Aug. 7, 1945. F. BUCK 2,381,423

FUEL INJECTOR

Filed April 12, 1940

Fig. 1.

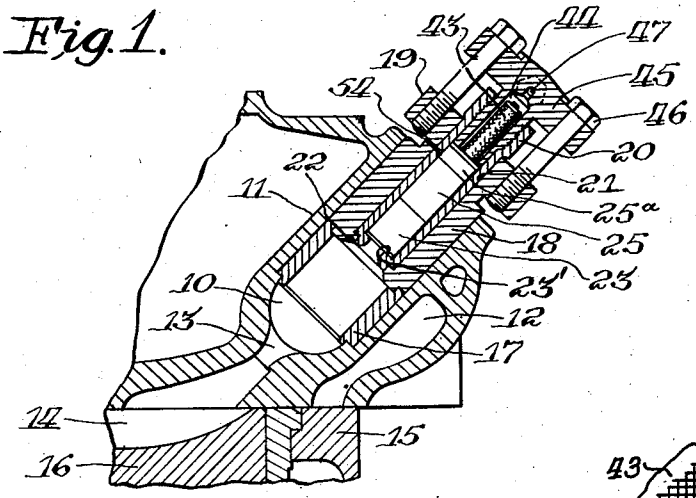
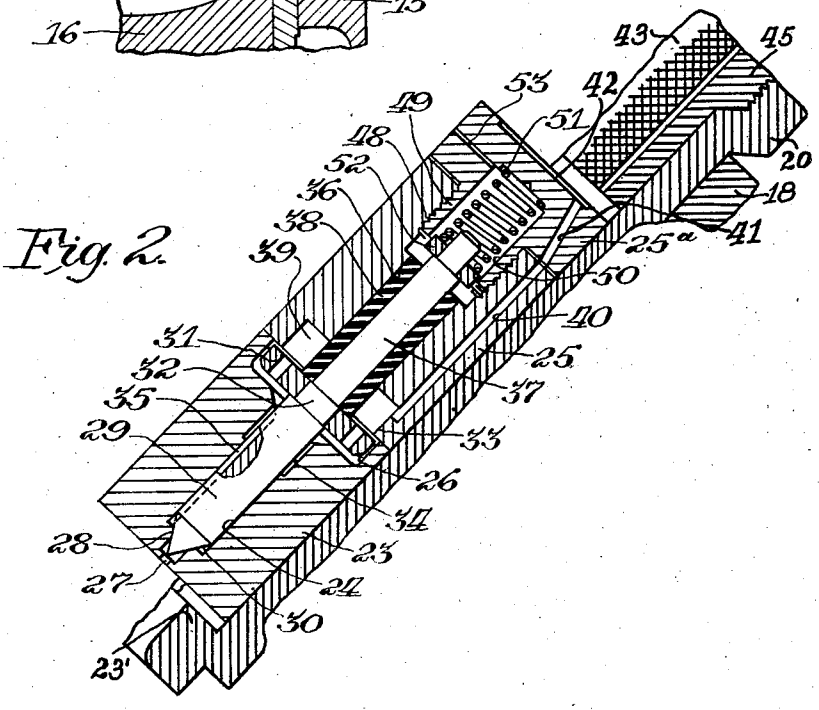


Fig. 2.



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FUEL INJECTOR

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13 Claims. (Cl. 299—107.6)

This invention relates to fuel injectors for internal combustion engines, particularly compression ignition oil engines. More specifically, the invention relates to fuel injection valves of the hydraulically operated type.

The principal object of the invention is to provide an injector with a simple and efficient valve loading means to provide economy and durability of construction and to function as a liquid seal to eliminate the necessity of a by-pass drain from the fuel injector. The invention consists essentially of an injection valve of the hydraulically operated type in which an oil resistant substance, such as Neoprene, is utilized to provide for spring loading the valve and simultaneously acting as a seal to allow the necessary axial movement of the valve. An auxiliary spring means is also used on the valve outside the high compression chamber, this being made possible by the seal provided by the resilient material.

In the accompanying drawing, which forms part of this specification,

Figure 1 is a sectional view through the center of a fuel injection unit showing the unit mounted on a cylinder head of an internal combustion engine, only such portion of the engine head block and cylinder being shown as are necessary to illustrate the position of the nozzle; and,

Figure 2 is an enlarged sectional view taken through the axis of the valve unit utilized in the nozzle assembly.

