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(54) **FUEL INJECTION VALVE**

KRAFTSTOFFEINSPRITZVENTIL

SOUPAPE D'INJECTION DE CARBURANT

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EP 3 695 110 B1

Description

[0001] The present disclosure relates to a fuel injection valve for injecting fuel directly or indirectly into an internal combustion engine of a vehicle.

[0002] Fuel injection valves typically have a valve body of stainless steel comprising a cavity with a fluid inlet portion and a fluid outlet portion and a valve needle axially movable in the cavity. The valve needle is actuated by an electromagnetic actuator unit which has an armature connected to the valve needle and movable in the cavity.

[0003] The electromagnetic actuator unit further comprises a coil which can be energized to move the armature. Pole pieces made of a material of high magnetic permeability serve to direct the magnetic field. Other metal parts of the injection valve can influence the magnetic field likewise and have an impact on the performance of the injection valve.

[0004] US 5 238 192 A relates to solenoid operated fluid metering devices such as solenoid operated fuel injector valves for internal combustion engines, and in particular to the organization and arrangement of a filter on such a device for filtering certain particulate material from fluid entering the device.

[0005] DE 10 2006 055 088 A1 relates to an injector valve for controlling a fuel quantity injected into an internal combustion engine for motor vehicles, comprises a valve body movable by an electromagnetic coil system against a valve seat. The valve body is connected with a soft-magnetic armature of the electromagnetic coil system, which has a coil with a soft-magnetic core. A lamination stack from evolvent-shaped laminated soft-magnetic sheet metal is intended as soft-magnetic core.

[0006] US 2007 000 480 A1 relates to a fuel injector for the direct injection of fuel into the combustion chamber of a mixture-compressing internal combustion engine having external ignition includes a valve housing formed by a nozzle body, and a seal which seals the fuel injector from a cylinder head of the internal combustion engine. The seal has a sleeve-type design with a structured cross section and extends across the axial length of the nozzle body.

[0007] EP 2 841 761 A1 relates to a fuel injection system which has a fuel distributor and multiple fuel injection valves each disposed on a cup of the fuel distributor. At least one injection valve is mounted on the associated cup by way of at least one holding element. An abutment surface is provided on the outer side of the cup. A support surface is configured on the underside of the cup. The holding element is moreover configured as a holding clamp. An abutment surface is provided on an outer side of the fuel injection valve. The holding clamp engages on the one hand behind the abutment surface of the cup and on the other hand behind the abutment surface of the fuel injection valve. The holding clamp furthermore pushes the fuel injection valve toward the support surface.

[0008] It is an object of the present invention to provide a fuel injection valve with a better magnetic performance. In particular, magnetic losses shall be minimised.

[0009] This object is achieved by means of a fuel injection valve having the features of claim 1.

[0010] Advantageous embodiments and developments of the fuel injection valve are specified in the dependent claims, the following description and the drawings.

[0011] According to an aspect of the invention, a fuel injection valve is provided comprising a valve body with a central longitudinal axis. The valve body comprises a cavity with a fluid inlet portion and a fluid outlet portion. In particular, the cavity is defined by an interior surface of the hollow valve body. The fuel injection valve further comprises a valve needle axially movable in the cavity, i.e. the valve needle is received in the cavity and axially movable with respect to the valve body. The valve needle prevents a fluid flow through the fluid outlet portion in a closing position and releases the fluid flow through the fluid outlet portion in further positions.

[0012] The fuel injection valve further comprises an electromagnetic actuator unit being operable to actuate the valve needle.

[0013] A metal housing is partially arranged around the valve body and the electromagnetic actuator unit. The metal housing is at least partially laminated.

[0014] The housing may expediently represent a magnetic yoke for guiding magnetic flux of the electromagnetic actuator unit. In particular, the electromagnetic actuator unit comprises an armature which is fixed to the needle or coupled to the needle by a form-fit and/or force-fit connection to cause the needle to move axially in the cavity in response to a magnetic field generated when the coil is energized. The housing may expediently be operable to guide the magnetic field towards the armature.

[0015] By the housing being at least partially laminated it is understood that at least a part of the housing is made of multiple layers of metal.

