Feb. 22, 1949. J. F. HOFFER 2,462,500

COMPENSATOR CONTROL FOR PUMPS

Filed July 13, 1946 2 Sheets-Sheet 1

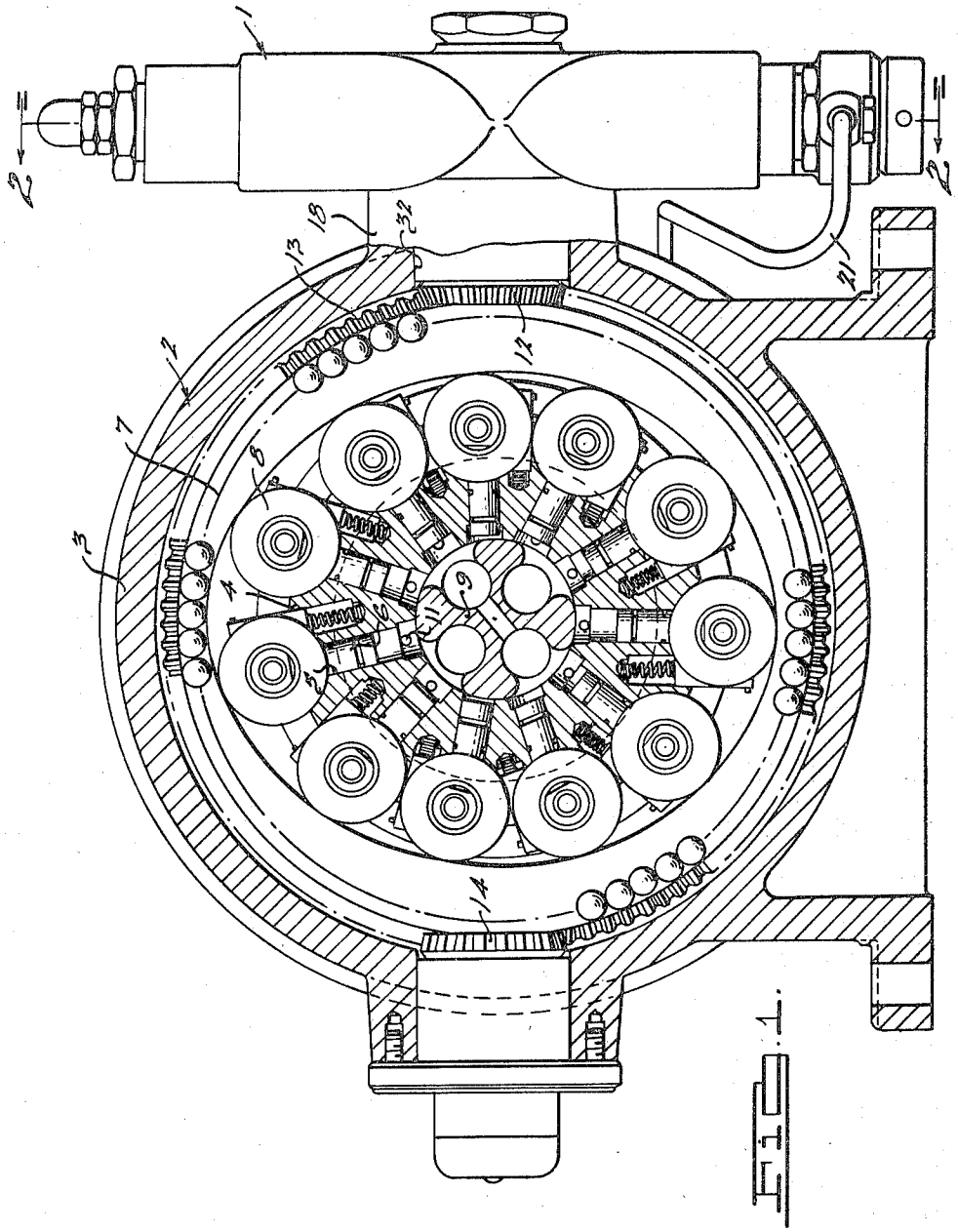


FIG. 1.

