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(54) Injector tip seal

(57) Fuel injector (10) for direct injection in an internal combustion engine, the fuel injector (10) being designed to be inserted into a mounting bore (14) of a cylinder head (12) which opens into a combustion chamber (16), said fuel injector (10) having an injector body (18) which ends with a tip portion (20) provided with a nozzle (22), characterized by said tip portion (20) being provided with at least one tip seal (38) comprising a ring shaped body formed of metallic wire mesh, said tip seal (38) being able to close the annular gap between the tip portion (20) and the mounting bore wall (40) in view to dissipate thermal energy from the tip portion (20) to the cylinder head (12), and said tip seal (38) being elastically flexible in order to allow radial compression of the tip seal (38) during mounting and dismounting operations of the fuel injector (10) in the mounting bore (14).

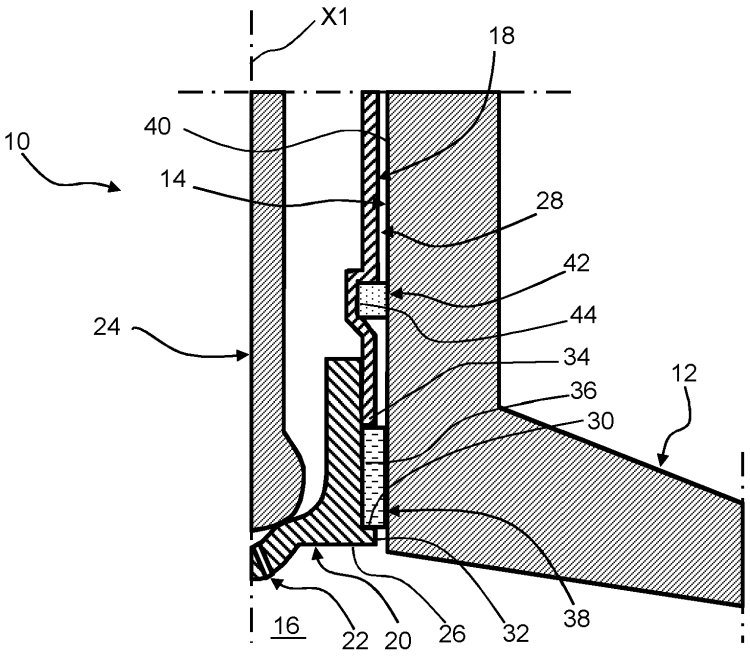

Figure 1

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to a fuel injector and a tip seal for sealing an annular clearance gap between the fuel injector and a mounting bore therefor.

BACKGROUND OF THE INVENTION

[0002] A direct injection engine has adopted a configuration in which a fuel injector is mounted into a mounting hole in a cylinder head, and fuel is injected directly into a cylinder from a nozzle at the tip of this fuel injector. Accordingly, it is required to prevent leakage of combustion gas at high pressure from an annular clearance gap between the fuel injector body and the mounting bore wall.

[0003] A structure in which an annular groove is provided on an outer peripheral surface of the fuel injector body, and a rubber or resin seal ring is installed into the annular groove has been known as a sealing structure against the leakage. Various alternative embodiments have also been proposed, especially a seal of resin such as PTFE (polytetrafluoroethylene).

[0004] However, new requirements are to be faced in an engine with two separate fuel systems, one being a GDi system (Gasoline Direct injection), the other being a PFi system (Port Fuel injection). Various strategies can be implemented with this type of engine.

[0005] A first strategy is to combine the highly efficient GDi fuel injection with an alternative to operate the vehicle with a PFi based CNG system (Compressed Natural Gas). It allows to benefit from low CNG operating cost and also its significant CO2 emission advantage, yet at the same time not be disadvantaged by the not fully developed infrastructure for CNG filling stations and therefore to have a liquid fuel GDi system as a back-up.

[0006] A second strategy is with both GDi and PFi systems operating with the same liquid fuel. The benefit here is to operate the engine in PFi mode in conditions in which GDi operation would result in high particulate number emissions. This is an approach to meet requirements for Euro 6/7 in regard to particulate number emission regulation.

[0007] At a more advanced stage, a third strategy is to use injectors for direct injection with CNG and some other PFi fuel systems.

[0008] For all these strategies, the engine operates for long durations without actuating the injector for direct injection (GDi/CNG). The result is that the inner cooling of the injector tip, normally provided by the fuel injected, is not happening any more. This causes injector tip temperature to be significantly higher when the GDi injector is disabled (up to 500°C) than in normal operation (up to 250°C).

