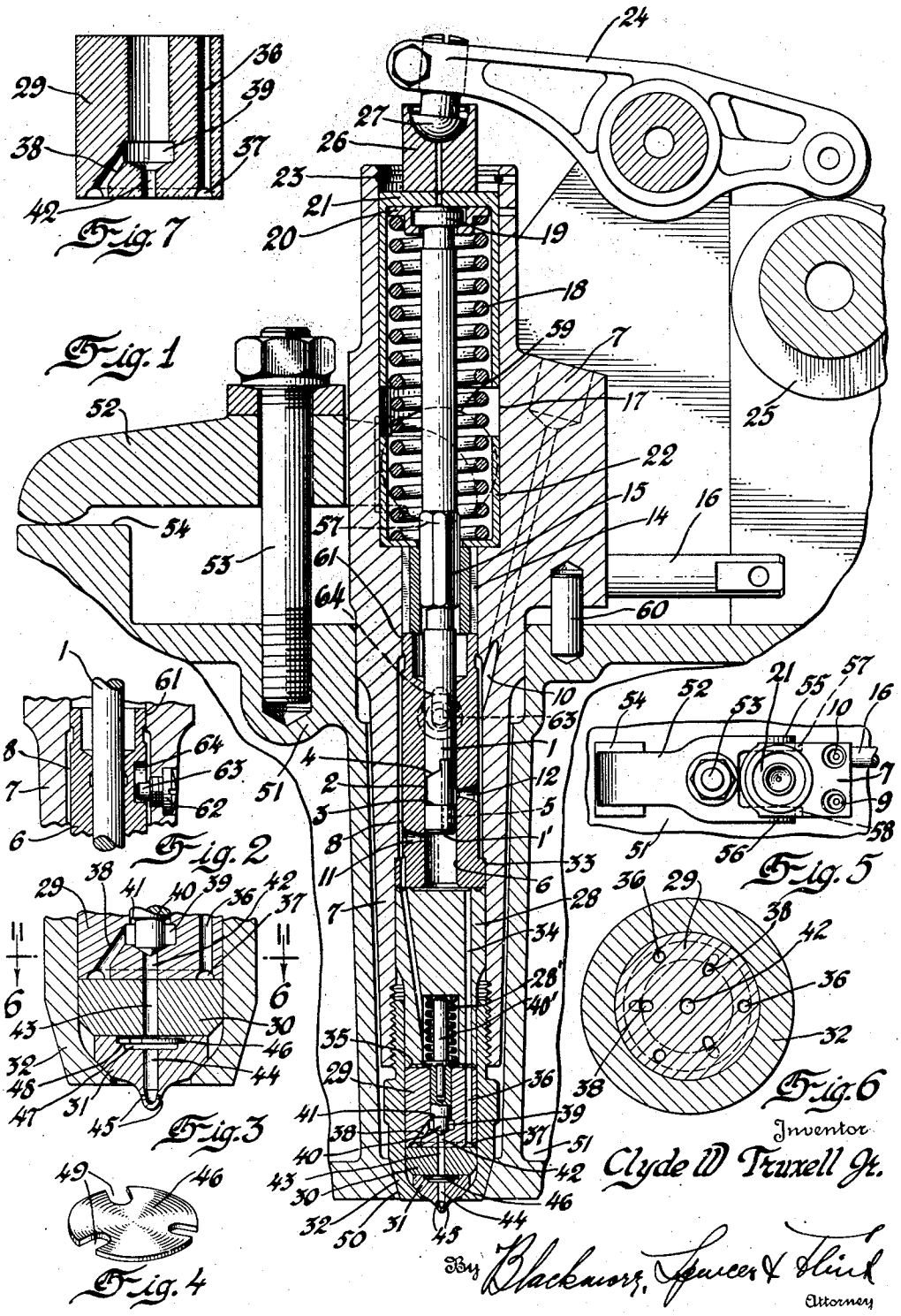
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FUEL PUMP INJECTOR

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FUEL PUMP INJECTOR

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2 Claims. (Cl. 123—32)

This invention relates to liquid fuel injectors for internal combustion engines and particularly to an injector having a pump and nozzle combined in one unit.

Still more specifically it relates to improvements in a unit fuel pump injector of the general type shown in U. S. Patent No. 1,981,913 on November 27th, 1934.

The displacement of such fuel pump injectors is small, but the injection pressure is comparative'y very high and the parts have to be sufficiently strong to withstand the very high fluid pressure to which they are subjected. Moreover and aside from any questions of economy of material, there is often only limited space available for mounting the injector on the cylinder head of an internal combustion engine. For these reasons it becomes an important problem of design to secure adequate strength within the limitations of permissible size.

It has been found for instance, that the seat piece of the needle injection valve with high pressure oil ducts therein as commonly arranged, is insufficiently strong; that the injector housing may be distorted by the tightening of the hold-down bolts in the flange through which it is commonly held on its seating in an engine cylinder head.

