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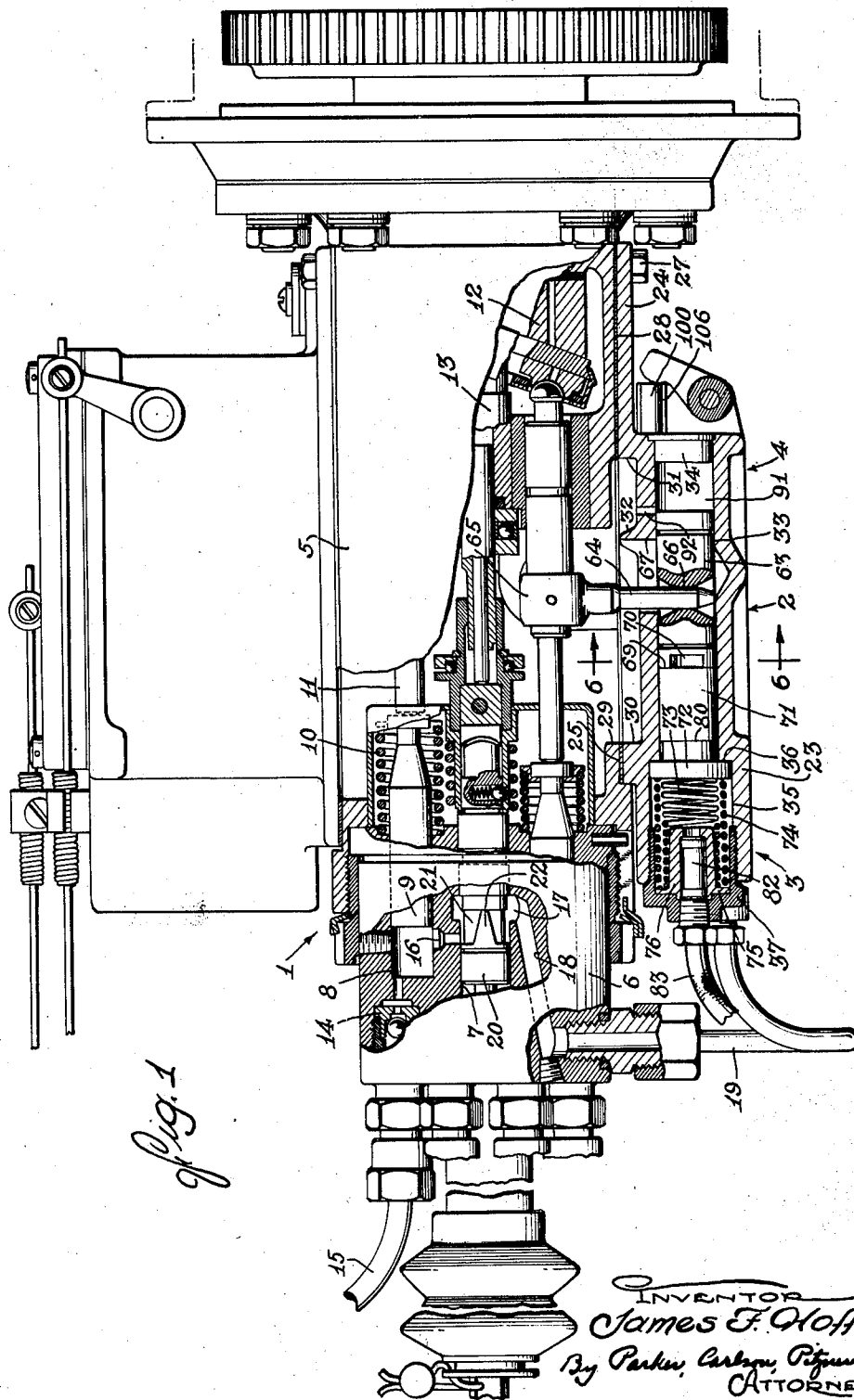
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PUMP STRUCTURE

