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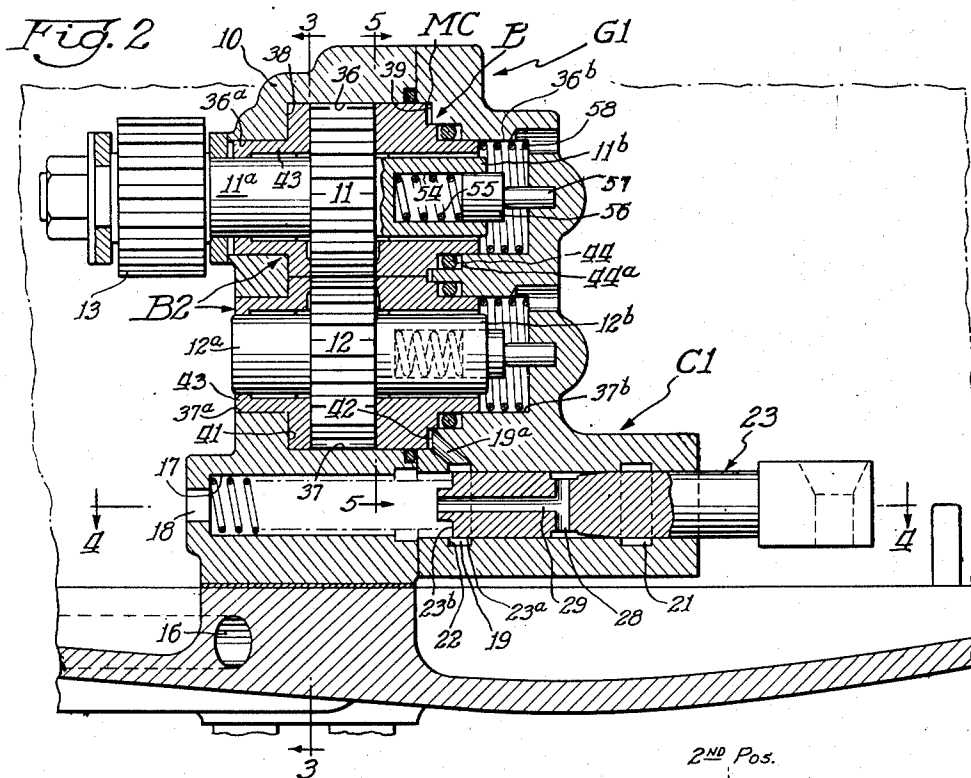
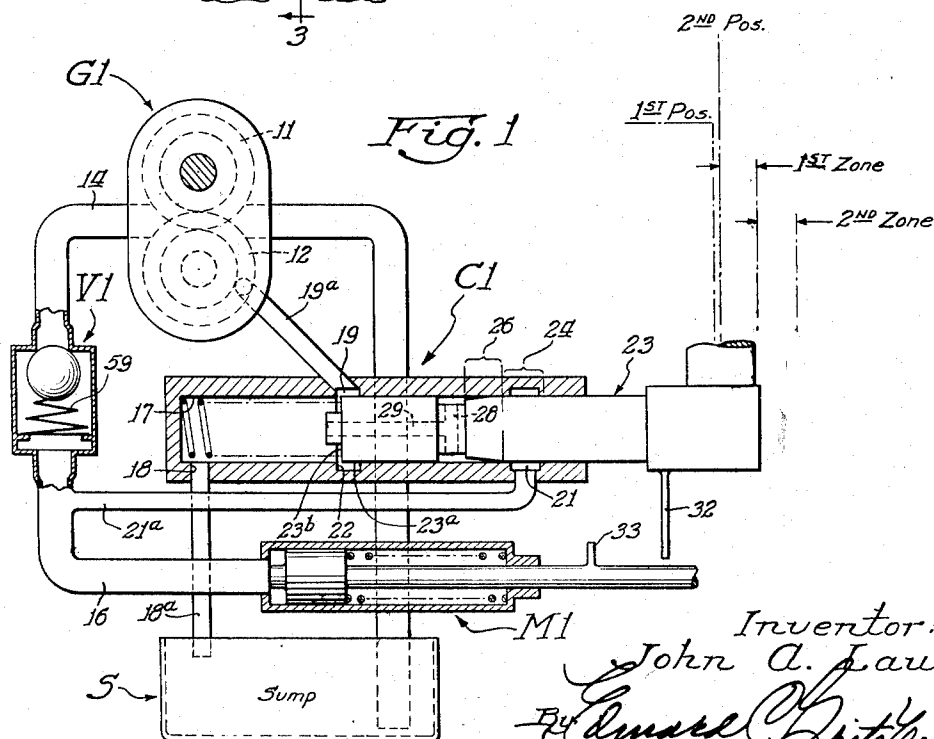
J. A. LAUCK

