Oct. 19, 1954 E. F. WICHOREK 2,691,945

PRESSURE LOADED GEAR PUMP

Filed Aug. 30, 1950

Fig. 1

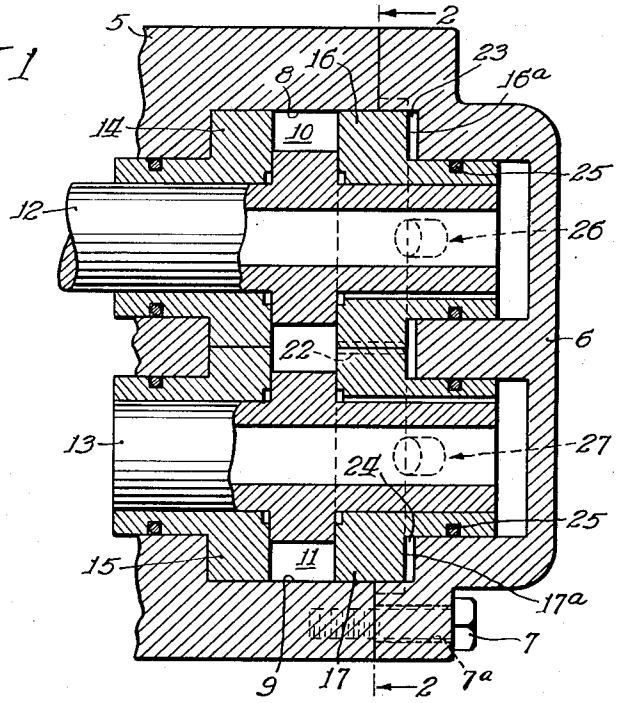


Fig. 2

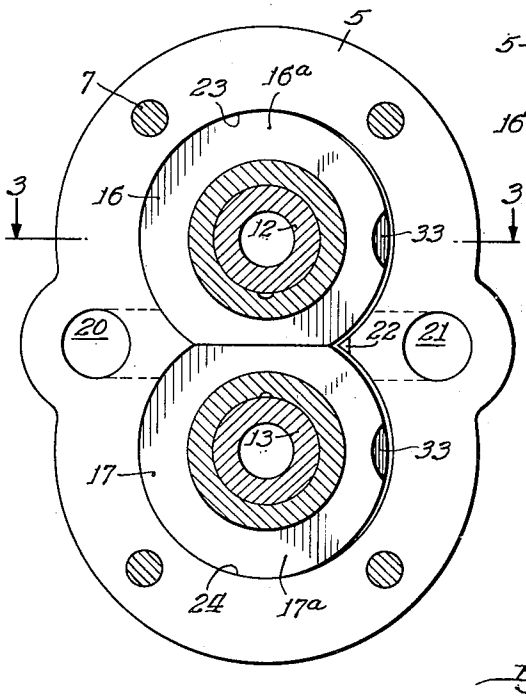
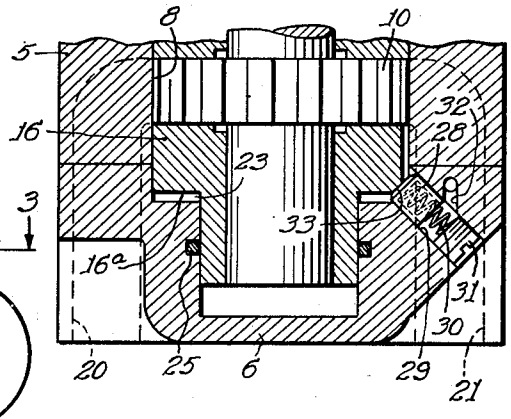


Fig. 3



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Patented Oct. 19, 1954

2,691,945

UNITED STATES PATENT OFFICE

2,691,945

PRESSURE LOADED GEAR PUMP

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Application August 30, 1950, Serial No. 182,254

13 Claims. (Cl. 103—126)

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

In a pressure loaded, intermeshing gear type 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 surfaces of the axially adjustable bushings to urge these bushings into sealing engagement with their associated gears. As disclosed in United States Patent No. 2,420,622 to Roth et al., by carefully selecting the relative areas of the forward surfaces of the bushings and of the motive surfaces of the bushings, it is possible to control within very close limits the actual sealing pressure provided. In practice, this requires a somewhat higher effective pressure in the direction of seal than in the direction tending to open the seal.

