

June 29, 1948.

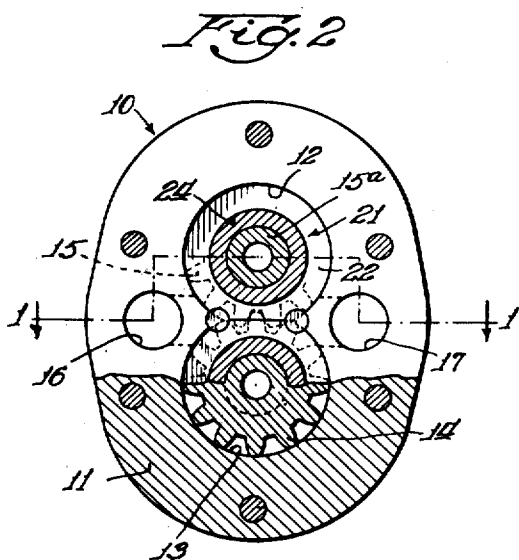
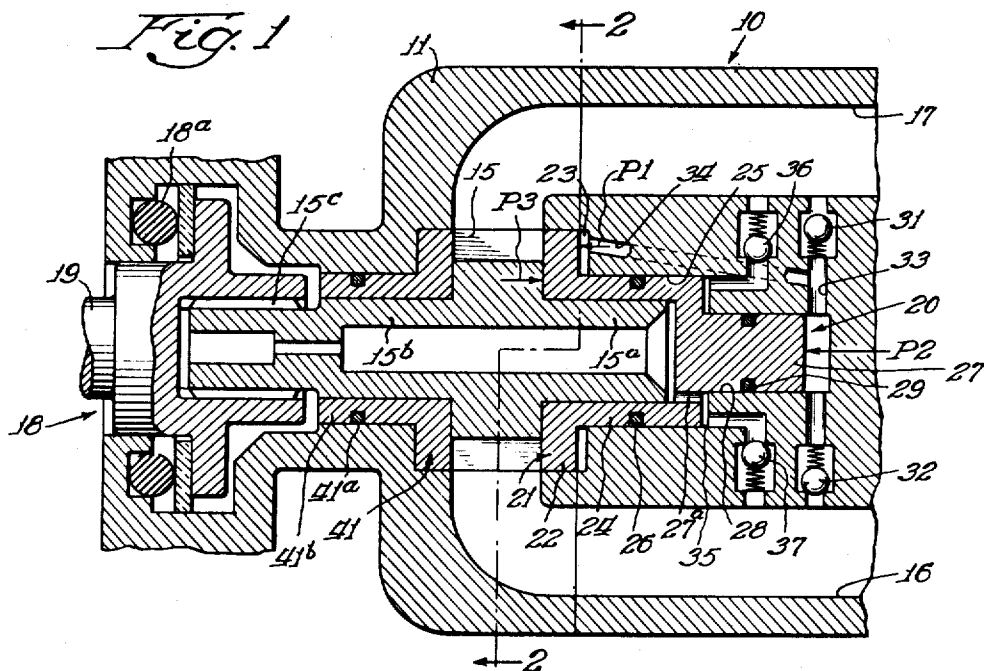
J. A. LAUCK

