(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 301 293 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.04.2018 Bulletin 2018/14

(51) Int Cl.:
F02M 51/00 *(2006.01)* ***F02M 61/10*** *(2006.01)*
F02M 61/14 *(2006.01)* ***F02M 61/16*** *(2006.01)*

(21) Application number: **16191686.1**

(22) Date of filing: **30.09.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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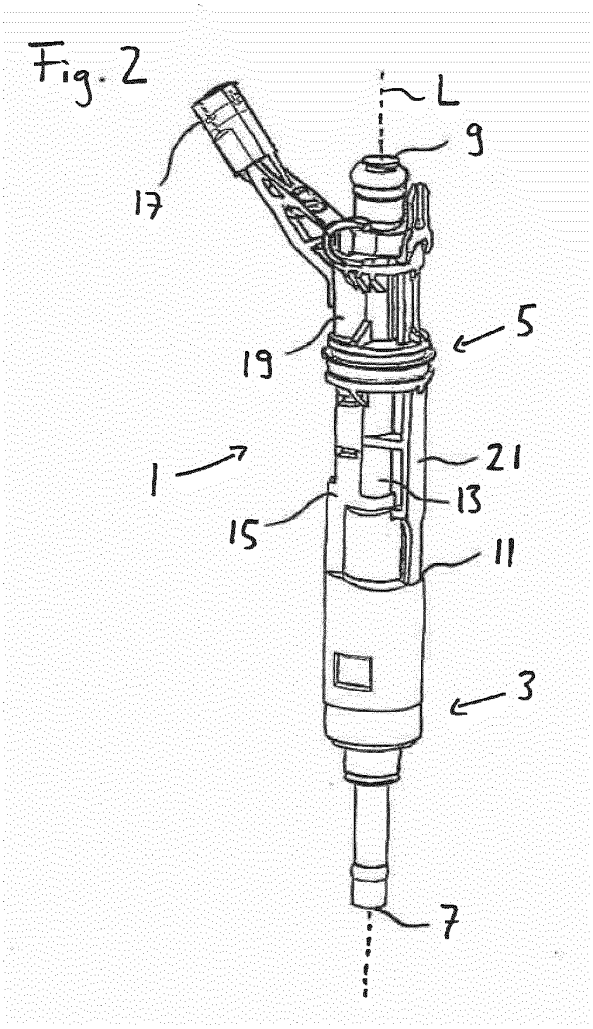
(54) **LONG INJECTOR FOR AN INTERNAL COMBUSTION ENGINE**

(57) A long injector (1) for fuel injection into an internal combustion engine comprises a base portion (3) and an extension portion (5) and a longitudinal axis (L),
wherein the base portion (3) and the extension portion (5) are at least partially arranged in a plastic housing (19), the plastic housing (19) comprising a cavity, an electrical connection between the base portion (3) and the extension portion (5) being arranged inside the cavity, walls of the cavity forming a first longitudinal protrusion (15) of the plastic housing (19),
wherein the plastic housing (19) comprises a second longitudinal protrusion (21), the second longitudinal protrusion (21) being arranged essentially opposite of the first longitudinal protrusion (15).



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Description

[0001] The present invention relates to a long injector for an internal combustion engine.

[0002] In common internal combustion engines, fuel injector systems are used to inject pressurized fuel directly into combustion chambers of the internal combustion engines. To achieve a high efficiency of the engine, the fuel injector must be inserted deeply into the combustion chamber.

[0003] The typical length of a standard injector is about 90 mm. However, longer injectors have been developed to overcome problems due to the restricted space in the cylinder block and densely arranged components around the cylinder head.

[0004] In this disclosure, a long injector is understood to be an injector with a length greater than 90 mm, which has a base injector portion comprising the functional components for the fuel injection and an extension portion, which puts into effect the hydraulical and the electrical extension.

[0005] EP 2 700 805 A1 discloses a long injector for an internal combustion engine which comprises a base portion and an extension portion, the base portion and the extension portion being contained in a plastic housing formed in an overmolding process.