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2 Sheets-Sheet 1



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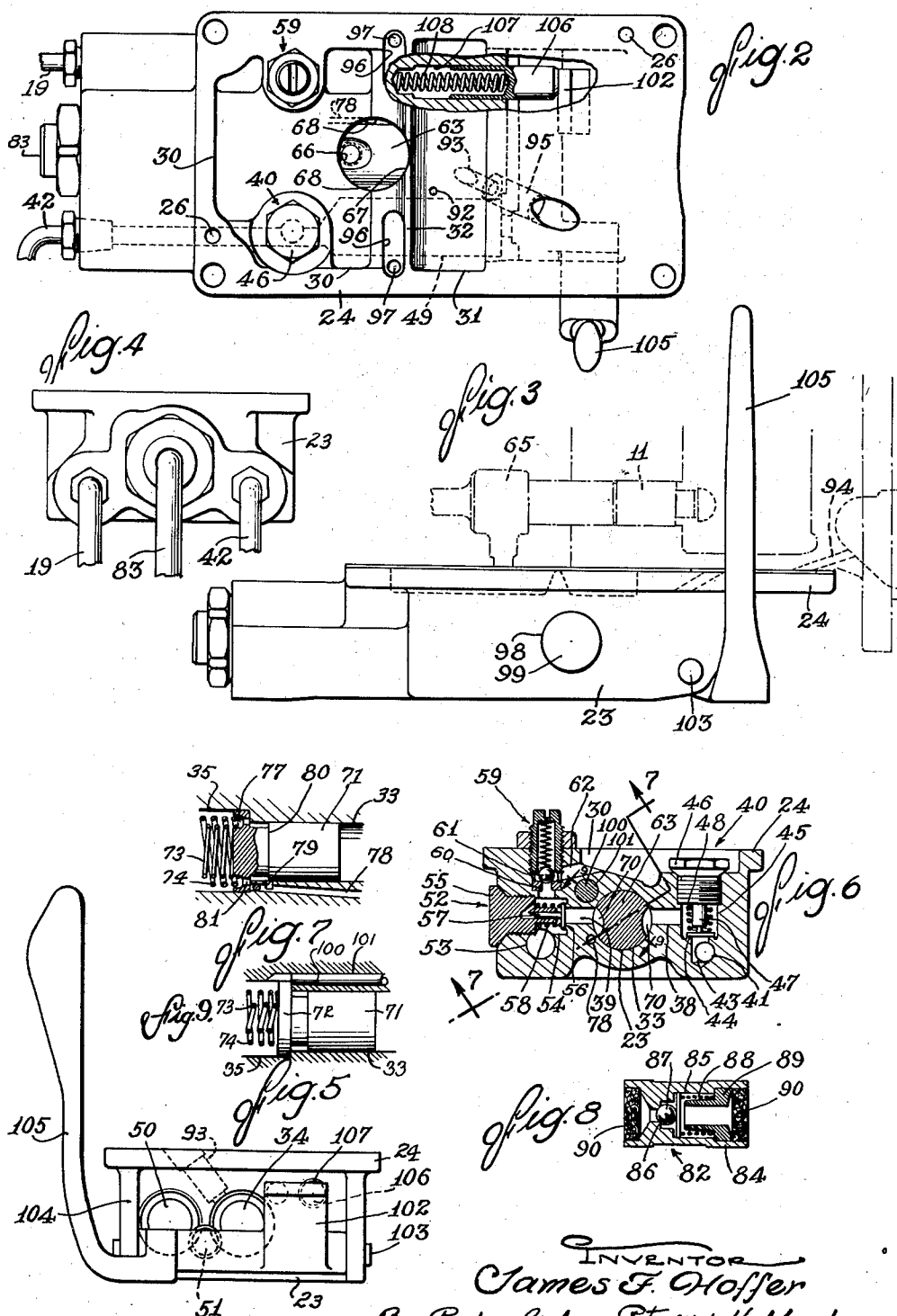
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PUMP STRUCTURE

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5 Claims. (Cl. 103—44)

The present invention relates to improvements in pumps and has particular reference to a new and improved pump structure which is especially suited for use with a delivery pump for supplying fuel in metered charges at a relatively high pressure to an internal combustion engine.

