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(54) ELECTROMAGNETIC SWITCH, MANUFACTURING METHOD THEREFOR, AND VEHICLE ENGINE

ELEKTROMAGNETISCHER SCHALTER, HERSTELLUNGSVERFAHREN DAFÜR UND KRAFTFAHRZEUG

COMMUTATEUR ÉLECTROMAGNÉTIQUE, SON PROCÉDÉ DE FABRICATION ET MOTEUR DE VÉHICULE

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Description

Technical Field

[0001] The invention relates to a solenoid switch used in a vehicle starter, a method for manufacturing the solenoid switch, and a vehicle starter comprising the solenoid switch.

Background Art

[0002] A starter of a vehicle generally comprises a DC electric motor, a transmission mechanism, a control mechanism, and the like. In the starting procedure of the vehicle engine, the electric motor generates a rotational torque which is transmitted to a gear ring on a flywheel of the engine via a driving gear or pinion of the transmission mechanism to drive a crank shaft of the engine to rotate.

[0003] The control mechanism controls the ON/OFF state of an electric circuit of the starter, and controls the engagement and disengagement between the driving gear and the gear ring. Nowadays, a solenoid switch is generally used as the control mechanism of the starter. Document WO 2011/115054 A1 shows a contact switching device in which a movable iron core provided at one end portion of a movable shaft is attracted to a fixed iron core, based on excitation and degauss of an electromagnet portion, by which the movable shaft reciprocates in a shaft center direction, and a movable contact of a movable contact piece arranged at another end portion of the movable shaft contacts and departs from a fixed contact. The movable shaft is inserted into a through-hole provided in a magnet holder so as to move slidably, and an annular partition wall is projected on a movable shaft side with respect to the movable contact in a vicinity of an opening portion of the through-hole of the magnet holder.

[0004] Document US2008/0007373 A1 discloses a magnet switch for a starter comprising a plunger and a switch frame. A return spring presses the plunger in a direction opposite to a stationary core . The return spring is arranged between the stationary core and the plunger. A rod is a columnar member securing the movable contact to the plunger. The rod is secured to an end face of a large-diameter columnar part of the plunger. The movable contact is arranged at a tip end portion of the rod through an insulator. The movable contact is pressed against the fixed contacts by a contact-pressure spring.

[0005] Figure 1 is a schematic view of the structure of a current solenoid switch of the starter. The solenoid switch mainly comprises a fixed core 4 and a winding assembly 6, both fixedly mounted in a housing 2, two contact studs 10 carried by a cap 8 which is fixed to the housing 2, a movable core 16 axially movable in the inner side of the winding assembly 6, and push rods 12 and 18 fixed to the movable core 16, wherein a contact bridge 14 is mounted to a back end of the push rod 12, and an engagement window to be engaged with a pinion-engaging lever 9 is formed in a front end of the push rod 18.

[0006] When a driver starts the vehicle using an ignition key, an electro-magnetic force is generated in the movable core 16 by the winding assembly 6 so that the movable core 16 moves backwards towards the fixed core 4. As a result, the contact bridge 14 is moved by the push rod 12 to a position in contact with the two contact studs 10 to electrically connect the two contact studs with each other, so that a main circuit of the electric motor is switched on to drive the electric motor to rotate. When the contact bridge 14 comes into contact with two contact studs 10 and electric connection is established between the two contact studs 10, the movable core 16 continues to move towards the fixed core 4 through a small reserve distance, until it is stopped by the fixed core 4. During the movement of the movable core, the front end of the push rod 18 pulls the transmission mechanism via the pinion-engaging lever 9 so that the driving gear moves forwards to be engaged with the gear ring on the flywheel of the engine, thereby the engine is started. By means of the reserve distance, the above function of the solenoid switch can be maintained even if the contact portions between the contact bridge 14 and the two contact studs 10 are burnt off to a certain extent.

[0007] During the assembling of the solenoid switch shown in Figure 1, the engagement window is formed in advance in the front end of the push rod 18, and the push rods 12 and 18 are assembled in advance to the movable core 16. Then, the winding assembly 6 and the fixed core 4 are mounted into the housing 2, and the movable core 16, which carries the push rods 12 and 18, is mounted inside the winding assembly 6. Then, the contact bridge 14 is assembled onto the push rod 12, and finally, the cap 8 is fixed to the housing 2. In such a solenoid switch, once the assembling is finished, positional relations between components of the solenoid switch are fixed and cannot be adjusted. The tolerance range of the reserve distance is large since there is a complex dimension chain from the movable core 16, via the winding assembly 6 and the housing 2, to the cap 8. On the other hand, as to the positioning precision of the engagement window, there is also a problem related with lacking adjustability after the assembling of the solenoid switch as well as a problem related with the complex dimension chain between the engagement window and the contact studs 10. Thus, the tolerance ranges of the dimension and position of the engagement window are also large. The above mentioned two large tolerance ranges result in various problems, such as low positioning precision of the driving gear, etc.

Summary of the Invention

[0008] An object of the invention is to solve the problem of low positioning precision of the driving gear resulted from the large tolerance ranges of the reserve distance and the engagement window of the solenoid switch in the vehicle starter of the prior art.

[0009] For this end, according to an aspect of the invention, there provides a method for manufacturing a solenoid switch for a vehicle starter, comprising the steps of:

(1) fixedly mounting a fixed core into a housing;
(2) mounting a movable core, which carries a single push rod and a compression spring, into the housing so that the movable core is able to move back and forth in the housing, the push rod being slidable back and forth in the movable core, and the push rod extending through the fixed core so that a back end of the push rod is exposed from a back portion of the fixed core;
(3) mounting an elastic member onto the push rod and mounting a contact bridge onto the back end of the push rod so that the push rod is able to move with respect to the contact bridge in a backward direction against an acting force of the elastic member;
(4) moving the push rod backwards until it is detected that an initial electric connection state is established between two contact studs, which are disposed behind the contact bridge, via the contact bridge;
(5) moving the push rod further backwards through a reserve distance; and
(6) fixing the movable core to the push rod in a state that the movable core is pushed against the fixed core.

[0010] In the manufacturing method described above, the reserve distance may be 0.5 to 1.5 mm, preferably about 1 mm.

[0011] In the manufacturing method described above, preferably, the initial electric connection state is detected by using an electric current sensor, and it is determined that the initial electric connection state is established between the two contact studs when the electric current sensor detects that an electric current flows through the two contact studs.

[0012] In the manufacturing method described above, preferably, in step (6), the movable core is fixed to the push rod by crimping, riveting or welding a portion of the material of the movable core to the push rod.

[0013] In the manufacturing method described above, preferably, the portion of the material of the movable core, which is to be crimped, riveted or welded, is pre-formed as a cylindrical portion at a front end of the movable core.

[0014] In the manufacturing method described above, preferably, a portion of push rod, to which the portion of the material of the movable core is to be crimped or riveted, is formed with a roughened surface, one or more recesses or one or more protrusions in advance.
preferably, the manufacturing method further comprises the following step to be conducted after step (6): (7) forming an engagement window in a front end of the push rod in a state of keeping the movable core biasing against the fixed core, the engagement window being configured to be inserted by a front end of a pinion-engaging lever.