2,627,232

HYDRAULIC POWER UNIT

Filed Sept. 7, 1948

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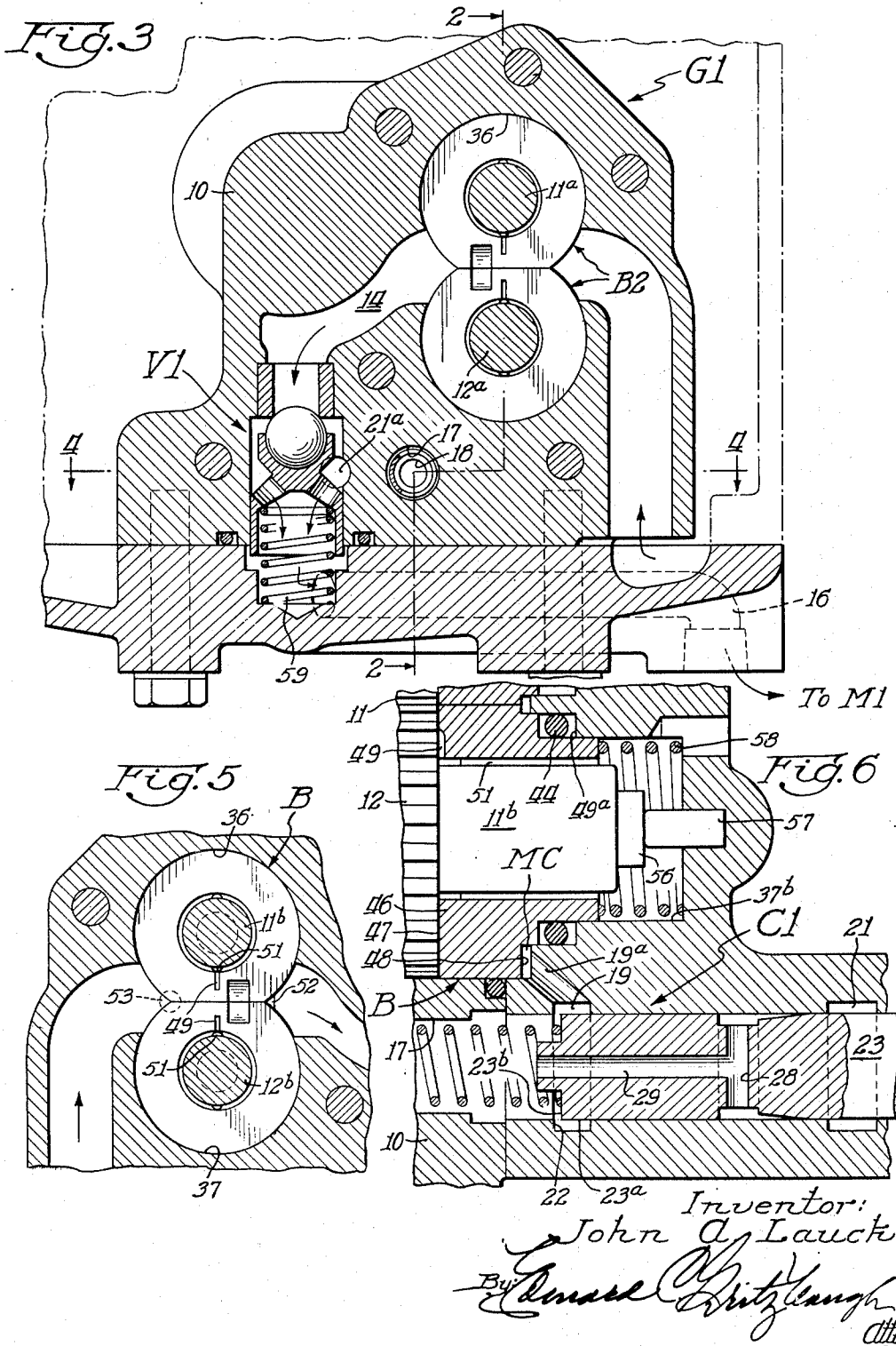
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