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

(72) Inventor: **Green, Alan**
Maidstone
Kent ME14 2BA (GB)

(74) Representative: **Gregory, John David Charles**
Delphi Diesel Systems
Patent Department
Courteney Road
Gillingham
Kent ME8 0RU (GB)

(54) **Fuel injectors and method of installing fuel injectors to an engine**

(57) A fuel injector (10) has an injector body (12) having a leading end (16), a trailing end (20), a fuel inlet passage (30) and a backleak passage (22) and a fitting (14) that fits onto said injector body at a position remote from the leading end. A chamber (60) for receiving fuel from the backleak passage is defined between the injector body and the fitting.

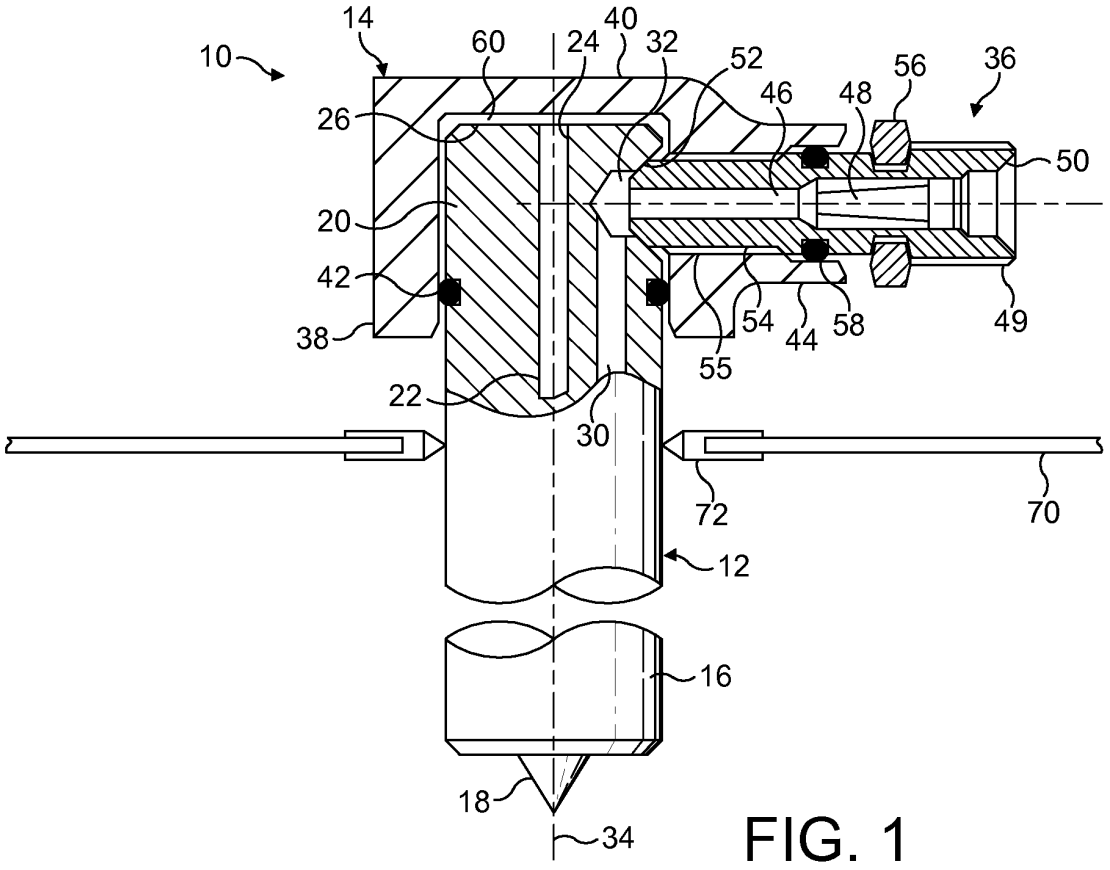

FIG. 1

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Description

Field of the Invention

[0001] The invention relates to fuel injectors and installing fuel injectors to an engine.

Background to the Invention

[0002] Conventional fuel injectors have an axially extending threaded connection at their trailing end for attachment to a high pressure fuel delivery pipe. The minimum bend radius permitted in this pipe can cause installation problems and limits the height of the assembly.