2,444,165

PUMP WITH PRESSURE BUSHING

Filed Aug. 16, 1943

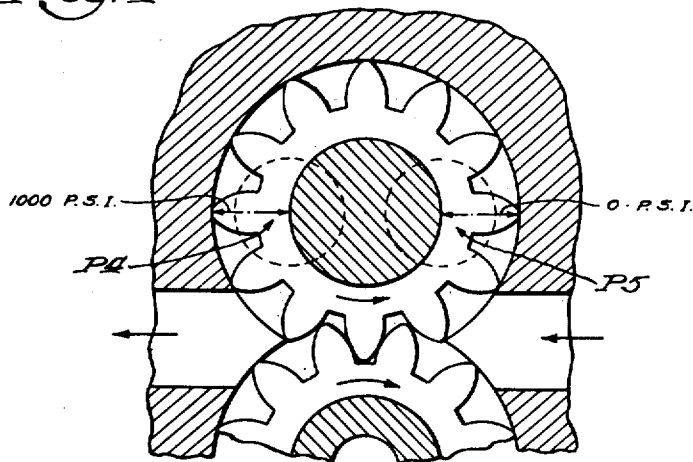
4 Sheets-Sheet 1



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4 Sheets-Sheet 2



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PUMP WITH PRESSURE BUSHING

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4 Sheets-Sheet 4

Fig. 8

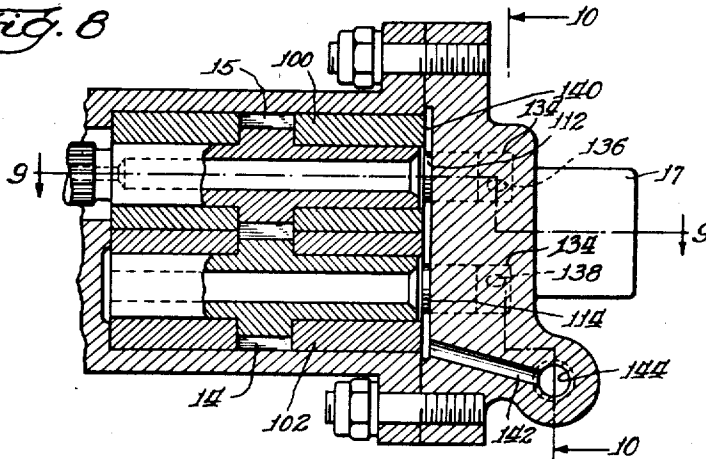


Fig. 9

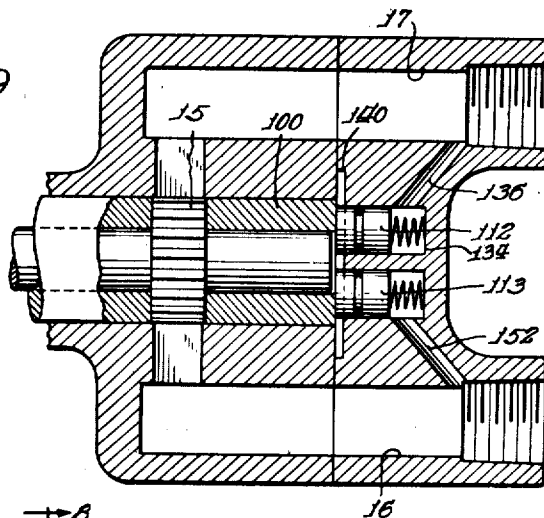
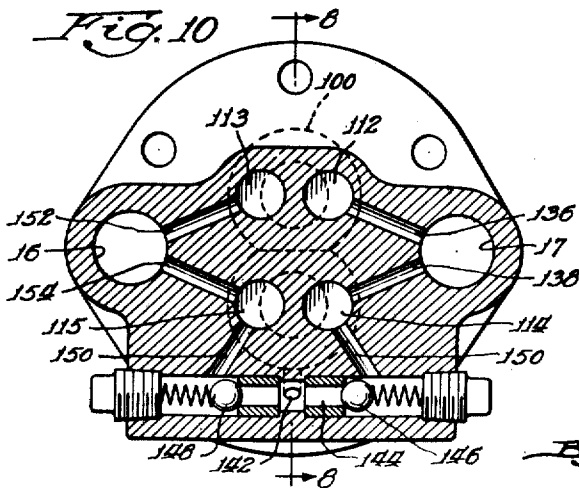


Fig. 10



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UNITED STATES PATENT OFFICE

2,444,165

PUMP WITH PRESSURE BUSHING

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mesne assignments, to Borg-Warner Corpora-
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Application August 16, 1943, Serial No. 498,748

3 Claims. (Cl. 103—126)

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This invention is directed to high pressure gear type liquid displacing devices, and particularly to an improved arrangement for maintaining axial adjustable end of plate or bearing bushings in sealed contact with the side faces of the associated gears.

It is an object of this invention to provide an improved arrangement of pressure operating means effecting and maintaining the requisite sealed engagement between the end bushings and the associated faces of the gears, notwithstanding the fact that high output pressures are reached which result in enormous pressures between the gears and the bushings tending to effect separation thereof with a resulting loss of volumetric efficiency. This invention is closely related in object to copending Roth and Lauck Serial No. 439,030, filed April 15, 1942, and issued as Patent 2,420,622 of May 13, 1947, and is considered as presenting still another improved solution to the same general problem.

Since it is desired to cause a sealing action between the gears and the associated face plate or, as herein described, movable bushing bearing, in the direction of the associated gear faces, which has a small differential value or increment greater than the oppositely acting pressure between the gear faces and the bushing, it is an object to disclose a construction which will accomplish this desired feature.

It is a further object or feature of this invention to provide a bushing means wherein the bushing is movable to and away from the face of the associated gears, and in which the liquid pressure from the outlet of the gears operates to load the bushing urging it against the gears whereby a sealing action with the face of the gears is accomplished. In this connection, it is an object to provide a construction in which the load urging the bushing against the gears will always predominate for the pumping action by a small amount over the oppositely acting force tending to separate the bushings from the gears.