[0006] The plastic housing of a long injector comprises more plastic material which is also present over a greater length compared to that of a standard injector. It has been found, that with regard to long injectors, distortion of the plastic housing due to uneven cooling and shrinkage in the overmolding process can impact the injector overall run-out.

[0007] It is an object of the present invention to improve the injector overall run-out and to reduce distortion of the plastic housing.

[0008] This object is achieved by means of a long injector according to claim 1.

[0009] Advantageous embodiments and developments are objects of the dependent claims.

[0010] According to one aspect of the invention, a long injector for fuel injection into an internal combustion engine is disclosed, comprising a base portion and an extension portion and a longitudinal axis. The base portion and the extension portion are at least partially arranged in a plastic housing. The plastic housing comprises a cavity. An electrical connection between the base portion and the extension portion is arranged inside the cavity. Walls of the cavity form a first longitudinal protrusion of the plastic housing. Furthermore, the plastic housing comprises at least one second longitudinal protrusion, the second longitudinal protrusion being arranged essentially opposite of the first longitudinal protrusion.

[0011] The term "protrusion" is understood to mean a part of the plastic housing which protrudes from the main surface of the housing, in particular in radial direction. The material forming the protrusion is arranged at a greater distance from the longitudinal axis of the injector than the main part of the housing. That the protrusion is a "longitudinal" protrusion means in particular that its main direction of extension is parallel to the longitudinal axis.

[0012] By the second protrusion being arranged essentially opposite of the first longitudinal protrusion, it is understood that the second protrusion is arranged in a position where its counterbalancing effect, which is described below, is in accordance with that of a protrusion being arranged essentially opposite of the first protrusion. To put it differently, the distance vectors from the longitudinal axis to the first protrusion and to the second protrusion are preferably anti-parallel. In other words, the first longitudinal protrusion and the second longitudinal protrusion are positioned in different half spaces with respect to a plane comprising the longitudinal axis and in particular intersecting neither of the first and second longitudinal protrusions. It is possible to form more than one second protrusion, dividing the counterbalancing effect between them. In this case, the position of each second protrusion depends on its mass. In each case, the at least one second protrusion is arranged to counterbalance distortion caused by the first protrusion.

[0013] The long injector has the advantage, that the second longitudinal protrusion balances the volume of molded plastic material. This more even spatial distribution of the plastic material leads to a more even cooling and shrinkage after the molding process. Thus, distortion of the long injector is minimized.

[0014] In one embodiment, the electrical connection between the base portion and the extension portion comprises at least one wire. The at least one wire may be overmolded with the first longitudinal protrusion and thereby form the cavity in the latter. The walls of the cavity are in this case represented by the molded material surrounding the at least one wire.

[0015] According to one embodiment, the second longitudinal protrusion is made of solid plastic and does not comprise a cavity. While the first protrusion functions to house the electrical connections between the base portion and a terminal, the second protrusion according to this embodiment only functions to counterbalance the effect of the first protrusion during the overmolding process. In particular, the second longitudinal protrusion has no electrical function.

[0016] According to one embodiment, the length of the first and second longitudinal protrusions are essentially equal. The length of the protrusions is hereby defined as their extent in longitudinal direction and in particular defines the main direction of extension.

[0017] This embodiment has the advantage, that the effect of the first protrusion is counterbalanced along its entire length.

[0018] According to one embodiment, a center of mass of the plastic housing has a distance d from the longitudinal axis of the long injector with $d \leq 0.2\ D$ or even $d \leq 0.1\ D$, where D is the diameter of the injector.

[0019] The diameter D and the distance d are defined locally at every point of the longitudinal extend of the

protrusions. The given condition d ≤ 0.2 D or even d ≤ 0.1 D must be fulfilled according to this embodiment essentially over the whole length of the plastic housing. Hence, the center of mass of the plastic housing is very close to the longitudinal axis of the long injector. This has the advantage that the material of the plastic housing is very well balanced and distortion effects are minimized.

[0020] Further advantages, advantageous embodiments and developments of the long injector will become apparent from the exemplary embodiments which are described below in association with the schematic figures.