[0003] It is known to provide fuel injectors which have an injector body provided with an entry projecting from the side of the injector body for connection to the high pressure fuel delivery pipe. This arrangement avoids, or at least reduces, the height problem. However, such side entry fuel injectors give rise to problems where an engine top cover is to be installed over the installed injector. Specifically, such covers include an aperture to allow the cover to be installed over the fuel injector and the aperture is fitted with an aperture seal. If such a cover is fitted over an installed side entry injector, the aperture seal may be damaged or destroyed. If the side entry is not perpendicular to the injector body, it may be possible to avoid this problem by removing the seal prior to installing the engine cover and subsequently fitting and adjusting the seal. However, this increases the installation work required and if the angle of the side inlet is made steeper relative to the injector body to make it easier to install the engine cover, the height reduction benefit obtained by having a side entry is reduced.

Summary of the Invention

[0004] The invention provides a fuel injector comprising an injector body having a leading end, a trailing end, a fuel inlet passage and a backleak passage and a fitting that fits onto said injector body at a position remote from said leading end to define therebetween a chamber for receiving fuel from said backleak passage. The fuel inlet passage has an inlet end defined in a sidewall of said injector body and said fitting comprises an opening through which, in use, fuel is supplied to said fuel inlet passage. The fuel injector further comprises an inlet connector having a fuel delivery passage, the inlet connector being securable to said fitting such that it extends through said opening to engage the fuel inlet passage such that fuel can pass from said fuel delivery passage into said fuel inlet passage.

[0005] Preferably the fitting comprises a cap that fits over said trailing end of the injector body. Also, the cap may be substantially flat to minimise the axial height of the fuel injector. The chamber may be defined between the cap and a transverse end face of the trailing end of the injector body.

[0006] In order that the leaked fuel can be circulated back to the fuel system, preferably the fitting comprises an outlet that is connectable to a backleak return pipe that is in communication with the chamber. For convenient fitting, the outlet may comprise a projection for sealingly engaging a flexible backleak return pipe by push-fitting.

[0007] In order for the fitting to be secured to the injector body, the inlet connector may have a leading end that is engageable in a complementary formation of the injector body (for example a male/female thread connection) when the inlet connector is secured to the fitting. Such an arrangement substantially prevents relative movement between the fitting and the injector body. Moreover, such an arrangement avoids the need to secure the fitting directly to the injector body which would be a more complex and costly assembly to manufacture. In addition, such an arrangement avoids any damage that may occur to an injector body formed with a threaded connection.

[0008] Preferably the opening in the fitting defines a through-passage that extends through a tubular projection extending from a side-wall of the fitting.

[0009] In a second aspect, the invention extends to an internal combustion engine fitted with a fuel injector as defined above.

[0010] In a third aspect, the invention also includes a method of installing a fuel injector to an engine, the method comprising fitting a leading end of a fuel injector body into an inlet port of an engine, securing a cover to the engine over a trailing end of the injector body such that said trailing end projects through an aperture in the cover, installing a fitting onto the injector body externally of the engine cover and such that a chamber is defined between the injector body and the fitting for receiving backleak fuel from a backleak passage provided in the injector body.

[0011] For convenience of assembly, the fitting is installed on the injector body by pushing the fitting onto the trailing end of the injector body. The fitting may be in the form of a cap such that, when installed, the chamber is installed between a transverse end wall of the injector body and an opposing wall of the cap.

[0012] It should be appreciated that preferred and/or optional features of the first aspect of the invention can be combined with the second and third aspects of the invention, and vice-versa.

Brief Description of the Drawings

[0013] In order that the invention may be well understood, some embodiments thereof, which are given by way of example only, will now be described with reference to the drawings in which:

Figure 1 is a partial cross-sectional view of a fuel injector installed in an engine top cover looking in the direction of the arrows I in Figure 2; and

Figure 2 is a plan view of the fuel injector looking from above as viewed in Figure 1.

Detailed Description of the Embodiments

[0014] Referring to Figures 1 and 2, a fuel injector 10 comprises an injector body 12 and a fitting in the form of a cap 14 that fits onto the injector body. The injector body 12 is essentially a plain cylinder and has a leading end 16 fitted with a nozzle indicated schematically at 18 and a trailing end 20 on which the cap 14 is fitted. The leading end 16 of the injector body and nozzle components may be of any suitable known type and may include features to assist with fitting and sealing in a port of an engine.

