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FUEL PUMP

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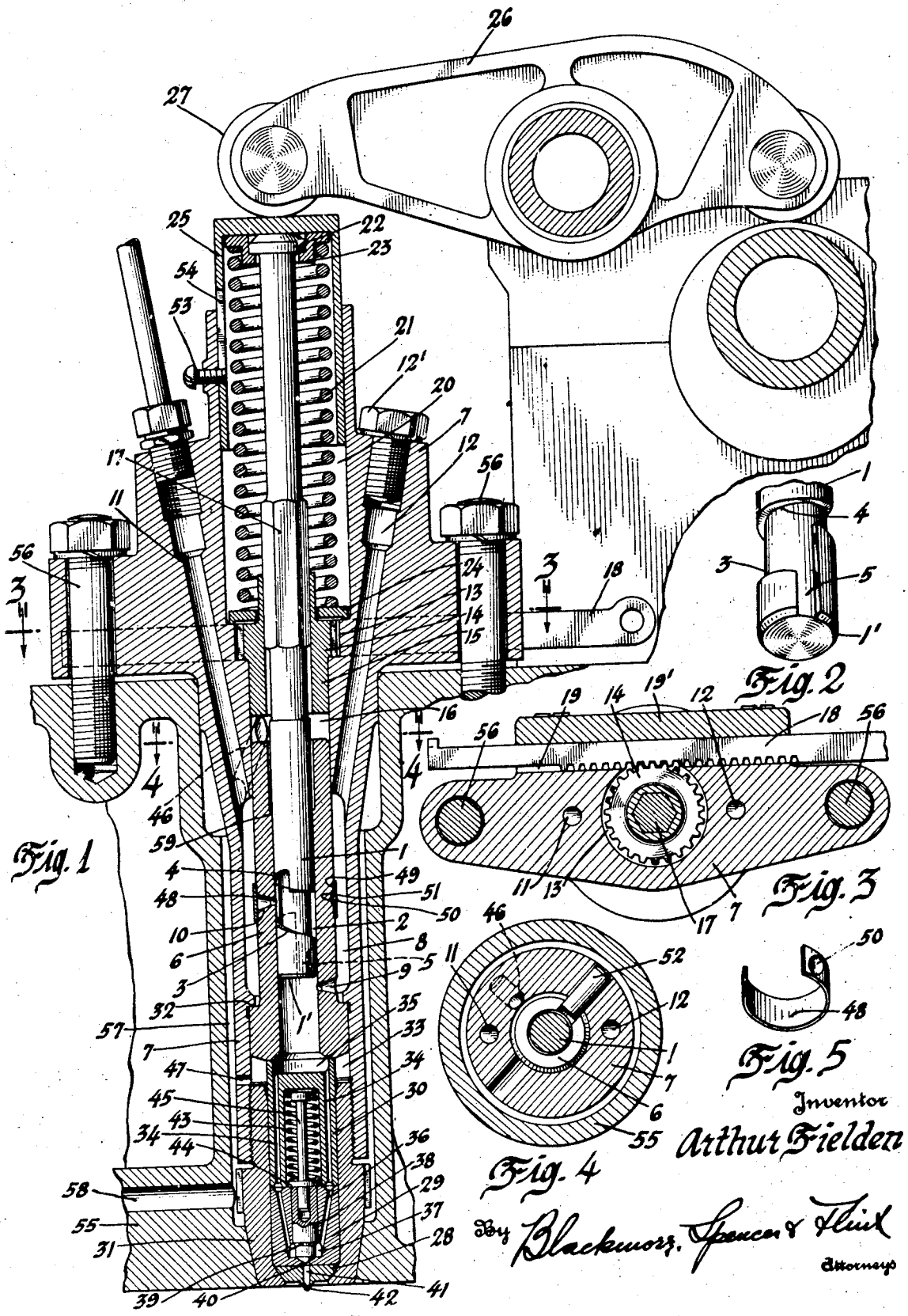


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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FUEL PUMP

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8 Claims. (Cl. 103—41)

This invention relates to pumps and especially to pumps for the periodic discharge of fluid at high pressure and in measured quantities.

