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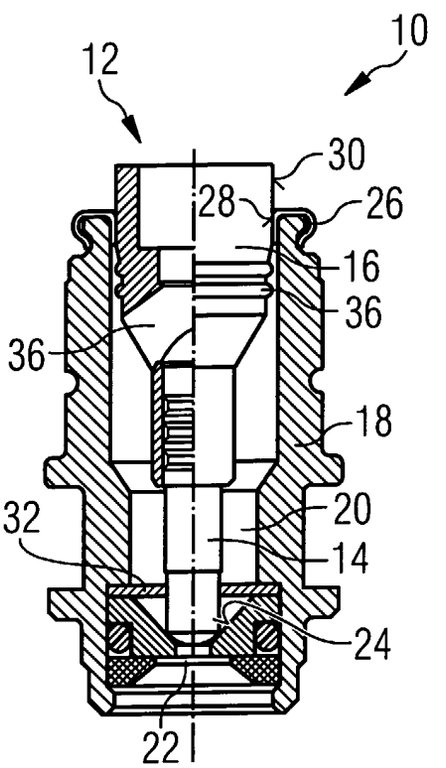
Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) Valve needle assembly and method for producing the same

(57) The invention refers to a valve needle assembly comprising a valve needle (14) and an electro-magnetic armature (16) coupled to the valve needle (14), the valve needle assembly being suited for use in a valve assembly (10) of an injector unit for injecting fuel into an engine of a vehicle, said valve assembly comprising a valve body (18) with a valve body cavity (20), in which the valve needle assembly is to be inserted, said valve body (18) comprising at least one ring type guiding zone (28) for guiding an axial movement of the valve needle assembly, and the valve needle assembly comprising a corresponding cylindrical guiding zone (30).

In accordance with the invention it is provided that sizing means (28,34,36) comprise at least one sizing member (36) neighbouring the cylindrical guiding zone (30) for sizing the diameter of the ring type guiding zone (28) when inserting the valve needle assembly into the valve body cavity (20).

FIG 3



EP 1 469 187 A1

Description

[0001] The present invention refers to a valve needle assembly comprising a valve needle and an electromagnetic armature coupled to the valve needle, the valve needle assembly being suited for use in a valve assembly of an injector unit for injecting fuel into an engine of a vehicle, said valve assembly comprising a valve body with a valve body cavity, in which the valve needle assembly is to be inserted, said valve body comprising at least one ring type guiding zone for guiding an axial movement of the valve needle assembly and the valve needle assembly comprising a corresponding cylindrical guiding zone.

[0002] The present invention further refers to a valve assembly, in particular for use in an injector unit for injecting fuel into an engine of a vehicle, comprising a valve body with a valve body cavity and a valve orifice, in which valve body cavity there is installed a valve needle assembly comprising a valve needle movable along its longitudinal axis between a closed position, in which the valve needle obturates the valve orifice, and an open position, in which the valve needle does not obturate the valve orifice, said valve body comprising at least one ring type guiding zone for guiding the axial movement of the valve needle assembly and the valve needle assembly comprising a corresponding cylindrical guiding zone.

[0003] The present invention finally refers to a method for producing a valve assembly, in particular for use in an injector unit for injecting fuel into an engine of a vehicle, comprising the steps of providing a valve body with a valve body cavity having at least two openings and comprising a ring type guiding zone; providing a valve needle assembly comprising a valve needle coupled to an electro-magnetic armature and further comprising at least one cylindrical guiding zone having an outer diameter corresponding substantially to the inner diameter of the valve body's ring type guiding zone; inserting the valve needle assembly into the valve body cavity, such that the valve needle is allowed to move along its longitudinal axis in a way guided by the interaction of the corresponding guiding zones.

[0004] Injector units for injecting fuel into a modern engine of a vehicle comprise valve assemblies for metering the fuel with high precision with respect to volume and time of injection. Common valve assemblies, as illustrated e.g. in Fig. 6 mainly consist of a valve body and a valve needle assembly. The valve needle assembly usually comprises the valve needle coupled to an electro-magnetic armature capable of being actuated by a corresponding external coil. According to the actuation the valve needle is movable along its longitudinal axis. The valve body, that may be assembled from several parts, provides an outer application surface, e.g. for outer holding means, and an inner cavity that can be flooded with fuel. The cavity comprises at least two openings: one, into which the valve needle assembly usually is inserted and another one providing the valve orifice, which is opened and closed by the valve needle.