The fuel injector shown in the drawing is of the unit type and is illustrated as fitting into a pre-combustion chamber 10 formed in the cylinder head 11 of the engine. Water is circulated through a cooling space 12 surrounding the pre-combustion chamber. In the particular form illustrated a Venturi shaped outlet 13 from the pre-combustion chamber communicates with the main combustion space 14 of the engine. Portions of the engine block 15 and the piston 16 are shown. The entire injector may be removed as a unit from the pre-combustion chamber.

An annular spacer member 17 is fitted first into the pre-combustion chamber. An annular nozzle supporting member 18 is fitted into the pre-combustion chamber against the spacer 17. Said member is provided with a flange 19 by which it is secured to the cylinder head by means of suitable cap screws, not shown, but which are conventional in construction.

A sleeve 20 is fitted in a bore 21 formed in the member 18. Said sleeve is provided with a lower end portion of reduced diameter which fits against an inturned flange 22 at the bottom of the member 18. The sleeve 20 is provided with a lower end portion 23' of reduced diameter to form an abutment for supporting the nozzle assembly.

The nozzle assembly, which is shown in section in Figure 2, includes a lower casing member 23, an upper casing 25 and a cap member 25a. The lower casing member 23 is provided with a bore 24 extending from an enlarged cylindrical recess 26 at the open end of the member to a point adjacent the engine end of the member. At said end a discharge orifice 27 is provided as a communication between the bore 24 and the pre-combustion cup of the engine. A conical valve seat 28 is also provided between the orifice 27 and the bore 24.

A cylindrical valve member 29 is slidably mounted in the bore 24, being fitted in said bore for an operating sliding fit. The lower end of the valve member 29 is provided with a conical valve end portion 30 cooperating with the valve seat 28 to control the flow of fuel through the orifice 27. A stop member 31 is fitted on a reduced portion 32 of the valve member 29 in the recess 26. Said stop member is provided with passages therethrough to provide for the free flow of fuel. The upper surface of the stop member 31 is positioned slightly below the upper surface of the casing member 23. This construction provides a stop for limiting opening of the valve as the stop member abuts an overhanging portion 33 of the upper casing member 25. This distance is very small and is carefully calibrated to give the proper opening of the valve to secure the best fuel spray characteristic.

The bore 24 is provided with an enlarged section 34 to provide for free communication of the recess 26 with a fuel flow passage 35 formed along the lower end portion of the valve member 24. Said passage communicates with the lower end of the bore to provide for fuel flow to the orifice 27 when the valve is unseated.

The upper casing member 25 is provided with a bore 36 which is considerably greater in diameter than the reduced upper portion 37 of the valve member 24. A member 38 formed of Neoprene, or some similar resilient material which is resistant to oil, is fitted between the portion 37 of the valve member 24 and the bore 36. Said material may be bonded to each of the contacting surfaces or it may be fitted under compression into the space without actual bonding, the compression fit being relied upon to seal against the flow of fuel.

An annular recess 39 is formed in the lower end

face of the casing member 25 to provide an oil chamber, said recess being smaller in diameter than the recess 26 to provide the stop shoulder 33, previously described. A fuel spray conduit 40 is formed by a bore in the casing member leading from the recess 39 to the upper end of the casing member, where it communicates with a conduit 41 in the cap or closure member 25a. A milled recess 42 in the top of the member 25a receives fuel from a filter 43 fitted into a bore 44 of a clamping and retaining member 45, said member is threaded into the upper end of the sleeve 20. When said retaining member is threaded into the sleeve 20, this member and sleeve are thereby drawn axially together to press and retain the elements 23 and 25 into the stacked end-to-end relation shown in Fig. 2, the elements 25 and 25a having been already secured in end-to-end relation by turning of the threaded flange 49 into the threaded bore 48. The spring loading or pretensioning of the resilient sleeve 38 is attained pursuant to the members 23 and 25 being thus forced into abutment at their opposed ends, whereby the valve seat 28 presses endwise on the valve stem 29 to displace it axially inwardly of the bore 36 to tension the resilient sleeve an amount limited by the endwise abutment of the parts 23 and 25. Cap screws 46 extending through a flange on the member 45 are threaded into the flange 19 thereby securing the nozzle assembly in position in the injector unit. The fuel is supplied to the filter 43 through a conventional fitting and supply passage 47 being shown in the member 45.