It relates to injection pumps for the supply of fuel to an internal combustion engine and to pumps in which a suitable bypass or relief port or ports in communication with the pumping space is or are closed or opened to control the effective delivery and the beginning and end of discharge. Said pumps are adapted for use with a pressure loaded delivery or discharge valve opened by the pump pressure and which may constitute an injection valve for the discharge of fuel at high pressure through suitable spray holes into a combustion chamber.

The invention relates particularly to such fuel pumps of the plunger type in which the valve action controlling the bypass or relief ports as well as the pump inlet port is constituted by the stroke movement itself of the pump plunger and its cylinder relatively to one another.

One object of the invention is a fuel pump of the above general type which will be simple and cheap to manufacture which will have a minimum of ports and leakage paths, a wide range of timing adjustment, and in which there will be a preliminary bypass port opening into that part of the pressure space which is uppermost at a point higher than the inlet port, open after the inlet port has closed on the delivery stroke, whereby any air mixed with the oil and which will of itself tend to rise to the highest point of the pressure space will be pumped out through this bypass port before discharge commences and before the high pressure of discharge which is developed immediately upon closure of this bypass port.

Another object of the invention is to control the beginning of discharge and/or injection by the closure of the bypass port.

Another object of the invention is to prevent the bypass port from functioning as an inlet port whereby the flow of oil entering the fuel pump will be in one direction and upwards, still further assisting in the separation and escape of any air towards the upper end of the pressure space without the admixing influence of a contrary and opposing flow which would occur if the bypass port also functioned as an inlet port.

A further object is to construct such a fuel pump in which there are only two controlled ports both opening into a single annular chamber surrounding the cylinder barrel forming a reservoir for fuel at low pressure from a suitable source, one port serving as an inlet for fuel into the cylinder barrel and for relief of fuel out from the cylinder to control the end of injection, and the other serving for bypass of fuel out from the cylinder before the beginning of injection and for control of the beginning of injection.

A still further object of the invention is to combine an injection valve and sprayer nozzle with such a fuel pump all in one unit assembly, having an air cushion chamber in the housing above the top end of the annular reservoir, and a leakage drain from the fuel pump constituting also an air vent for any air in excess of that required to fill the air cushion chamber.

The accompanying drawing shows the application of the invention to a unit fuel pump and injection nozzle in which the plunger is provided with oblique edges or helical lips controlling the beginning and ending of injection and variable by turning the plunger whereby an earlier injection is accompanied by a later cutoff. The turning of the plunger is effected through a rack engaging a pinion loosely splined on the plunger so that the latter is capable of reciprocating motion through the pinion.

In the drawing:

Figure 1 is a part sectional elevation of a combined fuel pump and injection nozzle mounted in the cylinder head of an internal combustion engine.

Figure 2 is an enlarged perspective view of the end of the plunger.

Figure 3 is a section on line 3—3 of Figure 1 showing the means for angular turning adjustment of the plunger.

Figure 4 is a section on line 4—4 of Figure 1 showing the means for locating the cylinder bushing in the pump housing.

Figure 5 is a perspective view of a suitable check valve for the bypass port to prevent the influx of oil into the cylinder barrel through this port.

The pump plunger 1 has at its lower end an annular groove or space 2 dividing the circumferential surface of the plunger into two parts. The lower surface is bounded by the bottom circumferential edge 1' and a helical edge 3 while the upper surface has a helical edge 4. A channel or duct 5 connects the annular space between the edges 3 and 4 with the space below the end of the plunger.

