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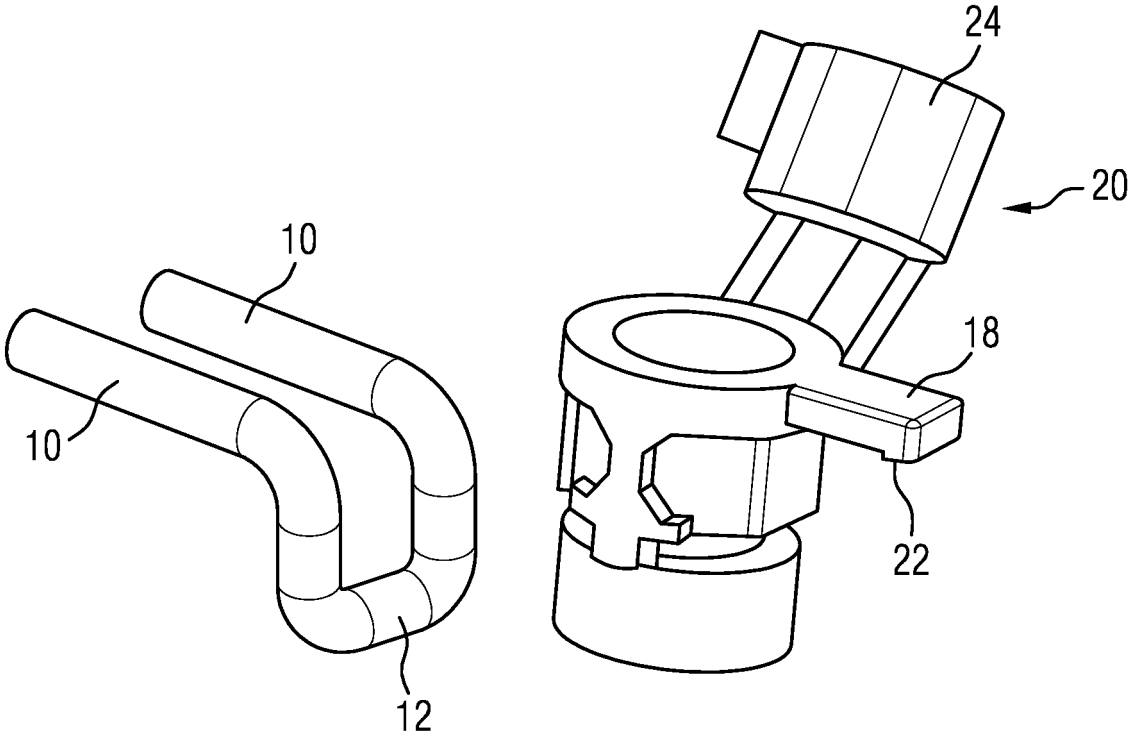
(54) FUEL INJECTION ASSEMBLY FOR AN INTERNAL COMBUSTION ENGINE

(57) A fuel injection assembly is provided that comprises an elongate fuel injector (4) having a longitudinal axis, a fuel inlet port and a fuel outlet port, an injector cup (6), and a holding clip (8) for securing the fuel injector (4) to the injector cup (6). The injector cup (6) comprises a generally cylindrical body and has an upper and a lower end, a recess at its lower end adapted to receive a fuel inlet port of the fuel injector (4), and an opening or openings (14) formed in the peripheral wall of the injector cup (6) for receiving the holding clip (8). The holding clip (8) is generally U-shaped having two generally parallel arms (10) extending from a base part (12) of the clip (8). The arms (10) are adapted to pass through the openings (14) to engage opposite sides of the fuel injector (4) to secure the fuel injector (4) in the injector cup (6). The fuel injector (4) has a projecting tab (18) engaged by the holding clip (6) when the clip (8) is inserted in the injector cup (6) to locate the angular position of the fuel injector (4) relative to the injector cup (6).

FIG 3



EP 3 786 441 A1

Description

[0001] The present disclosure relates to a fuel injection assembly for an internal combustion engine, particularly but not exclusively, for a multi-cylinder gasoline direct injection internal combustion engine.

[0002] Fuel injection assemblies are widely used for injecting fuel into an internal combustion engine, particularly for an internal combustion engine having an injector for each cylinder of a multi-cylinder engine in which the fuel is supplied from a reservoir in the form of a common rail to which each of the injectors is connected. In some systems the injectors are secured directly to the cylinder head of the engine to project into the combustion chamber. Such arrangements have a disadvantage in that noise generated by the injection and combustion process is transmitted through the engine to the exterior. In order to reduce noise transmission one solution is to isolate the injector from direct mechanical connection with the engine. In some arrangements, the fuel injector is suspended in a fuel rail injector cup which is itself secured to the fuel rail and the engine. In this way there is no direct mechanical coupling between the injector and the engine components.

[0003] A further problem arises in that it possible for the fuel injector to pivot about the axis of the injector cup during assembly. However, the fuel injector should be precisely positioned angularly relative to the injector cup so that the fuel injector fuel output is in the correct position for fuel injection into the combustion chamber. In some arrangements this is achieved by means of a further component known as an indexing clip. Such arrangements are shown for example in US Patent No.8,479,710 and WO 2015/135732.

[0004] The present disclosure seeks to provide a fuel injection assembly which is easier and quicker to assemble, particularly in securing the fuel injector in the injector cup. According to the present disclosure there is provided a fuel injection assembly that comprises an elongate fuel injector having a longitudinal axis, a fuel inlet port and a fuel outlet port, an injector cup and a holding clip for securing the fuel injector to the injector cup. The injector cup comprises a generally cylindrical body extending along the axis and having an upper and a lower end. The injector cup has a recess at its lower end adapted to receive a fuel inlet port of the fuel injector. The injector cup also includes an opening or openings formed in the peripheral wall of the injector cup for receiving the holding clip. The holding clip is generally U-shaped and has two generally parallel arms extending from a base part of the clip. The arms are adapted to pass through the opening(s) in the injector cup to engage opposite sides of the fuel injector to secure the fuel injector in the injector cup. The fuel injector has a projecting tab engaged by the base part, when the holding clip is inserted in the injector cup, to accurately locate the angular position of the fuel injector relative to the injector cup. The projecting tab may have thereon a resilient latch which engages the base part of the clip to secure the injector against axial rotation and radial movement relative to the injector cup.