[0005] The perfect longitudinal movement of the valve needle is very critical. Any lateral movement or misalignment yields substantial wear of the valve needle and/or the valve seat. Thus, some guiding of the movement is required.

[0006] Usually, there are provided two guiding zones that shall be referred to as upper and lower guides in the following. The current invention refers mainly to the upper guide. However, the inventive principle is also applicable to the lower guide. The upper guide represents a ring type guiding zone and is often configured as an eyelet around the valve body's upper rim, where the valve needle assembly is inserted. However, the upper guide may also be shaped like a hollow cylinder or the like, the term "ring type" covering all these alternatives. When assembled, a cylindrical section of the valve needle assembly, usually a section of the electro-magnetic armature, acts as a cylindrical guiding zone in interaction with the ring type guiding zone of the valve body.

[0007] The correct relative dimensions of the ring type guiding zone and the cylindrical guiding zone are obviously very important for the correct function of the injector unit. If, e.g. the opening of the ring type guiding zone is too large with respect to the cylindrical guiding zone, this results in a lateral component of movement of the valve needle, yielding to excessive wear and the risk of jamming. On the other hand, if the opening of the ring type guiding zone is too small with respect to the cylindrical guiding zone, this results in excessive friction, also yielding to wear and the risk of jamming.

[0008] Unfortunately, it often is not sufficient to size each one of the interacting guiding zones according to the theoretical specifications including tolerances of machining, since the relative dimensions are crucial. Also, even if all parts are machined with high precision, some distortions due to welding heat or crimping processes when assembling the unit may result in a mismatch of the corresponding guiding zones.

[0009] It is an object of the present invention to provide a valve needle assembly which overcomes the disadvantages of the prior art and in particular to provide a device that guarantees for a better relative matching of the corresponding guiding zones.

[0010] This object is obtained by the features of the independent claim 1. Preferred embodiments are defined by the depending claims 2 to 9.

[0011] The valve needle assembly according to the present invention improves a valve needle assembly according to the prior art by a sizing means comprising at least one sizing member neighbouring the cylindrical guiding zone for sizing the diameter of the ring type guiding zone when inserting the valve needle assembly into the valve body cavity.

[0012] That means, there is no longer the need of machining and assembling the corresponding guiding zones with extremely high precision (and still risking a

mismatch), because the correct sizing is carried out while assembling the valve assembly, i.e. while inserting the valve needle assembly into the valve body cavity. In other words, according to the invention, the valve needle assembly is provided with a self-sizing zone neighbouring its cylindrical guiding zone. Thus, it is sufficient to roughly pre-size the ring type guiding zone, because it is automatically fine-sized during the insertion of the valve needle assembly. However, it is still possible to produce and assemble correctly machined parts and only use the self-sizing zone of the valve needle assembly as a checking means in order to confirm the matching of the interacting zones. The term "sizing" is, thus, to be understood in a wide meaning comprising both the alternatives in a sense of "shaping" as well as "checking".

[0013] In a preferred embodiment of the present invention the sizing means are positioned on the electromagnetic armature. The armature usually comprises the region with the largest diameter of the valve needle assembly. Thus, it represents a section, that has to be guided in any case, usually by the upper guide. Also, because of its large diameter it is mechanically relatively stable and can sustain the force necessarily applied to it when sizing the ring type guiding zone. However, the basic idea of the invention can additionally or alternatively be applied to the valve needle and the corresponding lower guide.

[0014] In a further preferred embodiment of the invention at least one sizing member is configured as a full perimeter beaded ring around a cylindrical portion of the valve needle assembly. A beaded ring reduces the contact surface between the sizing means and the ring type guiding zone to be sized. Thus, the required force is reduced, facilitating the sizing process.

[0015] According to a further advantageous embodiment at least one beaded ring has a rounded profile. This is a consequent continuation of the idea explained above and results in a minimized contact surface.

[0016] In a further improved embodiment of the present invention the sizing means is configured of a plurality of coaxial full perimeter beaded rings around a cylindrical portion of the valve needle assembly. Using several beaded rings takes into account a settlement of the material undergoing a plastic deformation. Thus, the sizing process is repeated the number of beaded rings times, while inserting the valve needle assembly only once.