The plunger works in a cylinder 6 which is a bushing in a housing 7. Between the bushing and the housing is an annular chamber 8 formed by an enlarged bore of the housing. Two parts 9 and 10 through the wall of the bushing 6 connect the annular chamber 8 with the bore of the

bushing. These ports are on opposite sides of the bushing to reduce interference.

A duct 11 drilled through the upper part of the housing into the upper end of the annular chamber 8 serves for the supply of fuel to this annular chamber from any suitable low pressure source. A similar duct 12 has its outer end closed by a screwed plug 12' and constitutes an air cushion chamber.

Above the upper end of the bushing 6 the housing is counterbored to form a pocket 13 for a pinion 14 having a bearing formed by a boss 15 extending into the bore of the housing and having a clearance between itself and the upper end of the bushing to leave a clearance space 16 therebetween.

The plunger 1 has a hexagonal "splined" portion 17 in the pinion 14 so that it may be turned thereby but is capable of longitudinal reciprocating motion therein.

The pinion 14 may be angularly turned for adjustment of the beginning and end of injection by a rack 18 which can slide back and forth in a horizontal groove 19 in the housing opening out into the pocket 13. The rack is retained in the groove by a plate 19'.

Above the pocket 13 the housing is counterbored to provide a pocket 20 for a spring 21. The upper end of the plunger is provided with a head 22 and a seating collar 23 for the spring 21. The other end of the spring is provided with a seating collar 24 resting in the bottom of the pocket 20.

The upper end of the plunger with its spring is enclosed by a cover 25 which reciprocates in the pocket 20 under the influence of any suitable driving means such as the rocking lever 26 with roller 27 for the down or pressure stroke of the plunger, the spring 21 effecting the return or suction stroke of the plunger.

Below the bushing 6 the housing 7 is internally threaded for the injection valve parts consisting of a nozzle piece 28, a valve seat piece 29 and a distance piece 30 all within a bored out threaded cap piece 31 which screws into the housing.

The nozzle piece 28 has a conical seating in the cap piece 31 and all three parts 28, 29, and 30 together with the bushing 6 are clamped tightly together and onto a shoulder 32 in the housing 7 when the cap piece 31 is screwed therein leaving a clearance space 33 between the bushing and the cap piece 31.

Ducts 34 through the piece 30 lead the fuel from a pocket 35 therein in open communication with the pumping space below the plunger 1 to ducts 36 leading to a chamber 37 in the piece 29. In this chamber 37 is a seating for an injection valve 38 which has an area provided by a shoulder 39 so that it is lifted by the pressure of the oil in the chamber 37 to permit the flow of oil through a bore 40 in the piece 29 and a bore 41 in the piece 28 to suitable spray holes 42.

The lifting of the valve 38 is resisted by a spring 43 in the piece 30 acting on the valve through a collar 44 on a stem piece 45 for the valve which forms also a stop limiting the valve lift to a predetermined amount.

The strength of the spring 43 and the loading it provides for the injection valve 38 which is the loaded delivery valve of the pump determines the minimum injection pressure.

A drain hole 46 from the clearance space 16 to the outside of the housing serves to drain away any oil which may leak between the plunger and the upper end of the bushing or between the upper end of the bushing and the housing while a drain hole 47 from the clearance space 33 serves to drain away any similar leakage oil from the lower end of the bushing. The drain hole 46 will also serve as a vent for any air separating out from the fuel in the chamber 8 in excess of that required to fill the air cushion chamber 12.

The port 10 is provided with a check valve of any suitable type. In the example illustrated it consists of a flat spring 48 curved to fit tightly in a shallow annular groove 49 around the bushing 6 with one end over the port 10 and the other end locating and holding the spring in position by a projection or dimple 50 formed thereon and sprung into a corresponding depression 51 in the bushing.

The bushing 6 is located in the housing 7 with its ports 9 and 10 at a fixed angular relationship to the plunger by a pin 52.

A small screw 53 through the housing 7 engages a slot 54 in the cover 25 retaining the cover over the plunger and its spring but permitting its reciprocating movement.

