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(54) **SOLENOID SWITCH AND VEHICLE STARTER**

(57) A vehicle starter and a solenoid switch thereof are disclosed, the solenoid switch comprising a switch casing (1); a solenoid core (3) supported by the switch casing in a manner of being movable in an axial direction; a boot (7) adapted for sealing between the solenoid core and the switch casing; and a fixing ring (8) configured to fix the boot to the switch casing. First axial retention means ((24) engaged in (18)) is provided between the boot and switch casing for maintaining the relative axial position between the boot and switch casing, and second axial retention means (25) is provided on the boot for maintaining the relative axial position between the fixing ring and the boot. Service life of the boot and the fixing ring can be prolonged.

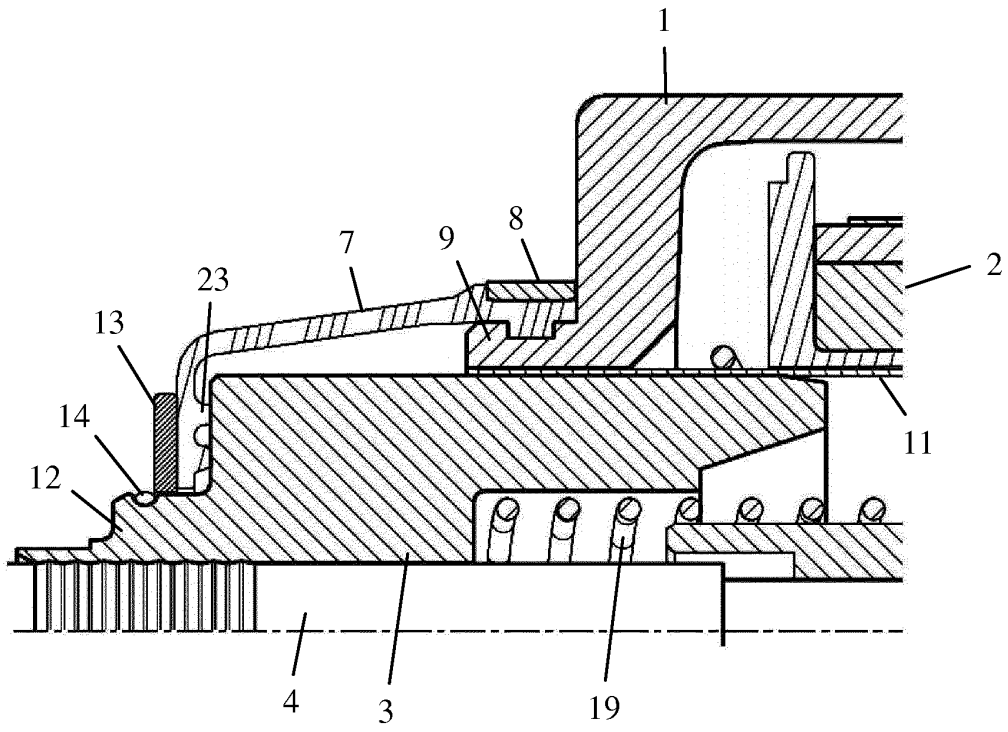

Figure 3

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Description

Technical Field

[0001] The disclosure relates to a solenoid switch to be used in a vehicle starter and a vehicle starter comprising such a solenoid switch.

Background Art

[0002] A starter of an automotive vehicle generally controls the action of a driving gear with a solenoid switch so that the driving gear meshes with a mating gear on an engine flywheel to drive a crankshaft of the engine to rotate. Figure 1 shows a known solenoid switch which mainly comprises a switch casing 1, an electromagnetic coil 2 mounted in the switch casing 1, a solenoid core 3 slidably mounted in the switch casing 1, an actuating bar 4 fixedly carried by the solenoid core 3 and configured for driving an actuating fork 5 for the driving gear to pivot, an end cap 6 fixed to the switch casing 1, and a boot 7 mounted between the solenoid core 3 and the switch casing 1, the boot 7 being generally made of rubber, for preventing water and other extraneous matters from entering into the switch casing 1.

[0003] A front portion of the boot 7 is clamped against a front portion of the solenoid core 3, a back portion of the boot 7 is clamped by a fixing ring 8 to a projected tubular portion 9 formed on a front end of the switch casing 1, and the fixing ring 8 itself is restricted by the end cap 6. As shown in Figure 2, the end cap 6 comprises several mounting portions 10 through which screws are inserted for fixing the end cap 6 to the switch casing 1. Each mounting portion 10 is in the form of a partial cylinder, with an inner side being opened to form a pair of opposing edges. Each edge has been cut away at its back end to form a step 11, and these steps support a back end of the fixing ring 8 to restrict the position of the fixing ring 8 in an axial direction.

