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FUEL INJECTION PUMP

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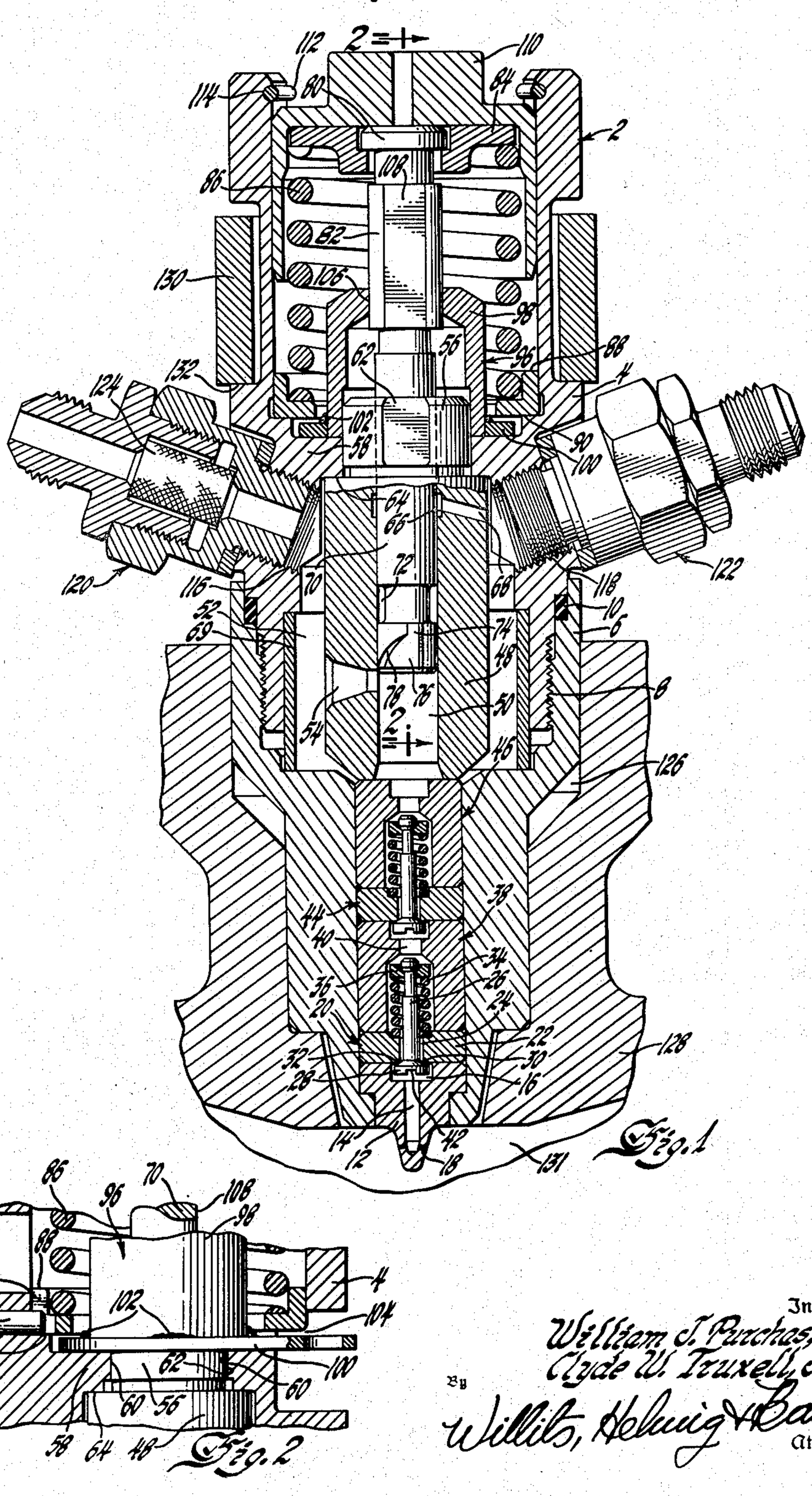

Fig. 1

Fig. 2

Inventors
William J. Purchas, Jr. &
Clyde W. Truxell, Jr.

By Willits, Helwig & Baillio
Attorneys

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FUEL INJECTION PUMP

William J. Purchas, Jr., and Clyde W. Truxell, Jr., Grand Rapids, Mich., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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1 Claim. (Cl. 299—107.2)

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The present invention relates to fuel supply means for internal combustion engines and more particularly to fuel injection pumps for controlling and effecting the delivery of fuel under pressure to the cylinders of a solid fuel injection engine.

