



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

(43) Date of publication:
01.07.2015 Bulletin 2015/27

(51) Int Cl.:
H01C 7/105 (2006.01)

(21) Application number: **13877033.4**

(86) International application number:
PCT/CN2013/077263

(22) Date of filing: **14.06.2013**

(87) International publication number:
WO 2014/134885 (12.09.2014 Gazette 2014/37)

(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
Designated Extension States:
BA ME

(72) Inventors:
• **ZENG, Qinglong**
Huizhou
Guangdong 516221 (CN)
• **CHEN, Zetong**
Huizhou
Guangdong 516221 (CN)

(30) Priority: **08.03.2013 CN 201320106078 U**
03.05.2013 CN 201310160926

(74) Representative: **Laufhütte, Dieter**
Lorenz Seidler Gossel
Rechtsanwälte Patentanwälte
Partnerschaft mbB
Widenmayerstrasse 23
80538 München (DE)

(71) Applicants:
• **LONG KE ELECTRONICS (HUI YANG) CO., LTD.**
Huizhou, Guangdong 516221 (CN)
• **OTOWA ELECTRIC Co., LTD.**
Osaka (JP)

(54) **TUBULAR VOLTAGE DEPENDENT RESISTOR**

(57) A tubular voltage dependent resistor, comprising: a voltage dependent resistor chip, wherein the voltage dependent resistor chip is tubular, and an inner elec-

trode and an outer electrode are respectively arranged on the inner wall and the outer wall of the tubular voltage dependent resistor chip.

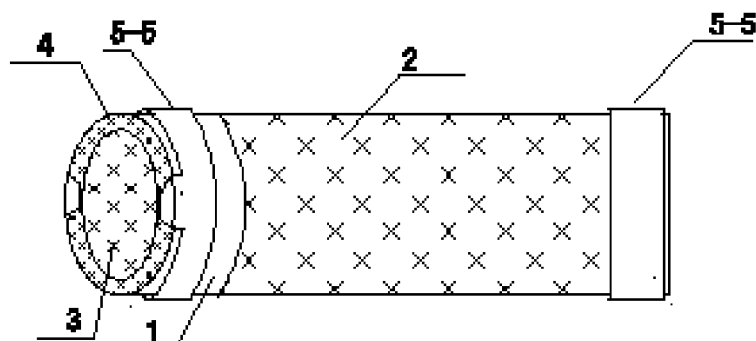


Fig. 1

Description

Technical field

[0001] The present invention relates to a tubular voltage dependent resistor.

Background

[0002] Existing Metal Oxide Voltage dependent resistors have a special nonlinear current-voltage characteristic. Once an unusual condition, such as the lighting stroke, electromagnetic interference, frequent switching of power or power system failure, is encountered in use, the voltage of the circuit will increase suddenly to exceed the breakover voltage of the voltage dependent resistor and the voltage dependent resistor will be entered into the breakover status. Then, the current (I) and voltage (V) are in a nonlinear relationship that can be represented by a nonlinear coefficient of which the value can be several tens or more than one hundred. At this point, the resistance of the voltage dependent resistors reduces to only several Ohms, which allows the release of overvoltage by forming a surge current in order to protect the connected electronic product(s) or expensive module(s).

[0003] Existing voltage dependent resistors are usually in the shape of a planar rectangle or circle that is relatively space-occupied. However, a compact, powerful, universal, easy-to-install and cost effective voltage dependent resistor is desired in the modern electronic technologies.

Summary of the invention

[0004] The technical problem to be solved by the present invention is to provide a compact, powerful, easy-to-install and cost effective tubular voltage dependent resistor in view of the problems in the prior art.

[0005] To solve the technical problem mentioned above, the present invention provides a tubular voltage dependent resistor, comprising: a voltage dependent resistor chip, wherein the voltage dependent resistor chip is tubular, and an inner electrode and an outer electrode are respectively arranged on the inner wall and the outer wall of the tubular voltage dependent resistor chip.

[0006] In an embodiment, the tubular voltage dependent resistor chip has a tubular length of from 8 mm to 100 mm, an inner diameter of from 3.5 mm to 50 mm, and an outer diameter of from 4.5 mm to 80 mm.

[0007] In an embodiment, the tubular voltage dependent resistor chip is in the shape of a circular tube or a rectangular tube.

[0008] In an embodiment, an inner extraction electrode and an outer extraction electrode are arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip respectively, with the inner extraction electrode and the outer extraction electrode connected to the inner electrode and the outer electrode respectively.