[0009] Because of the higher temperatures reached, standard tip seals are no more convenient for this type of applications. Particularly, PTFE seals tend to quickly deteriorate when injector tip temperature is above 300°C.

SUMMARY OF THE INVENTION

[0010] The present invention aims at solving the above mentioned problem. For this purpose, it is proposed an injector tip seal comprising a ring shaped body formed of metallic wire mesh in view to provide high thermal conductivity and radial elasticity.

[0011] The present invention also proposes a fuel injector for direct injection in an internal combustion engine, the fuel injector being designed to be inserted into a mounting bore of a cylinder head which opens into a combustion chamber, said fuel injector having an injector body which ends with a tip portion provided with a nozzle, characterized by said tip portion being provided with at least one tip seal according to claim 1, said tip seal being able to close the annular gap between the tip portion and the mounting bore wall in view to dissipate thermal energy from the tip portion to the cylinder head, and said tip seal being elastically flexible in order to allow radial compression of the tip ring during mounting and dismounting operations of the fuel injector in the mounting bore.

[0012] Thanks to the tip seal of the invention, the injector tip portion can dissipate thermal energy through the wire mesh towards the cylinder head, which prevents deterioration of the injector even when the injector is not used for long periods of time, another injection system being used instead for these periods of time.

[0013] The tip seal of the invention allows arrangement of another sealing element, above the tip seal, which is protected from high-temperature combustion gas and so can be manufactured as a standard PTFE seal for example.

[0014] Thanks to the particular structure and material of the tip seal of the invention, installation and maintenance efficiency is maintained because of the radial elasticity and compressibility.

[0015] Advantageously, at least one annular sealing element is mounted on the outer peripheral wall of the injector body in order to be able to close the annular gap between the injector body and the mounting bore wall, said annular sealing element being protected from high temperatures in the combustion chamber by said tip seal.

[0016] According to an advantageous feature, said tip portion is provided with at least one annular shoulder for axially retaining the tip seal on the tip portion.

[0017] According to another advantageous feature, said injector body comprises an outer sleeve which is assembled to the injector tip portion, said tip seal being located between the free end of the tip portion and the proximal end of the outer sleeve.

[0018] It is also provided an arrangement of a fuel injector in the mounting bore of the cylinder head of a direct injection internal combustion engine, characterized by said fuel injector having at least one of the previous fea-

tures, the tip seal being in radial contact with the tip portion and with the mounting bore wall in order to transfer heat from the tip portion to the cylinder head.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention is now described by way of example with reference to the accompanying drawings in which:

- figure 1 is a partial cross-section view showing schematically the arrangement of an injector in a cylinder head according to a preferred embodiment of the invention;
- figure 2 is a perspective view showing schematically the tip seal provided on the injector of figure 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] An in-cylinder fuel injector 10 according to a preferred embodiment of the present invention will now be described with reference to figure 1. The in-cylinder is applied to an in-cylinder type gasoline engine.

[0021] An internal combustion engine (gasoline engine) is mainly composed of a cylinder block (not shown) and a cylinder head 12. The cylinder head 12 has, near its intake port (not shown), a mounting bore 14 which extends into a combustion chamber 16 along a main axis X1.

[0022] In the following description, the main axis X1 will be orientated vertically from the bottom to the top, which corresponds to the orientation of figure 1, without limiting purpose.

[0023] It has to be noted that figure 1 shows only the lower half portion of the injector 10.

[0024] The fuel injector body 18 is axially inserted into the mounting bore 14, the tip portion 20 of the fuel injector 10, which comprises a nozzle 22, extending into the combustion chamber 16.

[0025] The fuel injector 10 comprises a pintle 24 which is axially movable in the injector body 18 in order to control opening and closing of the nozzle 22.

[0026] According to the embodiment shown, the tip portion 20 has a substantially tubular shape closed at the lower end by a transversal wall 26 provided with the nozzle 22. The fuel injector body 18 comprises a tubular sleeve 28, the tip portion 20 being inserted into the lower end of the tubular sleeve 28. The tip portion 20 also has an annular radial shoulder 30 on the peripheral axial surface 32 of the tip portion 20, preferably located as close as possible to the transversal wall 26. The annular radial shoulder 30 delimits with the tip end 34 of the tubular sleeve 28 a recessed groove 36.