[0017] In a further improvement of the present invention each beaded ring of the plurality of beaded rings has an outer diameter that is larger than the outer diameter of its neighbouring beaded ring further apart from the valve needle assembly's cylindrical guiding zone. This means, when inserting the valve needle assembly according to the invention, the ring type guiding zone is contacted and sized by several beaded rings of increasing diameter. Thus, the plastic deformation induced by each beaded ring represents only a fraction of the total plastic deformation. This results in a reduction of the required force as well as in a smoother surface.

[0018] In a further preferred embodiment of the present invention at least one beaded ring, preferably the one most apart from the cylindrical guiding zone of the valve needle assembly, has an outer diameter that is slightly larger than the desired inner diameter of the valve body's ring type guiding zone. Even if a plurality of beaded rings are used for sizing, there will be always a residue settlement of material. This residue settlement is taken into account by the feature described, thus, yielding to a correctly dimensioned guiding zone.

[0019] In a further preferred embodiment of the present invention the sizing means has a surface made from a material harder than the material of the valve body's ring type guiding zone. This is advantageous, because no wear of the sizing means has to be taken into account.

[0020] In a further improved embodiment of the present invention the material of the surface of the sizing means is a chrome comprising alloy. This is a cheap way to implement a hard, smooth and corrosion resistant surface. The term chrome comprising alloy also comprises a pure chrome surface. Evidently, this comprises the possibility to only plate parts of the total surface, e. g. only the beaded rings.

[0021] It is a further object of the present invention to provide a valve assembly which overcomes the disadvantages of the prior art and in particular provides a device that guarantees for a better relative matching of the corresponding guiding zones.

[0022] This object is obtained by the features of the independent claim 10.

[0023] The valve assembly according to the present invention improves a valve assembly according to the prior art by the valve needle assembly being configured according to any one of the embodiments explained above. The effects and advantages of this feature are analogue to the effect and advantages described above.

[0024] It is finally a further object of the present invention to provide a method for producing a valve assembly that is easy to implement and that yields to a better interaction of the corresponding guiding zones while reducing the required preciseness with which the interacting parts have to be machined.

[0025] This object is obtained by the features of the independent claim 11. Preferred embodiments are defined by the depending claims 11 to 15.

[0026] The method according to the present invention improves the method according to the prior art by the valve needle assembly having a sizing means with at least one sizing member neighbouring the cylindrical guiding zone and by the step of sizing the diameter of the ring type guiding zone by the sizing means when inserting the valve needle assembly into the valve body cavity.

[0027] This means, that the final sizing of the ring type guiding zone is carried out using the valve needle as-

sembly when inserting it, rather than using separate tools prior to inserting the valve needle assembly. This way, the dimensions of the interacting guiding zones are optimised with respect to each other, which is essential for a proper operation.

[0028] In a preferred embodiment of the method according to the present invention the step of inserting the valve needle assembly comprises inserting a valve needle assembly according to one of the claims 1 to 9. This is an advantageous way to easily implement the features of the method according to the invention. Those skilled in the art can recognize the effects and advantages from the above explanations.

[0029] In a further preferred embodiment of the method according to the present invention the step of sizing the diameter of the ring type guiding zone comprises the compression of the ring type guiding zone's material inducing a plastic deformation. This is advantageous over the abrasion of material, because it results in a smoother surface and there are no particles left in the valve body cavity corrupting the operation of the valve needle.

[0030] In a further preferred embodiment of the method according to the present invention the force is measured, which is required for inserting the valve needle assembly into the valve body cavity. The measured values are preferably used to decide if the ring type guiding zone and/or the valve needle assembly are machined within desired specifications. If the force measured is too low, this is an indication that the ring type guiding zone of the valve body is oversized with respect to the cylindrical guiding zone of the valve needle assembly. On the other hand, if the force measured is too high, this is an indication that the ring type guiding zone of the valve body is undersized with respect to the cylindrical guiding zone of the valve needle assembly.