[0015] The injector body 12 is provided with a backleak passage 22 that extends from an inlet end (not shown) to an outlet end 24 that is located in a transverse end surface 26 of the injector body. The injector body 12 is additionally provided with a fuel inlet passage 30 that extends in the lengthways direction of the injector body parallel to the axis 34 of the injector body. The fuel inlet passage 30 serves to deliver high pressure fuel to the leading end 16 of the injector body for supply to an engine via the nozzle 18. The fuel inlet passage 30 has an inlet end 32 defined by a cross drilling that extends perpendicular to the axis 34 of the injector body 12 through the side of the injector body. The inlet end 32 of the fuel inlet passage includes a conical sealing surface for mating with an inlet connector 36.

[0016] The cap 14 is a metal part comprising a generally cylindrical body 38 having a side wall that depends down and around the upper part of the trailing end of the injector body 12 and is closed at one end by a transverse wall 40. The cap 14 is sized to be a clearance fit over the trailing end 20 of the injector body 12. The injector body 12 is provided with a groove in which an O-ring 42 is seated for sealing against the inside of the cylindrical body 38. The cap 14 is provided with a generally tubular extension 44 that is formed integrally with the cylindrical body 38 and projects from the body substantially perpendicular to the axis of the body. The tubular extension 44 defines an opening in the cap 14 through which fuel is supplied to the inlet end 32 of the fuel inlet passage 30.

[0017] The inlet connector 36 is a generally cylindrical body provided with an axially extending fuel delivery passage 46 that is made up of a series of drillings. Those drillings may include one that is sized to receive an edge filter 48. The drilling at the upstream end of the fuel delivery passage 46 provides a conical surface 50 for sealingly engaging a suitably shaped end of a high pressure fuel delivery pipe (not shown). At the same end, the inlet connector 36 is provided with external threading 49 by means of which a union nut can be used to couple the high pressure fuel delivery pipe to the inlet connector.

[0018] The leading end of the inlet connector 36 has a conical surface 52 that leads into an externally threaded portion 54 that engages an internal threading 55 provided at the inner end of the tubular extension 44 of the cap 14. A hexagonal formation 56 is provided on the inlet connector 36 so that it can be firmly secured to the cap 14 by screwing the threading 54 into the internal threading 55 of the tubular extension 44. The conical surface 52 is shaped to complement the conical sealing surface of the inlet end 32 of the fuel inlet passage 30 so that when the inlet connector 36 is screwed into position in the tubular extension, the two surfaces mate to form a seal between the inlet connector and the injector body 12. The engagement between the two conical surfaces additionally fixes the cap 14 to the injector body 12 so that relative movement between the two parts is substantially prevented.

[0019] It should be appreciated that the cap 14 takes the form of a unitary component that secures the inlet connector 36 to the injector body 12 and also provides a chamber for the collection of leakage fuel. Furthermore, since the inlet connector 36 is provided with the threading 54 that screws into the threading 56 of the cap 14, a threaded engagement is not required between the cap 14 and the injector body 12. Beneficially, therefore, the injector body 12 is manufactured more cost effectively and is less prone to damage during maintenance actions.

[0020] An O-ring 58 is provided inside the tubular extension 44 adjacent the free end of the tubular extension to seal between the tubular extension and the inlet connector 36.

[0021] When the cap 14 is secured in place on the free end 20 of the injector body 12, the transverse wall 40 is disposed opposite and apart from the transverse end surface 26 of the injector body to define a backleak vent chamber 60 therebetween in which fuel from the backleak passage 22 is received. It should be appreciated that the transverse wall 40 is preferably substantially flat, as shown in Figure 1, to minimise the axial height of the injector.

[0022] The cap 14 is provided with an outlet connection 62 for connection to a backleak return pipe (not shown). In the embodiment, the outlet connection 62 is a push-fit connector on which a backleak return pipe can sealingly engage by push-fitting, although alternative connections (such as, for example, a screwed fitting) can be used. The outlet connection 62 is in fluid communication with the back leak vent chamber 60 so that backleak fuel from the chamber can flow into the backleak return pipe for return to a low pressure fuel reservoir.

