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(71) Applicant:
Delphi Technologies, Inc.
Troy, MI 48007 (US)

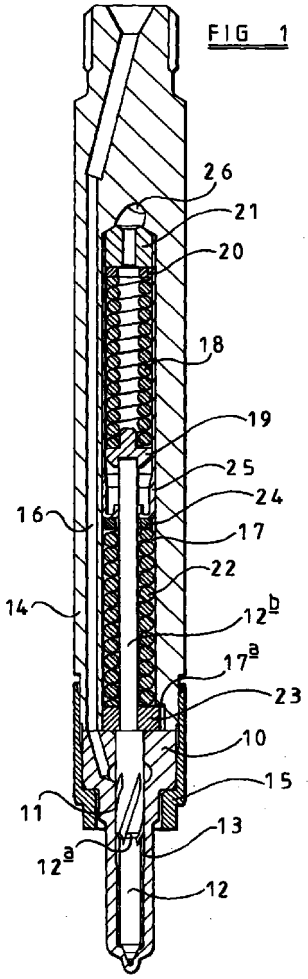
(72) Inventor: **Walker, Keith Graham**
Chatham, Kent ME5 7RB (GB)

(74) Representative:
Pople, Joanne Selina
Marks & Clerk,
Alpha Tower,
Suffolk Street
Queensway, Birmingham B1 1TT (GB)

(54) Fuel injector

(57) A fuel injector comprising a valve needle (12) biased towards a seating by a first spring (18), the first spring (18) being located within a spring chamber (17) having a closed end. The valve needle (12) is engageable with a moveable stop member (23) which is biased towards a rest position by a second spring (22) located within the spring chamber (17). The fuel injector also includes a spring abutment member (25) for the second spring (22), the spring abutment member (25) being of tubular form and transmitting the spring load of the second spring (22) to the closed end of the spring chamber (17).

FIG 1



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Description

[0001] This invention relates to a fuel injector for use in supplying fuel under high pressure to a combustion space of an engine of the compression ignition type. In particular, the invention relates to a fuel injector of the two-stage lift type.

[0002] A known two-stage lift fuel injector comprises a valve needle biased towards a seating by a first spring. The needle is arranged such that, upon movement of the needle away from the seating by a predetermined distance, the needle engages a moveable stop member, further movement of the needle being against the action of both the first spring and a second spring which urges the moveable stop member towards a rest position. The springs are typically located within a blind bore formed in a housing part. The first spring is located at the blind end of the bore, the spring load being transmitted to the needle through an elongate rod. The second spring encircles the rod and is engaged between the moveable stop member and a spring abutment secured within the bore.

[0003] Difficulties have been encountered in securing the spring abutment in position. In some arrangements the spring abutment has been secured in position by deforming the housing part. Other arrangements have used a screw-threaded arrangement to expand the spring abutment to secure it in position. Such techniques are unsatisfactory as they are either expensive or introduce relatively complex steps into the assembly process.

[0004] According to a first aspect of the present invention there is provided a fuel injector comprising a valve needle biased towards a seating by a first spring, the first spring being located within a spring chamber having a closed end, the needle being engageable with a moveable stop member biased towards a rest position by a second spring located within the spring chamber, the fuel injector further comprising a spring abutment member for the second spring, the spring abutment member being of tubular form and transmitting the spring load of the second spring to the closed end of the spring chamber.

[0005] The first spring is conveniently located within the spring abutment member.

[0006] Such an arrangement is advantageous in that the step of locating the spring abutment member within the spring chamber during the assembly process is simple to perform.

[0007] According to a second aspect of the present invention, there is provided a method of assembling a fuel injector comprising a spring chamber for receiving first and second springs, the spring chamber having a closed end associated therewith, the method comprising the steps of inserting the first spring into a spring abutment member of tubular form, inserting the spring abutment member and the first spring into the spring chamber such that an end of the spring abutment member engages the closed end of the spring chamber, and inserting a second spring into the spring chamber such that a force due to the second spring acts on the spring abutment member to retain the spring abutment member in position within the spring chamber.

[0008] The method may include the further step of inserting an insert member into the spring chamber such that a surface of the insert member is in abutment with the closed end of the spring chamber.

[0009] The invention also relates to a spring abutment member for use in such an injector.

[0010] The invention will further be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional view of a fuel injector in accordance with an embodiment of the invention;

Figure 2 is an enlargement of Figure 1; and

Figure 3 is a sectional view of the spring abutment member of the injector of Figure 1.