In this connection, it is a further object to present a construction in which the fluid used in loading the gears is manually controlled by a release means which prevents overloading the bushing, and further, it is an object to provide an arrangement incorporating one or more metering valves in the fluid conduit system between the pump outlet and the bushing loading surfaces.

It is a further object of this invention to provide an outlet liquid pressure operated unbalanced bushing and bearing construction of the above type in combination with an arrangement

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providing for automatic reversal of the direction of operation in response only to the reverse rotation of the gear, without requiring any special adjustment or reversal of other parts.

5 It is a still further object to provide, in a high pressure liquid displacement gear device of the present type, any improved arrangement for establishing and maintaining a plurality of liquid pressure zones each having an important function in connection with the operation of the end plate or bushing and associated coupling seal.

10 It is a further object of the invention to provide a bona fide form of construction in which the movable end plate or bushing bearing is loaded in whole or in part by separate piston means. In this arrangement, it is a feature to present a construction in which the load may be distributed to the portion of the bearing on which the greatest pressure tending to move the bearing
15 away from the gears is exercised. It is a further feature to present a construction in which the proper portion of the bearing is loaded by piston means or otherwise regardless of the direction the pump rotates, it being understood that a reversal of direction of the pump changes the portion of the bearing which is most heavily loaded.

25 It is an object to present an improved arrangement which is relatively simple to manufacture, which lends itself to modern manufacturing operation, and which is rugged and durable in operation.

Other and more particular objects, advantages and uses of my invention will become apparent from a reading of the following specification,
35 taken in connection with the accompanying drawings forming a part thereof and wherein:

Fig. 1 is an axial broken-away sectional view, showing the essential elements of a gear pump incorporating a preferred embodiment of my invention;
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Fig. 2 is a cross-sectional view taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a view corresponding generally to that of Fig. 1, but showing a modified form wherein
45 separate piston means are used to load the movable bearing, and wherein a metering and relief means are disclosed for controlling the fluid pressure exerted on the movable flange bearing;

Fig. 4 indicates diagrammatically the distribution of pressure in a pumping operation wherein the gears of a gear pump operate with different pressures at different positions with the consequent result, the view being a fragmentary cross-sectional view to the gear wheel of a pump corresponding to those disclosed herein.
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Fig. 5 is an axial sectional view of another modified construction, this view being slightly fragmentary, and serving to show a somewhat different arrangement of sealing valve and piston loading means.

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 5 and 6—6 of Fig. 7 looking in the direction of the arrows;

Fig. 7 is a cross-sectional view taken on the line 7—7 of Fig. 5 looking in the direction of the arrows;

Fig. 8 illustrates still another modification, the view illustrating the piston loading of the movable bearing with the use of a metering valve;

Fig. 9 is a view taken on the line 9—9 of Fig. 8, looking in the direction of the arrows; and

Fig. 10 is a view taken on the line 10—10 of Fig. 8 illustrating particularly the valve arrangement controlling the flow of fluid in the bushing loading piston.

Referring more in detail to the drawings, and referring first to the construction shown in Figs. 1 and 2 in particular, 10 indicates generally a gear type pump with certain conventional portions thereof broken away for the purpose of clarity, the pump including especially a housing 11 formed with a pair of internal overlapping bores 12 and 13, receiving therein a pair of gears 14 and 15, meshing in the general area of overlap of said bores.

Leading to and from said gears 14 and 15, in the area of meshing therebetween, are a pair of main flow passages 16 and 17, either of which may become the inlet or the discharge passage depending upon the direction of rotation of the gears 14 and 15. The actual terminal connections forming part of the housing have been shown broken away for the purpose of simplicity, it not being deemed necessary to show this conventional structure.

Gears 14 and 15, as will be apparent from Figs. 1 and 2 each include oppositely extending trunnions, journals, or shafts, seated in bearing members as hereinafter more fully described and, as is apparent from the drawing, the bearing members are received in reduced extensions on both sides of the bores 12 and 13. Only the journals 15A and 15B of the gear 15 are shown in detail since the corresponding journals of gear 14 are identical therewith except that journal 15B is provided with a splined extension 15C cooperating with a flexible coupling 18, including a shaft 19 for driving gear 15 and a flexible sealing ring 18A.