[0027] Advantageously, a tip seal 38 is mounted onto the peripheral axial surface 32 of the tip portion 20. The tip seal 38 comprises a ring shaped body formed of metallic wire mesh, as illustrated by figure 2. Preferably, the tip seal 38 is received in the recessed groove 36, its axial length being substantially equal to the axial dimension of the recessed groove 36. Thus the tip seal 38 is retained axially downwardly by the annular radial shoulder 30 and upwardly by the tip end 34 of the tubular sleeve 28.

[0028] Preferably, the tip seal 38 has a substantially rectangular or square cross-section. The wire mesh is made of highly compressed metal mesh in order to have stable dimensions. The metal is selected advantageously among stainless steel, bronze, copper, or corresponding alloy, providing good heat conduction. The wire mesh provides also flexibility thanks to its elasticity in order to close the annular gap between the tip portion 20 and the mounting bore wall 40 without preventing slight tilting of the injector 10, with regards to its main axis X1, during a mounting or dismounting operation of the injector 10 into the mounting bore 14. The flexibility of the wire mesh allows also compensating for annular clearance gap due to manufacturing.

[0029] According to the embodiment shown, an additional annular seal 42 is arranged between the tubular sleeve 28 and the mounting bore wall 40, above the tip portion 20, in an additional recessed groove 44 provided in the tubular sleeve 28. The annular seal 42 enables the injector 10 to be held in the mounting bore 14 while preventing leakage of combustion gas from the combustion chamber 16. The annular seal 42 is preferably made from a fluorocarbon resin, such as a polytetrafluoroethylene (PTFE), or an elastic resin with high heat resistance, such as fluorocarbon rubber.

[0030] The tip seal 38 offers protection to the annular seal 42 against high temperatures and provides increased heat dissipation for the tip portion 20 of the injector 10 thanks to good heat conduction through the wire mesh material of the tip seal 38. The wire mesh allows heat to be transferred from the tip portion 20 to the cylinder head 12.

[0031] In addition to retaining the tip seal 38, the annular shoulder 30 provides additional protection to the tip seal 38 and annular seal 42 by limiting the exposed surfaces of the tip seal 38 and recessed groove 36 to combustion gases.

[0032] The arrangement of the fuel injector 10 according to the invention allows construction of an internal combustion engine wherein an indirect fuel injection system can be used for long periods of time while the direct fuel injector 10 is disabled, and still maintain a high reliability of the direct fuel injector 10 by preventing over heating of the injector tip portion 20. The arrangement of the invention is more robust than previous solutions.

Claims

1. Injector tip seal (38) comprising a ring shaped body formed of metallic wire mesh in view to provide high thermal conductivity and radial elasticity.

2. Fuel injector (10) for direct injection in an internal

combustion engine, the fuel injector (10) being designed to be inserted into a mounting bore (14) of a cylinder head (12) which opens into a combustion chamber (16), said fuel injector (10) having an injector body (18) which ends with a tip portion (20) provided with a nozzle (22), **characterized by** said tip portion (20) being provided with at least one tip seal (38) according to claim 1, said tip seal (38) being able to close the annular gap between the tip portion (20) and the mounting bore wall (40) in view to dissipate thermal energy from the tip portion (20) to the cylinder head (12), and said tip seal (38) being elastically flexible in order to allow radial compression of the tip seal (38) during mounting and dismounting operations of the fuel injector (10) in the mounting bore (14).

3. Fuel injector (10) according to the preceding claim, **characterized by** at least one annular sealing element (42) which is mounted on the outer peripheral wall of the injector body (18) in order to be able to close the annular gap between the injector body (18) and the mounting bore wall (40), said annular sealing element (42) being protected from high temperatures in the combustion chamber (16) by said tip seal (38).

4. Fuel injector (10) according to claim 2 or 3, **characterized by** said tip portion (20) being provided with at least one annular shoulder (30) for axially retaining the tip seal (38) on the tip portion (20).

5. Fuel injector (10) according to anyone of claims 2 to 4, **characterized by** said injector body (18) comprising an outer sleeve (26) which is assembled to the injector tip portion (20), said tip seal (38) being located between the free end of the tip portion (20) and the proximal end (34) of the outer sleeve (26).