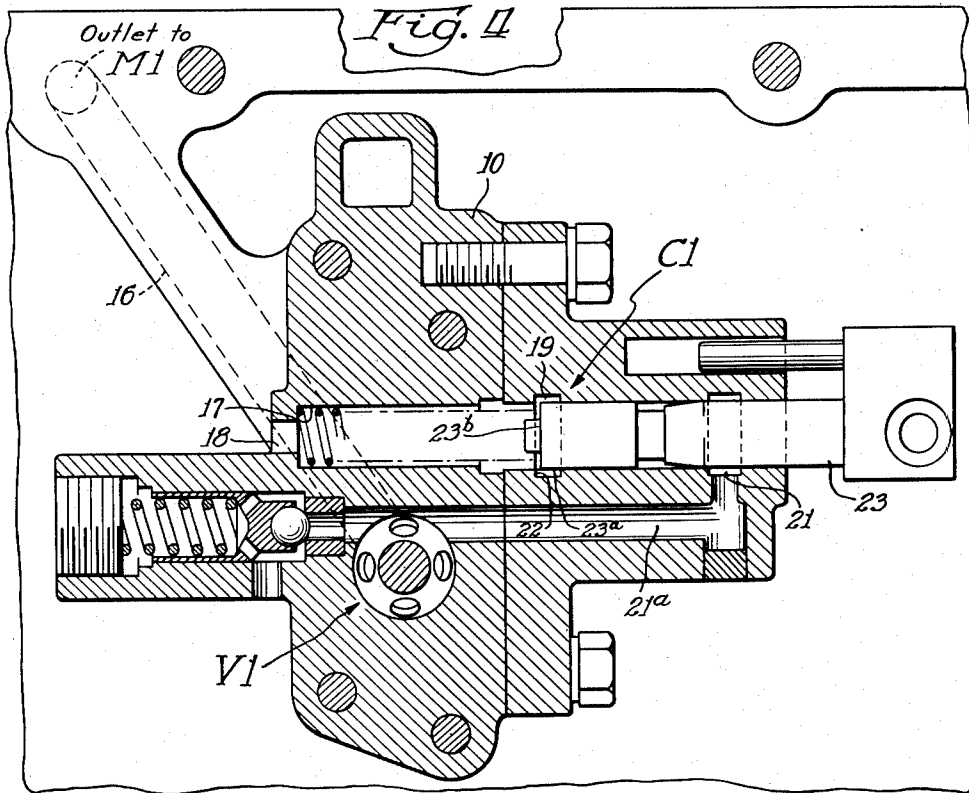
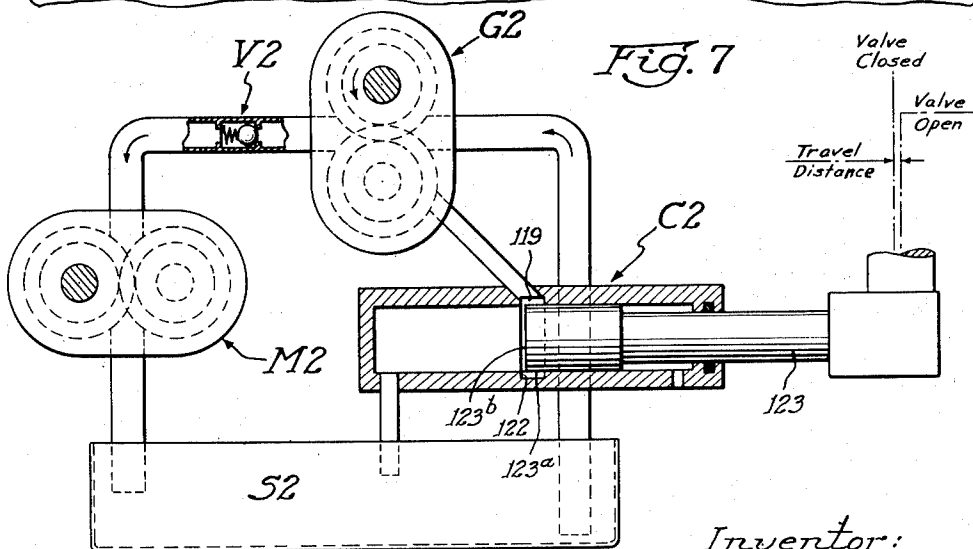
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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HYDRAULIC POWER UNIT