Figure 1 shows a perspective view of a long injector according to a currently unclaimed configuration and

Figure 2 shows a perspective view of a long injector according to an embodiment of the present invention.

[0021] Figure 1 shows a long injector 1 for fuel injection into an internal combustion engine. The long injector has a base portion 3, which is electrically and hydraulically coupled to an extension portion 5 in a coupling area 11.

[0022] The base portion 3 comprises the valve elements (not shown) of the injector 1 and the fluid outlet portion 7. The extension portion 5 comprises a fluid inlet portion 9. The extension portion 5 further comprises an extension tube 13 for the hydraulical extension of the injector 1 and an electrical extension linking terminals of the base portion 3 to a terminal 17 of the long injector 1.

[0023] The electrical connection is made by conductors arranged inside a plastic housing 19. The plastic housing 19 houses at least parts of the base portion 3 and the extension portion 5 and is formed in an overmolding process.

[0024] The plastic housing 19 has a cavity inside a first longitudinal protrusion 15. The longitudinal protrusion 15 has the form of a rib and extends along the extension portion in longitudinal direction at least to the coupling area 11. The coupling area 11 is defined as the region where the base portion 3 and the extension portion 5 are linked. In the coupling area, the extension tube 13 is linked to a tube of the base portion 3, and the terminals of the base portion are contacted by the electrical extension.

[0025] Figure 2 shows a long injector 1 according to an embodiment of the invention. The injector 1 differs from the injector 1 shown in figure 1 in that its plastic housing 19 comprises a second longitudinal protrusion 21.

[0026] The second longitudinal protrusion 21 is arranged essentially opposite of the first longitudinal protrusion 15 and extends downwards to the coupling area 11. The second longitudinal protrusion 21 counterbalances the amount of plastic material on each side of the injector 1 and reduces distortion of the injector 1 due to shrinkage of the plastic material of the plastic housing 19 in the overmolding process.

[0027] To achieve a balance, the amount of material on both sides of the injector has to be essentially the same and has to undergo essentially the same shrinkage, while small deviations can be compensated. A balance can be achieved if the center of mass of plastic material for each point is on the longitudinal axis L or at least close to the longitudinal axis L. Furthermore, distortion is reduced if local deviations of the center of mass from the axis L are not systematically to one side.

[0028] Hence, a mold for producing the plastic housing 19 is designed in a way to produce a second protrusion 21 which counterbalances the effects of the first protrusion. Typically, it is not advantageous if the second protrusion 21 mirrors the first protrusion 15, because inside the first protrusion, the cavity for the electrical connections is arranged. While the second protrusion 21 could also contain a cavity, it will typically be easier to manufacture the second protrusion 21 without a cavity and consider the thus deviating spatial distribution of plastic material.

[0029] In the embodiment shown in figure 2, the second longitudinal protrusion 21 also has the form of a rib and extends along the extension portion 5 in longitudinal direction to the coupling area 11, like the first protrusion 15.

[0030] It would also be possible to have more than one second protrusion 21 counterbalancing the effect of the first protrusion 15. For example, if it is not desirable to place the second protrusion 21 exactly opposite of the first protrusion 15, it might be advantageous to place instead two second protrusions at an equal distance symmetrically with respect to the first protrusion 15.

Claims

1. Long injector (1) for fuel injection into an internal combustion engine, comprising a base portion (3) and an extension portion (5) and a longitudinal axis (L),
   wherein the base portion (3) and the extension portion (5) are at least partially arranged in a plastic housing (19), the plastic housing (19) comprising a cavity, an electrical connection between the base portion (3) and the extension portion (5) being arranged inside the cavity, walls of the cavity forming a first longitudinal protrusion (15) of the plastic housing (19),
   wherein the plastic housing (19) comprises at least one second longitudinal protrusion (21), the second longitudinal protrusion (21) being arranged essentially opposite of the first longitudinal protrusion (15).

2. Long injector (1) according to claim 1,
   wherein the second longitudinal protrusion (21) is made of solid plastic and does not comprise a cavity.

