



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
14.10.2015 Bulletin 2015/42

(51) Int Cl.:
H01H 51/06 (2006.01) F02N 11/00 (2006.01)

(21) Application number: **13794212.4**

(86) International application number:
PCT/CN2013/075981

(22) Date of filing: **21.05.2013**

(87) International publication number:
WO 2013/174253 (28.11.2013 Gazette 2013/48)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

• **CHEN, Guojun**
Changsha
Hunan 410100 (CN)
• **CHEN, Jiming**
Changsha
Hunan 410100 (CN)

(30) Priority: **21.05.2012 CN 201210158379**

(71) Applicants:
• **Bosch Automotive Products (Changsha) Co., Ltd**
Changsha, Hunan 410100 (CN)
• **Robert Bosch GmbH**
70442 Stuttgart (DE)

(74) Representative: **Bee, Joachim**
Robert Bosch GmbH
Zentralabteilung Patente
Postfach 30 02 20
70442 Stuttgart (DE)

(72) Inventors:
• **BORES, Javier**
Changsha
Hunan 410100 (CN)

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

(57) A method for manufacturing a solenoid switch of a vehicle starter, comprising: arranging within a housing (2) a fixed core (4) and a movable core (6) having a single-piece-type push rod (30), arranging an elastic element (22) onto the push rod, arranging a contact bridge (14) at the rear end of the push rod, allowing the push rod to move rearwards until detecting that an initial electric connection state is established between two contact studs (10) via the contact bridge, allowing the push rod to move further rearwards for a reserved stroke, then, in a state that the movable core is kept abutted against the fixed core, fixing the movable core onto the push rod, and processing the front end of the push rod into an engagement window (40a) used for inserting therein the upper end of a shift fork. Also, the solenoid switch manufactured on the basis of the method and the vehicle starter comprising such solenoid switch. Employment of the method in manufacturing of the solenoid switch allows for reductions in reserved stroke tolerance, in positioning tolerance, and in engagement window size, thus increasing the positioning precision of a drive gear.

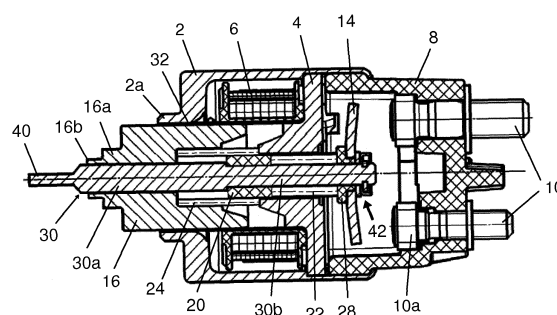


Figure 2

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. 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.

[0004] 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.

[0005] 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.

[0006] 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

[0007] 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.

[0008] 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, 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.

[0009] In the manufacturing method described above, the reserve distance may be 0.5 to 1.5 mm, preferably about 1 mm.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] Preferably, the engagement window is formed by mechanical punching or by laser cutting.

[0015] The invention in another aspect provides a solenoid switch for a vehicle starter comprising: a fixed core; a movable core adapted to be able to move back and forth with respect to the fixed core; a pair of contact studs disposed behind the fixed core; a single push rod carried by the movable core, 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; an elastic member mounted onto the push rod; and a contact bridge mounted to the back end of the push rod and facing towards the pair of contact studs, the push rod being adapted to be able to move with respect to the contact bridge in a backward direction against an acting force of the elastic member; wherein in a state that, after initial electric connection is established between the two contact studs via the contact bridge, the push rod is moved backwards through a reserve distance, and that the movable core is pushed against the fixed core, the movable core is fixed to the push rod.

[0016] In the solenoid switch described above, prefer-

ably, the reserve distance is 0.5 to 1.5 mm, preferably about 1 mm.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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 a solenoid switch described above for controlling the operations of the electric motor and the transmission mechanism.

[0022] 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.

[0023] 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

[0024]

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 embodiment 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

[0025] Now some preferred embodiments of the invention will be described with reference to the drawings.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] In addition, a sleeve piece 20 and a compres-

sion 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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. A back 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).

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] Then, the sleeve piece 20 and the compression spring 24 are mounted onto the push rod 30.

[0050] 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.

[0051] 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.

