This invention has to do with liquid displacing devices and the like. More particularly, the invention relates to such liquid displacing devices as gear type pumps, with axially adjustable end plates or bushings therefor which are operable to load and unload the pumps, the present invention being an improvement over and special application of the structure disclosed and claimed in Roth and Lauck Serial No. 439,030, filed April 15, 1942, now Patent No. 2,420,622.

Devices of the class described are used in various installations, among the more common uses being the delivery of pressure liquid to an accumulator or storage tank, in which liquid is generally maintained under a predetermined pressure or delivery to any other conventional pressure consumer. There are many uses for such a device. By way of example, one use is for operating retractable landing gears for an airplane. Such operating means for the landing gear of an airplane may incorporate an accumulator in which the pressure is built up to a substantial predetermined amount, and from which fluid is withdrawn under said pressure to operate the landing gear motor.

In such an arrangement as above described, it is desirable to maintain the pressure as near a constant as possible. To this end, a pumping means is usually provided which will bring the pressure in the accumulator up to the amount desired, and which will then be automatically cut out so as not to overload the accumulator. As the pressure in the accumulator is dropped by use of fluid from the accumulator, the pump must be cut in again to build up the pressure as rapidly as possible to the predetermined desirable level. It is a feature of this invention to provide a device which accomplishes the above purposes, and which will automatically relieve the operating load on the pump when the accumulator has reached the desired pressure.

In this connection, it is another object of this invention to provide a device in which the pump is automatically unloaded by means within the pump housing. More specifically, it is a feature of this invention to provide a construction in which the pump is automatically unloaded by movement of the end plate or bushing means within the pump when the pressure in the accumulator or the pressure being delivered to some other pressure consuming device reaches the desired value.

It is one of the principal objects of this invention to provide a construction in which use is made of an axially adjustable end plate or bushing effective to provide a liquid pressure operated pumping seal with the adjacent side faces of the intermeshing gears during the time it is desired to generate liquid pressure and further providing for the movement of the end plate or bushing to break the pumping seal and unload the gears when it is desired to discontinue the delivery of pressure liquid.

Another object is to provide a unitary construction in which it is unnecessary to have a separate unloading valve outside of the pump proper. One of the features of this construction is that it is compact and unitary, and eliminates the necessity for a return line separate and distinct from the pump housing, and therefore reduces the vulnerability of the installation to damage by machine-gun fire and the like. In this connection, one of the advantages is due to the fact that the pump unloading means and the return conduits therefor are located within the same housing as the pump means.

It is an object of this invention to provide a construction wherein the end plate or bushing for the pump is loaded with the necessary increment of pressure to maintain the same in a close engagement with the pumping means, and thus to increase the efficiency of the pumping means, and wherein the end plate or bushing is likewise provided with means moving it away from the pumping means and allowing the fluid to escape from or recirculate around the pumping means for the purpose of unloading the pump, when the delivery pressure has reached the desired value.

It is a further object of this invention to provide a modified construction incorporating an improved form of end plate or bushing arrangement in which the bushing is loaded as a piston. In this connection one feature, which is optional but which may be incorporated in such a modified bushing, is the removal of the undercut or low pressure area formed by grooving the bushing on the gear side. This feature is feasible, especially by reason of the fact that the area of the bushing loaded by the hydraulic pressure is considerably greater than in the principal embodiment.

In connection with the modified form, it is a particular feature of the invention to add a reducing valve by which the increment of pressure may be varied as desired so that the bushing is effective for whatever pressures are called for by the operating conditions under which the pump is used.

It is a further object of this invention to pro-
A construction in which a minimum number of parts are used to accomplish the above purposes; a construction which is simplified in design and construction; a construction which may be made of relatively light material, and which is automatic, necessitating little or no manual operation or care.

Another object, advantages and uses of the invention, will become more apparent after reading the following specification and claims, and after consideration of the drawings forming a part of the specification, wherein:

Fig. 1 is a sectional side elevational view taken on the lines 1—1 of Fig. 2, looking in the direction of the arrows;

Fig. 2 is a cross-sectional view taken on the line 2—2 of Fig. 1, looking in the directions of the arrows; and

Fig. 3 is a cross-sectional view illustrating a modified form of invention having a reducing valve added and likewise having a greater portion of the area of the bushing hydraulically loaded.

Referring more in detail to the construction shown in Figs. 1 and 2 of the drawing, there is provided a pump housing 10 having pumping means such as the gears 12 and 14, which mesh and perform the pumping operation in the normal manner of ordinary gear pumps.