Because the pressure loadable bushings must be axially movable, a certain minimum clearance must be provided between the sides of the bushings and the adjacent sides of the chambers or bores in the pump housing in which the bushings are received. In addition, in order to facilitate production of the pump, the cover section of the housing in which the barrel portions of the bushings are received is provided with holes through which the mounting bolts extend which holes are made somewhat larger in diameter than the diameter of the bolts so that the cover section may be readily aligned with the housing. As a result, if the bushings are located adjacent the discharge side of the pump during assembly then the cover section will be located in accordance with the location of the bushings, will be shifted in the direction of the discharge side. Thus when the pump is finally assembled the bushings may be locked in metal to metal contact with the discharge side of the pump chamber. Accordingly, a pump may be assembled in which the clearance of the bushings adjacent the inlet side of the pump is large enough, because of the corresponding reduction in clearance adjacent the discharge side of the pump, due to lateral or transverse shifting of the bushings and cover section of the housing, to provide a substantial leakage path to inlet pressure. This, of course, reduces materially the efficiency of the pump.

Also, in the usual form of pressure loaded pump, the pressure loading motive chamber to which output pressure is supplied will be substantially uniformly subjected to the output pressure; that is to say, at any point on the motive surfaces at the rear of the bushing, the same pressure will exist. This is not true, however, of the forward or gear side face engaging surface of the bushing. This 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, at which area the pressure gradient is at its highest level. Accordingly, it will be evident that while the total pressure forces acting on the motive surfaces of the bushing may be made to equal the total pressure forces acting on the forward surfaces of the bushing, or to exceed these latter forces, the pressures acting on particular areas of the forward surfaces will not be uniform and the portion of the forward bushing surface nearer the inlet will be subjected to a lesser 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 bushing in the pump and results in uneven wear, thereby increasing the power required to turn the pump. Wear is, of course, concentrated on the inlet side of the pump.

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An object of the present invention is to provide a new and improved pressure loaded type, intermeshing gear pump.

A further object of the present invention is to provide a pressure loaded type intermeshing gear pump wherein the pressure loadable bushings are shifted during assembly of the pump toward the inlet side of the pump to reduce leakage in this area during operation of the pump and also during operation of the pump the bushings are urged toward the adjacent gear side face in the area adjacent the discharge side of the pump so as to compensate to some extent 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 that during assembly of the pump the pressure loadable bushings are urged transversely toward the inlet side of the pump and pressed axially toward the gear side face portions adjacent the discharge side of the pump. In accordance with one embodiment of this invention, this means comprises a plunger associated with each of the pressure loadable bush-

ings and located so as to engage the rear flanged surface of the pressure loadable bushings at an acute angle with respect to the axis of the pump, the plunger being moved by spring pressure during assembly of the pump and either by spring pressure alone or spring pressure in combination with fluid pressure generated by the pump during the operation of the pump to provide the compensation for the pressure gradient. The plunger has its axis directed so that one component of the plunger force tends to move the associated bushing toward the inlet side of the pump and the other component of the plunger force tends to move the associated bushing toward the associated gear side face portion adjacent the discharge side of the pump.

Other objects and advantages of the 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 the line 2—2 of Fig. 1 and showing to advantage the arrangement of the spring-pressed plungers; and

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2 showing the location of the spring-pressed pistons.

Referring now to the drawings and particularly to Fig. 1 thereof, a pump generally similar to that shown in the aforementioned Roth et al. patent is illustrated comprising a sectional housing having a main body portion 5 and a right closure member or cover member 6. These sections are normally bolted together as by the bolts 7 and cooperate to define therewithin a pair of parallel axis, intersecting bores or pumping gear chambers 8 and 9 which are arranged to receive in complementary relationship intermeshing pumping gears 10 and 11, respectively. More particularly, bolts 7 extend through holes 7a formed in the cover member 6 and are threaded into suitable threaded apertures formed in the housing section. The holes 7a are made somewhat larger in diameter than the shanks of the bolt 7 to permit the cover 6 to be adjusted with respect to the housing during assembly whereby to permit the bushings to be shifted toward the inlet side of the pump. In the embodiment illustrated, the pumping gears have integrally formed therewith hollow journal shafts 12 and 13, respectively, and the left portions of the journal shafts 12 and 13 are received in conventional flanged bushings 14 and 15 mounted in the left portions of the pumping gear chambers 8 and 9. The right portions of the gear journals are received, respectively, in axially adjustable, pressure loadable flanged bushings 16 and 17 mounted in the right side of the pumping gear chambers.