[0031] In the following the present invention will be explained in more detail with respect to the drawing, in which

Figure 1 illustrates a valve needle assembly according to a preferred embodiment of the present invention;

Figure 2 illustrates three alternative embodiments of a valve needle assembly according the present invention;

Figure 3 illustrates a valve assembly according to the present invention in its final configuration;

Figure 4 illustrates an enlarged view of the interacting guiding zones of the valve assembly shown in Fig. 3;

Figure 5 illustrates four steps of a preferred method for producing the valve assembly shown in Fig. 3.

Figure 6 illustrates a valve assembly according to the prior art;

[0032] Fig. 6 illustrates a valve assembly 10' according to the prior art. A valve needle assembly 12' comprises a valve needle 14' which is coupled to an actuating unit 16' which is configured as an electro-magnetic armature. The valve needle assembly is movable along its longitudinal axis upon actuation by an external coil (not shown). The valve needle assembly 12' is positioned in a valve body cavity 20' of a valve body 18'. The valve needle assembly 12' is positioned such that, upon actuation, the valve needle 14' closes and opens a valve orifice 22' by moving to and from a valve seat 24'.

[0033] As explained above, the perfectly linear movement of the valve needle 14' is essential for a long lifetime operation of the valve assembly 10'. Thus, two guiding zones are provided inside the valve body cavity 20', namely an upper guide 26' and a lower guide 28'. The upper guide 26' is configured as a metallic sleeve or eyelet crimped on the upper rim of the valve body 18'. The inner diameter of the eyelet 26' matches the outer diameter of the armature 16' of the valve needle assembly 12'. They, thus, provide two interacting guiding surfaces or guiding zones, namely a ring type guiding zone 28' of the valve body 18' (the eyelet 26') and the cylindrical guiding zone 30' of the armature 16'. The lower guide 32' is configured as an aperture having a diameter, that matches the diameter of the valve needle 14' and which is positioned near the valve seat 24'. It is obvious, that proper relative dimensions of the upper guide 26' with respect to the armature 16' are crucial for a correct behaviour during operation. However, as they are configured as two separate elements being inserted and fixed in the valve body cavity 20' in different steps, it is difficult to obtain such proper dimensioning.

[0034] In the following like reference numerals without prime (') symbolize like or functionally equal elements as in Fig. 6.

[0035] Fig. 1 illustrates a valve needle assembly 10 according to the present invention. The valve needle 14 may be configured in the conventional way. However, according to the invention the armature 16 is provided with a sizing zone 34 neighbouring the guiding zone 30. The sizing zone 34 comprises two beaded rings 36 acting as sizing means, when inserting the valve needle assembly 12 into the valve body 18, as is explained below in further detail. In the preferred embodiment the beaded rings 36 differ in diameter from each other, where the beaded ring most apart from the guiding zone 30 - the lower one in Fig. 1 - has the smallest outer diameter. The outer diameter of the beaded ring closest to the guiding zone 30 - the upper one in Fig. 1 - has an outer diameter, that is preferably slightly larger than the outer diameter of the cylindrical guiding zone 30.

[0036] As can be seen from Fig. 1a, in the preferred embodiment, there is provided an inner fuel channel in the armature 16 with a fuel outlet 38. However, this is

not essential for the invention.

[0037] Fig. 2 illustrates three alternative embodiments of a valve needle assembly according to the present invention. As can be seen from Fig. 2 in comparison to Fig. 1 the overall diameters of different sections of the valve needle assembly are not essential, but may be chosen in accordance with the special application. Fig. 2c illustrates, thus, an embodiment that corresponds essentially to the one shown in Fig. 1. Fig. 2a and 2b illustrate embodiments with one beaded ring 36 only. The embodiments of Fig 2a, 2b, and 2c differ in the profile of the beaded rings 36, which can be rounded, square, triangular, or otherwise shaped.

[0038] Fig. 3 illustrates a valve assembly according to the present invention in its final configuration, i.e. with the valve needle assembly 12 inserted in the valve body 18.

[0039] Fig. 4 illustrates an enlarged view of the interacting guiding zones 28, 30 of the valve assembly shown in Fig. 3. When inserting the valve needle assembly 12, the sizing zone 34 with the beaded rings 36 first passes by the ring type guiding zone 28 of the eyelet 26 sizing its diameter such, that the matching between the ring type guiding zone 28 of the eyelet 26 and the cylindrical guiding zone 30 of the armature 16, following the sizing zone 34 in being inserted, is optimised. Thus, the outer diameter of the beaded rings 36 is smaller than the inner diameter of the valve body cavity 20 in this section, resulting in a clearance 40, which ensures, that the sizing zone 34 does not interfere with the axial movement of the valve needle assembly during operation.