[0004] In this solenoid switch, the steps 11 on the end cap 6 can provide only a small supporting area to the fixing ring 8, so the fixing ring 8 is prone to be damaged. In addition, the requirement on the concentricity between the end cap 6 and the switch casing 1 is relatively high, because otherwise the end cap 6 may compress the boot 7 via the fixing ring 8 with different compression forces at different locations so the boot 7 may be damaged after a certain time of operation.

Summary of the Disclosure

[0005] An object of the disclosure is to solve the problem that service life of the boot and its fixing ring in the vehicle starter according to the prior art is short.

[0006] For this end, according to one aspect of the disclosure, there provides a solenoid switch to be used in a vehicle starter, which comprises a switch casing, a solenoid core supported by the switch casing in a manner of being movable in an axial direction, a boot adapted for sealing between the solenoid core and the switch casing, and a fixing ring configured to fix the boot to the switch casing; wherein first axial retention means is provided between the boot and switch casing for maintaining the relative axial position between the boot and switch casing, and second axial retention means is provided on the boot for maintaining the relative axial position between the fixing ring and the boot.

[0007] According to a possible embodiment, the first axial retention means comprises a protrusion and/or recess formed on one of the boot and the switch casing and a mating recess and/or protrusion formed on the other one of the boot and the switch casing.

[0008] According to a possible embodiment, the switch casing comprises a main body and a projected tubular portion projected forwards from the main body, a back portion of the boot being clamped to the projected tubular portion by the fixing ring, and the first axial retention means being formed on the back portion of the boot and the projected tubular portion.

[0009] According to a possible embodiment, the protrusion is in the form of a ring-like protrusion, and the recess is in the form of a ring-like recess mating with the ring-like protrusion.

[0010] The ring-like protrusion and the ring-like recess each preferably has a rectangular, hook-like or dovetail-like cross section.

[0011] According to a possible embodiment, the second axial retention means comprises a step formed on an outer periphery of the boot.

[0012] The step is preferably in the shape of a circular ring extending around the outer periphery of the boot.

[0013] According to a possible embodiment, the fixing ring is in the form of a complete circular ring. Such a fixing ring is formed preferably of an elastic material such as rubber.

[0014] Alternatively, the fixing ring is in the form of a split ring. Such a fixing ring preferably comprises a self-locking structure or is provided with a locking member for locking it.

[0015] According to a possible embodiment, a front portion of the boot is slidably fitted around the solenoid core in a sealing manner.

[0016] According to a possible embodiment, with the front portion of it being fixed to the solenoid core and being movable together with the solenoid core.

[0017] According to a possible embodiment, the front portion of the solenoid core comprises a protruding portion, and the front portion of the boot forms a front end portion which extends radially inwards, the front end portion being mounted around the protruding portion and being fastened to a main portion of the solenoid core by a fastening element.

[0018] According to a possible embodiment, the front end portion of the boot is formed with an elastic protrusion facing towards the main portion of the solenoid core, the elastic protrusion being elastically deformed in a state of

being compressed against the main portion of the solenoid core by the fastening element. For example, the elastic protrusion is in the form of a circular ring, which may comprise two or more concentric circular rings.

[0019] According to another aspect of the disclosure, there provides the vehicle starter which comprises a solenoid switch as described above for controlling the start of a vehicle engine.

[0020] According to the disclosure, the boot is mounted to the switch casing by means of the fixing ring, the boot itself is provided with a retention structure for the fixing ring, so the position of the fixing ring is restricted without needing the help of the end cap. In this way, the boot and the fixing ring are not damaged under the action of the end cap as in the prior art, so the service life of the boot and the fixing ring can be prolonged.

Brief Description of the Drawings

[0021]

Figure 1 is a partial sectional view of a solenoid switch of a vehicle starter according to prior art.

Figure 2 is a partial perspective view of an end cap of the solenoid switch shown in Figure 1.

Figure 3 is a partial sectional view of the solenoid switch of the vehicle starter according to the disclosure.

Figure 4 is a partial sectional view of a switch casing of the solenoid switch shown in Figure 3.

Figure 5 is a sectional view of a boot of the solenoid switch shown in Figure 3.