In the embodiment illustrated, the upper pumping gear 10 is the driving gear and is rotated in a clockwise direction, as viewed in Fig. 2. In accordance with conventional pump design practice, the journal shaft of the upper gear may be extended to the left, as viewed in Fig. 1, and coupled to a suitable power source. Low pressure liquid is introduced into the pump housing at inlet 20 formed in the left side of the pump housing, as viewed in Fig. 2, and high pressure liquid is discharged from the pump housing, through outlet 21 formed in the right side of the housing, the inlet and outlet ports communicating with the inlet and discharge areas of the intermeshing pumping gears. The pressure loadable bushings are normally fitted into the bores with sufficient clearance to permit slight axial movement of the bushings with respect to the bores to establish the desired pressure loaded seal during operation of the pump.

In the operation of a pump of this type, discharge pressure generated by the intermeshing gears may be communicated from the outlet or discharge side thereof to the annular pressure loading areas, designated 16a and 17a in the drawings and located at the back of the bushings, through an axially extending passage 22 formed between the peripheries of the flanged portions of the bushings on the discharge side of the pump at the point of convergence of the flanged portions of the bushings. Areas 16a and 17a cooperate with the adjacent walls of the housing bores 8 and 9 and the peripheries of the barrel portions of the bushings 16 and 17 to define annular pressure loading chambers 23 and 24, respectively. The passage 22 extends from the discharge side of the gears to the right, as viewed in Fig. 1, to the intercommunicating portions of the pressure loading chambers 23 and 24 at their point of juncture.

Escape of pressure rearwardly from the pressure loading surfaces is substantially prevented by means of an O-ring seal 25 disposed about the periphery of the rear or barrel portions of each bushing in a suitable annular groove 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 in accordance with conventional pressure loaded pump practice as set forth in the above-referenced Roth et al. patent.

Since it is necessary in order to permit the slight axial movement required of the bushings in order to establish a seal, to fit the bushings with some clearance in the bushing receiving chambers the bushings may actually be assembled in such manner that more clearance is provided adjacent the inlet side of the pump than adjacent the discharge side of the pump, that is to say that the axially movable bushings may be slightly off-centered with respect to the axis of the bushing receiving chambers and located nearer the discharge port than the inlet port. This shifted alignment of the bushings is then maintained during operation of the cover section which is then bolted rigidly in position and which follows the location of the bushings or may itself be shifted to facilitate location of the bushings adjacent the inlet port. Since, in the operation of the pump, the pressure applied to the pressure loading chambers 23 and 24 is substantially equivalent to discharge pressure, the leakage path provided by the excessive clearance occurring when the bushings are positioned nearer the discharge port than the inlet port may be sufficient to materially reduce the efficiency of the pump. For example, tests have indicated that at discharge pressures on the order of 5,000 p. s. i., a leakage passage of .005 diameter will reduce pump output up to fifty per cent.

In accordance with the present invention, there is associated with each of the pressure-loadable bushings a spring-pressed plunger or piston assembly 26 and 27, respectively, which exerts a force tending to move the axially movable pressure-loadable bushings to the left, as viewed in Fig. 2, so that the left sides of their

flanged portions engage closely the sides of the pump chambers adjacent the inlet side of the pump. Since the low pressure area of the pump is confined to the area adjacent the inlet side of the pump, the fact that the bushings are shifted slightly to the left causes a gap or space on the discharge side of the pump is not significant. This shifted alignment of the bushings is then maintained when the assembly of the pump is completed by locking the bolts 7 securely in position, the cover section 6 being then shifted also toward the inlet side of the pump.

More particularly, the upper piston assembly 26 of this invention comprises, as shown in Fig. 3, a hollow-bodied piston 28 of generally cylindrical configuration having its left or upper end closed, as viewed in Fig. 3, and the piston is slidably journaled in a suitably formed, axially extending chamber 29 formed in the cover member 6 of the pump housing. Associated with the piston 28 is a helically coiled spring 30, the left or upper end of which bears against the inner side of the cross portion of the piston, that is the head of the piston, and the right or lower end of which bears against the inner end of a threaded retaining member 31, which is threaded into the lower right end of chamber 29; chamber 29 is in turn suitably threaded to receive this member 31. By selecting the compression of spring 30 and by adjusting the position of member 31, the force exerted by the spring 30 may be closely regulated.