[0011] The fuel injector illustrated in Figure 1 comprises a nozzle body 10 having a blind bore 11 formed therein. A needle 12 is slidable within the blind bore 11, the needle 12 being shaped to engage a seating defined adjacent the blind end of the bore 11 to control communication between a delivery chamber 13 defined between the needle 12 and the bore 11 located upstream of the seating and a plurality of outlet openings which communicate with the bore 11 downstream of the seating. The needle 11 includes a region of diameter substantially equal to the diameter of the adjacent part of the bore 11, this part of the needle 12 cooperating with the bore 11 to guide the needle 12 for sliding movement within the bore 11.

[0012] The nozzle body 10 is secured to a nozzle holder 14 by means of a cap nut 15. The nozzle holder 14 is provided with drillings which form a supply passage whereby fuel is supplied, in use, to the bore 11 and delivery chamber 13. The fuel supplied to the delivery chamber 13 acts upon angled thrust surfaces including surface 12a of the needle 12 applying a force to the needle 12 urging the needle 12 away from its seating.

[0013] The needle 12 is spring biased towards its seating by means of a spring arrangement located within a spring chamber 17 defined by a blind bore formed in the nozzle holder 14. The spring arrangement includes a first spring 18 located adjacent the blind end of the spring chamber 17. The first spring 18 engages a spring abutment member 19 carried by an extension 12b of the needle 12. The first spring 18 further engages a shim 20 which in turn engages an insert member 21 located at the blind end of the spring chamber 17. It will be appreciated that the magnitude of the load applied by the first spring 18 to the needle 12 urging the needle 12 towards its seating is dependent upon

the nature of the spring 18 and the size of the shim 20. The insert member 21 may, of course, be omitted if desired.

[0014] The spring chamber 17 further houses a second spring 22 which is engaged between a moveable stop member 23 and a shim 24 which engages a tubular spring abutment member 25. The tubular spring abutment member 25 is conveniently formed using a deep drawing technique. As illustrated most clearly in Figure 3, the tubular spring abutment member 25 is, for the most part, of thin walled form, and is provided at its end closest to the seating with an inwardly extending flange 25a having an inwardly turned lip 25b provided at its inner periphery. The tubular spring abutment member 25 is located within the spring chamber 17 such that the end of the spring abutment member 25 remote from the flange 25a is located at the blind end of the spring chamber 17 such that the spring load applied to the tubular spring abutment member 25 by the second spring 22 is transmitted to the nozzle holder 14 at the blind end of the spring chamber 17.

[0015] The moveable stop member 23 is provided with a passage through which the extension 12b extends. As illustrated in Figure 1, the extension 12b is of reduced diameter compared to the part of the needle 12 which guides the needle 12 for sliding movement, these parts of the needle defining a step or shoulder which is engageable with the moveable stop member 23 upon movement of the needle 12 beyond a predetermined distance. Prior to engagement of the needle 12 with the moveable stop member 23, the moveable stop member 23 is urged by the second spring 22 towards a rest position in which it engages the upper end surface of the nozzle body 10. The moveable stop member 23 is provided with a plurality of radially extending arms or projecting regions which are engageable with stop surfaces 17a associated with the spring chamber 17 to limit the distance through which the moveable stop member 23 and hence the needle 12 are moveable.

[0016] In use, the supply passage 16 is connected to any suitable source of fuel under high pressure, for example, to an output of a rotary distributor pump. Where a rotary distributor pump is used, the pump is arranged such that, when fuel injection is not to take place, the supply passage 16 contains fuel at a relatively low pressure. Similarly, the fuel pressure within the delivery chamber 13 is relatively low, thus the magnitude of the force applied to the needle 12 urging the needle 12 away from its seating is low, and the needle 12 is retained in engagement with its seating by the first spring 18. The shoulder of the needle 12 is spaced from the moveable stop member 23, thus the second spring 22 plays no part in holding the needle 12 in engagement with its seating.

[0017] When fuel injection is to commence, fuel under pressure is applied to the supply passage 16. As a result, the fuel pressure within the delivery chamber 13 will rise and a point will be reached beyond which the needle 12 is able to lift away from its seating against the action of the first spring 18. The movement of the needle 12 continues until the shoulder of the needle 12 moves into engagement with the moveable stop member 23. The movement of the needle 12 out of engagement with its seating permits fuel to flow from the delivery chamber 13 to the outlet openings, thus injection of fuel takes place. The distance moved by the needle 12 is small and the rate at which fuel is delivered is low as the small clearance between the needle 12 and its seating throttles fuel delivery.

[0018] Once the shoulder of the needle 12 has moved into engagement with the moveable stop member 23, it will be appreciated that the magnitude of the force acting against the action of the fuel under pressure within the delivery chamber 13 rises. As a result, the movement of the needle 12 ceases.