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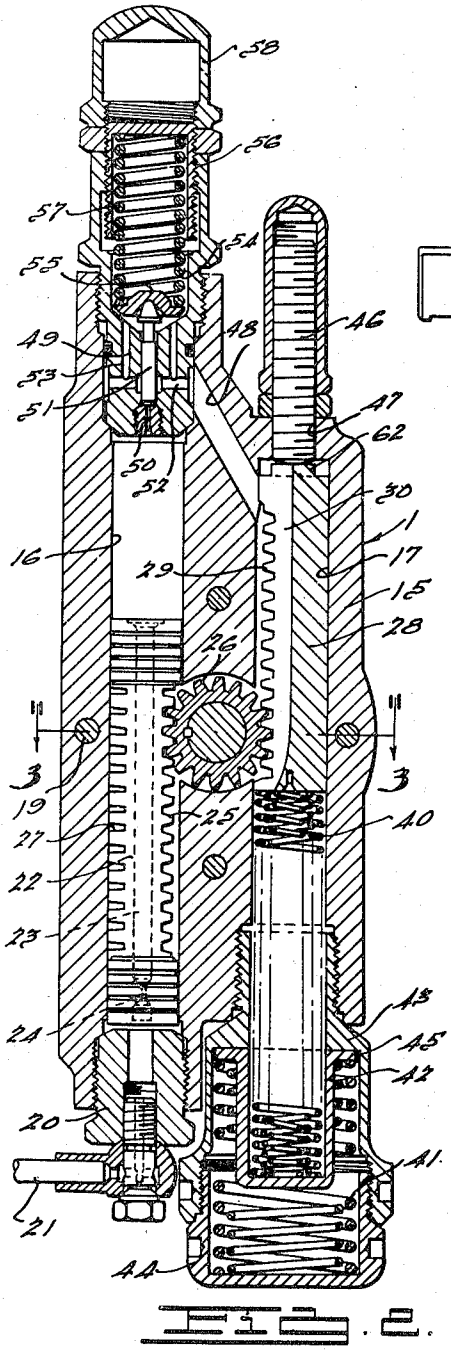


FIG. 2.

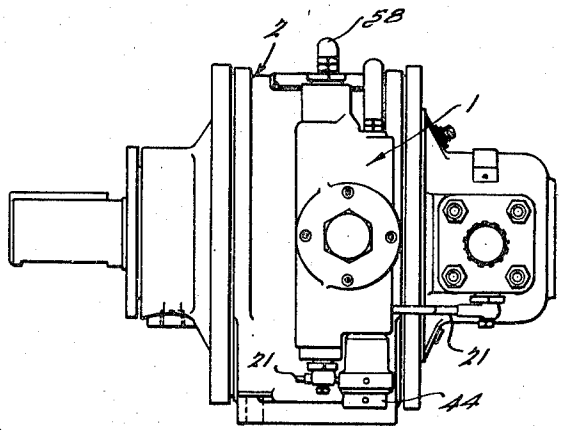


FIG. 4.

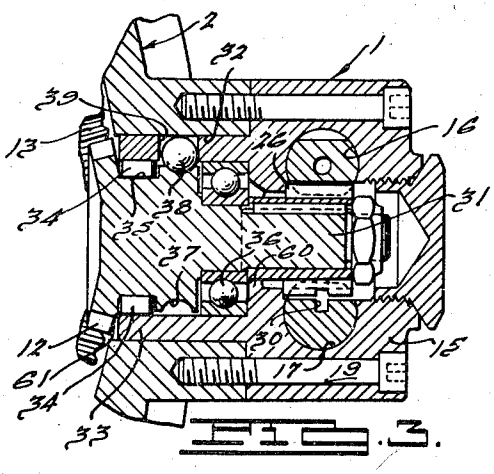


FIG. 3.

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COMPENSATOR CONTROL FOR PUMPS

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Application July 13, 1946, Serial No. 683,349

10 Claims. (Cl. 103—37)

1

The present invention relates to a constant pressure compensator particularly for use with a variable displacement pump.

One of the primary objects of the present invention is to provide a compensator which maintains a preselected pressure, which may be adjustable, on a variable displacement pump, regardless of pump delivery (volume); that is, for example, whether a ram associated with the pump is moving slow or fast.

Another object of the invention is to provide a quick-acting, constant-pressure compensator control of the type mentioned which is surgeproof.

A further object of the invention is to provide a compensator of the type mentioned which is in hydraulic balance and positive in its action.

Other objects of the invention will become apparent from the following specification, drawings relating thereto, and from the claims hereinafter set forth.

In the drawings in which like numerals are used to indicate like parts in the several views throughout;

Fig. 1 is a vertical cross-sectional view of a variable delivery pump having a compensator, shown in elevation, according to the present invention associated therewith;

Fig. 2 is a vertical cross-sectional view of the compensator taken substantially along the line 2—2 of Fig. 1;

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

Fig. 4 is an end elevational view on a reduced scale of the pump shown in Fig. 1 and taken from the right end thereof.