An object of the invention is to provide a new and improved transfer pump unit comprising a primary pump for transferring fuel to a delivery pump and having a pressure controlled plunger, which plunger serves also as the pumping element of an auxiliary pump for removing fuel leaking from the delivery pump.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings,

Figure 1 is a fragmentary vertical sectional view of a pump structure embodying the features of my invention, part of the structure being shown in side elevation.

Fig. 2 is a top plan view of a transfer pump unit forming part of the structure.

Fig. 3 is a side elevation of the transfer pump unit.

Fig. 4 is a left-end elevation.

Fig. 5 is a right-end elevation.

Fig. 6 is a transverse vertical sectional view taken along line 6—6 of Fig. 1.

Fig. 7 is a fragmentary detail sectional view taken along line 7—7 of Fig. 6.

Fig. 8 is an enlarged sectional view through a valve forming part of the transfer pump unit.

Fig. 9 is a fragmentary detail sectional view taken along line 9—9 of Fig. 6.

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 transfer pump unit, including a primary pump 2 for supplying or transferring fluid under a relatively low pressure to the inlet of the delivery pump 1, and two auxiliary pumps 3 and 4 respectively for scavenging accumulated fluid leaking from the pumping means of the delivery pump, and accumulated lubricant leaking from or circulating through the driving mechanism of the delivery pump. The pumps 2, 3 and 4 are combined in a unit assembly, and are operated in timed relation to each other and to the delivery pump 1.

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 my Patent No. 2,265,232, issued De-

cember 9, 1941. In the present instance, the fuel delivery pump 1 comprises a housing 5 adapted to be mounted on a suitable support, such as the crank case of an internal combustion engine. A cylinder body 6 is mounted in one end of the housing 5, and is formed with a central bore 7 and with a plurality of parallel pump cylinders 8 arranged in angularly spaced relation about the bore. A plurality of pump pistons 9 are reciprocally disposed in the cylinders 8, and are urged outwardly by compression springs 10. Mounted in the other end of the housing 5 is a driving mechanism for effecting reciprocation of the pistons 9 in uniformly timed sequence. This mechanism comprises a plurality of actuating plungers or tappets 11 reciprocally guided in the housing 5, and disposed in axial alignment, and in end abutting engagement, respectively with the pistons 9. 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 7. The pressure ends of the pump cylinders 8 open respectively through outlet check valves 14 to a plurality of delivery lines 15, and have individual inlet ports 16 opening in a common transverse plane from the bore 7. A groove 17 is formed in the periphery of the bore 7, and is open to an inlet passage 18 connected to a low pressure fluid supply line 19. Mounted in the bore 7 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 a narrow land area 22 movable successively across the ports to close each port during a predetermined portion of the working stroke of the associated piston 9. The valve member 20 is operatively connected to the shaft 13 for rotation thereby in timed relation to the reciprocation of the pistons 9.

In the operation of the delivery pump 1, 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 fuel leaking from the closed ends of the cylinders 8 along the pistons 9, and from the groove 17 inwardly along the valve member 20, will pass into the left-end portion of the interior of a housing 5 between the cylinder body 6 and the pump driving mechanism. Similarly, any lubricant leaking inwardly along the plungers 11 will also pass into the right-end portion of the interior of the housing 5 between the cylinder body 6 and the driving mechanism.

The transfer pump unit comprises a generally rectangular body 23 which is normally disposed

in a horizontal position, and which is formed at the top with a flat marginal flange or plate 24 adapted to be secured in position against a mounting surface 25 on the underside of the delivery pump housing 5. Preferably, the plate 24 is located by a plurality of diagonally spaced dowel pins 26 and is secured to the housing 5 by four corner bolts 27. A marginal gasket 28 is inserted between the housing 5 and the plate 24 to obtain a fluid-tight connection.