[0005] Embodiments in accordance with this disclosure have the advantage of a low-cost solution to problems associated with both the cost of the individual components and the production assembly. The holding clip consists of a single U-shaped element which is easy and economical to produce, namely, in an embodiment, from a length of wire. Assembly of the fuel injector and injector cup is a simple two step operation; the fuel injector is inserted in the injector cup, and the holding clip is pushed into place to locate the fuel injector in the injector cup. In particular, the arms of the holding clip are pushed into the opening(s) of the injector cup and the base part of the holding clip is pushed over the projecting tabe.

[0006] The projecting tab acts as a location tab and sets the axial position of the fuel injector with respect to the injector cup as arms of the holding clip are positioned in the openings of the injector cup and engage opposing sides of the fuel injector and the base part of the U-shaped holding clip engages the projecting location tab, whereby the base part of the U-shaped holding element is positioned under the projecting location tab. The projecting tab is positioned between the arms of the holding clip. The latch of the projecting tab engages with the base of the holding clip and is also used to hinder radial movement of the fuel injector about the injector cup. By engaging the base part of the holding clip, the latch prevents radial and axial movement of the holding clip and consequently of both arms of the holding clip and therefore relative radial and axial movement between the fuel injector and the injector cup.

[0007] The latch may engage a top side and an outer side of the base part of the holding clip and whilst the projecting tab is positioned between the two arms of the holding clip. In some embodiments, the inner surfaces of the two arms face one another and may engage the side faces of the projecting tab and the lower surface of the projecting tab and/or latch engage the top side of the base part of the holding clip with the latch further engaging the outer side of the base part of the holding clip. This arrangement locates the fuel injector with respect to the injector cup and secures the fuel injector against radial movement with respect to the injector cup due to the latch engaging the outer side of the base part of the holding clip. This arrangement also secures the fuel injector against axial movement with respect to the injector cup due to the engagement of the inner surfaces of the two arms with the projecting tab and the engagement of the latch with the base part.

[0008] The base part of the holding clip may engage the projection tab by a snap-fit. For example, the latch may urge the base part of the holding clip towards the injector cup after the holding clip has been pushed over the latch.

[0009] The projecting tab and the latch if present may be formed integrally in an overmoulding bonded to the fuel injector.

[0010] In some embodiments, the projecting tab extends radially outwardly relative to the longitudinal axis of the fuel injector. The projecting tab may extend substantially perpendicularly to the longitudinal axis of the fuel injector.

[0011] In some embodiments, the angle of the axis of the projecting tab is inclined outwardly relative to the longitudinal axis of the fuel injector, i.e. the angle between the axis of the projecting tab and the longitudinal axis may be less than 90°, but greater than 0°.

[0012] In some embodiments, the projecting tab has a frusto-pyramidal cross-section increasing in size from its free end. This shape can assist in providing a good fit between the holding clip and the projecting tab.

[0013] In some embodiments, the arms of the holding clip are bent to include a bend, which may be substantially 90°. In these embodiments, the base part is positioned in a different plane compared to the distal end of the arms.

[0014] The holding clip may have the form of a wire which is bent into a U-shape with a further bending of the bottom portion of the U at a certain angle to the top part of the U that is formed by the distal ends of the arms. In some embodiments, the angle of the further bend may be around 90° but could be larger or smaller than 90° depending on the application.

[0015] In some embodiments the projecting tab extends about an axis substantially parallel to and spaced from the longitudinal axis of the fuel injector. For this embodiment, the arms of the holding clip may be substantially straight.

[0016] In some embodiments, the fuel injector comprises an annular groove and the arms of the holding clip pass through the openings to engage opposite sides of the annular groove in the fuel injector to secure the fuel injector in the injector cup.

[0017] In some embodiments, the annular grove is formed in a plastics component part of the fuel injector. The holding clip may be formed of a metal wire, or of a plastics material.

[0018] The projecting location tab is attached to the fuel injector, in particular, the overmoulding, and is mechanically coupled to the holding clip which is also coupled to the injector cup.

[0019] The angular position of the projecting location tab with respect to a connector of the overmoulding can vary. In some embodiments, the projecting tab may form an angle of around 90° to the connector of the overmoulding or be positioned opposite the connector and form an angle of 180°. However, the angular position of the projecting tab with respect to the connector may vary from these two particular angles depending on the application.

[0020] In some embodiments, the projecting location tab can be formed integrally with the injector overmoulding. In other embodiments, an additional external element forming the projecting location tab may be attached to the injector. A separate element may be useful if different materials for the injector overmoulding and the projecting tab are to be used.

[0021] The distance between the two parallel arms can be selected depending on the application. For bent designs, the relative length of the top part of the U and the bottom part of the U may vary depending on the application. Whilst a holding clip having a cross-section which is substantially the same throughout may have a lower cost, it is also possible to vary the cross-sectional area of portions of the holding clip. A frusto-pyramidal shape of the tab can be used to facilitate manufacturing and can also be used to provide a particular interference during the insertion of the holding clip and to increase the indexing accuracy.

