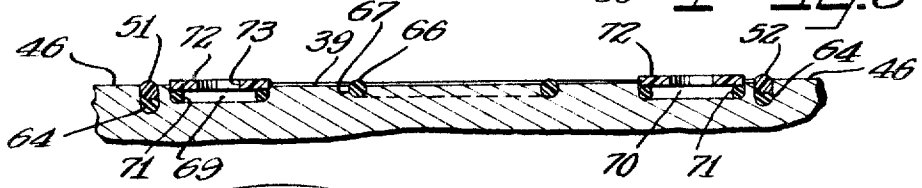

Fig. 4

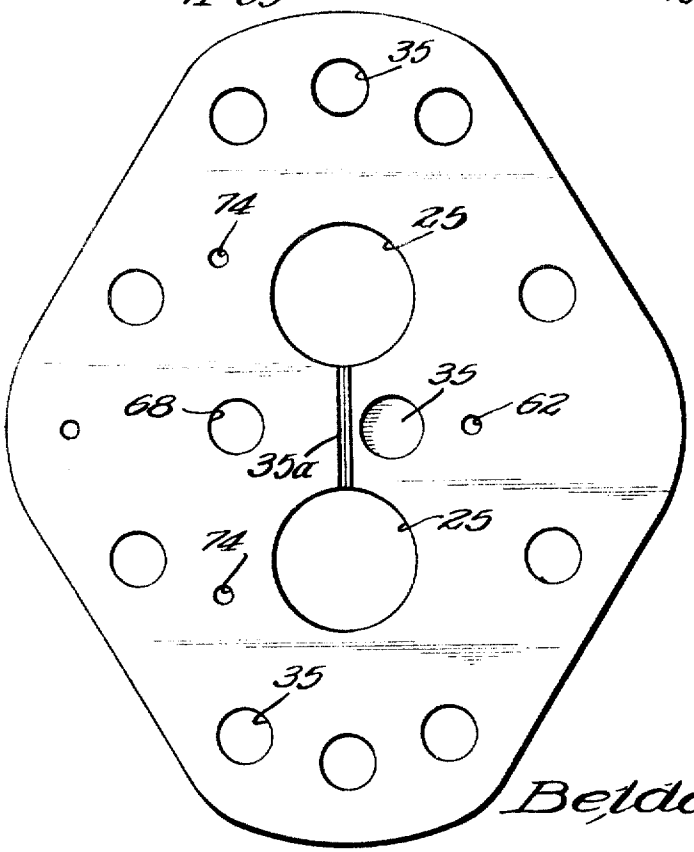

Fig. 5

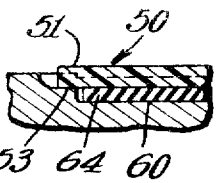

Fig. 6

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United States Patent Office 3,270,680 Patented Sept. 6, 1966

3,270,680

PRESSURE LOADED GEAR PUMP

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16 Claims. (Cl. 103—126)

This invention relates generally to pumps and more particularly to a pressure loaded gear pump assembly having a pumping chamber formed therein and including rotary impellers in the chamber for pumping fluid from an inlet to an outlet side of the chamber. One wall of the chamber adjacent one side of the impellers has a relief portion formed therein surrounded by a sealing surface and interposed between the adjacent side faces of the impellers and the relief portion is a flexible end plate forming a pressure recess in said relief portion. An elongated partitioning member or gasket divides the pressure recess into a first portion adjacent the inlet side of the chamber and a second portion adjacent the outlet side. Means are provided to communicate the inlet and outlet portions of the pressure recess with their adjacent sides of the chamber for loading the end plate into engagement with the side faces of the impellers by means of pump generated fluid pressure. The ends of the partitioning member are received respectively in spaced grooves formed in the sealing surface and opening to the end plate for providing a good sealing relation therebetween to minimize or eliminate leakage of fluid past the partitioning member from the second to the first portion of the pressure recess.

It is, therefore, an object of the invention to provide, in a pump of the pressure-loaded end plate type with a pressure recess behind the end plate to load the end plate with pump generated fluid pressure, improved partitioning means in the pressure recess to divide portions thereof to attain better balanced loading of the end plate.

Another object of the invention is to provide an improved pressure loading arrangement for a flexible end plate of a pressure loaded gear pump.

