Feb. 9, 1943. J. F. HOFFER 2,310,370

PUMP STRUCTURE

Original Filed May 7, 1938 2 Sheets-Sheet 1

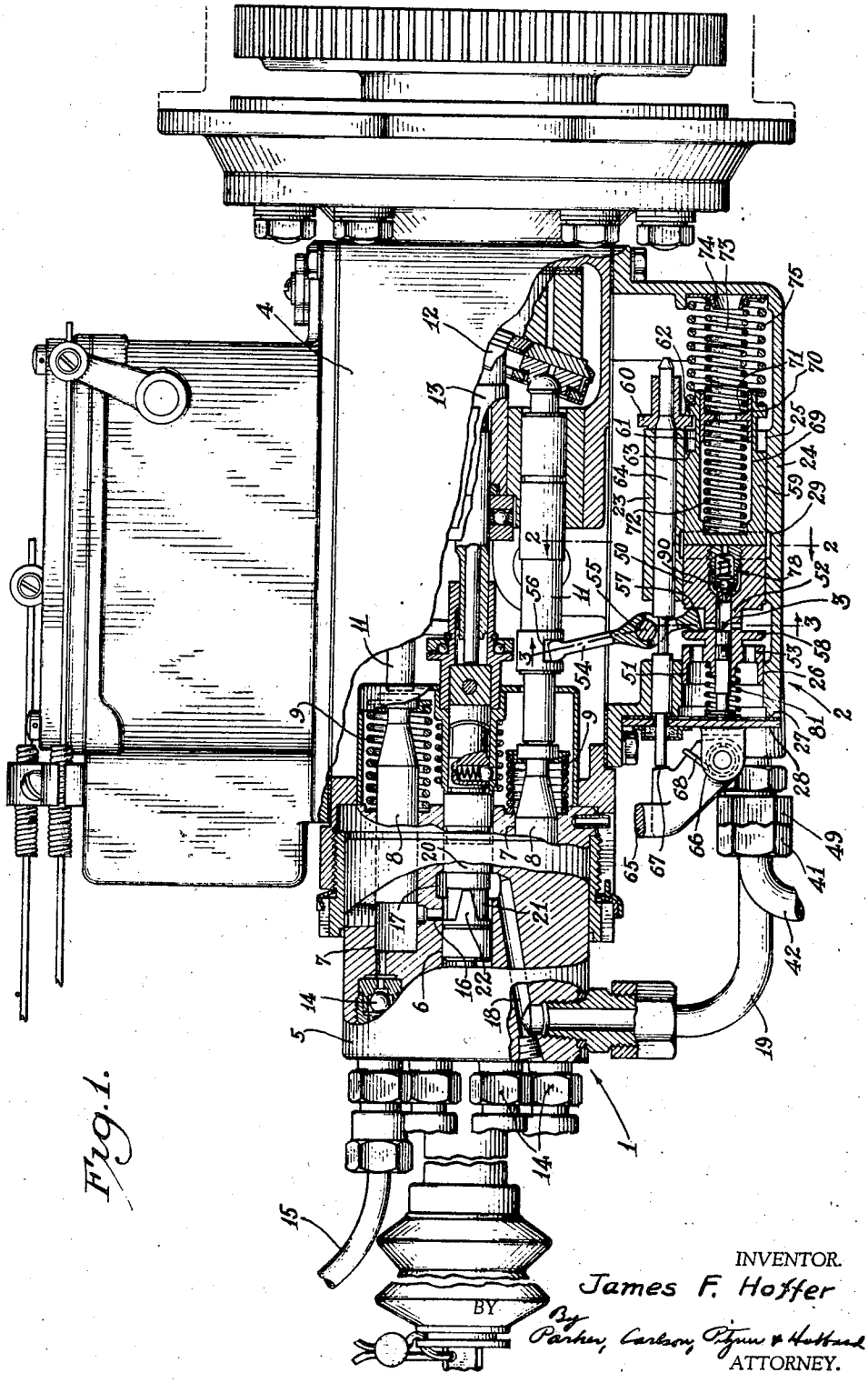

Fig. 1.