For the purpose of properly sealing the gears on the side faces thereof, I have provided a special arrangement of coaxially adjustable end plates, bushings, or bearings, sometimes herein referred to as bushing bearings, with fluid pressure actuating means. The bearing is indicated generally at 20, and this bearing in the modification shown, together with the means for controlling it, form the subject matter in combination to which the present invention is directed.

The gear journal for each gear has interposed between it and the enclosing housing a specially constructed axially adjustable bearing bushing, nut for journal 15A being indicated at 21, and including a radially extending flange or piston portion 22, sealably fitting the bore receiving the gear 15, but having an axial thickness less than the space receiving the same to thus provide an annular high pressure actuating chamber 23 for the purpose to be described. Thus bearing 20 further includes an axially extending tubular por-

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tion 24, received in reduced bore 25 and sealed with reference thereto by a flexible seal ring 26.

In a particular part of my invention, a piston 27 is formed as an extension of tubular portion 24 of bushing assembly 21. As will be apparent from other figures, the piston member 27 may be equally well formed separately from bushing assembly 21 so long as the same is arranged to apply axial pressure to bushing assembly 21.

Piston member 27 is sealed with reference to the bore 28, in which the same operates, by means of a flexible sealing ring 29. A passage 27A leads from the interior of tubular extension 24 for the purpose of placing the same in communication with the low pressure side of the pump as will appear. I contemplate, in the preferred embodiment a separate piston (not shown) identical to the piston 27, for cooperation with the bushing assembly of gear 14. However, it will be apparent that a single piston 27 may be made to apply the necessary axial pressure to both of the bushings on one side of the gears.

Discharge fluid pressure is delivered to chamber 23, there applying a first axial force P1 to bushing assembly 21, by way of small check valves 31 or 32, depending upon the direction of rotation and hence whether the flow passages 16 or 17 form the outlet passage, then through passages 33 and 34. Passage 33 also leads to the piston member 27 for operating the same to thus supply an additional axial force P2 for urging bushing 21 into engagement with the side or face of gear 15. It is important to note that the effective pressure area of the back side of bushing flange or piston portion 22, in chamber 23, together with the pressure area of the piston 27, are made such that the total of coaxial forces P1 and P2, acting to press bushing flange 22 into contact with gear 15 is always slightly greater than the opposing coaxial force P3 of the fluid attempting to force the bushing bearing 22 away from the gear, this differential, being only a small fraction of the outlet pressure. This is always true when the pump is operating as a pump, regardless of how high the output pressure may become. It has been observed that even where the output pressure may be in the neighborhood of several thousand pounds per square inch, the difference between the sum of P1 plus P2 on the one hand and P3 on the other is still only a small amount, a few pounds for example. It will then be seen that so long as there extends a small increment of pressure in the direction of bushing engagement with the gear, the bushing can never be forced away from the gear by fluid pressure exerted between the gear and the bushing.

Referring to gear 14, it will be apparent that an identical bushing construction will be provided including a piston member, the same not being shown since it is believed to be apparent from a disclosure and description of the structure associated with gear 15.

It will be important to note that the small differential pressure tending to maintain engagement is always present during the pumping action, irrespective of whether the pump is operating at a relatively low pressure or a very high pressure. In other words, the pressure of the frictional engagement between the bushing and the associated face of the gear does not vary appreciably with a change in output pressure from low pressure to a pressure substantially equal to the maximum of the pump, but this pressure differential urging the bushing into contact with the gear always preferably remains at

a very low value, as it is usually only necessary, as above pointed out, that the same be a small differential greater than the pressure between the bushing and the gear, tending to separate the same.

For the purpose of releasing excess fluid pressure in the assembly on the low pressure side of the bushing 21, passage 35 leads alternatively to check valves 36 or 37, depending again upon whether passage 16 or 17 is the high pressure side.

Gears 14 and 15 are preferably provided on the opposite side thereof about the associated journal, with similar bushing bearing assemblies, but not necessarily having axial adjustment. Bushing bearing 41 for gear 15 is shown in Fig. 1 with a tubular extension 41, said extension having a flexible seal 41a interposed between its outer periphery and the housing 11. The corresponding bushing for gear 14 is not shown, for the purposes of simplicity. In addition, the well known elements of the present type of pump are contemplated, but a detailed description and showing thereof are unnecessary to an understanding of the present embodiment and have been omitted for the purposes of clarity.

Referring next to the construction shown particularly in Fig. 3, there is provided a modification wherein there is preferably a combined metering and release valve, shown in its entirety at 50, interposed between the pressure loaded bushing and the outlet pressure side of the pump, that is, the high pressure side of the pump. In other words, there is a metering valve and a release valve in the circuit comprising the fluid connection to the main flow passages. In the arrangement shown in Fig. 3, this metering and release valve is manually adjustable whereby the pressure necessary to effect a release upon a maximum desired load may be varied if desired.