[0015] Preferably, the engagement window is formed by mechanical punching or by laser cutting.

[0016] The invention in another aspect provides a solenoid switch for a vehicle starter manufactured by the manufacturing method described above.

[0017] In the solenoid switch described above, preferably, the reserve distance is 0.5 to 1.5 mm, preferably about 1 mm.

[0018] In the solenoid switch described above, preferably, a portion of the material of the movable core is attached to the push rod by crimping, riveting or welding.

[0019] In the solenoid switch described above, preferably, the portion of the material of the movable core, which is to be crimped, riveted or welded, is in the form of a cylindrical portion pre-formed at a front end of the movable core.

[0020] In the solenoid switch described above, preferably, a portion of push rod, to which the portion of the material of the movable core is to be crimped or riveted, is formed with a roughened surface, one or more recesses or one or more protrusions in advance.

[0021] In the solenoid switch described above, preferably, an engagement window is formed in a front end of the push rod, the engagement window being configured to be inserted by a front end of a pinion-engaging lever.

[0022] The invention in yet another aspect provides a vehicle starter which comprises: an electric motor; a transmission mechanism coupled with an output shaft of the electric motor; and the solenoid switch described above for controlling the operations of the electric motor and the transmission mechanism.

[0023] According to the invention, a single push rod is used, and the reserve distance is set by further moving the push rod backwards after the initial electric connection state between the contact bridge and the two contact studs has been sensed. Thus, the reserve distance is not affected by any complex dimension chain, so the tolerance of the reserve distance can be reduced.

[0024] In addition, in a state that the push rod further moves backwards through the small reserve distance after the initial contact between the contact bridge and the two contact studs, and that the movable core is kept to be biased against the fixed core, the push rod and the movable core are fixed together and the engagement window is formed. Thus, the tolerance ranges of the dimension and position of the engagement window can be reduced, and the positioning precision of the driving gear can be improved.

Brief Description of the Drawings

[0025]

Figure 1 is a schematic structural view of a solenoid switch of a vehicle starter according to the prior art.

Figure 2 is a schematic view showing the structure and an initial assembly stage of a solenoid switch of a vehicle starter according to a preferred embodi-

ment of the invention.

Figure 3 is a schematic view showing an intermediate stage of the solenoid switch shown in Figure 2.

Figure 4 is a schematic view showing a final stage of the solenoid switch shown in Figure 2.

Figure 5 is a schematic view showing a contact bridge that can be used in the solenoid switch shown in Figure 2 and the mounting manner thereof.

Figure 6 is a schematic view showing the structure of a solenoid switch of a vehicle starter according to another preferred embodiment of the invention.

Detailed Description of Preferred Embodiments

[0026] Now some preferred embodiments of the invention will be described with reference to the drawings.

[0027] Figure 2 shows a solenoid switch used in a vehicle starter according to an embodiment of the invention. The solenoid switch comprises a housing 2 which has a substantially cylindrical main body and a diameter-reduced portion 2a formed at a front end (left end in Figure 2, or the end facing towards the vehicle engine) of the main body.

[0028] A fixed core 4 is fixedly mounted in a back portion of the main body of the housing 2. The fixed core 4 comprises a substantially disk like larger-diameter portion fixed in the main body of the housing 2, a substantially cylindrical smaller-diameter portion protruding forwards from the larger-diameter portion, and a substantially frusto-conical portion protruding forwards from the smaller-diameter portion. Further, a guiding hole is formed in an axial direction all the way through the fixed core 4.

[0029] A substantially cylindrical sleeve 32 of a non-magnetic material (for example, brass) is mounted in the housing 2, the sleeve 32 having a front end inserted into the diameter-reduced portion 2a of the housing 2 and a back end mounted around the smaller-diameter portion of the fixed core 4. In this way, the sleeve 32 is fixed in the housing 2.

[0030] A winding assembly 6 is mounted between the sleeve 32 and the main body of the housing 2 and is carried by the sleeve 32.

[0031] A movable core 16 is disposed in a substantially front portion of the sleeve 32 to be moveable axially therein. The movable core 16 is substantially cylindrical and is formed therein from front to back with a mounting through hole, a spring accommodating socket and a frusto-conical accommodating socket, with their diameters increased in sequence. The substantially frusto-conical portion of the fixed core 4 is adapted to be inserted in the frusto-conical accommodating socket of the movable core 16.

[0032] A single push rod 30 is fixedly carried by the movable core 16 so as to be able to move axially with the movable core 16. The push rod 30 has a substantially cylindrical front larger-diameter segment 30a and a substantially cylindrical back smaller-diameter segment 30b, the two segments being coaxially disposed and being continued end-to-end. The front larger-diameter segment 30a has a front portion that is fixed to the mounting through hole of the movable core 16 and a back portion that extends in the spring accommodating socket of the movable core 16. A transition step formed between the front larger-diameter segment 30a and the back smaller-diameter segment 30b is arranged in the spring accommodating socket of the frusto-conical accommodating socket.

[0033] The back smaller-diameter segment 30b of the push rod 30 extends backwards in the axial direction from the front larger-diameter segment 30a through the guiding hole in the fixed core 4, and a back end of the back smaller-diameter segment 30b is exposed from a back end surface of the fixed core 4.

[0034] A front end of the front larger-diameter segment 30a extends forwards from a front end surface of the movable core 16, and the front end of the front larger-diameter segment 30a comprises (for example, is formed integrally with) a flat head 40. An engagement window is formed in the flat head so that an upper end of a pinion-engaging lever (not shown) can be inserted therein. The pinion-engaging lever is pivotably supported at its substantially middle portion, and a lower end of the pinion-engaging lever is coupled with a transmission mechanism. In this way, when the push rod 30 moves backwards (to the right in Figure 2) in the axial direction, the transmission mechanism is moved forwards in the axial direction by the pinion-engaging lever so that a driving gear or pinion of the transmission mechanism moves towards a gear ring on a flywheel of the engine and come into engagement therewith. On the contrary, when the push rod 30 moves forwards (to the left in Figure 2) in the axial direction, the transmission mechanism is moved backwards in the axial direction by the pinion-engaging lever so that the driving gear of the transmission mechanism is disengaged from the gear ring on the flywheel of the engine.

[0035] A contact bridge 14 is mounted onto the back smaller-diameter segment 30b of the push rod 30, near the back end of the push rod 30. Specifically, with reference to Figure 2 in conjunction with Figure 5, a mounting seat 28 is mounted onto the back smaller-diameter segment 30b to be axially slidable thereon. The mounting seat 28 may be formed of insulative plastics. The mounting seat 28 has a substantially circular ring shape, having an inner periphery slidably fitted onto the back smaller-diameter segment 30b. The mounting seat 28 comprises a front flange 28a and a back cylinder section 28b. The front flange 28a has an outer diameter which is larger than both the outer diameter of the back cylinder section 28b and the inner diameter of the guiding hole of the fixed core 4. A contact bridge 14 is carried by the back cylinder section 28b, the contact bridge 14 having a front side that

is biased against the front flange 28a and a back side stopped by a fastening device 42.

