

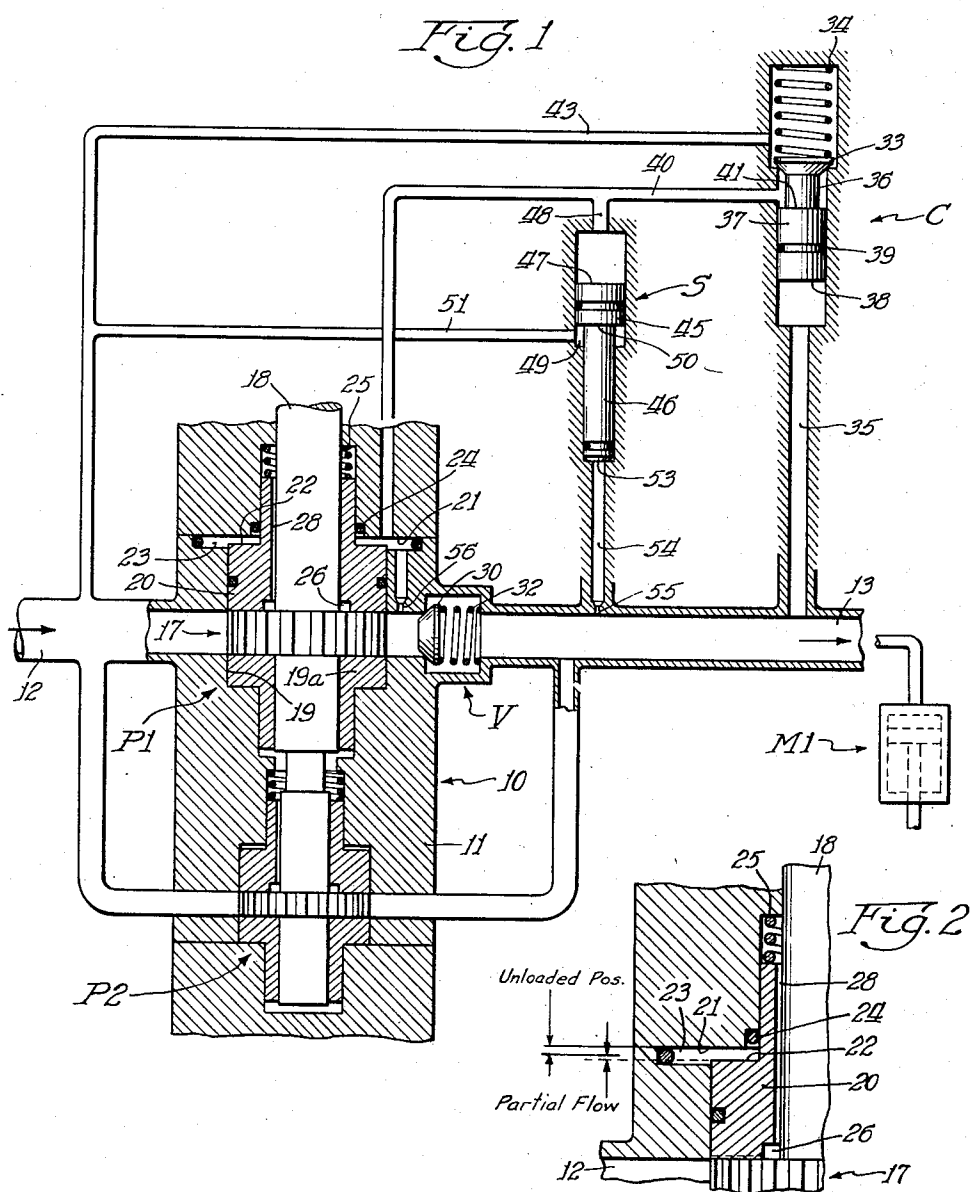
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GEAR PUMP

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2,845,868

GEAR PUMP

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This invention relates to hydraulic power units, and is particularly concerned with an improvement in an arrangement of fixed displacement intermeshing gear type pressure generators or pumps wherein the pumps of such an arrangement operate to deliver non-compressible liquid pressure to a resistance consumer or motor and wherein automatic means function to vary the output of one of said pumps over a range of pressures according to the demand for pressure made upon the arrangement by said motor.