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Fig. 2.

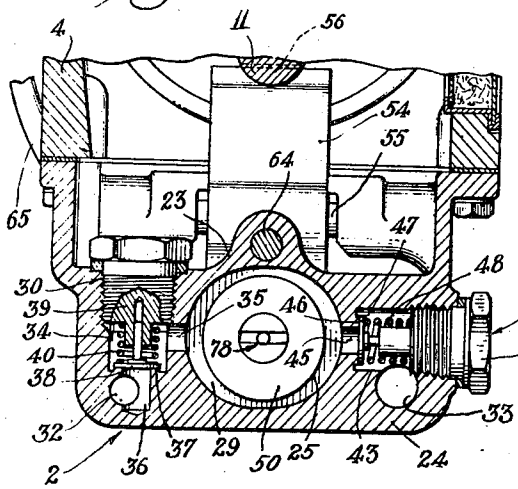


Fig. 3.

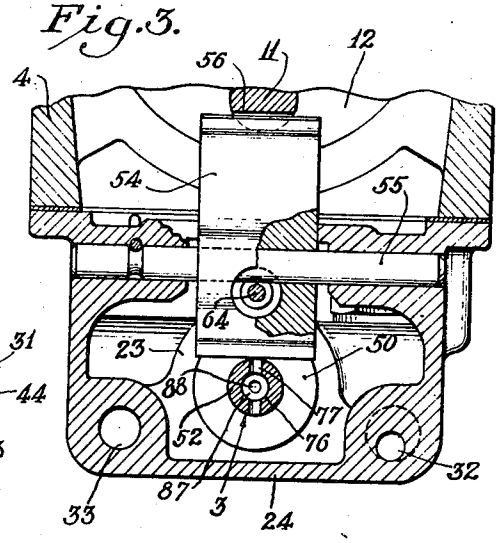
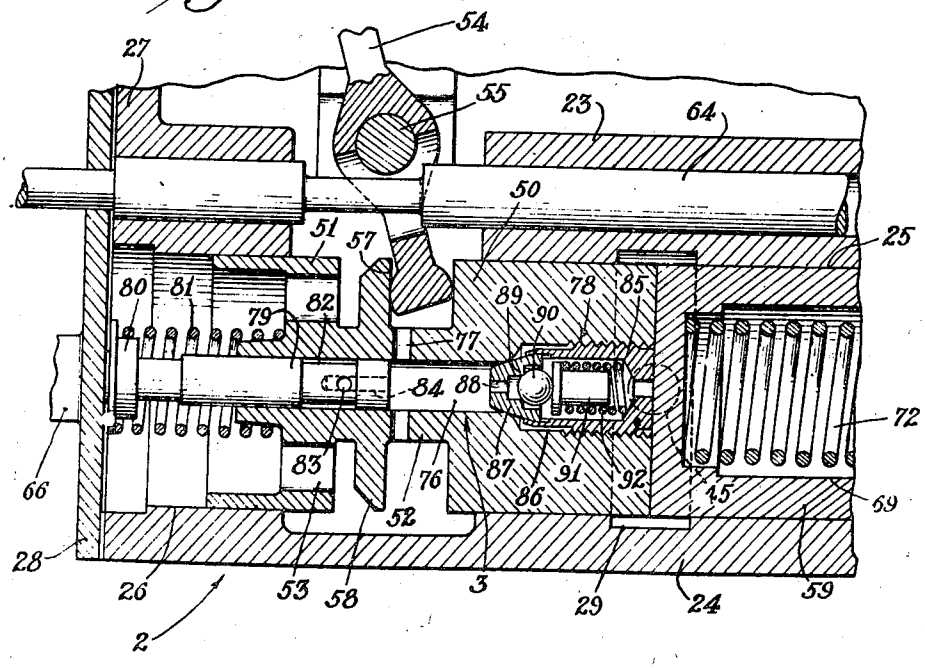


Fig. 4.