The housing 10 has the inlet conduit 16, which opens from the inlet side of the gears 12 and 14, whereby liquid to be pumped reaches the gears. The inlet conduit has a threaded terminal 17 adapted to communicate with a source of liquid to be pumped (not shown). The housing 10 is likewise provided with the outlet conduit 18, which in turn leads to the valve chamber 20 terminating in a threaded connection 22 adapted to deliver to a device (not shown) to be filled with liquid under pressure. The valve chamber 20 contains a valve means such as the spring-pressed ball valve 21, which normally closes the communication of outlet conduit 18 with said valve chamber 20, except when the ball 21 is displaced by forcing fluid therearound under pressure from the pump. The valve 21 at all times prevents the return of pressure from the accumulator to the outlet side of the pump by closing the terminal of conduit 18.

The gears 12 and 14 are provided with oppositely extending shafts or journals 24, 28 and both gears are driven through a drive engaging means of coupling element 26. This coupling element 26 is adapted to be engaged by a suitable driving means generally similar to that indicated at 101 in Fig. 3, for rotation of the shaft 24 and gears 12 and 14.

The housing 10 preferably has a hollow base, the hollow portion herein being designated 34, and said housing is also preferably provided with a circular flange portion 30 having the bolt holes 32 for attaching the housing assembly to a supporting means (not shown). In the arrangement shown in Figs. 1 and 2 herein, the drive gear 26 of the shaft 24 driving the gears 12 and 14, is adapted to be connected with a suitable driving means in the space 34.

A flanged end plate bearing and pumping seal defining means in the form of flanged bushings 38, preferably comprised of bronze or the like, include a journal bearing portion 38a for reception of journals 24 and 28 extending axially from the opposite sides of the gears. The radial flange portions 38d of bushings 38 engage the corresponding side faces of the adjacent gears in pumping seal relationship when held thereagainst by pressure will appear.

Ordinarily, the bushing 38 is securely seated in or fastened to the housing 10, and will remain in the position shown in Fig. 1. A fluid seal 40 may be provided between the bushing and housing 10 as shown in Fig. 1, which is to prevent leakage of fluid therearound. Preferably the bushing 38 is provided with what may be defined as an annular relieved recess 42, communicating with a small axial drain channel 44 leading into the space 34, where said liquid may be drained off in any desired manner, such as by finding its way through a hollow portion 36 of shaft 28 to the space 38, herein referred to as sump 80, on the other side of the gear and out the drain 60 provided for that purpose.

On the opposite side of the gears 12 and 14, from the stationary flange bushing 38, there is provided a similar but axially adjustable end plate bearing and pumping seal defining means likewise in the form of a flanged bushing bearing 46. These movable or axially adjustable flanged bushing bearings 46 likewise form the bearing support for the journals 24 and 28.

When the intermeshing gears are delivering liquid under pressure, the surfaces 45a of flanged bushing bearings 46 bear against the side faces 12a and 14a of gears 12 and 14 and effect there-with the necessary pumping seal.

An annular relieved recess 52 corresponding in shape to the annular relieved recess 42 is provided in the movable flange bearing 46, and a drain channel 50 corresponding to the drain channel 44 is likewise formed in the flange bearings 46. The annular relieved recess 52 serves the purpose of draining off seepage from the gears 12 and 14, and of reducing the flange area on which the pumped fluid exerts outward pressure away from the gear. This latter is important, the reason for which will be apparent in the description of the operation hereinafter.

The drain channel 50 preferably discharges into the small space between the hollow end of the bushing 46 and the left hand end of the journals 24 and 28, from whence the fluid so discharged will usually find its way through the centrally oriﬁced end thrust washer 54 into the pump 38 where it will be drawn off as previously indicated.

The movable flange bearing 46 is mounted in the housing 10, with which it has a substantially close fit, which fit provides for limited axial adjustment. A fluid seal ring 55 is shown in Fig. 1 and has been provided to prevent leakage of fluid between the housing 10 and the bearing 46.

Between the movable flanged bearing 46 and housing 10, there is normally maintained a fluid pressure of 150 psi when the bearing 46 is in an engaged position with respect to the gear wheels 12 and 14. The function of this pressure is to prevent the movement of the bearing or bushing away from the side faces of the gears 12 and 14. Under certain conditions, such as when the load on the pump results in the building up of the output pressure.
The thrust washer 54 is held in engagement with the flange bearing 48 as shown in Fig. 1 preferably by a spring 58 which is effective to provide the initial pumping seal.

The pressure chamber or chamber 48 is connected to the outlet conduit 18 by the fluid passage 62. The pressure chamber 48 likewise is provided with an opening to a release means such as the release conduit 44, which leads into what may be termed the chamber 66.

