Dec. 17, 1957 J. F. MURRAY 2,816,512

PRESSURE LOADED GEAR PUMP

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Fig 1

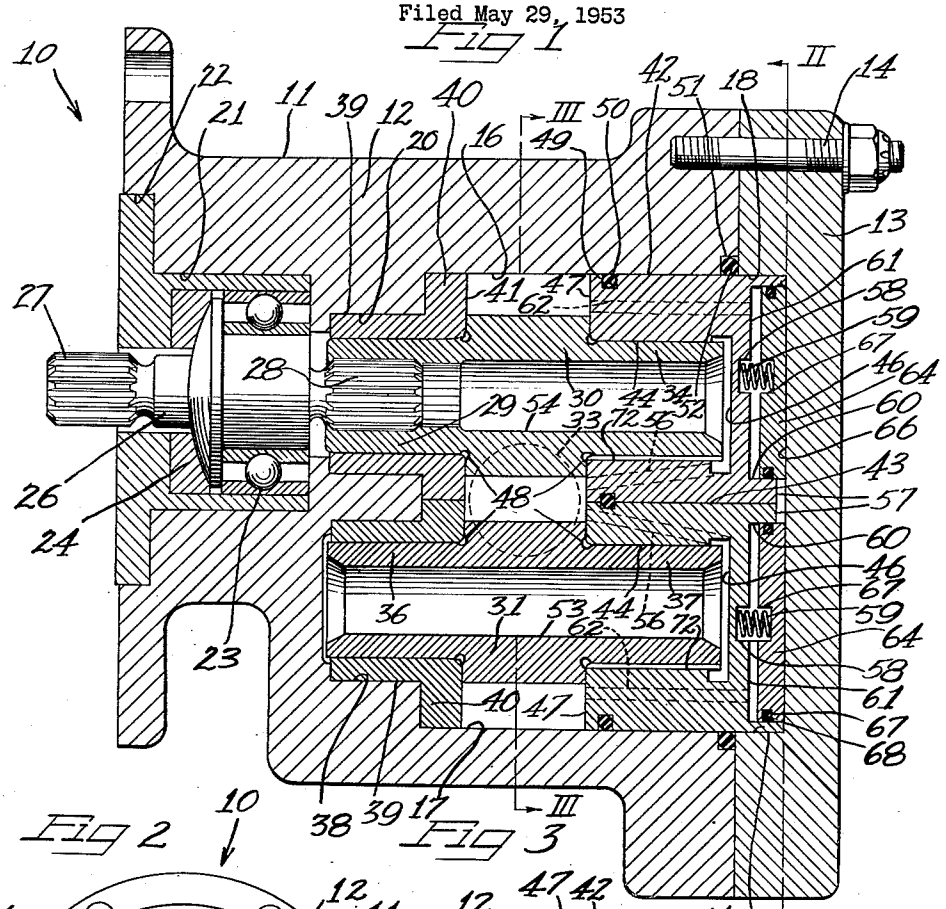


Fig 2

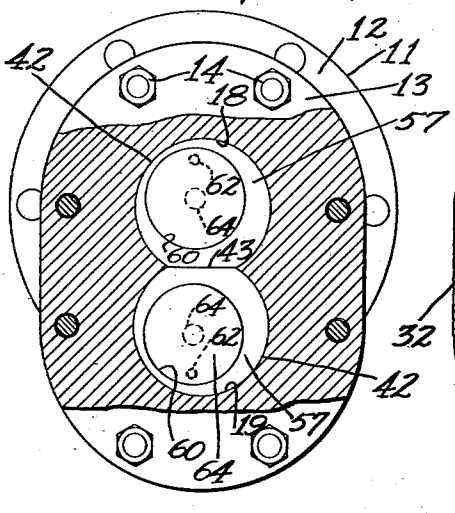


Fig 3

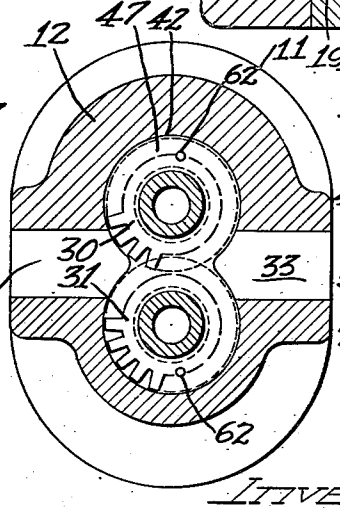
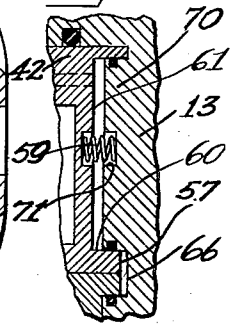


Fig 4



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PRESSURE LOADED GEAR PUMP

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This invention relates particularly to a pressure loaded gear pump wherein an axially movable pressure loadable end plate adapted to sealingly engage an adjacent side face of a rotary fluid displacement member has a motive surface providing a plane area subject to liquid pressure generated by the pump which is offset relative to the motive surface to locate the center of pressure of the plane area in coaxial alignment with the centroid of the separating forces acting on the end plate in an opposite direction thereby to balance the unequal pressure forces normally acting on the end plate.

In gear pump constructions, a pair of rotary intermeshing gears are enclosed by a closely fitting housing which locates an inlet and an outlet at oppositely disposed points of the meshed portions of the gears. Fluid pressures are developed around the periphery of the gears and vary from a minimum at points adjacent the pump inlet to a maximum at points adjacent the pump outlet or pump discharge. There is, therefore, a non-uniform distribution of pressure forces acting on any axially movable pressure loadable end plate provided to sealingly engage the adjacent side faces of the rotary meshing gears tending to separate the end plates from the gears.

In order to counteract such separating forces, pumps have been provided wherein a motive surface is provided on the end plate which is subject to fluid pressure generated by the pump. It will be evident, however, that in accordance with the principles of physics, liquid pressure is exerted with equal intensity in all directions and, accordingly, any motive surface subjected to a fluid pressure will be subjected to a pressure force which is uniformly distributed over the entire motive surface. By virtue of such uniform distribution, the counterbalancing forces will tend to be greater on the inlet side of the pump and the separating forces will tend to be more effective towards the outlet side of the pump thereby producing a twisting tendency on the end plate seriously interfering with the proper operation of the pump.