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5 Claims. (Cl. 103—42)

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This invention relates to power units and more particularly to liquid pressure power units including manually operable control valve means.

Liquid pressure power units including a continuously driven pressure generator, an intermittently operated pressure responsive motor, and manually adjustable control valve means have been proposed heretofore. However, previously known arrangements have lacked the refinement, sensitiveness, precision of control and efficiency of operation necessary, for example, under the rigid requirements involved in raising and lowering tractor drawn agricultural implements.

In previously available arrangements, it has been found necessary to either provide a very large flow capacity by-pass valve capable of handling the entire output of the pressure generator almost instantaneously when the delivery of pressure liquid to the motor is to be discontinued; or alternatively, provide means effective to throttle the inlet flow to the generator. The disadvantages and undesirable aspects of each of these previous arrangements have become well known.

It is an object of this invention to provide an improved efficient and effective power unit including means for selectively delivering liquid pressure to a pressure responsive motor; holding said pressure on said motor; and subsequently metering said liquid pressure away from said motor for controlling the return movement thereof.

It is a further object to provide an arrangement of the present character employing an intermeshing gear type pressure generator having pressure loadable and unloadable end plate and gear journal bearing defining means and manually selective control valve means for maintaining the pressure liquid acting on said end plate means or alternatively relieving the same therefrom depending upon the position of said manual means.

It is a further and more particular object to provide an arrangement of the above character incorporating manually operable control valve means effective in a first position thereof to maintain said loading pressure on said end plate, to thus cause said pressure generator to deliver pressure liquid to said motor; the control valve means being movable a minute distance to a second position effective to instantaneously relieve said loading pressure and cause said generator to discontinue the delivery of pressure liquid to said motor, while locking in place the pressure

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liquid already delivered to said motor to thus maintain said motor in the position to which the same has been moved; and the control valve means being further movable to a third position effective to meter said delivered liquid away from said motor at a precise rate dependent upon the extent of such movement, while at the same time continuing to relieve the pressure liquid from acting on said end plate bearing and pumping seal defining means.

It is a more specific object to provide an arrangement of the above character wherein said manually selectable control means is in the form of a plunger or spool type valve having a cylindrical housing formed with a plurality of axially spaced ports and including a plunger or spool type valve proper formed with specially arranged axially spaced peripheral valving surfaces for cooperation with said ports.

Other objects, advantages and uses of the present invention will become apparent from the reading of the following specification taken in connection with the appended drawings, which form a part thereof, and, wherein:

Fig. 1 is a schematic layout view partially in section showing a preferred embodiment of the invention;

Fig. 2 is an enlarged axial cross-sectional view taken substantially on line 2—2 of Fig. 3 showing to advantage the pressure loadable and unloadable generator, and the associated manually selectable control valve arrangement which in combination forms the particular subject matter to which the present invention is directed;

Fig. 3 is a cross-sectional view taken substantially on line 3—3 of Fig. 2;

Fig. 4 is a cross-sectional view taken substantially on line 4—4 of Fig. 2;

Fig. 5 is a cross-sectional view taken substantially on line 5—5 of Fig. 2;

Fig. 6 is an enlarged broken away view of a portion of Fig. 2 bringing out to particular advantage the novel relationship and cooperation of the precise form of pressure loaded bushing assembly and the precise form of manually actuable control valve in combination; and

Fig. 7 is a schematic layout view partially in section showing an alternative somewhat simplified embodiment of the present invention.

Referring in greater detail to the drawings and first to the preferred embodiment of the hydraulic power unit shown in Figs. 1 through 6, it will be seen that a pump or liquid pressure generator 61 includes a unitary housing 10 enclosing gears

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11, 12, and manually actuatable control valve means C1. Generator G1 is adapted to be continuously driven, as for example, by having the usual geared connection 13 with the internal combustion engine of a tractor or other vehicle (not shown) requiring an intermittent supply of pressure liquid for operating a pressure responsive piston motor M1 associated with the vehicle. Liquid from a supply sump S is delivered by generator G1 through conduit 14 to a one-way check valve V1, thence through conduit 15 to motor M1, the latter being adapted to operate a device associated with the vehicle, the present arrangement being particularly suitable for the raising and lowering of a plow or for operating other agricultural implements drawn by a tractor (not shown).

In installations of the present character, it is important that there be provided a very sharp and precise control of the initiation and the discontinuance of pressure liquid delivery by pressure generator G1. To this end the present invention provides in combination, a precise form of pressure generator comprising a liquid pressure loadable and unloadable bushing assembly or end plate means B subject to the novel and improved control valve unit C1, both incorporated in the unitary housing 10.

Manually actuatable control valve unit C1 comprises essentially bore 17 formed in the unitary housing 10 and having a plurality of axially spaced ports including a port 18 adapted to maintain the left-hand portion of bore 17 in continuous communication with the sump S through conduit 18a; a port 19 in communication through conduit 19a with the pressure loading chamber of bushing assembly B; and port 21 in communication through conduit 21a with the pressure delivery line 16 to motor M1. Axially adjustable valve plunger proper 23 cooperates with ports 19 and 21 to provide a plurality of operating conditions as will appear.

Port 19 is in the form of an annular recess in the wall of bore 17 and has a generally rectangular cross section, including a forward wall 22 extending substantially at a right angle to the axis of the bore 17. Cooperating with annular port 19 is cylindrical surface portion 23a of a plunger 23. This cylindrical surface portion 23a converges with a left end surface 23b, extends substantially at a right angle to the axis of bore 17 and forming with the cylindrical surface a very effective valve proper cooperating with the radial inner terminal of valve port wall 22 to provide a sharp opening and closing of port 19 requiring only a very minute movement of the plunger. As will be apparent hereinafter, unloading of the pressure loadable bushing assembly B requires a flow capacity of only a few drops per second through port 19, or only a very small fraction of the flow rate produced by the gears. It is very important as one of the more specific aspects of the embodiment of the invention disclosed that the opening and closing of port 19 require only a very small axial movement of plunger 23 as will appear from the description of the operation thereof in effecting the loading and unloading of pressure generator G1.