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UNITED STATES PATENT OFFICE

2,310,370

PUMP STRUCTURE

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Original application May 7, 1938, Serial No. 206,509. Divided and this application July 8, 1940, Serial No. 344,343

21 Claims. (Cl. 103—37)

The present invention relates to improvements in pump structures and has particular reference to a pump structure adapted for supplying fuel in metered charges and under pressure to an internal combustion engine.

One of the objects of the invention is to provide a new and improved pump structure comprising a relatively high pressure delivery pump, and a primary pump for supplying fluid under a relatively low pressure to the inlet of the first mentioned pump and also for returning fluid leakage from the first mentioned pump with the normal fluid supply to the inlet.

Another object is to provide a novel pump structure of the foregoing character in which the two pumps are connected in a unitary structure and are driven in timed relation and in which the primary pump has an auxiliary pump for introducing fluid leakage from the interior of the delivery pump into the primary pump.

In the accompanying drawings, Figure 1 is a side elevational view partially in longitudinal section of a pump structure embodying the features of my invention.

Fig. 2 is a fragmentary transverse sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a fragmentary transverse sectional view taken along line 3—3 of Fig. 1.

Fig. 4 is an enlarged fragmentary sectional view of the auxiliary leakage pump.

The present application is a division of my copending application Serial No. 206,509, filed May 7, 1938 (Patent No. 2,265,232).

Referring more particularly to the drawings, the pump structure illustrating the invention comprises generally a delivery pump 1 for discharging fluid under a relatively high pressure, and a primary pump 2 for supplying or transferring fluid under a relatively low pressure to the inlet of the delivery pump. The primary pump 2 serves also to return fluid leaking from the delivery pump to the inlet of the latter, and for this purpose preferably includes an auxiliary pump 3 for introducing the leakage fluid into the primary pump for mixture and delivery with the normal fluid supply.

The high pressure delivery pump 1 may be of any desired form or type, and is herein disclosed for purposes of illustration as an adjustable metering and distributing fuel pump like that disclosed in United States Letters Patent to Carroll R. Alden No. 2,156,933, issued May 2, 1939. Briefly described, the delivery pump 1 comprises a housing 4 adapted to be mounted on a suitable support. A cylinder body 5 is mounted in one end of the housing 4, and is formed with a central bore 6 and with a plurality of parallel pump cylinders 7 arranged in annularly spaced relation about the bore. A plurality of pump pistons 8 are reciprocably disposed in the cylinders 7 and are urged outwardly by compression springs 9. Mounted in the other end of the housing 4 is a driving mechanism for effecting reciprocation of the pistons 8 in uniformly timed sequence. This mechanism comprises a plurality of actuating plungers 11 reciprocably guided in the housing 4, and disposed in axial alignment and end abutting engagement respectively with the pistons 8. A rotary swash plate 12 coacts with the plungers 11, and is operable by a central drive shaft 13 in axial alignment with the bore 6. The pressure ends of the pump cylinders 7 open respectively past check valves 14 to a plurality of delivery lines 15, and have individual inlet ports 16 opening in a common transverse plane to the bore 6. A groove 17 is formed in the periphery of the bore 6, and is open to an inlet passage 18 connected to a low pressure fluid supply line 19. Mounted in the bore 6 is a rotary valve member 20 having a relief area 21 adapted to effect communication between the ports 16 and the groove 17 and having an arrow land area 22 movable successively across the ports to close each port during a predetermined portion of the working stroke of the associated piston 8. The valve member 20 is operatively connected to the shaft 13 for rotation thereby in timed relation to the reciprocation of the pistons 8.

In operation, predetermined quantities of fluid, such as liquid fuel, are discharged under a relatively high pressure and in timed sequence to the delivery lines 15. Any fluid leaking from the closed ends of the cylinders 7 along the pistons 8 or from the groove 17 inwardly along the valve member 20 will pass into the interior of the housing 4 between the cylinder body 5 and the driving mechanism.