The complete assembly constitutes a unit fuel pump and injection nozzle which may be mounted in a suitable bore through the cylinder head of an internal combustion engine.

As shown, the cap piece 31 of the combined fuel pump and injection nozzle has a conical seating in a bore through a cylinder head 55 in which it is held by the studs 56. A suitable clearance between this bore and the housing 7 provides an annular space 57 into which the drain holes 46 and 47 may discharge any leakage. The annular space 57 is itself drained by a channel 58 in the cylinder head which returns the leakage oil to a supply tank not shown.

It will be noted that the lapped bore of the bushing 6 has been counterbored at the upper end in order to eliminate the slight bell mouthing of the bore resulting from the lapping operation. The shoulder 59 reduces the tendency for any fine gritty particles to be drawn in between the lapped surfaces as would otherwise be the case.

In operation, fuel at a small head of pressure is supplied to the annular chamber 8 through the duct 11. In the position shown the plunger 1 is at the top of its stroke and has uncovered the inlet port 9 allowing oil to flow into the pumping space over and above the oil always remaining in the pocket 35 the ducts 34 and 36 and the chamber 37, and to rise through the channel 5 and into the annular space 2 in the plunger. As the plunger descends it first covers the inlet port 9 and then pumps oil and any air bubbles mixed therewith up through the channel 5 and out through the bypass port 10 back into the annular chamber 8 until the edge 4 covers the port 10. At this point and there now being no other outlet from the pumping space, the pressure rises rapidly in the pumping space and its connections with the chamber 37 containing the spring loaded valve 38 until the pressure on the exposed area of the valve is sufficient to lift the valve off its seat and the oil is injected into the engine cylinder through the spray holes 42. The injection continues under the influence of the downwardly moving plunger until the edge 3 uncovers the port 9 which now functions as a pressure relief port terminating the injection and bypassing the remaining oil delivered by the plunger from the pumping space through the channel 5, into the annular space 2 and back into the annular chamber 8.

The air chamber 12 acts as a pressure accumulator, reducing the pressure variations on the inlet

side of the pump as a result of the opening and closing of the ports 9 and 10.

The capacity of the chambers and passages on the pressure side of the pump is sufficiently small and there are no valves between the effective injection pumping space and the injection valve itself so that practically no delayed closing of the injection valve occurs as a result of the compressibility of the fluid when the port 9 is opened to terminate injection.

While the pump might be operated without the check valve 48 over the bypass port 10 in which case oil could flow into the pump cylinder through the port 10 as well as the port 9, there would be a flow in opposite directions through the passage 5 both at the same time, with an admixing influence on the fuel and any air bubbles entering the pump chamber. With a check valve over the port 10 preventing the flow of oil into the cylinder through this port the oil taken into the pump will always flow in one direction and upwards through the passage 5. This is the direction in which any air bubbles tend themselves to rise and hence their separation towards the top of the annular space 2 is assisted and since a part of the charge is always bypassed through the port 10 before injection the possibility of any air interfering with the injection of oil into the engine cylinder is reduced.

I claim:

1. In a fluid pump, in combination, a cylinder, a plunger cooperative therewith as a pump for the pressure discharge of fluid from the cylinder through a delivery outlet provided with a loaded delivery valve, a pair of ports and coacting control edges therefor on the cylinder and plunger, comprising an inlet port and a bypass port spaced from each other, the bypass port opening from that part of the pressure space which is uppermost, at a point higher than the inlet port and the aforementioned delivery outlet, the ports and control edges together providing for bypassing of fluid, including any air or gas bubbles, out from the uppermost part of the pressure spaces of the pump cylinder after the closing of the inlet port and before the pressure discharge through the loaded delivery valve, for the beginning of pressure discharge upon closure of the bypass port and for closure of the delivery valve by the opening of one of the ports to relieve the fluid pressure after the discharge of a measured quantity of fuel through the delivery valve.