[0052] Then, the cap 8, which carries the two contact studs 10 is mounted to the housing 2 from the back side of it.

[0053] In such a pre-assembled solenoid switch, the push rod 30 is able to slide in the movable core 16.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] 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).

[0070] 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.

[0071] 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. The attached claims and their equivalents are intended to cover all the modifications, substitutions and changes as would fall within the scope and spirit of the invention.

Claims

1. 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, 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.

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 when the electric current sensor detects that an electric current flows through the two contact studs.

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 is fixed to the push rod by crimping, riveting or welding a portion of the material of the movable core to the push rod.

5. The method for manufacturing a solenoid switch for a vehicle starter of claim 4, wherein 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.

6. The method for manufacturing a solenoid switch for a vehicle starter of claim 4, wherein 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.

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 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.

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

9. A solenoid switch for a vehicle starter, comprising:

a fixed core;
a movable core adapted to be able to move back and forth with respect to the fixed core;
a pair of contact studs disposed behind the fixed core;
a single push rod carried by the movable core, 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;
an elastic member mounted onto the push rod; and
a contact bridge mounted to the back end of the push rod and facing towards the pair of contact studs, the push rod being adapted to be able to

move with respect to the contact bridge in a backward direction against an acting force of the elastic member;

wherein in a state that, after initial electric connection is established between the two contact studs via the contact bridge, the push rod is moved backwards through a reserve distance, and that the movable core is pushed against the fixed core, the movable core is fixed to the push rod.

10. The solenoid switch of claim 9, wherein the reserve distance is 0.5 to 1.5 mm, preferably about 1 mm.

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

12. The solenoid switch of claim 9 or 10, 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.

13. The solenoid switch of claim 11 or 12, wherein 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.

14. The solenoid switch of any one of claims 9 to 13, wherein 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.

15. 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 14 for controlling the operations of the electric motor and the transmission mechanism.