The upper end of the casing member 25 is provided with a threaded bore 48 into which a depending sleeve portion 49 of the cap member 25a is threaded. Said cap member is also provided with a bore 50 in which a compression spring 51 is mounted. Said spring abuts a collar 52 fitted on a reduced end portion of the upper end portion 37 of the valve member. A small bleed passage 53 is provided in the bore 49 to prevent hydraulic locking of the valve unit in the event that the resilient sealing member 38 should be ruptured in operation of the device. The bleed opening 53 communicates through any suitable means, such as the passages 54 indicated in Figure 1, with the atmosphere. This bleed opening serves in another sense as an indicator to show rupture of the sealing member 38 by which an operator is able to judge the condition of the injection units.

In the operation of a valve constructed according to this invention, fuel is supplied in properly timed relation under a pressure to the injector unit through the passage 47, the filter 43, the conduits 41 and 40 to the recesses 39 and 26. It is possible in a construction of this type to keep the fuel capacity of the passages and chambers in which oil is maintained under pressure to a minimum, thereby reducing problems resulting from compression of the oil and elasticity of the confining walls. When pressure in the nozzle assembly increases to the point at which the nozzle is designed to operate, the hydraulic action overcomes the action of the elastic member 38 which is compressed axially with a sheer stress. The hydraulic pressure also overcomes the compression spring 51 which, together with the resiliency of the material 38, determines the opening pressure of the valve. When the valve is open, the fuel under pressure passes downwardly through the passage 35 over the valve seat 28 and discharges as a spray from the orifice 27 into the combustion chamber.

By the use of an elastic deformable material, such as Neoprene, which is resistant to the action of oil, applicant has been able to provide a simplified, low cost injection valve assembly for high compression engines with several inherent advantages. Prior nozzles of this type utilizes springs entirely as the resistance against the hydraulic action operating to open the valve. All springs have certain characteristics, particularly a vibration period, depending upon size and type of spring. This characteristic has resulted in the past in valve actions acting to vibrate the valve with detriment to the seating surface and under some conditions even resulting in slight opening of the valve with subsequent fuel dribble. There are also other surging actions in the fuel supply volume due to the pump characteristics and the elasticity of the fuel conducting conduits. These actions have been objectionable in connection with spring compression members for valves, as there is very little damping action in a conventional spring construction. By the use of a resilient, elastic material, applicant has not only provided a combined sealing means, which can be made absolutely fluid tight, but at the same time has provided a resilient means which is inherently self-damping due to the internal friction with the consequent absorbing of pulsations or surging movements. An auxiliary spring may be used on the outer end of the valve without the provision of drain back to the fuel system as has been necessary with all valves utilizing packed sealing members. The provision of the safety relief conduit is not intended in any way to reflect a loss of fuel during operation. It is merely to provide a safety factor to protect the injection pump in the event that the sealing member 38 is ruptured during operation.

It is understood that applicant claims as his invention all modifications of the injection nozzle unit falling within the scope of the appended claims.

What is claimed is:

1. An injection nozzle assembly for solid fuel injection engines comprising a casing structure formed with a fuel chamber, an inlet and an outlet conduit communicating with said chamber, a valve structure mounted in the chamber having a valve movable in an axial direction and positioned to control the outlet conduit, said structure having a bore communicating with the chamber, said valve structure having a stem member extending through said bore slightly spaced from the walls thereof to provide a space between the stem and the wall of the bore, the length of said bore being relatively large compared to the thickness of such space, and a sealing, damping and compression member of rubber-like oil resistant material fitted in said space and bonded to the walls thereof.

2. An injection nozzle assembly for solid fuel injection engines comprising a casing structure formed with a bore terminating adjacent one end thereof, a discharge passage formed in the structure at the terminal end of the bore, a valve seat adjacent the discharge passage, said casing structure being formed with a fuel receiving recess in communication with the bore, a valve structure including an axially movable cylindrical valve member extending into the bore and formed with an end portion cooperating with the valve seat, a portion of said valve member being spaced from the bore at the end opposite the discharge passage and beyond the communicating point of the recess to provide a space between said portion of

the valve member and the bore, an oil resistant rubber-like resilient sealing and compression member fitted in said space in nonslipping relation with respect to the walls thereof, said member being unconfined at the ends of said space, means for supplying fuel under pressure to the recess, and means for providing the flow of fuel from said recess to the valve end of the bore, said space being long relative to its thickness whereby the resistance to shear is very large and whereby the shear resistance is effective to act as a valve opening control means at the pressures necessary for solid fuel injection and to damp out pulsations due to elasticity of the injection system acting to vibrate the valve structure.