Port 21 is spaced axially to the right of port 19 and may likewise be in the form of an annular recess in cylindrical bore 17. Port 21 is arranged to be closed by cylindrical valving surface 24 of plunger 23 when in opposed relation thereto, and is arranged to be gradually opened for permitting metered return flow therethrough, in accordance

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with the position of tapered metering surface 26 with respect to the port 21.

Control valve plunger 23 has a plurality of positions important to the operation of this unit including; a first position in which cylindrical valving surface 23a overlaps port 19 shutting off the relief of pressure from pressure loadable bushing or end plate assembly B of pressure generator G1, as will appear, and causes the pressure liquid to hold the bushing B in pumping seal engagement with the adjacent gear side faces with the result that pressure generator G1 is caused to deliver pressure liquid from sump S through check valve V1 to motor M1. Control valve plunger 23 is movable axially a minute distance of the order of $\frac{1}{32}$ to $\frac{1}{64}$ of an inch, to a second position thereof effective instantaneously to permit a sufficient number of drops of liquid to pass away from the rear of bushing B through port 19 past valving surfaces 22, 23a, 23b, and through port 18 to sump S thus permitting bushing B to move in the outward direction to reduce the pumping seal engagement with the gear side face and discontinuing the further delivery of pressure liquid from generator G1 to motor M1. It will thus appear that upon cylindrical valving surface 23a uncovering the terminal of annular groove defining end surface 22, the entire periphery becomes instantly available for the flow of liquid therethrough. This feature, together with the loadable and unloadable bushing feature of generator G1, renders possible the sharp sensitive response with only a very minute axial travel of plunger 23. The fact that annular groove defining surface 22 is substantially parallel to the terminal surface 23b of plunger 23 also adds to the refined operation. In this second position valve plunger 23 continues to be effective through cylindrical surface 24 to maintain port 21 closed and this, together with the one-way action of valve V1, locks the pressure liquid in contact with the piston of motor M1 and thus holds the same in the position to which it has been previously moved. This locked condition continues to prevail throughout a limited further axial movement of valve plunger 23 which may be referred to as the first zone following the movement of the valve to the second position thereof. Control valve plunger 23 has a third position or range of movement which may more properly be referred to as a second zone of movement. When valve plunger 23 enters the second zone, conical metering valve surface 26 begins to meter the liquid pressure away from motor M1 through conduits 16, 21a, port 21, passages 28, 29 in valve 23, port 18 and conduit 18a back to sump S, the rate at which this return metering is accomplished being determined by the extent of the axial movement of the valve plunger 23.

The limit of movement of motor M1 in the driven direction thereof may be controlled by the provision of a suitable stop 32 engageable by a complementary stop 33 carried by the piston of motor M1 effective when engaged to move valving surface 23a axially to the right and relieve the loading pressure from acting on bushing B.

The sharply defined opening and closing of port 19 by cylindrical valving surface 23a is very important to the improved operation realized by the present novel arrangement. The pressure loadable and unloadable bushing B, as will appear, is very sensitive to only a few drops of pressure liquid being relieved therefrom, thus making it practicable to effect the present refined and precise operation by an almost infinitesimal movement of manually actuatable valve plunger 23.

Generator G1 includes pressure loadable and unloadable bushing B and is generally similar in arrangement and mode of operation to the gear pump construction disclosed and claimed in earlier Roth and Lauck Patent No. 2,420,622 dated May 13, 1947, except for the structure providing for the axial movement of the bushing making practicable the loading and unloading thereof. Essentially, this preferred form of pressure generator includes the intermeshing gears 11, 12 received in bores 36, 37 with radial end walls 39, 39, 41, 42, said gears having axially oppositely extending journals 11a, 11b, 12a, 12b received in reduced housing bores 36a, 36b, 37a, 37b. Pressure loadable and unloadable bushings B are preferably provided on one side of the gears, the right side being employed in the present installation, while on the other side of the gears there are provided fixed bushings B2. Bushings B are arranged to have a limited axial movement sufficient to permit establishing the desired pumping seal between the inner faces thereof and the gear side faces, and a motive pressure chamber MC is provided to receive pressure generated by gears 11, 12 for holding the bushings in engagement with the gear side faces. Bushings B each preferably comprises an outwardly extending tubular portion 43 received about the corresponding gear journal and within the corresponding reduced housing bore. A flexible O-ring seal 44 is interposed between the tubular portion 43 and a stepped recess 44a in the housing bore. Enlarged radial inner flange 46 is coextensive with the gear teeth and has a forward gear side face engaging surface area 47 and a rear pressure actuating surface area 48 defining in part a motive chamber MC. Relief recess 49 is formed in the forward face 47 of the bushing and is placed in communication with a low pressure area by axial groove 51. The bushings B have a sufficient axial movement to allow a limited slip or by-pass of liquid between the forward face 47 and the gear side face under conditions where the control valve has been operated to discontinue the delivery of liquid pressure to motor M1, as will appear. While the pressure may be directed to motive chamber MC from the delivery side of the gear teeth in a number of ways, it is preferred that this be accomplished as disclosed in the above earlier patent by providing an axially extending restricted flow passage 52 at the position of convergence between the upper and lower bushings B on the outlet side of the gear teeth while closing the corresponding passage by means of a plug 53 on the inlet side of the gear teeth to prevent recirculation.