If it were desirable only to locate the bushings so that their sides adjacent the inlet port were fitted as closely as possible to the adjacent side walls of the housing in this area, then the chamber 30 could be located at right angles to the axis of the pump so that all the force exerted by the piston would be used in locating the bushings against the inlet side of the pump housing. However, in the operation of a gear pump of the type herein shown, a pressure gradient exists across the faces of the bushings adjacent to the gear side faces, the pressure gradient extending from a low pressure value corresponding to the inlet pressure of the pump on the inlet side thereof to a pressure value corresponding to the discharge pressure of the pump at the outlet side thereof. On the other hand, the pressure applied to the motive surfaces 16*a* and 17*a* is normally substantially uniform over the full extent thereof. It will be apparent, therefore, that since the gear side face pressure acting against the loading pressure in the area adjacent the discharge side of the pump exceeds the gear side face pressure acting against the loading pressure in the area adjacent the inlet side of the pump, the axially movable bushings 16 and 17 will tend to engage the gear side faces with a correspondingly greater force adjacent the inlet side. This unbalanced arrangement results in increased wear and, more particularly, uneven wear resulting ultimately in accelerated deterioration of the pump. In accordance with the present invention, this factor is taken into account by locating the piston so that the force exerted by the piston on the bushings is divided into two components, one component urging the bushings toward the inlet side of the pump and the other component urging the bushings toward the associated gear side face in the area thereof adjacent the discharge side of the pump.

More particularly, it will be seen that chamber 29 is located at an acute angle with respect to the axis of the pump and the head of the piston engages the rear edge of the flanged portion of the bushing 16 across the corner thereof. This corner may be beveled as indicated at 33. By selecting the angle of the axis of chamber 29 and consequently of piston 28, the division of the piston force may be controlled so that either more or less is applied in the direction tending to move the bushing to the left, as viewed in Figs. 2 and 3, or more or less is applied in the direction tending to push the bushing toward the gear side face in the area of the discharge side of the pump.

This force exerted by this spring 30 may, in accordance with this invention, be supplemented by supplying discharge pressure from the discharge side of the pump to the back of the piston. For this purpose, a short angularly extending passage 32 may be formed in the cover and body section 5, passage 32 communicating at one end with the discharge side of the pumping gears and at its other end with the mid-portion of the chamber 29 at a point located so that the piston 28 does not block the passage. The hydraulic pressure so supplied may, of course, be regulated by selecting the area of the piston exposed to pressure.

The construction of the piston assembly 27 associated with the lower pressure loadable bushing 17 is identical with that of the assembly 26.

From the foregoing, it will be evident that the spring pressure, which is always effective, will during the assembly of the pump push the bushings to the left and forward, as viewed in Figs. 2 and 3, and then, after the pump is placed in operation, as the pump discharge pressure rises to its operating value and this pressure is communicated to the rear of the pistons, the pistons will supplement the force urging the bushings forward and to the left, thus assuring proper location of the bushings in the housing and compensating in part at least for the pressure gradient across the gear side face-engaging surfaces of the bushings. In practice, it has been found that the pump arrangement disclosed herein facilitates construction of the pump, particularly in that it allows a greater tolerance between the pressure-loadable bushings and the chambers and requires less skill for proper assembly. During the operation of the pump the compensation for uneven loading tends to increase the efficiency of the pump by providing a better seal.

Where herein the various parts of this invention have been referred to as being located in a right or left position or an 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 but one embodiment of this invention has been shown and described, it will be understood that many changes and modifications may be made therein without departing from the spirit or scope of the present invention. While it is desirable in many applications to employ both spring and hydraulic pressure on the pistons, it will be apparent that either may be used without the other also.

What is claimed is:

1. A pressure loaded type, intermeshing gear pump of the type comprising a housing having a chamber formed therein and an inlet port on the inlet side of said chamber and a discharge port on the discharge side of said chamber, a

pumping gear in said chamber adapted to be engaged on one side face by a bushing, a pressure loadable bushing adapted to engage said gear side face in sealing relation, and spring-pressed means disposed at an angle with respect to the axis of said gears urging said pressure loadable bushing angularly with respect to said axis and against the inlet side of said pump during assembly of said pump, the spring force being supplemented during the operation of said pump by discharge pressure applied to said means.

2. A liquid pump comprising a housing having a pump chamber and an inlet leading to and an outlet leading from said pump chamber, means including a rotatable member received in said pump chamber for forcing fluid from said inlet and out of said housing through said outlet, an end plate in said pump chamber having a back face normally spaced from the adjacent end wall of said chamber and having portions cooperable with said housing to provide a pressure chamber, said end plate having an axis of movement parallel to the axis of rotation of said rotatable member, said end plate also having a front face subject to pressures in said pump chamber and cooperable with the adjacent side face of said rotatable member to provide a pumping seal therewith, one of said last two mentioned faces having a relief recess formed therein to limit the sealing area between said side face and said front face, means establishing communication between said relief recess and said inlet, means establishing communication between said pressure chamber, at the back face of said end plate and said outlet, the relation of the area of said back face to said sealing area being such that the force acting upon said back face of said end plate always exceeds slightly the sealing force acting upon the front face of said end plate whereby it maintains said pumping seal without excessive friction, wear or loss of volumetric efficiency, and means associated with said end plate arranged to provide a first force acting generally at right angles to the direction of the sealing force acting on said back face during the operation of the pump to urge said end plate toward the inlet side of said housing during assembly of the pump thereby to reduce leakage between the periphery of said end plate and the adjacent inner wall of said housing on the inlet side of said pump, said means being arranged to provide a second force acting generally parallel to the direction of said sealing force and in the same direction to urge said end plate toward the adjacent gear side face on the outlet side of said housing.