The primary pump 2 comprises a body 23 located within and integral with the bottom wall of a casing 24 which is open at the top and bolted to the underside of the pump housing 4. The interior of the casing 24 is open to the pump housing 4, and adapted to receive and collect any fluid leaking into the latter from the pump body 5.

The body 23 is formed with a longitudinal pump cylinder 25 open at opposite ends to the interior of the casing 24. A guide bore 26 in spaced axial alignment with the cylinder 25 opens through one end wall 27 of the casing 24,

and is closed at the outer end by an end plate 28 suitably bolted in position.

Formed in the cylinder 25 intermediate its ends is a peripheral groove 29 connected at opposite sides respectively through inlet and outlet valves 30 and 31 to supply and delivery passages 32 and 33. The inlet valve 30 comprises a bore defining a valve chamber 34 opening downwardly in one side of the body 23 and connected through a passage 35 to the groove 29. A valve passage 36 intersects the supply passage 32 and opens through an annular valve seat 37 to the chamber 34. A suitable valve member 38 is slidably guided in a screw cap 39 threaded with a fluid tight seal into the upper end of the chamber 34, and is normally urged by a compression spring 40 into engagement with the seat 37. The passage 32 opens to one end of the casing 24, and is connected through a screw fitting 41 to a conduit 42 adapted for connection with a suitable source of fluid supply, such as a tank (not shown). It will be understood that the valve 30 will open in response to the intake pressure in the cylinder 25.

The outlet valve 31 comprises a bore defining a valve chamber 43 in the other side of the body 23, and closed at the outer end by a screw cap 44. The chamber 43 intersects the delivery passage 33, and is connected to the groove 29 through a valve passage 45 encircled by an annular valve seat 46. A valve member 47 is slidably guided in the cap 44, and is normally urged into engagement with the seat 46 by a compression spring 48. It will be understood that the valve 31 will open in response to the delivery pressure in the cylinder 25. The passage 33 opens to one end of the casing 23, and is connected through a screw fitting 49 to the line or conduit 19 leading to the inlet of the pump 1.

The pump 2 also comprises a piston having a head 50 and a cup-shaped guide 51 interconnected by an axial stem 52, and reciprocable respectively in one end of the cylinder 25 and in the guide bore 26. Suitable openings 53 are formed in the connecting end wall of the guide 51 to permit pressure relief in the bore 26. Preferably, the piston 50 is driven by the pump 1 and hence in timed relation to the pistons 8. The drive comprises a rocker lever 54 mounted intermediate its ends on a pin 55 in the casing 24 for oscillation about an axis extending transversely of the piston 50. The upper end of the lever 54 is rounded, and engages in a transverse notch 56 in the underside of the lowermost operating plunger 11. The lower end of the lever 54 is similarly rounded, and engages in an annular groove 57 defined by the piston head 50 and a spaced flange 58 integral with the stem 52.

Extending reciprocably into the end of the cylinder 25 opposite the piston 50 is a pressure control plunger 59. This plunger is urged inwardly by spring pressure, and in effect constitutes a yieldable end wall for the pressure chamber of the pump 2. Inward movement of the plunger 59 is limited by a stop 60 adjustably mounted within the casing 24. In the present instance, the stop 60 consists of a disk which projects peripherally into an annular groove 61 formed in the outer end of the plunger 59 and defining oppositely facing abutment shoulders 62 and 63. The stop 60 is slidably mounted on the inner end of a rod 64 extending slidably through the pump body 23 and the end wall 27 and end plate 28 to the exterior of the casing 24 in parallel relation to the plunger 50, and is normally in engagement with the adjacent end of the pump body. A priming lever 65 is pivotally mounted on a bracket 66 on the end plate 28, and is provided with a lug 67 in abutment with the outer end of the rod 64. The lever 65 is normally held in its outermost position by means of a spring 68. It will be evident that swinging the lever 65 inwardly against the rod 64 will cause the stop 60 through engagement with the shoulder 62 to shift the pressure plunger 59 outwardly in a pump priming stroke.

