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(54) **Safety check valve for unit fuel pump injector.**

(57) In a fuel injector including an injector housing (10) having spray orifices (70), a valve seat (68) within the body (10) and closely adjacent the spray orifices (70), a valve (66) movable within the body (10) between positions seated against the seat (68) and spaced from the seat (68), means (80) within the body (10) biasing the valve (66) towards the position against the seat (68), means (22) for receiving fuel at a first pressure, means (12) for increasing the pressure of the fuel to a second pressure higher than the first pressure, means (46, 60, 58, 62) for delivering the fuel at the second pressure to the valve (66), means (74) responsive to the receipt of fuel at the second pressure for moving the valve (66) from the position against the seat (68) to the position spaced from the seat (68), the improvement including means (50, 54) for limiting the delivery of fuel at the first pressure from the receiving means (22) to the valve (66) and for limiting the flow of fuel from the valve (66) to the receiving means (22).

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Description

Safety Check Valve for Unit Fuel Pump-Injector

Technical Field

This invention relates to a fuel injection apparatus and particularly to unit type fuel pump-injectors for diesel and other engines.

Background Art

Many internal combustion engines, particularly those operating on the diesel cycle, require an apparatus to inject a predetermined amount of fuel into the engine combustion chamber at the proper time in the operating cycle.

One device for accomplishing this result is a unit fuel pump-injector which performs the dual functions of injecting fuel into the engine combustion space and metering the amount of fuel to be injected.

Typically, the fuel injector housing contains a cylindrical bore in which a plunger is reciprocable. Clamped to the lower end of the housing is a spacer block which defines a pump cylinder for the plunger. This spacer block contains an annular groove connected to a plurality of passageways which lead to a fuel chamber surrounding a needle valve located in the tip of the fuel injector.

In the usual case, low pressure fuel is supplied to the plunger cylinder and on each downward or injection stroke of the plunger, this fuel is forced under high pressure through the passageways and into the fuel chamber located in the injector tip. This high pressure fuel forces the needle valve off its valve seat and uncovers multiple orifices leading to the combustion space. Fuel is thus injected from

the plunger cylinder to the engine combustion space. When pressure on the fuel in the injector tip fuel chamber is relieved, the needle valve is returned to a closed position by a spring.

The upper surface of the spacer block defining the plunger cylinder(chamber)usually includes a check valve in the form of a circular flat disc which prevents combustion gases from entering the plunger cylinder if the needle valve fails to close or closes too slowly.

This check valve is necessary since proper engine performance depends upon the proper amount of fuel being injected at the proper point in the engine cycle. Combustion gas in the pump cylinder will delay and reduce the amount, or completely prevent the injection of fuel during the succeeding injection cycle because the gas must be forced into the combustion space before fuel may be injected.

In addition, if a large amount of gas enters the fuel supply system, sudden and unpredictable power loss and/or engine failure may result.

During engine operation, it sometimes happens that the needle valve becomes stuck in the open position or the injector tip becomes damaged or broken off entirely.

In the typical system, there is no way to prevent low pressure fuel from leaking from the plunger cylinder into the combustion space when this occurs. Consequently, low pressure fuel will be allowed to flow from the plunger cylinder into the combustion space during the upward and dwell portions of the plunger cycle.

This constant fuel flow will have seriously adverse effects on engine mechanical condition and performance since it will result in fuel waste, excessive localized engine heating, and excessive hydrocarbon exhaust emissions.

Disclosure of Invention

In one aspect of the present invention, there is provided means to resiliently urge the check valve against the lower surface of the plunger housing with sufficient force to limit the flow of low pressure fuel from the plunger cylinder to the injector tip.

The check valve will thus provide the dual functions of limiting both combustion gas from entering the plunger chamber and low pressure fuel from escaping from the plunger cylinder to the combustion space in the event that the injector tip is damaged or the needle valve malfunctions.

Brief Description of the Drawing

Fig. 1 is an enlarged partial section of a unit fuel pump-injector made according to one embodiment of the invention.

Best Mode for Carrying out the Invention

An exemplary embodiment of a unit fuel pump-injector is illustrated in Fig. 1 and comprises a housing 10 in which a plunger 12 is reciprocable. The lower end of the housing 10 supports a bushing 14 which forms a cylinder 22 for the plunger 12. An annular space 16 surrounding the bushing 14 is supplied with low pressure fuel by a fuel pump 18 (shown schematically) via a fuel inlet port 20. This low pressure fuel is subsequently delivered to the plunger cylinder 22 by two bushing ports 24, 26. Any excess fuel delivered to the injector by the fuel pump 18 is returned to a fuel system tank 28 (shown schematically) by an exit port 30.