[0016] Typically, the housing is arranged around the valve body to receive the actuator unit, in particular the coil and part of its power supply. The housing is made of a metal, e.g. stainless steel, for example by a turning manufacturing technology.

[0017] The fuel injection valve according to the present invention has the advantage, that due to the laminated design of the housing eddy currents are minimized. Thus, magnetic losses can be reduced and the overall magnetic performance of the injector can be improved.

[0018] In one embodiment, the housing may be overmoulded, preferably to be permanently connected to the valve body. Additionally or alternatively, a press-fit connection may be established between the housing and the valve body for permanently connecting the housing to the valve body.

[0019] Preferably, the housing is comprised by an integrally formed power group module of the fuel injection valve. The power group module may expediently com-

prise the housing, the coil and a plastic part - the plastic part being in particular produced by overmolding the housing and the coil. That the power group module is "integrally formed" means in particular that it cannot be nondestructively disassembled. The plastic part preferably comprises an electrical connector for connecting the coil to an electronic control unit. The power group module may be permanently connected to the valve body by means of the overmolded plastic part fixing the module to the valve body and/or by a press-fit connection with the valve body, e.g. between the housing and the valve body.

[0020] According to an embodiment, a laminated part of the housing comprises a plurality of single layers which extend perpendicular to the radial direction with respect to the central longitudinal axis L of the injection valve. In other words, the single layers follow one another in radial direction.

[0021] This has the advantage that the orientation of the layers effectively helps to reduce eddy currents, which tend to occur in radial direction in the housing.

[0022] According to an embodiment, the housing is at least partially formed by a wrapped metal sheet. By this it is understood that at least a part of the housing is formed by a metal sheet which is wound around an axis. In particular, a metal sheet can be wound around the central longitudinal axis L of the valve body.

[0023] This has the advantage, that eddy currents, which typically occur in radial direction, cannot propagate but would have to travel along the turns of the wrapped housing increasing the total length of travel. Thus, magnetic losses due to eddy currents can be minimized.

[0024] Furthermore, a housing formed by a wrapped metal sheet can be manufactured easily and at low cost.

[0025] The housing may consist entirely of metal. This may be advantageous for assembling the housing, including e.g. producing of welded and/or soldered connections. Alternatively, the single layers are metal layers which alternate with insulating layers. In another development, the wrapped metal sheet is laminated with an insulating layer. For example, the metal layers or the metal sheet, respectively, are/is coated with an insulating film. In this way a particular high resistance between the metal layers or the turns of the wrapped metal sheet is achievable and the eddy currents may be particularly small.

[0026] According to an embodiment of the invention, the metal sheet has a thickness of 0.05 mm to 0.2 mm, the limits being included. Such a sheet may be wound in 5 to 40 turns, the limits being included, to build up a housing of the required thickness which may be in the order of 1.6 mm.

[0027] According to an embodiment, the housing comprises a mantle part extending around the valve body and surrounding the electromagnetic actuator unit, the mantle part being laminated. The mantle part can also be denoted as a peripheral part. The housing further comprises a washer part forming the base of the housing and extending radially from the valve body. The washer part may be in the shape of a disc having a main plane of extension which is perpendicular to the longitudinal axis. One axial end of the mantle part may expediently adjoin the washer part.

[0028] According to this embodiment, the housing has at least two separate parts which may be joined for example by laser welding. One part of the housing, the mantle part, can be easily manufactured in the laminated design, for example by wrapping a metal sheet.

[0029] The second part, the washer part, would be more difficult to manufacture in a laminated fashion. However, this part typically has a lower contribution to the magnetic performance of the valve. Therefore, the washer part may be massive and may be produced by a process like stamping.

[0030] This embodiment has the advantage, that the housing can be manufactured easily and at low cost.

[0031] According to an embodiment of the invention, at least the laminated part of the housing is made of ferritic or martensitic stainless steel. These materials are suited for the use in an injection valve and are magnetic.

[0032] Further advantages, advantageous embodiments and developments of the valve assembly for an injection valve, the fluid injection valve and the engine will become apparent from the exemplary embodiments which are described below in association with the schematic figures.

Figure 1 shows a cross-section of a fuel injection valve with a housing according to an embodiment of the invention;

Figure 2 shows a partial cross-section of the housing according to figure 1 and

Figure 3 shows a perspective view of a first part of the housing according to figure 2.