It is an object of the present invention to provide an improved fuel injection pump of simplified construction.

It is a further object of the present invention to provide a fuel injection pump so constructed and arranged to substantially reduce untimely fuel injection caused by fuel surging within the injector structure.

These and other objects are attained in accordance with the present invention by providing a fuel injection pump in which fuel injection is controlled by an improved multiple valve arrangement which substantially reduces fuel injection caused by fuel pressures in the internal chambers resulting from surging of the confined fuel.

For a better understanding of the invention, reference may be had to the drawing in which Figure 1 is an elevational view partly in section and partly broken away of the fuel injection pump of the present invention; Figure 2 is a view taken on the line 2—2 of Figure 1 with parts broken away and parts in section.

Referring now to the drawing there is illustrated the fuel injection pump of the present invention comprising a shell or casing 2 formed of an injector body portion 4 and an injector nut portion 6 secured together in threaded engagement at 8 with a sealing ring 10 of suitable material, such as "neoprene" clamped therebetween to provide a sealed joint. Within the injector nut portion 6 and at its lower end there is disposed a nozzle or spray tip 12 formed with a central passage 14 terminating at its upper end in an enlarged passage 16 and provided with radially disposed transverse passages 18. Seated at the upper end of the nozzle or spray tip 12 there is an injector valve assembly 20 consisting of a bushing 22 having a central passage 24 enlarged at its upper end, as shown. Disposed in the passage is a valve 26 provided with an enlarged head 28 with a conical seating surface 30 adapted to engage the valve seat 32 of the bushing 22. The valve is yieldingly urged to its closed position on seat 32 by the helical spring 34 which surrounds the stem of the valve 26 with one end recessed in the enlarged upper end of passage 24 and the other end in engagement with a C-washer 36, slidably secured to the stem of the valve 26. A valve spring cage 38 having a passage 40 with

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upper and lower enlarged portions is disposed within the injector nut adjacent to the valve assembly with the stem of the valve 26, spring 34 and C-washer 36 recessed in the lower enlarged portion of passage 40. With the valve assembly 20 disposed adjacent the nozzle or spray tip 12 the enlarged head 28 is recessed in the enlarged passage 16 of the nozzle or spray tip 12. To avoid complete stoppage of fuel flow from passage 24 of bushing 22 to passage 14 of the nozzle or spray tip 12 because of breakage of spring 34, C-washer 36 or the stem of valve 26 permitting the valve to fall by gravity to close passage 14, the enlarged head 28 is provided with a transverse slot 42 which will permit fuel flow to passage 14 should the valve become inoperative by breakage of one of the hereinbefore mentioned valve parts. Positioned at the upper end of valve spring cage 38 is a second valve assembly 44 and valve spring cage 46 such as described in connection with valve assembly 20 and valve spring cage 38.

Disposed within the casing 2 there is a cylindrical bushing 48 provided with a central passage 50 in communication with an annular space 52 surrounding the bushing by means of a passage 54 through the wall of the bushing. The lower end of the bushing 48 is seated on the upper end of valve cage 46 with the bushing passage 50 and the central passage of the valve spring cage 46 in communication. The bushing is formed with a reduced end 56 which passes through an inwardly extending flange 58 formed integral with the injector body portion 4. Oppositely disposed flat surfaces 60 formed on the flange walls, see Figure 2, cooperate with similar flat surfaces 62 on the reduced end 56 of bushing 48 to prevent the rotation of the bushing within the casing. As shown, a shoulder 64 formed at the junction of the body of bushing 48 and its reduced upper end 56 seats on the lower side of the inwardly extending flange 58; thus with the bushing 48, valve assemblies 20 and 44, valve spring cages 38 and 46 and nozzle or spray tip 12 assembled, as shown, they are clamped end-to-end as the injector nut 6 is threaded on the injector body 4. An annular oil groove 66 is formed in the wall of passage 50 at substantially the upper end of bushing 48 and is connected with annular space 52 by a passage 68 through the wall of the bushing. To prevent surging fuel within the annular space 52 from eroding the inner walls of the injector body 4 and injector nut 6, a cylindrical deflector 69 of suitable hard material is loosely positioned within the casing, as shown.