As shown in Fig. 3, there is provided a bore in the pump housing, here indicated as the axially extending bore 52. This bore 52 is preferably provided with a reduced portion forming a port 54, leading into the high pressure chamber between the end of the bearing member 20, and the pump housing. This high pressure chamber may be designated as the high pressure chamber 56, for purposes of reference.

Seated on an annular ledge portion 58 formed by the reduced bore for the port 54, is a valve 60, the stem of which is here shown as extending axially of the bore 52, and which stem has a guide portion or spider 62. This guide portion 62 is provided with cutaway portions whereby fluid may flow past it, but the said portion 62 "rides in" the bore 52, to assist in maintaining the valve stem in axial alignment with the bore.

The bore 52 is likewise provided with an insert 64, which is spaced from the port 54 to form a low pressure chamber 66, and which insert 64 has a hole or passage through the center thereof in which the valve stem of the valve 60 moves. This valve stem for the valve 60 preferably has a close sliding fit in the insert, one which is substantially liquid tight.

Spaced axially from the insert 64, toward the outer end of the bore 62 is a collar 68. The stem of the valve 60 passes through this collar 68, and there is sufficient clearance between the stem and the collar to effect a metering action of fluid passing therebetween. A space between the collar 68 and the insert 64 comprises a high pressure bore chamber 70, which communicates with the outer end chamber 72 of the bore 52 by means

of the metering passage around the valve stem 60 through the collar 68.

The outer end of the bore 52 is closed by a plug 74 which is externally threaded to engage internal threads in the bore 52 and which is adjustable by threading into and out of bore 52 for the purpose hereinafter set forth.

The plug 74 engages a spring 76 which seats on the portion 62 of valve 60, the pressure on the spring 76 exerted by the plug 74 determining the pressure in the high pressure chamber 56 necessary to unseat valve 60 from the shoulder portion 58 and relieve excess pressure in the high pressure chamber 56.

The high pressure bore chamber 70 is placed in communication with the annular high pressure chamber 23 and with the high pressure chamber 56 by means of one or more passages 78 for fluid. This is obvious from an examination of Fig. 3. The low pressure chamber 66 is placed in communication with the low pressure side of the pump by means of one or more passages 80 discharging into the main flow passages 16 or 17 as the case may be. Valve means, here shown as the spring pressed ball valve 82, closes the low pressure passage 80 to the inlet of fluid from the high pressure side of the pump but permits fluid under pressure in the low pressure passage 80 to escape into the low pressure side of the pump, that is into the "inlet" conduit formed by the main flow passage 16 or 17 as the case may be, depending upon the direction of rotation of the pump. It is believed this operation is obvious from the figure.

The chamber 72 is placed in fluid communication with the high pressure or outlet side of the pump being the main flow passage 16 or 17, depending upon the direction of rotation of the gears. This is accomplished by means of passages 86. These passages are provided with valves 88 which operate in reverse to the valve means 82. These valves 88 are operable on the high pressure side of the pump, the pressure being taken from the main flow passages 16 or 17, depending upon the direction of rotation of the pump. Their operation is believed obvious.

The operation of the pump shown in Fig. 3 is as follows. Assume that the gears are rotating in a direction so that the high pressure side of the pump is the main flow passage 17, and that the low pressure side is the main flow passage 16, the fluid flowing to the pump in the passage 16 will be placed under pressure and will enter passage 17 from where it will be conducted to the device operated by the fluid pressure. The passage 17 however will discharge a small quantity of its fluid into the passage 86 past the valve 88 from where it flows into the chamber 72. Upon entering the chamber 72 it will pass the portion 62 of the valve 60, and be metered between the stem of the valve 60 and the collar 68. This metering action will cause the fluid pressure in the high pressure chamber 70 to rise and will conduct such fluid pressure through the passages 78 into the high pressure chamber 56 at the end of the piston and into the annular high pressure chamber 23 about the annular flange portion of the bearing or piston.

Since the bushing area subject to pressure in the chamber 56 and the annular chamber 23 is greater than the loaded area on the gear face side of the bushing, the amount of pressure will be sufficient to maintain the bushing bearing in engagement with side face of gear 15. In this connection, a low pressure area on the portion

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of the bearing which may be called the under-side or gear side, at the end, is created by the port means 90 which discharges into the hollow end portion of the shaft forming the trunnion for the gear 15, from where it may be carried to the low pressure area or discharged outside the pump as desired. This relieves pressure due to leakage between the pump and the side of the bearing. These port means may terminate in an annular portion as indicated in Fig. 3 whereby all entrapped fluid will be relieved through passage 80, as shown by the dotted lines.