[0040] Fig. 5 illustrates four steps of a preferred method for producing the valve assembly shown in Fig. 3.

[0041] In step a) there are provided a valve body 18 and an eyelet 26. The valve body 18 may be configured as a single part as well as an assembly from several parts fixed together. The eyelet is preferably made from some non-magnetic material, thus acting additionally as a non-magnetic shell. The eyelet is preferably crimped on the upper rim of the valve body 18. However, other methods of fixing the eyelet 26 to the valve body 18 are applicable, too.

[0042] In step b) the valve needle assembly 12 is inserted into the valve body 18. The armature of the valve needle assembly 12 is preferably made from some magnetic and corrosion resistant steel like 430 FR Annealed solenoid Quality. Due to the configuration of the sizing zone 24 neighbouring the cylindrical guiding zone 30 according to the invention, the material of the eyelet 26 is compressed and plastically deformed during the insertion process. Apart from some inevitable settlement of material, which can be compensated by an accordingly larger diameter of the sizing zone 34, the ring type guiding zone 28 is, thus, sized to the desired diameter.

[0043] In step c) the valve seat 24 and the valve orifice 22 are inserted, preferably as a prefixed unit.

[0044] In Fig. 5d the valve assembly 10 is shown in its final configuration.

[0045] While the invention has been described in the context of preferred embodiments, it will be apparent to those skilled in the art that the present invention may be modified in numerous ways and may assume many embodiments other than that specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the invention which fall within the scope of the invention.

Claims

1. A valve needle assembly comprising a valve needle (14) and an electro-magnetic armature (16) coupled to the valve needle (14), the valve needle assembly being suited for use in a valve assembly (10) of an injector unit for injecting fuel into an engine of a vehicle, said valve assembly comprising a valve body (18) with a valve body cavity (20) in which the valve needle assembly is to be inserted, said valve body (18) comprising at least one ring type guiding zone (28) for guiding an axial movement of the valve needle assembly and the valve needle assembly comprising a corresponding cylindrical guiding zone (30),
characterized by
sizing means (28, 34, 36) comprising at least one sizing member (36) neighbouring the cylindrical guiding zone (30) for sizing the diameter of the ring type guiding zone (28) when inserting the valve needle assembly into the valve body cavity (20).

2. The valve needle assembly according to claim 1,
characterized in that
the sizing means (28, 34, 36) being positioned on the electro-magnetic armature (16).

3. The valve needle assembly according to any one of the preceding claims,
characterized by
at least one sizing member being configured as a full perimeter beaded ring (36) around a cylindrical portion of the valve needle assembly.

4. The valve needle assembly according to claim 3,
characterized by
at least one beaded ring (36) having a rounded profile.

5. The valve needle assembly according to claim 3 or 4,
characterized in that
the sizing means being configured of a plurality of coaxial full perimeter beaded rings (36) around a cylindrical portion of the valve needle assembly.

6. The valve needle assembly according to claim 5,
characterized in that

each beaded ring (36) of the plurality of beaded rings (36) having an outer diameter that is larger than the outer diameter of its neighbouring beaded ring (36) further apart from the valve needle assembly's cylindrical guiding zone (30).

7. The valve needle assembly according to claim 5 or 6,
characterized by
at least one beaded ring (36) having an outer diameter that is slightly larger than the desired inner diameter of the valve body's (18) ring type guiding zone (28).

8. The valve needle assembly according to any one of the preceding claims,
characterized in that
at the sizing means (28, 34, 36) having a surface made from a material harder than the material of the valve body's (18) ring type guiding zone (28).

9. The valve needle assembly according to claim 8,
characterized in that
the material of the surface of the sizing means (28, 34, 36) being a chrome comprising alloy.