[0036] In addition, a sleeve piece 20 and a compression spring 22 are mounted around the push rod 30. The sleeve piece 20 is located on a front portion of the back smaller-diameter segment 30b, while the compression spring 22 is compressed between a back end of the sleeve piece 20 and the front flange 28a of the mounting seat 28. The outer diameter of the sleeve piece 20 is determined so that the sleeve piece 20 is slidably fitted in the guiding hole of the fixed core 4.

[0037] In the state that the contact bridge 14 is clamped onto the back end of the push rod 30 in the above described manner, the contact bridge 14 is able to move (slide) forwards in the axial direction on the back smaller-diameter segment 30b of the push rod 30 against the pushing force of the compression spring 22, but the backward movement of the contact bridge 14 is blocked by the fastening device 42.

[0038] It is appreciated that the fastening device 42 may have any suitable structures, for example, the structure shown in Figure 5, in which the fastening device 42 comprises a washer 44 biased against the back side of the contact bridge 14, a gasket 46 arranged behind the washer 44, and a clip 48 arranged behind the gasket 46 and fixed to the back end of the push rod 30. It is appreciated that any structures and elements can be used here, only if they allow the contact bridge 14 to move forwards with respect to the push rod 30 and prevent the contact bridge 14 from moving backwards with respect to the push rod 30 on the back end of the push rod 30.

[0039] The sleeve piece 20 may be made of insulative plastics and is substantially cylindrical. The sleeve piece 20 has a front end that is biased against the transition step between the front larger-diameter segment 30a and the back smaller-diameter segment 30b and a back end that is pushed by a front end of the compression spring 22.

[0040] A cap 8 is fixed to the back portion of the housing 2, and two contact studs 10 pass through the cap 8 and are fixed thereto. The contact studs 10 each have a front enlarged portion that forms a contacting end 10a, and front end surfaces of the two the contacting ends 10a face towards the back surface of the contact bridge 14.

[0041] The cap 8 may be made of plastics. Each contact stud 10 has a front portion that is fixed in the cap 8 and a back portion that is exposed from a back surface of the cap 8.

[0042] The two contact studs 10 may be fixed to the material of the cap 8 by an insert injection molding process. Alternatively, the two contact studs 10 may be fixed to the cap 8 by fasteners. For example, the back portion of each contact stud 10 may be formed with a screw thread so that a nut (not shown) having a mating thread engaging with the screw thread may be used for locking the contact stud 10 to the cap 8.

[0043] Further, a compression spring 24 is mounted between the movable core 16 and the fixed core 4. The compression spring 24 has a front portion that is disposed in the spring accommodating socket of the movable core 16 and a front end that pushes against a bottom of the spring accommodating socket. The compression spring 24 also has a back portion that is arranged around the sleeve piece 20. Aback end of the compression spring 24 biases against a front end surface of the fixed core 4 (or the substantially frusto-conical portion of it).

[0044] The compression spring 24 acts as a returning spring for the push rod 30. The compression spring 22 acts as not only a returning spring for the contact bridge 14, but also a returning spring for the push rod 30. It is contemplated that the push rod and the contact bridge may alternatively be equipped other types of returning elastic elements.

[0045] A boss 16a is formed at the front end of the movable core 16, surrounding the push rod 30. The boss 16a protrudes forwards from a front end surface of the main body of the movable core 16. The boss 16a has an outer diameter which is significantly smaller than the radial dimension of the main body of the movable core 16.

[0046] A cylindrical fixing connection portion 16b is formed at the front end of the boss 16a, in the form of a hollow cylinder surrounding the push rod 30. The fixing connection portion 16b protrudes forwards from a front end surface of the boss 16a, and has a radial thickness which is set such that the fixing connection portion 16b can be fixed to the outer periphery of the push rod 30 (or the front larger-diameter segment 30a of it) by crimping, riveting, welding or other manners using a crimping tool, a riveting tool, a welding tool or other types of tools.

[0047] According to the invention, for manufacturing the solenoid switch shown in Figure 2, the elements described above are formed in advance, but the flat head 40 has not been formed with the engagement window yet.

[0048] Then, these elements are assembled. As a first step, the fixed core 4, which carries the sleeve 32 and the winding assembly 6 therewith, is mounted into the housing 2.

[0049] Then, the back end of the push rod 30 is inserted into and through the mounting through hole of the movable core 16 from the front side of the movable core 16 so that the front larger-diameter segment 30a of the push rod 30 is arranged in the mounting through hole of the movable core 16 and is slidable therein.

[0050] Then, the sleeve piece 20 and the compression spring 24 are mounted onto the push rod 30.

[0051] Then, the movable core 16, which carries the push rod 30, the sleeve piece 20 and the compression spring 24 therewith, is mounted into the housing 2 from the front side of it, wherein the movable core 16 is inserted in the sleeve 32 and is slidable therein, the back smaller-diameter segment 30b of the push rod 30 passes through the guiding hole of the fixed core 4 so that the back end of the push rod 30 is exposed from the back side of the fixed core 4, the sleeve piece 20 is inserted at least in part in the guiding hole of the fixed core 4, and the compression spring 24 is compressed between the movable

core 16 and the fixed core 4.

[0052] Then, the compression spring 22 is mounted onto the back smaller-diameter segment 30b of the push rod 30 from the back side of it, with a major portion of the compression spring 22 being inserted into the guiding hole of the fixed core 4. Then, the mounting seat 28, the contact bridge 14 and the fastening device 42 are mounted onto the back end of the push rod 30 in sequence. Now the compression spring 22 is pre-compressed between the sleeve piece 20 and the mounting seat 28.

[0053] Then, the cap 8, which carries the two contact studs 10 is mounted to the housing 2 from the back side of it.

[0054] In such a pre-assembled solenoid switch, the push rod 30 is able to slide in the movable core 16.

[0055] Then, a sensing device, such as an electric current sensor, which can sense the connection/break state between the two contact studs 10 is coupled to the exposed back portions of the two contact studs 10.

[0056] Now a pushing force directed backwards (to the right in Figure 2) in the axial direction is applied to the push rod 3 to move the push rod 30 backwards, and then the contact bridge 14 comes into contact with the contacting ends 10a of the two contact studs 10, as shown in Figure 3. In this procedure, the movable core 16 may also move backwards (for example, urged by the flat head 40) against the pushing force of the compression spring 24.

[0057] Once the contact bridge 14 initially comes into contact with the two contact studs 10, the contact bridge 14 is stopped from further moving backwards, while the push rod 30 continues to move backwards. Now the compression force in the compression spring 22 starts to become increased so that the contact pressure force between the contact bridge 14 and the two contact studs 10 is increased gradually. After the contact bridge 14 initially contacts the two contact studs 10 and then the push rod 30 further moves backwards through a first distance which is very small (for example, 0.05 to 0.1 mm), an initial electric connection state is established between the contact bridge 14 and the two contact studs 10. In this stage, the compression force in the compression spring 22 is increased by a value (which equals to current compression force minus the pre-compression force in it) which is very small.