Figure 6 is a sectional view of a fixing ring of the solenoid switch shown in Figure 3.

Figures 7-9 are side views of some possible embodiments of the fixing ring shown in Figure 6.

Detailed Description of Preferred Embodiments

[0022] Now some preferred embodiments of the disclosure will be described with reference to the drawings. It is noted that the drawings are presented for explaining the theory of the disclosure only and thus are not drawn in scale.

[0023] First, a solenoid switch of a vehicle starter of the disclosure will be described using Figure 3. It is noted that, when describing the solenoid switch of the disclosure, the term "front" related with orientation refers to the side proximal to the vehicle engine, and "back" refers to the side distal from the vehicle engine.

[0024] As sown in Figure 3, the solenoid switch of the disclosure comprises a switch casing 1 for mounting functional components of the solenoid switch. With reference to Figure 4, the switch casing 1 has a substantially cylindrical main body 15, and the main body comprises a front end wall 16. The switch casing 1 further has a projected tubular portion 9, in the form of a substantially circular tube, projected forwards from the front end wall 16, the projected tubular portion 9 being coaxial with the main body 15. The front end wall 16 and the projected tubular portion 9 define a through hole 17 therein, the through hole 17 extending axially from a front end surface of the projected tubular portion 9 and opened into an internal space defined in the main body 15. Further, the projected tubular portion 9 is formed with a ring-like recess 18 which is recessed radially inwards from the outer periphery of the projected tubular portion 9.

[0025] The electromagnetic coil 2 is fixedly mounted in the main body 15. When energized, the electromagnetic coil 2 generates a magnetic field.

[0026] The solenoid core 3 is disposed in the through hole 17, and is slidable relative to the switch casing 1 in the axial direction. Under the action of the magnetic field generated by the electromagnetic coil 2, the solenoid core 3 slides axially backwards (to the right in Figure 3). When the electromagnetic coil 2 is deenergized and the magnetic field disappears, the solenoid core 3 slides axially forwards (to the left in Figure 3) to its home position under the action of a return spring (the compression spring 19 shown in Figure 3 or the like).

[0027] A substantially cylindrical sleeve 11 made of a nonmagnetic material (for example, brass) is mounted in the switch casing 1, the sleeve 11 having a front end inserted in the through hole 17 and a back end extending into the internal space in the main body 15. The sleeve 11 provides support and guidance to the solenoid core 3, without interfering with the magnetic field generated by the electromagnetic coil 2.

[0028] An actuating bar 4 is fixedly carried in the solenoid core 3, the actuating bar 4 being configured to dive an actuating fork (not shown) for a driving gear to pivot so as to engage/disengage the driving gear with/from the a mating gear on an engine flywheel. The solenoid core 3 has a main portion and a substantially cylindrical protruding portion 12 extending forwards from a front end surface of the main portion. The actuating bar 4 may be fixed in the solenoid core 3 by performing a crimping operation performed on the protruding portion 12.

[0029] The boot 7 is mounted between the solenoid core 3 and the switch casing 1 to form sealing between them to prevent water and other extraneous matters from entering into the switch casing 1. The boot 7 is generally made of rubber or other elastic materials.

[0030] As shown in Figures 3 and 5, the boot 7 is an integrally formed single piece, which mainly comprises a substantially truncated cone shaped tube portion 20, a front end portion 22 extending radially inwards from a front end of the tube portion 20, and a clamped portion 21 extending backwards from a back end of the tube portion 20 in the axial direction.

[0031] The front end of the tube portion 20 has a smaller diameter than the back end of the tube portion 20. In addition, the tube portion 20 is formed to be elastically deformable so that it can be compressed in the axial direction. For example, the tube portion 20 may be formed to have a form of a bellow.

[0032] The clamped portion 21 is in the form of a substantially circular tube, having an inner diameter substantially equal to or slightly smaller than the outer diameter of the projected tubular portion 9. The clamped portion 21 comprises a ring-like protrusion 24 protruding radially inwards from the inner periphery of the ring-like protrusion 24, the shape and dimensions of ring-like protrusion 24 corresponding to that of the ring-like recess 18 on the projected tubular portion 9.

[0033] The front end portion 22 has a substantially disk like shape, and comprises a central hole to be passed through by the protruding portion 12. Further, an elastic protrusion 23 is formed on a back surface of the front end portion 22 and protrudes backwards. The elastic protrusion 23 is preferably in the form of a circular ring like protrusion, and, for example, may comprise two or more protrusions in the form of concentric circular rings.

