

June 16, 1942.

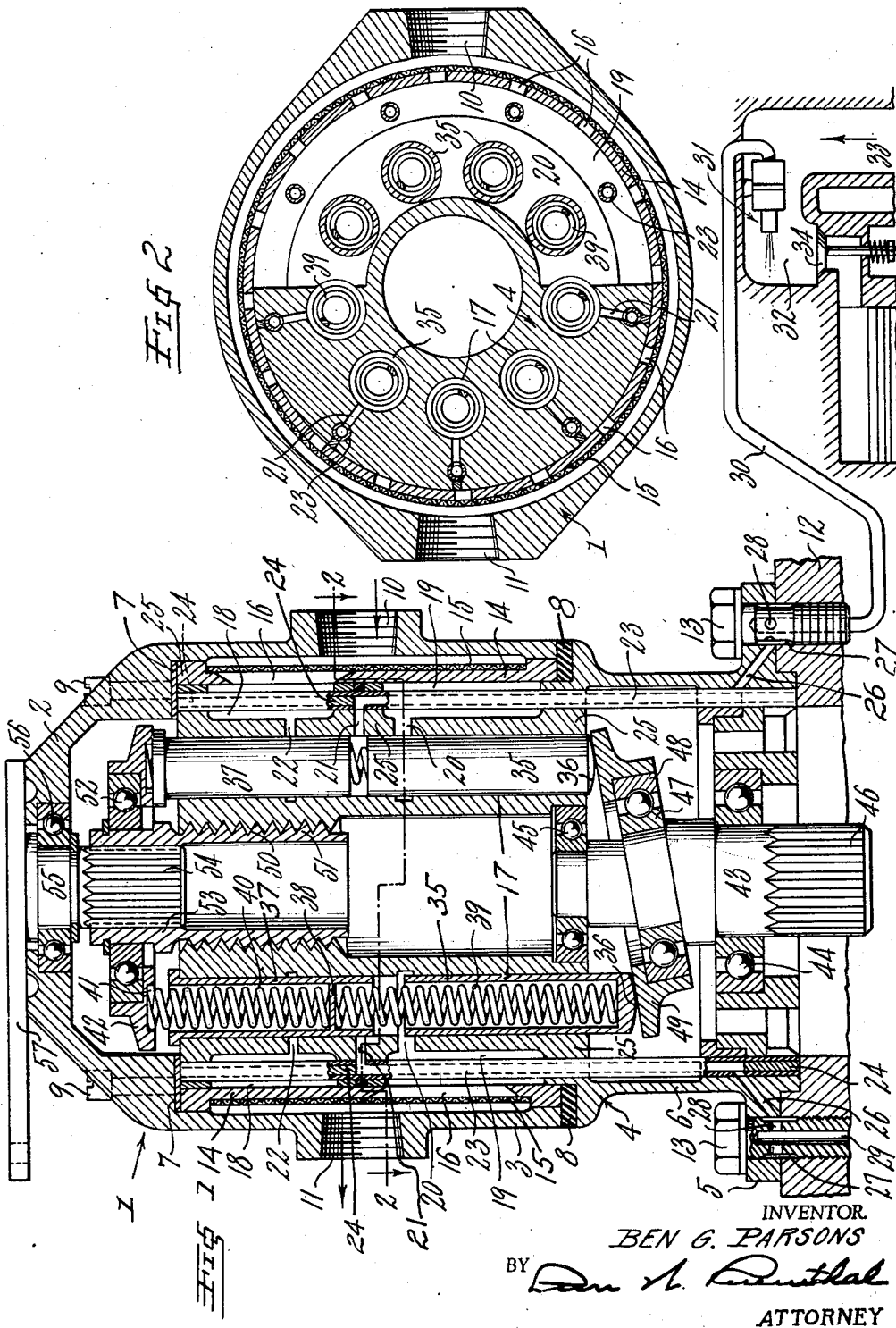
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LIQUID PUMP