Any suitable spring means may be provided for urging the plunger 59 inwardly. In the present instance, the plunger 59 is formed with an axial bore 69 opening to the outer end. A float bushing 70, having an internal flange 71 defining a spring seat, is slidable in the bore 69. A compression spring 72 in the bore 69 engages one side of the seat 71. A similar spring 73 engages the other side of the seat 71 and a stationary seat 74 mounted in the adjacent end wall of the casing 24. The bushing 70 permits the use of the two relatively short springs 72 and 73 which will not tend to buckle objectionably or rub against the surface of the bore 69 as would be likely if a single long spring were employed in their stead. A third compression spring 75, encircling the spring 73 and also engaging the seat 74, acts directly against the outer end of the plunger 59. The three springs 72, 73 and 75 all tend to urge the plunger 59 inwardly, and are provided in lieu of one spring in order to obtain the desired thrust force and at the same time avoid a high spring rate. By the present construction, no perceptible or material variation in the thrust force over the range of spring movement is experienced, and consequently the plunger 59 tends to maintain the delivery of the pump 2 under a substantially constant pressure regardless of volume displacement.

In operation, fluid will enter the cylinder 25 through the valve 30 during the suction stroke of the piston 50, and will be discharged through the valve 31 during the pressure stroke. The pressure plunger 59 is operable automatically to vary the displacement of the pump 2 in accordance with the requirements of the pump 1 at a predetermined maximum pressure. If the maximum displacement of the pump 2 is required, the springs 72, 73 and 75 will hold the shoulder 62 in engagement with the stop 60 to locate the pressure plunger 59 in its innermost position. In the event that the full displacement of the pump 2 is not required, the pressure in the cylinder 25 will cause the plunger 59 to move outwardly during the pressure stroke of the piston 50 so that only part of the displacement of the piston will be discharged through the valve 31. In the subsequent suction stroke, the plunger 59 will move inwardly to maintain the fluid in the cylinder 25 under the predetermined maximum discharge pressure until the shoulder 62 again engages the stop 60, and thereafter fluid in an amount sufficient to refill the cylinder 25 will enter through the valve 30. It will therefore be evident that the pump is self-relieving.

The function of the hand lever 65 and associated parts is to permit manual reciprocation of the plunger 59 independently of the piston 50 for the purpose of priming the injection system without cranking the engine. Hand priming is resorted to when for any reason the system becomes air bound, for example, as a result of the fuel tank running dry. The priming is accom-

plished by working the lever 65 a sufficient number of full strokes to expel the air and to fill the system with oil under maximum primary pump pressure. Thereafter, the springs 72, 73 and 75 will fail to move the plunger 59 to the left, thereby automatically rendering the hand priming mechanism inoperative as soon as its purpose is accomplished.

The primary pump 2 serves to return leakage fluid collecting in the interior of the casing 24 to the inlet of the pump 1. The auxiliary pump 3 is automatically operable to return the leakage fluid into the cylinder 25 during the suction stroke of the piston 50. In its preferred form, the pump 3 is built into the piston 50, and specifically comprises an axial cylinder bore 76 opening through the stem 52 and having radial inlet ports 77 opening to the groove 57. The inner end of the bore 76 is adapted to discharge through an outlet valve 78 into the cylinder 25. A pump plunger 79 is reciprocable in the outer end of the bore 76, and is provided with an external head 80 normally held against the end plate 28 by a coiled compression spring 81.

During the pressure stroke of the piston 50, the plunger 79 is relatively retracted from the bore 76 to uncover the ports 77. If the fluid level in the casing 24 is at or above the ports 77, the fluid will enter and fill the pressure end of the bore 76. During the subsequent intake stroke of the piston 50, the plunger 79 will be forced into the bore 76 in a pressure stroke to discharge the fluid past the valve 78. The capacity of the pump 3 is sufficiently in excess of the normal leakage that the fluid level in the casing 24 will be automatically maintained at the ports 77.