Yet another object of the invention is to provide a positive displacement fluid pump comprising a plurality of shaft mounted rotary members and a "floating" pressure loaded end plate for the rotary members with an improved arrangement for isolating various motive surfaces of the end plate to provide increased independency of deflection or movement of such surfaces and to increase the efficiency of 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 sheets of drawings in which a preferred structural embodiment of a pump incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is a cross-sectional view of a gear pump incorporating the principles of the present invention;

FIGURE 2 is an elevational end view of the pump cover section taken substantially along lines II—II of FIGURE 1;

FIGURE 3 is a sectional view of the pump cover taken along lines III—III of FIGURE 2 and including a fragmentary portion of the pump casing in section;

FIGURE 4 is a fragmentary sectional view of an interior wall of the pump cover taken along lines IV—IV of FIGURE 2;

FIGURE 5 is a plan view of a flexible wear plate of the invention; and

FIGURE 6 is an enlarged fragmentary cross-sectional

view of an end portion of a partitioning member taken along lines VI—VI of FIGURE 2.

As shown in the drawings:

The pump of the present invention is indicated generally at reference numeral **10** and although the principles of the present invention are of general applicability, the particular form of pump herein described is a gear pump which inclues a casing having a center body member **11** closed at one side by a closure plate **12** and closed at the opposite side by a cover member **13**, suitable alignment studs **14** and fastener members **16** being provided for aligning the casing components and for holding them together in firm assembly.

The center body member **11** is provided with a generally ovoid-shaped pumping chamber or cavity indicated generally at **17** bounded by an outer wall **18**. Opposite sides of the chamber **17** form an inlet side **19** and an outlet side **20**, and it will be appreciated that suitable side ports as well as conduits or passageways are provided within the other parts of the pump casing for communicating the inlet and outlet sides of the pumping chamber **17** with the plumbing system of a hydraulic circuit.

A pair of similar gears is rotatably meshed within the pumping chamber **17** and as illustrated in FIGURE 1 in connection with the details of the driver gear, there is provided a gear hub **21** press-fit on a shaft including a first shaft extension **22** and a second shaft extension **23** extending from opposite side faces of the gear hub **21**, the side faces being identified respectively at **24** and **26**. The shaft extension **23** has a coupling portion **27** adapted to be connected to a suitable prime mover for rotatably driving the pump.

In the closure plate **12** there is provided a bore **28** to receive in press-fit relation a bearing sleeve **29** in order to provide a journal for the shaft extension **22**.

The closure plate **12** is also provided with a flat surface or wall **30** extending perpendicularly to the axis of the driver gear shaft and forming a side wall to the pumping chamber **17** as well as providing a thrust and sealing surface for the side face **24** of the gear.

In order to provide a bearing surface for the shaft extension **23**, the pump cover **13** is also provided with a bore **31** into which is press fit a bearing sleeve **32**. A sealing device **33** is mounted in the cover member **13** to effect a seal with the shaft extension **23**.

A driven gear **34** mounted on a shaft **36** meshes with the driver gear **21** to provide the fluid displacement or pumping action and it will be understood that the gear **34** and shaft **36** are mounted within the pump casing similarly in the manner of gear **21**.

The cover member **13** has formed thereon a wall surface **37** which extends transversely or radially to the gear shafts and parallel to the gear side faces **26** to provide an interior wall for the pumping chamber **17**.

The gear pump illustrated in the drawings generates a pumping action when the meshed gears rotate by receiving fluid between the gear teeth as the teeth of the two gears separate or disengage at the inlet side of the pumping chamber and by expelling such fluid from between the teeth as the teeth begin to mesh or engage on the discharge side of the pumping chamber. Since the fluid-filled spaces between the gear teeth are not completely isolated from adjacent spaces a fluid pressure within the spaces increases continuously as the gear teeth and the spaces therebetween are rotated from the inlet to the outlet side of the pumping chamber.

This variation in fluid pressure around the circumference of the gears makes it desirable to seal the side faces of the gears with sealing forces which vary around the circumference of the gears in accordance with the

circumferential variation in fluid pressures generated by the gears.

In addition, during operation of the gear pumps the gears will expand somewhat due to temperature rise and it is desirable that provision be made to allow for expansion in the width of the gears while providing simultaneously the requisite sealing effect on the side faces of the gears.

In accordance with the principles of the present invention, a thin, flexible wear or end plate **38** is interposed between side faces **26** of the gears **21** and **34** and the interior wall **37** of the cover member **13**.