In the U. S. Patent 2,505,191 there was disclosed an effective and commercially practical arrangement for effective unloading a selected one of a group of pressure generators upon the occurrence of a pre-determined maximum delivery pressure without unloading the entire output of the generators by means of complicated and expensive valve structures. In that patent, the liquid pressure generating unit comprising a pair of intermeshing gear pumps of the pressure loaded type having at least one set of axially adjustable pressure loadable end plates or bearing bushing defining means (sometimes hereinafter referred to as bushings) was disclosed as disposed in a unitary housing with the pressure loadable bushings of each of the separate pumps responsive to loading pressure generated by their respective gears which loading pressure is effective under pre-determined conditions to maintain said bushings in pumping seal engagement with the corresponding side faces of the pump gears. The unit was further characterized by the incorporation in said housing of a pilot control or unloading valve means responsive to the combined or joint output pressure of said pumps. When the combined pressure reached a selected maximum value, the pilot control valve functioned to relieve the loading pressure acting on the bushings of one of the pumps thus permitting the relieved bushings to move axially out of sealing engagement with the adjacent gear side faces permitting the pressure generated by said one of the pumps to return to inlet. In this unit the unloaded condition of the selected pump was maintained until a pre-determined minimum pressure condition was reached whereby the selected pump was again loaded.

The above described unit, as shown in the Lauck patent, was particularly characterized by being operable to provide a well-defined and clear-cut pressure point at which a selected one of the pumps was to be unloaded and maintained unloaded without the presence of hunting or cutting in or out of said selected pump which usually means that the selected pump to be loaded or unloaded delivers usually either full flow or zero flow during its operation.

However, it has been found in practice that it is particularly desirable to have the pump selected to load and unload under pre-determined conditions to deliver not only full flow and zero flow as the selected pump would do when constructed in accordance with the teachings of the aforementioned Lauck patent but, to deliver

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a partial rate of flow according to the demand made upon the unit by the resistance consumer motor. This partial rate of flow demand made upon the selected pump in the arrangement described in the Lauck patent 2,505,-

- 5 191 caused what is known as chattering caused by the inter-cooperation and inter-relationship in effective sizes of the unloading valve and the axial movable bushings. For example, it has been found that in order for the selected pump to supply a partial rate of flow after having been unloaded it is necessary that its bushings travel from a fully unloaded position to some intermediate position between the pumping seal position when the pump is fully loaded and the fully unloaded position. Under these circumstances the bushings, being sensitive to the pressure demand, over-travel or go beyond the desired intermediate position and must return to the desired intermediate position—causing hunting or chattering. Obviously, too, the action of the bushings of the selected pump can detrimentally offset the operation of the un-
- 10 loading valve.

It is, therefore, a primary object of my invention to improve the arrangement described in the Lauck patent by providing that arrangement with a means to allow the pump, selected to unload and load, to deliver not only

- 15 full flow or zero flow of fluid but also partial flow of fluid according to the demand made on the entire unit without chattering or over-travel on the part of the bushings of the selected pump.
- 20 Briefly, my invention incorporates in the arrangement of the type herein described a shuttle type device which effectively cooperates with the unloading valve and the pressure loadable bushings in the pump selected to deliver a range of flow which will temporarily stop the bushings immediately prior to reaching their partial flow
- 25 position from the fully unloaded position and then allow the bushings to travel to their selected intermediate position after a short interval of time. This momentary stopping of the bushings in their travel and then allowing them to proceed to their final position acts to decrease over-travel thus minimizing chattering, allowing the power unit to deliver any flow rate the consumer motor may demand. It has been found also that the shuttle device tends to dampen out pulsations or surges in the outlet or discharge during the partial flow of the operation of the power unit by transferring these pulsations and surges to the pressure loading chamber where they can escape through the unloading valve to inlet pressure. A more complete operation of my present invention will be explained in detail hereinafter.

- 30 Accordingly, it is a specific object of my invention to incorporate a shuttle type device in a power unit of the type herein described advantageously arranged to co-operate with the pressure loadable bushings of one of the pumps of the power unit and with the unloading valve to allow said power unit to deliver, without chattering, any flow rate the system or consumer motor may demand.

- 35 A still more specific object of my invention is to incorporate a shuttle type device in a power unit of the type herein described which will reduce pulsations and surges in the discharge side of the power unit.

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

- 45 Figure 1 is a schematic, partially sectional view of a hydraulic pressure power unit constructed in accordance with my present invention showing to advantage the construction and arrangement of the anti-chattering shuttle device; and

- 50 Figure 2 is an enlarged size, schematic in partially sec-

tional view of a pressure control chamber and a portion of the bushing and housing shown in Figure 1.

Referring in greater detail to the embodiment shown in the drawings, there is shown a liquid pressure power unit, indicated in its entirety as 10, comprising a unitary housing 11 having a common low pressure liquid inlet 12, a common high pressure outlet 13 and incorporating therein a first intermeshing gear type pressure generator or pressure loaded pump P-1, a second intermeshing gear type pressure generator or pressure loaded pump P-2, a one-way check valve assembly V, a pilot control or unloading valve assembly C and a shuttle control device assembly S.