The release chamber 66 comprises a chamber space receiving the hollow threaded sleeve or like closure member 68 which will be described hereinafter, and which carries means closing one end of said chamber 66, and a piston chamber 85 with an opening or port 54 leading to the valve chamber 20. Within the piston chamber 85 is located a sliding piston 88, having a stem 88a effective under selected conditions of pressure to engage ball check valve 74. Piston 88 normally seats against the port 54 and closes the port. There is no communication between the piston chamber 86 and the port 54 for the reason that the slideable piston 88 is always interposed between the two although the piston 88 moves longitudinally in the piston chamber 85 within limits.

The member 68 is hollow and has formed therein a chamber 69. An opening 84 is made from the chamber 69 to the relief or piston chamber 85. The throat 84 is formed by narrowing the chamber 69 near the end thereof, which results in an annular ledge portion forming a seat for the valve 74. This ledge portion is shown at 16. Means such as the port 78 forms a communication for a fluid opening between the chamber 66 and the chamber 69. These ports 78 may be provided at a channeled portion of the sleeve 68 so as to provide positive communication between the release conduit 64 and the chamber 66, ports 78, and chamber 69.

The threaded plug 70 closes the opposite end of the sleeve 68 and forms a seat for the spring 72 urging the valve 74 in the direction of valve seat 76. This plug 70 is adjustable longitudinally of the sleeve 68 so as to vary the tension of the spring 72. The sleeve 68 has threads into the housing 10 and is likewise longitudinally adjustable so as to vary the tension of the spring 99 pressing against the piston 88, and so as to regulate the clearance of the end face of the stem 88a of the piston 88 relative to the ball valve 74.

The purpose of this will be apparent from the description of the operation of the device.

The fluid seal rings 80 and 82 are provided to prevent leakage of fluid around the sleeve 68. The fluid bypass 96 is connected to the piston chamber 85 between the position of the piston and the adjacent end of the sleeve 68. This fluid bypass 96 is for the purpose of conducting fluid from the piston chamber 85 back into the inlet side of the pump.

A drain 60 is provided for conducting fluid which may be entrapped within the sump 88 and discharging such fluid into the bypass 96 leading into the inlet or into some other low pressure area.

Referring next to the arrangement shown in Fig. 3, there is provided a modified form of pump 60 in which the annular relief recesses 42 and 52 of Fig. 1 have been eliminated, for the reason that they are unnecessary with the bushing or end plate arrangement shown in said Fig. 3, and in which the bushing is loaded as a piston across substantially its entire area on one side. In this arrangement a reducing valve has been added whereby the effective pressure acting to load the bushing or end plate may be controlled.

This arrangement comprises the pump housing 110 which is modified somewhat as compared to the housing 10 of Figs. 1 and 2. In this arrangement the gear 112 is shown as having a hollow drive shaft 124 provided with a knurled or grooved integral drive coupling element 120. This drive coupling element 126 extends into the hollow space 104 and is provided therein in the base or flange portion 130 in a manner generally similar to that in Fig. 1.

The cooperating flexible coupling member 101, here shown as integral with the drive shaft 126 extends into the space 134 and drivingly engages the drive coupling element 126 in the well known manner. Fluid sealing means comprising the flexible seal ring 103, the washer 104, and the combined end plate and bearing 105 serves to seal effectively the space 134, while allowing loading of the shaft 126 driving the coupling 126 and gear 112.

This modified construction of Fig. 3 is provided with the fixed flanged bushing bearing 138, the outlet conduit 118, the valve chamber 120, the spring pressed ball valve 121, the inlet conduit 116, the port 134, the port-closing piston 165, the spring 166 and the chamber 166, all of which means are generally similar to the arrangement shown in Figs. 1 and 2 for the same elements.

The device incorporates a modified form of closure arrangement shown generally at 168, which differs slightly from that of Figs. 1 and 2. It comprises the threaded sleeve 168a inserted in the chamber 166 in a manner generally similar to that of the arrangement shown in Figs. 1 and 2. This sleeve 168a contains a ball valve 174 seated on a shoulder 176, said ball valve being loaded by the spring 172 under pressure plug 170. The chamber 169 has the ports 170 placing the interior of chamber 169 in fluid communication with chamber 166. The ball valve 174 is adapted to be engaged by the stem 168a of the piston 168 in the same manner that the ball valve 121 of Fig. 1 is engaged by the stem 88a of piston 88. The gear 112 (as well as the companion gear which is not shown in the cut-away figure but which corresponds generally to the gear 14 in Fig. 1), is abutted on its side opposite the fixed flanged bushing bearing 138 by the axially adjustable or movable flanged bushing bearing 145. This flanged bushing bearing 145 is carried within the housing 110 in the manner indicated in Fig. 3 and forms a bearing for the shaft 126 on the side of the gear 112 on which said movable bearing is located. The flanged bushing bearing 145 differs from the bushing bearing 46 in Fig. 1 in that it is closed across the portion thereof adjacent the end of the shaft 126 and the end of the shaft (not shown) for the other gear wheel. For convenience in reference, this portion will be called the end portion of said bushing bearing. This arrangement permits the pressure loading of the bushing bearing as if it were a piston.