In accordance with the principles of the present invention, improved means are provided to neutralize and balance the separating force and also to prevent any twisting tendency on the end plates due to the non-uniform separating force. In its broadest aspect, the present invention contemplates the provision of a motive surface on the end plate having a plane area subject to liquid pressure generated by the pump, which plane area is offset relative to the motive surface to locate the center of pressure of the plane area in coaxial alignment with the centroid of the separating forces acting on the end plate in an opposite direction, thereby to balance the unequal pressures acting on the end plate.

It is an object of the present invention, therefore, to provide a pressure loaded gear pump wherein an axially movable pressure loadable end plate is utilized and wherein means are provided to neutralize and balance the separating forces acting thereon.

It is a further object of the present invention to minimize twisting tendencies on pressure loadable axially movable end plate means provided in a pressure loaded gear pump.

Another object of the present invention is to provide a motive surface on a pressure loadable axially movable gear pump end plate having a plane area subject to liquid pressure generated by the pump and offset relative to the motive surface to locate the center of pressure of the plane area in coaxial alignment with the centroid of the separating forces acting on the end plate in an opposite direction.

A further object of the present invention is to provide improved sealing means for a pressure loaded gear pump, thereby to increase the volumetric efficiency.

Yet another object of the present invention is to provide a pressure loaded gear pump of increased pressure capacity.

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 drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

Figure 1 is a cross-sectional view with parts shown in elevation of a pressure loaded gear pump incorporating the principles of the present invention;

Figure 2 is a reduced cross-sectional view taken substantially on line II—II of Figure 1;

Figure 3 is a reduced cross-sectional view taken substantially on line III—III of Figure 1; and

Figure 4 is a fragmentary cross-sectional view showing an alternative structural embodiment of the pump structure provided in Figure 1.