Filed Feb. 28, 1941

2 Sheets-Sheet 1



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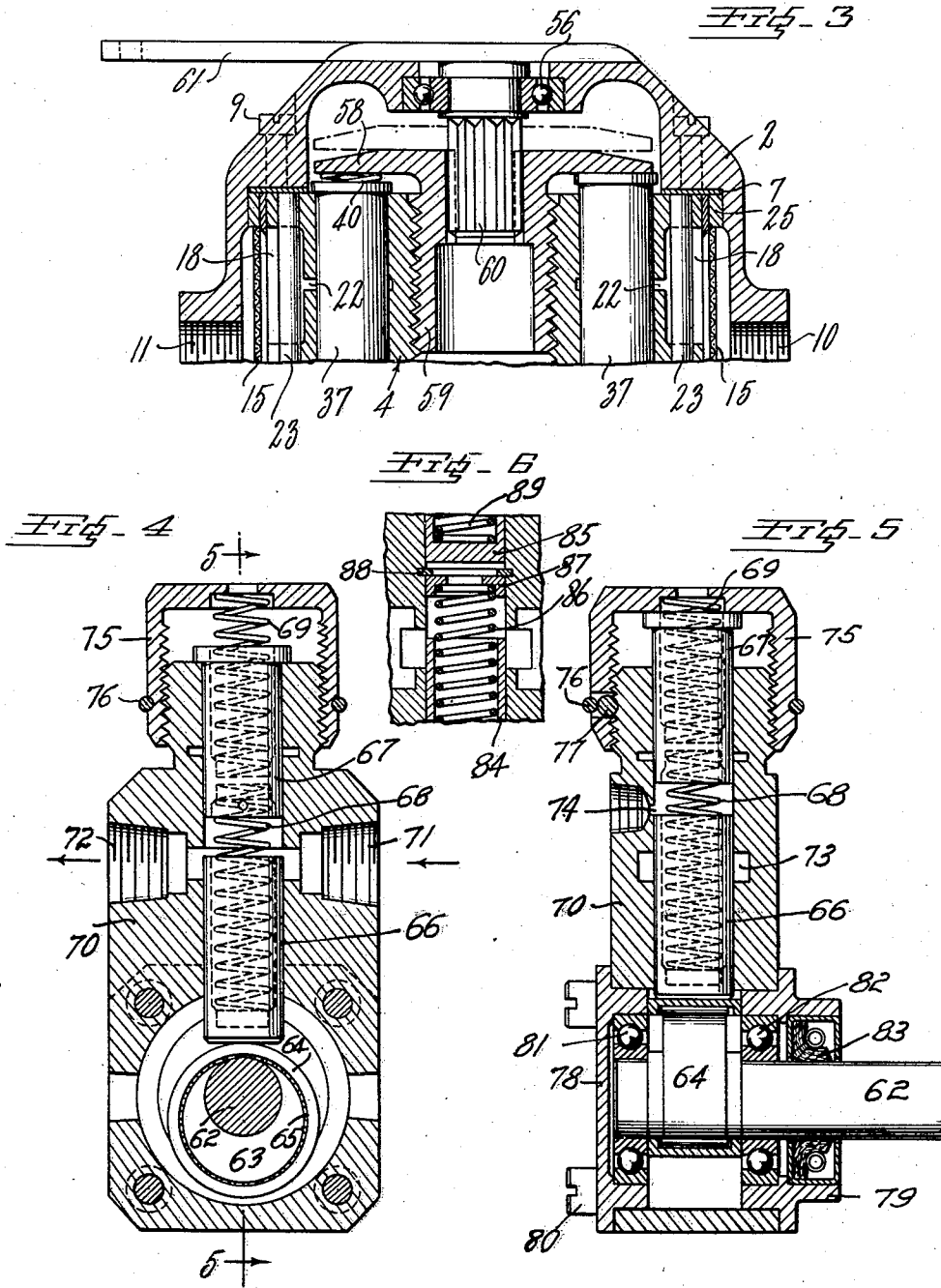
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LIQUID PUMP

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20 Claims. (Cl. 103—162)

The present invention relates to liquid pumps, and particularly to single cylinder and multicylinder pumps for supplying gasoline, fuel oil, water and other liquids to a nozzle or spray device in an amount which is metered and preferably begins at such a variable time in the engine cycle as is predetermined in accordance with an adjustable setting of the pump.

The primary object of the invention is to provide an arrangement whereby there is obtained a small, strong, compact and inexpensive pump of this kind of comparatively large capacity with comparatively low working pressures, and light in weight but rigid in construction. One of the preferred features contributing to these characteristics is a hollow delivery plunger and a hollow control piston therefor in which are partly or wholly enclosed the return springs. Another preferred contributing feature has to do with multicylinder pumps with or without control pistons but with delivery ducts in the form of rigid tubes circularly spaced around the pump and substantially strengthening the structure thereof.