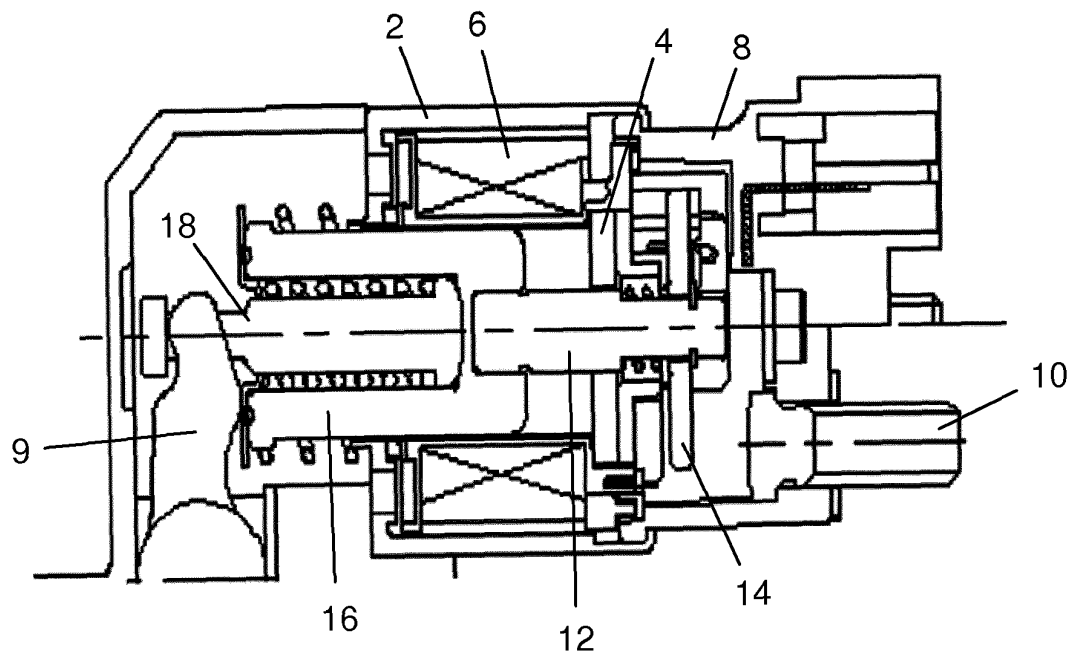


Figure 1

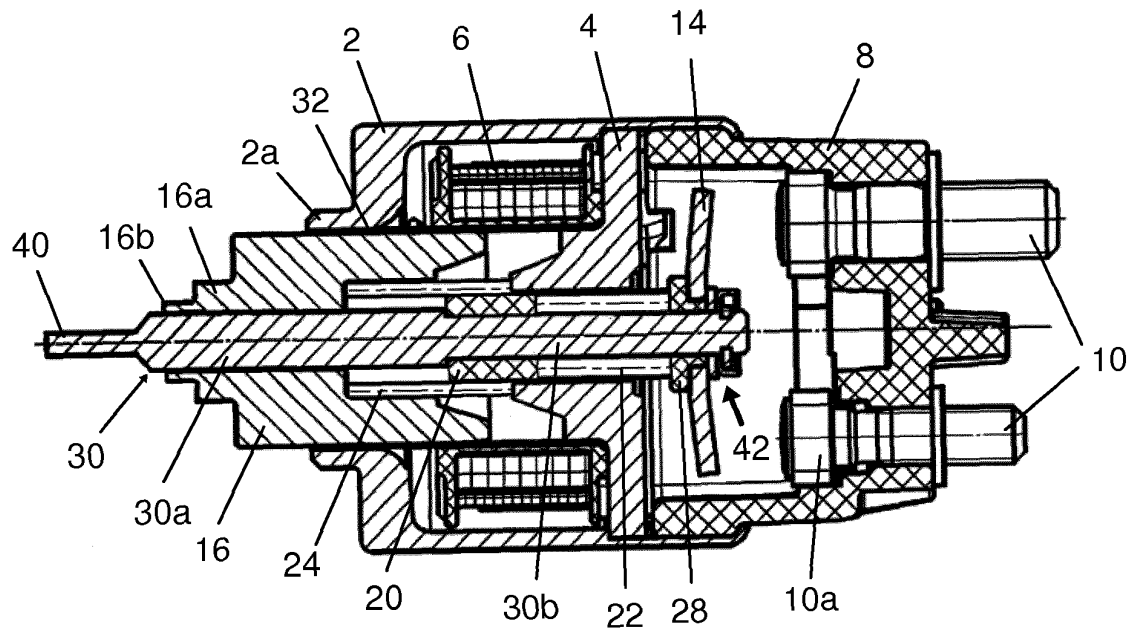


Figure 2

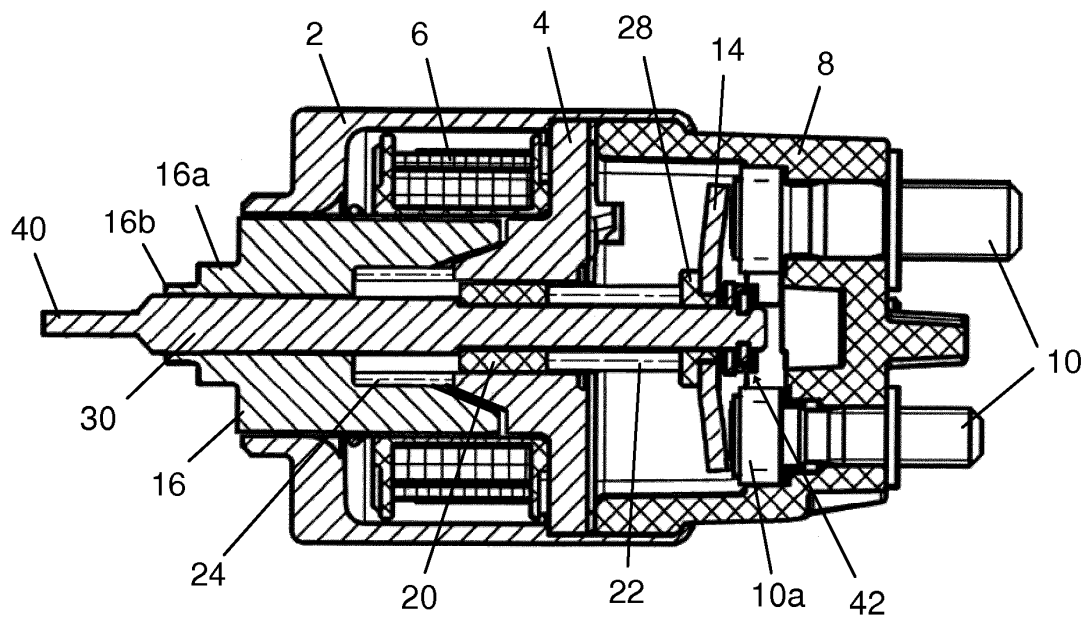


Figure 3

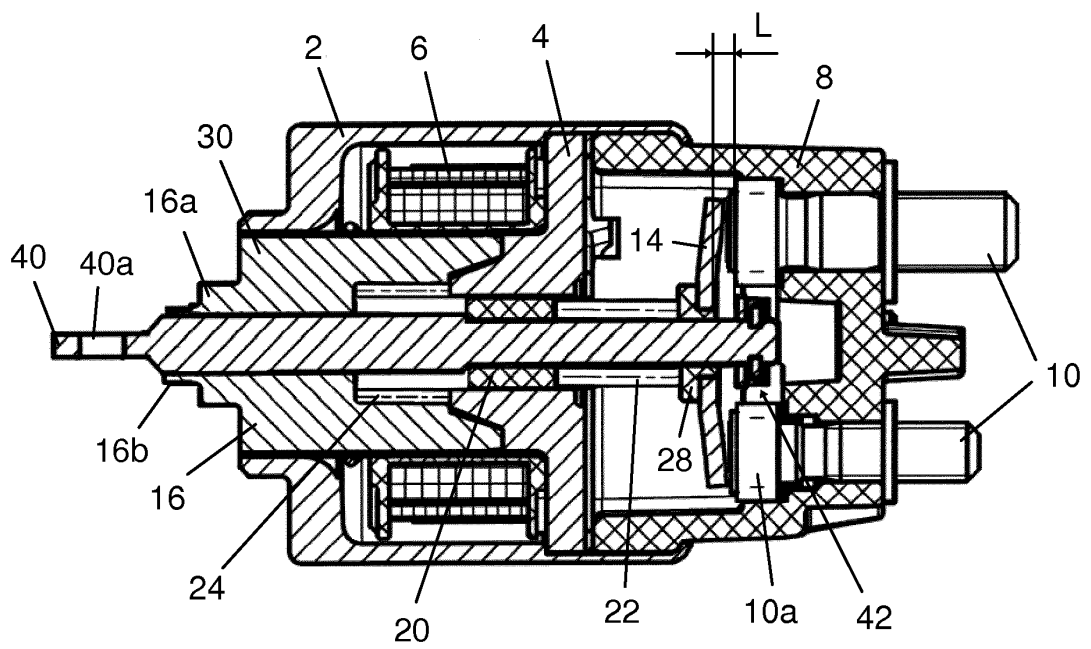


Figure 4

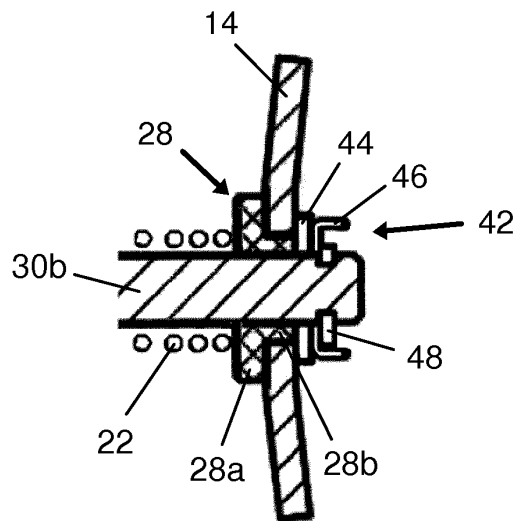


Figure 5

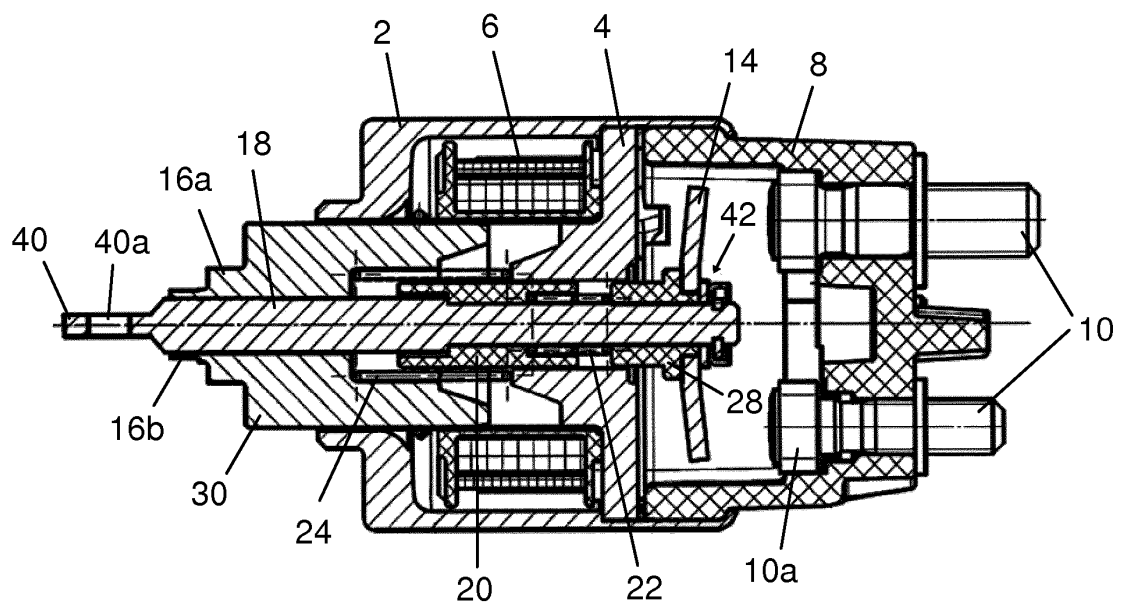


Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075981

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, CNPAT, CNKI: switch, vehicle, motor, start+, core, position, precision, locat+, inductor, transformer, electric connection

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 202564149 U (BOSCH AUTOMOTIVE PROD CHANGSHA CO LTD et al.) 28 November 2012 (28.11.2012) claims 1-15	1-15
A	CN 101026051 A (DENSO CORP.) 29 August 2007 (29.08.2007) the whole document	1-15
A	CN 101858292 A (DENSO CORP.) 13 October 2010 (13.10.2010) the whole document	1-15