[0022] To summarise, the fuel assembly according to the embodiments described herein enables a retaining and indexing function between the fuel injector and the injector cup to the provided using small number of components as the holding clip has a U-shape and can be formed from a single piece. The components may be provided at low cost. Due to the simple and reliable attachment of the fuel injector to the injector cup with the holding clip and projecting location tab, manufacturing costs can be reduced and the fuel injector accurately and precisely positioned.

[0023] Embodiments of the disclosure will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 shows a side view of a fuel injection system comprising a fuel rail with three fuel injectors,

Figure 2 shows part of the fuel injector, injector cup and holding clip of figure 1,

Figure 3 shows a perspective view of the holding clip and connection block of figures 1 and 2,

Figure 4 shows a side view of an alternative embodiment of a fuel injection system,

Figure 5 shows a sectional view of the fuel injector, injector cup and holding clip of figure 4,

Figure 6 shows a perspective view of the connection block and projecting tab of figures 4 and 5,

Figure 7 shows a side view of an alternative embodiment of a fuel injection system,

Figure 8 shows a sectional view of the fuel injector, injector cup and holding clip of figure 4, and

Figure 9 shows a perspective view of the connection block and projecting tab of figures 7 and 8.

[0024] Referring now to Figure 1 there is shown a fuel rail assembly with a fuel rail 2 to which three fuel injectors 4 are connected. However, the fuel rail assembly is not limited to three fuel injectors and for use with a three

cylinder internal combustion engine and may include any number of fuel injectors 4. In multi-cylinder engines each cylinder has an associated fuel injector for injecting fuel directly into the combustion chamber. The fuel rail 2 forms a reservoir for fuel which is supplied to the fuel rail by a high-pressure pump (not shown).

[0025] Each fuel injector 4 is in fluid communication with the fuel rail through an injector cup 6 secured to, or formed integrally with, the fuel rail 2. A hydraulic passage for supplying fuel to each fuel injector 4 is thus provided from the reservoir in the fuel rail 2 to the fuel injector 4. To assemble the fuel injector 2 to the injector cup 4, an inlet port of the fuel injector 4 is inserted in an opening in the bottom of the injector cup 6, the injector cup 6 being in hydraulic communication with the fuel rail 2 thus providing the hydraulic passage from the fuel rail to the fuel injector 2.

[0026] Referring now also to Figures 2 and 3, there is shown a holding clip 8 which secures the fuel injector 4 to the injector cup 6. The holding clip 8 is generally U-shaped and has two substantially parallel arms 10 extending from base part 12 of the clip 8 that extends between the two arms to form the U-shape. The holding clip 8 may be formed of a metal wire and may have a circular cross section. In this embodiment, the arms 10 of the holding clip 8 include a bend of around 90° so that the distal ends of the arms 10 extend at substantially right angles to a base portion of the arms 10 so that the base part 12 of the holding clip 8 is positioned in a different plane from the distal ends of the arms 10. The U-shaped base portion of the holding clip 9 is at right angles to the length of the distal ends of the parallel arms 10.

[0027] The arms 10 are adapted to pass through spaced openings 14 in the injector cup 6 and to engage opposite sides of an annular groove 16 on the fuel injector 4 to secure the fuel injector 4 in the injector cup 6 against movement in the axial direction and against axial movement in the direction of the longitudinal axis L. The arms 10 are a tight or interference fit in the openings 14.

[0028] Since the groove 16 by which the holding clip 8 engages the fuel injector 2 extends around the fuel injector 4, it is possible for the fuel injector 4 to rotate about the longitudinal axis L relative to the injector cup 6. This may be undesirable because it is necessary for the fuel injector 4 to be at the correct angular displacement when it enters the combustion chamber of the engine to ensure that the desired characteristics and direction of the fuel being injected are realised. In this disclosure the angular position of the fuel injector 4 relative to the injector cup 6 is determined by and maintained by a location tab 18 which is formed on and projects from an electrical connection block 20 in the form of an overmoulding bonded securely onto the fuel injector 4. in this embodiment the projecting location tab 18 projects outwardly radially from the longitudinal axis L of the fuel injector 4 and extends substantially perpendicularly to the longitudinal axis L of the fuel injector 4.

[0029] In some embodiments, the location tab 18 is resilient. In some embodiments, the projecting location tab 18 has a latch 22 adjacent its outer end. The latch 22 extends from the lower surface of the projecting location tab 18, substantially perpendicularly to the projecting location tab 18 and generally parallel to the longitudinal axis L.

[0030] Assembly of the fuel injector 4 to the injector cup 6 is achieved very quickly in two steps. The fuel injector 4 is inserted in the injector cup 6 and the arms 10 of the holding clip are then inserted in the openings 14 where they are a tight fit and engage the annular groove 16 of the fuel injector 4. The U-shaped base part 12 of the holding clip engages under the projecting location tab 18, deflecting the end of the projecting location tab 18 to enable the U-shaped base part 12 to engage the latch 22. In Particular, the outer surface, i.e. the surface that faces away from the fuel injector 4 is engaged with the base part 12. The resilience of the projecting location tab 18 ensures that the U-shaped base part 12 firmly engages location tab 18 and the latch 22, in particular the inner surface of the latch 22 that faces towards the fuel injector 4. Forces which occur in practice such as vibration or external shocks which would tend to move the fuel injector 4 relative to the injector cup 6 are transmitted and absorbed by the U-shaped base part 12 and thus the disturbing forces are distributed substantially equally in the two arms 10. This minimises the risk of displacement occurring between the fuel injector 4 and the injector cup 6.

[0031] Referring now to Figures 4, 5 and 6 there is shown an alternative arrangement where like references denote like parts. In this embodiment, the projecting location tab 18 is disposed opposite and approximately 180° from the connection element 24 whereas in the first embodiment illustrated in Figure 3 the location tab 18 is disposed at 90° to the connection element 24.

[0032] The precise position and direction of the projecting location tab 18 will be determined by the particular installation for which the injection assembly is intended.