[0034] A front portion of the boot 7 is clamped against a front portion of the solenoid core 3. Specifically, the protruding portion 12 of the solenoid core 3 extends through the central hole of the front end portion 22, and a stop ring 13 is mounted around the protruding portion 12 and pushes the front end portion 22 in the axially backward direction, so that the protrusion 23 is biased against the front end surface of the main portion of the solenoid core 3 to be elastically compressively deformed. In this state, a fastener, such as an elastic clamping ring 14 which clamps into a clamping groove on the protruding portion 12, is used for locking the stop ring 13 to the protruding portion 12, thereby the front end portion 22 of the boot 7 is clamped against the front end surface of the main portion of the solenoid core 3, and thus seals the front end surface of the main portion of the solenoid core 3 under the action of the elastic deformation of the protrusion 23 and/or of other portions of the front end portion 22. In this way, the front end portion 22 is movable axially together with the solenoid core 3, while the axial movement of the solenoid core 3 is not impeded by the boot 7 due to the elastically deforming ability of the tube portion 20. Meanwhile, the sealing between the solenoid core 3 and the switch casing 1 can be always maintained, no matter what axial position the solenoid core 3 is at.

[0035] The back portion of the boot 7 is clamped onto the projected tubular portion 9 by a fixing ring 8. Specifically, the clamped portion 21 is fixed around the projected tubular portion 9. On this point, it is appreciated that the clamped portion 21 having an inner diameter slightly smaller than the outer diameter of the projected tubular portion 9 is advantageous, since the clamped portion 21 may clamp tightly around the projected tubular portion 9 in the slight expansion state of the clamped portion 21.

[0036] Further, the ring-like protrusion 24 of the clamped portion 21 is engaged in the ring-like recess 18 of the projected tubular portion 9 to prevent the clamped portion 21 from moving axially forwards and disengaged from the projected tubular portion 9. In this manner, the mating structure of the ring-like protrusion 24 and the ring-like recess 18 forms axial retention means for restricting the clamped portion 21 with respect to the projected tubular portion 9 (i.e., restricting the boot 7 with respect to the switch casing 1).

[0037] The axial location of the ring-like protrusion 24 on the clamped portion 21 is designed such that, when the ring-like protrusion 24 is engaged in the ring-like recess 18, the back end of the clamped portion 21 is near the front end surface of the main body 15 of the switch casing 1.

[0038] The cross sectional shape of the ring-like protrusion 24/the ring-like recess 18 is designed to contribute to axial restriction. For example, the cross sectional shape may be rectangular as illustrated, or may be hook-like or dovetail-like or any other shapes that help the mating or engagement of the projected tubular portion 9 with the ring-like recess 18 for achieving axial locking.

[0039] Further, the ring-like protrusion 24/the ring-like recess 18 may comprise several protrusions/recesses, and there is no limitation to the number of the protrusion(s)/recess(es), which can be determined according to the size and strength of concrete structures.

[0040] Further, the locations of the ring-like protrusion 24/the ring-like recess 18 is not limited to the illustrated one. According to the spirit of the disclosure, one of the clamped portion 21 and the projected tubular portion 9 may be provided with the ring-like protrusion 24 and/or the ring-like recess 18, and the other one may be provided with the ring-like recess 18 and/or the ring-like protrusion 24.

[0041] A step 25 which projects radially outwards is formed on the transition portion between the tube portion 20 and the clamped portion 21. The step 25 is preferably in the form of a complete circular ring extending along the outer periphery of the transition portion between the tube portion 20 and the clamped portion 21, although it may alternatively be discrete, for example, it may comprise a plurality of arc segments distributed along the outer periphery of the transition portion. A back end surface of the step 25 is preferably perpendicular to the central axis of the boot 7. Further, the height of the step 25, by which the step 25 protrudes radially outwards from the outer periphery of the transition portion, is preferably approximate to, but slightly smaller than, the radial thickness of the fixing ring 8.

[0042] As shown in Figure 6, the fixing ring 8 has a certain axial width which corresponds to the axial distance between the back end surface of the step 25 and the back end of the clamped portion 21. In this way, once the clamped portion 21 is assembled to the projected tubular portion 9 as shown in Figure 3, the fixing ring 8 may be mounted around the clamped portion 21 between the back end surface of the step 25 and the front end

surface of the main body 15, with little axial clearance.