Pressure loaded pump or liquid pressure generator P-1 is preferably constructed in general conformity with the disclosure and claims of the U. S. Patent 2,420,622 to Roth et al. and comprises essentially a pair of intermeshing gears (one shown) indicated in their entirety as 17 mounted on axially extending shafts (drive shaft 18 being shown) received in a pump chamber 19 formed in the housing 11 and journaled in a pair of fixed body bushings 20 (one shown) and a pair of axially movable, pressure loadable, bearing bushing defining means 21 (one shown) engaging the gear side faces on one side thereof in pumping seal relation. The bushings are formed radially co-extensive with the gear teeth and sufficient clearance is provided between the axially movable bushings 20 and the adjacent end wall 21 of the housing to permit axial movement of the bushings.

In the operation of a pump of the pressure loaded type, a portion of the discharge pressure generated by the intermeshing gears is communicated from the outlet or discharge side thereof to annular motive pressure surface areas 22 at the back of the axially movable bushings. The bushings including motive surface areas 22 cooperate with the adjacent wall 21 of the housing to define behind each bushing an annular pressure loading or motive pressure chamber indicated in its entirety as 23. Escape of pressure rearwardly of the pressure loading chambers 23 is substantially prevented by means of an O-ring seal 24 disposed about the rear portion of each bushing in a suitable annular groove formed in the periphery of the bushing or in the adjacent bore wall. Any pressure leaking past the O-ring seals 24 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-referred-to Roth et al. Patent 2,420,622 or in the Lauck Patent 2,505,191.

To provide an initial sealing relationship between the bearing bushing defining means and the gear side faces coiled compression springs 25 are disposed against the bushings to urge the forward surfaces thereof into engagement with the gear side faces.

In the usual pressure loaded pump constructed in accordance with the teachings of the aforementioned Roth et al. Patent 2,420,622, relief recesses, such as 26, are formed in each of the radially inner portions of the forward or gear engaging surfaces of the axially movable pressure loadable bushings 20 and are placed in communication with a pressure lower than the discharge pressure generated by the pump through a clearance between the gear journals and the bushing bores or by specific grooves or channels 28 extending axially of the inner cylindrical surface of the bore of the bushings. These recesses 26 control the effective pressure area relationship between the rear or motive surfaces 22 and the forward gear engaging surfaces of the pressure loadable bushings, the area and size of these recesses being determined in any particular pump so as to control the effective pressure in such a manner that the axial force resulting from the pressure generated by the pump acting against the forward gear engaging surfaces of the bushings tending to produce an axial movement of the bushings away from the gear side faces is effectively controlled and overcome by the oppositely directed loading forces acting against

the rear or motive surfaces 22 of the bushings which latter axial forces are made, in practice, to slightly exceed the first mentioned axial forces and thereby maintain sealing engagement with the gear side faces.

The secondary pump P-2 is constructed in a manner identical to that of pump P-1, hence no detailed description thereof is deemed necessary. It will be noted that in the arrangement described in the aforesaid patent to Lauck 2,505,191, the small displacement pump P-2 is disclosed as having a different construction of its bushings and its housing in order to provide the maximum motive surface area on the back face of the bushings, the particular construction of which was disclosed and claimed in Wichorek Patent 2,472,031. However, in view of the schematic showing of this application, the pressure loadable bushings of pump P-2 are shown as having a construction identical to that of the pressure loadable bushings 20 of the pump P-1.

One-way check valve assembly V between pump P-1 and pump P-2 comprises a disc-like valve proper 30 seating in the direction of flow from pump P-1 with coiled compression spring 32 functioning to urge the valve proper 30 in the direction of its seal. Delivery of pressure from the pump P-1 is effective to open valve 30 and permit flow from pump P-1 to the common outlet 13 while any tendency of liquid to flow from pump P-2 in the direction of discharge side of pump P-1 is prevented by the automatic closing of the valve proper 30.

Pilot control valve assembly C comprises disc-like or conically shaped valve proper 33 suitably chambered for axial movement in housing 11 and urged in the direction of its seat by means of coil compression spring 34 against the flow of fluid from the combined discharge pressure of pumps P-1 and P-2 when pump P-1 is discharging full or partial flow or against the output pressure of pump P-2 when pump P-1 is fully unloaded; this pressure communication being effective through passage 35. Reduced stem 36 connects the valve proper 33 with motive piston 37, motive surface 38 of which is responsive to the discharge of pumps P-1 and P-2, as aforesaid, through passage 35. O-ring seal 39 is disposed in suitably formed grooves in piston 37 to prevent pressure communication leaking past motive surface 38 toward valve proper 33. Valve proper 33 is in pressure communication with motive pressure chambers 23 of pump P-1 through passage 40 and it is important to note that the area 41 of piston 37 facing valve proper 33 is the same as the effective area of valve proper 33 thus completely balancing valve proper 33 against any influence exerted by pressure from passage 40. In other words, the development of pressure acting upon the motive surface area 22 in motive chambers 23, while in communication through passage 40 with valve proper 33, nevertheless has no influence on valve proper 33. Thus valve proper 33 is completely and entirely responsive to the delivery of pressure upon check valve assembly V which is the delivered pressure of both pumps P-1 and P-2 when pump P-1 is fully or partially loaded and the delivered pressure of pump P-2 when pump P-1 has been fully unloaded. Too, pump P-2, while of small displacement, is of sufficient capacity to make up for any losses by leaks, etc. and at the same time maintain the requisite pressure or motive surface 38 of piston 37 for the purpose of maintaining valve proper 33 open until the flow demand becomes more than pump P-2 can deliver. Obviously, spring 34 can be adjusted in any suitable manner for the purpose of varying its compression value. Opening of valve proper 33 communicates pressure in line 40 from motive pressure chamber 23 to inlet 12 by means of passage 43.