As shown on the drawings:

The pump of the present invention is shown generally at **10** and comprises a casing **11** including a housing member **12** and a cover **13** retained in firm assembly with one another by means of a plurality of fasteners indicated generally at **14**.

The housing member **12** and the cover member **13** are provided with registering intersecting bores, the housing member **12** including intersecting bores **16** and **17**, respectively, and the cover member including intersecting bores **18** and **19**, respectively, all of which cooperating to form a pumping cavity in which the other components of the pump **10** are received.

Toward one end of the housing member **12**, the bore **16** opens into a reduced bore **20**. A somewhat larger bore **21** counterbored as at **22** opens out of the end of the housing member **12** and receives a bearing assembly indicated generally at **23** and a shaft sealing unit indicated generally at **24**. A stub shaft **26** is splined as at **27** to effect a driving connection with a power source and is journalled for rotation in the bearing assembly **23**, an additional spline connection being indicated at **28** to effect driving engagement with a shaft extension **29** provided on one side of a driver gear **30** rotatable in the bore **16**.

A driven gear **31** meshes with the driver gear **30** and is rotatable in the bore **17**.

As is clearly shown in Figure 3, the housing member **12** of the casing **11** is suitably recessed to provide an inlet **32** and an outlet **33** at oppositely disposed points of the meshed portions of the gears **30** and **31**.

In addition to the shaft extension **29** extending from one side of the driver gear **30**, a shaft extension **34** is provided on the opposite side of the driver gear **30** and the driven gear **31** is also provided with oppositely extending shaft extensions identified by the reference characters **36** and **37**, respectively.

A reduced bore **38** similar to the bore **20** is provided at the end of the bore **17** and a fixed bushing member **39** is located in each respective bore **20** and **38** to provide a journal bearing surface for the shaft extensions **29** and **36** on the driver gear **30** and the driven gear **31**, respectively.

Each of the fixed bushings **39** is provided with a radially extending flange portion indicated at **40** and providing a radially extending sealing face **41** for engaging an adjacent side face of a corresponding gear **30** or **31**.

An axially movable pressure loadable bushing **42** is provided on the other side of each respective gear member **30** and **31**. Each bushing **42** is received for sliding movement in a corresponding pair of adjacent bores **16** and **18** or **17** and **19**. Because the casing bores intersect, each bushing is provilded with a flat chordal section on the outside diameter thereof, thereby to provide a mating joint indicated by the common reference numeral **43** in Figure 2 and in Figure 1.

Each bushing has a radially extending front face which is particularly characterized by a bearing bore or recess **44** receiving and providing a journal bearing surface for a corresponding shaft extension **34** or **37**.

The recess **44** terminates at a bottom plane area indicated at **46** which is spaced from the end of each respective shaft extension **34** or **37** in order to afford limited axial movement of each respective bushing **42**.

Radially outwardly of the recess **44** is provided a generally annular plane area forming a front sealing face **47** which engages an adjacent side face of the respective gear members **30** and **31**.

It may be noted that each of the gear members **30** and **31** is provided with conventional annular machining reliefs identified by the reference character **48** which are provided to minimize galling, seizure and binding between the relatively rotatable components of the pump **10**.

An annular peripheral groove **49** formed in a peripheral surface of the bushings **42** and extending through the mating joint **43** receives a seal member **50** adapted to engage the walls of the bores **16** and **17** in the housing member **12**, thereby effecting a sealing joint between the bushings **42** and the housing member **12** while permitting relative axial movement.

The housing member **12** is also recessed as at **51** to receive a seal member **52** for effecting a sealing joint between the cover member **13**, the housing member **12** and the bushings **42**.

A passage **53** extends through the driven gear **31** and a passage **54** extends through the driver gear **30**, thereby intercommunicating the recesses **44** in the respective bushings **42** and other portions of the pump structure. The recesses **44** communicate with a zone of low pressure, for example, a passageway **56** is provided to communicate the recess **44** with the inlet side of the pump, thereby minimizing dashpot action which would interfere with the axial adjustment movement of the bushing **42** and eliminating high pressure pockets in the pump casing **11**.