The plunger 12 has the usual by-pass means including an external groove 32 or so-called "scroll", by which opening and closing of the ports 24, 26 in

the bushing 14 is controlled, and connecting axial and transverse passages 34, 36 for by-passing fuel from the plunger cylinder 22 to the annular fuel space 16 when the groove 32 is in registry with one or the other of the ports 24,26.

Thus, during each downward or injection stroke of the plunger 12 from its position shown, fuel is initially by-passed to the annular space 16 from the plunger cylinder 22 through the plunger 12, but after the groove 32 has moved out of registry with the upper port 24 and the lower port 26 is closed by the plunger 12, fuel is displaced under high pressure through an opening 38 in the lower end of the bushing 14 until the groove 32 moves into registry with the lower port 26 to again by-pass fuel and end injection.

Other details of the upper or pump part of the unit form no part of the present invention, and are common to the constructions shown and described in such United States patents as Engel, Jr. 2,951,643, issued September 6, 1960 and Peichert 2,898,051, issued August 4, 1959, hence will not require further description here.

Clamped in the lower portion of the housing 10 by the bushing 14, are the remainder of the elements comprising the fuel injector, which include a spray tip 40, a spring chamber 42' and a spacer block 44. The spacer block 44 has an annular cavity 46 facing the lower opening 38 of bushing 14, and projecting centrally upward from the bottom of the cavity 46 is a protuberance 48 which forms a stop for a circular flat disc check valve 50. The protuberance 48 includes a circular recess 52 containing a spring 54 for resiliently urging the check valve 50 toward the opening 38 in the bushing 14. The check valve 50 has a greater diameter than the cylinder 22 so as to

seal about the opening 38 when urged thereagainst by the spring 54.

The cavity 46 is connected to an annular groove 56 located in the lower face of the spring retainer 42 by a plurality of passageways 58,60. A plurality of inclined passages 62 connect the annular groove 56 and a fuel chamber 64 which surrounds a needle valve 66 located in the spray tip 40. At the lower end of the fuel chamber 64 is an outlet for fuel delivery in the form of a tapered seat 68 for the needle valve 66, below which seat 68 are located a plurality of spray orifices 70.

The upper end of the spray tip 40 is provided with a bore 72 for guiding opening and closing movements of the needle valve 66. A piston portion 74 of the needle valve 66 slidably fits this bore 72, and has its lower end exposed to fuel pressure in the fuel chamber 64. A reduced portion 75 of the needle valve 66 upper end extends through an opening 76 and the lower portion of the spring chamber 42' and abuts a spring seat 78. Compressed between this spring seat 78 and lower surface of the spacer block 44 is a coil compression spring 80 which biases the needle valve 66 to its closed position as shown.

Industrial Applicability

In operation, low pressure fuel is supplied by the fuel pump 18 to the intake port 20, the annular space 16, the bushing ports 24,26 and the plunger chamber(cylinder) 22. This fuel is at a relatively low pressure (approximately 80 psi) and is retained in the plunger chamber by the check valve 50 and the check valve spring 54 which is suitably selected to insure such retention.

When it is desired to inject fuel into the combustion space, the plunger 12 begins a downward

or injection stroke which directs fuel at a much higher pressure against the check valve 50 which opens against the bias of the spring 54. Fuel flows past the check valve 50, through the passages 60, 58, 62 and to the fuel chamber 64. This fuel then acts upon the piston portion 74 of the needle valve 66 and raises the needle valve 66 away from the valve seat 68. The spray tip orifices 70 are then placed in fluid communication with the fuel chamber 64 and fuel is injected into the engine combustion space (not shown).

When the groove 32 registers with the bushing port 26, pressure on the fuel in the tip 40 is relieved and the compression spring 80 overcomes the force provided by the fuel in the fuel chamber 64 to return the needle valve 66 to the closed position and interrupt the flow of fuel to the combustion space.

Simultaneously, pressure on the fuel located in the plunger chamber 22 is relieved thus allowing the check valve spring 54 to force the check valve 50 against the lower surface of the bushing 14 to seal thereagainst and halt fuel flow from the chamber 22.

In the event that the needle valve 66 becomes stuck in the open position or the injector(spray) tip 40 becomes damaged, fuel will not be allowed to escape into the engine combustion chamber except during a downward or injection stroke of the plunger 12, thereby providing approximately normal operation.