[0023] In use, the injector assembly 10 is fitted to an engine (not shown) by first fitting the leading end 16 of the injector body 12 (without the cap 14 and inlet connector 36) into an inlet port in the engine cylinder head. An engine top cover 70 is then fitted over the injector body 12 onto a cover seat provided on the engine such that the trailing end 20 of the injector body projects through an aperture provided in the engine top cover (in practice a multi-cylinder engine will have a plurality of injector bodies fitted in respective inlet ports and the engine top cover will have respective apertures for the injectors). The engine top cover 70 is provided with a seal-

ing element 72 around the aperture, which sealingly engages the injector body 12.

[0024] Once the engine top cover 70 is secured in place, the cap 14 is fitted onto the trailing end 20 of the injector body 12 bringing the cylindrical portion 38 of the cap into engagement with the O-ring 42 provided on the injector body. It is preferred that prior to fitting the cap 14 the tubular extension 44 is at least roughly aligned with the inlet end 32 of the fuel inlet passage 30. The inlet connector 36 is then inserted into the tubular extension 44 of the cap 14 and rotated to bring the threading 54 into engagement with the internal threading 55 of the tubular extension. When the conical surface 52 of the inlet connector 36 starts to engage the conical sealing surface of the inlet end 32 of the fuel inlet passage 30, any misalignment will be corrected automatically and the inlet connector can be screwed firmly into position by means of a spanner applied to the hexagonal formation 56. If the tubular extension 44 is not well aligned with the inlet end 32 of the fuel inlet passage 30 when the leading end of the inlet connector 36 is screwed in, the cap 14 can be rotated relative to the injector body 12 until the conical surface 52 is felt to engage in the conical sealing surface of the inlet end. Once the inlet connector 36 is firmly screwed into position, relative movement between the cap 14 and injector body 12 is substantially prevented and the backleak vent chamber 60 is sealed against leakage between the cap and injector body by the O-rings 42, 58.

[0025] To complete the fitting process, a high pressure fuel delivery pipe (not shown) is secured to the inlet connector 36 by pressing the end of the pipe into the conical surface 50 and threading a union nut onto the threading 49. Additionally, a backleak pipe (not shown) is push-fitted onto the outlet connection 62.

[0026] It will be appreciated that the embodiment provides a side entry fuel injector 10 that can easily be installed to an engine fitted with an engine top cover 70. Since the injector body 12 can be installed separately from the cap 14 and inlet connector 36 and is simply a generally cylindrical body, it is relatively easy to fit the engine top cover over the installed injector body without the risk of damaging or destroying the engine top cover aperture seal 72. The cap 14 and inlet connector 36 can easily be fitted to the injector body 12 once the engine top cover is installed. Thus the advantages of height reduction available when side entry fuel injectors are used can be readily obtained even when an engine top cover has to be installed over the fuel injectors.

[0027] Although it is preferred that the fuel injector 10 is configured as a side entry fuel injector, it could be modified to provide the high pressure fuel supply axially. With this configuration, use of the fitting 14 to define a back leak vent chamber and provide an outlet for connection to a backleak return pipe provides potential advantages in the provision of the backleak return path that is simple and easily assembled.

[0028] It will be appreciated that the backleak vent chamber 60 does not have to be provided between the transverse end 26 of the injector body 12 and the top wall 40 of the fitting 40. Instead, a fitting could be provided with a suitably positioned recess such that the backleak vent chamber is defined between the fitting and a sidewall of the injector body.

[0029] It will be appreciated that the position of the outlet connection of the fitting can be selected to accord with a particular engine to which it is to be installed so as to provide optimum routing of the backleak return. One alternative position for the outlet connection is indicated by dashed lines in Figure 2.

[0030] It is envisaged that the fitting will be made of a suitable metal, for example steel. However, it might also be made of a non-metallic material that have the required properties such as ceramics or suitable engineering plastics.