3. Long injector (1) according to claim 1 or 2, wherein the length of the first and second longitudinal protrusions (15, 21) are essentially equal.

4. Long injector (1) according to any of the preceding claims, wherein a center of mass of the plastic housing (19) has a distance d from the longitudinal axis L of the long injector (1) with $d \leq 0.2\ D$, where D is the diameter of the injector (1).

5. Long injector (1) according to any of the preceding claims, wherein a center of mass of the plastic housing (19) has a distance d from the longitudinal axis L of the long injector (1) with $d < 0.1\ D$, where D is the diameter of the injector (1).

Fig. 1

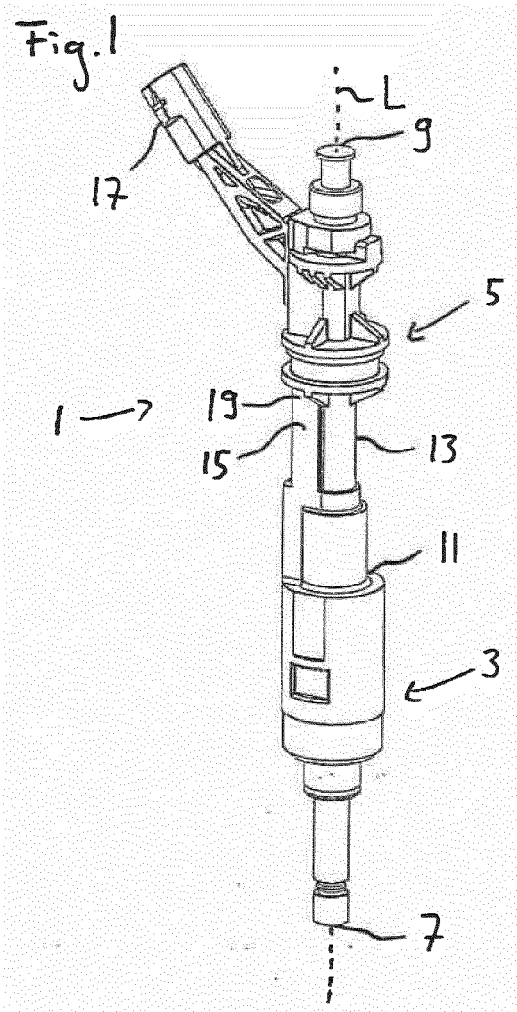
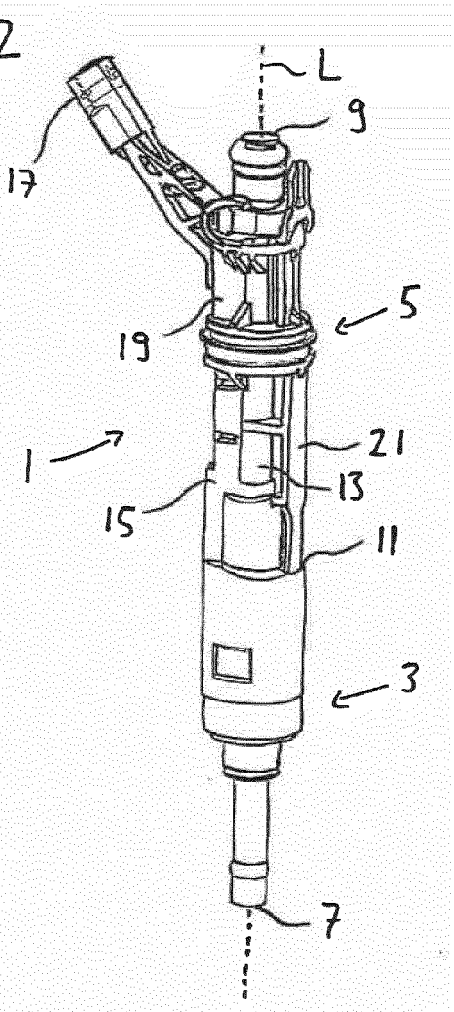


Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 1686

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 February 2017	Morales Gonzalez, M

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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