The wear plate **38** operates to effectively acmodate expansion of the gears while providing a seal for the side faces of the gears. In order to receive the shafts **23** and **36**, the end plate **38** is provided with circular apertures **25**, and in order to receive the alignment studs **14** and the fastener members **16**, the plate is provided with apertures as at **35**. A pair of trapping reliefs **35** and **35***a* may be formed in the end plate adjacent the area at which the gears **21** and **34** come together in meshing relation.

Further in accordance with the invention, the interior wall **37** against which one side of the wear plate **38** abuts has formed therein a slightly undercut generally ovoid-shaped relief portion or recess **39** which is centrally positioned with respect to and which completely surrounds the gear shafts **23** and **36** as viewed in FIGURE 2. The recess **39** is bounded by a side wall **40** having a pair of spaced parallel side portions **41** and **42** connected at opposite ends thereof by semi-circular portions **43** and **44**.

That portion of the interior wall **37** surrounding the relief portion **39** forms a sealing surface **46** and has formed therein a circumferentially continuous loop forming a fluid collection trough or channel **47** which extends inwardly of the outer margin around the interior wall **37** in registry with a similar channel **48** formed in a facing wall **49** of the center body member **11**.

The inlet side of the relief portion **39**, that is, that portion thereof which lies adjacent the inlet side **19** of the pumping chamber **17**, is separated from the discharge side of the undercut portion by means of a partitioning or gasketing member **50**, which may be formed of material such as nylon or the like, and which is interposed between the wear plate **38** and the relief portion **39**. It will be noted that the gasket member **50** divides the relief portion **39** such that the gasket **50** is generally symmetrical about a plane transverse to the plane within which the axes of shafts **23** and **36** lie and situated intermediate the two shafts. The gasket **50** is generally arcuately shaped and comprises a pair of end portions **51** and **52** which terminate in grooves as at **53** formed in the sealing surface **46**, from which the gasket member **50** extends in a pair of straight leg portions **54** and **56** on opposite sides of the shafts **23** and **36** and at right angles to a line drawn between the axes of the shafts, and then extends concentrically around portions of the shafts in central portions as at **57** and **58** which join in a reversely curved middle portion **59**.

The cross-sectional configuration of the gasket member **50** is generally circular and that portion thereof that extends into the relief portion **39** in FIGURE 2 is received in a groove **60** which is deeper than the groove **53** formed in the raised surface **46** and which is also deeper than the cross-sectional dimension of the gasket **50**.

Another groove **61** is formed in the relief portion **39** and is substantially as deep as and is in open communication with the groove **60**.

As illustrated best in FIGURES 3 and 4, an aperture or fluid passageway **62** is formed in the flexible wear plate **38** in registry with the groove **61** on the discharge side of the pump. During operation, high pressure fluid in the discharge side of the pumping chamber **17** flows through aperture **62**. Such fluid is under a pressure substantially

equal to the discharge pressure of the pump and fills the space between the relief portion **39** and a back or motive surface **63** of the wear plate **38** on the discharge side of the gasket member **50**.

In order to prevent leakage of high pressure fluid from the discharge to the suction or inlet side of the relief portion **39**, the gasket member **50** is initially subjected to a constant bias against the adjoining surface of the wear plate **38** by means of a generally circularly-shaped resilient biasing member constituted of rubber or the like as indicated at reference numeral **64** housed within the deep groove **60** under the gasket member **50**. The free-state cross-sectional dimension of the biasing member is such that, when added to the cross-sectional dimension or thickness of the gasket **50**, the total thickness of the two is greater than the depth of the groove **60** and the depth of the relief portion **39**.

When fluid at pump generated pressure is introduced into the groove **60**, the gasket member **50** is pressure loaded into abutting engagement with the motive surface **63** of the wear plate **38**.

To further enhance the improved balance loading it is further contemplated in accordance with the present invention to communicate areas of the wear plate **38** adjacent the inlet side **19** of the pumping chamber **17** to inlet pressures. For this purpose, another gasketing or sealing member **66** which, in the illustrated embodiment, constitutes an O-ring, is housed in an annular groove **67** formed in the interior wall **37** of the cover member **13** and extending in part in the relief portion **39** and in the sealing surface **46**, respectively. An aperture or fluid passageway **68** is formed in the wear plate **38** to communicate inlet pressure inwardly of the O-ring **66**.

Spaced from the O-ring **66** circumferentially with respect to the gears **21** and **34** are a pair of disc-shaped cavities **69** and **70** formed in the interior wall **37** partly in register with the undercut portion **39** and partly in register with the raised portion **46**. Housed respectively within the cavities **69** and **70** are a pair of biasing members as at **71** which, in the illustrated embodiment, constitute O-rings made of rubber or the like material having an overall diameter substantially equal to the diameter of the cavities and having a cross-sectional thickness less than the depth of the cavities.