[0033] Figure 1 shows an injection valve 1 for the injection of fuel into an internal combustion engine. The injection valve 1 comprises a valve assembly 3 with a valve body 4 with a central longitudinal axis L. The valve body 4 comprises a cavity 9 with a fluid inlet portion 5 and a fluid outlet portion 7.

[0034] A valve needle 11 is arranged axially movable in the cavity 9. The valve needle 11 prevents a fluid flow through the fluid outlet portion 7 in a closing position. To achieve this, the needle 11 has a ball 13 welded to its lower end which interacts with a valve seat (not shown in detail) of the valve body 4.

[0035] The injection valve 1 further comprises an electromagnetic actuator unit 20 to actuate the valve needle 11. The actuator unit 20 comprises an armature 21 which may be fixed to the needle 11 or coupled to the needle 11 in some other way to cause the needle 11 to move axially in the cavity 9 in response to a magnetic field. The actuator unit 20 further comprises a coil 23 which may

be energized to induce a magnetic field. The magnetic field acts on the armature 21 to cause it to travel upwards and take the needle 11 with it against the force of the calibration spring 25. Thus, the ball 13 leaves the valve seat and fuel is released through the fluid outlet portion 7.

[0036] When the magnetic field ceases, the valve needle 11 is moved downwards by the force of the calibration spring 25 and the fluid outlet portion 7 is closed again.

[0037] The injection valve 1 further comprises a pole piece 27 which serves to direct the magnetic field. Other magnetic components of the injection valve 1 contribute to directing the magnetic field, too. A metal housing 29 is arranged around the valve body 4 enclosing the coil 23 and being fixed to the valve assembly 3 by means of a plastic housing 31.

[0038] The metal housing 29, the coil 23 and the plastic housing 31 are, thus, comprised by an integrally formed power group module of the fuel injection valve.

[0039] The housing 29 is made of stainless steel, in particular ferritic or martensitic stainless steel, and is therefore magnetic. Thus, the housing 29 contributes to the magnetic performance of the injection valve 1. More Specifially, the housing 29 is operable to guide magnetic flux generetad by the coil 23 in operation in axial direction along the coil 23 on the side of the coil facing away from the valve body 4 and in radial direction towards the armature 21. Therefore, the housing 29 axially overlaps the pole piece 27, the coil 23 and the armatuare 21.

[0040] The housing 29 is at least partially formed of laminated metal, that is multiple layers of metal. In particular, the layers extend perpendicular to the radial direction with respect to the central longitudinal axis L, thereby reducing the occurrence of eddy currents.

[0041] Figure 2 shows a partial section of the housing 29 according to figure 1. The housing 29 comprises two separate parts, which are joined together by laser welding.

[0042] The first part of the housing 29 is the mantle part 33 which is laminated and consists of multiple layers 37 of metal. The mantle part 33 has the shape of a hollow cylinder extending coaxially with the coil 23 and the valve body 4 around the central longitudinal axis L. In this way, a good axial guidance of the magnetic flux is enabled in the mantle part 33, while eddy currents in the mantle part 33 may be particularly small.

[0043] The layers 37 may be formed by a single metal sheet which is wrapped around the central longitudinal axis L in a number of turns. However, the layers 37 may also be formed by a number of cylindrical metal parts of different diameters. In the embodiment shown in figures 1 to 3, the layers 37 are formed by a single sheet of metal which is wrapped around the central longitudinal axis L. This embodiment is easy to manufacture.

[0044] The second part of the housing 29 is the washer part 35 which forms a base of the housing 29 and extends radially from the valve body 4. The washer part 35 has an inner surface 39 which contacts the valve body 4 when the injection valve 1 is assembled. On an upper side 41 of the washer part 35, the mantle part 33 is arranged. The washer part 35 is not laminated, but massive and can be manufactured by stamping. In this way, it advantageously enables a good guidance of the magnetic flux in radial direction towards the armature 21. Therefore, the washer part 35 may expediently axially overlap the armature 21.

[0045] The washer part 35 and the mantle part 33 are joined together by laser welding before the injection valve 1 is assembled.