Still another object is to provide in this or other kind of pump an improved stationary filter arrangement for the liquid supplied to the cylinder or cylinders thereof, preferably of the kind in which the outer periphery thereof is continually washed by the flow of liquid forming the surplus not discharged by the pump at the time and in which the cleansing of the filter is assisted by surplus liquid returned from the cylinder or cylinders through the filter.

The structural features and arrangements by which these and other objects are attained will be understood from the following description taken in connection with the accompanying drawings, which show as examples single and multicylinder pumps particularly adapted in accordance with the invention for injecting gasoline through a nozzle or nozzles into the manifold or cylinders of internal combustion engines.

In the drawings, Fig. 1 is a central vertical section, partly in elevation and partly diagrammatic, of a 9-cylinder pump with a manual adjustment for the beginning of injection and the quantity of delivery, in combination with a nozzle mounted in the engine manifold; Fig. 2 is a section of the pump on line 2—2 of Fig. 1; Fig. 3 shows in central section, partly in elevation, a modified form of manual adjustment; Fig. 4 is a central vertical section, partly in elevation, of a single cylinder pump shown with the delivery plunger in its lowermost position; Fig. 5

is a section, partly in elevation, on line 5—5 of Fig. 4 but with the plunger in its uppermost position; and Fig. 6 is a fragmentary view in vertical section of a modified form of spring arrangement applicable to the multicylinder pump of Fig. 1 or the single cylinder pump of Fig. 4.

Referring to Figs. 1 and 2, the exterior casing is formed by a filter housing 1 comprising an upper or cap portion 2 and an integral depending annular portion 3 of suitable aluminum alloy, and also by an integral plunger housing or pump body 4 comprising a steel forging with a flanged base 5 and an upstanding annular portion 6. These two housings, having their annular portions 3 and 6 telescoped, are separated above by a copper ring 7 and below by a synthetic rubber ring 8. The circular series of screws 9, bearing on the cap portion 2 and threaded into the pump body, hold the two telescoped portions rigidly against rings 7 and 8. The filter housing contains a gasoline inlet 10 and outlet 11 into which suitable conduits (not shown) are screwed. The base 5 is secured to the engine or other support 12 by a circular series of nickel steel or stainless steel stud bolts 13 comprising one for each pump cylinder.

Arranged concentrically within the filter housing, is a stationary filter comprising an annular cage 14 of stainless steel, also secured between the rings 7 and 8, and an annular filter screen 15, of any suitable kind such as closely spaced bronze wires soldered to the cage at its upper and lower ends. The cage has a plurality of circularly arranged axial slots 16 staggered in its upper and lower halves. The pump body has nine circularly arranged delivery cylinders or barrels 17 around all of which are two annular channels 18 and 19 open respectively to the upper and lower slots 16. For the delivery barrels there is a common inlet port 20 of ring form, and for each barrel there is a delivery or discharge port 21 and a leakage outlet or trap 22 of ring form.

Also extending concentrically around the pump body within the channels 18 and 19 is a plurality of nickel steel tubes 23, with plugs 24 in their ends as shown, each tube being arranged radially outside a delivery barrel and having its bore connected to the delivery port 21 thereof. The tubes extend through the flanges 25 of the pump body, and because of the material and arrangement there results a pump which is of great strength for its weight, and rigid in construction against mechanical distortion under the extreme vibration usually present on engines,

particularly on airplanes. The bore of each tube 23 extends into communication with a duct 26 which leads to a circular recess 27 around a respective stud bolt 13 so that the tube communicates with the recess at any position to which the bolt may be turned. From opposite points of this recess extends the cross passage 28 leading to the central bore 29 of the stud bolt, from which extends a pipe 30 to the respective nozzle 31 in the manifold 32 of the engine. Air enters the manifold at 33, and, after mixing with the gasoline spray emerging from the nozzle, enters the engine cylinder through the inlet valve 34.

