

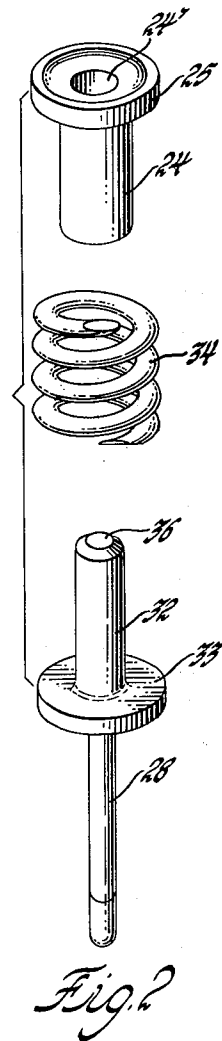
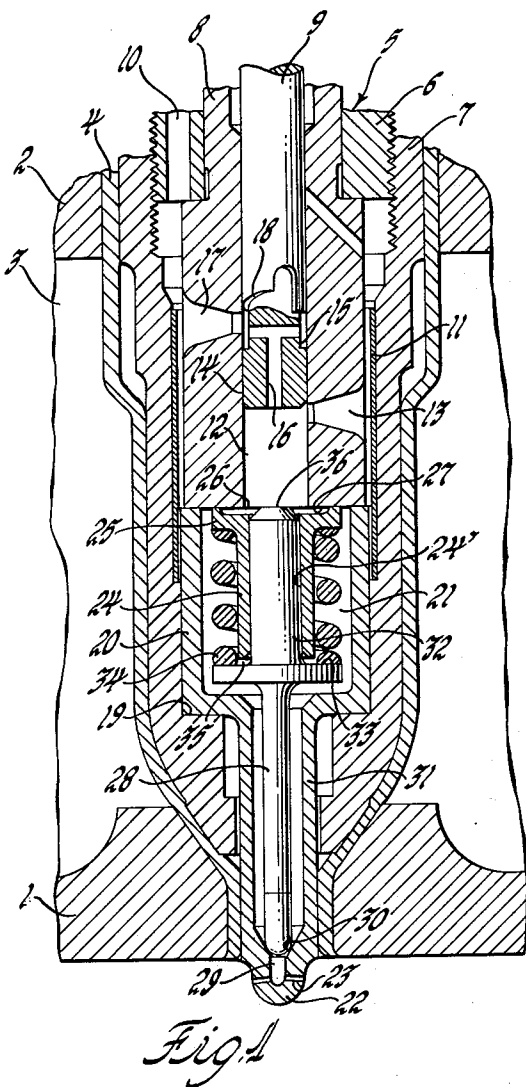
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ACCUMULATOR TYPE INJECTION APPARATUS

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1

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ACCUMULATOR TYPE INJECTION APPARATUS

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This invention relates to apparatus for effecting periodic injections of fluid under high pressure, such as liquid fuel into the combustion chamber of an internal combustion engine, and particularly to such apparatus of the accumulator type.

Although the invention is described and shown in a unit fuel injector-pump as installed in a diesel engine cylinder head, such is for purposes of illustration only and it will be appreciated that the principles involved are of broader application. Broadly stated, the principal object of the invention is to provide an accumulator type injector which is more economical to manufacture, more reliable in operation, easier to service and which allows use of a wider range of fuels (particularly in the so-called "bunker" range) than those proposed heretofore.

In accordance with the invention, the accumulator chamber of the injector has its inlet controlling check valve and is outlet controlling injection valve in mutually guiding relation and providing the sole lateral support for each other during their opening and closing movements. As a result, what might be called a "floating" action is obtained whereby the conventional needle type injection valve is employed without the necessity of high manufacturing cost, faulty operation due to misalignment and foreign particles, or the requirement of having to use selective fits in assembling the needle valve with the other parts of the injector.

These and other objects and advantages of the invention will be more readily apparent from the following description, having reference to the drawing wherein:

Figure 1 is a longitudinal sectional view through the lower portion of the injector-pump, mounted in an engine cylinder head.