The bottom wall of the pump housing 5, intermediate the pumping unit and the drive mechanism, is formed with an opening 29 which is circumscribed by the marginal surface 25, and which hence is closed by the plate 24 of the body 23. The top face of the plate 24 is recessed to form two open reservoirs or sumps 30 and 31 which are arranged respectively to collect fuel and lubricant leaking from the pumping unit and the drive mechanism into the housing 5 and then dripping or draining through the opening 29. A transverse rib or dam 32, rising to the top level of the plate 24, separates the sumps 30 and 31 to prevent intermingling of the leakage fuel and lubricant. The fluids collecting in the sumps 30 and 31 are removed by the auxiliary pumps 3 and 4 as is hereinafter more fully described.

The primary pump 2, for transferring fuel to the supply line 19 of the pump 1, comprises a longitudinal medial cylinder 33 formed in and opening through the body 23. One end of the cylinder is closed by a plug 34, and the other end is formed with a counterbore 35 constituting an auxiliary cylinder and defining an outwardly facing annular stop shoulder 36. A sleeve nut 37 is threaded into the outer end of the counterbore 35 to close the latter.

Opening respectively to opposite sides of the cylinder 33 in a common transverse plane intermediate its ends are an inlet port 38 and an outlet port 39. The inlet port 38 is connected through an inlet check valve 40 with a supply passage 41 which extends to one end of the body 23. A suction line 42 leading from a suitable source of fuel, such as a supply tank (not shown) is detachably connected to the body 23 and communicates with the outer end of the passage 41.

The inlet check valve 40 comprises a valve passage 43 intersecting the supply passage 41 and opening vertically through a valve seat 44 to a valve chamber 45. The chamber is closed at the top by a screw plug 46, and connects with the port 38. A suitable valve member 47 is slidably guided in the plug 46, and is normally urged by a compression spring 48 into engagement with the seat 44.

Formed in the body 23 and connected to the inner end of the supply passage 41 is a large bore 49 which serves as a surge chamber or accumulator. The outer end of the bore 49 is closed by a plug 50, and the two plugs 34 and 50 are secured in position by a lock screw 51.

The outlet port 39 is connected through an outlet check valve 52 to a delivery passage 53 which extends to one end of the body 23, and is connected with the supply line 19 leading to the inlet of the pump 1. The outlet check valve 52 comprises a valve chamber 54 formed in one side of the body 23, and closed by a screw plug 55. The chamber 54 opens through a valve seat 56 to the outlet port 39, and intersects the delivery passage 53. A suitable valve member 57, slidably guided in the screw plug 55, is normally urged into engagement with the seat 56 by a coiled compression spring 58.

A relief valve 59 is connected to the chamber 54 to dissipate excessive pressures in the event of abnormal operating conditions. The valve 59 has an inlet passage 60 controlled by an adjustable spring-seated ball valve member 61, and has an outlet passage 62 opening to the sump 30.

Reciprocally mounted in the cylinder 33 intermediate its ends is a pump piston 63. Preferably, the piston 63 is driven by the delivery pump 1 in timed relation to the pistons 9. The drive connection comprises a vertical pin 64 which is formed at the upper end with a sleeve 65 fitting snugly about and rigidly locked to the lowermost actuating plunger or tappet 11. The lower end of the pin 64 extends with a close fit into a diametrical bore 66 in the piston 63 substantially midway of its ends. A relatively large vertical bore 67 in the body 23 opens downwardly from the sump 30, and fully intersects the cylinder 33 to permit the drive connection and to accommodate the translation of the pin 64. The bore 67 is somewhat larger in diameter than the cylinder 33, and hence provides vertical passages 68 at opposite sides of the piston 63 adapted to receive fuel from the sump 30.