[0043] Further, the fixing ring 8, in use, has an inner diameter substantially equal to, but preferably smaller than, the normal outer diameter of the clamped portion 21. In this way, the clamped portion 21 is fixed radially relative to the projected tubular portion 9 by the fixing ring 8.

[0044] Considering the elasticity of the clamped portion 21, it is preferable that the fixing ring 8 has an inner diameter in use smaller than the normal outer diameter of the clamped portion 21, because in this condition the clamped portion 21 may be elastically compressively deformed under the radial compressive force of the fixing ring 8 to clamp further tightly around the projected tubular portion 9.

[0045] In the state that the fixing ring 8 surrounds the clamped portion 21, the step 25 prevents the fixing ring 8 from moving forwards to be detached from the clamped portion 21. Thus, the step 25 forms axial retention means for restricting the fixing ring 8 with respect to the clamped portion 21 (i.e., with respect to the boot 7). It can be understood that the step 25 may be in various suitable forms and may have various cross sectional shapes, only if it can prevent the fixing ring 8 from detached in the axial direction.

[0046] The fixing ring 8 itself may also be in various suitable forms. For example, Figure 7 shows a fixing ring 8 in the form of a complete circular ring. Such a fixing ring 8 can be made of an elastic material, such as rubber, so that the fixing ring 8 may be expanded and put around the clamped portion 21, and then shrinks to constrict the clamped portion 21 tightly with a sufficient radial compressive force.

[0047] Figure 8 shows a spring type fixing ring 8 in the form of a split ring having an opening 30 therein, the fixing ring 8 being formed of a material that has sufficient rigidity and resiliency, for example, steel. Thus, the opening 30 can be expanded so that the fixing ring 8 can be put onto the clamped portion 21, and then the opening 30 is released to reduce its size so that the fixing ring 8 constricts the clamped portion 21 tightly.

[0048] Figure 9 shows a split type fixing ring 8 having a self-locking structure at its opening, the fixing ring 8 having two free ends that may be separated from each other/locked together. In the state that the two free ends are separated from each other, the fixing ring 8 may be put onto the clamped portion 21, and then the two free ends are locked together so that the fixing ring 8 constricts the clamped portion 21 tightly. In the embodiment shown in Figure 9, the self-locking structure comprises a locking tooth 31 formed on each of the two free ends. The locking tooth 31 on each free end may comprise a plurality of teeth so that the inner diameter of the fixing ring 8 or the compressive force applied onto the clamped portion 21 is adjustable. Other types of self-locking structure may also be used here.

[0049] In an embodiment which is not shown, the split type fixing ring 8 may be provided with a locking member, such as a screw type or snap type locking member, for fastening the fixing ring 8.

[0050] Other types of the fixing ring can be conceived by those skilled in the art under the spirit of the disclosure.

[0051] It is appreciated that, according to the spirit of the disclosure, the front portion of the switch casing 1 may alternatively be constructed in other forms than the projected tubular portion 9, and the front portion of the solenoid core 3 may alternatively be constructed in other forms than the protruding portion 12, only if the boot 7 can be assembled in a sealing manner between the switch casing 1 and the solenoid core 3 in a manner like that described above.

[0052] It is also appreciated that it is not necessary to fix the front end of the boot 7 to the front portion of the solenoid core 3. For example, the front end of the boot 7 may alternatively be designed to be slidable in a sealing manner on the solenoid core 3 (for example, slidable on the main portion or the protruding portion 12 of the solenoid core). In this condition, the front end portion 22 may be adapted to be slidably fitted around a corresponding portion of the solenoid core 3 (rather than be fixed in the manner described above), and the ability of axial compression by elastic deforming of the tube portion 20 may be omitted in this case.

[0053] It is noted that the solenoid switch of the disclosure comprises also an end cap (not shown) fixed to the switch casing 1 as in the prior art, but the end cap does not involve in the assembling of the boot 7, and thus the end cap does not contact with or act on the boot 7 or the fixing ring 8. In this way, neither the boot 7 nor the fixing ring 8 will be damaged under the action of the end cap, so the service life of the boot 7 and the fixing ring 8 can be prolonged.

[0054] In addition, due to the fact that the boot 7 is assembled without the participation of the end cap, the requirement on the concentricity between the end cap and the switch casing 1 can be lowered down, which renders the assembling of the end cap easier.

[0055] Although the disclosure has been described with reference to particular embodiments, the scope of the disclosure is not limited to the illustrated and described details, and various modifications to these details may be made without departing from the spirit of the disclosure.