Figure 2 is an exploded view of the check valve, needle type injection valve and their common biasing spring, each shown in perspective.

Referring now in detail to the drawing, the inner and outer walls 1 and 2 of the engine cylinder head which define the cylinder head cooling jacket 3 are provided with aligned openings in which is seated a conventional injector sheath 4. Seated, in turn, in the sheath 4 is a unit type fuel injector-pump designated generally by the numeral 5, of which only the lower portion is illustrated since the pump driving means and fuel supply means associated with the upper end of the unit form no part of the invention.

The lower end portion of the structure forming the upper body 6 of the unit is shown threadedly connected to an elongated hollow nut 7 which extends downwardly within the sheath 4, and within the upper portion of this nut 7 is the pump which comprises a pumping cylinder in the form of a bushing 8 and pump plunger 9. Fuel, entering the nut 7 via the passage 10 in the body 6, supplies an annular fuel reservoir defined by an annular sleeve 11 lining the nut opposite the lower end of the bushing or pump cylinder 8. The pump chamber 12 defined by the lower portion of the cylinder 8 communicates with this reservoir via a lower fuel inlet and bypass port 13,

2

through which fuel is bypassed back to the reservoir during the downward or pumping stroke of the plunger until the land 14 on the plunger traverses and closes this port 13. An external groove 15 on the plunger is registerable with the port 13 during the pumping stroke, and this groove is in communication at all times with the pumping chamber 12 via a passage 16 in the plunger.

The particular injector-pump illustrated also has an upper fuel inlet and bypass port 17 in the side of the cylinder 8, and this is closed by the upper edge of the groove 15 during the downward or pumping stroke of the plunger. Such closing of the port 17 occurs subsequent to the lower port 13 being closed by the plunger land 14. Between such sequential closing of the ports 13 and 17 fuel is additionally bypassed from the pumping chamber 12 via the plunger passage 16 and groove 15 through the port 17 to the annular reservoir. The amount of such additional bypassing determines the quantity of the fuel charge delivered from the pump chamber during each pumping stroke. This is regulatable by rotating the plunger 9 about its longitudinal axis (by conventional means, not shown), since the upper edge 18 of the groove 15 is made helical.

Seated against a shoulder 19 within the nut 7 and clamped at its upper end against the lower end of the pump cylinder 8 is a hollow member 20 whose upper portion is enlarged to form an accumulator chamber 21. The lower portion of this member extends through the lower ends of the nut 7 and sheath 4, respectively, and terminates below the inner wall 1 of the cylinder head as a spray tip 22. Provided in the spray tip are the usual injection orifices 23, through which fuel enters the engine combustion chamber from the accumulator chamber 21.

Located within the accumulator chamber and laterally spaced from the walls of the member 20 is a sleeve-like check valve 24 whose upper end is externally flanged as shown at 25. The lower end of the pump cylinder 8 is open and forms an outlet 26 for the fuel charge displaced from the pumping chamber by the plunger during the pumping stroke. Since this outlet 26 connects directly with the accumulator chamber 21 it also constitutes the fuel inlet to the latter, and the lower end of the pump cylinder adjacent this pump cylinder outlet 26 forms a seat 27 for the flange 25 of the check valve. At 28 is shown a needle type injection valve whose lower end normally closes the outlet 29 of the accumulator chamber, a seat 30 being provided within the lower end of the member 20 for this purpose. It will be noted that the injection valve 28 is laterally spaced from the lower side walls 31 of the spray tip forming member 20. The upper end of the injection valve 28 is provided with a stem portion 32 which has a loose sliding fit within the opening formed by the bore 24' of the check valve 24, their respective external and internal surfaces serving to provide the sole means for guiding each other during relative opening and closing movements of the check valve and injection valve. A shoulder 33 formed by an enlargement intermediate the ends of the injection valve 28 supports a coil spring 34 whose opposite end bears upwardly against the flange 25 of the check valve. This spring thus acts as biasing means to normally maintain the check valve 24 closed against its seat 27 on the pump cylinder and the injection valve closed against its seat 30 adjacent the accumulator outlet 29. When both such valves are seated in their closed positions shown, a spacing 35 exists between the injection valve shoulder 33 and the lower end of the check valve 24, and the amount of this spacing limits the extent of opening of both valves.