10. A valve assembly, in particular for use in an injector unit for injecting fuel into an engine of a vehicle, comprising a valve body (18) with a valve body cavity (20) and a valve orifice (22), in which valve body cavity (20) there is installed a valve needle assembly (1212) comprising a valve needle (14) movable along its longitudinal axis between a closed position, in which the valve needle (14) obturates the valve orifice (22), and an open position, in which the valve needle (14) does not obturate the valve orifice (22), said valve body (18) comprising at least one ring type guiding zone (28) for guiding the axial movement of the valve needle assembly (12) and the valve needle assembly (12) comprising a corresponding cylindrical guiding zone (30),
characterized in that
the valve needle assembly (12) being configured according to any one of the claims 1 to 9.

11. A method for producing a valve assembly (10), in particular for use in an injector unit for injecting fuel into an engine of a vehicle, comprising the steps of

- providing a valve body (18) with a valve body cavity (20) having at least two openings and comprising a ring type guiding zone (28);

- providing a valve needle assembly (12) comprising a valve needle (14) coupled to an electro-magnetic armature (16) and further comprising at least one cylindrical guiding zone (30) having an outer diameter corresponding substantially to the inner diameter of the valve body's (18) ring type guiding zone (28);

- inserting the valve needle assembly (12) into the valve body cavity (20), such that the valve needle (14) is allowed to move along its longitudinal axis in a way guided by the interaction of the corresponding guiding zones (28; 30),

characterized in that
the valve needle assembly (12) having a sizing means (28, 34, 36) with at least one sizing member (36) neighbouring the cylindrical guiding zone (30), and by the step of sizing the diameter of the ring type guiding zone (28) by the sizing means (28, 34, 36) when inserting the valve needle assembly (12) into the valve body cavity (20).

12. The method according to claim 11,
characterized in that
the step of inserting the valve needle assembly (12) comprises inserting a valve needle assembly (12) according to one of the claims 1 to 9.

13. The method according to claim 11 or 12,
characterized in that
the step of sizing the diameter of the ring type guiding zone (28) comprises compressing the ring type guiding zone's (28) material for inducing a plastic deformation.

14. The method according to any one of the claim 11 to 13,
characterized by
measuring the force required for inserting the valve needle assembly (12) into the valve body cavity (20).

15. The method according to claim 14,
characterized by
using the measured force values to decide if the ring type guiding zone (28) and/or the valve needle assembly (12) are machined within desired specifications.

