

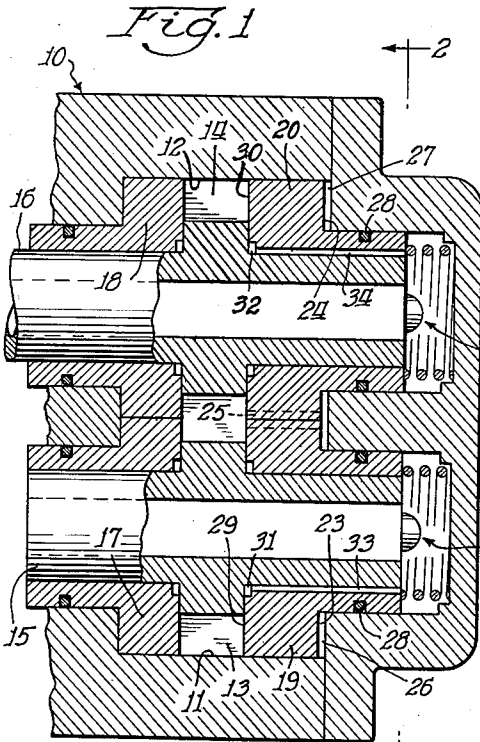
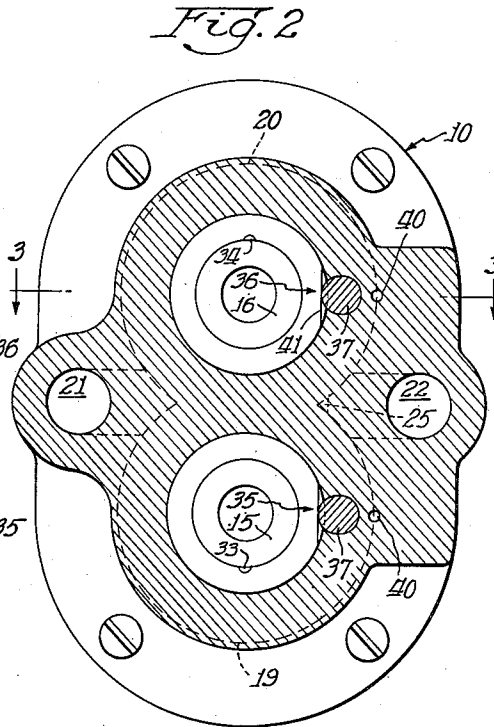
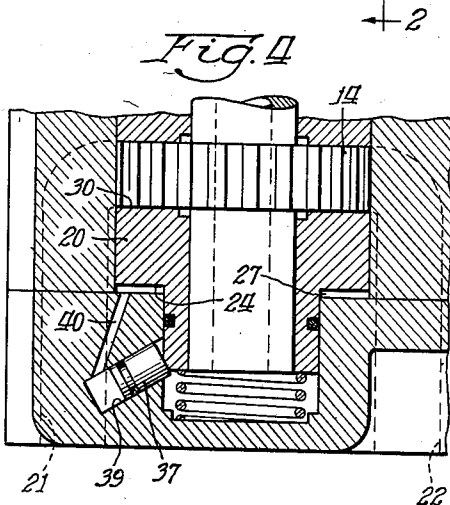
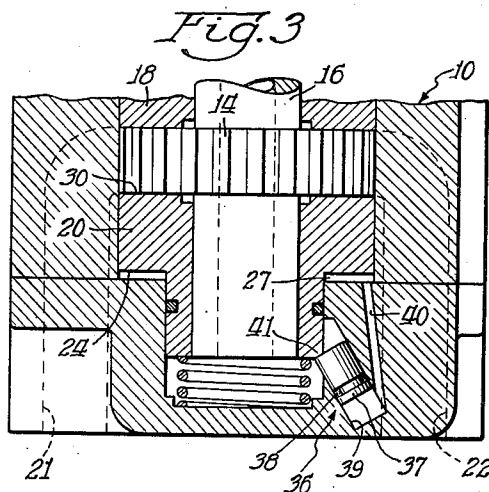
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F. E. NORLIN

2,822,759

PRESSURE LOADED GEAR PUMP

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Inventor:
Francis E. Norlin

By: *Joseph A. Borge*
Att.