In general, the automatic, constant-pressure compensator control of the present invention is constructed so that it may be mounted on variable displacement pumps interchangeably with other types of controls on the pumps. The control is connected to the pump delivery through a relatively small conduit which renders it responsive to changes in pump delivery pressures. The compensator unit comprises principally combination piston and rack members which function in response to pump delivery pressure to increase or decrease pump delivery, as required, to maintain a preselected pressure regardless of variation in the pump delivery from zero to maximum.

The compensator is quick-acting and surgeproof, and this is accomplished by the fact that springs do not act on opposite ends of the plunger and the rack plunger is in a chamber of oil which is in hydraulic balance at both ends.

Referring to the drawings, the constant-pressure compensator or pressure-actuated volume control unit of the present invention is generally indicated at 1 and is illustrated as being used with a variable displacement pump generally indicated at 2. In the illustrated embodiment, the variable displacement pump 2 is of the type disclosed and claimed in the co-pending application of James F. Hoffer, Serial No. 649,021, filed February 20, 1946. Reference may be had thereto for a complete and detailed description of the pump 2. For the purpose of understanding the present invention, the pump 2 is of the radial type and includes a housing 3 within which a rotor 4 is rotatably mounted. The rotor 4 has a plurality of radial bores 5 formed therein within which plungers 6 are reciprocably disposed. The plungers 6 are operatively connected with reaction rings 7 through axle and roller means, indicated at 8. The inner faces of the reaction members 7 are elliptical, and the rollers 8 are maintained in contact with the elliptical surface of the reaction rings by centrifugal force upon rotation of the rotor 4. The plungers are fitted to the cylinders or bores in the rotor in a plurality of banks of a number of plungers per bank, each one bank being axially spaced from the other and there being 11 plungers per bank in the embodiment illustrated. The rotor rotates on a fixed pintle 9 having suitable passages and ports for directing the oil inlet into those cylinders passing through two opposite quadrants and also for directing the oil delivery out of those cylinders passing through the other two opposite quadrants. Each plunger makes two inlet and two delivery strokes per revolution.

In the variable displacement pump here illustrated, two banks of 11 plungers each are arranged on the single rotor 4. The plungers in the two banks are arranged in parallel relation, and each pair of parallel cylinders is in open communication by means of a drilled passage 11 in the rotor.

The plunger rollers at each bank roll against a separate elliptical reaction ring. These reaction rings are rotatably mounted in the pump housing and are geared together by means of a gear 12 which meshes with facing ring gear teeth 13 on the reaction rings. Upon rotation of the gear 12, the reaction rings are caused to rotate in opposite directions in response to rotation of the volume control gear 12.

At full delivery, the major axes of the elliptical reaction rings are parallel; and at zero delivery, the major axes are 90 degrees apart. Thus, by rotating the gear 12 and consequently by varying the relative positions of the major axes of the

elliptical reaction members, the volume displaced by the pump may be varied. When the major axes are 90 degrees apart, the net delivery stroke is zero because the displacement of these plungers moving radially outwardly exactly equals the displacement of these plungers moving radially inwardly in both delivery quadrants and both suction quadrants. As the angle between the major axes is reduced from 90 degrees, the net plunger displacement increases. When this angle becomes zero degrees, the major axes are parallel and both plungers of a pair of parallel plungers are reciprocating in phase through full delivery and suction strokes.

It will be seen that a gear 14 similar to gear 12 is also provided at a diametrically opposed portion so that the volume control may be mounted on either side of the pump.

The compensator unit 1 comprises a housing 15 having a pair of longitudinally extending parallel bores 16 and 17 formed therein. The housing 1 may be mounted to a boss or annular flange 18 on either side of housing 3 by means of suitable bolts 19.

One end of bore 16 communicates through suitable fittings 20 and a tube or conduit 21 with the delivery outlet of the pump so that a portion of the fluid delivered under delivery pressure is introduced into one end of the bore 16.

A rack plunger 22 is reciprocably disposed within the bore 16. The plunger 22 has an axially-extending passageway 23 therethrough which is provided with a flow-restricting orifice 24 adjacent the inlet end. It will thus be appreciated that fluid under pressure introduced into the lower end of chamber 16 passes through restriction 24 and passageway 23 into the opposite end of the bore 16 so that the plunger 22 is, in effect, in hydraulic balance.

The plunger 22 has rack teeth 25 formed thereon which are adapted to mesh with the teeth of a pinion 26 rotably mounted within the housing between bores 16 and 17. The opposite side of the plunger 22 is formed with a plurality of axially spaced transverse grooves 27 therein which are desirable, because of the teeth on the opposite side, to balance the compressive stresses on the rack.