2. A fluid pump according to claim 1, in which termination of the pressure discharge is effected by the opening of the inlet port to relieve the fluid pressure.

3. In a fluid pump in combination, a cylinder, a plunger cooperative therewith as a pump for the pressure discharge of fluid from the cylinder through a delivery outlet provided with a loaded delivery valve, a pair of ports and coacting control edges therefor on the cylinder and plunger comprising an inlet port and a bypass port spaced from each other, the bypass port opening from that part of the pressure space which is uppermost, at a point higher than the inlet port and the aforementioned delivery outlet, said bypass port being provided with a check valve permitting the flow of fluid out from the cylinder but preventing the flow of fluid into the cylinder, the ports and control edges together providing for bypassing of fluid out from the uppermost part of the pressure space of the pump cylinder after the closing of the inlet port and before the pressure discharge through the loaded delivery valve, for the beginning of pressure discharge upon closure of the bypass port and for closure of the delivery valve by the opening of one of the ports to relieve the fluid pressure after the discharge of a measured quantity of fuel through the delivery valve.

4. A fluid pump according to claim 3, in which termination of the pressure discharge is effected by the opening of the inlet port to relieve the fluid pressure.

5. In a fluid pump in combination, a cylinder, a plunger cooperative therewith as a pump for the pressure discharge of fluid from the cylinder through a loaded delivery valve, coacting ports and control edges therefor on the cylinder and plunger including an inlet port and a bypass port, a check valve in the bypass port preventing the flow of fluid into the pump pressure space, the bypass port opening from that part of the pressure space which is uppermost at a point higher than the inlet port, the ports and the control edges for the ports being so arranged and disposed that the bypass port is open after the inlet port has closed on the delivery stroke of the pump, all whereby fluid enters the pump only through the inlet port and rises upward and a part of the pump charge is expelled through the bypass port from the uppermost part of the pressure space after the closure of the inlet port and before the high pressure of discharge through the delivery valve which is developed immediately upon closure of the bypass port.

6. A fluid pump according to claim 5 in which termination of the pressure discharge is effected by the opening of the inlet port to relieve the fluid pressure.

7. In a fluid pump in combination, a cylinder, a plunger in the cylinder, a delivery outlet provided with a loaded delivery valve for the pressure discharge of fluid from the cylinder, an inlet port and a bypass port in the cylinder, said bypass port opening from that part of the pressure space which is uppermost, at a point higher than the inlet port and the delivery outlet, and control edges for the ports constituted by the end of the plunger and the two edges of an annular groove thereon said groove being in continuous communication with the pressure chamber of the pump whereby on the delivery stroke of the pump the inlet port is first closed by one edge, the bypass port is next closed by another edge to control the beginning of discharge through the loaded delivery valve, and one of the ports is finally opened by the otherwise unused edge to relieve the pressure and terminate discharge through the delivery valve.

8. In a fluid pump in combination, a cylinder, a plunger in the cylinder, a delivery outlet provided with a loaded delivery valve for the pressure discharge of fluid from the cylinder, ports including an inlet port and a bypass port in the cylinder, said bypass port opening from that part of the pressure space which is uppermost, at a point higher than the inlet port and the delivery outlet, and control edges for the ports constituted by the end of the plunger and the two edges of an annular groove thereon such that on the delivery stroke of the pump the inlet port is first closed by the end of plunger, the bypass port is next closed by one edge of the annular groove to control the beginning of discharge through the loaded delivery valve, and the inlet port is finally opened by the other edge of the annular groove to relieve the pressure and terminate discharge through the delivery valve.

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CERTIFICATE OF CORRECTION.

Patent No. 1,981,913. November 27, 1934.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 140, claim 8, strike out the words "such that" and insert instead said groove being in continuous communication with the pressure chamber of the pump whereby; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of February, A. D. 1935.

(Seal)

Leslie Frazer
Acting Commissioner of Patents.