For the purpose of maintaining gears 11 and 12 in engagement with the inner faces of bushings B2 when the loading pressure has been relieved from chamber MC, the journals 11b, 12b are formed with cylindrical recesses 54 receiving coil compression spring 55 and a floating closure plug 56, the outer terminal of which plug is held in engagement with a fulcrum pin 57 axially supported by the housing 10 of generator G1. Coil compression springs 58 function to urge the bushings in the direction of the gear side faces to thus assure an initial pumping seal engagement prior to the generation of sufficient pressure for acting in motive pressure chamber MC for this purpose.

In practice, the compression values of coil compression springs 58 for effecting the initial pumping seal, and coil compression spring 59 of one-way check valve V1 are specially chosen with

reference to one another. Springs 58 are given a compression value such that the pumping seal effect produced thereby will cause the gears to develop a very low pressure of the order of about 50 to 100 p. s. i. In other words, the bushings, when unloaded, are not completely out of liquid sealing engagement with the gear side faces, this relationship being necessary in order that the generator will respond immediately to a slight movement of valve plunger 23 in the direction causing cylindrical surface 23a to overlap and close port 19. Coil compression spring 59 of one-way check valve V1 is therefore given a compression value sufficiently above that of coil compression springs 58 to assure that valve V1 will not open in response to the range of pressure or value of pressure produced by the generator when only springs 58 are acting to urge the bushing into pumping seal engagement with the gear side face. Under this condition, the pressure generator will merely generate a pressure within a range of the order of 50 to 100 p. s. i. and any tendency of the pressure to rise above this value will result in a sufficient movement of the bushing away from the gear side face to prevent any further rise, the liquid then circulating from the outlet side of the gear teeth back to the inlet side thereof, between the gear side face and the associated bushing. Check valve V1 will be opened only when it is desired to transmit liquid pressure to motor M1 as indicated by the operator moving valve plunger 23 to the left and closing port 19 with the result that the liquid pressure builds up within motive chamber MC, which causes the pressure generated by the gears to supplement the pressure of springs 58 in holding the bushings in pumping seal engagement with the gear side faces. The combined pressures will have a value sufficiently high to cause opening of valve V1 and the delivery of pressure liquid to motor M1.

Turning to Fig. 7, there is disclosed a somewhat simplified embodiment of the present invention as applied to a power unit incorporating both a rotary gear-type pressure generator G2 and a corresponding form of rotary motor M2. Since the liquid pressure for operating motor M2 is supplied continuously and directed therefrom back to the sump S2, when the same is being driven, there is no need for the special provision of means for effecting the return of this pressure liquid from the motor. Therefore, the tapered metering surface, important to the modification of Fig. 1, is not required in this simplified construction.

It will be seen, however, that the broader aspects of the present invention are incorporated in Fig. 7 including the pressure loadable and unloadable gear-type generator G2, one-way check valve V2, and the special construction of control valve C2 for selectively causing the loading and unloading of the generator with only a very small or minute travel of plunger 123. Port 119, including radially extending terminal surface 122, corresponds to port 23 and radially extending surface 22 of the modification disclosed in Figs. 1 through 6. Valving surfaces 123a and 123b of plunger 123 correspond to surfaces 23a, 23b of valve plunger 23 of the above modification.

It will be again noted in this alternative form of the invention that due to the unique characteristics of the pressure generator incorporating loadable and unloadable bushings under the control of valve C2, having the specially constructed port 119 and cooperating plunger valve

ing surface 123a, there results a very sharp and refined control of the transition between the on and off delivery condition of the generator G2 with only a very small axial movement of valve plunger 123 of the order of $\frac{1}{64}$ to $\frac{1}{32}$ of an inch.

While the present invention has been described in connection with certain specific embodiments thereof, it is to be understood that this is by way of example and that the invention is to be defined by the appended claims, which should be given a scope commensurate with the prior art.