In each barrel 17 is a hollow delivery plunger 35 of chrome steel having a rounded bottom 36. Above each delivery plunger is a chrome steel control piston 37 with open ends and cross web 38. A long helical spring 39 extends from the bottom of the delivery plunger to the web of the control piston, and a shorter but stiffer helical spring 40 extends from the web 38 into a pocket 41 in the underside of an adjustable stop plate 42. Centrally of the pump body near the bottom of the central bore therein is a drive shaft 43 mounted on ball bearings 44 and 45 and having a serrated end 46 for an adjustable drive coupling (not shown) with or without an automatic timing device as desired. This shaft carries eccentrically an inner ball race 47 of which the outer ball race 48 carries a flat topped swash plate 49 so that as the shaft rotates, the swash plate is given a circularly-advancing tilting movement without rotation and thereby lifts the delivery plungers 35 serially in movements of sine wave characteristic. In this way there is a rolling action between the swash plate and the rounded bottom 36 of each delivery plunger with substantially no sliding friction between them. The delivery plungers 35 are thus given upward movements progressively around the circle and with them the respective control pistons 37 are moved correspondingly upwardly until they in turn contact the stop plate 42. After each control piston is stopped, as shown at the right in Fig. 1, the corresponding delivery plunger alone continues its lift and starts the delivery of gasoline as will be more fully described hereinafter.

The pump body is internally threaded at 50 near the upper end of its central bore, into which is screwed a hollow stud 51 fastened to the inner race of ball bearing 52, the outer race thereof being mounted in the stop plate 42. The inner surface of the top part 53 of stud 51 is longitudinally fluted and engaged by similar flutes at 54 on stub shaft 55 which is rotatably mounted in the ball bearing 56 carried by the cap portion 2. Upon turning the handle 57 fixed on the shaft 55, the stud 53 is turned and thus raised or lowered in the threads at 50 along the fluted end of shaft 55. The stop plate 42 is thus raised or lowered but is held from turning by the pressure of the springs 40.

In the modification of Fig. 3, the stop plate 58 is an integral part of the hollow stud 59, so that the stop plate turns, while being raised or lowered between the full line and broken line positions shown, whenever the fluted shaft 60 is turned by the handle 61.

The single cylinder pump of Figs. 4 and 5 is intended to have an outside filter (not shown) but if desired the filter could be incorporated similarly to that shown in the embodiment of Figs. 1 and 2. This pump of Figs. 3 and 4 is op-

erated from the power shaft 62 through eccentric 63 fast thereon, between the lowermost and uppermost positions as shown. The ring 64 is supported by the eccentric on a needle bearing 65 and rises and falls without turning as a result of the downward pressure exerted on it by the delivery plunger 66. Above this plunger is the control piston 67, these and the springs 68 and 69 being substantially identical with the corresponding parts of Figs. 1 and 2. The plunger and piston are reciprocal in the barrel of the pump housing 70, which has an inlet 71, outlet 72, ring inlet port 73 and a delivery port 74 for a delivery conduit (not shown) communicating directly with a nozzle in the engine cylinder. The top of the housing 70 is threaded for engagement with a cap 75 having a depression into which the piston spring 69 extends. This cap may be screwed up and down and thereby forms an adjustable stop for the control piston 67. The cap may be releasably held in any adjusted position by the spring ring 76 and ball 77. On opposite sides of the pump housing 70, near the bottom thereof, are two end caps 78 and 79 clamped thereagainst by the screws 80. The end plate 78 carries a ball bearing 81 and the end plate 79 carries a ball bearing 82 and an oil seal 83.

In Fig. 6 is shown a modified form of plunger piston springs which may be applied to each of the single or multicylinder pumps of the previous embodiments. Instead of extending the spring of the delivery plunger 84 into the control piston 85, the spring 86 reacts against an annular member 87 held in the barrel by a snap ring 88, and the lower end of spring 89 in the control piston reacts against the closed bottom thereof.

The operation of the multicylinder pump of Figs. 1 and 2 will now be described. The pump shaft 43 is driven at cam shaft speed for a 4-cycle engine, or at crank shaft speed for a 2-cycle engine, in proper timed relation thereto, and the swash plate 49 then raises the delivery plungers 35 in turn progressively. During operation of the pump, gasoline flows into the inlet 10 and fills the circular channels 18, 19 and the interiors of all delivery plungers and control pistons open at the time to the channels through the inlet ports 20. The surplus supply of gasoline flows around the outside of the screen 15 and continuously washes away any particles of dust, dirt or other foreign matter there deposited. As each delivery plunger rises and closes its inlet port 20, pressure on the substantially incompressible gasoline is quickly built up to overcome the spring 40 and lift the control piston 37 until its top engages the stop plate 42. Before such engagement, the gasoline entrapped in the pistons is subjected to less than the opening pressure of the nozzle 31 and therefore in such period no gasoline is injected by the pump even after the outlet port 21 is uncovered by the delivery plunger. However, as soon as such engagement occurs to prevent further lift of the control piston 37, the entrapped gasoline is subjected to ever increasing pressure as the lift of the delivery plunger continues, until the pressure on the gasoline in the duct 30 at the nozzle 31 reaches that required to lift the spring-pressed pin of the nozzle to open the spray passages into the engine manifold 32. The delivery of gasoline spray into the manifold then continues until the delivery plunger is at the end of its upward stroke (as shown at the right in Fig. 1). Any gasoline leaking past the delivery plunger to the