[0033] In a further embodiment illustrated in Figures 7, 8 and 9, the location tab 18 extends about an axis spaced from but parallel to the axis L. In this embodiment, the holding clip 8 has a simplified construction since the arms 10 and the U-shaped base part 12 of the holding clip 8 lie in a common plane.

[0034] In further embodiments (not shown) the U-shaped base part 12 of the holding clip 8 may lie at an acute angle relative to the length of the arms 10. The projecting location tab 18 may have a frusto-pyramidal cross section increasing in size from its free end. The holding clip may be formed of a plastics material or a special steel such as stainless steel or carbon steel. It may also be formed of a moulding or forging, which would facilitate the clip having a nonuniform cross-section at various parts along its length.

Reference List

[0035]

2	Fuel rail
4	Fuel injector
6	Injector cup
8	U-shaped holding clip
10	Arms
12	base part
14	Openings
16	Annular groove
18	Projecting tab
20	Connection block
22	Latch
24	Connection element

Claims

1. A fuel injection assembly, comprising:

an elongate fuel injector (4) having a longitudinal axis, a fuel inlet port and a fuel outlet port,
an injector cup (6), and
a holding clip (8) for securing the fuel injector (4) to the injector cup (6),
wherein the injector cup (6) comprises a generally cylindrical body extending along the longitudinal axis and having an upper and a lower end, the injector cup (6) having a recess at its lower end adapted to receive a fuel inlet port of the fuel injector (4), an opening or openings (14) being formed in the peripheral wall of the injector cup (6) for receiving the holding clip (8),
wherein the holding clip (8) is generally U-shaped having two generally parallel arms (10) extending from a base part (12) of the clip (8), the arms (10) being adapted to pass through the openings (14) to engage opposite sides of the fuel injector (4) to secure the fuel injector (4) in the injector cup (6),
wherein the fuel injector (4) has a projecting tab (18) engaged by the holding clip (6) when the clip (8) is inserted in the injector cup (6) to locate the angular position of the fuel injector (4) relative to the injector cup (6),
wherein the projecting tab (18) has thereon a latch (22) which engages the base part (12) of the holding clip (6) to secure the injector (4) against axial rotation and radial movement relative to the injector cup (6).

2. A fuel injector assembly according to claim 1, wherein the latch (22) engages an outer side of the base part (12) of the holding clip (12).

3. A fuel injector assembly according to claim 1 or 2, wherein the base part (12) of the holding clip (6) engages the projection tab (18) by a snap-fit.

4. A fuel injector assembly according to any one of the preceding claims, wherein the projecting tab (18) is formed integrally in an overmoulding bonded to the fuel injector (4).

5. A fuel injector assembly according to any one of the preceding claims, wherein the projecting tab (18) extends radially outwardly relative to the longitudinal axis of the fuel injector (4).

6. A fuel injector assembly according to ay one of claims 1 to 4, wherein the angle of the axis of the projecting tab (18) is inclined outwardly relative to the longitudinal axis of the fuel injector (4).

7. A fuel injector assembly according to any one of claims 1 to 6, wherein the tab (18) has a frusto-pyramidal cross-section increasing in size from its free end.

8. A fuel injector assembly according to any one of the preceding claims, wherein the arms (10) of the holding clip (8) include a bend such that the base extends at substantially 90° to a distal end of the arms (10).

9. A fuel injector assembly according to any one of claims 1 to 7, wherein the projecting tab (18) extends about an axis substantially parallel to and spaced from the longitudinal axis of the fuel injector (4).

10. A fuel injector assembly according to claim 9, wherein the arms (10) of the holding clip (8) are substantially straight.

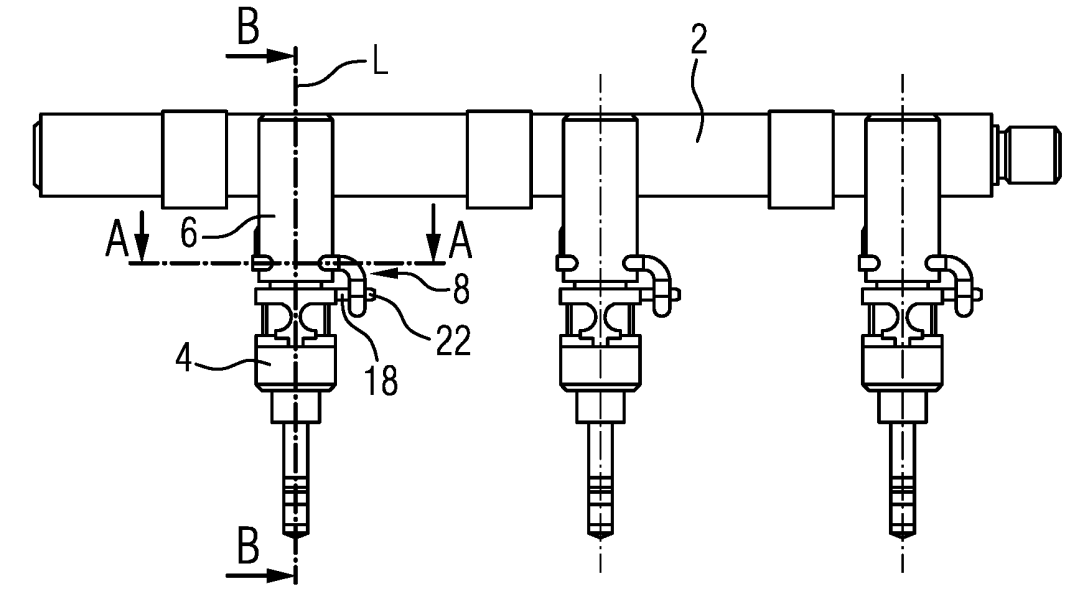
11. A fuel injector assembly according to any one of the preceding claims, wherein the fuel injector (4) comprises an annular groove (16) and the arms (10) of the holding clip (8) pass through the openings (14) to engage opposite sides of the fuel injector (4) to secure the fuel injector (4) in the injector cup (6).