When the pressure in the chamber 56 and in the annular chamber 23 reaches a predetermined regulable amount, it will raise the valve 60 from its seat on the ledge portion 56 and allow any excess pressure to escape into the low pressure chamber 66 from which it is conducted into the low pressure side of the pump through passage 80. The pressure necessary to relieve this valve may be adjusted by manual manipulations of the plug 74 by threading it in or out. If desired a longer stem than that shown to the valve 60 may be provided, so that it will touch the plug 74 when the plug is threaded into the bore a maximum distance, for the purpose of locking the release valve against operation. With this arrangement, of course, any pressure in the outlet of the pump would be reflected to the movable bushing bearing through the metering means, regardless of the amount of the pressure.

Due to the operation of the valves 88 and 82, as is obvious from the drawing, the pump may be run in either direction and identical loading action will take place.

Referring next to Fig. 4, there is here shown schematically the pressure diagram for the gear pump, by which location of the centers of pressures loading the movable bushings, especially in Figs. 5, 6, 7, 8, 9 and 10, hereinafter referred to, may be determined. This schematic arrangement of Fig. 4 is self-explanatory, but it may be noted that the location of the pistons as indicated in Figs. 5 through 10 should be such that they are approximately centered on the points P4 and P5, for each gear wheel.

For the rotation of the gears in one direction, the point P5 represents zero points per square inch, while the point P4 represents approximately maximum points per square inch. It is understood upon reversal of direction of rotation, the point P5 would be the high pressure point and P4 the low pressure point. Each of the gears of the gear pump has a corresponding pressure diagram substantially as that shown in Fig. 4.

As shown in this schematic drawing, the maximum pressure is assumed to be 1,000 pounds per square inch. Referring next to Figs. 5, 6, and 7, there is shown a modified form of construction in which the bushing bearing is pressure loaded by means of separate pistons, preferably so located that the pressure exerted by the pistons on each portion of the periphery of the bearing is in proportion to the outward pressure exerted on the corresponding bearing space adjacent the pump gear, and in which the separate pistons may be loaded in different amounts depending upon the direction of the rotation of the gear wheels, among other things.

For simplification in manufacture, and to secure a more direct thrust on the bearing for pressure loading of the bearing, the bushing bearing 100, which is a movable bushing bearing in connection with gear wheel 15, and the bushing bearing 102 which is the corresponding movable

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bushing bearing in connection with gear wheel 14, have been shown as having the flange portion shown in Figs. 1, 2, and 3 eliminated. Likewise, the bushing bearings 104 and 106, which are the fixed bushing bearings, are devoid of flange portions. Flange portions may be added, if desired. The movable bushing bearings 100 and 102 are movable axially on the gear wheel trunnion in the same manner that the bushing bearing 21 was movable in connection with the trunnion 15a. There is preferably a low pressure area at the end of each trunnion for the gear 14 and 15 on the movable bushing side, said low pressure chamber for the movable bushing end being numbered 108 and forming a chamber space into which the movable bushings may be moved. Located in reduced axial extensions 110 of the bore forming the chamber 108, are the separate pistons 112 and 114 which bear against the edges of the bushing bearings 100 and 102, on one side thereof as is clear from the drawings. Preferably these pistons are so located that they are adapted to exert pressure against the edge portion directly in axial line with the edge portion receiving the most outward pressure from the fluid in the gear 15. It is understood, however, that the pistons may be located in any convenient position and that more than two for each "side" of the pump may be provided. Springs 116 are provided for exerting a relatively light pressure on each of the pistons urging the respective bushing in the direction of the gear wheel by an amount sufficient to overcome inertia and friction.

As is apparent from the drawings, Figs. 5, 6, and 7, the pistons on each side of the pump are loaded separately. Thus the pistons 112 and 114 are loaded and controlled by means of fluid entering through a metering valve 118, while the pistons 113 and 115 are loaded in control by the adjustable metering valve 120. To economize on space and provide a more compact construction, the bores for metering valves 118 and 120 are shown as extending across the pump housing instead of axially as in Fig. 1. Either arrangement is equally operable, however, and the choice is one of manufacturing and design advantage.