Shuttle type device S comprises an enlarged piston portion 45 and a reduced piston portion 46 suitably chambered for axial movement in housing 11. Enlarged piston portion 45 has a motive surface area 47 subject

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to pressure in chambers 23 acting upon the motive pressure responsive surfaces 22 through passages 40 and 48. Chamber 49 formed by the housing 11, reduced piston portion 46 and area 50 on the side opposite motive surface area 47 is vented to inlet pressure through passages 51 and 43. Motive pressure surface 53 on reduced stem portion 46 at the other extremity of shuttle device S from motive pressure area 47 is communicated to outlet 13 passage so as to be responsive to the combined discharge pressure of pumps P-1 and P-2, or to the discharge pressure of pump P-2 when pump P-1 is fully unloaded through passageway 54 and restricted orifice 55 formed to communicate with outlet passage 13. It is important to note also that discharge pressure delivered by pump P-1 intermediate the discharge side of gears 17 and one-way valve assembly V to pressure loading chambers 23 and to motive surface area 47 of shuttle device S will be restricted in its flow by orifice 56 formed, in the embodiment shown, in the housing. The purpose of restricted orifices 55 and 56 will be explained fully hereinafter.

In the operation of a hydraulic power unit of the type herein described, upon the starting of pump P-1 and P-2, by rotation of common drive shaft 18, pressure in common high pressure outlet 13 will rise, determined, of course, by the relative displacements of pumps P-1 and P-2 and the pressure demand of motor M-1. The combined pressure in outlet 13, upon reaching the predetermined pressure level, acts upon motive surface area 38 of piston 37 in unloading valve C to open valve proper 33 and relieved of fluid pressure in motive chambers 23 acting upon the rear or motive surfaces 22 of the axially movable bushings 20 of pump P-1 thus permitting the bushings 20 to move axially away from or out of pumping seal engagement with the side faces of gears 17. This action unloads pump P-1 as hereinbefore described, and unless the flow demand made upon the unit is more than the flow that can be developed by the relatively small displacement pump P-2, the bushings 20 of pump P-1 will come to rest against the pump housing—the fully unloaded position of bushings 20. It can be seen that at any flow demand on the unit between a full flow, developed by both pumps P-1 and P-2 fully loaded, and the flow developed by the small pump P-2, when P-1 is fully unloaded, will move the bushings 20 to positions intermediate the position of pumping seal engagement and the fully unloaded position such as some intermediate position in the partial flow range indicated in Figure 2.

A study of Figure 2 will show that the movement of the bushings 20 in a typical operation of a unit of the type herein described that any intermediate position of partial flow development is at a very small distance from the gear side face. The distances actually involved in a typical unit is between five thousandths of an inch from the gear side faces. The remainder of the distance that the bushings travel, from the pumping seal engagement position adjacent the gear side face to the fully unloaded position against the pump housing, is for the purpose of relieving any back pressure developed inside the pump P-1 and by-passing this back pressure to inlet across the gear side faces. Obviously, any internal or back pressure in pump P-1, under these circumstances, is very small.

During operation, as the flow demand on the unit is such that the flow developed by the pump P-2 is sufficient, pump P-2 will maintain unloading valve C open and bushings 20 will be in their fully unloaded position with no further delivery of pressure from pump P-1 past one-way check valve assembly V. Obviously, under these conditions, shuttle device S is in an upward (as viewed in Figure 1) position by action of the pressure in passage 54 acting on motive surface area 53; the pressure acting on motive surface area 47 having been

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relieved to inlet. Orifice 55 between discharge outlet 13 and passage 54 is employed for the purpose of slowing shuttle device S in its upward travel.