channel 22 flows into the trap 18 from whence it, with the surplus gasolene from inlet 10, flows to the pump outlet 11. Thence upon the downward suction stroke of the delivery plunger, caused by the spring 39 as permitted by the swash plate 49, the control piston 37 follows under action of its spring 40 to its bottom limit (substantially as indicated at the left of Fig. 1), a fresh supply of gasolene being taken into the interior of the barrel while the inlet channel 20 is again open. The point in the engine cycle at which the injection begins, and the quantity of gasolene delivered, are thus predetermined by the position of the stop plate 42 as adjusted by the handle 57. Likewise with the modified form of adjustment shown in Fig. 3, this point is predetermined by the stop plate 58 as adjusted by the handle 61. It is thus apparent that the control piston controls a delivery characteristic of the plunger.

The stop plate 42 of Fig. 1 and the stop plate 58 of Fig. 3 may be raised or lowered by the manual adjusting handle 57 or 61 as the case may be. In either case, the gasolene is discharged from each pump barrel through the delivery port 21 as soon after the control piston 37 engages the stop plate as the delivery plunger is lifted enough higher to develop that pressure on the gasolene sufficient to open nozzle 31.

Irrespective of the adjusted position of the stop plate of either form, the pressure on the gasolene delivered from each barrel rises to its delivery pressure in a few degrees of the pump cycle after the control piston engages the stop plate. Owing to the sine wave characteristic of the upward lift of the delivery plunger by the swash plate, there is a period of about 30° in the pump cycle in which there is a substantially constant speed of the delivery plunger. In this period, the time rate displacement of the delivery plunger is substantially constant and therefore the volume of fuel discharge is at a substantially constant rate. Thereafter, the work piston decelerates in its speed of upward movement and the volume rate of the fuel discharge consequently decreases, while the pressure on the fuel similarly decreases until the needle of nozzle 31 is closed by its spring. For the remainder of the upward stroke of the piston, if any, the fuel is discharged past the control piston into the trap channel 22. Owing to the fact that there is no delivery valve controlling the delivery port, and no check valve in the pump or in the conduit leading from it to the nozzle, and furthermore due to the fact that the pressure of the springs 39 and 40 varies but slightly during the period of lift of the pistons, the pressure on the gasolene in the pump cylinder during substantially the whole period of delivery of fuel is at substantially the minimum possible under the conditions. This feature reduces the precision necessary in the fits between pistons and barrels, and reduces the leakage past the control pistons. Furthermore, it reduces the weight of the pump and working parts necessary to withstand the pressure. Concomitantly, this increases the rigidity of the parts against mechanical distortion with the consequent improvements in operation and durability. Not only does the absence of all delivery valves, check valves, and modifying springs simplify the construction, but the use and arrangement of the circularly disposed tubes 23 further strengthen the pump and result in less weight for the same rigidity and

output capacity than would otherwise be the case.

The operation of the single cylinder pump of Figs. 4 and 5 will now be understood from the foregoing, the difference residing mainly in the use of an outside filter to deliver strained gasolene to the inlet of the pump, in the form of adjustable stop plates, and in the use of the eccentric 63 for lifting the delivery plunger.

In the modified spring arrangement of Fig. 6, whether applied to a single cylinder or a multicylinder pump, the delivery characteristics of the gasolene are substantially the same as described above. In this case, it is the pressure of the gasolene alone, and not that in addition to the pressure of the spring on the delivery plunger, that lifts the control piston to its stop plate.

The hollow delivery plungers of the single and multicylinder pumps herein are expansible from a comparatively loose fit to a tight fit in the barrel as pressure is developed in the gasolene. Also the filter cage may be readily exposed and removed for inspection and replacement upon removing the filter housing. Furthermore, the clearing of the screen is aided by the pumps in forcing back through it some of each charge of gasolene initially sucked into the barrels on the downward stroke of the plungers, which, together with the proximity to the screen of the inlet ports, ensures the supply of clean gasolene to all the barrels throughout extended periods of use.