FIG 1A

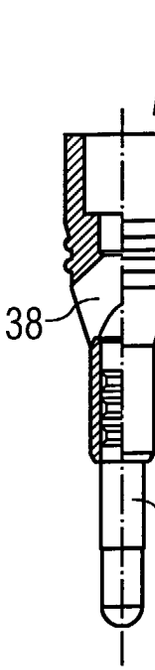


FIG 1B

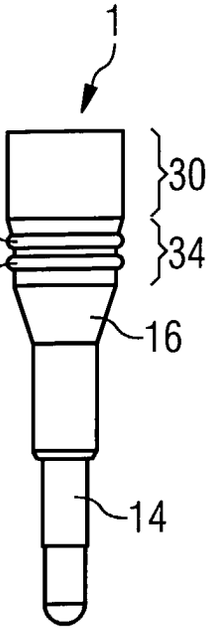


FIG 2A

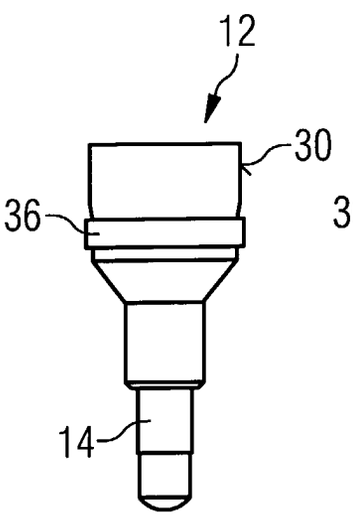


FIG 2B

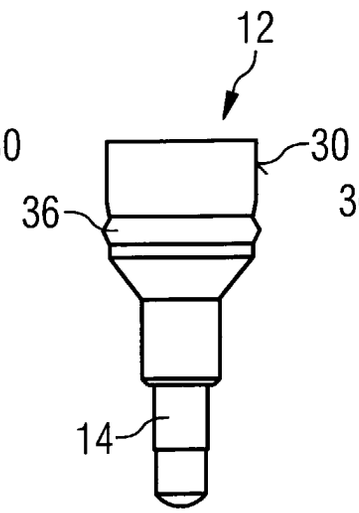


FIG 2C

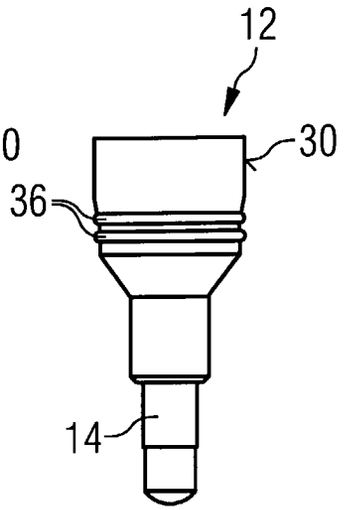


FIG 3

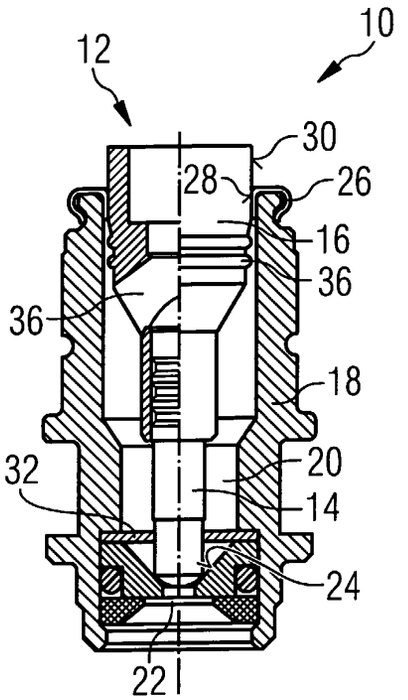

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FIG 4

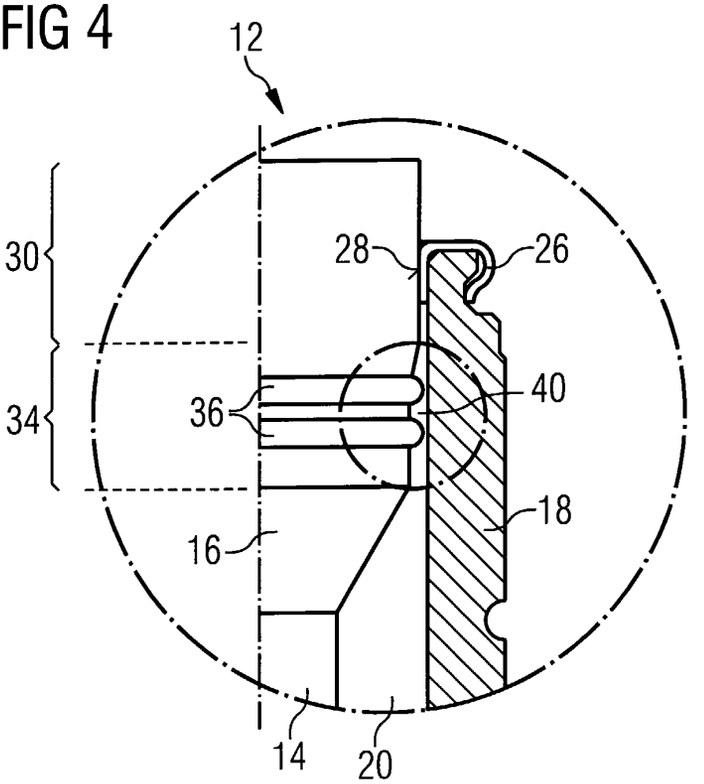
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FIG 5A