One end of the piston 63, having an end face 69, constitutes the active end in the primary pump 2. At the end of the pressure stroke, the piston face 69 advances substantially to the plane of the inlet and outlet ports 38 and 39. To prevent blocking of these ports, suitable arcuate grooves 70 are formed in opposite sides of the piston 63 at the end face 69.

In operation, movement of the piston 63 on its outward stroke away from the ports 38 and 39 will cause the flow of fuel from the supply tank through the inlet valve 40 in whatever amount is required to fill the cylinder 33, and movement of the piston in the reverse direction on the pressure stroke will cause the discharge of fuel under pressure through the outlet check valve 52 to the supply line 19 for the delivery pump 1.

A pressure control plunger 71 is reciprocable in the left end of the cylinder 33 in opposed relation to the active end of the piston 63, and coacts therewith to define the pressure chamber of the pump 2. The plunger has an enlarged peripheral flange or head 72 freely reciprocable in the auxiliary cylinder 35, and adapted to limit inward movement by engagement with the stop 36. The plunger 71 is urged inwardly by spring pressure, and in effect constitutes a yieldable end wall of the pump pressure chamber. In the present instance, the spring means comprises two coaxial compression springs 73 and 74 which at one end bear against a flange 75 on a pilot sleeve 76 seated in the sleeve nut 37, and which at the other end engage in a centering recess 77 in the head 72.

The displacement of the piston 63 is normally equal to and preferably in excess of the maximum requirements of the associated fuel injection pump 1, and the pressure control plunger 71 is operable automatically to vary the volume of fuel actually delivered in accordance with the existing requirements at a predetermined maximum pressure. If at any time the full displacement of the piston 63 is required, the springs 73 and 74 will maintain the head 72 against the stop 36 to constrain the plunger 71 against movement out of its innermost position. In the event that the full displacement of the piston 63 is not required, the pressure in the cylinder 33 will cause the plunger 71 to move outwardly during

the pressure stroke of the piston 63 so that only part of the displacement of the piston will be discharged through the valve 52. In the subsequent suction stroke of the piston 63, the plunger 71 will move inwardly to maintain the fuel in the cylinder 33 under a predetermined maximum discharge pressure until the head 72 again engages the stop 36, and thereafter fuel in an amount sufficient to refill the cylinder will enter through the valve 40. If no fuel is required by the delivery pump 1, the plunger 71 will travel in synchronism with the piston 63, thereby resulting in zero delivery. Consequently, the pump 2 is self-relieving to supply the demands of the delivery pump 1 from zero to maximum at the maximum delivery pressure.

The auxiliary pump 3 utilizes the counterbore 35 as a cylinder, and the plunger 71 as a piston, and is operable to take leakage fuel from the sump 30 and transfer it to the source of supply for the delivery pump 1 or to some other convenient place. The pump 3 has an inlet passage 78 which connects at one end with the bottom of the bore 67, and which opens at the other end through a port 79 to the outer end portion of the cylinder 33. The piston 71 serves to uncover the port 79 when in its innermost position in the cylinder 33, and to close the port upon initial movement out of this position. In the present instance, the piston 71 is formed beneath the head 72 with a peripheral groove 80 adapted to communicate with the port 79 when the head 72 engages the stop 36, and with a plurality of apertures 81 opening from the groove 80 through the head 72 to complete the flow connection to the cylinder 35.

The pump 3 has an outlet check valve 82 mounted in the sleeve 76 and adapted for connection to a return line 83. The valve 82 may be of any suitable form, and in the present instance (see Fig. 8) comprises a body 84 having a valve passage 85 with a seat 86. A ball valve member 87 is normally urged against the seat 86 by a coiled compression spring 88 which is confined in the body 84 by a tubular pilot sleeve 89. Preferably, filtering elements 90 are mounted in opposite ends of the valve body 84.