Reciprocably mounted within the bushing 48 there is a piston or plunger 70. Adjacent the lower end of the plunger there is provided an annular groove 72 which is in communication with chamber 50 in bushing 48 through a longitudinally extending slot 74. The longitudinal slot 74 terminates in a recess 76 formed in the wall of the piston at its lower end with one side wall 78 of the recess 76 extending helically and circumferentially around the piston, as shown. The upper end of the piston 70 is formed with an enlarged head 80 and an enlarged portion 82. The head 80 of piston 70 is recessed in an upper spring seat 84 which is yieldingly urged upwardly by a helical spring 86. The lower end of spring 86 is seated on a lower spring seat 88 which in turn is seated on an annular shoulder 90 formed in the inner wall of the injector body portion 4. The lower spring seat 88 is provided with a longitudinally extending slot 92, see Figure 2, which receives the end of a pin 94 passing through the wall of the injector body portion 4 to prevent rotation of the lower spring seat in the injector body portion 4.

Rotatably mounted on the upper surface of the inwardly extending flange 58 is a control assembly 96 comprising a sleeve 98 and a control arm 100, see Figure 2, attached to the sleeve at 102 by suitable means such as welding. The control arm 100 extends through a slot 104 in the wall of the injector body portion 4 extending circumferentially around the body portion to permit an angular movement of the control arm and sleeve through substantially 90 degrees. The sleeve 98 receives the upper portion of the reduced end 56 of bushing 48 which extends above the inwardly extending flange 58 and is provided with a central passage 106 through the end thereof through which the plunger 70 passes to permit reciprocation of the plunger. To provide for rotation of the plunger and control of the quantity of fuel forced from the fuel pump injector in a manner which will be described hereinafter, the passage 106 has a flat wall portion, not shown, which is adapted to engage a cooperating flat surface portion 108 on the enlarged portion 82 of the plunger. Such a construction permits reciprocation of the plunger in the sleeve but restricts rotary movement of the plunger to the angular movement of the control assembly in the casing.

The plunger 70, upper and lower spring seats 84 and 88, control assembly 96 and spring 86 are held in assembled relation within the injector body 4 by a follower sleeve 110 which is reciprocably mounted in the upper portion of the body. A generally C-shaped clamping spring 112 recessed in an annular groove 114 in the inner wall of the body and adjacent its upper end retains the follower sleeve in the body.

Threaded passages 116 and 118 communicating with the annular space 52 receive the fuel inlet and outlet fittings 120 and 122 both of which are adapted to removably contain filter elements 124, as shown.

The assembled injector is fitted into a passage 126 in the cylinder block of a solid fuel injection engine 128 with the passage 126 formed with a well configuration conforming to the external wall contour of the injector nut portion 6 thereby providing a seat for the injector on the engine head with the nozzle or spray tip 12 exposed in the combustion space 131 of the cylinder. A yoke having arms 130 engaging the shoulder 132 in the outer wall of the injector body 4 is attached to the cylinder head 128 and secures the fuel pump injector in the cylinder block.

In operation, fuel lines, not shown, connect the inlet and outlet fittings 120 and 122 to a fuel pump, not shown, which forces fuel to circulate under the pump pressure through the inlet fitting 120, the enlarged space 52 and out through the outlet fitting 122 to be returned to the pump. Any well known means such as a rocker arm and push rod engaging a cam on the camshaft of the engine may be used to effect a downward movement of the follower 110 and the plunger 70. With fuel circulating in the annular space 52 and filling the pumping chamber 50, the recess 76 and annular groove 72 on the plunger 70, a downward stroke of the plunger closes the passage 54 and forces fuel entrapped in the pumping chamber 50 under high pressure past the upper and lower valves and out of the orifices 18 and into the combustion space 131 in the form of finely divided spray. In this connection it will be obvious that the angular position of the plunger 70 and the circumferentially extending helical side wall 78 of the recess 76 determines the position of the plunger in the pumping chamber at which the passage 54 is closed to the pumping chamber. With the control assembly and plunger in substantially the positions as shown, passage 54 is closed as the end of the plunger passes the lower edge of the passage. In this position a maximum volume of fuel will be entrapped in the pumping chamber and will be forced out of the injector by the downward movement of the plunger. With the plunger and control assembly rotated, the circumferentially extending helical sidewall 78 of recess 76 is placed in position to close the passage 54 at a considerably greater depth of the plunger in the pumping chamber, thus forcing a smaller quantity of fuel from the injector. As the plunger continues its downward stroke in any of its rotated positions in the bushing, the groove 72 opens into the passage 54 and fuel from the pumping chamber is passed through the longitudinally extending slot 74 to groove 72 and backwardly through the passage 54 and against the deflector 69. Fuel which leaks by the groove 72 and along the side wall of the plunger 70 is entrapped in the oil groove 66 and drains through passage 68 to the annular space 52.