[0058] Such an initial electric connection state can be detected by the sensing device so that the sensing device obtains an initial connection signal. For example, the electric current sensor obtains an initial electric current signal of the two contact studs 10 when there is an electric current initially flowing through the two contact studs 10.

[0059] After the initial connection signal is detected, the push rod 30 is further moved backwards through a second distance which is larger than the first distance. For example, the second distance is 0.5 to 1.5 mm, preferably about 1 mm. The second distance may be regarded as a reserve distance for ensuring reliable electric connection between the contact bridge 14 and the contact portions of the two contact studs 10 even if burnt-off occurs there.

[0060] Now the solenoid switch is in the position shown in Figure 4, in which the fastening device 42 and the contact bridge 14 are separated by a distance L (which equals to the first distance plus the second distance), which distance is the backward moving distance of the push rod 30 after the initial contact between the contact bridge 14 and the two contact studs 10.

[0061] In this state, the movable core 16 is pushed in the backward direction, until it abuts against the fixed core 4 so that it is stopped from further moving backwards. For example, now the back end surface of the movable core 16 biases against the front end surface of the substantially cylindrical smaller-diameter portion of the fixed core 4.

[0062] In the state that the push rod 30 is kept in backward moving distance and the movable core 16 biases against the fixed core 4, the push rod 30 is fixed in the movable core 16. The fixing between them is achieved by using a crimping tool, a riveting tool, a welding tool or other types of tools to fix the fixing connection portion 16b of the movable core 16 to an outer periphery of the push rod 30 (the front larger-diameter segment 30a) by crimping, riveting, welding or other manners. By providing the boss 16a, a large operation space is presented for the crimping tool, the riveting tool, the welding tool or other types of tools used here.

[0063] For increasing the connection strength between the push rod 30 and the movable core 16, a portion of the movable core 30, which is predetermined to be crimped or riveted, is subjected to a pre-treatment, for example, formed with a roughened surface, one or more recesses, one or more protrusions or the like, in advance

[0064] After the push rod 30 and the movable core 16 are fixed together, in a state that the movable core 16 is kept to bias against the fixed core 4, an engagement window 40a, into which the front end of the pinion-engaging lever is to be inserted, is formed in the flat head 40 of the push rod 30. The engagement window 40a may be formed by punching, laser processing or other manner. In the procedure for forming the engagement window 40a, one or more locations (for example, the surface) of the housing 2 may be used as a locating reference.

[0065] After the engagement window 40a is formed, the movable core 16 is released so that it, together with the push rod 30, moves forwards (to the left in Figure 4) under the action of the pushing forces of the compression springs 22 and 24. After the push rod 30 moves forwards through the distance L, the fastening device 42 comes into contact with the contact bridge 14 and then forces it away from the two contact studs 10. Then, under the action of the pushing force of the compression spring 24, the movable core 16, together with the push rod 30, continues to move forwards, until the front flange 28a of the mounting seat 28 biases against the back end of the fixed core 4, for example, seats in a back end socket of the fixed core 4. In this state, the movable core 16, together

with the push rod 30, is stopped from further moving forwards.

[0066] It should be noted that, in the solenoid switch manufacturing process of the invention, the assembling sequence of various elements is not limited to that described above; rather, the assembling sequence can be varied according to concrete structures of these elements.

[0067] In the structure and manufacturing process of the solenoid switch according to the invention, the reserve distance is set by further moving the push rod 30 backwards after the initial electric connection state between the contact bridge 14 and the two contact studs 10 has been detected. Thus, the reserve distance is not affected by any complex dimension chain, so the tolerance of the reserve distance can be very small.

[0068] Further, a single push rod 30 is used, which replaces the two push rods of the prior art. In this configuration of the invention, in the state that, after the contact bridge 14 and the two contact studs 10 comes into initial contact, the push rod 30 further moves backwards through a distance, and that the movable core 16 biases against of the fixed core 4, the push rod 30 and the movable core 16 are fixed together and the engagement window 40a is formed. Thus, only a simple dimension chain (the contact bridge 14 to the single push rod 30) exists between the engagement window 40a and the contact studs 10, so the tolerance ranges of the dimension and position of the engagement window are also very small. In other words, the engagement window has only dimension and position tolerances created in the final manufacturing stage, so the intermediate fitting tolerance which affects the tolerance ranges of the dimension and position of the engagement window in the prior art can be avoided. The dimension and position tolerances of the engagement window of the invention are much smaller than that of the prior art, and the positioning precision of the driving gear can be improved significantly.

[0069] It can be seen that the invention presents improvements to the structure and manufacturing manner of the solenoid switch by using the single push rod to reduce the tolerances of the reserve distance and the dimension and position of the engagement window. The structures and arrangements of other elements related with the single push rod, such as the structures of the sleeve piece 20, the mounting seat 28 and the fastening device 42, the arrangement manners of the compression springs 22 and 24, and the like, do not have any limitation to the concept of the invention.

[0070] As an example, Figure 6 shows a solenoid switch of a vehicle starter according to another preferred embodiment of the invention, which differs from the solenoid switch shown in Figures 2-4 mainly in that the sleeve piece 20 has an enlarged diameter. In this case, the diameter of the guiding hole of the fixed core 4 is increased accordingly. As a result, a gap between the inner periphery wall of the guiding hole of the fixed core 4 and the outer periphery wall of the back smaller-diameter segment 30b of the push rod 30 is increased, and thus the magnetic gap between the fixed core 4 and the push rod 30 is enlarged so that the effect of the push rod 30 to the magnetic circuit generated by the winding assembly 6 becomes smaller. In this way, it becomes possible to form the push rod 30 using a low-price magnetic material (for example, ordinary steel). By comparison, the push rod 30 in the solenoid switch shown in Figures 2-4 is generally formed of a high-price non-magnetic material (for example, copper, copper alloy, stainless steel, or the like).

[0071] The invention in another aspect relates a solenoid switch formed by the above described manufacturing method and having the above structure as well as a vehicle starter comprising such a solenoid switch.

[0072] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the invention as defined in the attached claims.

Claims

1. A method for manufacturing a solenoid switch for a vehicle starter, comprising the steps of:

   1.) fixedly mounting a fixed core (4) into a housing (2);
   2.) mounting a movable core (16), which carries a single push rod (30) and a compression spring (24), into the housing (2) so that the movable core (16) is able to move back and forth in the housing (2), the push rod (30) being slidable back and forth in the movable core (16), and the push rod (30) extending through the fixed core (4) so that a back end of the push rod (30) is exposed from a back portion of the fixed core (4);
   3.) mounting an elastic member (22) onto the push rod (30), and mounting a contact bridge (14) onto the back end of the push rod (30) so that the push rod (30) is able to move with respect to the contact bridge (14) in a backward direction against an acting force of the elastic member (22);
   4.) moving the push rod (30) backwards until it is detected that an initial electric connection state is established between two contact studs (10), which are disposed behind the contact bridge (14), via the contact bridge (14);
   5.) moving the push rod (30) further backwards through a reserve distance; and
   6.) fixing the movable core (16) to the push rod (30) in a state that the movable core (16) is pushed against the fixed core (4).