In operation, it will be seen that the plunger 71 performs the dual function of controlling the effective displacement of the pump 2 at a given maximum pressure in accordance with the requirements of the pump 1, and at the same time of serving as the piston of the pump 3. Upon inward movement of the piston 71 to the right into engagement with the stop 36, a suction is created in the cylinder 35, and the port 79 is opened to admit fuel from the sump 30. Upon outward movement of the piston 71, the port 79 is cut off, and thereafter the fuel in the cylinder 35 is compressed and discharged through the valve 82 into the line 83 for return to the fuel supply tank. While the pump 3 is operative only as an incident to the reciprocation of the plunger 71, the latter is reciprocated enough in the normal operation of the pump structure to remove all the leakage fuel accumulating in the sump 30.

The auxiliary pump 4, for removing lubricant leaking from the housing 5 and collecting into the sump 31, utilizes the right end of piston 63 as the pumping element and the closed end of the cylinder 33 as the cylinder or pressure chamber 91. Thus, the piston 63 is of the double acting type, its pressure stroke for the pump 2 being the suction stroke for the pump 4, and its

suction stroke for the pump 2 being the pressure stroke for the pump 4.

The cylinder 91 has an inlet port 92 which opens from the sump 31, and which is uncovered by the piston 63 at the end of the suction stroke and is closed in the initial movement of the piston on the pressure stroke. The cylinder 91 also has an outlet passage 93 which opens through the body 23 to the top face of the flange 24 in registration with a passage 94 through the housing 5 for returning the discharged lubricant to the crank case of the engine. The gasket 28 between the body 5 of the pump 1 and the mounting plate 24 of the pump 2 is suitably apertured to establish communication between the passages 93 and 94. Inserted in the passage 93 is an outlet check valve unit 95 of the same type as the valve 82.

In operation, the piston 63 uncovers the inlet port 92 at the end of the suction stroke in the cylinder 91 to permit the entry of accumulating lubricating oil from the sump 31. On the pressure stroke of the pump 4, the piston 63 will discharge the lubricant from the cylinder 91 through the passages 93 and 94 and valve 95 to the engine crank case.

The dam 32 prevents the fuel and lubricant collecting respectively in the sumps 30 and 31 normally from intermingling. If either of the auxiliary pumps 3 or 4 should fail to operate properly to transfer the fluid collecting in the corresponding sumps, the associated sump would fill up and the fluid therein would overflow the dam 32. Means is provided for indicating such abnormal condition of operation, and in the present instance, this means comprises two longitudinal grooves 96 formed in the top of the dam at opposite sides of the vertical bore 67, and arranged to catch any overflow from either sump. The grooves 96 are connected through vertical down-flow passages 97 to two relatively large bores 98 formed in opposite sides of the body 23. Suitable filters 99 are mounted in the bores 98. In the event of any overflow, fluid will pass to the filters 99, and indicate that at least one of the pumps 3 and 4 is not operating properly. From the character of the fluid noticeable at the filters 99, the offending pump can be identified.

Means is also provided for reciprocating the plunger 71 manually to prime the pump 1 without cranking the engine when the pump is idle. The means for this purpose comprises an actuating plunger 100 which extends reciprocally through a bore 101 in the body 23. One end of the plunger 100 projects for engagement with the head 72, and the other end projects from the body 23 for engagement by the rounded free end of a lever arm 102 fixed on a rock shaft 103. The latter is journaled in parallel spaced lugs or webs 104 integral with one end of the body 23. A hand lever 105 may be fixed on the shaft 103 for actuating the latter. Normally, the springs 73 and 74 acting through the head 72 tend to move the piston 71 in its suction stroke, and to swing the lever 105 to the right. Additional spring means may, however, be provided for insuring movement of the lever 105 to the right independently of the piston 71. This spring means comprises a plunger 106 reciprocable in a bore 107 parallel to the bore 101 in the body 23, and urged outwardly by a coiled compression spring 108 into engagement with the lever arm 102. By alternately actuating the hand lever 105, first in one direction against the action of the springs 73, 74 and 108, and then in the reverse direction, pumping reciprocation will be imparted to the piston 71, independently

of the operation of the pump 2. The piston 11 will, on its outward stroke, take in fuel through the valve 40, and on its pressure stroke discharge fuel through the valve 52.