1

2,822,759

PRESSURE LOADED GEAR PUMP

Francis E. Norlin, Chesterland, Ohio, assignor to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

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This invention relates to a pressure loaded gear pump and more particularly to an arrangement for insuring proper location for the pressure loadable bushings in a pressure loaded type gear pump.

In a pressure loaded, intermeshing gear pump having one or more sets of axially movable, pressure loadable bushings, a part of the output or discharge pressure of the pump is applied to the rear or motive surface of the axially movable bushings to urge these bushings into sealing engagement with their associated gears. As disclosed in United States Patent No. 2,420,622 to Lauck et al., by carefully selecting the relative areas of the forward surface of the bushings adjacent the gear side faces and the rear or motive surface of the bushings, it is possible to control within very close limits the actual sealing pressure provided. In practice, this requires a somewhat high pressure in the direction of pressure tending to open the seal.

In the usual form of pressure loaded pumps of the type described herein, the pressure loadable rear or motive surface of the bushings to which output pressure is directed will be substantially uniformly subjected to the output of pressure throughout the entire area, that is to say, at any point on the rear or motive surface of the bushings the same pressure will exist. This is not true, however, of the forward or gear side engaging surface of the bushings. The gear side face engaging forward surface is normally subjected to a distinct pressure gradient extending from the inlet pressure in the area adjacent the pump inlet, which is the lowest pressure of the gradient, to the outlet pressure in the area adjacent the discharge side of the pump, which is the highest pressure level in the gradient. Accordingly, it will be evident that while the total pressure forces acting on the motive pressure surface of the bushings may be made to equal the total pressure forces acting on the forward surfaces of the bushings, or to slightly exceed this latter force, the pressure acting on particular areas on the forward surfaces of the bushings will not be uniform and the portion of the forward bushing surface nearer the inlet will be subject to less pressure tending to break the seal than the portion of the forward bushing surface nearer the outlet of the pump. This unbalanced pressure condition tends to twist the pump bushings and results in uneven wear, thereby increasing the power required to turn the pump. Wear is concentrated, of course, on the inlet side of the pump.

It has been found that this unbalanced pressure condition can, to some extent, be reduced by providing balancing grooves on the gear face engaging surface of the pressure loadable bushings, these balancing grooves communicating at one end with the discharge side of the pump and extending circumferentially towards the inlet of the pump but terminating short thereof.

It has been found further that this unbalanced pressure condition can be substantially reduced by providing the pressure loadable bushings with eccentric pressure areas in the back of the bushings which are offset with respect to the concentrically disposed annular areas on the forward surfaces of the bushings so as to compensate in ef-

2

fect for the pressure gradient extending across the forward surfaces of the bushings. This latter embodiment has met with success and the eccentric or offset areas on the motive surfaces of the pressure loadable bushings may be accomplished by offsetting the barrel or tubular portion of the bushings, or by providing the motive surface with sealing means which will prevent discharge pressure from acting over the entire area thereof.

It has also been found that this pressure gradient can be compensated for by providing eccentric offset relief recesses in the forward surface of the bushings with the major portion of the recess being disposed nearer the outlet than the inlet so as to compensate in effect for the existing pressure on the discharge side of the pump.

It has also been found that this pressure gradient can also be compensated for by providing the pressure loadable axially movable bushings with means responsive to fluid pressure generated by the pump during operation thereof to direct the forces attained by this fluid pressure in such a manner that these forces tend to move the associated bushing towards the adjacent gear face at an area adjacent the discharge side of the pump. It is to this latter manner of compensating for this pressure gradient or unbalanced condition that this present invention is directed.

Accordingly, an object of the present invention is to provide a new and improved pressure loaded type intermeshing gear pump wherein pressure loadable bushings are urged towards the adjacent gear side face at an area adjacent the discharge side of the pump during operation thereof so as to compensate for the pressure gradient over the gear side face engaging surface of the bushings.

In accordance with this invention, a pressure loaded type intermeshing gear pump having one set of axially movable pressure loadable bushings may be provided with means for exerting a force so directed during operation of the pump that the bushings are urged axially towards the gear side face in an area adjacent the discharge side of the pump.

In accordance with one embodiment of this invention, the means for exerting forces which urge the bushings axially in an area adjacent the discharge side of the pump comprises a plunger associated with each of the flanged, pressure loadable, axially movable bushings and located so as to engage the terminal or end of the barrel or tubular portion of the bushings at an angle to the axis of the pump, the plunger being motivated by pressure generated by the pump to provide compensation for the aforementioned pressure gradient. In accordance with this embodiment, this plunger or piston may be positioned adjacent the discharge side of the pump directing the greater components or major portion of its force towards the area adjacent the discharge side of the pump.