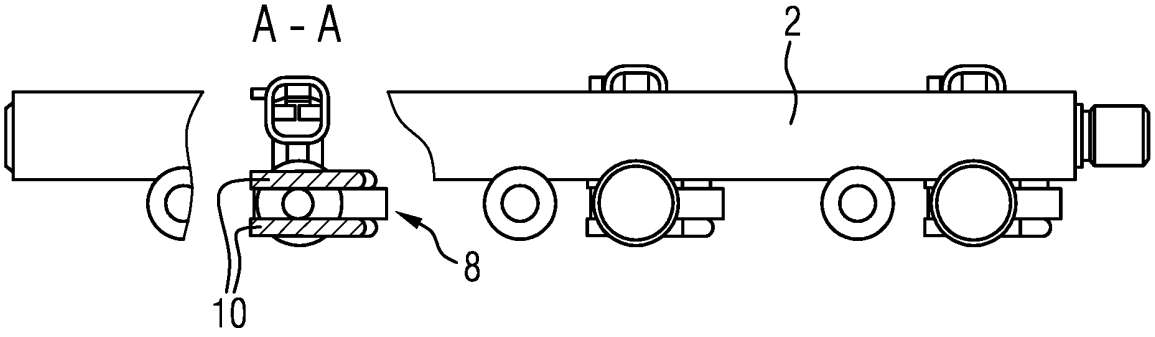
12. A fuel injector assembly according to claim 11, wherein the annular grove (16) is formed in a plastics component part of the fuel injector (4).

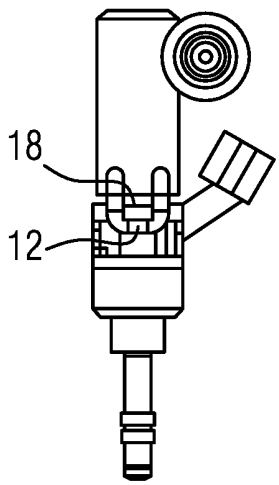
13. A fuel injector assembly according to any one of the preceding claims, wherein the holding clip (8) is formed of a metal wire.

14. A fuel injector assembly according to any one of claims 1 to 12, wherein the holding clip (8) is formed of a plastics material.