Various combinations of the pumps 1, 2, 3, and 4 are disclosed and claimed in my copending divisional application Serial No. 566,066, filed December 1, 1944, the present application being directed to the type of pump exemplified by the pump 3.

I claim as my invention:

1. A pump structure comprising, in combination, a body having a cylinder, said body being formed in the top with a sump and with a bore opening from said sump of greater width than the diameter of the cylinder to and intersecting said cylinder, a piston reciprocable in said cylinder, drive means for said piston extending outwardly through said bore, means for supplying fluid to said cylinder during the suction stroke of said piston and for discharging fluid from said cylinder during the pressure stroke of said piston, a pressure control plunger reciprocable in said cylinder independently of said piston and constituting an end wall thereof in opposed relation to said piston, said control plunger being movable outwardly solely in response to pressure fluid in said cylinder, spring means for urging said plunger inwardly with a predetermined pressure, and means utilizing said control plunger as an auxiliary piston for transferring fluid from said sump to a point external of said cylinder.

2. A pump structure comprising, in combination, a cylinder body formed with a cylinder, a piston reciprocable in said cylinder, inlet valve means and outlet valve means opening to and from said cylinder, spring means tending to urge said piston toward and into one end position, fluid pressure means for periodically actuating said piston out of said end position in opposition to said spring means, a plunger extending reciprocably through said body for actuating said piston in opposition to said spring means, a rock shaft journaled in said body, and a lever arm on said shaft and engaging one end of said plunger to actuate the latter.

3. A pump structure comprising, in combination, a cylinder body formed with a cylinder, a piston reciprocable in said cylinder, inlet valve means and outlet valve means opening to and from said cylinder, spring means tending to urge said piston toward and into one end position, fluid pressure means for periodically actuating

said piston out of said end position in opposition to said spring means, a plunger extending reciprocably through said body for actuating said piston in opposition to said spring means, a rock shaft journaled in said body, a lever arm on said shaft and engaging one end of said plunger to actuate the latter, and supplemental spring means mounted on said body and acting against said lever arm in a direction to release said plunger.

4. A pump structure comprising, in combination, a body formed with a horizontal longitudinal cylinder and an aligned auxiliary cylinder and with a sump in the top and a recess opening downwardly from said sump and intersecting said cylinder, a piston reciprocable in said cylinder, said recess defining downflow passages at opposite sides of said piston, a plunger reciprocable in said cylinder and having an apertured head reciprocable in said auxiliary cylinder, means for supplying fluid to and from said cylinder between said plunger and said piston, spring means acting on said plunger in opposition to the pressure in said cylinder, an inlet passage opening from said recess and having an inlet port opening to said cylinder beneath said head, said plunger having a groove beneath said head normally open to said port and adapted to close said port upon outward movement of said plunger against said spring means, and outlet valve means opening from said auxiliary cylinder.

5. A pump structure comprising, in combination, a body formed with a horizontal longitudinal cylinder and an aligned auxiliary cylinder and fluid supply openings and a recess intersecting said cylinder, a piston reciprocable in said cylinder, said recess defining down-flow passages at opposite sides of said piston, a plunger reciprocable in said cylinder and having an apertured head reciprocable in said auxiliary cylinder, means for supplying fluid to and from said cylinder between said plunger and said piston, spring means acting on said plunger in opposition to the pressure in said cylinder, an inlet passage opening from said recess and having an inlet port opening to said cylinder beneath said head, said plunger having a groove beneath said head normally open to said port and adapted to close said port upon outward movement of said plunger against said spring means, and outlet valve means opening from said auxiliary cylinder.

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