Having thus described my invention, what I claim is:

1. In a liquid pump having a plunger barrel with inlet and outlet ports, a hollow delivery plunger reciprocative in said barrel, operating means acting to move said plunger in its delivery stroke to force liquid through said outlet port, a spring extending into the plunger and acting to effect its return suction stroke and draw liquid through said inlet port into said barrel, and a control piston in said barrel for controlling the amount of liquid delivered through the outlet port in each delivery stroke of said plunger.

2. In a liquid pump having a barrel with inlet and outlet ports, a hollow delivery plunger and a hollow control piston reciprocative in said barrel, said piston controlling the amount of liquid delivered through the outlet port in each delivery stroke of said plunger, operating means acting to move said plunger and piston in their delivery strokes to force liquid through said outlet port, a spring extending into said plunger and acting to effect its return suction stroke and draw liquid through said inlet port into said barrel, and a spring extending into said piston and acting to effect its return stroke.

3. In a liquid pump having a barrel with inlet and outlet ports, a hollow delivery plunger and a hollow control piston reciprocative in said barrel, operating means acting to move said plunger and piston in their delivery strokes to force liquid through said outlet port, a spring extending into said plunger and acting to effect its return suction stroke and draw liquid through said inlet port into said barrel, a stop member cooperative with said piston to control the amount of liquid delivered through the outlet port in each delivery stroke of said plunger, and a spring extending into said piston and reacting between it and the stop member and acting to effect the return stroke of said piston.

4. In a liquid pump having a barrel with inlet and outlet ports, a hollow delivery plunger and a hollow control piston reciprocative in said bar-

rel, operating means acting to move said plunger and piston in their delivery strokes to force liquid through said outlet port, a spring extending into said plunger and piston and reacting therebetween, a stop member cooperative with said piston to control the amount of liquid delivered through the outlet port in each delivery stroke of the plunger, and a spring extending into said piston and reacting between it and said stop member, said springs acting to effect the return suction strokes of said plunger and piston and draw liquid through said inlet port into said barrel.

5. In a liquid pump having a barrel with inlet and outlet ports, a hollow delivery plunger and a hollow control piston reciprocative in said barrel, operating means acting to move said plunger and piston in their delivery strokes to force liquid through said outlet port, a spring extending into said plunger and reacting against said barrel for moving said plunger in its return suction stroke to draw liquid through said inlet port into said barrel, a stop member cooperative with said piston to control the amount of liquid delivered through the outlet port in each delivery stroke of said plunger, and a spring extending into said piston and reacting between it and said stop member.

6. In a liquid pump having a plunger barrel with inlet and outlet ports, a hollow delivery plunger reciprocative in said barrel, operating means acting to move said plunger in its delivery stroke to force liquid through said outlet port, a spring extending into said plunger and acting to effect its return suction stroke and draw liquid through said inlet port into said barrel, and control means including a piston movable in said barrel for controlling the amount of liquid delivered through the outlet port in each delivery stroke of said plunger, said barrel having a trap which throughout the movement of said piston in said barrel is in registry with said piston and in communication with said inlet port.

7. In a liquid pump, a reciprocative delivery plunger, a reciprocative control piston for said plunger, an adjustable stop member for said piston, operating means for reciprocating the plunger and piston, and rotatable and axially-movable adjustable mechanism including a non-rotatable member arranged to engage the piston to limit its reciprocative movement in one direction.

8. In a multicylinder liquid pump, an integral pump body having a plurality of delivery barrels and a threaded portion, reciprocative delivery plungers and control pistons in said barrels, operating means for reciprocating said plungers and pistons, and an adjustable stop mechanism arranged in engagement with said threaded portion and having an adjustable stop for said pistons.

9. In a multicylinder liquid pump, an integral pump body having a plurality of circularly-disposed delivery barrels and a central threaded bore, reciprocative delivery plungers and control pistons in said barrels, operating means for reciprocating said plungers and pistons, an adjustable stop mechanism comprising a rotatable member in engagement with said threaded portion and a stop plate for said pistons supported on a bearing in said rotatable member, and springs reacting between said pistons and stop plate.