Between the flanged portions of the bushing bearing 145, there is provided what may be termed an annular pressure channel or chamber 146 generally similar to the annular channel or chamber 48 of Figs. 1 and 2. There is a slightly different arrangement of delivering pressure to this pressure channel which will be brought out hereinafter. The end portion of said movable bushing bearing 145 is provided with a clearance or chamber space 145, allowing movement of the piston axially of the shaft 124 and
forming a second pressure chamber by means of which the end portion of the movable bushing bearing may have fluid pressure applied thereto. The spring 158 exerts a constant tension tending to move the bushing bearing 146 against the side of the gear 112 and its companion gear (not shown) for ensuring initial pumping seal as in Fig. 3.

The outlet conduit 116, between the gears and the ball valve 121 is provided with a fluid passage 182, which discharges into a metering valve chamber 163 formed in the housing. This fluid conduit 162 in the manner shown. The metering valve chamber 163 is formed in the housing 110, and contains a regulatable metering valve designated in its entirety as 161. The metering valve 161 and chamber 163 include a valve guide 171 which is fastened in the housing and through which extends a valve 173, here shown as a poppet type valve which seats on the shoulder or ledge portion forming a valve seat 175, in the chamber 163, but which valve may be moved away from said shoulder 175. The collar 171 is provided, which collar has a restricted opening through which the stem of the valve 173 extends, there being considerable clearance between said stem and the valve body whereby fluid may flow to both sides of the collar 171.

The stem of the valve 173 terminates in an integral head having portions thereof spaced from the side wall of the chamber 163, whereby the valve 173 may move axially within the chamber 163, and also whereby fluid entering the chamber 163 from the fluid passage 162 may be conducted past the head portion of the valve 173 and through the opening in the collar around the valve stem as above indicated.

Coll spring 179 is seated in a space provided therefor in a threaded closure plug 181 urging valve 173 in the direction of seat 175. The plug 181 may be rotated into or out of the casing or housing 110 to vary the spring pressure acting on the valve 173, as is clearly apparent from the drawing, whereby the hydraulic pressure exerted on the movable bushing 146 may be regulated as hereinafter more fully described. A bushing leading conduit 183 leads from the portion of the chamber 163 between the metering collar 171 and the valve guide 171, said conduit 183 branching with outlet ports to the annular pressure channel 148 and the pressure chamber 149. Said conduit 183 also has a relief portion 183a leading to the metering valve chamber 163 at what may be termed the bottom end thereof between the shoulder 175 and the closed end of the chamber 163.

There is provided a discharge conduit 185 leading from the portion of the chamber 163 located between the shoulder 175 and the valve guide 171. This discharge conduit 185 discharges into a cross conduit 187 leading from the portion of the chamber 163 between the plunger 188 and the end of the chambered bolt 189. This cross conduit 187 discharges into the inlet conduit 116 for the pump; in other words, it discharges into the low pressure area for the pump.

It is understood that the pressure on the ball valve 174 may be regulated by adjusting the tension of the spring 172. By increasing the size of the insert 170 or the weight of the spring 172, the seating pressure on the ball valve 174 may, if desired, be changed. The particular pressure on said valve, however, is not so important 78 so long as it normally remains closed unless physically unseated by the plunger 188. The tension of the spring regulating the plunger 188 may be varied by threading the chambered sleeve 185a downward into the housing as will be obvious from examination of Fig. 3.

The operation of the device of Figs. 1 and 2 will be readily apparent from an examination of said figures. When the pumping operation is being performed, the coupling 28 will normally be turned in an anti-clockwise direction as shown in Fig. 1, turning the gears 12 and 14 so as to carry fluid or liquid from the inlet conduit 18 into the outlet conduit 18. Until the delivery pressure is built up to a predetermined amount, the ball valve 74 will remain seated, and communication with the relief conduit 84 will thus be closed off. By reason of the pressure of the spring 58, the movable bushing bearing 46 will normally move up against the gears 12 and 14, so that fluid from the outlet 18 is introduced through the fluid passage 62 to the pressure chamber 48, pressing the movable bushing bearing 46 against the gear wheels 12 and 14. The resultant pressure urging the bushings into pumping seal engagement with the gear side faces will remain greater than the oppositely acting force on the gear side by small differential determined by the relative areas of surface 46b of the flange exposed to pressure within the pressure chamber 48 and the area of surface 46a on the gear side of the bushing flange. The amount of the flange area exposed to the action of the pressure in the channel 48 will remain substantially greater during the pumping action because of the area "blocked off" by the teeth of the gear, because of the low pressure area due to the annular relief recess 82, and because of the surface against the portion of the gears which do not carry liquid in the pumping operation. As long as there is substantial pressure in the pressure channel 48 the bushing will remain in firm pumping seal engagement with the side faces of gears 12 and 14.