Another plunger 28 is reciprocably disposed within bore 17 and has rack teeth 29 formed on one side thereof which mesh with pinion 26. The plunger 28 has a longitudinally extending groove 30 formed therein adjacent the base of the teeth 29 which serves a purpose that will be described hereinafter.

The volume control gear 12 has a shaft portion 31 integral therewith which projects through an opening 32 in the pump housing 3. The pinion 26 is keyed to the shaft 31 for rotation therewith. A telescoping sleeve 33 is integral with the compensator housing 15 with needle bearings 34 interposed between the adjacent surfaces of the sleeve 33 and an annular groove 35 formed in the body portion of the gear 12. The body portion of the gear 12 is also rotatably mounted with respect to the housing 15 by means of a ball bearing assembly 36.

In order to control the relative movement between the elliptical reaction rings between zero displacement and full displacement a groove 37 is formed in the body of the gear shaft and extends only partway around the periphery thereof. A ball 38 is received within an opening 39 in the sleeve 33, as shown in Fig. 3, and when the parts are assembled, the ball 38 projects within the groove 37. The ball 38 is abutting against the ends of the groove 37 serves to limit the rotative movement thereof.

Thus, through the pinion and rack interconnection between plungers 22 and 28, upon movement of plungers 22 and 28 in opposite directions the pinion 26 and the gear 12 are caused to rotate which effect relative rotation of the reaction rings to vary the volumetric delivery of the pump.

The plunger 28 is urged toward full volume position, or its upper position, viewing Fig. 2, by means of a plurality of springs 40 and 41. The springs 40 engage the under end of piston 28 with the opposite ends thereof received within a cup 42. The cup 42 is movably supported within a fitting 43 which is threaded into the housing 15 and is provided with an opening therethrough aligned with bore 17. An end closure cap 44 is threaded into the end of fitting 43. Springs 41 are disposed therein with one end of the springs 41 abutting against the bottom of the cap 44 and the opposite ends thereof embracing the cup 42 and abutting against the annular flange 45 thereof to support the cup 42 for axial movement therein against the action of springs 41.

The plunger 28 is formed with a reduced axial projection 62 in the upper end thereof which is adapted to abut against a stop screw 46 which may be threaded through an opening 47 formed in the housing 15 and axially aligned with the bore 17. A lock nut and closure map may be disposed over the stop screw 46. By adjusting the axial position of the screw 46, the upward movement of the plunger 28 is limited to limit the full flow adjustment.

The upper ends of the bores 16 and 17 may be placed in communication through an inner-communicating passageway 48 and a pressure relief valve unit 49. The pressure relief valve unit is threaded into the housing 15 in axial alignment with the bore 16 adjacent the upper end thereof and includes an axially-disposed surge-dampening orifice 50 which is positioned between the upper end of the bore 16 and the inlet to the relief valve. A valve plunger 51 is disposed within an axial opening in the body of the relief valve and when moved away from its seat above the orifice 50 communicates the bore 16, through orifice 50 with passageways 52 and 53 formed therein. The passageway 52 communicates with passageway 48 and passageway 53 communicates with a valve chamber 54. The plunger 51 projects upwardly within the chamber 54 and engages within a groove on the under side of the valve cup 55. An inverted cup 56 is threaded into the body portion of the valve and has a coil spring 57 therein which abuts against the base of the cup at one end with the opposite end abutting against the upper surface of the cup 55 to urge the valve plunger 51 against its seat. A cap 58 is threaded to the upper end of the cup 56. By adjusting the position of the cup 56, and therefore the tension on the spring 57, the pressure at which the valve plunger 51 opens may be adjustably set. Thus, the upper pressure at which the compensator will function may be adjustably predetermined.

In the operation of the device above-described, pump delivery pressure acts through tube 21 and passes into the lower end of bore 16 to act upon the adjacent end of plunger 22. Pressure within bore 16 in the opposite end of plunger 22 is balanced through passageway 23. When the pressure within bore 16 exceeds the predetermined setting of the pressure relief valve, the valve plunger 51 is unseated to permit passage of fluid