[0019] The rate at which fuel is delivered by the injector is relatively low compared to the rate at which fuel is supplied towards the delivery chamber 13, and the fuel pressure within the delivery chamber 13 will rise. As a result, the force urging the needle 12 away from its seating will rise, and a point will be reached beyond which the needle 12 is able to move against the combined action of the first and second springs 18, 22, the needle 12 lifting the moveable stop member 23 out of engagement with the nozzle body 10, the movement of the needle 12 continuing until the moveable stop member 23 abuts the stop surfaces 17a. The movement of the needle 12 by this further distance allows fuel to flow to the outlet openings at an increased rate, thus fuel injection takes place at a higher rate.

[0020] In order to terminate injection, the fuel pressure within the supply passage 16 and delivery chamber 13 is reduced, the needle 12 returning into engagement with its seating under the action of the first and second springs 18, 22.

[0021] It will be appreciated that as the needle 12 moves, the volume of the spring chamber 17 available for occupation by fuel or other fluid varies, and in order to ensure that the needle 12 does not become hydraulically locked in its closed position, the spring chamber 17 is vented through a passage formed in the member 21 and a passage 26 to a low pressure fluid reservoir.

[0022] As the spring abutment member 25 is in the form of a tube located within the spring chamber 17 and engaged with the blind end of the spring chamber 17, it will be appreciated that the assembly process for the injector does not include a step of deforming the nozzle holder to secure the spring abutment member in position. As the nozzle holder 14 is not deformed in this manner, should it be necessary to disassemble the fuel injector, then the spring abutment member 25 can be removed from the injector. It has been found that the tubular spring abutment member 25 is able to withstand the load applied by the second spring 22 without buckling or otherwise deforming. As illustrated in Figure 1, in order to accommodate the tubular spring abutment

member 25, the first spring 18 is of slightly reduced diameter compared to the second spring 22, the first spring 18 being located within the tubular spring abutment member 25. The tubular spring abutment member 25 is held in position within the spring chamber 17, in use, by the action of the second spring 22, and no operation is necessary during the assembly process to secure the spring abutment member 25 in position.

[0023] The operation of the injector where fuel sources other than a rotary fuel pump are used is similar to that described hereinbefore and so will not be described in further detail.

Claims

1. A fuel injector comprising a valve needle (12) biased towards a seating by a first spring (18), the first spring (18) being located within a spring chamber (17) having a closed end, the valve needle (12) being engageable with a moveable stop member (23) biased towards a rest position by a second spring (22) located within the spring chamber (17), the fuel injector further comprising a spring abutment member (25) for the second spring (22), the spring abutment member (25) being of tubular form and transmitting the spring load of the second spring (22) to the closed end of the spring chamber (17).

2. A fuel injector according to Claim 1, wherein the spring abutment member (25) includes an inwardly extending flange (25a) at one end thereof.

3. A fuel injector according to Claim 2 ,wherein the spring abutment member (25) is located within the spring chamber (17) such that the end of the spring abutment member (25) remote from the flange (25a) is located at the closed end of the spring chamber (17).

4. A fuel injector according to Claim 2 or Claim 3 wherein the inwardly extending flange (25a) has an inwardly turned lip (25b) at its inner periphery.

5. A fuel injector according to any of Claims 1 to 4, wherein an insert member (21) is received within the spring chamber (17), a surface of the insert member being in abutment with the closed end of the spring chamber (17), the insert member (21) being interposed between the closed end of the spring chamber (17) and the first spring (18).

6. A fuel injector according to any of Claims 1 to 5, wherein the first spring (18) has a diameter less than the diameter of the second spring (22) so as to permit accommodation of the spring abutment member (25) within the spring chamber (17).

7. A fuel injector according to any of Claims 1 to 6, wherein the valve needle (12) comprises a first region (12a) and an extension region (12b), the extension region (12b) being of reduced diameter compared to the first region (12a) so as to define a step.

8. A fuel injector according to Claim 7, wherein the movable stop member (23) is provided with a passage through which the extension region of the needle (12b) extends such that the step is engageable with the movable stop member (23).

9. A fuel injector according to Claim 8 or Claim 9 wherein the moveable stop member (23) is provided with a plurality of radially projecting regions which are engageable with one or more stop surfaces associated with the spring chamber (17) to limit the distance through which the stop member (23) is moveable.

10. A fuel injector according to any of the preceding claims wherein the spring chamber (17) is provided with vent means (26) for permitting fluid within the spring chamber (17) to escape to a low pressure fluid reservoir.