[0009] In an embodiment, the inner electrode is connected to the inner extraction electrode directly or by a conductor.

[0010] In an embodiment, the inner electrode and the outer electrode independently have a number of from 1 to 3.

[0011] In an embodiment, when there is one inner electrode and two or more outer electrodes, a plurality of outer extraction electrodes are arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip with each outer extraction electrode connected to each outer electrode correspondingly.

[0012] In an embodiment, an outer extraction electrode, being connected to the outer electrode correspondingly, is arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip, and a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end passing through one end of the tubular voltage dependent resistor chip and the other connected to one outer extraction electrode, thereby forming a circuit-protecting type tubular voltage dependent resistor.

[0013] In an embodiment, the end of the fuse tube connected to the outer extraction electrode is used as the power output end, and the other end of the fuse tube is used as the power input end, or vice versa.

[0014] In an embodiment, an outer extraction electrode and an inner extraction electrode are arranged on the ends of the tubular voltage dependent resistor chip respectively, with the outer extraction electrode connected to the outer electrode correspondingly, and a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end connected to the inner electrode and the other end connected to the inner extraction electrode, thereby forming a self-protecting type tubular voltage dependent resistor.

[0015] In an embodiment, an outer extraction electrode, being connected to the outer electrode correspondingly, is arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip, there are two inner electrodes separately arranged along the axial direction of the voltage dependent resistor chip, and a fuse tube is arranged in the inside cavity space of the voltage dependent resistor chip with the ends connected to the two inner electrodes respectively, thereby forming a self-protecting type tubular voltage dependent resistor.

[0016] In an embodiment, the outer extraction electrode is correspondingly connected to the outer electrode by a low temperature alloy, thereby forming a self-protecting type tubular voltage dependent resistor.

[0017] In an embodiment, a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end passing through one end of the tubular voltage dependent resistor chip and the other end connected to the inner extraction electrode, thereby forming a circuit- and self-protecting type tubular voltage dependent resistor.

[0018] In an embodiment, the outer extraction elec-

trode is connected to the outer electrode by a low temperature alloy, thereby forming a circuit- and self-protecting type tubular voltage dependent resistor.

[0019] In an embodiment, the inner extraction electrode is a metal terminal cap, a metal clamp, a metal clamping ring, or a pin, and the out extraction electrode is a metal terminal cap, a metal clamp, or a metal clamping ring.

[0020] In an embodiment, the outer extraction electrode, as a metal terminal cap, is arranged on both ends of the tubular voltage dependent resistor chip, and the inner extraction electrode is a pin extracted insulatingly from the metal terminal cap.

[0021] In an embodiment, the outer extraction electrode is a metal terminal cap, a metal clamp, or a metal clamping ring.

[0022] In an embodiment, the outer extraction electrode is a metal terminal cap with an warped edge correspondingly connected to the outer electrode by a low temperature alloy, a metal clamp, or a metal clamping ring.

[0023] In an embodiment, the fuse tube is a temperature-dependent type, a current-dependent type, or a voltage-dependent type.

[0024] The present invention provides the following beneficial effects.

1. The voltage dependent resistor chip in the present invention is configured in a tubular shape, which utilizes space efficiently, reduces the occupied area, and meets the product miniaturization requirements while retaining the electric performance.

2. A plurality of voltage dependent resistors can be formed by arranging a plurality of electrodes, outer extraction electrodes and inner extraction electrodes in the present invention to constitute various equivalent circuits, which enables the present invention more powerful and flexible to use.

3. A plurality of electrodes, outer extraction electrodes and inner extraction electrodes are configured to be conveniently connected with the universal fuse tube holder by clamping or screwing in the present invention, which reduces the running costs.

4. A fuse tube is arranged in the present invention, with one end as the power input end and the other end as the power output end, the power flowing into the power input end and out of the power output end, by which a circuit-protecting device can be formed by cutting off the power supply in an emergency to protect the equipment.

5. A low temperature alloy or fuse tube is configured to be connected to the tubular voltage dependent resistor in a tandem manner in the present invention, by which a self-protecting device can be formed by

cutting off the power supply before the malfunction of the tubular voltage dependent resistor in order to shut down and protect the equipment(s).

6. A low temperature alloy is configured to be connected to the tubular voltage dependent resistor in a tandem manner in the present invention, thereby conferring a powerful circuit- and self-protecting function.

DESCRIPTION OF THE DRAWINGS

[0025]

Figure 1 is a schematic structure view of Example 1 of the present invention.

Figure 2 is the equivalent circuit diagram of Figure 1.