[0046] Figure 3 shows a perspective view of the mantle part 33 of the housing 29. From this figure, it can be seen that the mantle part 33 has the form of a hollow cylinder and that according to this embodiment, it is formed by a single metal sheet 43 which is wrapped around the central longitudinal axis L several times, thereby forming multiple layers 37.

Claims

1. Fuel injection valve (1), comprising

- a valve body (4) with a central longitudinal axis (L) comprising a cavity (9) with a fluid inlet portion (5) and a fluid outlet portion (7),
- a valve needle (11) axially moveable in the cavity (9), the valve needle (11) preventing a fluid flow through the fluid outlet portion (7) in a closing position and releasing the fluid flow through the fluid outlet portion (7) in further positions,
- an electro-magnetic actuator unit (20) for actuating the valve needle (11),
- a metal housing (29) being partially arranged around the valve body (4) and the electromagnetic actuator unit (20),

characterised in that the metal housing (29) is at least partially laminated,

wherein a laminated part of the housing (29) comprises a plurality of single metal layers (37) which extend perpendicular to the radial direction with respect to the central longitudinal axis L or the housing (29) is at least partially formed by a wrapped metal sheet (43) and wherein the housing (29) comprises

- a mantle part (33) extending around the valve body (4) and surrounding the electromagnetic actuator unit (20), the mantle part (33) being laminated, and
- a washer part (35) forming the base of the housing (29) and extending radially from the valve body (4).

2. Fuel injection valve (1) according to the preceding claim, wherein the washer part (35) is not laminated, but massive.

3. Fuel injection valve (1) according to any of the preceding claims,
wherein the metal sheet (43) has a thickness of 0.05 mm to 0.2 mm, the limits being included.

4. Fuel injection valve (1) according to the preceding claim, wherein the metal sheet (43) is wound in 5 to 40 turns, the limits being included.

5. Fuel injection valve (1) according to any of the preceding claims, wherein the housing (29) represent a magnetic yoke for guiding magnetic flux of the electromagnetic actuator unit (20).

6. Fuel injection valve (1) according to any of the preceding claims,
wherein the electro-magnetic actuator unit (20) comprises an armature (21) for actuating the valve needle (11) and the washer part (35) axially overlaps the armature (21).

7. Fuel injection valve (1) according to any of the preceding claims, wherein the housing (29) is comprised by an integrally formed power group module of the fuel injection valve (1) which comprise the housing (29), a coil (23) of the electromagnetic actuator unit (20) and a plastic part produced by overmolding the housing (29) and the coil (23) .

8. Fuel injection valve (1) according to any of the preceding claims,
wherein at least the laminated part of the housing (29) is made of a ferritic or martensitic stainless steel.

Patentansprüche

1. Kraftstoffeinspritzventil (1), umfassend

- einen Ventilkörper (4) mit einer mittigen Längsachse (L), der einen Hohlraum (9) mit einem Fluideinlassabschnitt (5) und einem Fluidauslassabschnitt (7) umfasst,
- eine Ventilnadel (11), die in dem Hohlraum (9) axial bewegbar ist, wobei die Ventilnadel (11) in einer Schließposition einen Fluidstrom durch den Fluidauslassabschnitt (7) verhindert und in weiteren Positionen den Fluidstrom durch den Fluidauslassabschnitt (7) freigibt,
- eine elektromagnetische Betätigungseinheit (20) zum Betätigen der Ventilnadel (11),
- ein Metallgehäuse (29), das teilweise um den Ventilkörper (4) und die elektromagnetische Betätigungseinheit (20) herum angeordnet ist,

dadurch gekennzeichnet, dass
das Metallgehäuse (29) mindestens teilweise laminiert ist, wobei ein laminierter Teil des Gehäuses (29) eine Vielzahl von einzelnen Metallschichten (37) umfasst, die sich rechtwinklig zur Radialrichtung in Bezug auf die mittige Längsachse L erstrecken, oder das Gehäuse (29) mindestens teilweise durch ein gewickeltes Metallblech (43) gebildet ist und wobei das Gehäuse (29) umfasst:

- ein Mantelteil (33), das sich um den Ventilkörper (4) herum erstreckt und die elektromagnetische Betätigungseinheit (20) umgibt, wobei das Mantelteil (33) laminiert ist, und
- ein Scheibenteil (35), das die Basis des Gehäuses (29) bildet und sich radial vom Ventilkörper (4) erstreckt.