Thus, in addition to performing the usual function of preventing combustion gas from entering the fuel supply, the unique construction of the check valve/check valve spring unit 50, 54 limits any undesired flow of fuel to the injector tip.

Other aspects, objects and advantages of this invention may be obtained from a study of the

drawing, the disclosure and the appended claims.

Claims

1. A fuel injector comprising:

an injector housing (body) (10) including spray orifices (70);

a valve seat (68) within said body (10) closely adjacent said spray orifices (70);

a valve (66) movable within said body (10) between positions seated against said seat (68) and spaced from said seat (68);

means (80) within said body (10) for biasing said valve (66) towards said position against said seat (68);

means (22) within said body (10) for receiving fuel at a first pressure;

means (12) for increasing the pressure of said fuel to a second pressure higher than said first pressure;

means (46,60,58,62) for delivering said fuel at said second pressure to said valve (66);

means (74) responsive to the receipt of fuel at said second pressure for moving said valve (66) from said position against said seat (68) to said position spaced from said seat (68); and

means (50,54) for limiting the delivery of fuel at said first pressure from said receiving means (22) to said valve (66), for limiting flow from said valve (66) to said receiving means (22), and for permitting delivery of fuel at said second pressure to said valve (66).

2. A fuel injector comprising:

an injector housing (10) including spray orifices (70);

a valve seat (68) within said body (10) closely adjacent said spray orifices (70);

a valve (66) movable within said body (10) between position seated against said seat (68) and spaced from said seat (68);

means (80) within said body (10) for biasing said valve (66) towards said position against said seat (68);

means (22) within said body (10) for receiving fuel at a first pressure;

means (12) for increasing the pressure of said fuel to a second pressure higher than said first pressure;

means (46,60,58,62) for delivering said fuel at said second pressure to said valve (66);

means (74) responsive to the receipt of fuel at said second pressure for moving said valve (66) from said position against said seat (68) to said position spaced from said seat (68);

a check valve (50) located within said delivery means (46, 60, 58, 62); and

means (54) biasing said check valve (50) against said receiving means (22) at a force sufficient to limit the flow of fuel at said first pressure from said receiving means (22) to said valve (66) while permitting fuel at said second pressure to flow thereto.

3. The fuel injector of claim 2 wherein said check valve (50) is a flat, relatively thin, disc abutting said receiving means (22).

4. The fuel injector of claim 2 wherein said biasing means (54) is a spring.

5. A fuel injector comprising:

an injector housing (10) including spray orifices (70);

a valve seat (68) within said body (10) closely adjacent said spray orifices (70);

a valve (66) movable within said body (10) between position seated against said seat (68) and spaced from said seat (68);

means (80) within said body (10) for biasing said valve (66) towards said position against said seat (68);

means (22) within said body (10) for receiving fuel at a first pressure;

means (12) for increasing the pressure of said fuel to a second pressure higher than said first pressure;

means (46, 60, 58, 62) for delivering said fuel at said second pressure to said valve (66);

means (74) responsive to the receipt of fuel at said second pressure for moving said valve (66) from said position against said seat (68) to said position spaced from said seat (68);

a flat, relatively thin, disc-shaped check valve (50); and

means (54) for biasing said check valve (50) against said receiving means (22) with sufficient force to limit the flow of fuel at said first pressure from said receiving means (22) to said valve (66) while permitting fuel at said second pressure to flow thereto.