Claims

1. A fuel injector (10) comprising an injector body (12) having a leading end (16), a trailing end (20), a fuel inlet passage (30), a backleak passage (22) and a fitting (14) that fits onto said injector body at a position remote from said leading end to define therebetween a chamber (60) for receiving fuel from said backleak passage, wherein said fuel inlet passage (30) has an inlet end (32) defined in a sidewall of said injector body and said fitting (14) comprises an opening through which, in use, fuel is supplied to said fuel inlet passage (30), the fuel injector further comprising an inlet connector (36) having a fuel delivery passage (46), the inlet connector (36) being securable to said fitting (14) such that it extends through said opening to engage the fuel inlet passage (30) such that fuel can pass from said fuel delivery passage into said fuel inlet passage (30).

2. A fuel injector as claimed in claim 1, wherein said fitting comprises a cap (14) that fits over said trailing end of the injector body.

3. A fuel injector as claimed in claim 2, wherein said chamber (60) is defined between said cap (14) and a transverse end surface (26) of said trailing end (20) of the injector body (12).

4. A fuel injector as claimed in any one of the preceding claims, wherein said fitting (14) comprises an outlet (62) that is connectable to a backleak return pipe and in flow communication with said chamber (60).

5. A fuel injector as claimed in claim 4, wherein said outlet comprises a projection (62) for sealingly engaging a flexible backleak return pipe by push-fitting.

6. A fuel injector as claimed in any one of the preceding

claims, wherein said inlet connector (36) has a leading end (52) engageable in a complementary formation of said injector body (12) when the inlet connector is secured to the fitting (14) such that relative movement between the fitting and injector body is substantially prevented.

7. A fuel injector as claimed in any one of the preceding claims, wherein the inlet connector (36) comprises a trailing end (49) that, in use, projects from said fitting (14) and is configured for connection to a fuel delivery device.

8. A fuel injector as claimed in any one of the preceding claims, wherein said opening in the fitting (14) comprises a through-passage that extends through a tubular projection (44) that extends from a sidewall (38) of said fitting (14).

9. An internal combustion engine fitted with a fuel injector as claimed in any one of the preceding claims.

10. An internal combustion engine as claimed in claim 9, wherein said engine is fitted with a cover and said trailing end of the injector body (12) and said fitting (14) are disposed externally of said cover.

11. A method of installing a fuel injector (10) to an engine, the method comprising fitting a leading end (16) of a fuel injector body (12) into an inlet port of an engine, securing a cover (70) to the engine over a trailing end (20) of the injector body such that said trailing end projects through an aperture in the cover, installing a fitting (14) onto the injector body externally of the engine cover and such that the fitting sealingly engages the injector body and a chamber (60) is defined between the injector body and the fitting for receiving backleak fuel from a backleak passage (22) provided in the injector body.

12. A method of installing a fuel injector to an engine as claimed in claim 11, wherein the fitting is a cap (14) and when installed, said chamber (60) is defined between a transverse end wall (26) of the injector body and an opposing wall (40) of the cap.

13. A method of installing a fuel injector to an engine as claimed in claim 11 or claim 12, comprising fitting a backleak return pipe to an outlet connection (62) of said fitting (14) that is in fluid communication with said chamber such that backleak fuel from the fuel injector can flow to a reservoir via said backleak return pipe.

14. A method of installing a fuel injector to an engine as claimed in any of claims 11 to 13, comprising securing an inlet connector (36) into an opening provided in said fitting (14) to secure the fitting to the injector body (12), said inlet connector comprising a through-passage (46) through which fuel can be supplied to an inlet end (32) of the fuel inlet passage (30).

15. A method of installing a fuel injector to an engine as claimed in claim 14, comprising inserting said inlet connector (36) into said opening in a direction generally perpendicular to a longitudinal axis (34) of the injector body (12).