Also housed in the cavities **69** and **70** in overlying relation with respect to the O-rings **71** are a pair of annularly shaped discs or buttons as at **72**, each having an aperture **73** formed therein centrally thereof and in registry with an aperture **74** formed in the wear plate **38**.

During operation of the pump the discs **72**, which are constantly biased by means of the O-rings **71** into engagement with the motive surface **63** of the wear plate **38**, are biased additionally as a result of fluid pressure in the cavities **69** and **70** corresponding with fluid pressures in the pumping chamber **17** adjacent the apertures **74**. The remaining portion of the recess **39** on the inlet side of the gasket member **50** outside of the ring **66** and the cavities **69** and **70** is under a pressure somewhere intermediate inlet and outlet pressure.

Depending on such factors as, for example, fluid viscosity and discharge pressure, a minimal amount of fluid may leak past the sealing surface **46** of the interior wall **37** and into the collection channel **47**. Means are provided such as cored passageways in the casing for communicating fluid from the collection channel **47** back to the inlet side of the pump.

In addition, a fluid return chamber **76** is provided in the pump cover member **13** and communicates the bores which receive the shafts **23** and **36** with the suction side of the pumping chamber **17** through a fluid passageway **77** formed in the cover member **13** and the aperture **68** provided in the wear plate **38**.

Although minor 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 gear pump comprising,
a housing having a pumping chamber including an inlet and an outlet,
rotary gears for pumping fluid from the inlet to the outlet,
said casing having a wall on one side of said chamber opposite the adjoining side faces of the gears characterized by a relief recess opposite said pumping chamber and a sealing surface outwardly of said relief recess,
an end plate interposed between said gears and said wall having a sealing face on one side thereof for engaging the side faces of the gears and a motive face on the other side thereof to form a wall of said relief recess,
said end plate having at least one opening opposite the outlet side of the pump for conducting fluid at pump generated pressure into said relief recess, and
an elongated sealing member having its opposite ends clamped between said sealing surface and said motive face at spaced apart points on the inlet side of the pump and having an intermediate section curved through said relief recess on the outlet side of the pump,
thereby to partition the relief recess into a pressure control zone communicating with said opening to load a corresponding area of said motive face with discharge pressure, and
a reduced pressure zone on the inlet side of the pump.

2. A gear pump as defined in claim 1, wherein said wall has a groove formed therein receiving, positioning and retaining said sealing member.

3. A gear pump as defined in claim 2, and including a resilient gasket in the bottom of said groove and generally coextensive in length therewith to form a continuous biasing means for initially biasing said sealing member against said end plate.

4. A gear pump as defined in claim 3, and including means in said housing for conducting fluid at pump generated pressure into the bottom of said groove to pressure load said sealing member after the pump is in operation.

5. The gear pump as defined in claim 1, wherein said sealing area has a trough-shaped groove formed therein outwardly of said relief recess and communicating with the pump inlet to return any leakage fluid to the pump inlet.

6. A gear pump as defined in claim 1, and including a generally circular sealing means including an O-ring sealing member and a groove for receiving same on the inlet side of the pump to form an isolated zone behind said end plate, and means communicating said isolated zone to the pump inlet, thereby to assist in balancing the forces on said end plate.

7. A gear pump as defined in claim 2, wherein said groove formed in said wall has shallow end portions in said sealing surface of less depth than thickness of said sealing member to ensure a good sealing relationship.

8. In a pump,
a housing having means including an interior wall forming a chamber,
rotary fluid impellers in said chamber having axes extending transversely to said interior wall for pumping fluid from an inlet, low-pressure side of said chamber to an outlet, high-pressure side,
means in said interior wall forming a recessed relief surface around said impeller axes and forming a sealing surface around the periphery of said relief surface,
a thin flexible end plate interposed between said interior wall and said impellers and having one side thereof providing a wear surface for adjoining side faces of said impellers and having an opposite side thereof covering said relief surface and extending over said sealing surface of said interior wall to form a pressure recess between said relief surface and said opposite side,
means clamping said end plate into engagement with said sealing surface,
seal means in said recess to partition said recess into first and second portions adjacent, respectively, said low and said high pressure sides of said chamber, and
fluid passageway means communicating, respectively, said first and said second portions of said recess with said low and said high pressure sides of said chamber to pressurize said recess portions and to urge adjacent portions of said end plate into engagement with the adjoining faces of said impellers in accordance with the pressures in said low and said high pressure sides of said chamber.