In accordance with a second embodiment of this invention, a pressure loaded type intermeshing gear pump having one set of flanged, axially movable, pressure loadable bushings may be provided with a piston or plunger associated with each of the pressure loadable, axially movable bushings and located so as to engage the terminal or end of the barrel or tubular portion of the bushings at an angle with respect to the axis of the pump, the plunger being motivated by fluid pressure generated by the pump during operation thereof to provide for compensation of the pressure gradient. This piston or plunger may be located on the inlet side of the pump directing major components or a major portion of its force towards the area adjacent the discharge side of the pump and at an angle to the axis of the bushing.

Accordingly, a further goal of this invention is to provide a new and improved pressure loaded type intermeshing gear pump with pistons or plungers so located with respect to the axially movable, pressure loadable,

3

flanged bushings so as to provide a force, the major portions of which are directed towards the discharge side of the pump to urge the bushing axially towards the area adjacent the discharge side to compensate for the pressure gradient existing on the forward gear side face engaging surface of the bushing.

Other objects, features and advantages of this present invention will be apparent from the following detailed description thereof taken in conjunction with the drawings wherein:

Fig. 1 is a fragmentary, axial, sectional view of a pressure loaded type intermeshing gear pump constructed in accordance with one embodiment of this invention;

Fig. 2 is a transverse sectional view taken substantially along line 2—2 of Fig. 1 and showing to advantage the arrangement of the fluid pressure responsive pistons constructed in accordance with one embodiment of this invention;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 2 and showing to advantage the location of the fluid pressure responsive pistons with respect to the fluid pressure responsive axially movable bushings constructed in accordance with the one embodiment of this invention; and

Fig. 4 is a sectional view of a pressure loaded type intermeshing gear pump similar to the view taken along line 3—3 of Fig. 2, but showing to advantage the location of the fluid pressure responsive pistons with respect to the fluid pressure responsive axially movable bushings constructed in accordance with another embodiment of this invention.

Referring now to the drawings and more particularly to Fig. 1 thereof, a pump generally similar to that shown in the aforementioned Lauck et al. Patent No. 2,420,622 is illustrated comprising a housing indicated in its entirety by numeral 10 having formed therein a pair of parallel intersecting bores or pumping chambers 11 and 12, which are arranged to receive in complementary relationship intermeshing pumping gears 13 and 14, respectively. In the embodiment illustrated in Fig. 1, the pumping gears have integrally formed therewith hollow journal shafts 15 and 16, respectively, the left hand portions of the journal shafts 15 and 16 being journaled in fixed flanged body bushings 17 and 18 mounted in the left portion of the pumping gear chambers 11 and 12. The right hand portions of the gear journals are received in axially movable, pressure loadable, flanged bushings 19 and 20 mounted in the right side of the pumping gear chambers 11 and 12.

In the embodiment illustrated, the upper pumping gear 14 is the driving gear and may be rotated in a clockwise direction, as viewed in Fig. 2, and in accordance with conventional pump design practice the journal shaft 16 of the upper gear 14 may be extended to the left as viewed in Fig. 1 and coupled to a suitable source of power (not shown). Low pressure fluid is introduced into the pump housing at inlet 21 formed on the left side of the pump housing, as viewed in Fig. 2, and high pressure liquid is discharged from the pump housing through outlet 22 formed on the right side of the housing, the inlet and outlet ports communicating with inlet and discharge areas of the intermeshing pumping gears. Pressure loadable, axially movable bushings 19 and 20 are normally fitted in the bores or chambers 11 and 12 with sufficient clearance to provide slight axial movement of the bushings with respect to the bores to establish the desired pressure seal during operation of the pump.

In the operation of a pump of this type, that is, a pump constructed in accordance with the teachings of the aforementioned Lauck et al. Patent No. 2,420,622, discharge pressure generated by the intermeshing gears may be communicated from the outlet or discharge side thereof to the pressure loading areas designated at 23 and 24 in the drawings and located in the back of the flanged portion of the bushings through an axially extending passage 25

4

formed between the peripheries of the flanged portions of the bushings on the discharge side at a point of convergence of the flanged portions and the housing of the pump. The passage 25 extends from the discharge side of the gears, as viewed in Fig. 1, to the inter-communicating portions of the pressure loading chambers 26 and 27 at their point of juncture.