FIG 1







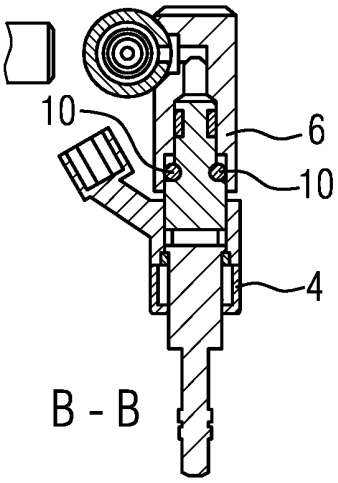


FIG 2

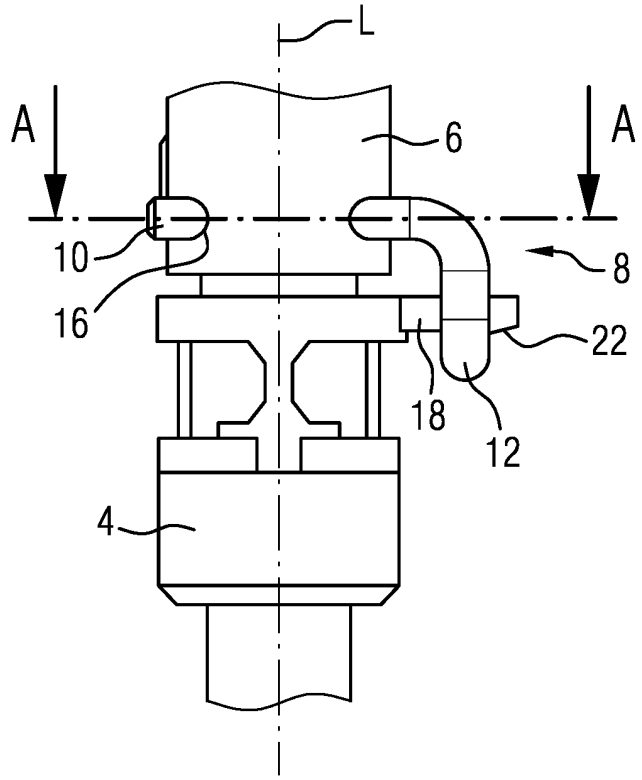


FIG 3

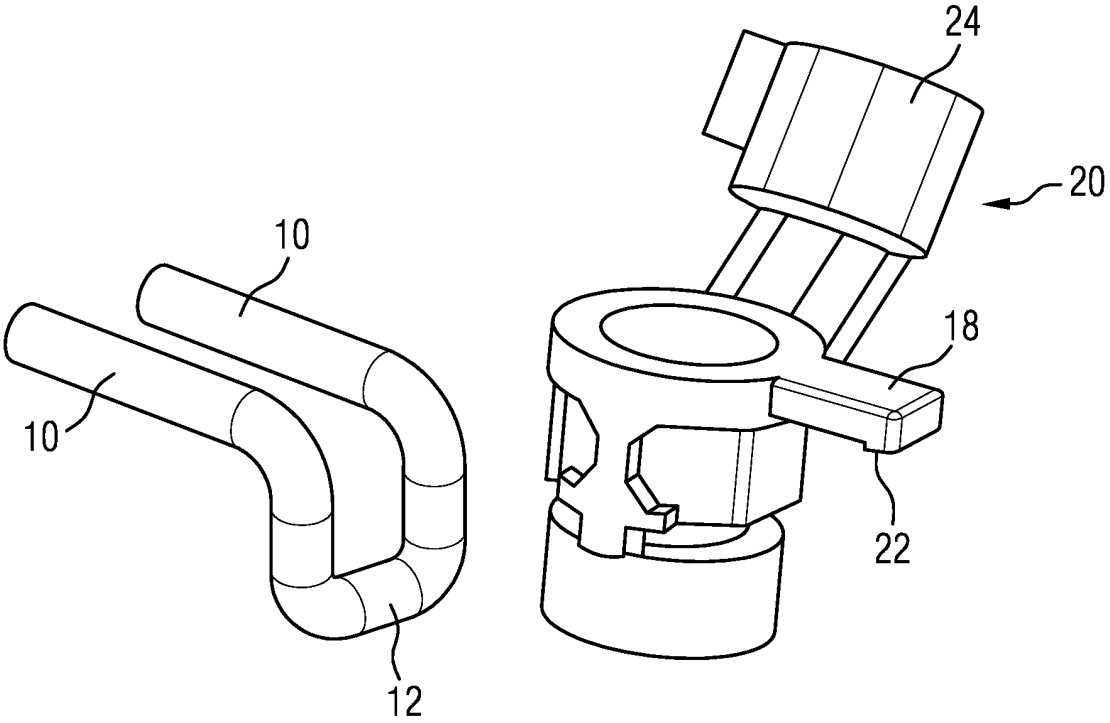
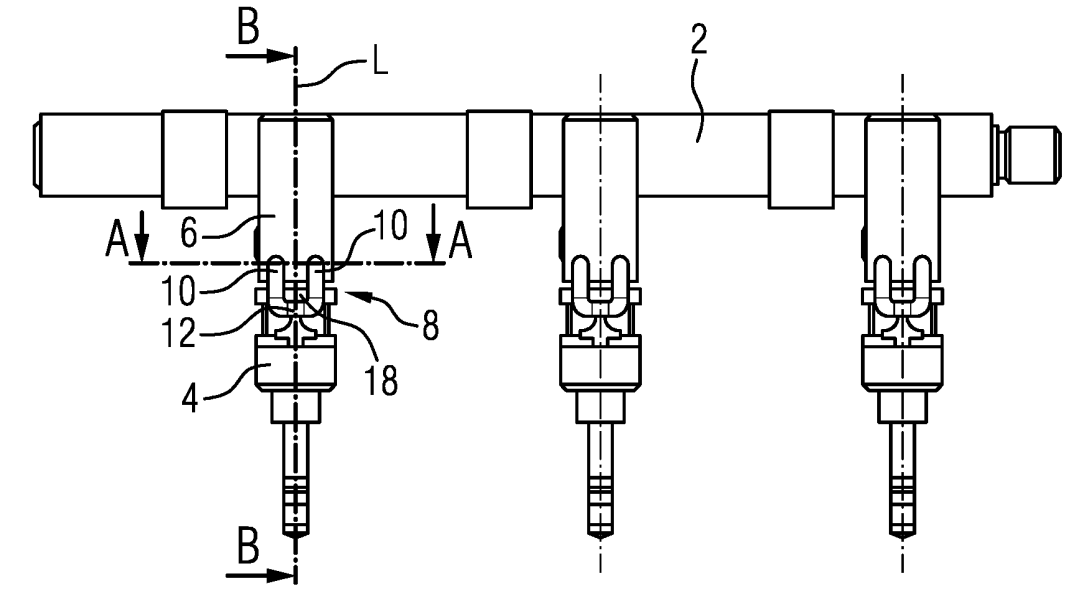
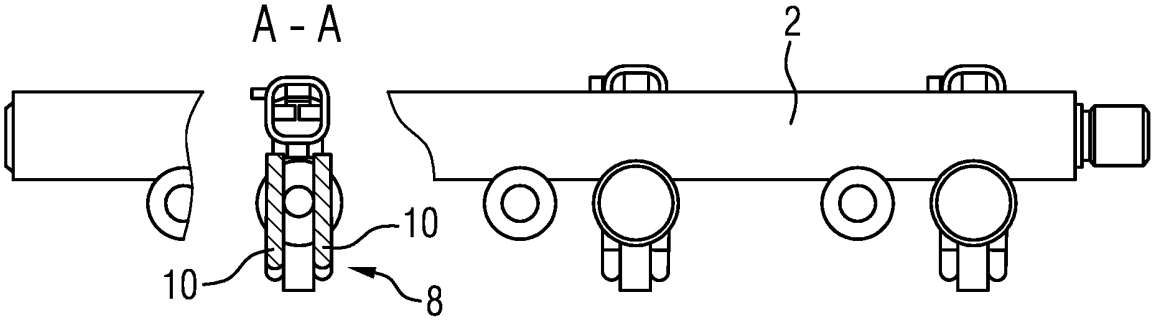
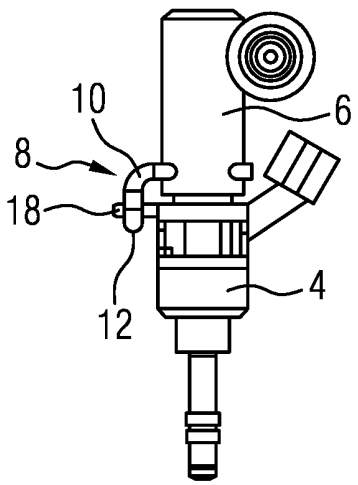