2. Kraftstoffeinspritzventil (1) gemäß dem vorhergehenden Anspruch, wobei das Scheibenteil (35) nicht laminiert, sondern massiv ist.

3. Kraftstoffeinspritzventil (1) gemäß einem der vorhergehenden Ansprüche,
wobei das Metallblech (43) eine Dicke von 0,05 mm bis 0,2 mm aufweist, wobei die Grenzen eingeschlossen sind.

4. Kraftstoffeinspritzventil (1) gemäß dem vorhergehenden Anspruch,
wobei das Metallblech (43) in 5 bis 40 Windungen gewickelt ist, wobei die Grenzen eingeschlossen sind.

5. Kraftstoffeinspritzventil (1) gemäß einem der vorhergehenden Ansprüche, wobei das Gehäuse (29) ein magnetisches Joch zum Führen des Magnetflusses der elektromagnetischen Betätigungseinheit (20) darstellt.

6. Kraftstoffeinspritzventil (1) gemäß einem der vorhergehenden Ansprüche,
wobei die elektromagnetische Betätigungseinheit (20) einen Anker (21) zum Betätigen der Ventilnadel (11) aufweist und das Scheibenteil (35) den Anker (21) axial überlappt.

7. Kraftstoffeinspritzventil (1) gemäß einem der vorhergehenden Ansprüche, wobei das Gehäuse (29) von einem einstückig ausgebildeten Leistungsgruppenmodul des Kraftstoffeinspritzventils (1) umfasst ist, das das Gehäuse (29), eine Spule (23) der elektromagnetischen Betätigungseinheit (20) und ein durch Umspritzen des Gehäuses (29) und der Spule (23) hergestelltes Kunststoffteil umfasst.

8. Kraftstoffeinspritzventil (1) gemäß einem der vorhergehenden Ansprüche,
wobei mindestens der laminierte Teil des Gehäuses (29) aus einem ferritischen oder martensitischen rostfreien Stahl hergestellt ist.

Revendications

1. Soupape injection de carburant (1), comprenant

un corps de soupape (4) avec un axe longitudinal central (L) comprenant une cavité (9) avec une partie d'entrée de fluide (5) et une partie de sortie de fluide (7),
un pointeau de soupape (11) mobile axialement dans la cavité (9), le pointeau de soupape (11) empêchant un écoulement de fluide à travers la partie de sortie de fluide (7) dans une position de fermeture et libérant l'écoulement de fluide à travers la partie de sortie de fluide (7) dans d'autres positions,
une unité d'actionneur électromagnétique (20) pour actionner le pointeau de soupape (11),
un boîtier métallique (29) partiellement disposé autour du corps de soupape (4) et de l'unité d'actionneur électromagnétique (20), **caractérisé en ce que**
le boîtier métallique (29) est au moins partiellement stratifié,
une partie stratifiée du boîtier (29) comprenant une pluralité de couches métalliques uniques (37) qui s'étendent perpendiculairement à la direction radiale par rapport à l'axe longitudinal central L ou le boîtier (29) étant au moins partiellement formé par une feuille métallique enveloppée (43)
et le boîtier (29) comprenant
une partie enveloppe (33) s'étendant autour du corps de soupape (4) et entourant l'unité d'actionneur électromagnétique (20), la partie enveloppe (33) étant stratifiée, et
une partie rondelle (35) formant la base du boîtier (29) et s'étendant radialement depuis le corps de soupape (4) .

2. Soupape d'injection de carburant (1) selon la revendication précédente, la partie rondelle (35) n'étant pas stratifiée, mais massive.

3. Soupape d'injection de carburant (1) selon l'une quelconque des revendications précédentes,
la feuille métallique (43) ayant une épaisseur de 0,05 mm à 0,2 mm, les limites étant incluses.

4. Soupape d'injection de carburant (1) selon la revendication précédente, la feuille métallique (43) étant enroulée en 5 à 40 tours, les limites étant incluses.