It will be apparent from the figures, that metering valve 118 receives its pressure, if any (depending upon the direction of rotation of the pump), from the main flow passage 17, while the metering valve 120 receives its fluid from and is controlled by, the fluid in the main flow passage 16. Except in their low pressure chambers, the structures forming the metering valve and housing therefor are not connected. The low pressure chambers preferably are connected by passage 66a, since they each will have to have an outlet to the low pressure side.

As is clear from examination of Figs. 5, 6, and 7, the construction of the metering valve and release valve 118 and 120 may be the same as provided in connection with the assembly 50 of Fig. 3. However, I have disclosed a slightly modified construction generally similar to that of Fig. 3, except that instead of the plug 74, I have provided a modified closure and adjustment means. This comprises a member 122 which is internally and externally threaded to be inserted into one of the bores of the housing and which carries a threaded insert 124. The caps 126 may be provided to thread down on the threaded insert and hold the latter in position much in the nature of a lock washer or member, while providing a better seal than would be the case without the cap. The insert 124 is slotted for adjustment

with a screw driver or may be otherwise provided with adjusting means by which it may be moved up or down in the metering valve bore whereby the tension on the spring holding the valve seated may be regulated. Otherwise, the valve arrangement is generally similar in construction to that shown in Fig. 3.

The inlet from the high pressure conduit, which may be the passage 128 or 130 as the case may be, depending upon the direction of rotation of the pump gear, communicates with the chamber 72 of the respective valve bores. In the low pressure chambers 66, the passage 80 leads from both valves and has intercommunication so that the discharge may be to the low pressure side of the pump regardless of whether it is the main flow passage 16 or the main flow passage 17. Check valves 82 are generally similar to those of Fig. 3, except that the assembly is slightly different in an inconsequential manner from a patentable standpoint.

The construction of both metering valves in Fig. 5, Fig. 6, and Fig. 7 may be identical and only one is described for purposes of clarity.

The operation of the device shown in Figs. 5, 6, and 7 follows and it is assumed, for the purpose of describing it, that the fluid enters the pump through the low pressure main flow passage 16 and, after the pumping operation, is forced out through the high pressure main flow passage 17. In order to load properly the bushing 100, the pistons 112 and 114 will have to be loaded, while it is unnecessary ordinarily when the direction of rotation is as indicated, to load the pistons 113 and 115. Fluid from the passages 17 will enter the passages 128 and flow to the valve 118 in the same manner as it flowed to the valve 50. There the fluid will be metered and conducted through the passages 132 to load the pistons 112 and 114 which load the bushings. When the pressure reaches a certain predetermined amount, the excess fluid will pass through the discharge port 54 and will raise the valve 118 from its seat, allowing excess pressure to escape through the low pressure passage 80 into the main flow passage 16. In such arrangement, there is no need for a valve in the passage 128 similar to the valve 88 since there is no inter-communication between the chambers 72 for the two metering valves.

Upon reversal of the pump the other metering valve 120 will operate, while the valve 118 will remain unloaded. The pressure, upon reversal pump, in the main flow pipe 17 will be low, and will allow the valve 118 to unseat and the pistons 112 and 114 to move out of pressure loaded position. In such latter event, the pistons 113 and 115 will be separately operated and will have no communication of fluid pressure with the pistons 112 and 114.

Refer next to the modifications shown in Figs. 8, 9, and 10. There is provided a more simple and compact means of piston loading the bushing bearing 100 and its companion bearing 102, by means of two sets of pistons operated without the metering valve but having a release valve for each pair of pistons.

As shown in the drawings, the pump and bushing arrangement may be the same as that of Figs. 5, 6, and 7, except that the metering valve 118 and the metering valve 120 have been removed from the assembly. As shown in these figures, the pistons 112, 113, 114, and 115 are arranged in approximately the same way as are the similarly numbered pistons of Figs. 8, 9, and 10. The high pressure main flow passage 17, for example,

is connected to the chamber 134 for the pistons on one side of the pump, that is, for pistons 112 and 114 by means of passages 136 and 138 respectively. With this arrangement, when the main flow passage 16 is the low pressure area and the inlet side of the pump, the pistons 113 and 115 are entirely unloaded, and the pistons 112 and 114 are fully loaded. Upon reversal of the pump, the pistons 113 and 115 will be loaded while the pistons 112 and 114 will be allowed to unload through their passages 136 and 138 into the main flow passage 17. In this arrangement there is provided a low pressure area at the end of the bushing 100 and 102. This area, herein referred to as space or chamber 140, in reality could be more properly termed an intermediate pressure area in that the pressures are fluid pressures of relatively low amount, escaping along the shaft of the gear and around the piston by leakage, and which enter the space 140 and are conducted by the passage 142 into the discharge area 144. This pressure displaces the ball valve 146 or 148, depending upon which one is on the low pressure side, and escapes through the piston chamber into the inlet side of the pump. The passage 150 for each side or group of pistons acts as the conduit for the escape of this relatively minute quantity of fluid. It is noted that the spring loading on one of the balls 146 or 148, must be displaced by this minute quantity of fluid, and the pressure necessary to do this furnishes sufficient fluid around the trunnions and bearings to lubricate them.