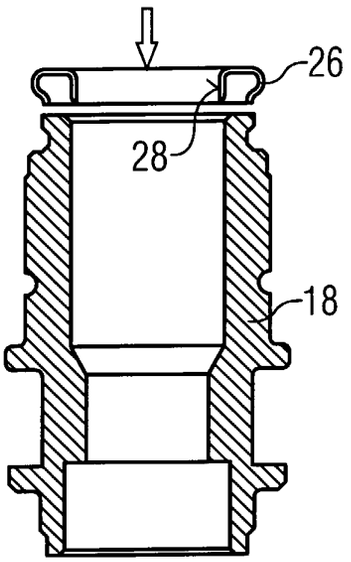


FIG 5B

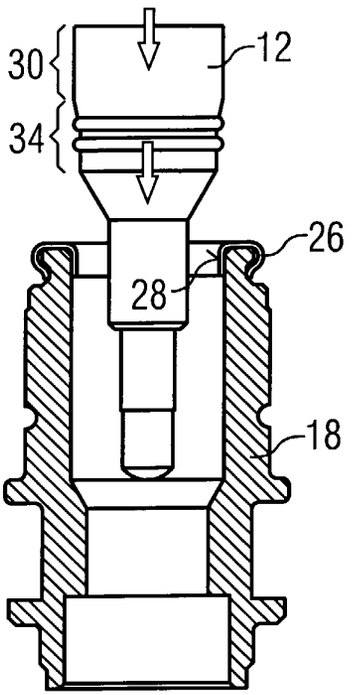


FIG 5C

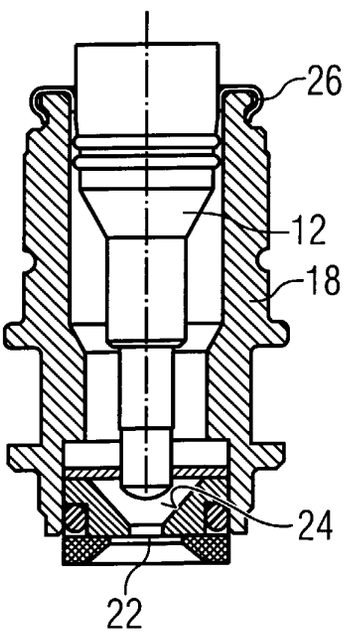


FIG 5D

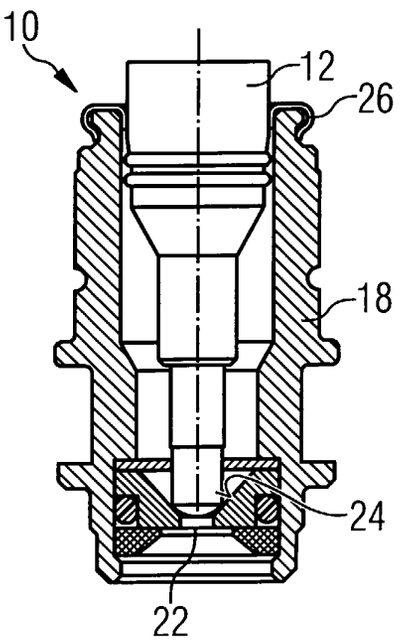
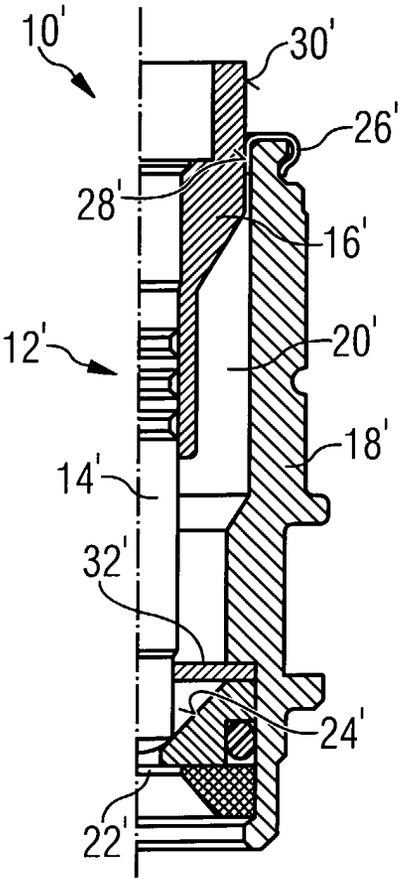


FIG 6 Prior Art



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 00 8954

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	DE 100 51 016 A (BOSCH GMBH ROBERT) 18 April 2002 (2002-04-18) * paragraph '0019! - paragraph '0029!; figures 1,2 *	1,2,10 8,9	F02M51/06 F02M61/16 F02M61/12
Y	US 6 062 499 A (NAKAMURA MASAHITO ET AL) 16 May 2000 (2000-05-16) * column 5, line 39 - column 6, line 10; figures 2,5,6,10 *	8,9	
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