One object of the present invention is an improved arrangement of fuel ducts in an injection valve seat piece, whereby, when the part is nitrided or nitrogen case hardened, there will be no sections of hard brittle steel unsupported by a core of tougher steel and the incidence of failure through cracking under the high pressure to which it is subjected will be reduced.

Another object of the invention is an improved manner of holding the injector on its seating in an engine cylinder head.

Another object of the invention is to provide means for preventing gas from passing from the combustion chamber of the engine into the injector at such times as the needle injection valve may not be seating properly.

A still further object of the invention is a means of locating the cylinder bushing of the fuel pump which is a press fit in the injector housing, with its ports at a fixed angular relationship relative thereto.

The foregoing and other objects of the invention will be apparent from the following description and the claims in conjunction with the drawing in which—

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 part sectional view showing the manner of locating the cylinder bushing in the housing.

Figure 3 is an enlarged part sectional view of the needle valve seat piece, the injection nozzle and associated parts.

Figure 4 is an enlarged view of a part of Figure 3.

Figure 5 is a plan view of Figure 1.

Figure 6 is a sectional view on line 6—6 of Figure 3.

Figure 7 is an enlarged sectional view of the nitrided needle valve seat piece showing how the improved arrangement of fuel ducts, leaves an adequate core of tougher steel to support the more brittle case hardening in every section of the part.

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 an 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 constituting a reservoir having supply and return lines 9 and 10 for fuel oil from a suitable low pressure source of supply (not shown).

Suitable inlet and by-pass ports 11 and 12 are provided between the pump cylinder 6 and the annular reservoir 8, and the edges 1', 3 and 4 on the plunger constitute control edges therefor.

The arrangement of the ports and control edges in the cylinder and plunger is such that on the delivery stroke of the pump, after the closing of the inlet port 11 by the end 1' of the plunger, fuel is by-passed from the pump pressure space into the reservoir through the by-pass port 12 until this is covered by the edge 4 of the annular groove on the plunger; thereupon injection delivery of fuel begins and continues until the port 11 is uncovered by the edge 3 of the annular groove on the plunger.

Above the upper end of the bushing 6 is a pinion 14. The plunger 1 has a hexagonal "splined" portion 15 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 of injection by a rack 16.

Above the pinion 14, the housing is counterbored to provide a pocket 17 for a spring 18. The upper end of the plunger is provided with a head 19 and is held between a seating collar 20 for the spring 18, and a spring cage 21 constituting a plunger follower. The other end of the spring is provided with a spring cage 22 seating in the bottom of the pocket 17.

The plunger follower 21 is at all times retained within the housing 7 by a snap ring 23. The plunger follower 21 and the plunger 1 are reciprocated under the influence of any suitable driving means such as the rocker arm 24 actuated by a cam 25 on the down or delivery stroke of the plunger, the spring 18 effecting the return or suction stroke of the plunger.

Between the plunger follower 21 and the rocker arm 24 is a block 26 slidable over the flat surface of the plunger follower and having a cupped upper surface engaging a ball ended member 27 adjustably connected to the rocker arm 24.

Below the bushing 6 are the injection valve parts consisting of a needle valve spring cage 28, an injection valve seat piece 29, a slug 30 and a nozzle piece 31. The nozzle piece 31 has a conical seating in a cap piece 32 which screws into the housing.

All four parts 28, 29, 30 and 31, together with the bushing 6, are clamped tightly together and onto a shoulder 33 in the housing 7 when the cap piece 32 is screwed therein.

A duct or ducts such as 34 lead fuel from the pumping space below the plunger 1, through piece 28, into a circular groove 35 between the piece 28 and piece 29. From the groove 35 a duct or ducts such as 36 are provided through the valve seat piece 29 to a circular groove 37 between the piece 29 and the slug 30. From the groove 37 a duct or ducts 38 lead to a chamber 39 in the piece 29. In this chamber 39 is a seating for a needle valve 40 which has an area provided by a shoulder 41 so that it is lifted by the pressure of the oil in the chamber 39 to permit the flow of oil through a bore 42 in the piece 29, thence through a bore 43 in the slug 30 and a bore 44 in the nozzle piece 31, to the spray holes 45 therein.

The lifting of the injection valve 40 is resisted by a spring 28' in the piece 28 acting on the valve through a collar on a stem piece 40' for the valve which forms also a stop limiting the valve lift to a predetermined amount.

The strength of the spring 28' and the loading it provides for the injection valve 40, determines the minimum injection pressure.

As shown most clearly in Figure 3, the slug 30 effectively seals off the circular groove 37 but the bore 43 therein constitutes a continuation of the bore 42 in the valve seat piece 29 through to the bore 44 in the nozzle piece 31. Interposed between the bores 43 and 44 however, is a nonreturn clack valve 46 working in a pocket 47 in the piece 31. This clack valve 46 normally rests on a shoulder 48 in the pocket 47, there being a clearance of a few thousandths of an inch between the upper face of the clack valve 46 and the lower face of the slug 30.