3. A pump according to claim 2 wherein said force providing means comprises a piston arranged to engage said end plate at an acute angle with respect to the axis of the rotatable member.

4. A pump according to claim 2 wherein said force providing means comprises a spring-pressed piston adapted to bear against the end plate at an acute angle with respect to the axis of the rotatable member in response to pressure loading.

5. A pump according to claim 2 wherein said force providing means comprises a spring-pressed piston adapted to bear against the end plate at an acute angle with respect to the axis of the rotatable member in response to pressure loading, and means for supplying discharge pressure from said pump to said piston to supplement the spring force.

6. A pressure loaded type of intermeshing gear pump including a housing having a pair of pumping chambers formed therein and an inlet leading to and an outlet leading from said pumping chambers, intermeshing pumping gears disposed in said chambers and arranged to force liquid from said inlet through said chamber and out of said outlet, bushings associated with each of said pumping gears, at least one of said bushings being movable along a direction substantially parallel to the axis of rotation of said pumping gears in response to application of discharge pressure to the rear surface thereof to engage the associated gear side face in sealing relation, the forward faces of said bushing being subject to a liquid pressure gradient established during operation of the pump having its minimum pressure level at the inlet and its maximum pressure level at the outlet, and means for exerting a force having its axis at an acute angle with respect to the axis of rotation of said gears whereby one component of said force urges said bushing toward the inlet side of said pump and the other component of said force urges said bushing toward said pumping gear, said means being located so that the component of force exerted to urge said bushing toward said pumping gear is exerted against the portion of said bushing adjacent the discharge side of said pump whereby to compensate for the pressure gradient extending across the gear side face engaging surface of said bushing.

7. A pump according to claim 6 wherein said force providing means comprises a piston adapted to bear against said bushing.

8. A pump according to claim 6 wherein said force providing means comprises a spring-pressed piston adapted to bear against said bushing.

9. A pump according to claim 6 wherein said force providing means comprises a hydraulically actuated piston adapted to bear against said bushing.

10. A pressure loaded type of intermeshing gear pump including a housing having a pair of pumping chambers formed therein and an inlet leading to and an outlet leading from said pumping chambers, intermeshing pumping gears disposed in said chambers and arranged to force liquid from said inlet through said chambers and out said outlet, a bushing associated with each of said pumping gears, at least one of said bushings being movable in a direction substantially parallel to the axis of rotation of said pumping members in response to application of discharge pressure to the rear surface thereof to engage the associated gear side face in sealing relation, the forward surface of said bushing being subject to a pressure gradient generated by the liquid being pumped from inlet out said outlet, and means for exerting a force on said bushing having its direction at an angle with respect to the axis of said pumping gears whereby one component of said force urges said bushing towards the inlet side of said pump and the other component of said force urges said bushing in a direction parallel to the axis of said pumping gears and towards said pumping gears, said means being located so that the component of force exerted in the direction parallel to the axis of said pumping gears is exerted against the portion of said bushing adjacent the discharge side of the pump and greater than the component of force exerted in the direction toward the inlet side of said pump, whereby to compensate for the pressure gradient extending

across the gear side engaging surface of said bushings.

11. A pump according to claim 10 wherein said force providing means comprises a piston adapted to bear against said bushing.

12. A pump according to claim 10 wherein said force providing means comprises a hydraulically actuated piston adapted to bear against said bushing.

13. In a pump, a housing having an inlet and an outlet and providing a pumping cavity, a pumping element, a shiftable end plate closing one end of said cavity in said housing and being subject to pressures in the cavity which increase toward the outlet side of the cavity, said shiftable end plate forming together with means including a portion of said housing a pressure control chamber adjacent said cavity, a back face on said shiftable plate forming a wall on said pressure control chamber, and means for exerting a force on said end plate having its direction at an angle with respect to the axis

of said pumping element whereby one component of said force urges said plate towards the inlet side of said pump and the other component of said force urges said plate towards the pumping cavity, said means being located so that the component of force exerted to urge said plate towards said pumping cavity is exerted against the portion of said plate adjacent the discharge side of said pump to produce balancing forces urging the plate toward the cavity in proportion to the unequal forces urging the plate away from the cavity.

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