FIG 4







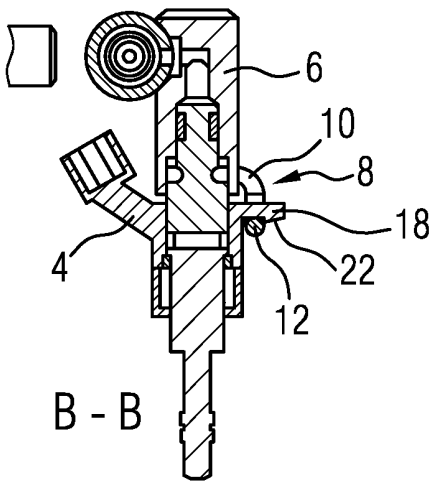


FIG 5

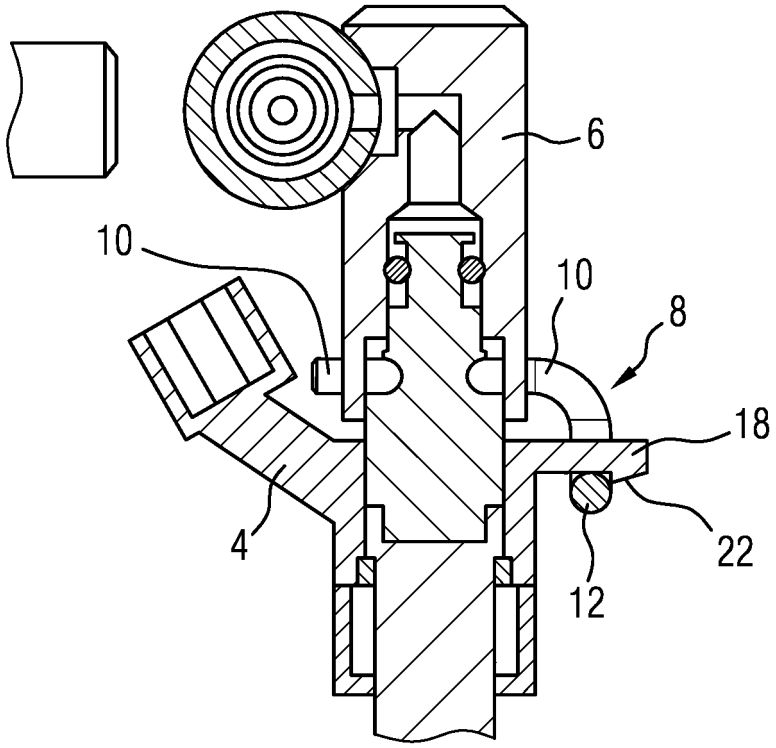


FIG 6

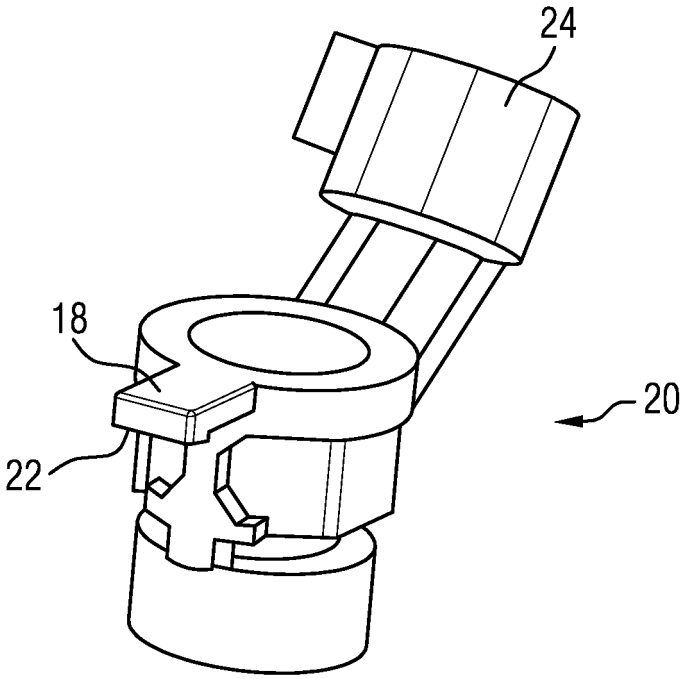


FIG 7

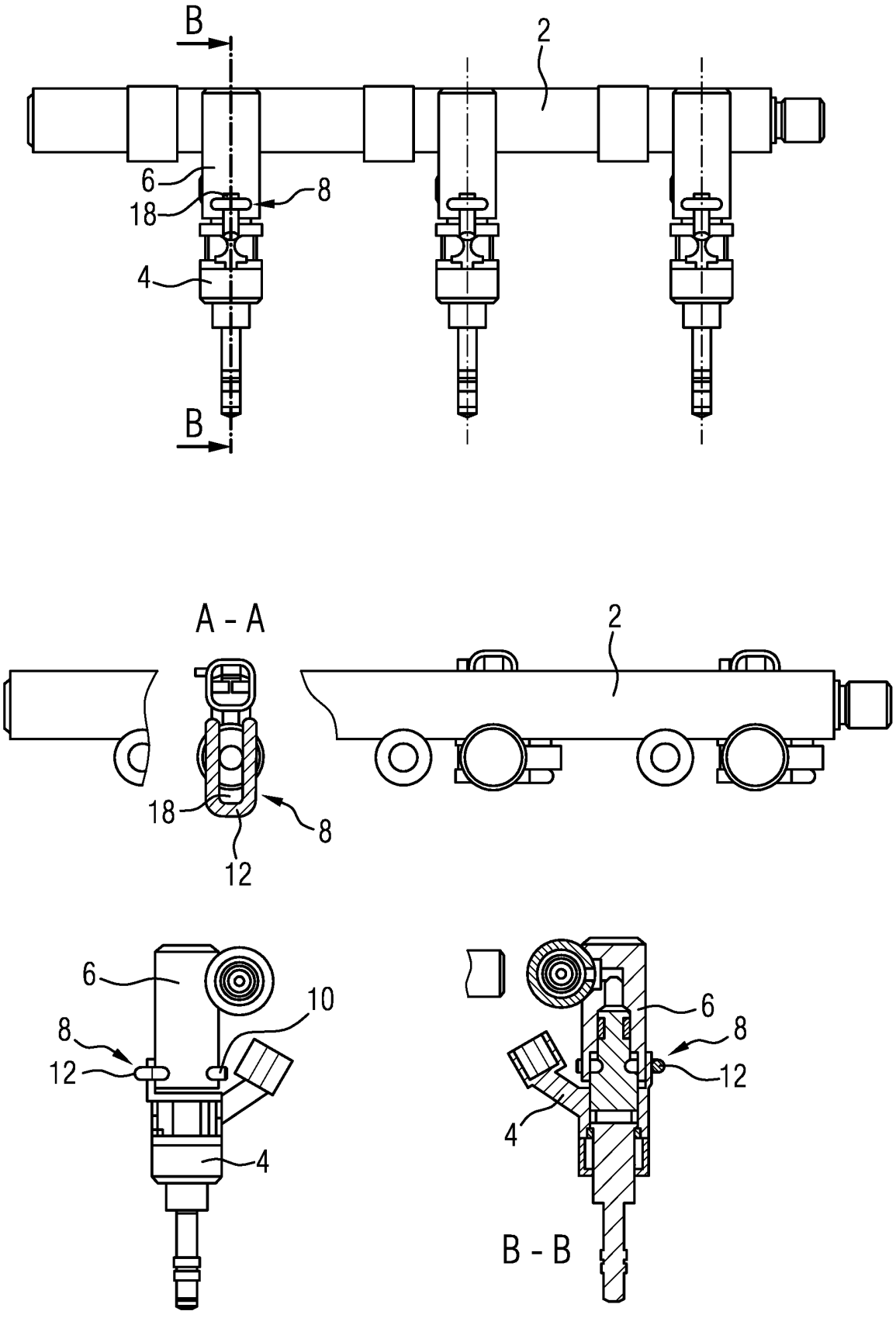


FIG 8

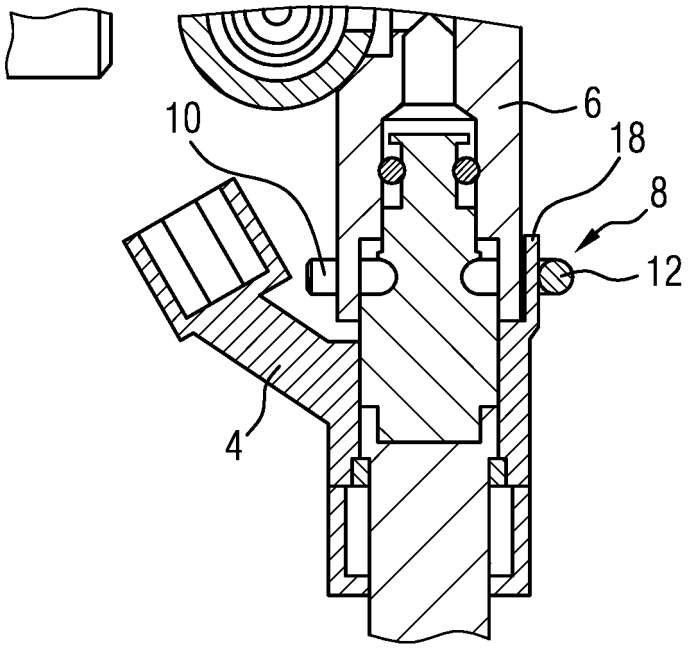
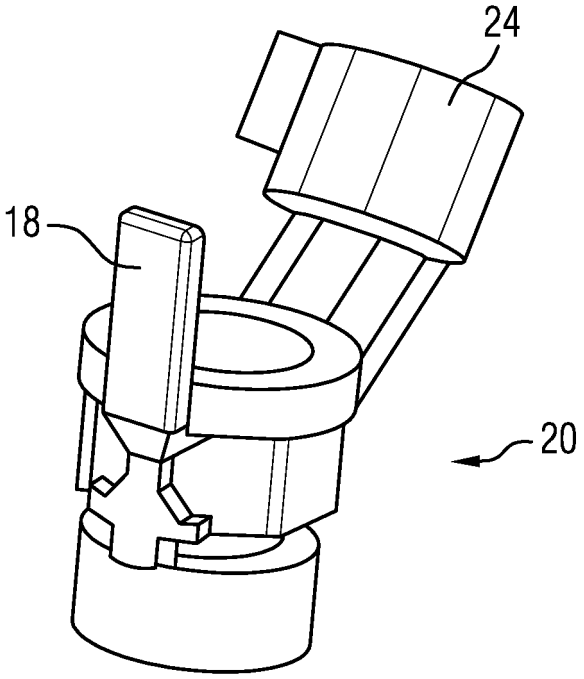


FIG 9



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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 3701

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2016/273501 A1 (CASS CHRISTOPHER M [US] ET AL) 22 September 2016 (2016-09-22) * figures 1-13 *	1-8,13, 14 9-12	INV. F02M61/14
Y	US 2016/177903 A1 (DI DOMIZIO GISELLA [IT] ET AL) 23 June 2016 (2016-06-23) * figures 1-20 *	9-12	
X	US 2010/012093 A1 (PEPPERINE DEAN M [US] ET AL) 21 January 2010 (2010-01-21) * figures 1,2 *	1	
X	EP 2 896 815 A2 (BOSCH GMBH ROBERT [DE]) 22 July 2015 (2015-07-22) * figures 1-8 *	1	

TECHNICAL FIELDS SEARCHED (IPC)
F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 January 2020	Morales Gonzalez, M

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 19 3701

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30-01-2020

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