When such is the case, the fluid from inlet 18 will be discharged into the outlet 18 and will force its way past the ball valve 21 into the chamber 20 and into the accumulator or other, consumer (not shown). When the desired pressure has been reached, for example 1000 pounds per square inch, the pressure in the chamber 20 will overcome the resistance of the spring 90 on the piston 88, and force the piston 88 toward the ball valve 74, unseating said ball valve and allowing communication from the chamber 68 into the piston chamber 86. The fluid from the pressure channel 48 will thus be relieved through the relief conduit 64 into the chamber 68 and through the port 78 into the chamber 63 from where it flows into the piston chamber 83 and out the fluid bypass 56 into the inlet side of the pump. This release of pressure will cause the bushing 46 to move outward some distance, allowing the gears 12 and 14 to rotate substantially free, or in other words, allowing the liquid to circulate about the gears at an appreciable pressure. The ball valve 21 will engage its seat, and any fluid in the outlet chamber 18 which may be under pressure will be conducted off through the relief conduit 64 in the manner above described. Thus it will be seen that the bushings are not held against the wheels 12 and 14 enough to overcome the outward pressure of the fluid in the gears, and the gears are permitted to run substantially free. This relieves the driving means of a substantial load.
As soon as the pressure exerted on the piston 88 drops as a result of pressure liquid being consumed, this allows the piston 88 to move back far enough for the ball valve 74 to engage the shoulders 76, thus the relief conduit 84 will be closed and will have the effect of blocking that conduit substantially as effectively as if it did not exist. With the ball 21 being pressed against the opening of the outlet conduit 18, the pressure in said conduit 18 will build up and will be forced into the fluid passages 82 and the pressure channel 48, securely sealing the bushing bearing against the side faces of the gears. The increment of pressure as above stated is always greater in the direction of producing a pumping seat and thus the pumping operation continues until the pressure in the outlet 18 is built up sufficiently to displace the ball valve 21 and start delivering to the accumulator or other consumer. This continues until the discharge pressure rises to a value to again cause piston 88 and plunger 82a to push the ball valve 74 out of engagement with the shoulder 76 and the cycle of operation is repeated.

It is occasionally true that there will be some leakage around the flange portions between the flange and the cover. This entrapped fluid will normally enter the annular channels 42 and 52 and be drawn off through the drains 44 and 50. That fluid going through the drain 44 is discharged ordinarily into the space 34, from whence it will find its way back through the bore 38 of shaft 28 into the supply end 36 and is drawn off through the drain 50. It is possible, however, to draw this fluid off in any other manner desired such as by a drain directly from the base 34 into the inlet 15.

The operation of the construction shown in Fig. 3 is generally similar to that of Figs. 1 and 2 except for the metering valve and for the loading of the movable flange bearing. When the pressure in the accumulator or other consumer (not shown) connected to the outlet of the valve chamber 30 falls below the desired amount, the piston 180 assumes the position shown in Fig. 3 and the ball valve 174 likewise is closed as shown on its seat. The pressure in chamber 118 builds up into the passage 162, the pressure exerted by the spring 156 on the bushing being sufficient to produce pumping action under such circumstances. Fluid under pressure will enter the metering valve chamber 163, will be metered past the head of the valve 173 through the collar 171 and into the pressure loading conduit 165. This metered pressure will be exerted on the surface of the movable flange bearing in the pressure channel 148 and a pressure chamber 145. The increment of such pressure will depend upon the amount of surface under pressure on the loading side of said flange bearing as compared to the amount of surface on the gear side of said flange bearing subjected to pressure.

When the pressure in outlet conduit 118 rises above the value of the pressure beyond valve 121 the valve will be opened and pressure liquid delivered therebeyond. When the desired pressure has been reached, the piston 180 will be displaced and be pressing the ball valve 174. This allows the pressure in the fluid passage 162 to discharge through the port 165 and ports 176 past the ball into the low pressure area of the cross conduit 187 from where it is led into the inlet port 116. When this occurs the back pressure in the loading conduit 183, pressure channel 148, and pressure chamber 145, will flow out through the metering valve chamber, port 165, into the cross conduit 187 and the movable flange bearing will be relieved of its fluid load allowing it to move away from the gear wheel sufficiently to substantially unload the pump.