11. A spring abutment member (25) for use in a fuel injector as claimed in any of Claims 1 to 10.

12. A method of assembling a fuel injector comprising a spring chamber (17) for receiving first and second springs (18, 22), the spring chamber (17) having a closed end associated therewith, the method comprising the steps of;

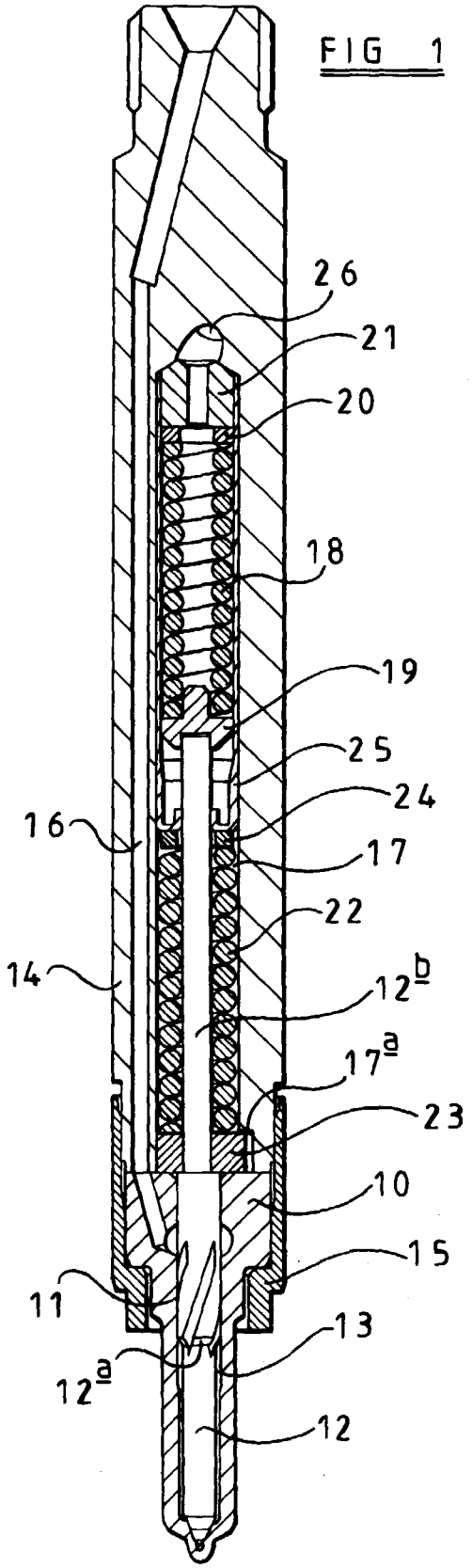
    inserting the first spring (18) into a spring abutment member (25) of tubular form;

    inserting the spring abutment member (25) and the first spring (18) into the spring chamber (17) such that an end of the spring abutment member (25) engages the closed end of the spring chamber (17); and

    inserting a second spring (22) into the spring chamber (17) such that a force due to the second spring (17) acts on the spring abutment member (25) to retain the spring abutment member (25) in position within the spring chamber (17).

13. The method according to Claim 12, including the further step of inserting an insert member (21) into the spring chamber (17) such that a surface of the insert member (21) is in abutment with the closed end of the spring chamber (17).

FIG 1



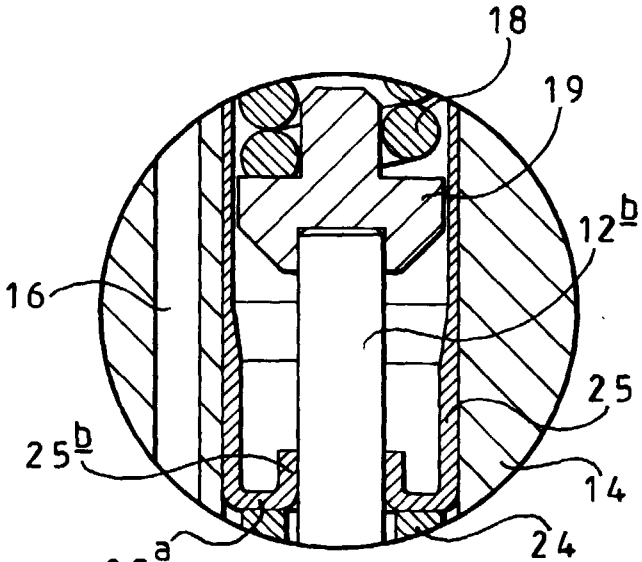


FIG 2

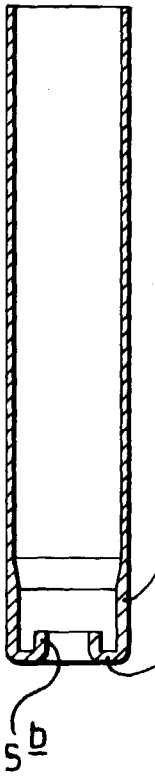


FIG 3