The passages 152 and 154 correspond in function to the passages 136 and 138 except that passage 152 leads from the piston 113 to the main flow passage 16 and the passage 154 leads from the piston 115 likewise to the main flow passage 16.

It may be understood that with the arrangement shown in Figs. 8, 9, and 10, the end plate of the housing is materially reduced in size and is more compact and lighter. This is an important feature where such pumps are used in the limited space provided in airplanes, for example, and where it is desired to cut down the weight of the pump.

Numerous details of the various figures are obvious and apparently do not need specific description. For example, in Fig. 8 the shafts or trunnions for the gear wheels are both shown as hollow, so that seepage fluid at the ends of the trunnions may be conducted back therethrough to the space 140 where it escapes in the regular way.

While I have described my invention in connection with one specific embodiment thereof, it is to be understood that this is by way of illustration and not by way of limitation, and the scope of my invention is defined solely by the appended claims which should be construed as broadly as the prior art will permit.

I claim:

1. In a gear type high pressure liquid displacement device including means defining a housing having a pair of parallel overlapping cylindrical bores, gears in said bores having teeth meshing in the area of said overlapping, said gears having pairs of oppositely extending journals, a plurality of bearing insert bushings received in said bores about said journals and in engagement with the side faces of said gears, means responsive to the outlet pressure on either side of said gears dependent upon the direction of rotation thereof, effective to selectively communicate said outlet pressure to the said bush-

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ings on at least one side of said gears urging the bushings into sealed relation therewith, including means comprising separate pistons bearing against the ends of said bushings and communicating through pressure metering means with the outlet pressure from said gear pump, and valve means in connection with said pressure metering means relieving the fluid pressure on said pistons above a desired predetermined amount.

2. In a device of the class described a gear pump, movable bushing means adjacent at least one face of each of the gears of said gear pump, piston means bearing on said movable bushing means, means loading said piston means from the outlet pressures existing in said gear pump, said last mentioned means including pressure metering means and adjustable valve means actuated by excessive pressure over a predetermined amount on said piston means for relieving the excess pressures on said pistons.

3. In a device of the class described, a gear pump, including movable bushing means adjacent one face of each of the gears of said gear pump, piston means bearing on said movable bushing means, means loading said piston means

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from the outlet pressures existing in said gear pump, said last mentioned means including pressure metering means and adjustable valve means actuated by pressure exceeding a predetermined amount on said piston means for relieving the excess pressure on said piston means, and said piston means being so positioned that the resultant of the forces impressed thereon opposes the resultant of forces acting in an opposite direction on the bushing means.

JOHN A. LAUCK.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,444,165.

June 29, 1948.

JOHN A. LAUCK

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 11, line 20, claim 2, for the word "pistons" read *piston means*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of September, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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ings on at least one side of said gears urging the bushings into sealed relation therewith, including means comprising separate pistons bearing against the ends of said bushings and communicating through pressure metering means with the outlet pressure from said gear pump, and valve means in connection with said pressure metering means relieving the fluid pressure on said pistons above a desired predetermined amount.

2. In a device of the class described a gear pump, movable bushing means adjacent at least one face of each of the gears of said gear pump, piston means bearing on said movable bushing means, means loading said piston means from the outlet pressures existing in said gear pump, said last mentioned means including pressure metering means and adjustable valve means actuated by excessive pressure over a predetermined amount on said piston means for relieving the excess pressures on said pistons.

3. In a device of the class described, a gear pump, including movable bushing means adjacent one face of each of the gears of said gear pump, piston means bearing on said movable bushing means, means loading said piston means

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from the outlet pressures existing in said gear pump, said last mentioned means including pressure metering means and adjustable valve means actuated by pressure exceeding a predetermined amount on said piston means for relieving the excess pressure on said piston means, and said piston means being so positioned that the resultant of the forces impressed thereon opposes the resultant of forces acting in an opposite direction on the bushing means.

JOHN A. LAUCK.

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Certificate of Correction

Patent No. 2,444,165.

June 29, 1948.

JOHN A. LAUCK

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 11, line 20, claim 2, for the word "pistons" read *piston means*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of September, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.