It may be noted that if the axial pressure force in the pump exerted on said flanged bearing 145 becomes greater than the increment desired, it may be reduced by adjusting the poppet valve 173 so that it will be unseated at the predetermined pressure. This will allow the excess pressure to escape through the discharge conduit 165 to the low pressure area, while retaining the desired increment of pressure acting on the bushing bearing.

There are of course a number of modifications which can be made in the construction shown. For example, both the bearings 138 and 148 may be made movable. Further, instead of the plurality of gears 12 and 14, some other well known form rotor might be used.

It is understood that the foregoing description is merely illustrative of a preferred embodiment of the invention and that the scope of the invention therefore should not be determined thereby but should be determined instead by the appended claims.

We claim:
1. A device of the class described, comprising in combination a housing, a pair of intermeshing gears forming a pumping means in said housing, each gear having axially extending journals and at least one of said gears having driving means in connection with one of said journals, fixed flange bushing means forming a bearing means for journals on one side of said gears and likewise forming the closure means for the side face of said gear on said side, a movable unloading flanged bushing bearing on the other side of said gears forming a bearing means for the corresponding journals, said movable flange bushing forming an adjustable closure for the adjacent face of said gears, inlet and outlet means for fluid pumped by said gears, an annular pressure variable channel formed between said housing and the flange portion of said movable bushing bearing, a pressure variable chamber formed between the housing and the end portion of said bushing bearing, conduit means leading from the outside side of said gears whereby fluid under pressure is pumped to the annular pressure channel and pressure chamber above mentioned, the arrangement being such that fluid pumped by said gears exerts pressure on said bushing bearing in said pressure chamber, and in said annular pressure channel urging said movable flange bushing bearing against said gears, and valve means relieving the fluid pressure on said movable bushing bearing when it reaches a predetermined amount, a metering valve in the fluid conduit means between the pump outlet and said annular pressure channel and pressure chamber, effective to regulate the pressure applied to said bushing bearing.

2. A device of the class described, comprising in combination a housing, a pair of intermeshing gears forming a pumping means in said housing, each gear having axially extending journals and at least one of said gears having driving means in connection with one of said journals, fixed flanged bushing means forming a bearing means for the corresponding journals on one side of said gears and likewise forming the closure means for the side face of said gears on said side, a movable unloading flanged bushing bearing on the other side of said gears forming a bearing means for the corresponding journals, said movable flanged
bushing bearing means forming an adjustable closure for the adjacent side faces of said gears said bushing bearing means having a closed terminal portion, inlet and outlet means for liquid to be pumped by said gears, an annular pressure variable channel formed between said housing and the flange portion of said movable bushing bearing, a pressure variable chamber formed between the housing and the closed terminal portion of said bushing bearing, conduit means leading from the outlet side of said gears whereby fluid under pressure is pumped to the annular pressure channel and pressure chamber above mentioned, the arrangement being such that fluid pumped by said gears exerts pressure on said bushing bearing in said pressure chamber, and in said annular pressure channel urging said movable flange bushing bearing against said gears, and valve means relieving the fluid pressure on said movable bushing bearing when it reaches a predetermined amount, a manually adjustable metering valve in the fluid conduit means between the pump outlet and the movable bushing bearing.

3. A liquid pressure pump comprising; a housing containing a pair of adjoining substantially cylindrical chambers having generally radially extending end walls, said housing also having a low pressure liquid inlet leading to a high pressure liquid outlet leading from said chambers; toothed gear members in said housing chambers respectively, said gear members meshing at the juncture of said cylindrical chambers and functioning to generate liquid pressure; bores in the end walls of said housing chambers forming reduced coaxial extensions of said cylindrical chambers, said gear members having journals extending from the opposite sides thereof into said reduced bores; bearings and pumping seal defining means including tubular portions surrounding said journals and received in the reduced bores on said one side of said gear members and substantially annular flange portions at the inner ends of said tubular portions received in said cylindrical chambers, said annular flange portions each having a front face cooperable with the adjacent side face of its corresponding gear member, said front face and said side face constituting a pair of adjacent faces which provide an area forming a pumping seal between said respective gear members and said annular portions during pumping, said front faces being subject to the gear generated pressures in said cylindrical chambers in communication with the gear teeth, each of said annular portions also having a back face normally spaced from the adjacent radial end wall of its associated housing chamber to provide an annular control pressure space at the back face of each of said annular portions; and pressure responsive means effective during a selected range of pump generated pressures to place said annular pressure spaces in communication with said generated pressures whereby said pressures act on said back faces to urge said front faces into sealing engagement with said gear side faces, said pressure responsive means being further responsive to the occurrence of a predetermined maximum output pressure to thus unload said pump and circulate fluid from the outlet past said flanged annular member front face to said inlet.