3. An injection nozzle assembly for solid fuel injection engines comprising a casing structure formed with a bore terminating adjacent one end thereof, a discharge passage formed in the structure at the terminal end of the bore, a valve seat adjacent the discharge passage, said casing structure being formed with a recess at an intermediate portion of the bore, a valve structure including an axially movable cylindrical valve member extending into the bore and formed with an end portion cooperating with the valve seat, a portion of said valve member being spaced from the bore at the end opposite the discharge passage and beyond the recess to provide a space between said portion of the valve member and the bore, a rubber-like resilent sealing and compression member fitted in said space in non-slipping relation axially of the valve member and of the bore wall and possessing a strain incurring therein a stress impositively forcing said valve member endwise to present its said end portion in valve-closing relation with said valve seat, means for supplying fuel under pressure to the recess, and means for providing the flow of fuel from said recess to the valve end of the bore, said space being long relative to its thickness whereby the resistance to shear is very large and whereby the shear resistance is effective to act as a valve opening control means at the pressures necessary for solid fuel injection and to damp out pulsations due to elasticity of the injection system acting to vibrate the valve structure.

4. An injection nozzle assembly for solid fuel injection engines comprising a casing structure formed with a bore terminating adjacent one end thereof, a discharge passage formed in the structure at the terminal end of the bore, a valve seat adjacent the discharge passage, an annular recess formed in the structure at an intermediate portion of the bore, an axially movable valve structure including a cylindrical valve member extending into the bore and formed with an end portion cooperating with the valve seat, a portion of said valve member being spaced from the bore at the end opposite the discharge passage and beyond the recess to provide a space between said portion of the valve member and the bore, a rubber-like resilient sealing, damping and compression member fitted in said space, said member being bonded to the surface of the valve member and to the bore surface, means for supplying fuel under pressure to the annular recess, and means providing for the flow of fuel from said recess to the valve end of the bore, said space being annular in cross section and thin relative to its length whereby said rubber-like member has a very large resistance to shear in an axial direction and is effective to dampen pulsations in the fuel column tending to vibrate the valve member on its seat.

5. An injection nozzle assembly for solid fuel injection engines comprising a casing structure formed with a bore terminating adjacent one end thereof, a discharge passage formed in the structure at the terminal end of the bore, a valve seat adjacent the discharge passage, an annular recess formed in the structure at an intermediate portion of the bore, a valve structure including a cylindrical valve member extending into the bore and formed with an end portion cooperating with the valve seat, a portion of said valve member being spaced from the bore at the end opposite the discharge passage and beyond the recess to provide a space between said portion of the valve member and the bore, a rubber-like resilient sealing and compression sleeve-like member fitted in said space in non-slipping relation with the portions of said valve member and of said bore contiguous therewith, said sleeve-like member being under a strain incurring therein a shear stress impositively holding said valve member in the endwise position that seats said valve member end portion upon said valve seat, said space and hence said sleeve-like member occupying the same being thin radially in proportion to their length and said compression member having an inherent high resistance to shear whereby endwise displacement of the valve member from the valve seat greatly increases the shear stress on the sleeve-like member, means for supplying fuel under pressure to the annular recess, and means providing for the flow of fuel from said recess to the valve end of the bore.

6. An injection nozzle assembly for solid fuel injection engines comprising a casing member formed with a bore terminating adjacent one end thereof, a discharge passage formed in the member at the terminal end of the bore, a valve seat adjacent the discharge passage, an annular recess formed in the member around the open end of said bore, a valve structure including a cylindrical valve member extending with a sliding fit into the bore and formed with an end portion axially seatable in valve-closing relation upon said valve seat, a second casing member mounted on the first casing member, said second casing member being formed with a second bore in alinement with the first mentioned bore, said valve member extending through said second bore spaced from the wall thereof to provide a space of annular cross section between the stem and the side wall of said second bore in opposed spaced relation therewith, a rubber-like resilient sealing and compression member fitted in said space in non-slipping relation with the valve stem and the opposed side wall of the second bore and under an axial shear strain incurring in said member a force urging said valve member endwise in the direction pressing said end portion thereof onto the valve seat, means for supplying fuel under pressure to the annular recess in the first casing member, and means providing for the flow of fuel from said recess to the valve end of the bore in said first casing member, said space being thin in radial cross section relative to its length whereby said rubber-like member has a very large resistance to shear in an axial direction and is effective to dampen pulsations in the fuel column tending to vibrate the valve member on its seat.