The clack valve has portions of its periphery cut away to constitute ports 49 therethrough.

In the position of the valve 46 illustrated in Figure 3, there is a sufficient path for the flow of fuel from the bore 43 over the top of the valve 46 and through the ports 49 therein to the bore 44 and thence to the spray holes. The clearance of a few thousandths of an inch between the valve 46 and the piece 30 is sufficiently restricted, however, that when there is any back pressure from the engine cylinder and the plunger 1 is not actually delivering fuel through the needle valve 40, there will be an insufficiently rapid equalization of pressure on both sides of the valve 46, which will be forced by the engine cylinder pressure against the piece 30, thereby sealing off the bore 43 therein against blow-back from the engine cylinder, which in the event that the needle valve is not seating properly, might otherwise blow out the fuel from the reservoir and supply lines, not only of the pump affected, but possibly of the pumps for other cylinders of the engine, with which it may be connected.

In an engine having a check valve of the type described between the needle valve and the nozzle of each injector, there can be no blowing out of the fuel of any of the pumps and even the one which may have an injection valve which is not seating properly will go on pumping and thus be more likely to clear itself and resume proper operation.

The valve seat piece 29 is of steel and is nitrided after machining to harden the seating and ducts and all its exposed surfaces. It has been found that when a valve seat piece with ducts as ordinarily arranged is hardened in this way, certain sections of the valve seat piece will be so small in area that the case will extend over the area between two boundary surfaces, leaving no core of tougher steel for adequate strength of the particular section, so that under the high operating pressures, small cracks will eventually develop therein, leading ultimately to the failure of the part.

According to the invention the ducts are arranged in a manner avoiding acute angles with the bore and the external surface of the valve seat piece and rather at an obtuse angle thereto as shown most clearly in Figure 7 so that an adequate core of tougher steel supports the more brittle case hardening in every section of the part. It will be apparent that the ducts 36 and 38 satisfactorily provide for this requirement as compared with the condition which would exist if the duct 36 were to lead directly to the chamber 39.

Referring now to Figures 1 and 5 and in order to provide adequate means of holding the injector on its seating 50 in the engine cylinder head 51 where space may be limited, while at the same time providing a hold-down pressure as close to the longitudinal axis of the injector as possible in order to prevent distortion of the pump housing and associated parts, the usual hold-down flange on the assembly is dispensed with and a hold-down crab consisting of a clamping bar 52, a bolt 53 and an abutment 54 on the cylinder head, is provided.

One end of the bar 52 is fulcrumed on the abutment 54 and the other end of the bar is provided with bifurcations 55 and 56 which bear on shoulders 57 and 58 constituted by the lower arced surfaces of a bored hole 59 through the housing 7. When the bolt 53 is tightened, the housing 7 is firmly held on its seating 50 in the cylinder head with a minimum of distortion of the housing and its associated parts.

The housing is located in proper position on the cylinder head by a dowel pin 60 and before and during the press fitting the cylinder bushing 6 is located with its ports 11 and 12 at the required angular relationship with the housing 7

in which it is press fitted at 61, by a screw 62 having an extended stem 63 which can enter the groove 64 in the cylinder bushing before the press fitting as shown most clearly in Figure 2.

I claim:

1. In a fuel injection device for an internal combustion engine, said injection device having a delivery valve consisting of a spring loaded needle valve in the delivery line to an injection nozzle, means preventing blowback from the combustion chamber of the engine into the injection device when there is any back pressure from the combustion chamber, at such times as the needle valve may not be seating properly, and the injection device is not actually delivering fuel, said means constituting a non-return valve between the needle valve and the nozzle and consisting of a disk freely floating between opposite seatings therefor in a pocket in the delivery line and movable alternatively by the fuel pressure and the back pressure from the combustion chamber, whichever is greater, on to one or the other of the said opposite seatings, there being ports through the disk and the seatings being such that the ports are open when the fuel pressure is the greater, and closed when the back pressure from the combustion chamber is the greater.

2. In a fuel injection device for an internal combustion engine, said injection device having a delivery valve in the delivery line to an injection nozzle, means preventing blowback from the combustion chamber of the engine into the injection device when there is any back pressure from the combustion chamber, at such times as the delivery valve may not be seated properly, and the injection device is not actually delivering fuel, said means constituting a non-return valve between the delivery valve and the nozzle and consisting of a disk freely floating between opposite seatings therefor in a pocket in the delivery line and movable alternatively by the fuel pressure and the back pressure from the combustion chamber, whichever is greater, on to one or the other of the said opposite seatings, there being ports through the disk and the seatings being such that the ports are open when the fuel pressure is the greater, and closed when the back pressure from the combustion chamber is the greater.

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