Escape of pressure rearwardly from the pressure loading areas is substantially prevented by means of O-ring seals 28 disposed about the peripheries of the tubular or barrel portions of each bushing in suitable annular grooves formed in the periphery of the bushing or in the adjacent bore wall. Pressure leaking past the O-ring seal may be vented to inlet pressure or to a zone of intermediate pressure according to conventional pressure loading pump practice. As described in the aforementioned Lauck et al. Patent No. 2,420,622, there is provided a refined balance of pressure between the pressure acting on the rear or motive surface areas 23 and 24 and the pressure acting on the forward gear engaging surfaces 29 and 30 of these bushings. Relief recesses 31 and 32 are formed either in the forward surface of the bushings or in the gear side faces, said relief recesses being vented to an area of lower than discharge pressure through an axially extending passage 33 and 34 formed in the bore of the bushings or through a loose fit between the journal of the gear and the bore of the bushing.

In accordance with the present invention, there is associated with each of the pressure loadable, axially movable bushings piston assemblies 35 and 36, respectively, which exert a force tending to move the axially movable, pressure loadable bushings towards the gear side face so that the right side of the bushing flanged portions, as viewed in Fig. 3, that is to say, the flanged portions of the bushings adjacent the discharge side of the pump, engage the sides of the gear side faces so as to compensate for the pressure gradient.

More particularly, the upper piston assembly 36 of this invention, as shown in Fig. 3, comprises a piston member 37 of general cylindrical configuration having its mid portion thereof recessed so as to receive an O-ring seal 38 and which is slidably journaled in a suitably formed angularly extending cylindrical chamber 39 formed in the housing 10. Discharge pressure, in accordance with this invention, may be supplied from the pressure loading chamber 27 of the associated bushings. For this purpose, a short substantially axially extending passage 40, communicating at one end with the loading pressure chamber 27 and at the other end communicating with the passage 39, is provided and located so that piston 37 does not block the passage 40 during operation. Fluid pressure so supplied may, of course, be regulated by selecting the area of the piston exposed to pressure.

In the operation of a gear pump of the type herein described, a pressure gradient exists on the forward gear engaging surface of the bushing adjacent the gear side faces. This pressure gradient extends from a low pressure value corresponding to the inlet pressure of the pump on the inlet side thereof to a high pressure value corresponding to the discharge pressure of the pump in the outlet side thereof. On the other hand, pressure applied to the rear or motive surface of the flanged portion of the bushing is normally substantially uniform over the full extent of the area thereof. It will be apparent, therefore, that since the gear side face pressure acting against the loading pressure adjacent the discharge side of the pump exceeds the gear side pressure acting against the loading pressure in the area adjacent the inlet side of the pump, the axially movable bushings 19 and 20 tend to engage the gear side face in correspondingly greater force adjacent the inlet side. This unbalanced condition results in greater wear and, more particularly, in uneven wear resulting ultimately in accelerated deterioration of the pump.

In accordance with the present invention, this unbalanced pressure condition is compensated for by so locating

5

the pressure responsive piston that the force exerted against the bushings has its greater components or its major portion urging the bushings towards the side of the gear at the area adjacent the discharge side of the pump.

More particularly, it can be seen, particularly in Fig. 3, that the chamber 39 is positioned at an angle with respect to the axis of the pump. The head of the piston 37 engages the rear or terminal edge of the barrel portion of the flanged, axially movable bushing 20 across the corner thereof. This corner may be beveled, as indicated at 41. By carefully selecting the angle between the axis of the chamber 39, and consequently the piston 37, and the axis of the pump, the force of the piston directed against the end or terminal barrel portion of the bushings may be controlled so that either more or less forces, as the case may be, are applied in a direction tending to move the bushing toward the area adjacent the discharge side of the pump.

It is to be noted, furthermore, that the piston 37 is so arranged with respect to the axially movable bushing that the piston engages the terminal end of the barrel portion of the bushing in back of the O-ring seal 28 disposed in a recess in the housing 10 between the pressure loaded motive chamber 27 and the rear of the bushing. Thus, pressure on the side of the piston 37 adjacent the bushing is at a low pressure whereas the opposite end of the piston communicates with high pressure in order to obtain suitable force keeping the bushing urged toward the discharge side of the pump.