10. In a multicylinder liquid pump, an integral pump body having a plurality of circularly-dis-

posed delivery barrels and a central bore, reciprocative delivery plungers and control pistons in said barrels, operating mechanism for reciprocating said plungers and pistons, an adjustable stop mechanism arranged near one end of said bore and having an adjustable stop plate for said pistons, and a drive shaft for said pump journaled in said pump body near the other end of said bore.

11. In a multicylinder liquid pump, a pump body having a plurality of plunger barrels each with a delivery port, delivery plungers in said barrels, operating means for reciprocating said plungers, for each barrel a tubular member in communication with said delivery port to form a delivery conduit therefor, and a casing enclosing said body and assisting in holding said tubular members in place therein.

12. In a multicylinder liquid pump, a pump body having a plurality of circularly-disposed plunger barrels each with a delivery port, delivery plungers in said barrels, operating means for reciprocating said plungers, arranged radially of each barrel a tubular member in communication with said delivery port to form a delivery conduit therefor, and a casing enclosing said body and assisting in holding said tubular members in place therein.

13. In a multicylinder liquid pump, a pump body having a plurality of plunger barrels each with a delivery port and having integral flanges, delivery plungers in said barrels, operating means for reciprocating said plungers, for each barrel a tubular member passing through said flanges and arranged in communication with the delivery port of its barrel to form a delivery conduit therefor, and a casing enclosing said body and assisting in holding said tubular members in place.

14. In a liquid pump having a plunger barrel with inlet and outlet ports, a delivery plunger reciprocative in said barrel to deliver liquid from said inlet port to said outlet port, a casing surrounding said barrel and having inlet and outlet ports in communication with each other and with the inlet port of said barrel, and a stationary filter in said casing interposed between the inlet ports of said casing and barrel, said pump having means for returning surplus liquid from said barrel through said filter to assist in cleansing the same.

15. In a multicylinder liquid pump having plunger barrels with inlet and outlet ports, delivery plungers operative in said barrels to deliver liquid from respective inlet ports to respective outlet ports, a casing surrounding said barrels and having inlet and outlet ports in communication with each other and with said inlet ports of the barrels, and a stationary filter in said casing interposed between said inlet ports of said casing and barrels, said pump having means for returning surplus liquid from said barrels through said filter to assist in cleansing the same.

16. In a multicylinder liquid pump having plunger barrels with inlet and outlet ports, delivery plungers operative in said barrels to deliver liquid from respective inlet ports to respective outlet ports, a perforated filter cage surrounding said barrels, a stationary filter covering the perforations of said cage, and a casing surrounding said cage and having inlet and outlet ports in communication with each other around the outside of said filter, said pump having means for returning surplus liquid from said barrels through said filter to assist in cleansing the same.

17. In a multicylinder liquid pump, a pump housing having a plurality of circularly-arranged plunger barrels with inlet and outlet ports, delivery plungers operating in said barrels to deliver liquid from respective inlet ports to respective outlet ports, a casing surrounding said pump body and having inlet and outlet ports in communication with each other, and a stationary circular filter fastened around said pump housing and held in place by said casing, said pump having means for returning surplus liquid from said barrels through said filter to assist in cleansing the same.

18. In a multicylinder liquid pump, a pump body with a plurality of circularly-arranged plunger barrels with inlet and outlet ports, delivery plungers operative in said barrels to deliver liquid from respective inlet ports to respective outlet ports, a plurality of circularly-disposed tubular members in communication with respective outlet ports of said barrels, a stationary circular filter surrounding said tubular members, and a casing surrounding said filter and having inlet and outlet ports in communication with each other around said filter, said tubular members and said filter being held in place by said casing, and said pump having means for return-

ing surplus liquid from said barrels through said filter to assist in cleansing the same.

19. In a liquid pump having a plunger barrel with inlet and outlet ports, a hollow delivery plunger reciprocative in said barrel, reciprocating means acting to move said plunger in its suction stroke to draw liquid through said inlet port into said barrel and to move said plunger in its delivery stroke to force liquid from said barrel through said outlet port, and control means including a piston in said barrel for controlling the amount of liquid delivered through the outlet port in each delivery stroke of said plunger.

20. In a liquid pump having a plunger barrel with an inlet port and an outlet port through its wall, a hollow plunger reciprocative in said barrel, reciprocating means acting to move said plunger in its suction stroke to draw liquid through said inlet port into said barrel and to move said plunger in its delivery stroke to force liquid from said barrel through said outlet port, and control means including a piston in said barrel for controlling the amount of liquid delivered through the outlet port in each delivery stroke of said plunger.

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