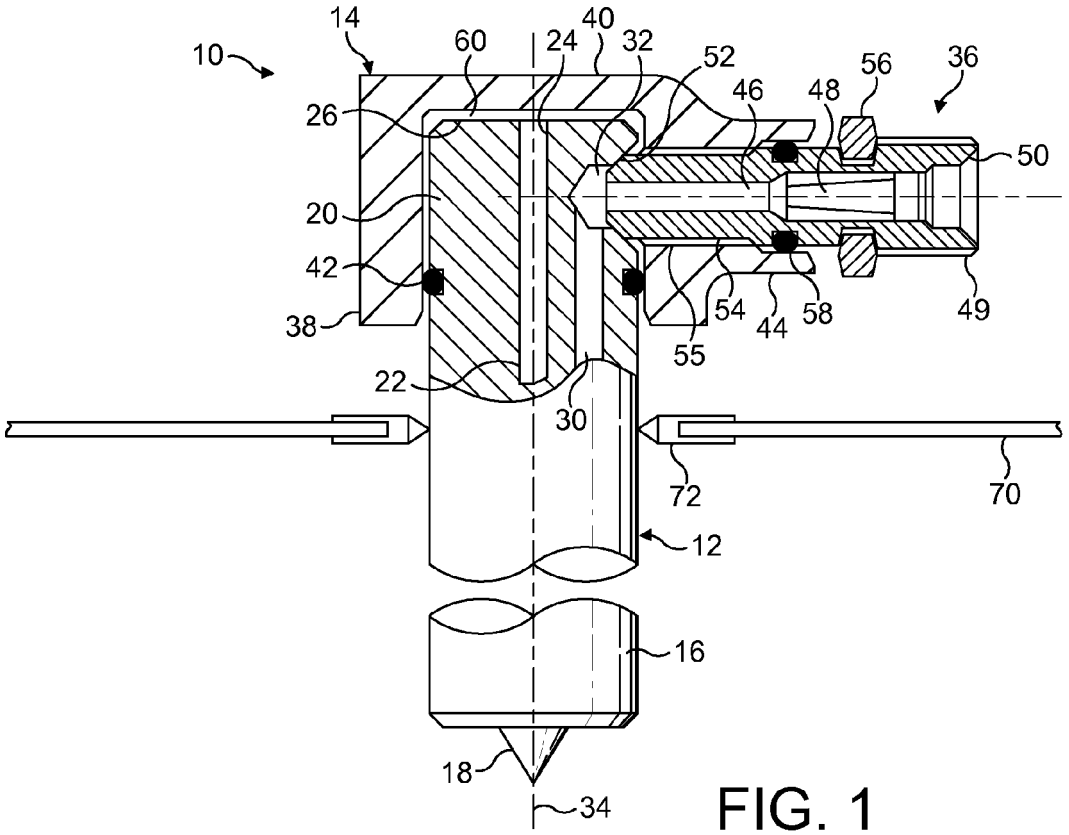
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FIG. 1

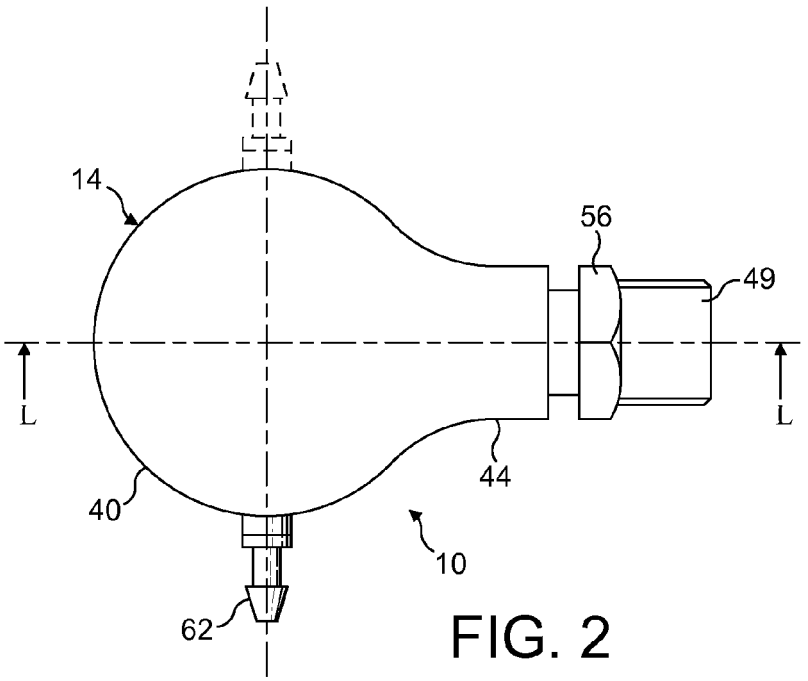
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FIG. 2