When the motor M-1 demands more flow than pump P-2 can deliver, the pressure developed by pump P-2 drops and unloading valve C tends to close because of this drop of pressure acting on motive surface area 38 and by action of spring 34 in opposition thereto. This movement of unloading valve C, creates an orifice, formed by valve proper 33 and its corresponding seat, which is set slightly less in size than orifice 56 adjacent the pumping gears 17 of pump P-1. As soon as the orifice in unloading valve C is created, pressure in the pressure loading chamber 23 begins to rise to equal any back pressure in pump P-1 intermediate the discharge side of gears 17 and one-way valve assembly V.

When the pressure in pressure loading chamber 23 rises sufficiently to equal any back pressure in pump P-1, pressure loading of the bushings 20 begins and the bushings are urged toward the gear side faces of gears 17. As the bushings move toward the gear side faces, and approach the partial flow range, as more clearly indicated in Figure 2, pressure in pump P-1 concurrently begins to rise and pressure in the pressure loading chamber also increases since the pressure developed by P-1 is communicated to the pressure loading chamber 23 through orifice 56. This concurrent pressure increase continues until the internal or back pressure in the pump P-1 slightly exceeds the pressure developed by the pump P-2, at which time one-way valve assembly V opens and pump P-1 starts delivering flow to the common discharge outlet 13.

In order to reduce over-travel and hunting of the bushings and reduce chattering of the unit during the action of the bushings described in the above paragraph which occurs when partial flow is demanded of the unit, shuttle type device S has been arranged to have an effective pressure area relationship with respect to the bushings 20 such that immediately prior to the pressure in pump P-1 reaching the value sufficient to open one-way check valve assembly V and deliver flow into the common discharge outlet 13, the pressure rise in conduits 40 and 48 will act upon motive surface area 47 of piston 45 to start the piston on its downward (as viewed in Figure 1) stroke. While piston 45 is travelling downwardly, the bushings 20 stop their movement toward the pumping gear side faces by reason of the fact that any flow through orifice 56 is now used to move the piston 45 instead of the bushings 20. As soon as the piston 45 reaches the end of its stroke, the bushings 20 again resume their travel toward the gear side face, however, the bushings have only a little distance to travel.

Turning again now to Figure 2 it can be seen that the distance that the bushings travel to reach their partial flow position is relatively long and because of this the bushings have a tendency to over-travel and hunt with resultant chattering of the pump. Now with the unbalance of the effective pressure area of the shuttle device with respect to the bushings 20 as aforesaid, the bushings will cease their travel immediately prior to their reaching their partial flow position, such stopping point being either at the beginning of or slightly within the partial flow range, until the shuttle device piston has completed its full stroke. When shuttle device piston reaches the end of its stroke, the bushings will resume their travel to their desired position.

In a typical example of the length of travel of the bushings it has been found that from fully unloaded position to the beginning of the partial flow range, is a distance of approximately fifty thousandths of an inch while the remaining distance that the bushings travel after the shuttle device complete its stroke can vary from one to five thousandths. Any over-travel and hunting because of this pause would obviously be substantially less than it would have been had the bushings travelled

the full fifty-one to fifty-five thousandths without pause.

It is important to note also that when the axially movable bushings 20 are in any of their partial flow positions in the partial flow range indicated in Figure 2 they are susceptible to movement by any fluctuations or surges in the high pressure output line 13. A surge toward higher pressure is normally expected to urge the bushings away from the gear side faces because of the increase in pressure across forward gear engaging surfaces of the bushings, however, it can be seen that any such surges will also urge shuttle device S toward its upward position. This movement, of course, tends to increase the pressure in conduits 40 and 48 by the action of motive surface 47 which is transferred to chamber 23. Thus the axially movable bushings, normally expected to move further away from the gear side faces, will remain substantially immovable in their desired position. In other words, the shuttle device S tends to dampen out pulsations and surges that may take place in the outlet line 13 by transferring them to the pressure loading chamber.

Wherein the various parts of my invention have been referred to as being located at the right or left or in an upward or downward position it will be understood that this was 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 drawing.

While my present invention has been disclosed in connection with certain specific embodiments it is to be understood that these are to be by way of example rather than limitation and that my invention is defined by the appended claims which should be given a scope consistent with the prior art.