What is claimed is:

1. In an arrangement for generating liquid pressure including a housing containing intermeshing gears adapted to be continuously driven, said housing being formed with a pair of adjoining substantially cylindrical chambers having generally radially extending end walls, said gears being received within said chambers, a low pressure liquid inlet leading to and a high pressure liquid outlet leading from said chambers, reduced bores in the end walls of said housing chambers forming co-axial extensions of said cylindrical chambers, said gears having journals extending from the opposite sides thereof into said reduced bores, axially adjustable bearing and pumping seal defining bushings in said housing on at least one side of said gear members embracing said journals, said bearing and pumping seal defining bushings including outwardly extending tubular portions received in sealed relation within said reduced bores and radially enlarged substantially annular flange portions received in said cylindrical chambers, said annular flange portions each having a front face engageable with the adjacent gear side face from a position below the roots of the teeth to the radially outer extremities of said teeth throughout the circumferential extent thereof, said front face and said side face constituting a pair of adjacent faces which provide a surface area forming a pumping seal between the respective gears and the corresponding annular flange portions, 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 spaced from the adjacent radial end wall of the housing to provide an annular control pressure space at the back of each of said annular portions, an annular relief recess formed in said front face radially inwardly of the roots of said gear teeth, means placing said relief recess in communication with a zone of relatively low pressure with relation to the generated pressure, passage defining means placing said space in restricted flow communication with the outlet pressure from said gears for causing the same to act on said pressure responsive surface for pressure loading said bushings in pumping seal engagement, and selectively controllable means including a cylindrical valve bore formed in said housing, port means in the side wall of said valve bore having a flow capacity only a small fraction of the total flow produced by said gears, said port means comprising an annular recess formed in the wall of said valve bore, said annular recess being defined in part by a generally radially extending side wall, a passage in said housing placing said port in communication with said annular control pressure space, a cylindrical spool valve proper received in said valve bore for manual adjustment therein, a relief port in said valve bore in communication with a zone of low pressure relative to said generated pressure and spaced from said port means, said spool valve

including a terminal piston portion defined by a first cylindrical surface area and a radial extending terminal surface converging therewith, whereby said cylindrical surface is effective to close said port means when moved into overlapping relation thereto, and is further effective upon a minute movement in the opening direction to uncover the port means, of the order of $\frac{1}{64}$ to $\frac{1}{32}$ of an inch, to thus cause flow to said relief port from said port means about the complete periphery of said piston terminal portion resulting immediately in sufficient relief of loading pressure from said motive chamber to cause the unloading of pressure liquid from further acting on said back face of said annular flange.

2. In an arrangement for generating liquid pressure including a housing containing intermeshing gears adapted to be continuously driven, axially adjustable end plate means within said housing engageable with the gear side faces from a position below the roots of the teeth to the radial outer extremities of said teeth throughout the circumferential extent thereof, said end plate means including an outwardly facing pressure responsive surface area effective in response to pressure generated by said gears for pressure loading said end plate means in pumping seal engagement, selectively controllable means including a manually actuatable valve effective when moved into closed position to confine said loading pressure in contact with said pressure responsive surface for causing liquid pressure generating action and effective when moved into open position to relieve said loading pressure for causing discontinuance of said liquid pressure generating action by venting said loading pressure to a zone of lower than discharge pressure, said valve having a flow capacity only a small fraction of the liquid flow produced by said gears, said valve having very sharp opening and closing characteristics and requiring a very short travel distance, said valve comprising means defining a cylindrical bore, a first port formed in the wall of said valve bore, a passage placing said port in communication with said pressure responsive surface area, a cylindrical plunger valve proper received in said valve bore for axial adjustment therein, a relief port in said valve bore in communication with a zone of low pressure relative to said loading pressure and spaced from said first port, said plunger having a first cylindrical valving surface merging with the inner terminal of said plunger for cooperation with said first port, and manual means for selectively operating said plunger to control communication between said first and second ports.

3. A hydraulic power unit for generating liquid pressure including a housing containing intermeshing gears adapted to be continuously driven, axially adjustable end plate means within said housing engageable with the gear side faces in sealing relation, compression spring means positioned between the housing and the end plate means effective to urge said end plate means in the direction of said gear side faces with a first predetermined force to assure an initial pumping seal, an outwardly facing motive area on said end plate means effective in response to liquid pressure generated by the gears and applied thereto to urge said end plate means into pumping seal engagement with a certain force supplementing said first force, conduit defining means placing said motive area in restricted flow communication with the outlet from said gears, a one-way check valve in the outlet from said intermeshing

gear pressure generating means, a second coiled compression spring associated with said check valve for urging the check valve in closing direction, said spring being selected to have a compression value exceeding that required to hold said check valve closed against the pressure developed by said intermeshing gears by virtue of the initial pumping seal provided by the first mentioned compression spring means, and valving means effective when moved into open position to relieve the liquid pressure from acting on said motive area, said valving means comprising a selectively controllable valve including a cylindrical valve chamber, said valve chamber having a first port formed therein communicating with said motive area and a second port formed therein communicating with a zone of lower than generated pressure, and a valve plunger disposed in said chamber and manually operable to a first position uncovering said first port and placing said motive area in communication with said zone of relatively low pressure through said second port to thus limit the pumping seal with the gear side faces to that produced by the compression spring, the plunger being manually shiftable to a second position overlapping the first port to maintain loading pressure on the motive area to supplement the action of the compression spring means.