through the restricting orifice 50 and through passageways 52 and 48 into bore 17. The fluid then passes along groove 30 between the teeth of pinion 26 through the space indicated at 60 (Fig. 3) through the ball bearing assembly 36 and past the space indicated at 61 (Fig. 3) adjacent the gear 12 and back into the pump housing. The pressure then acting upon the lower end of the plunger causes it to move in an upward direction against the action of springs 40 and 41 and causes rotation of the pinion 26 in a direction to reduce the volume delivered by the pump by rotation of the reaction rings in the proper direction. As soon as the pressure has been reduced to the predetermined setting, the valve plunger 51 closes to stop further movement of the plunger 22. Since the plunger 22 is in a chamber of oil, it is in hydraulic balance at both ends. The hydraulic pressure within the bore 16 adjacent the lower end of plunger 22 equals the hydraulic pressure above the plunger 22 within chamber 16 plus the spring force of springs 40 and 41. The force of springs 40 and 41 is relatively very small as compared to the hydraulic pressure on the ends of the rack. Since springs do not act on opposite ends of the plunger 22, surging is eliminated by the action of the surge-dampening orifice 50.

When the delivery pressure falls below the preselected pressure setting, the springs 40 and 41 serve to move the plunger 28 in an upward direction and the plunger 22 in a downward direction to increase pump volume. The restricting orifice 24 serves to permit this piston rack movement in the full volume direction under the influence of the springs. By the dual action above-described, the compensator acts quickly and positively to maintain the preselected pressure. It will be appreciated, as mentioned above, that such pressures may be varied by adjusting the spring pressure on spring 57.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

I claim:

1. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, a rotatable member in said housing operatively connected to said pistons for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure.

2. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second parallel bores therein, first and second pistons in said bores respectively, a rotatable member in said housing between said bores operatively connected to said pistons for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure.

3. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second parallel bores therein, first and second pistons in said bores respectively, a rotatable member in said housing between said bore, means operatively connecting said rotatable member to said pistons for rotation thereby upon movement of said pistons in opposite directions and adapted to be connected to volume control means on said pump, means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure.

4. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, a rotatable member in said housing operatively connected to said pistons for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, spring means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure, said second piston having a restricted passageway therethrough communicating opposite ends of said second bore.

5. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, a rotatable member in said housing operatively connected to said pistons for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, spring means acting on said first piston and tending to move said first piston toward full volume position, pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure, said second piston having a restricted passageway therethrough communicating opposite ends of said second bore, a passageway between said first and second bores, and a pressure relief valve in said last-named passageway.

6. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second parallel bores therein, first and second pistons in said bores respectively, a rotat-

able member in said housing between said bores, means operatively connecting said rotatable member to said pistons for rotation thereby upon movement of said pistons in opposite directions and adapted to be connected to volume control means on said pump, means acting on said first piston and tending to move said first piston toward full volume position, pressure connections between the pump and one end of said second bore and acting on said second piston to move said second piston toward low volume position in response to variations in pump pressure, and pressure relief means associated with said second bore operable in response to excessive pressure therein above a predetermined setting.

7. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, a rotatable member in said housing operatively connected to said pistons for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, spring means acting on said first piston and tending to move said first piston toward full volume position, pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure, said second piston having a restricted passageway therethrough communicating opposite ends of said second bore, a passageway between said first and second bores, a pressure relief valve in said last-named passageway, and a dampening orifice in said passageway between said second bore and said relief valve.

8. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second parallel bores therein, first and second pistons in said bores respectively, each of said pistons having facing rack teeth thereon, a gear member in said housing between said bores in mesh with said rack teeth for rotation thereby upon movement of said pistons in opposite directions and adapted to be connected to volume control means on said pump, means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure.

9. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, each of said pistons having facing rack teeth thereon and said second piston having balancing grooves formed thereon opposite to its rack teeth, a gear member in said housing in mesh with said rack teeth for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, spring means acting on said first piston and tending to move said first piston toward full volume position, and pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure, said second piston having a restricted passageway therethrough communicating opposite ends of said second bore.

10. In combination, a variable delivery pump having means for varying the volumetric delivery thereof, and a pressure actuated volume control unit adapted to be used with said variable delivery pump, said unit comprising a housing having first and second bores therein, first and second pistons in said bores respectively, each of said pistons having facing rack teeth thereon, and said second piston having balancing grooves formed thereon opposite to its rack teeth, a gear member in said housing in mesh with said teeth for rotation thereby upon movement of said pistons and adapted to be connected to volume control means on said pump, spring means acting on said first piston and tending to move said first piston toward full volume position, pressure connections between the pump and said second bore and acting on said second piston to move said second piston and said rotatable member in response to variations in pump pressure, said second piston having a restricted passageway therethrough communicating opposite ends of said second bore, a passageway between said first and second bores, and a pressure relief valve in said last named passageway.

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

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269,747	Great Britain	Apr. 28, 1927