I claim:

1. In a liquid pressure generating power unit, means defining an enclosing housing having a first pump chamber receiving a first pair of intermeshing gears, end plate bushing and bearing defining means normally received in pumping seal engagement with the side faces of said gears, said bushings each including a terminal surface radially outwardly coextensive with the adjacent gear teeth and engaging with the adjacent gear side face in pumping seal relation, said bushing means including a pressure responsive surface opposed to said terminal surface and spaced from the adjacent housing wall forming with said housing a motive pressure chamber, means delivering liquid pressure generated by the corresponding gears to said pressure chamber for normally urging said bushing means into pumping seal engagement with the corresponding gear side face; a second pump chamber in said housing receiving a second pair of intermeshing gears, said housing having a common inlet to said pairs of gears and a common outlet therefrom, a one-way check valve in said housing interposed between said pairs of gears effective to prevent reverse flow from said second pair of gears to said first pair of gears; means defining passage means interconnecting said pressure chamber with said inlet whereby the fluid in said pressure chamber is adapted to pass to said inlet; means defining a control valve assembly disposed in said passage means effective upon the occurrence of a combined discharge pressure of a selected value to relieve said pressure fluid from said pressure chamber and permit said bushing means to move axially out of sealing contact with the associated gears to a position which either fully or partially unloads said first pair of gears by controlling the amount of fluid passing through said passage means, while said second pair of gears continues to deliver liquid pressure to said common outlet; and means in fluid communication with said passage means intermediate said pressure chamber and said control valve assembly effective to reduce the overall movement of said bushing means from a fully loaded or fully unloaded position to any partially loaded position.

2. In a liquid pressure generating power unit, means de-

fining an enclosing housing having a first pump chamber receiving a first pair of intermeshing gears, end plate bushing and bearing seal defining means normally received in pumping seal engagement with the side faces of said gears, said bushings each including a terminal surface radially outwardly coextensive with the adjacent gear teeth and engaging with the adjacent gear side face in pumping seal relation, said bushing means including a pressure responsive surface opposed to said terminal surface and spaced from the adjacent housing wall forming with said housing a motive pressure chamber, means delivering liquid pressure generated by the corresponding gears to said pressure chamber for normally urging said bushing means into pumping seal engagement with the corresponding gear side face; a second pump chamber in said housing receiving a second pair of intermeshing gears; said housing having a common inlet to said pairs of gears and a common outlet therefrom, a one-way check valve in said housing interposed between said pairs of gears effective to prevent reverse flow from said second pair of gears to said first pair of gears; means defining passage means interconnecting said pressure chamber with said inlet whereby the fluid in said pressure chamber is adapted to pass to said inlet means defining a control valve assembly disposed in said passage means effective upon the occurrence of a combined discharge pressure of a selected value to relieve said pressure fluid from said pressure chamber and permit said bushing means to move axially out of sealing contact with the associated gears to a position which either fully or partially unloads said first pair of gears by controlling the amount of fluid passing through said passage means, while said second pair of gears continue to deliver liquid pressure to said common outlet; and means in fluid communication with said passage means intermediate said pressure chamber and said control valve assembly effective to reduce the overall movement of said bushing means from a fully loaded or unloaded position to any partially loaded position as the flow demand on the power unit varies and is reflected in the liquid pressure level in said common outlet and acting on said control valve assembly.

3. In a liquid pressure generating power unit, means defining an enclosing housing having a first pump chamber receiving a first pair of intermeshing gears, end plate bushing and bearing defining means normally received in pumping seal engagement with the side faces of said gears, said bushings each including a terminal surface radially outwardly coextensive with the adjacent gear teeth and engaging with the adjacent gear side face in pumping seal relation, said bushing means including a pressure responsive surface opposed to said terminal surface and spaced from the adjacent housing wall forming with said housing a motive pressure chamber, means delivering liquid pressure generated by the corresponding gears to said pressure chamber for normally urging said bushing means into pumping seal engagement with the corresponding gear side face; a second pump chamber in said housing receiving a second pair of intermeshing gears, said housing having a common inlet to said pairs of gears and a common outlet therefrom, a one-way check valve in said housing interposed between said pairs of gears effective to prevent reverse flow from said second pair of gears to said first pair of gears; means defining a control valve assembly effective upon the occurrence of a combined discharge pressure of a selected value to relieve said pressure fluid from said pressure chamber and permit said bushing means to move axially out of sealing contact with the associated gears to a position which either fully or partially unloads first pair of gears, said control valve assembly including means defining a pressure responsive motive surface and a pair of pressure balanced surfaces, means sealing said pair of balanced surfaces from communication with said first valve motive surface, means placing said valve motive surface in communication with the combined output pressure of said two pairs of gears

beyond said check valve, means defining passage means placing said pressure in said pressure chamber in communication with said balanced surfaces of said valve, whereby said pilot valve is moved to open position in response to a selected value of combined output pressure acting on said valve motive surface or to a closed position in response to the combined output pressure falling below the selected pressure value and is for relieving or increasing the pressure in said pressure chamber uninfluenced by the pressure liquid acting in said pressure chamber; and means in fluid communication with said passage means intermediate said pressure chamber and said control valve assembly effective to reduce the overall movement of said bushing means from a fully loaded or unloaded position to any partially loaded position as the flow demand on the power unit varies and is reflected in the liquid pressure level in said common outlet and acting on said control valve assembly.