Claims

1. A solenoid switch to be used in a vehicle starter, comprising:

   a switch casing (1);
   a solenoid core (3) supported by the switch casing in a manner of being movable in an axial direction;
   a boot (7) adapted for sealing between the solenoid core and the switch casing; and

a fixing ring (8) configured to fix the boot to the switch casing;
wherein first axial retention means is provided between the boot and switch casing for maintaining the relative axial position between the boot and switch casing; and
wherein second axial retention means is provided on the boot for maintaining the relative axial position between the fixing ring and the boot.

2. The solenoid switch of claim 1, wherein the first axial retention means comprises a protrusion and/or recess formed on one of the boot and the switch casing and a mating recess and/or protrusion formed on the other one of the boot and the switch casing.

3. The solenoid switch of claim 2, wherein the switch casing comprises a main body and a projected tubular portion projected forwards from the main body, a back portion of the boot being clamped to the projected tubular portion by the fixing ring, and the first axial retention means being formed on the back portion of the boot and the projected tubular portion.

4. The solenoid switch of claim 3, wherein the protrusion is in the form of a ring-like protrusion, and the recess is in the form of a ring-like recess mating with the ring-like protrusion, the ring-like protrusion and the ring-like recess each preferably having a rectangular, hook-like or dovetail-like cross section.

5. The solenoid switch of any one of claims 1 to 4, wherein the second axial retention means comprises a step (25) formed on an outer periphery of the boot, the step being preferably in the shape of a circular ring extending around the outer periphery of the boot.

6. The solenoid switch of any one of claims 1 to 5, wherein the fixing ring is in the form of a complete circular ring, and is formed preferably of an elastic material such as rubber; or
the fixing ring is in the form of a split ring, and preferably comprises a self-locking structure or is provided with a locking member for locking it.

7. The solenoid switch of any one of claims 1 to 6, wherein a front portion of the boot is slidably fitted around the solenoid core in a sealing manner; or
the boot is elastically deformable, with the front portion of it being fixed to the solenoid core and being movable together with the solenoid core.

8. The solenoid switch of claim 7, wherein the front portion of the solenoid core comprises a protruding portion (12), and the front portion of the boot forms a front end portion (22) which extends radially inwards, the front end portion being mounted around the protruding portion and being fastened to a main portion of the solenoid core by a fastening element.

9. The solenoid switch of claim 8, wherein the front end portion of the boot is formed with an elastic protrusion facing towards the main portion of the solenoid core, the elastic protrusion being, for example, a protrusion in the form of a circular ring, which may comprises two or more concentric circular rings, and the elastic protrusion being elastically deformed in a state of being compressed against the main portion of the solenoid core by the fastening element.

10. A vehicle starter comprising a solenoid switch according to any one of claims 1 to 9 for controlling the start of a vehicle engine.