In order to load the bushings **42** axially to move the bushings **42** into sealing relation with the gears **30** and **31**, a radially extending back face **57** is provided which forms a motive surface for the bushing **42**. Continuous biasing means are provided between the cover member **13** and the motive surface provided by the back face **57** in order to exert a continuous biasing force on the bushing **42** tending to maintain the bushing **42** in sealing relation.

In the embodiment of the invention shown in Figures 1 and 2, a bore **58** receives one end of the coil spring **59**. Each bushing is additionally provided with a counterbore **60** which provides a radially extending plane area **61** which is adapted to be subjected to fluid pressure generated in the pump **10**.

It will be appreciated that since the inlet **32** and the outlet **33** are located at oppositely disposed points of the meshed portions of the gears **30** and **31**, liquid pressures

will be developed around the periphery of the gears **30** and **31** which vary from a minimum at the inlet **32** to a maximum at the outlet **33**. There is, therefore, a non-uniform distribution of pressure tending to act on the sealing face **47** to separate the bushing **42** from the corresponding gear **30** or **31**.

In order to neutralize and balance this separating force and also in order to prevent any twisting tendency on the end plate or bushing **42** due to the non-uniform separating force, an equal and opposite force should be applied to the bushing **42** at the centroid of the separating force.

In accordance with the principles of the present invention, the counterbore **60** is formed in the back face **57** so as to be laterally offset with respect to the motive surface provided by the back face **57**. As shown in Figure 2, the counterbore **60** is offset towards the outlet side of the pump.

The recess or counterbore **60** in each bushing **42** is referenced to fluid pressure generated by the pump by means of a passageway **62** which extends through each bushing **42** and communicates fluid moved by the gears **30** and **31** adjacent the discharge or outlet **33**.

In order to confine the fluid pressure in the recess or counterbore **60** to act on the plane area **61**, the form of the invention shown in Figures 1–3 utilizes a piston member **64** having one end received in the recess or counterbore **60** and having its other end bottomed against an adjoining radially extending wall **66** provided by the cover member **13**. A bore **67** is provided in each piston member **64** to bottom the other end of each respective coil spring **59** so that a continuous biasing force will be exerted between the piston **64** and the corresponding bushing **42** to axially load the bushing **42** into sealing relation with the corresponding gear **30** or **31**.

When fluid pressure generated by the pump is communicated to the recess or counterbore **60**, it will be appreciated that the piston members **64** will be forced by high pressure against the fixed end of the pump casing **11** provided by the cover member **13** and an equal and opposite pressure will be evenly distributed over the plane area **61** at the bottom of the recess or counterbore **60**.

Each piston member **64** is provided with an annular groove **67** which seats a sealing member **68** engaging the side walls of the recess or counterbore **60**. A sealing member **69** is is also provided between the back face **57** of each bushing **42** and the radial wall **66** of the cover member **13** to engage the peripheral surface of each respective piston member **64**.

Because of the offset relation of the recess or counterbore **60** with respect to the motive surface afforded by the back face **57**, the plane area **61** subject to the liquid pressure generated by the pump will have a center of pressure which is displaced so as to be coaxial with the resultant center of pressure acting on the face **47** of the bushing. In other words, the center of pressure of the plane area **61** on each respective bushing **42** will be offset towards the outlet side of the pump.

By locating the center of pressure of the plane area **61** in coaxial alignment with the centroid of the separating forces acting on the bushing **42**, the unequal pressure forces acting on the bushing **42** will be balanced. Moreover, any tendency of the bushing **42** to twist in the housing member **12** and in the cover member **13** will be minimized and, accordingly, localized loading will also be minimized.

The embodiment of Figure 4 is identical in all respects with the embodiment of Figure 1, however, the function of the separate piston member **64** is developed by an integral boss **70** extending from the radial wall **66** of the cover member **13**, which boss **70** is shaped complementary to each respective recess or counterbore **60** in an adjoining back face **57** of a corresponding bushing **42**. The boss **70** is provided with a bore **71** seating the opposite end of the coil spring **59**.