4. In a high pressure noncompressible liquid power generating unit comprising means defining a housing having a low pressure liquid inlet, a high pressure liquid outlet and a pair of pump chambers therein; means defining a first pair of fixed displacement intermeshing gear units in a first one of said chambers; means defining a second pair of relatively small fixed displacement intermeshing gears in a second one of said chambers, end plate bearing and pumping seal defining means adjacent one side face of said gears in each of said chambers, each of said end plate means having a first surface radially outwardly co-extensive with the adjacent gear teeth and engageable with the gear side face in bearing and pumping seal relation, said end plate means having a second opposed surface responsive to liquid pressure generated by the corresponding gears effective to hold said end plate means in pumping seal relation with the corresponding gear side faces; a one-way check valve in said housing interposed between the outlet side of the gear teeth of said first pump and the outlet side of the gear teeth of said second pump for preventing reverse flow from said second pump to said first pump; means connecting said pumps in continuous driving relation; control valve means in communication with the pressure acting on the rear surface of the bushing means of one of said gear units for relieving said loading pressure, said control valve including a pressure responsive motive surface and means placing said motive surface of said control valve in communication with the joint output pressures of said two pumps whereby the occurrence of an output pressure of a selected predetermined value becomes effective to operate said control valve relieving the loading pressure on said first-named pump and permitting the corresponding end plate means to move out of pumping seal engagement with the gear side faces to a position which either fully or partially unloads said first pump, said second pump continuing to deliver liquid pressure to said outlet; and means defining a shuttle device in pressure communication with said control valve, common outlet and loading pressure communication means effective to reduce the overall movement of said end plate means from a fully loaded or unloaded position to any partially loaded position.

5. In a high pressure liquid power generating unit comprising means defining a housing having a low pressure liquid inlet, a high pressure liquid outlet and a pair of separate pump chambers therein; a first pair of fixed displacement intermeshing gears in a first one of said chambers; a second pair of relatively small fixed displacement intermeshing gears in the second one of said chambers, means connecting said pairs of gears in continuous driving relation, an end plate in said first pump chamber having a backface normally spaced from the adjacent end wall of said corresponding pump chamber and having portions cooperable with said housing to provide a pressure chamber, said end plate also having a front terminal face subject to the pressures in communication with the corresponding gear teeth and cooperable with the adjacent

side face of the corresponding gear to normally provide a pumping seal therewith, a relief recess formed in the gear engaging face of said end plate radially inwardly of its outer periphery to limit the effective sealing area between said end plate and said gear side face, a spring interposed between said housing and the outer terminal of said end plate effective to assure an initial pumping seal upon starting, means establishing communication between said relief recess and said inlet, means establishing restricted flow communication between the discharge side of the corresponding gears and said pressure chamber at the back face of said end plate, 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 normally slightly exceeds the force acting on said front face whereby to maintain said pumping seal without excessive friction wear or loss in volumetric efficiency; control valve means in communication with the pressure acting in said pressure chamber for relieving the same to permit said end plate to move axially out of pumping seal engagement with the associated gear side face to a position which fully or partially unloads said gear, said control valve including means defining a pressure responsive motive surface, means placing said motive surface of said control valve in communication with the combined output pressures of said two pumps whereby the generation of a combined output pressure of a selected predetermined value becomes effective to operate said control valve relieving the loading pressure in said chamber; thus fully or partially unloading or fully or partially reloading said first pair of gears, said second pump continuing to deliver liquid pressure to said outlet; and means defining a shuttle device in pressure communication with said control valve, said outlet and pressure chamber effective to reduce the overall movement of said end plate means from a fully loaded or unloaded position to any partially loaded position.

6. In a liquid pressure, power generating unit, means defining a first intermeshing gear type pump; means defining a second relatively small capacity intermeshing gear type pump; means connecting said pumps in continuous driving relation; said pumps having a common inlet and delivering to a common outlet; one-way check valve means interposed between the discharge sides of the gears of said pump effective to permit flow from said first pump to said second pump but preventing flow from said second pump to said first pump; said first pump including an axially adjustable end plate engageable with the associated gear side face for providing a pumping seal therewith and means for delivering pressure fluid generated by the corresponding gears into communication with the rear surface of said end plate for pressure loading said end plate; and means defining a control valve assembly effective upon the generation of a common outlet pressure of predetermined selected value effective to relieve the loading pressure from communication with the rear surface of said end plate and thus fully or partially unload said first pump, said control valve assembly including a valve proper in communication with the pressure acting on said rear surface of said end plate, spring means normally urging said valve in the direction of its seat against the flow from said back face, motive means connected with said valve effective when operated to open or close said valve and relieve or increase said loading pressure, means placing said motive means in communication with the combined output pressure from said pumps beyond said check valve, said valve and motive means including opposed balanced surfaces rendering said valve assembly nonresponsive to the pressure acting on the back face of said end plate; and means defining a shuttle device in pressure communication with said loading pressure, valve assembly and combined output pressure effective to assist said first pump in reaching a partially unloaded condition from a fully loaded or unloaded condition.