The construction of the piston assembly 35 associated with the lower pressure loadable, axially movable bushing 19, as viewed in Fig. 2, is identical with that piston assembly associated with the upper bushing 20.

In the second embodiment of this invention, as illustrated in Fig. 4, the same reference numerals are provided in connection with this embodiment as the embodiment shown in Fig. 3. In this embodiment, however, it is to be noted that the angle of the chamber 39, and likewise the piston 37, is located on the inlet side of the pump and located so that the components or a major portion of the force available by the action of the pressure responsive piston 37 are directed towards the area adjacent the discharge side of the pump.

From the foregoing it will be evident that in a pressure loaded, axially movable pump of the type described herein, the axially movable bushings have associated therewith a piston which is subject to pump discharge pressure which is communicated to the rear of this piston from the pressure loading chamber. The pistons thus supplement the pressure on the rear or motive chambers of the bushings urging the bushings forward towards sealing relationship with the gear side face. This supplemental force compensates for the pressure gradient existing across the gear side face engaging surface of the bushing.

It has been found in practice that in a pump arrangement as disclosed herein, because the pistons operate from a high pressure area towards a zone of intermediate or lower pressure found at the rear or terminal portions of the bushings, that the pressure gradient across the gear side faces is substantially reduced.

Where herein the various parts of the invention have been referred to as being located in the right or left position or in upper or lower position, it will be understood that this is done solely for the purpose of facilitating description, and that such references relate only to the relative positions of the parts as shown in the accompanying drawings.

While only two embodiments of this invention are shown and described, it will be understood that any changes or modifications may be made therein without departing from the spirit or scope of the present invention.

What is claimed is:

1. In a pressure generating pump of the type includ-

6

ing a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said axially movable bushings being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with said axially movable bushings for urging said bushings towards the gears, said means exerting its greatest force adjacent the outlet side of the pump and comprising pistons adjacent an end of each bushing and angularly disposed with respect to the axis of rotation of said intermeshing gears and responsive to fluid pressure.

2. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and being disposed adjacent an end of each bushing and angularly with respect to the axis of rotation of said intermeshing gears and responsive to fluid pressure.

3. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and comprising pistons responsive to fluid pressure disposed adjacent an end of each bushing and angularly with respect to the axis of rotation of said intermeshing gears.

4. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with the barrel portions of said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and being angularly disposed with respect to the axis of rotation of said intermeshing gears and responsive to fluid pressure.

5. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said

bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with the barrel portions of said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and comprising pistons responsive to fluid pressure angularly disposed with respect to the axis of rotation of said intermeshing gears.

6. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated at an angle with the barrel portions of said axially movable bushings for urging said bushings towards the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and comprising pistons responsive to fluid pressure and associated with said barrel portions.

7. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with the barrel portions of said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side

of the pump and comprising pistons responsive to fluid pressure and associated with said barrel portions at an angle with respect to the axis of rotation of said pumping gears.

8. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with the barrel portions of said axially movable bushings for urging said bushings toward the gears to offset said pressure gradient, said means exerting its greatest force adjacent the outlet side of the pump and comprising pistons responsive to fluid pressure located on the outlet side of said pump and associated with said barrel portions at an angle with respect to the axis of rotation of said pumping gears.

9. In a pressure generating pump of the type including a housing containing intermeshing gears and having an inlet leading to and an outlet leading from said housing, axially movable bushings and fixed bushings, each of said bushings having a forward surface engageable with the side face of said gears, said forward surface being subject to a pressure gradient existing between the fluid pressure adjacent the inlet and fluid pressure adjacent the outlet, said axially movable bushings having flanged portions and barrel portions, said flanged portions being subject to discharge pressure to maintain sealing engagement with the gear side faces during operation of the pump, and means associated with said axially movable bushings for urging said bushings towards the gears, said means exerting its greatest force adjacent the outlet side of the pump comprising pistons responsive to fluid pressure located on the inlet side of said pump and associated with the barrel portions at an angle with respect to the axis of rotation of said pumping gears.

References Cited in the file of this patent

UNITED STATES PATENTS

2,641,192	Lindberg	June 9, 1953
2,660,958	Lauck	Dec. 1, 1953
2,691,945	Wichorek	Oct. 19, 1954