7. An injection nozzle assembly for solid fuel injection engines comprising a casing member formed with a bore terminating adjacent one end thereof, a discharge passage formed in the member at the terminal end of the bore, a valve seat

adjacent the discharge passage, an annular recess formed in the member around the open end of said bore, a valve structure including a cylindrical valve member extending with a sliding fit into the bore and formed with an end portion cooperating with the valve seat, a second casing member mounted on the first casing member, said second casing member being formed with a bore in alinement with the first mentioned bore, said valve member extending through said bore and being spaced from the wall thereof to provide a space between the stem and the wall of the bore, a rubber-like resilient sealing and compression member fitted in said space, said member being bonded to the surface of the valve member and the bore surface of the casing member, means for supplying fuel under pressure to the annular recess in the first casing member, and means providing for the flow of fuel from said recess in the valve end of the bore in said first casing member, said space being annular in cross section and thin relative to its length whereby said rubber-like member has a very large resistance to shear in an axial direction and is effective to dampen pulsations in the fuel column tending to vibrate the valve member on its seat.

8. In a fuel injection nozzle, a body structure including fuel passages, valve means interposed between said passages and openable or closable to respectively provide or preclude communication between said passages, a valve stem bore in said structure, a valve stem of less diameter than said bore disposed axially movably therein and operably connected with said valve means to close the same when displaced in one direction to one axial position and displaceable in the opposite direction from said position as a precedent to opening of the valve means, a packing sleeve of resiliently distortable material disposed about the valve stem in said bore and with inner and outer peripheral portions respectively disposed in sealing and axially non-displaceable relation with said stem and with the periphery of said bore and with the body portion of the sleeve between said inner and outer peripheral portions under a biased axial stress impositively maintaining said valve stem in said axial position for closing the valve means.

9. The combination set forth in claim 8, in which there is also a spring arranged coaxially of and within a portion of the valve stem bore and reacting between said body structure and the valve stem to yieldingly resist axial movement of said valve stem from its said axial position.

10. A fuel injector comprising a cylindrical body having an axial bore opening through one end of said body and a fuel inlet passageway opening into said bore, a nozzle member secured to said end of said body and having a discharge opening registering with said bore and a valve seat in said discharge opening, a reciprocable valve for said valve seat adapted to be opened by the injection pressure of fuel supplied to said bore by said fuel inlet passageway, said valve having a stem disposed in said bore, and loading means for said valve comprising a rubber sleeve interposed between and bonded to said bore and stem inwardly of the point of communication of said inlet passageway with said bore, said sleeve being axially pretensioned by pressure transmitted thereto by said nozzle member to thereby hold said valve in closed position against pressure less than injection pressure and being capable of further axial tensioning to permit said valve to open at injection pressure.

11. A fuel injector comprising a body having a bore with a fuel inlet, a fuel outlet and a valve seat adjacent to the latter, a reciprocable valve for said valve seat adapted to be opened by the injection pressure of fuel supplied to said inlet, said valve having a stem rigid therewith and disposed in said bore, and loading means for said valve comprising an axially elastic sleeve interposed between and surface bonded to said bore and stem, said sleeve being axially pretensioned to hold said valve in closed position under pressure less than injection pressure and being capable of further axial tensioning to permit said valve to open at injection pressure.

12. A fuel injector comprising a body adapted to be supplied with fuel under pressure and having a discharge opening for said fuel and a valve for said opening adapted to be opened by the injection pressure of said fuel, said valve having a stem extending into said body, and loading means for said valve, said loading means comprising a separate rubber bushing interposed between and bonded to said body and valve stem and thus constituting a seal to prevent leakage of fuel therebetween, said bushing being axially pretensioned to hold said valve in closed position under pressure less than injection pressure and being capable of further axial tensioning to permit said valve to open at injection pressure.

13. A fuel injector comprising a body having a bore with a fuel inlet, a fuel outlet and a valve seat adjacent to the latter, a reciprocable valve for said valve seat adapted to be opened by the injection pressure of fuel supplied to said inlet, said valve having a stem rigid therewith and disposed in said bore, loading means for said valve comprising a rubber sleeve interposed between and bonded to said bore and stem, means for axially pretensioning said sleeve in said body to hold said valve in closed position under pressure less than injection pressure, said sleeve being capable of further axial tensioning to permit said valve to open at injection pressure, and a stop member located in said bore for limiting the opening movement of said valve.

FOSTER BUCK.

CERTIFICATE OF CORRECTION.

Patent No. 2,381,423. August 7, 1945.

FOSTER BUCK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 20, claim 7, after "casing" insert the word and period --member.--; line 21, beginning with the word "member" strike out all to and including "seat." in line 26, same claim; 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 11th day of December, A. D. 1945.

Leslie Frazer

(Seal) First Assistant Commissioner of Patents.