During operation, with each downward or pumping stroke of the plunger 9 the lower inlet and bypass port 13 is closed, followed by closing of the upper inlet and bypass port 17, after which fuel pressure is built up in the

pump chamber 12 sufficient to force the check valve 24 off its seat 27 and allow the fuel charge to enter the accumulator chamber 21 (which also contains fuel under residual pressure from a previous injection cycle). As the plunger continues its downward movement the fuel pressure in both the pumping cylinder and accumulator chamber continues to increase, but no opening of the injection valve 28 can occur because it is biased closed by the spring 34. When, however, the relief groove 15 on the plunger starts to uncover the lower bypass port 13 a sudden pressure drop in the form of a sonic wave will travel from the relief groove 15 through the plunger passage 16 and into the lower end of the pumping chamber 12. This sudden pressure drop when felt by the check valve 24 will allow spring 34 to return check valve 24 to its seat, thereby trapping a desired amount of fuel under pressure in the accumulator chamber 21. The pressure of this fuel will thence act on the differential area that exists between the respectively larger and smaller diameter upper and lower portions of the injection valve 28 and cause it to raise this valve and uncover the accumulator chamber outlet 29. Fuel will then flow out through the spray tip orifices 23 to the combustion chamber of the engine. When pressure of the fuel in the accumulator chamber 21 decreases sufficiently as the result of this injection, the spring 34 will return the needle valve to its seat, terminating the injection.

During the opening and closing movements of the check valve 24 it is laterally supported solely by its sliding engagement with the upper stem portion 32 of the injection valve. Conversely, during opening and closing movements of the injection valve, it receives its sole lateral support from the guiding action of the check valve 24 which then is held firmly on its seat 27 by the spring 34. Thus it will be appreciated, the injection valve 28 may be much more economically manufactured than were it required to be guided within the lower or spray tip portion 31 of the member 20, since no close tolerances between these parts need be maintained in accordance with my invention. Likewise, there is no possibility for binding and resultant sticking of the injection valve in operation, and the lack of any such close sliding fits makes the injector better adapted to use of fuels in the "bunker" range. Similarly, no sliding fit between the check valve 24 and the pumping cylinder 8 or the upper portion of the member 20, is required. Instead, only a relatively loose sliding fit between the injection valve and the check valve is required, thus enabling these and their adjacent parts of the injector to be more simply and economically manufactured.

While only a single preferred embodiment of the invention has been disclosed, it is appreciated that numerous minor changes in the construction and arrangement of the parts may be made without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. In a unit injector-pump, a pump cylinder having an outlet and a bypass port, a plunger movable in the cylinder to displace fluid therefrom via said outlet, said plunger having means operable during said movement to initially block communication between said outlet and said port and thence to reestablish said communication, a check valve controlling said outlet and openable in response to fluid pressure developed in the cylinder during said movement of the plunger while said port is blocked, an accumulator chamber receiving fluid passed by the check valve, said chamber having an outlet, an injection valve controlling said chamber outlet, said injection valve having an area exposed to fluid pressure in the cylinder and operative in response thereto to maintain said injection valve closed during plunger movement while said port is blocked, said injection valve being also exposed to fluid pressure in the chamber and operative in response thereto to open said injection valve when said port is

opened and said check valve closes, said check valve and injection valve having mutually slidable surfaces, a seat for said check valve when in closed position, a seat for said injection valve when in closed position, and biasing means urging said check valve and injection valve against their seats, said surfaces, seats and biasing means constituting the sole support for said check valve and injection valve against movement in a lateral direction relative to their opening and closing movements.