2. The method for manufacturing a solenoid switch for a vehicle starter of claim 1, wherein the reserve distance is 0.5 to 1.5 mm, preferably about 1 mm.

3. The method for manufacturing a solenoid switch for a vehicle starter of claim 1 or 2, wherein the initial electric connection state is detected by using an electric current sensor, and it is determined that the initial electric connection state is established between the two contact studs (10) when the electric current sensor detects that an electric current flows through the two contact studs (10).

4. The method for manufacturing a solenoid switch for a vehicle starter of any one of claims 1 to 3, wherein in step (6), the movable core (16) is fixed to the push rod (30) by crimping, riveting or welding a portion (16b) of the material of the movable core (16) to the push rod (30).

5. The method for manufacturing a solenoid switch for a vehicle starter of claim 4, wherein the portion (16b) of the material of the movable core (16), which is to be crimped, riveted or welded, is pre-formed as a cylindrical portion at a front end of the movable core (16).

6. The method for manufacturing a solenoid switch for a vehicle starter of claim 4, wherein a portion of push rod (30), to which the portion (16b) of the material of the movable core (16) is to be crimped or riveted, is formed with a roughened surface, one or more recesses or one or more protrusions in advance.

7. The method for manufacturing a solenoid switch for a vehicle starter of any one of claims 1 to 6, further comprising the following step to be conducted after step (6):
(7) forming an engagement window (40a) in a front end of the push rod (30) in a state of keeping the movable core (16) biasing against the fixed core (4), the engagement window (40a) being configured to be inserted by a front end of a pinion-engaging lever.

8. The method for manufacturing a solenoid switch for a vehicle starter of claim 7, wherein the engagement window (40a) is formed by mechanical punching or by laser cutting.

9. A solenoid switch for a vehicle starter, manufactured by the method of claim 1.

10. The solenoid switch of claim 9, wherein a portion (16b) of the material of the movable core (16) is attached to the push rod (30) by crimping, riveting or welding.

11. The solenoid switch of claim 10, the portion (16b) of the material of the movable core (16), which is to be crimped, riveted or welded, is in the form of a cylindrical portion pre-formed at a front end of the movable core (16).

12. The solenoid switch of claim 10 or 11, wherein a portion of push rod (30), to which the portion (16b) of the material of the movable core (16) is to be crimped or riveted, is formed with a roughened surface, one or more recesses or one or more protrusions in advance.

13. A vehicle starter comprising:

an electric motor;
a transmission mechanism coupled with an output shaft of the electric motor; and
a solenoid switch according to any one of claims 9 to 12 for controlling the operations of the electric motor and the transmission mechanism.

Patentansprüche

1. Verfahren zur Herstellung eines elektromagnetischen Schalters für einen Fahrzeugstarter umfassend die Schritte:

(1.) Fixieren eines festen Kerns (4) in einem Gehäuse (2);
(2.) Montieren eines beweglichen Kerns (16), welcher eine einzelne Druckstange (30) und eine Kompressionsfeder (24) trägt, in dem Gehäuse (2), sodass der bewegliche Kern (16) sich vor und zurück in dem Gehäuse (2) bewegen kann, wobei die Druckstange (30) in dem beweglichen Kern (16) nach hinten und nach vorne gleiten kann, und wobei die Druckstange (30) sich durch den festen Kern (4) erstreckt, sodass ein hinteres Ende der Druckstange (30) von einem hinteren Abschnitt des festen Kerns (4) hervorsteht;
(3.) Montieren eines elastischen Elements (22) an die Druckstange (30) und Montieren einer Kontaktbrücke (14) an das hintere Ende der Druckstange (30), sodass die Druckstange (30) bezüglich der Kontaktbrücke (14) in einer rückwärtigen Richtung gegen eine Druckkraft des elastischen Elements (22) bewegbar ist;
(4.) Bewegen der Druckstange (30) nach hinten, bis festgestellt wird, dass ein ursprünglicher elektrischer Verbindungszustand zwischen zwei Kontaktbolzen (10) hergestellt ist, welche hinter der Kontaktbrücke (14) angeordnet sind, über die Kontaktbrücke (14);
(5.) Bewegen der Druckstange (30) weiter nach hinten, über einen Reserveabstand; und
(6.) Fixieren des beweglichen Kerns an der Druckstange (30) in einen Zustand, in welchem der bewegliche Kern (16) gegen den festen Kern (4) gedrückt wird.

2. Verfahren zum Herstellen eines elektromagneti-

schen Schalters für einen Fahrzeugstarter nach Anspruch 1, wobei der Reserveabstand 0,5 bis 1,5mm, vorzugsweise ungefähr 1mm beträgt.

3. Verfahren zur Herstellung eines elektromagnetischen Schalters für einen Fahrzeugstarter nach Anspruch 1 oder 2, wobei der ursprünglich elektrische Verbindungszustand erkannt wird, indem ein elektrischer Stromsensor verwendet wird, und wobei bestimmt wird, dass der ursprünglich elektrische Verbindungszustand zwischen den zwei Kontaktbolzen (10) hergestellt ist, wenn der elektrische Stromsensor erkennt, dass ein elektrischer Strom durch die zwei Kontaktbolzen (10) fließt.

4. Verfahren zum Herstellen eines elektromagnetischen Schalters für einen Fahrzeugstarter nach einem der Ansprüche 1 bis 3, wobei in Schritt (6.) der bewegliche Kern (16) an der Druckstange (30) durch Krimpen, Nieten oder Schweißen eines Abschnitts (16b) des Materials des beweglichen Kerns (16) an die Druckstange (30) befestigt wird.

5. Verfahren zum Herstellen eines elektromagnetischen Schalters für einen Fahrzeugstarter nach Anspruch 4, wobei der Abschnitt (16b) des Materials des beweglichen Kerns (16), welcher gekrimpt, genietet oder geschweißt wird, als ein Zylinderabschnitt an einem vorderen Ende des beweglichen Kerns (16) vorgeformt ist.

6. Verfahren zum Herstellen eines elektromagnetischen Schalters für einen Fahrzeugstarter nach Anspruch 4, wobei ein Abschnitt der Druckstange (30), an welchem der Abschnitt (16b) des Materials des beweglichen Kerns (16) gekrimpt oder genietet wird, mit einer aufgerauten Oberfläche, einen oder mehreren Ausnehmungen oder einem oder mehreren Vorsprüngen zuvor gebildet wird.

7. Verfahren zum Herstellen eines elektromagnetischen Schalters für einen Fahrzeugstarter nach einem der Ansprüche 1 bis 6, ferner mit dem Schritt, der nach Schritt (6) durchzuführen ist:
(7) Bilden eines Eingriffsfensters (40a) an einem vorderen Ende der Druckstange (30) in einem Zustand, in welchem der bewegliche Kern (16) gegen den festen Kern (4) gedrückt gehalten wird, wobei das Eingriffsfenster (40a) konfiguriert ist, um durch ein vorderes Ende eines einen Kolben angreifenden Hebels eingesetzt zu werden.