6. Arrangement of a fuel injector (10) in the mounting bore (14) of the cylinder head (12) of a direct injection internal combustion engine, **characterized by** said fuel injector (10) being realized according to anyone of claims 2 to 5, the tip seal (38) being in radial contact with the tip portion (20) and with the mounting bore wall (40) in order to transfer heat from the tip portion (20) to the cylinder head (12).

7. Internal combustion engine comprising a direct fuel injector and an indirect fuel injection system, the direct fuel injector being disabled for certain periods of time while the indirect fuel injection system is used, **characterized by** being provided with an arrangement according to the preceding claim.

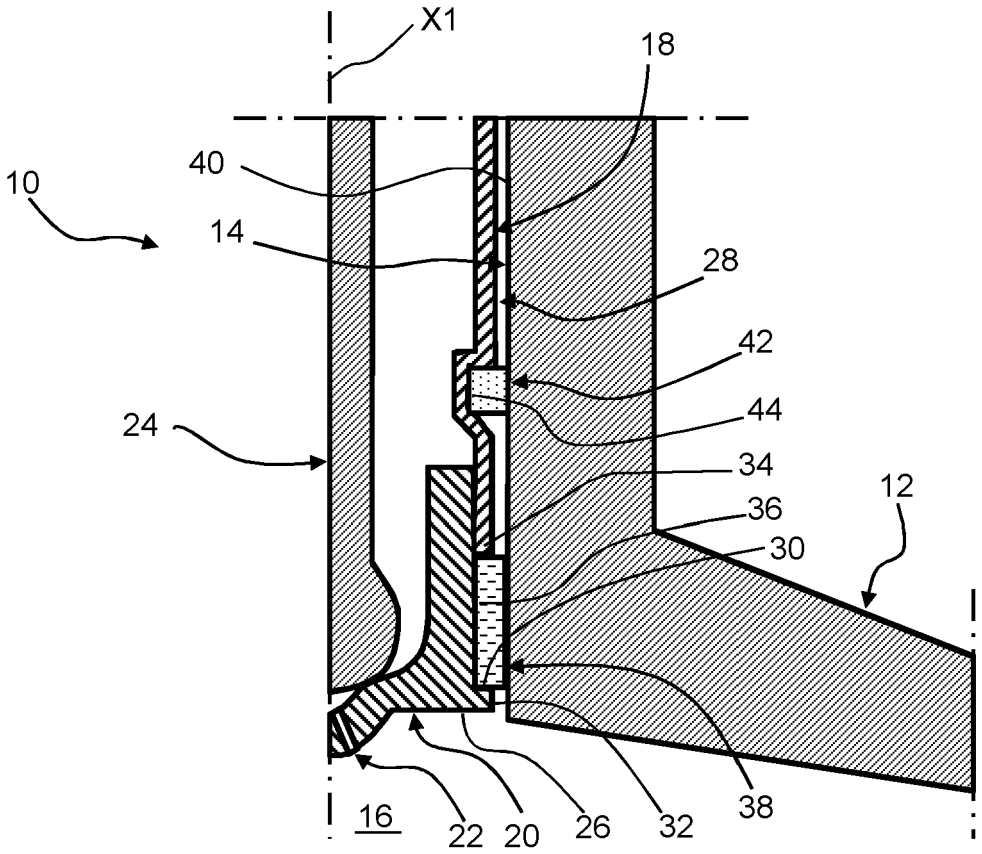

Figure 1

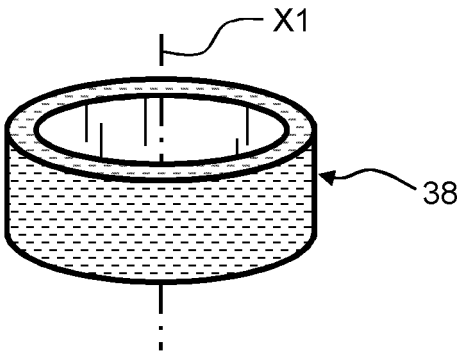

Figure 2

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EUROPEAN SEARCH REPORT

Application Number
EP 12 15 8314

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	FR 2 906 575 A1 (RENAULT SAS [FR]) 4 April 2008 (2008-04-04) * page 1, line 20 - page 2, line 31; figures *	1-7	INV. F02M61/14 F02M53/04 F02M69/04 F16J15/02
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TECHNICAL FIELDS SEARCHED (IPC)

F02M
F16J
F02F
F01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 July 2012	Landriscina, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 15 8314

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82