The leakage pump plunger 79 is formed with a peripheral groove 82 which is connected through radial bores 83 and an axial bore 84 to the inner end of the plunger, and which is movable into registration with the inlet ports 77 at the end of the pressure stroke to relieve the pressure in the cylinder bore 76. The relief or by-pass determines the end point of pressure discharge by the plunger 79. Consequently, changes in the length of stroke of the piston 50 as would be obtained by substitution of swash plates 12 of different angularities, will not change the effective capacity of the pump 3. The effective portion of the pressure stroke of the plunger 79 will remain constant regardless of changes in the length of relative plunger travel. If the level of leakage fluid in the casing 24 is below the ports 77, the cylinder bore 76 will be charged with air. The relief or by-pass also serves to prevent excess movement of the plunger 79 from compressing the air to a pressure sufficiently high to open the valve 78.

The valve 78 comprises a hollow body 85 threaded into an axial bore 86 in the working end of the piston 50 and connecting with the cylinder bore 76. A tapered member 87 is rigidly secured in the inner end of the body 85, and is clamped against the inner end edge of the bore 76 to define in effect the end wall of the latter. The member 87 is formed with a restricted valve port 88 opening from the bore 76 through a relatively large valve seat 89 to the interior of body 85. A ball valve member 90 is normally urged into engagement with the seat 89 by a retainer 91 actuated by a coil compression spring 92. The pressure of the spring 92 is sufficiently high to prevent opening of the valve 78 by air pressure or air-liquid emulsion pressure within the cylinder bore 76. The restriction of the port 88 prevents large particles of dirt and other foreign matter from entering the valve 78 and interfering with seating of the valve member 90. In the event that the valve member 90 fails to seat, the restriction also serves to insure continued delivery of fluid by the pump 2 so that when the pump structure is employed to supply fuel to an engine the latter will not stop for lack of fuel.

I claim as my invention:

1. A pump structure comprising, in combination, a pump having a chamber, a pump cylinder open at one end to said chamber and having fluid supply and discharge means connected to the other end, a piston reciprocable in said cylinder and means in said chamber for driving said piston, and a second pump driven from said last mentioned means in timed relation to said first mentioned pump and operable to return fluid leaking from said cylinder into said chamber back to said fluid supply means of said first mentioned pump.

2. A pump structure comprising, in combination, a pump having pumping elements with fluid supply means and fluid discharge means and having an enclosing housing adapted to receive fluid leaking from said elements, and a second pump driven in timed relation to said first mentioned pump and operable to return fluid leaking from said elements back to said supply means.

3. A pump structure comprising, in combination, a relatively high pressure delivery pump having an inlet and an outlet, pumping means taking fluid from said inlet and discharging it to said outlet, a relatively low pressure pump having an inlet and having an outlet connected to said first mentioned inlet and having pumping means driven in timed relation to said first mentioned pumping means, means for collecting fluid leaking from both said pumping means, and an auxiliary pump driven in timed relation to said low pressure pump and operable to transfer fluid leaking from said two pumping means and collecting in said last mentioned means to said low pressure pump for return with a normal supply of fluid to said first mentioned inlet.

4. A pump structure comprising, in combination, a casing having an internal fluid collecting chamber and a pump cylinder, a piston reciprocable in said cylinder, means for supplying fluid to said cylinder and for discharging fluid from said cylinder in response to the reciprocation of said piston, and an auxiliary pump operable by said piston and adapted to transfer fluid from said chamber to said cylinder.

5. A pump structure comprising, in combination, a casing having an internal fluid collecting chamber and a pump cylinder, a piston reciprocable in said cylinder, means for supplying fluid to said cylinder during the suction stroke of said piston, means for discharging fluid from said cylinder in response to the pressure stroke of said piston, and an auxiliary pump operable in timed relation to said piston for discharging fluid from said chamber to said cylinder only during the suction stroke of said piston and independently of said first mentioned means.