8. Verfahren zum Herstellen eines elektromagnetischen Schalters für einen Fahrzeugstarter nach Anspruch 7, wobei das Eingriffsfenster (40a) durch mechanisches Stanzen oder Laserschneiden gebildet ist.

9. Elektromagnetischer Schalter für einen Fahrzeugstarter, der gemäß dem Verfahren nach Anspruch 1 hergestellt ist.

10. Elektromagnetischer Schalter nach Anspruch 9, wobei ein Abschnitt (16b) des Materials des beweglichen Kerns (16) an der Druckstange (30) mittels Krimpen, Nieten oder Schweißen befestigt ist.

11. Elektromagnetischer Schalter nach Anspruch 10, wobei der Abschnitt (16b) des Materials des beweglichen Kerns (16), welcher gekrimpt, genietet oder geschweißt wird, in Form eines zylindrischen Abschnitts an einem vorderen Ende des beweglichen Kerns (16) vorgeformt ist.

12. Elektromagnetischer Schalter nach Anspruch 10 oder 11, wobei ein Abschnitt der Druckstange (30), an welchem der Abschnitt (16b) des Materials des beweglichen Kerns (16) gekrimpt oder genietet wird, mit einer aufgerauten Oberfläche, einem oder mehreren Ausnehmungen oder einem oder mehreren Vorsprüngen zuvor gebildet wird.

13. Fahrzeugstarter mit:

einem Elektromotor;
einem Transmissionsmechanismus, welcher mit einer Ausgangswelle des Elektromotors gekoppelt ist;
und einem elektromagnetischen Schalter gemäß einem der Ansprüche 9 bis 12 zum Steuern der Operation des Elektromotors und des Transmissionsmechanismus.

Revendications

1. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule, comportant les étapes consistant à :

1.) monter de manière fixe un noyau fixe (4) dans un boîtier (2) ;
2.) monter un noyau mobile (16) qui porte une tige de poussée unique (30) et un ressort de compression (24), dans le boîtier (2) de sorte que le noyau mobile (16) peut se déplacer en va-et-vient dans le boîtier (2), la tige de poussée (30) pouvant coulisser en va-et-vient dans le noyau mobile (16), et la tige de poussée (30) s'étendant à travers le noyau fixe (4) de sorte qu'une extrémité arrière de la tige de poussée (30) est exposée à partir d'une partie arrière du noyau fixe (4) ;
3.) monter un élément élastique (22) sur la tige de poussée (30) et monter un pont de contact (14) sur l'extrémité arrière de la tige de poussée

(30) de sorte que la tige de poussée (30) peut se déplacer par rapport au pont de contact (14) dans une direction vers l'arrière à l'encontre d'une force d'action de l'élément élastique (22) ;
4.) déplacer la tige de poussée (30) vers l'arrière jusqu'à ce qu'il soit détecté qu'un état de connexion électrique initial est établi entre deux plots de contact (10), qui sont disposés derrière le pont de contact (14), via le pont de contact (14) ;
5.) déplacer la tige de poussée (30) davantage vers l'arrière sur une distance de réserve ; et
6.) fixer le noyau mobile (16) sur la tige de poussée (30) dans un état où le noyau mobile (16) est poussé contre le noyau fixe (4).

2. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon la revendication 1, dans lequel la distance de réserve est de 0,5 à 1,5 mm, de préférence d'environ 1 mm.

3. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon la revendication 1 ou 2, dans lequel l'état de connexion électrique initial est détecté en utilisant un capteur de courant électrique, et il est déterminé que l'état de connexion électrique initial est établi entre les deux plots de contact (10) lorsque le capteur de courant électrique détecte qu'un courant électrique circule à travers les deux plots de contact (10).

4. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon l'une quelconque des revendications 1 à 3, dans lequel à l'étape (6), le noyau mobile (16) est fixé à la tige de poussée (30) en sertissant, en rivetant ou en soudant une partie (16b) du matériau du noyau mobile (16) à la tige de poussée (30).

5. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon la revendication 4, dans lequel la partie (16b) du matériau du noyau mobile (16), qui doit être sertie, rivetée ou soudée, est préformée comme une partie cylindrique à une extrémité avant du noyau mobile (16).

6. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon la revendication 4, dans lequel une partie de la tige de poussée (30), à laquelle la partie (16b) du matériau du noyau mobile (16) doit être sertie ou rivetée, est formée au préalable avec une surface rugosifiée, un ou plusieurs évidements ou une ou plusieurs saillies.

7. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon l'une quelconque des revendications 1 à 6, comportant en outre l'étape suivante devant être réalisée après l'étape (6), consistant à :
(7) former une fenêtre d'engagement (40a) dans une extrémité avant de la tige de poussée (30) dans un état de maintien du noyau mobile (16) en rappel contre le noyau fixe (4), la fenêtre d'engagement (40a) étant configurée pour être insérée par une extrémité avant d'un levier d'engagement de pignon.

8. Procédé pour fabriquer un interrupteur à solénoïde pour un démarreur de véhicule selon la revendication 7, dans lequel la fenêtre d'engagement (40a) est formée par poinçonnage mécanique ou par découpage au laser.

9. Interrupteur à solénoïde pour un démarreur de véhicule, fabriqué par le procédé de la revendication 1.

10. Interrupteur à solénoïde selon la revendication 9, dans lequel une partie (16b) du matériau du noyau mobile (16) est attachée par la tige de poussée (30) par sertissage, rivetage ou soudage.

11. Interrupteur à solénoïde selon la revendication 10, la partie (16b) du matériau du noyau mobile (16), qui doit être sertie, rivetée ou soudée, se présente sous la forme d'une partie cylindrique préformée sur une extrémité avant du noyau mobile (16).

12. Interrupteur à sphénoïde selon la revendication 10 ou 11, dans lequel une partie de la tige de poussée (30), à laquelle la partie (16b) du matériau du noyau mobile (16) doit être sertie ou rivetée, est formée au préalable avec une surface rugosifiée, un ou plusieurs évidements ou une ou plusieurs saillies.

13. Démarreur de véhicule comportant :

un moteur électrique ;
un mécanisme de transmission accouplé à un arbre de sortie du moteur électrique ; et
un interrupteur à solénoïde selon l'une quelconque des revendications 9 à 12 pour commander le fonctionnement du moteur électrique et du mécanisme de transmission.