9. In a pump,
a housing having means including an interior wall forming a chamber,
rotary fluid impellers in said chamber having axes extending transversely to said interior wall for pumping fluid from an inlet,
low-pressure side of said chamber to an outlet, high-pressure side,
means in said interior wall forming a recessed relief surface around said impeller axes and forming a sealing surface around the periphery of said relief surface,
a pair of spaced grooves formed in said sealing surface,
a thin flexible end plate interposed between said interior wall and said impellers and having one side thereof providing a wear surface for adjoining side faces of said impellers and having an opposite side thereof covering said relief surface and extending over said sealing surface of said interior wall to form a pressure recess between said relief surface and said opposite side,
means urging said wear plate into engagement with said sealing surface,
seal means including an elongated gasket member in said recess to partition said recess into first and said second portions adjacent, respectively,
said low and said high-pressure sides of said chamber, said gasket member having a pair of end portions extending, respectively, into said grooves in said sealing surface, and
fluid passageway means communicating, respectively, said first and said second portions of said recess with said low and said high pressure sides of said chamber to pressurize said recess portions and to urge adjacent portions of said end plate into engagement with the adjoining faces of said impellers in accordance with the pressure in said low and said high pressure sides of said chamber.

10. In a pump,
a housing having means including an interior wall forming a chamber,
rotary fluid impellers in said chamber having axes extending transversely to said interior wall for pumping fluid from an inlet, low-pressure side of said chamber to an outlet, high-pressure side,
means in said interior wall forming a relief recess surface around said impeller axes and forming a sealing surface around the periphery of said relief surface,
a thin flexible end plate interposed between said interior wall and said impellers and having one side thereof providing a wear surface for adjoining side faces of said impellers and having an opposite side thereof comprising a central motive surface covering said relief surface of said interior wall to form a pressure

recess and having a peripheral portion extending over said sealing surface of said interior wall,
a pair of spaced grooves of a given depth formed in said sealing surface and opening toward said wear plate,
means clamping said peripheral portion of said end plate into sealing engagement with said sealing surface of said interior wall,
seal means including an elongated gasket member in said pressure recess to partition said recess into first and second portions adjacent, respectively,
said low and said high-pressure sides of said chamber,
said gasket member having a pair of end portions extending, respectively, into said grooves in said sealing surface and having a depth greater than said given depth to abut said end plate, and
fluid passageway means communicating, respectively, said first and said second portions of said pressure recess with said low and said high pressure sides of said chamber to pressurize said recess portions and to urge corresponding portions of said end plate into engagement with the adjoining faces of said impellers in accordance with the pressure in said low and said high-pressure sides of said chamber.

11. In a pump,
a housing having means including a substantially planar interior wall forming a chamber,
a pair of rotary impellers in said chamber for pumping fluid from an inlet side of said chamber to an outlet side,
means in said interior wall forming a relief recess surface extending from said inlet to said outlet side of said chamber and a sealing surface around said relief surface,
a thin flexible end plate interposed between said interior wall and said impellers and covering said relief surface and extending over said sealing surface to form a pressure recess between said relief surface and said end plate,
means clamping said wear plate into engagement with said raised portion,
means partitioning said pressure recess into first and second portions adjacent, respectively, said inlet and said outlet sides of said chamber,
a pair of disc-shaped cavities formed in said interior wall on the inlet side of said partitioning means, a pair of centrally apertured buttons disposed, respectively, in said cavities,
an O-ring in each of said cavities having an outer diameter substantially equal to the diameter of its respective cavity and biasing its respective button against said end plate, and
means forming apertures in said end plate communicating, respectively, said inlet side of said chamber with said disc-shaped cavities and said outlet side of said chamber with said second portion of said pressure recess.