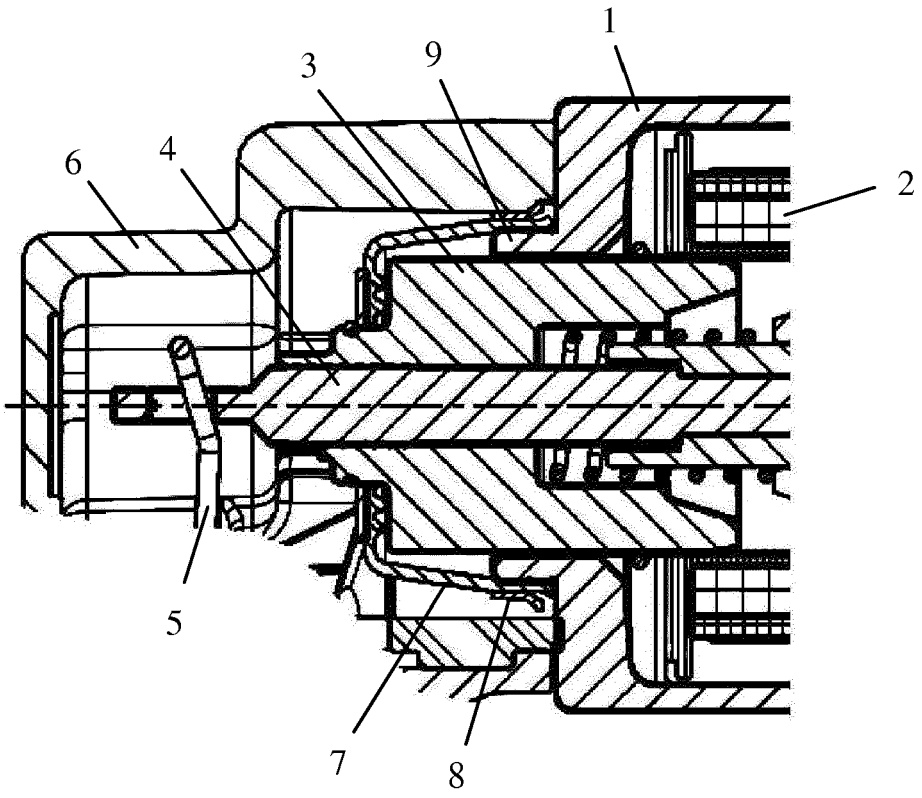

Figure 1

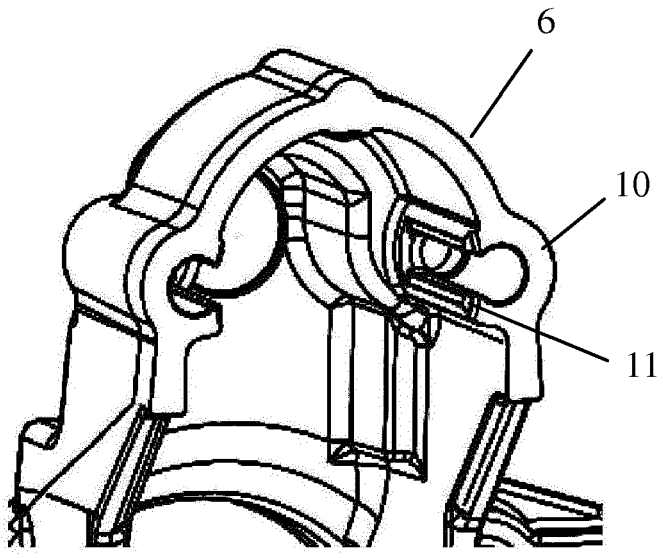

Figure 2

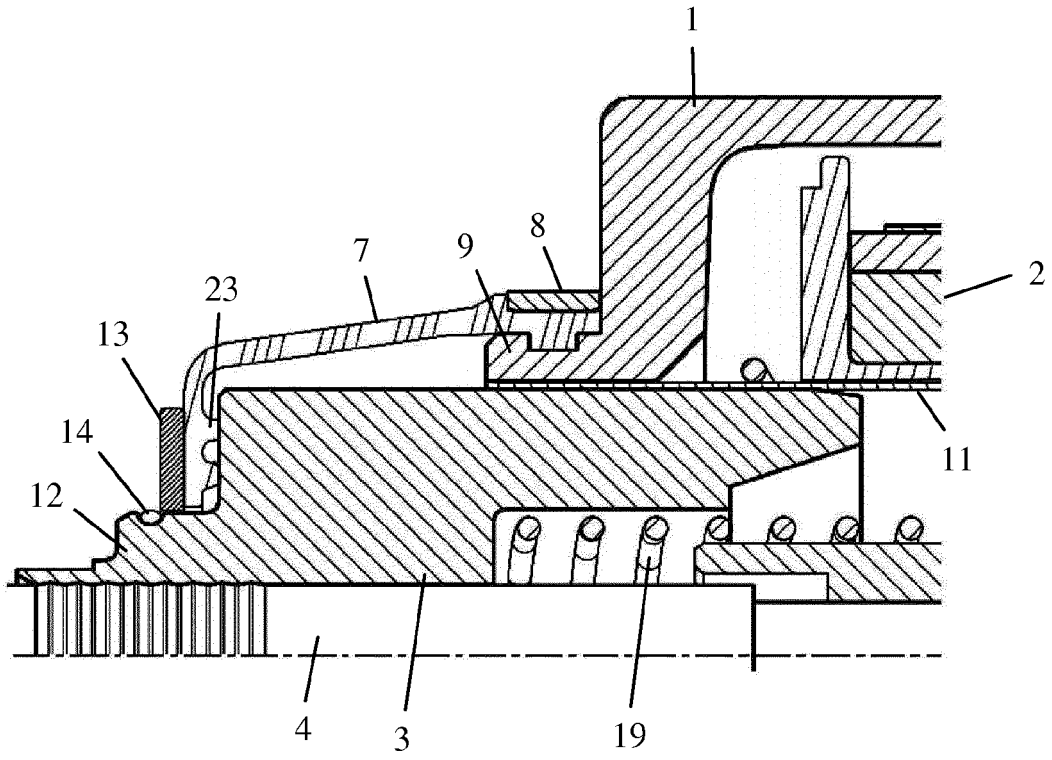

Figure 3

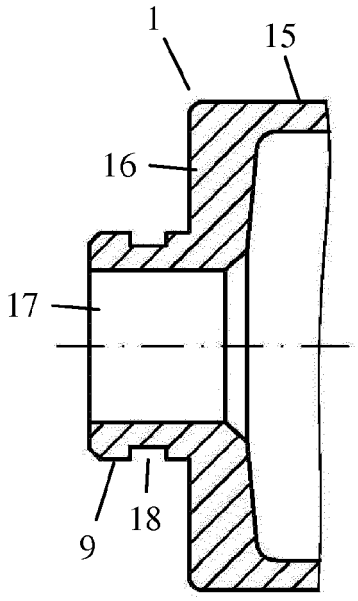

Figure 4

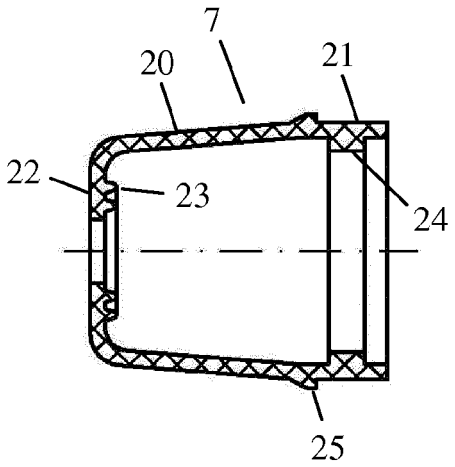

Figure 5

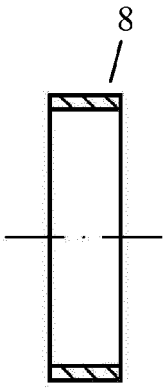

Figure 6

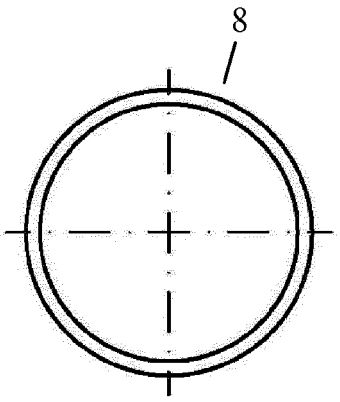

Figure 7

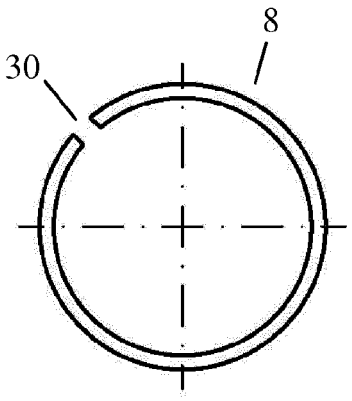

Figure 8

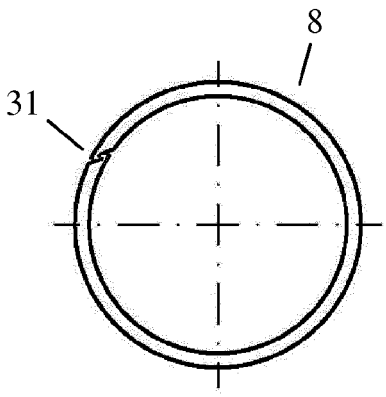

Figure 9

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 3800

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 375 055 A2 (BOSCH GMBH ROBERT [DE]) 12 October 2011 (2011-10-12) * paragraphs [0005] - [0007] * * paragraphs [0010], [0011], [0014]; figure 1 * * paragraphs [0016] - [0029]; figures 2-6 * -----	1-10	INV. H01H51/06 ADD. H01H9/04 F02N15/06
Y	US 2009/128266 A1 (KRAMER CLAUS [DE] ET AL) 21 May 2009 (2009-05-21) * paragraphs [0002], [0010] * * paragraphs [0031] - [0042]; figures 1-6 * -----	1-10	
A	US 2012/019340 A1 (RAMEZANIAN HOUMAN [DE] ET AL) 26 January 2012 (2012-01-26) * paragraph [0007]; figures 1, 2, 8a, 9a * -----	9	

TECHNICAL FIELDS SEARCHED (IPC)

H01H
F02N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 March 2016	Meyer, Jan

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 15 19 3800

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