6. A pump comprising, in combination, a casing having an internal fluid collecting chamber and a body integral with the floor of said chamber and formed with a longitudinal pump cylinder, means for discharging fluid under pressure from said cylinder, a piston reciprocable in said cylinder and having an axial stem formed with an auxiliary cylinder having inlet ports opening to said chamber and having an outlet check valve discharging through said piston to said pump

cylinder, and a plunger relatively reciprocable in said auxiliary cylinder in response to the reciprocation of said piston and movable at the end of its suction stroke to uncover said inlet ports.

7. A pump comprising, in combination, a casing having an internal fluid collecting chamber and a body formed with a pump cylinder, means for discharging fluid under pressure from said cylinder, a piston reciprocable in said cylinder and formed with an axial auxiliary cylinder having an inlet port opening to said chamber and having means including an outlet check valve discharging to said pump cylinder, and a plunger relatively reciprocable in said auxiliary cylinder and movable at the end of its suction stroke to uncover said inlet port, said plunger having a bypass passage open to said auxiliary cylinder and movable into communication with said port to relieve said auxiliary cylinder near the end of its pressure stroke.

8. A pump structure comprising, in combination, a high pressure pump of the pulsating type having a plurality of pump elements with fluid supply means and fluid discharge means, and a low pressure pump of the constant pressure type for supplying fluid to said supply means and for returning fluid leaking from said elements back to said supply means.

9. In combination, a high pressure pump of the pulsating type having pump elements with fluid supply means and fluid discharge means, a low pressure pump of the constant pressure type for supplying fluid to said supply means and a pump for supplying fluid leaking from said elements to said low pressure pump for return to said supply means.

10. In combination, a high pressure pump of the pulsating type having pump elements with fluid supply means and fluid discharge means, a low pressure pump normally of the constant pressure type for supplying fluid to said supply means, power drive means for operating said low pressure pump in timed relation to said high pressure pump, and means for manually operating said low pressure pump independently of said high pressure pump to deliver fluid to said supply means.

11. In combination, a high pressure variable delivery pump of the pulsating type having pump elements with fluid supply means and fluid discharge means, and a low pressure pump having fluid delivery means connected to said fluid supply means and having self-relieving means for varying the effective displacement and limiting the delivery pressure of the fluid displaced, whereby to provide a volume delivery variable in accordance with the demands of said first mentioned pump.

12. In a pump structure, in combination, a pump cylinder having inlet and outlet means, a piston extending slidably into one end of said cylinder, a coaxial auxiliary cylinder formed in the outer end of said piston and having inlet means and discharge means connected to said cylinder, a normally fixed plunger extending slidably into said auxiliary cylinder, and means for reciprocating said piston whereby to effect in one direction of movement a discharge phase in said cylinder and an intake phase in said auxiliary cylinder, and in the other direction of movement an intake phase in said cylinder and a discharge phase in said auxiliary cylinder.

13. A pump structure comprising in combination with a fluid reservoir, a fixed cylinder mounted horizontally in the bottom of said reservoir, a piston guided for power reciprocation in said cylinder, an axial cylinder bore opening to one end of said piston and having an inlet port in one side open to said reservoir and an outlet discharging to said cylinder, a pump plunger extending reciprocably into said bore, and spring means tending to urge said plunger out of said bore and to maintain said plunger in a fixed position for alternate pressure and intake strokes relative to said bore as an incident to the reciprocation of said piston, said plunger uncovering said port at the end of each intake stroke to admit fluid from said reservoir to said bore, and covering said port during each pressure stroke to discharge fluid under pressure from said bore.

14. A pump structure comprising in combination with a fluid reservoir, a cylinder located horizontally in the bottom of said reservoir, a piston reciprocable at one end in said cylinder and having at the other end a cylinder bore with an inlet port in one side open to said reservoir, an outlet check valve opening from said cylinder bore to said cylinder, a pump plunger extending for relative reciprocation into said bore, spring means tending to urge said plunger out of said bore, said plunger uncovering said port at the end of each intake stroke to admit fluid from said reservoir to said bore, and means for relieving said bore to said reservoir at the end of the pressure stroke of said plunger.