2. In a unit injector-pump, a pump cylinder and plunger having means cooperable at a predetermined point during the pumping stroke to vent the cylinder forwardly of the plunger and thereby limit the effective portion of said stroke, said cylinder having an outlet, an injector having a chamber connected to said outlet, a check valve openable inwardly of the chamber from said outlet, a seat for the check valve when in closed position, said chamber having an outlet opposite said cylinder outlet, an injection valve openable inwardly of the chamber from said chamber outlet, a seat for said injection valve when in closed position, said check valve having an opening providing the sole guiding support for said injection valve during opening and closing movements of the injection valve and through which fluid pressure in the cylinder acts against the injection valve in the closing direction, said injection valve being also continuously exposed to fluid pressure in the chamber, and compression spring means reacting oppositely against said check valve and injection valve to normally hold them in closed positions against their respective seats, said spring means being yieldable to accommodate both opening of the check valve by the fluid pressure developed in the cylinder during the effective portion of the pumping stroke and opening of the injection valve by the fluid pressure remaining in the chamber after the check valve recloses in response to venting of the pump cylinder, said check valve receiving its sole lateral support during its opening and closing movements from said injection valve.

3. In a unit injector-pump, a pump cylinder and plunger having means cooperable at a predetermined point during the pumping stroke to vent the cylinder forwardly of the plunger and thereby limit the effective portion of said stroke, said cylinder having an outlet, an injector having a chamber connected to said outlet, a check valve openable inwardly of the chamber from said outlet, said check valve consisting of a sleeve terminating with an external annular flange at its end adjacent said outlet, a closure seat for said flange in the chamber surrounding said outlet, said chamber having an outlet opposite said cylinder outlet, an injection valve openable inwardly of the chamber from said chamber outlet, a closure seat for the injection valve in the chamber surrounding said chamber outlet, said injection valve terminating oppositely of said chamber outlet with a stem portion slidably received by said sleeve providing the sole lateral support for each other during their opening and closing movements and having a shoulder facing the end of said sleeve remote from said flange, said shoulder being spaced from said sleeve end when both valves are seated to accommodate a limited opening movement of said valves relative to each other, and a coil spring encircling said sleeve and reacting oppositely against said flange and shoulder to bias both said valves closed against their respective seats, said spring being yieldable to accommodate both opening of the check valve by the fluid pressure developed in the cylinder during the pumping stroke prior to venting said cylinder and opening of the injection valve by the fluid pressure remaining in the chamber after said check valve closes in response to venting the cylinder.

4. In an injector and pump having a pump cylinder and plunger cooperable at a predetermined point during the pumping stroke to vent the cylinder forwardly of the plunger and thereby limit the effective length of the stroke, and an injector including an accumulator chamber chargeable with fluid under pressure from the cylin-

5

der during the pumping stroke, a check valve preventing return flow of the fluid from the chamber to the cylinder and an injection valve extending through the check valve and operably responsive to both the fluid pressure in the cylinder and that in the chamber in controlling injection of fluid from the chamber, the improvement wherein the check valve and the injection valve have their lateral extremities spaced from the surrounding internal lateral extremities of the injector-pump and have mutually slidable surfaces providing the sole lateral support for each when in open position. 10

5. In an injector for use with a pump for delivering fluid under pressure thereto and in which pump the fluid pressure is periodically relieved to terminate fluid delivery to the injector, said injector including a chamber having an inlet for fluid delivery from the pump and an outlet for injected fluid, a check valve normally closing 15

6

said inlet but operable to admit fluid into the chamber in response to superior pump delivery pressure, an injection valve normally closing said outlet but openable to accommodate injection of fluid from the chamber via said outlet in response to fluid pressure within the chamber exceeding fluid pressure on the pump side of said check valve, said injection valve and check valve having mutually guiding surfaces providing the sole lateral support for each other during their opening and closing movements.

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