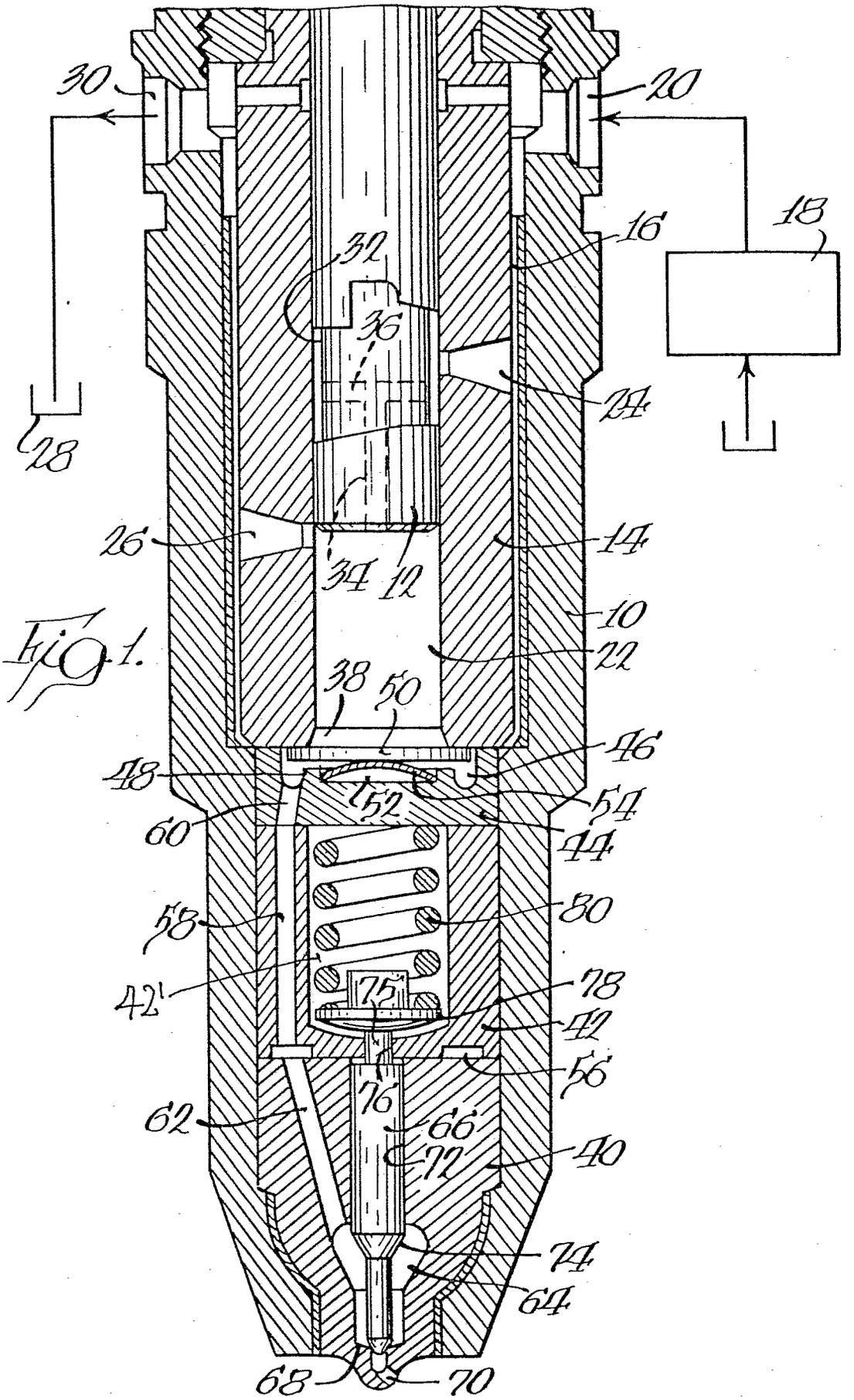
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Fig 1.

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EUROPEAN SEARCH REPORT

Application number
EP 80 10 1813

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	US - A - 3 257 078 (MEKKES) * Column 1, line 45 - column 3, line 55; figures 1-3 * --	1-5	F 02 M 57/02 59/46
X	GB - A - 714 610 (DAIMLER-BENZ) * Page 1, line 66 - page 2, line 98; figures 1,3 * --	1-5	
X	US - A - 2 762 654 (PURCHAS) * Column 1, line 50 - column 4, line 36; figures 1,2 * --	1-5	TECHNICAL FIELDS SEARCHED (Int.Cl. 3) F 02 M
X	US - A - 3 006 556 (SHADE) * Column 1, line 59 - column 3, line 34; figures 1-3 * --	1-3,5	
X	US - A - 4 054 248 (BEARDMORE) * Column 2, lines 11-64; figure 1 * --	1-3,5	
X	GB - A - 541 100 (C.A.V.) * Page 2, line 69 - page 3, line 64; figure 1 * --	1,2,4, 5	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
X	FR - A - 2 366 460 (FRIEDMANN & MAIER) * Page 4, lines 9-39; figure 1 * -- ./.	1,2,4, 5	

The present search report has been drawn up for all claims

&: member of the same patent family, corresponding document

Place of search	Date of completion of the search	Examiner
The Hague	20-06-1980	HAKHVERDI

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EUROPEAN SEARCH REPORT

Application number EP 80 10 1813

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	US - A - 3 177 857 (KUCHEN) * Column 3, lines 9-11; figure *	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)