By placing the two check valve assemblies 20 and 44 with like spring tensions in series in the outlet passages from the pumping chamber 50 to the nozzle or spray tip 12, double the pressure is required in the pumping chamber to open the lower valve against its biasing spring than would be required to open the upper valve against its spring tension or a single valve between the pumping chamber and the nozzle. As the plunger 70 moves downwardly in the entrapped fuel in pumping chamber 50 the pressure in the pumping chamber increases until the tension of the spring of the upper valve is overcome thus filling the passage 40 with fuel under the pressure of the fuel in pumping chamber 50. The pressure of the fuel in passage 40 acts upwardly against the valve adding to the tension of its closing spring to require in pumping chamber 50 a fuel pressure substantially two times the pressure of the fuel in passage 40 to overcome the tension of spring 34 in the lower valve assembly 20 to open valve 26 and force the fuel from chamber 50 through the outlet passages to the orifices 18 of the nozzle 12.

With this arrangement and the position of the

lower valve substantially near the outlet orifices, optimum operating characteristics are provided.

With the two valves in series in the outlet passage a sufficiently high pressure is required for ejection of the fuel that pressures built up in the pumping chamber and connected passages due to surging of the fuel during the movements of the plunger in the bushing are not sufficient to open the valves and prematurely eject fuel to the combustion chamber 131. Further, with the lower valve placed substantially near the orifices 18, air or combustion gases which may become entrapped in the passages of the nozzle 12 by the movement of the piston are reduced to a minimum thus maintaining fuel to air ratios which are substantially constant.

What we claim as new and desire to secure by Letters Patent of the United States is:

In a fuel injection pump, a casing comprising upper and lower hollow members having their adjacent ends in telescoping interthreaded engagement, said upper member having an internal flange forming a lower fuel receiving chamber and an upper spring chamber, said flange having an opening connecting said chambers, said opening having a flat side, a cylindrical bushing disposed longitudinally within said casing having a reduced diameter upper portion with a flat side fitting said opening and a lower portion of larger diameter in abutment with the underside of said flange, a plunger slidably fitting the bore of said bushing and extending from the upper end thereof into said spring chamber, a spring retainer secured to the upper end of said plunger, a helical spring compressed between said retainer and said flange, a follower of inverted cup shape enclosing the retainer and guided for reciprocation therewith by the side walls of said spring chamber, said plunger having an elongated flat sided portion embraced by said spring, an inverted cup-shaped sleeve having a flat sided aperture in its end wall slidably fitting said plunger portion, a control arm secured to said sleeve and passing through the side wall of said upper member, said upper member being provided with an elongated slot accommodating rotation of said arm to effect angular adjustment of said plunger about the axis of said bushing, said bushing lower portion forming a fuel pumping chamber below said plunger and provided with a plunger controlled port in the bushing wall through which fuel may enter said pumping chamber from said fuel receiving chamber when the plunger is retracted by said spring, said upper member having fuel inlet and outlet connections communicating with said fuel receiving chamber, said lower member

having an internal shoulder defining the lower limit of said fuel receiving chamber and a passage extending therefrom through the lower end of said lower member, said central passage having an internal shoulder adjacent its lower end, a fuel nozzle fitting the lower end of said passage and retained by said shoulder, said nozzle having a longitudinal fuel duct of restricted capacity terminating at its upper end in an enlargement, a check valve assembly in said passage comprising a downwardly opening check valve having a head loosely received in said enlargement with a stem extending upwardly in said passage, a valve seat resting on said nozzle and having a longitudinal duct embracing the valve stem with only sufficient clearance to accommodate required fuel flow during pump operation, a spacer resting on said seat and having a downwardly open recess in its lower end forming an enclosure for said valve stem, resilient valve closing means substantially filling the space between said stem and the interior surfaces of said recess, said spacer having a longitudinal fuel duct communicating with said recess and terminating at its upper end in an enlargement, a second check valve assembly in said passage identical to said first named assembly having its valve head loosely received in said spacer enlargement and its valve seat resting on said spacer, a second spacer in said passage identical to said first named spacer and resting on the valve seat of said second check valve assembly, said valve seats and spacers having a close fit throughout their length with the walls of said passage and being clamped in stacked end-to-end abutting relation between said nozzle and said bushing by the interthreaded engagement of said upper and lower members.

WILLIAM J. PURCHAS, JR.
CLYDE W. TRUXELL, JR.

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