In order to provide adequate lubrication for the journal

surface between each bushing 42 and a shaft extension 34 or 37, an axial groove indicated at 72 is machined the full length of the bearing bore and extends between the bottom plane area 46 of the recess 44 and a corresponding side face of each respective gear member 30 and 31.

Although various 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. In a fluid pump, a housing having an inlet and an outlet and having a pumping cavity formed therein, pumping means in said cavity to move fluid from said inlet to said outlet, whereby unequal pressure forces in the cavity vary from the inlet side to the outlet side and a backing plate forming a sealing face on the front surface thereof for said cavity in said housing, said backing plate having a back surface recessed to provide a plane area at the bottom of the recess adapted to be subject to fluid pressure and having a center of pressure displaced toward the pump outlet, and means confining fluid pressure generated by said pump in said recess to act on said plane area, thereby to balance unequal pressure forces in the cavity, while sealing against an adjoining side face of said pumping means in said cavity.

2. In a fluid pump, a housing having an inlet and an outlet and having a pumping cavity formed therein, pumping means in said cavity to move fluid from said inlet to said outlet, whereby unequal pressure forces in the cavity vary from the inlet side to the outlet side and a backing plate forming a sealing face on the front surface thereof for said cavity in said housing, said backing plate having a back surface recessed to provide a plane area at the bottom of the recess adapted to be subject to fluid pressure and having a center of pressure displaced toward the pump outlet, a piston having one end received in said recess and the other end bottomed against said housing, and means communicating fluid pressure generated by said pump to said recess to act on said plane area, thereby to balance unequal pressure forces in the cavity, while sealing against an adjoining side face of said pumping means in said cavity.

3. In a fluid pump, a housing having an inlet and an outlet and having a pumping cavity formed therein, pumping means in said cavity to move fluid from said inlet to said outlet, whereby unequal pressure forces in the cavity vary from the inlet side to the outlet side and a backing plate forming a sealing face on the front surface thereof for said cavity in said housing, said backing plate having a back surface recessed to provide a plane area at the bottom of the recess adapted to be subject to fluid pressure and having a center of pressure displaced toward the pump outlet, said housing having a boss portion extending into said recess to confine fluid pressure therein, and means communicating fluid pressure generated by said pump to said recess to act on said plane area, thereby to balance unequal pressure forces in the cavity, while sealing against an adjoining side face of said pumping means in said cavity.

4. In a fluid pump, a housing having an inlet and an outlet and having a pumping cavity formed therein, pumping means in said cavity to move fluid from said inlet to said outlet, whereby unequal pressure forces in the cavity vary from the inlet side to the outlet side and a backing plate forming a sealing face on the front surface thereof for said cavity in said housing, said backing plate having a back surface recessed to provide a plane area at the bottom of the recess adapted to be subject to fluid pressure and having a center of pressure displaced toward the pump outlet, a piston having one end received in said recess and the other end bottomed against said housing, and means communicating fluid pressure generated by said pump to said recess to act on said plane area, thereby to balance unequal pressure forces in the cavity, and a spring between said piston and said backing plate to continuously bias said backing plate towards the cavity, whereby said backing plate seals against an adjoining side face of said pumping means.

5. In a fluid pump, a housing having an inlet and an outlet and having a pumping cavity formed therein, pumping means in said cavity to move fluid from said inlet to said outlet, whereby unequal pressure forces in the cavity vary from the inlet side to the outlet side and a backing plate forming a sealing face on the front surface thereof for said cavity in said housing, said backing plate having a back surface recessed to provide a plane area at the bottom of the recess adapted to be subject to fluid pressure and having a center of pressure displaced toward the pump outlet, said housing having a boss portion extending into said recess to confine fluid pressure therein, and means communicating fluid pressure generated by said pump to said recess to act on said plane area, thereby to balance unequal pressure forces in the cavity, and a spring between said housing and said backing plate to continuously bias the backing plate towards the cavity, whereby said backing plate seals against an adjoining side face of said pumping means.