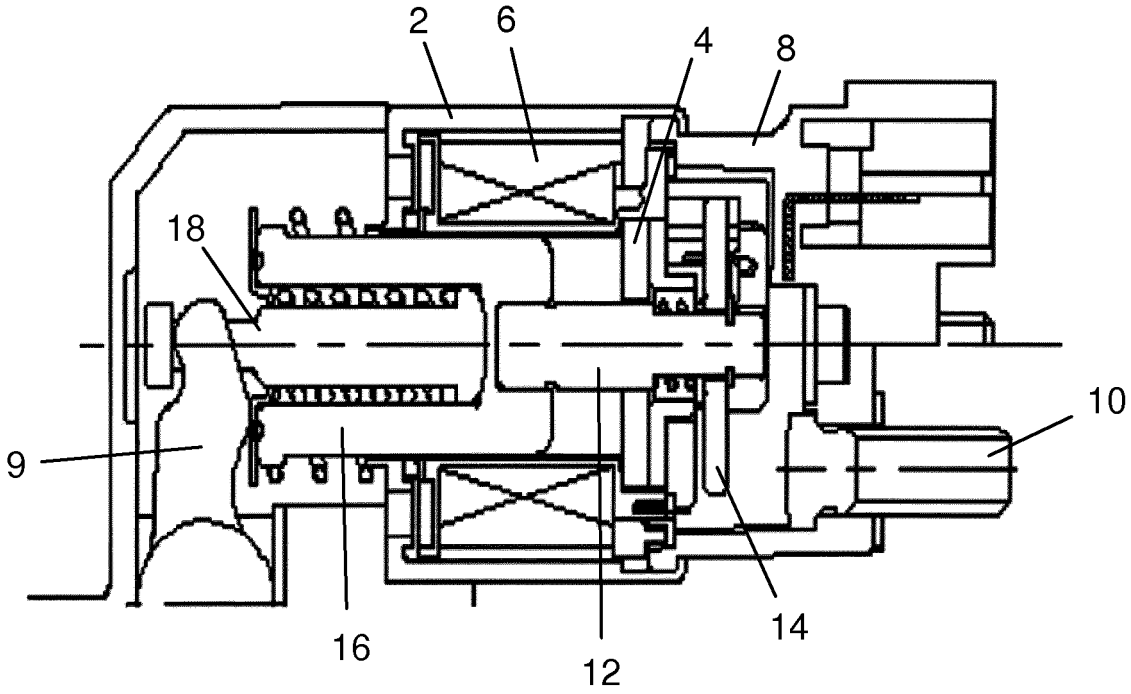

Figure 1

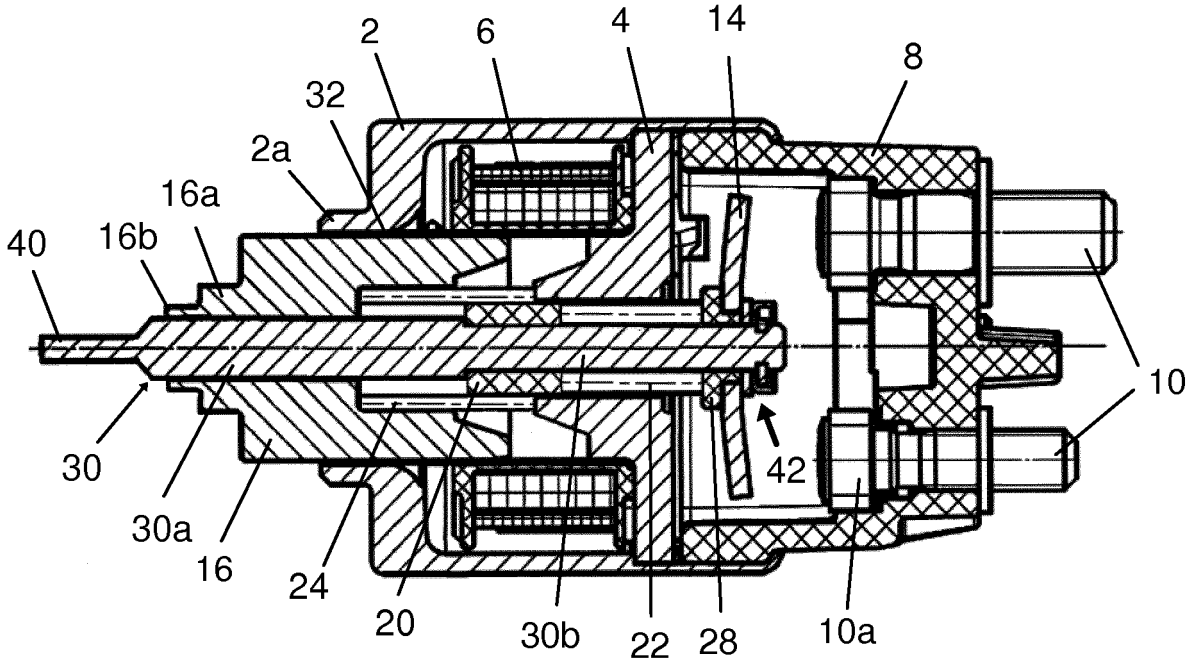

Figure 2

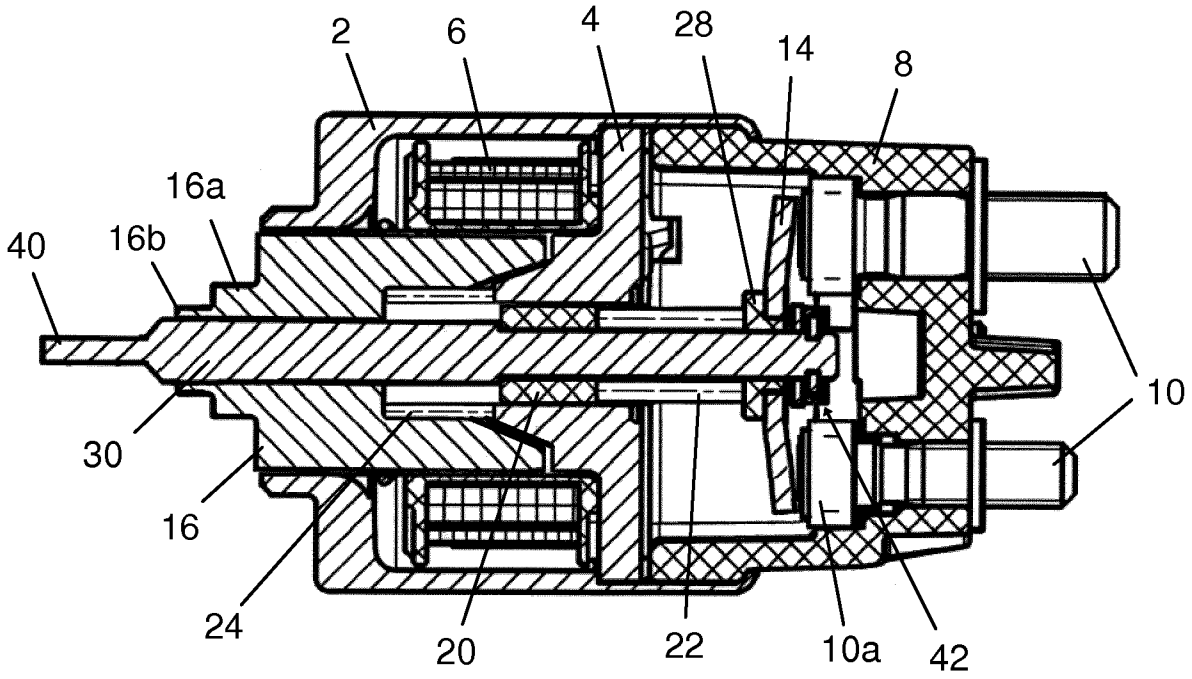

Figure 3

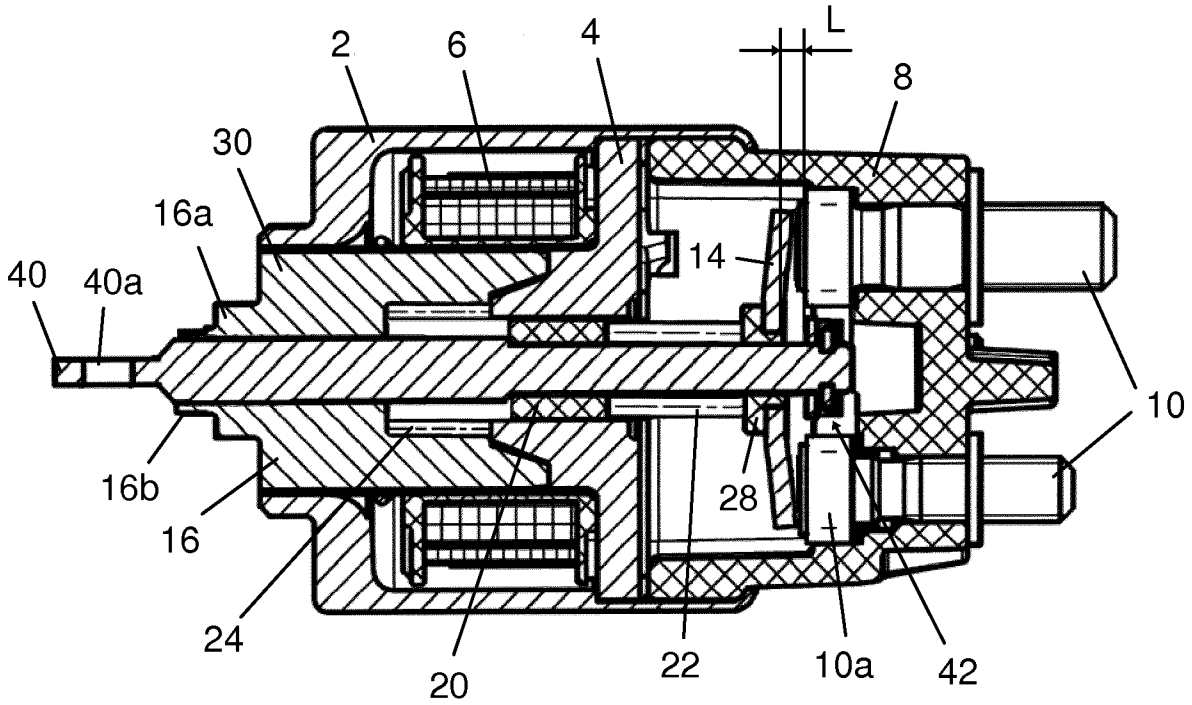

Figure 4

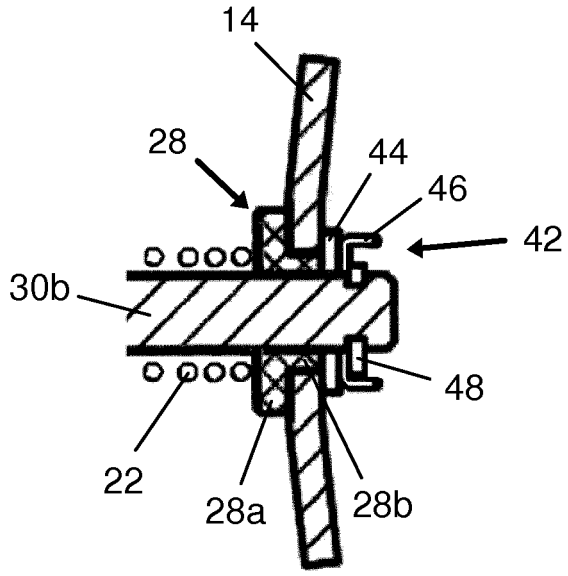