15. A pump comprising in combination with a fluid reservoir, a cylinder body mounted horizontally in the bottom of said reservoir and guided therein for power reciprocation, an axial cylinder bore opening to one end of said body and having an inlet port in one side open to said reservoir, a pump plunger extending reciprocably into said bore, spring means tending to urge said plunger out of said bore and to maintain said plunger in a fixed position for alternate pressure and intake strokes relative to said bore as an incident to the reciprocation of said body, said plunger uncovering said port at the end of each intake stroke to admit fluid from said reservoir to said bore, and means for discharging fluid under pressure from said bore in response to the pressure stroke of said plunger.

16. A pump comprising in combination with a fluid reservoir, a body located horizontally in the bottom of said reservoir and having a cylinder bore with an inlet port in one side open to said reservoir, a pump plunger extending for relative reciprocation into said bore, spring means tending to urge said plunger out of said bore, said plunger uncovering said port at the end of each intake stroke to admit fluid from said reservoir to said bore, a discharge passage having an outwardly opening valve seat and a restricted port opening from said bore in spaced relation to said seat, an outlet check valve member adapted to engage said seat, and spring means tending to hold said member against said seat with a pressure sufficient to prevent lifting of said member by any gas pressure created in said bore.

17. In a pump structure, in combination, a high pressure pump having a pump element with fluid supply means and fluid discharge means, a low pressure pump having fluid delivery means connected to said fluid supply means and having self-relieving means for limiting the delivery pressure to provide a volume delivery variable in accordance with the demands of said first mentioned pump, power drive means for operating said low pressure pump in positive timed relation to said high pressure pump, and means for man-

ually operating said self-relieving means to effect the delivery of fluid from said low pressure pump to said fluid supply means independently of operation of said low pressure pump by said power drive means.

18. In a pump structure, in combination, a high pressure pump having fluid supply means and fluid discharge means, a low pressure pump having a cylinder, a pump piston reciprocable in one end of said cylinder and a self-relieving piston in the other end of said cylinder for limiting the delivery pressure to provide a volume delivery variable in accordance with the demands of said first mentioned pump, said cylinder having fluid inlet means and having fluid outlet means adapted to receive the fluid displaced by either of said pistons, power drive means for operating said pump piston in timed relation to said high pressure pump, and means for manually operating said self-relieving piston independently of said power drive means.

19. In a pump structure, in combination, a first pump having a pump cylinder with inlet and outlet means, a piston reciprocable in said cylinder, and a second pump operable by said piston and having outlet means opening through said piston to said cylinder and operable to supply fluid to said cylinder during the intake phase in said cylinder.

20. A pump structure comprising in combination, a relatively high pressure delivery pump having an inlet and an outlet, pumping means taking fluid from said inlet and discharging it to said outlet, and means for collecting fluid leaking from said pumping means, a relatively low pressure pump having an inlet and having an outlet connected to said first mentioned inlet and having pumping means driven in timed relation to said first mentioned pumping means, and an auxiliary pump driven in timed relation to said low pressure pump and operable to transfer fluid leaking from said first mentioned pumping means and collecting in said second mentioned means to said low pressure pump for return with a normal supply of fluid to said first mentioned inlet.

21. A pump structure comprising, in combination, a metering pump having a supply inlet and a delivery outlet, piston means adapted to adjustably alter the effective displacement of said metering pump irrespective of the pressure in said delivery outlet, a second pump adapted to supply fluid to said supply inlet of said metering pump, said second pump including a plunger having a constant length of stroke but of variable effective displacement inversely responsive to the pressure of fluid supplied by said second pump, a sump associated with said first and second pumps, and a third pump comprising a plunger of constant stroke and fixed effective displacement adapted to transfer fluid from said sump to the supply inlet of said first pump against and irrespective of the pressure of fluid delivered by said second pump.

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