5. Soupape d'injection de carburant (1) selon l'une quelconque des revendications précédentes, le boîtier (29) représentant une culasse magnétique pour guider le flux magnétique de l'unité d'actionneur électromagnétique (20) .

6. Soupape d'injection de carburant (1) selon l'une quelconque des revendications précédentes,
l'unité d'actionneur électromagnétique (20) comprenant une armature (21) pour actionner le pointeau de soupape (11) et la partie rondelle (35) chevauchant axialement l'armature (21).

7. Soupape d'injection de carburant (1) selon l'une quelconque des revendications précédentes, le boîtier (29) étant constitué par un module de groupe de puissance faisant partie intégrante de la soupape d'injection de carburant (1) qui comprend le boîtier (29), une bobine (23) de l'unité d'actionneur électromagnétique (20) et une pièce en plastique produite par surmoulage du boîtier (29) et de la bobine (23).

8. Soupape d'injection de carburant (1) selon l'une quelconque des revendications précédentes,
au moins la partie stratifiée du boîtier (29) étant en un acier inoxydable ferritique ou martensitique.

FIG 1

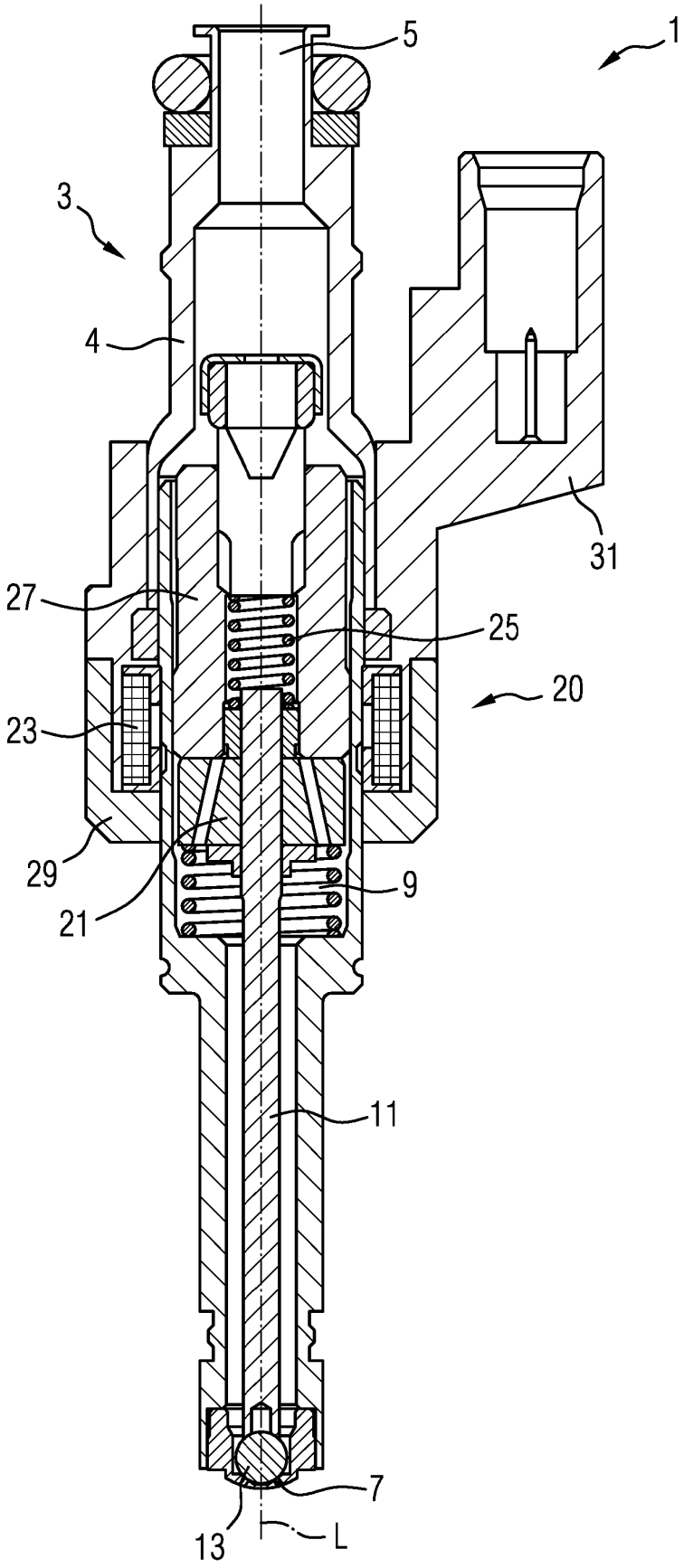


FIG 2

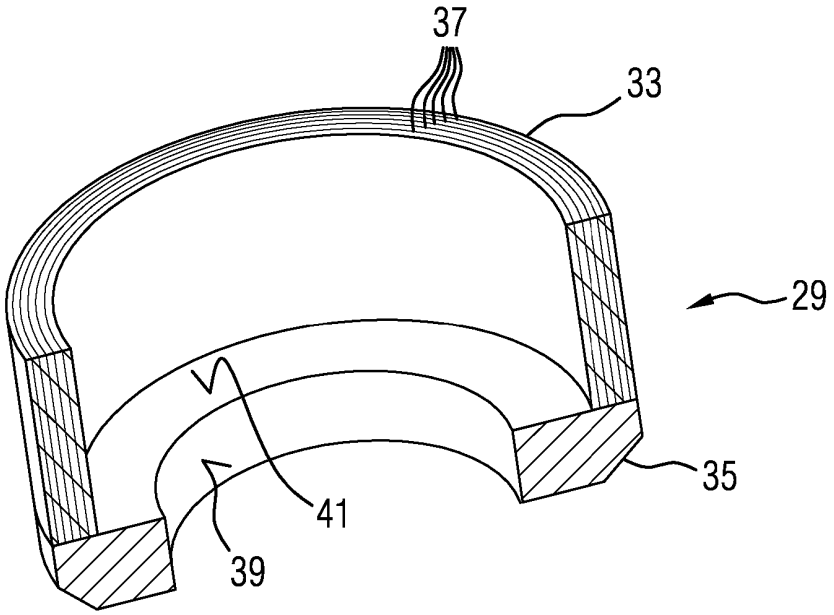
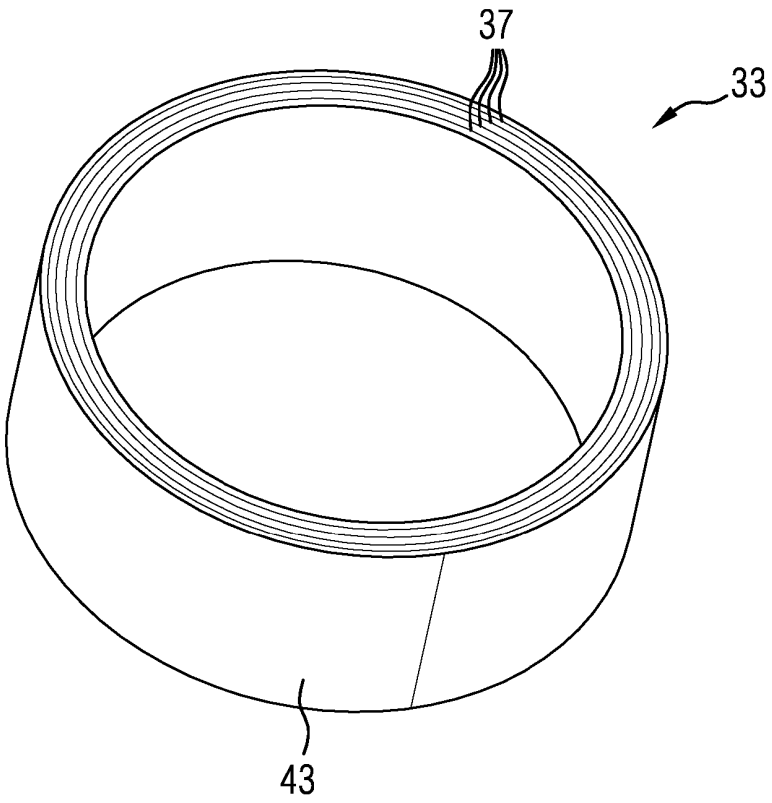


FIG 3



REFERENCES CITED IN THE DESCRIPTION

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