4. A liquid pressure pump comprising; a housing containing a pair of adjoining substantially cylindrical chambers having generally radially extending end walls, said housing also having a low pressure liquid inlet leading to and a high pressure liquid outlet leading from said chambers; a toothed gear member in each of said housing chambers, said gear members meshing at the juncture of said cylindrical chambers; bores in the end walls of said housing chambers forming reduced coaxial extensions of said cylindrical chambers, said gear members having journals extending from the opposite sides thereof into said reduced bores; bearing and pumping seal defining means in said housing on at least one side of said gear members, said bearing and pumping sealing means including tubular portions surrounding said journals and received in the reduced bores on said one side of said gear members and substantially annular flange portions at the inner ends of said tubular portions received in said cylindrical chambers, said annular flange portions each having a front face cooperable with the adjacent side face of its corresponding gear member, said front face and said side face constituting a pair of adjacent faces which provide an area forming a pumping seal between said respective gear members and said annular flange portions during pumping, said front faces being subject to the pressures in said cylindrical chambers in communication with the gear teeth, each of said annular portions also having a back face normally spaced from the adjacent radial end wall of its associated housing chamber to define with said housing an annular motive chamber for exerting leading pressure on said annular flange portions, said motive chamber being of sufficient capacity to provide for the axial movement of said annular flange portions away from said gear side faces resulting in relatively low pressure return flow of fluid from the outlet of said pump back to the inlet of said pump when the pressure is relieved from said control pressure chamber; means effective during a selected range of outlet pressures to maintain said annular pressure spaces in communication with pump generated pressures, said means being responsive to the occurrence of a predetermined maximum value of pressure to place said annular motive chambers in communication with said inlet to thus relieve the pressure in communication with said back faces and cause said bearing and seal defining means to move axially away from said gears to thus unload said pump and circulate fluid from the outlet past said flanged annular member front face to said inlet.

5. A liquid pressure pump comprising; a housing containing a pair of adjoining substantially cylindrical chambers having radial end walls, said housing also having an inlet leading to said an outlet leading from said chambers; a toothed gear member in each of said housing chambers, said gear members meshing at the juncture of said cylindrical chambers; bores in the end walls of said housing chambers forming reduced coaxial extensions of said cylindrical chambers, said gear members having journals extending on the opposite sides thereof into said reduced bores; bearing and pumping seal defining means in said housing on at least one side of said gear members, said bearing and pumping sealing means including tubular portions surrounding said journals and received in the reduced bores on said one side of said gear members
and substantially annular flanged portions at the inner ends of said tubular portions received in said cylindrical chambers, said annular flanged portions each having a front face cooperating with the adjacent side face of its corresponding gear member, said front face and said side face constituting a pair of adjacent faces which provide an area forming a pumping seal between said respective gear members and said annular portions during pumping, said front face being subject to the pressures in said cylindrical chambers in communication with the gear teeth, each of said annular flanged portions also having a back face normally spaced from the adjacent radial end wall of its associated housing chamber to provide an annular control pressure space at the back face of each of said annular portions, means defining relief recesses disposed radially inwardly of the roots of the teeth of said gear members, and communicating with the radial inner portions of the area providing said pumping seal; means establishing communication between said relief recesses and a zone under less pressure than the pressure in said outlet under normal pumping conditions; said annular control pressure space being of sufficient capacity to provide for the axial movement of said annular flanged portions away from said gear side faces to provide clearance for the return flow of fluid from the outlet of said pump to the inlet of said pump when the pressure is relieved from said control pressure chamber; means effective during a selected range of outlet pressures to maintain said annular pressure spaces exclusively in communication with pump generated pressures, said last named means being responsive to the occurrence of a predetermined maximum pressure to place said annular spaces in communication with said inlet to thus relieve the pressure in communication with said back faces and cause said bearing and seal defining means to move axially away from said gears to unload said pump and recirculate fluid from the outlet past said flanged annular member front face to said inlet.