Figure 5

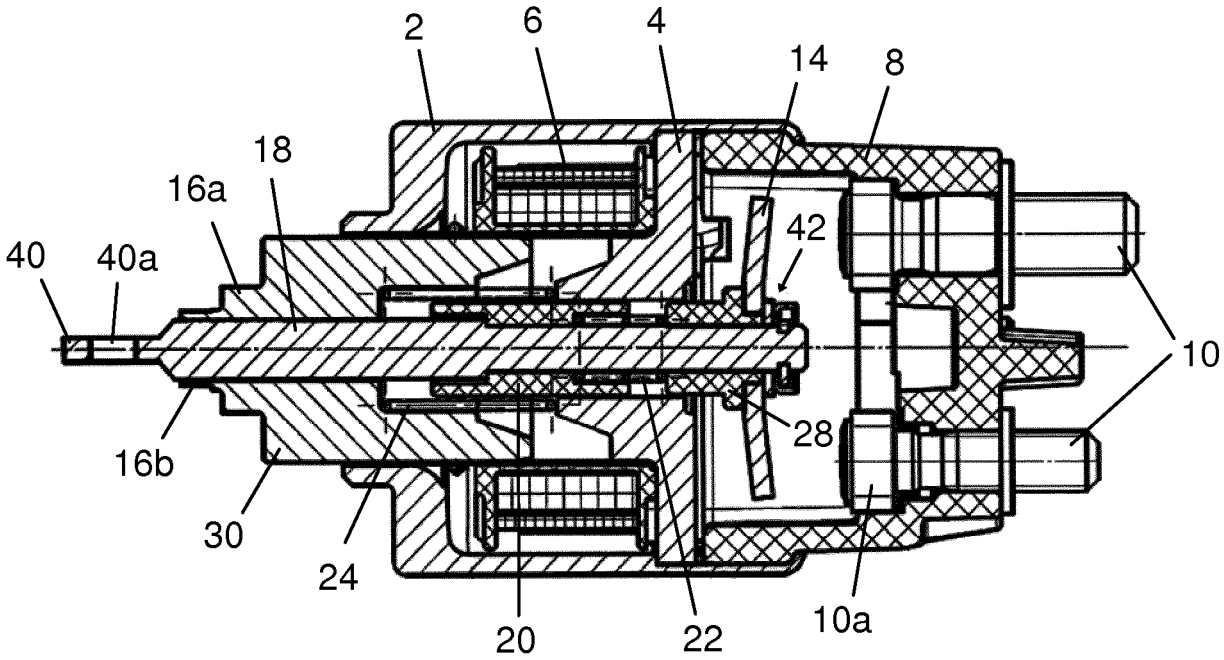

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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- WO 2011115054 A1 **[0003]**
- US 20080007373 A1 **[0004]**