6. A fluid pump, comprising a housing having a pair of intersecting bores providing a pumping cavity, a pair of rotary intermeshing gears in said cavity, each gear having shaft portions extending axially of each respective bore, a movable pressure loadable bushing member in each bore having a recess providing a journal bearing surface for a corresponding shaft portion, a front face on each bushing for sealing an adjacent side face of a corresponding gear, a back face on each bushing spaced from an adjacent wall provided by said housing, and a recess in said back face and forming a plane area at the bottom of the recess subject to fluid pressure generated by the pump and having a center of pressure displaced laterally with respect to the center of said back face to balance unequal pressure forces on the front face and means confining said fluid pressure generated by the pump in said recess.

7. A fluid pump, comprising a housing having a pair of intersecting bores providing a pumping cavity, a pair of rotary intermeshing gears in said cavity each having shaft portions extending axially of each respective bore, a movable pressure loadable bushing member in each bore having a recess providing a journal bearing surface for a corresponding shaft portion, a front face on each bushing for sealing an adjacent side face of a corresponding gear, and a back face on each bushing spaced from an adjacent wall provided by said housing, and a cylinder recess in said back face providing a plane area at the bottom thereof, a piston having one end closing said recess and the other end engaging said adjacent wall of said housing, a spring in said recess bottomed against said bushing and against said piston to continuously bias the piston and the bushing apart, and means communicating fluid pressure generated by the pump to said cylinder recess to act on said plane area for pressure loading said bushing into sealing relation.

8. A fluid pump, comprising a housing having a pair of intersecting bores providing a pumping cavity, a pair of rotary intermeshing gears in said cavity, each gear having shaft portions extending axially of each respective bore, a movable pressure loadable bushing member in each bore having a recess providing a journal bearing surface for a corresponding shaft portion, a front face on each bushing for sealing an adjacent side face of a corresponding gear, and a back face on each bushing spaced from an adjacent wall provided by said housing, a recess in said back face providing a plane area at the bottom thereof, means communicating fluid pressure generated by the pump into the recess, and means extending from said adjacent housing wall into said recess to confine the

fluid pressure in said recess for acting over said plane area, thereby to pressure load said bushing into sealing relation.

9. A fluid pump comprising a rotary pumping member having a shaft and a radially extending fluid displacement means, a bushing having a radially extending front face characterized by a recess receiving and providing a journal bearing surface for said shaft, and a generally annular plane area engaging an adjacent side face of the fluid displacement means, said bushing having a plane area at the bottom of said recess spaced from the end of said shaft to permit axial movement of said bushing on said shaft into a sealing relation at said annular plane area with said side face of the fluid displacement means, said bushing having a back face oppositely disposed from said front face, casing means providing a pumping cavity for the pumping member with an inlet at one side thereof and an outlet at the opposite side thereof, said annular plane area being subject to fluid pressures increasing from the inlet side of the pump to the outlet side of the pump thereby shifting the centroid of separating force laterally of the geometric center of said annular plane area, and means confining fluid pressure generated by the rotary fluid displacement means to a plane area on said back face offset towards the outlet of the pump to provide a center of pressure opposite the centroid of separating force operating on said annular plane area.

10. A fluid pump comprising a rotary pumping member having a shaft and a radially extending fluid displacement means, a bushing having a radially extending front face characterized by a recess receiving and providing a journal bearing surface for said shaft, and a generally annular plane area engaging an adjacent side face of the fluid displacement means, said bushing having a plane area at the bottom of said recess spaced from the end of said shaft to permit axial movement of said bushing on said shaft into a sealing relation at said annular plane area with said adjacent side face of said fluid displacement means, said bushing having a back face oppositely disposed from said front face, casing means providing a pumping cavity for the pumping member with an inlet at one side thereof and an outlet at the opposite side thereof, said annular plane area being subject to fluid pressures increasing from the inlet side of the pump to the outlet side of the pump thereby shifting the centroid of separating force laterally of the geometric center of said annular plane area, a recess in said back face providing a plane area at the bottom of the recess offset towards the outlet side of the pump, means communicating fluid pressure generated by the pump to said recess, and plug means in said recess between said bushing and said casing means confining said fluid pressure in said recess to act on said offset plane area at the centroid of the fluid pressure forces acting on said bushing in an opposite direction.

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