6. A liquid pressure pump comprising: a housing having substantially cylindrical chambers having generally radially extending end walls, said housing also having an inlet leading to and an outlet leading from said chambers; intermeshing gears in said housing chambers, said gears meshing at the juncture of said cylindrical chambers; bores in the end walls of said housing chambers forming reduced coaxial extensions of said cylindrical chambers, said gear members having journals extending from the opposite sides thereof into said reduced bores; bearing and pumping seal defining means in said housing on at least one side of said gears, said bearing and pumping seal defining means including tubular portions surrounding the journals and received in the reduced bores on at least one side of said gear members and substantially annular radially extending portions of each of said tubular portions received in said first named cylindrical chambers, said annular portions each having a front face cooperative with the adjacent side face of its corresponding gear, said front face and said side face constituting a pair of adjacent faces forming a pumping seal between said respective gear members and said annular portions during pumping, one of said two last mentioned faces having a relief recess formed therein inwardly of the roots of the gear teeth, said front faces being subject to the pressures in said cylindrical chambers in communication with the gear teeth, each of said annular portions also having a back face normally spaced from the adjacent radial end wall of its associated housing chamber to provide an annular motive pressure space at the back face of each of said annular portions; means establishing communication between said relief recess and said inlet; and means effective during a selected range of outlet pressures to place said annular motive pressure spaces exclusively in communication with pressures generated by said gear members, means being further responsive to the occurrence of a predetermined maximum pressure in said outlet to place said annular motive pressure spaces in communication with said inlet to thus relieve the pressure in communication with said back faces and cause said bearing and seal defining means to move axially away from said gears to unload said pump and permitting the recirculating flow of fluid from the outlet back between the gear side faces and said front faces of said annular portions to said pump inlet.

7. In a liquid pressure gear pump: means defining a housing having a low pressure liquid inlet, a high pressure liquid outlet and an intervening pumping chamber including spaced end walls; intermeshing liquid displacing gears received in said pumping chamber between said end walls; end plate bearing and pumping seal defining means in said chamber, said end plate bearing and pumping seal defining means having a first generally radially extending surface engaging with the adjacent gear side face and being radially outwardly coextensive with the gear teeth, said end plate bearing and pumping seal defining means having a second oppositely facing surface normally separated from the adjacent end wall of said chamber to provide a space for liquid under pressure generated by said gears effective upon said second surface for holding said first surface in contact with the pressures generated by said gears during a selected range of said pressures; and means responsive to the generation of a selected maximum value of liquid pressure by said gears effective to place said space in communication with a zone of lower pressure than the pressure being generated by said gears, whereby to cause said first surface of said end plate bearing and pumping seal defining means to be moved out of pumping seal engagement with said gear side face and thus unload said pump.

8. In a liquid pressure pump: means defining a housing having a low pressure liquid inlet, a high pressure liquid outlet and an intervening pump chamber receiving intermeshing gears between the end walls thereof adapted to be driven by an external source of power for generating liquid pressure; axially adjustable bearing and pumping seal defining means in said chamber adjacent at least one side face of each of said gears, said means including a radial flange portion having a first surface on one side thereof radially outwardly coextensive with the gear teeth, said flange portion having a second surface on the opposite side thereof normally separated from the adjacent housing end wall and providing a space for liquid under pressure generated by said gears for urging said radial flange into pumping seal relation with the associated gear
face; conduit defining means effective to place said space and second surface in pressure liquid communication with the pressure generated by said gears; and means responsive to the generation of a pressure by said gears having a selected maximum value effective to place said space in communication with said inlet whereby to cause said first surface of said bearing and pumping seal defining means to move axially out of pumping seal engagement with said gear side face and the liquid in said pump to be recirculated from the outlet of said gears back to the inlet to said gears between said gear side face and said flange to thus relieve the load on said pump.

9. In a pressure liquid gear pump: means defining a housing having a low pressure liquid inlet, a high pressure liquid outlet and an intervening pumping chamber including spaced end walls; rotary interm ething liquid displacing gears received in said pumping chamber between said end walls; end plate bearing and pumping seal defining means in said chamber, said end plate bearing and pumping seal defining means having a first generally radially extending surface engageable in bearing and pumping seal relation with the adjacent gear side face and being radially outwardly coextensive with the gear teeth, said end plate bearing and pumping seal defining means having a second surface opposed to said first surface normally separated from the adjacent end wall of said chamber to provide a space for liquid under pressure generated by said gears effective upon said second surface for holding said first surface in pumping seal relation with said gear side face; means effective to place said space and second surface in communication with liquid pressure generated by said gears, said means including passage means for leading liquid to said space and a reducing valve for producing a drop in the pressure delivered from the outlet of said gears to said space; and means responsive to the generation of a selected maximum value of liquid pressure by said gears to place said space in communication with a zone of lower pressure than the value of said reduced pressure to thus cause said first surface of said end plate bearing and pumping seal defining means to be moved out of sealing engagement with said gear side face and thus relieve the load on said pump.

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