4. In an arrangement for generating liquid pressure including a housing containing intermeshing gears adapted to be continuously driven, said housing being formed with a pair of adjoining, substantially cylindrical chambers having generally radially extending end walls, said gears being received within said chambers, a low pressure liquid inlet leading to and a high pressure liquid outlet leading from said chambers, reduced bores in the end walls of said housing chambers forming co-axial extensions of said cylindrical chambers, said gears having journals extending from the opposite sides thereof into said reduced bores, axially adjustable bearing and pumping seal defining bushings in said housing on at least one side of said gear members embracing said journals, said bearing and pumping seal defining bushings including outwardly extending, tubular portions received in sealed relation within said reduced bores and radially enlarged, substantially annular flange portions received in said cylindrical chambers, said annular flange portions each having a front face engageable with the adjacent gear side face from a position below the roots of the teeth to the radially outer extremities of said teeth throughout the circumferential extent thereof, said front face and said side face constituting a pair of adjacent faces which provide a surface area forming a pumping seal between the respective gears and the corresponding annular flange portions, 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 spaced from the adjacent radial end wall of the housing to provide an annular control pressure space at the back of each of said annular portions, an annular relief recess formed in said front face radially inwardly of the roots of said gear teeth, means placing said relief recess in communication with a zone of relatively low pressure with relation to the generated pressure, passage defining means placing said space in restricted flow communication with the outlet pressure from said gears for causing the same to act on said pressure responsive surface for pressure loading

said bushings in pumping seal engagement, and selectively controllable means including a cylindrical valve bore formed in said housing, port means in the side wall of said valve bore having a flow capacity only a small fraction of the total flow produced by said gears, said port means comprising an annular recess formed in the wall of said bore, said annular recess being defined in part by a generally radially extending side wall, a passage in said housing placing said port in communication with said annular control pressure space, a relief port in said valve bore in communication with a zone of lower than said generated pressure and spaced from said port means, a cylindrical spool valve proper received in said valve bore for manual adjustment therein, said spool valve including a terminal piston portion defined by a first cylindrical surface area and a radial extending terminal surface converging therewith, whereby said cylindrical surface is effective to close said first port when moved into overlapping relation thereto, and is further effective upon a minute movement in the opening direction to uncover the first port, of the order of $\frac{1}{64}$ to $\frac{1}{32}$ of an inch, to thus cause flow to said relief port from said first port about the complete periphery of said piston terminal portion resulting immediately in sufficient relief of loading pressure from said motive chamber to cause the unloading of pressure liquid from further acting on said back face of said annular flange, said spool valve being movable to a further variable position whereby return flow through said high pressure liquid outlet may be metered.

5. In an arrangement for generating liquid pressure including a housing containing intermeshing gears adapted to be continuously driven, said housing having an inlet and an outlet port formed therein, axially adjustable end plate means within said housing engageable with the gear side faces from a position below the roots of the teeth to the radial outer extremities of said teeth throughout the circumferential extent thereof, said end plate means including an outwardly facing pressure responsive surface area effective in response to pressure generated by said gears for pressure loading said end plate means in pumping seal engagement, selectively controllable means including a manually actuatable valve effective when moved into closed position to confine said loading pressure in contact with said pressure responsive surface for causing liquid pressure generating action and effective when moved into open position to relieve said loading pressure for causing discontinuance of said liquid pressure generating action, said valve having a flow capacity only a small fraction of the liquid flow produced by said gears, said valve having very sharp opening and closing characteristics and requiring a very short travel distance, said valve comprising means defining a cylindrical valve bore, a first port formed in the wall of said valve bore, a passage placing said port in communication with said pressure responsive surface area, a relief port formed in said valve bore and communicating with a zone of lower than said generated pressure and spaced from said first port, a cylindrical plunger valve proper received in said valve bore for axial adjustment therein, said plunger having a first cylindrical valving surface merging with the inner terminal of said plunger for cooperation with said first port and for controlling flow from said first port to said relief port, and manual means for selectively operating said plunger, a third port formed in the

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wall of said bore, and a tapered metering surface on said plunger arranged to cooperate with said third port to control return flow from said third port to said relief port.

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