12. In a pump,
a housing having means including a flat interior wall forming a pumping chamber,
a pair of rotatable shafts situated in spaced parallel relation and projecting outwardly from said interior wall,
the axes of said shafts residing in a first plane extending transversely to said interior wall,
a pair of meshing gears mounted on said shafts for pumping fluid from an inlet, low-pressure side of said chamber to an outlet, high-pressure side of said chamber,
means in said interior wall forming a relief portion surrounding said shafts and having a generally ovoid-shaped outer wall comprising a pair of spaced side portions extending parallel to said first plane and a pair of interfacing arcuately-shaped portions interconnecting the ends of said side portions,

a thin flexible end plate overlying said interior wall to form a pressure recess in said relief portion and abutting adjoining side faces of said gears to provide a wear surface therefor,
an elongated gasket member completely partitioning said pressure recess into first and second portions adjacent, respectively, said low and said high pressure sides of said chamber,
said gasket member being generally symmetrical about a second plane transverse to said first plane and situated intermediate said shafts and comprising,
a pair of straight leg portions extending, on opposite sides of said shafts in the direction of said first plane, from spaced points on said outer wall of said relief portion at right angles to said first plane,
a pair of central portions extending, respectively, around portions of said shafts in concentric and radially spaced relation thereto, and
a backwardly curved middle portion joining said central portions intermediate said shafts, and
fluid passageways formed in said end plate and communicating, respectively, said first and said second portions of said pressure recess with said low and said high sides of said chamber.

13. The pump as defined in claim **12** and including,
a first groove of a given depth formed in said relief portion and shaped complementarily to said gasket member for receiving said gasket member therein,
said gasket member having a depth less than said given depth, and
a second groove formed in said undercut portion and intersecting said first groove,
said second groove extending away from said first groove in said high-pressure side of said chamber and being substantially as deep as said first groove to supply high-pressure fluid to said first groove under said gasket member to urge said gasket member into engagement with said end plate.

14. The claim as defined in claim **13** and including,
a resilient generally cross-sectionally shaped biasing member in said first groove having a free state depth which is such that, when added to the depth of said gasket member, the summation of the two is greater than the summation of the depths of said first groove and said relief portion.

15. In a pump,
a housing having means including an interior wall forming a pumping chamber,
a pair of rotatable shafts situated in spaced parallel relation and projecting outwardly from said interior wall and across said chamber,
the axes of said shafts residing in a plane extending transversely to said interior wall,
a pair of meshing gears mounted on said shafts for pumping fluid from an inlet, low-pressure side of said chamber to an outlet, high-pressure side of said chamber,
means in said interior wall forming a relief portion surrounding said shafts and having a generally ovoid-shaped outer wall comprising a pair of spaced side portions extending parallel to said plane and a pair of interfacing arcuately-shaped portions interconnecting the ends of said side portions,
said means also forming a sealing surface surrounding said relief portion,
a thin flexible end plate overlying said interior wall to form a pressure recess in said relief portion and abutting adjoining side faces of said gears to provide a wear surface therefor,
an elongated gasket member completely partitioning said pressure recess into first and second portions ad-

jacent, respectively, said low and said high pressure sides of said chamber,

said gasket member comprising a pair of straight leg portions extending, respectively, on opposite sides of said shafts in the direction of said plane, from spaced points on said outer wall on one side of said plane and at right angles to said plane, and

a pair of disc-shaped cavities formed in said interior wall along said outer wall on said one side thereof and between and in spaced relation to said spaced points,

said cavities each having a first segment extending into said relief portion and a second segment extending into said sealing surface,

a pair of centrally apertured buttons disposed, respectively, in said cavities,

an O-ring in each of said cavities having an outer diameter substantially equal to the diameter of its respective cavity and biasing its respective button against said end plate, and

means forming apertures in said end plate communicating, respectively, said inlet side of said chamber with said disc-shaped cavities through said central apertures thereof and said outlet side of said chamber with said second portion of said pressure recess.

16. In a pump,

a housing having means including an interior wall forming a chamber,

rotary fluid impellers in said chamber having axes extending transversely to said interior wall for pumping fluid from an inlet, low-pressure side of said chamber to an outlet, high-pressure side,

means in said interior wall forming a relief portion around said impeller axes and forming a sealing surface around the periphery of said relief portion,

a thin flexible end plate interposed between said interior wall and said impellers and having one side thereof providing a wear surface for adjoining side faces of said impellers and having an opposite side thereof covering said relief portion and extending over said sealing surface to form a pressure recess between said relief portion and said opposite side, means urging said end plate into sealing engagement with said sealing portion,

partitioning means in said recess to partition said recess into first and second portions adjacent, respectively, said low and said high-pressure sides of said chamber,

fluid passageway means communicating, respectively, said first and said second portions of said recess with said low and said high-pressure sides of said chamber, and

a fluid collection trough formed in said interior wall around said sealing surface for collecting fluid which leaks past said sealing surface and said end plate.

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