7. In a liquid pressure generating power unit, means

defining an enclosing housing containing a first intermeshing gear pump and a second intermeshing gear pump, said housing having a common inlet to said pumps and a common outlet therefrom, said pumps having means connecting the same in continuous driving relation, each of said pumps including axially adjustable end plates, defining pumping seals with the adjacent gear side faces, means placing the rear surfaces of said plates in communication with pressures generated by the respective pumps effective to pressure load said plates, a one-way check valve in said housing effective to permit flow from said first pump to said common outlet but preventing flow from said second pump to said first pump, means defining a control valve assembly including a valve proper in pressure communication with the rear surface of the end plate of said first pump and seating against the flow therefrom, coil compression spring means having a selected compression value effective to urge said valve in the direction of its seat with a predetermined force, motive piston means connected with said valve for moving the same away from said seat, means placing said motive piston in pressure communication with the combined discharge pressures from said first and second pumps beyond said check valve, whereby the generation of a combined output pressure of a selected maximum value becomes effective to move said control valve to open position and relieve the loading pressure from the back face of the end plate of said first pump, while said second pump continues to deliver pressure fluid to said common outlet; and means defining a shuttle device in pressure communication with said rear surface, control valve and combined output pressure effective to assist said first pump in reaching a partially loaded condition from a fully loaded condition when said loading pressure is relieved and in reaching a partially loaded condition when said loaded pressure is increased by said control valve moving toward closed position.

8. In a high pressure liquid power generating unit comprising a housing having a low pressure liquid inlet, a high pressure liquid outlet, means defining a first relatively large displacement intermeshing gear type pump in said housing, means defining a second relatively small displacement intermeshing gear type pump in said housing, means connecting said pumps in continuous driving relationship, each of said pumps comprising axially adjustable end plates, means directing the discharge pressure from the respective pumps to the back faces of said end plates for pressure loading the same; means defining a control valve arrangement in pressure communication with the backface of the end plate of the relatively large displacement pump, said control valve having a motive piston means placing said motive piston in communication with the combined outlet pressures of said first and second pumps effective upon the occurrence of a combined output pressure of a selected predetermined value to operate said valve and relieve the loading pressure from the back side of said end plate associated with said relatively large displacement pump, said second relatively small displacement pump being effective to continue delivering pressure fluid to said common outlet; and means defining a shuttle device in pressure communication with said rear surface, control valve and combined output pressure effective to assist said first pump in reaching a partially loaded con-

dition from a fully loaded condition when said loading pressure is relieved and in reaching a partially loaded condition when said loaded pressure is increased by said control valve moving toward closed position.

9. In a liquid pressure power generating unit, means defining a first intermeshing gear type pump of the type employing pressure loaded bushings, means defining a second intermeshing gear type pump, a common inlet and a common outlet for said pumps, means interposed between the outlet sides of said first and second pumps effective to prevent flow from the second pump to the first pump, means defining pressure control chamber means in said first pump, said chamber means being adapted to receive liquid pressure to effect loading of said bushings, means defining passage means interconnecting said chamber means with said inlet, said passage means being adapted to permit the passage of liquid from said chamber means to said inlet, valve means disposed in said passage means responsive to the generation of a combined delivery pressure of a predetermined value effective to cause full or partial unloading and full or partial reloading of the pressure loaded bushings of said first pump by controlling the amount of liquid passing from said chamber means to said inlet while maintaining said second pump in operation, and means in fluid communication with said passage means intermediate said chamber means and said valve means effective to assist said first pump in reaching a partially loaded condition from a fully unloaded condition without chattering.

10. A hydraulic power unit including a first intermeshing gear type pump, pressure loadable bushings associated with the gears of said pump, said bushings being movable axially away from the associated gears to a position which fully or partially unloads said pump, a second intermeshing gear type pump, a common inlet and a common outlet for said two pumps, means defining pressure control chamber means in said first pump, said chamber means being adapted to receive liquid pressure to effect loading of said bushings, means defining passage means interconnecting said chamber means with said inlet, said passage means being adapted to permit the passage of liquid from said chamber means to said inlet, valve means disposed in said passage means responsive to the generation of a combined delivery pressure of a predetermined value effective to cause unloading of the first pump by controlling the amount of liquid passing from said chamber means to said inlet while maintaining said second pump in operation to deliver liquid pressure, and means in fluid communication with said passage means intermediate said chamber means and said valve means effective to assist said bushings in reaching any partial loading position from a fully loaded or unloaded position with a minimum of overtravel.

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