A	CN 201478208 U (DIXIE AUTO ELECTRIC SHANGHAI LTD) 19 May 2010 (19.05.2010) the whole document	1-15
A	EP 0789379 A1 (VALEO EQUIP ELECTRIQUES MOTEUR) 13 August 1997 (13.08.1997)	1-15

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search
15 July 2013 (15.07.2013)

Date of mailing of the international search report
15 August 2013 (15.08.2013)

Name and mailing address of the ISA
State Intellectual Property Office of the P. R. China
No. 6, Xitucheng Road, Jimenqiao
Haidian District, Beijing 100088, China
Facsimile No. (86-10) 62019451

Authorized officer
BAI, Qian
Telephone No. (86-10) 62411725

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075981

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	the whole document EP 0643411 A1 (IND MAGNETI MARELLI SPA) 15 March 1995 (15.03.1995) the whole document	1-15

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
 Information on patent family members

 International application No.
 PCT/CN2013/075981

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 202564149 U	28.11.2012	None	
CN 101026051 A	29.08.2007	JP 4525610 B2	18.08.2010
		US 2007194868 A1	23.08.2007
		US 7557684 B2	07.07.2009
		JP 2007227157 A	06.09.2007
		FR 2897717 A1	24.08.2007
		DE 102007007332 A1	06.09.2007
		CN 101026051 B	26.05.2010
CN 101858292 A	13.10.2010	JP 2010242555 A	28.10.2010
		US 2010251853 A1	07.10.2010
		DE 102010016239 A1	18.11.2010
		FR 2944065 A1	08.10.2010
		CN 101858292 B	24.10.2012
CN 201478208 U	19.05.2010	None	
EP 0789379 A1	13.08.1997	FR 2744768 A1	14.08.1997
EP 0643411 A1	15.03.1995	ES 2114100 T3	16.05.1998
		IT 1261588 B	23.05.1996
		DE 69409051 D1	23.04.1998
		EP 0643411 B1	18.03.1998

Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075981

A. CLASSIFICATION OF SUBJECT MATTER:

H01H 51/06 (2006.01) i

F02N 11/00 (2006.01) i