Figure 3 is a schematic structure view of Example 2 of the present invention.

Figure 4 is the equivalent circuit diagram of Figure 3.

Figure 5 is a schematic structure view of Example 3 of the present invention.

Figure 6 is the equivalent circuit diagram of Figure 5.

Figure 7 is a schematic structure view of Example 4 of the present invention.

Figure 8 is the equivalent circuit diagram of Figure 7.

Figure 9 is a schematic structure view of Example 5 of the present invention.

Figure 10 is the equivalent circuit diagram of Figure 9.

Figure 11 is a schematic structure view of Example 6 of the present invention.

Figure 12 is the equivalent circuit diagram of Figure 11.

Figure 13 is a schematic structure view of Example 7 of the present invention.

Figure 14 is the equivalent circuit diagram of Figure 13.

Figure 15 is a schematic structure view of Example 8 of the present invention.

Figure 16 is the equivalent circuit diagram of Figure 15.

Figure 17 is a schematic structure view of Example 9 of the present invention.

Figure 18 is the equivalent circuit diagram of Figure 17.

Figure 19 is a schematic structure view of Example 10 of the present invention.

Figure 20 is the equivalent circuit diagram of Figure 19.

Figure 21 is a schematic structure view of Example 11 of the present invention.

Figure 22 is the equivalent circuit diagram of Figure 21.

Figure 23 is a schematic structure view of Example 12 of the present invention.

Figure 24 is the equivalent circuit diagram of Figure 23.

Figure 25 is a schematic structure view of Example 13 of the present invention.

Figure 26 is the equivalent circuit diagram of Figure 25.

Figure 27 is a schematic structure view of Example 14 of the present invention.

Figure 28 is the equivalent circuit diagram of Figure 27.

Figure 29 is a schematic structure view of Example 15 of the present invention.

Figure 30 is the equivalent circuit diagram of Figure 29.

DETAILED DESCRIPTION

[0026] The present invention will be described below in conjunction with the drawings.

[0027] The present invention provides four kinds of devices to meet the requirements of different circumstances, depending on the use.

[0028] The first type is a voltage dependent resistor without protections, which shares a universal fuse tube holder for clamping and screwing. It will be described below by way of Examples 1 to 4.

Example 1:

[0029] Figure 1 is a schematic structure view of Example 1 of the present invention. As shown in Figure 1, the device comprises a tubular voltage dependent resistor chip 1, which is a magnet without an electrode coating. The tubular voltage dependent resistor chip 1 can be in the shape of a circular tube or a rectangular tube, the thickness of which determines the breakover voltage. An inner electrode 3 and an outer electrode 2 are coated on the inner and outer walls of the voltage dependent resistor chip 1, respectively. An inner extraction electrode and an outer extraction electrode are respectively arranged on the ends of the tubular voltage dependent resistor chip 1. The inner and outer extraction electrodes can be a metal terminal cap, a metal clamp, or a metal clamping ring. This example is described by way of metal clamping rings as the inner and outer extraction electrodes. A conductor 4 is arranged on one end surface of the voltage dependent resistor chip to connect the inner electrode 3 and the metal terminal cap 5-5. Between the outer electrode 2 and the conductor 4 is a gap that is without an electrode coating, or coated with an insulating layer. Neither is an electrode coating present on the other end surface of the voltage dependent resistor chip 1, in order to separate the same from the inner electrode 3 for safety. The voltage dependent resistor chip has a tubular length of 8 mm, an inner diameter of 3.5 mm, and an outer diameter of 4.5 mm. This example has the shape and size meeting the requirements of the international standards, can form a product structure belonging to the kind of universal fuses, and share a universal fuse holder for clamping and screwing. Figure 2 is the equivalent circuit dia-

gram of Figure 1.

Example 2:

[0030] Figure 3 is a schematic structure view of the Example 2 of the present invention. As shown in Figure 3, the device comprises a tubular voltage dependent resistor chip 1 which is a magnet without an electrode coating. The tubular voltage dependent resistor chip 1 can be in the shape of a circular tube or a rectangular tube, the thickness of which determines the service voltage. One inner electrode 3 and two outer electrodes 2-1, 2-2 are coated on the inner and outer walls of the tubular voltage dependent resistor chip 1, respectively. The two outer electrodes are separately arranged along the axial direction of the tubular voltage dependent resistor chip, with a gap not coated with an electrode between the adjacent outer electrodes. The two end surfaces of the voltage dependent resistor chip 1 are without an electrode coating, or coated with an insulating layer. To avoid that the inner and outer electrodes are too close to each other, the inner electrode 3 is a certain distance away from the two end surfaces when coated. An outer extraction electrode, as a metal terminal cap, a metal clamp, or a metal clamping ring, is arranged on both ends of the tubular voltage dependent resistor chip. This example is described by way of a metal terminal cap as the outer extraction electrode. That is, the metal terminal caps 5-0, 5-1 are arranged on the ends of the tubular voltage dependent resistor chip, and connected to the outer electrodes 2-1, 2-2 by welding or clamping, respectively. The inner electrode 3 is extracted by an inner extraction electrode. This example is described by way of a pin 8 as the inner extraction electrode. The metal terminal cap 5-0 has an aperture at which an insulating sleeve 9 is arranged. When the metal terminal cap 5-0 is arranged on one end of the voltage dependent resistor chip, the pin 8 extends out of the insulating sleeve 9. Figure 4 is the equivalent circuit diagram of the Example 2. The tubular voltage dependent resistor chip has a tubular length of 100 mm, an inner diameter of 50 mm, and an outer diameter of 80 mm. The voltage dependent resistors of this example share a universal fuse holder for screwing and welding. If the pin 8 is not extracted in this example, and both ends of the tubular voltage dependent resistor chip are connected by the metal terminal cap 5-1, the equivalent circuit will become two voltage dependent resistors in tandem connection.

Example 3:

[0031] Figure 5 is a schematic structure view of Example 3 of the present invention. Example 3 is substantially the same with Example 2 in structure, with the exceptions that there are three outer electrodes, the outer electrode 2-3 arranged on the periphery of the tubular voltage dependent resistor chip is fastened to the metal clamp (clamping ring) 11 by screwing of a bolt 12, welding, riv-

eting or clipping, the metal clamp (clamping ring) 11 is used as the outer extraction electrode of the outer electrode 2-3, and there are three outer extraction electrodes formed in this example. Figure 6 is the equivalent circuit diagram of Figure 5.

Example 4

[0032] Figure 7 is a schematic structure view of Example 4 of the present invention. Example 4 is substantially the same with Example 2 in structure, with the exceptions that there are two inner electrodes, namely 3-1 and 3-2, that are extracted by the pins 8 respectively, both the metal terminal caps 5-0 have an aperture at which the insulating sleeve 9 is arranged, and the two pins 8 extend out of the insulating sleeves 9 of the two terminal caps respectively. The equivalent circuit diagram is shown in Figure 8. In this example, the voltage dependent resistor chip has a tubular length of 45 mm, an inner diameter of 28 mm, and an outer diameter of 55 mm. The pin(s) 8 can be cancelled to form a new application example for the other examples with an exception of this one.

[0033] The second type is circuit-protecting and characterized in that a fuse tube in tandem connection is provided in the circuit and the Lin and Lout ends are used as the power input and output ends respectively, thereby cutting off the fuse tube to protect the equipment in an emergency. This type of devices meets the UL standard. The second type of the tubular voltage dependent resistors is described below by way of Examples 5 to 7.

Example 5:

[0034] Figure 9 is a schematic structure view of Example 5 of the present invention. Example 5 is substantially the same with Example 1 in structure with the exceptions that, the outer extraction electrodes arranged on the ends of the voltage dependent resistor chip are selected to be metal terminal caps 5-0; a fuse tube 10 is arranged in the inside cavity space of the tubular voltage dependent resistor chip with its lead 10-1 connected to the metal terminal cap 5-0 at one end, which metal terminal cap 5-0 is simultaneously connected to the outer electrode 2 by clamping or welding to form the output end Lout; and an insulating layer 6 is coated at the end surface of the voltage dependent resistor chip to avoid that the inner electrode 3 and the outer electrode 2 are too close to each other, so as to keep a safe distance between the electrodes. A conductor 4, being connected to the inner electrode 3, is arranged on the other end surface of the voltage dependent resistor chip, and welded to the metal terminal cap 5-0 at the same end. The aperture arranged in this metal terminal cap 5-0 is jacketed with a ring-shaped insulating sleeve 9, from which the lead 10-2 of the fuse tube 10 is extracted and used as the power input end Lin. A circuit-protecting type tubular voltage dependent resistor is thus formed. The fuse tube 10 is a temperature-dependent type, a current-dependent type, or a

voltage-dependent type. Figure 10 is the equivalent circuit diagram of Figure 9. Of course, the power input end Lin and the power output end Lout are interchangeable in this example.

Example 6:

[0035] Figure 11 is a schematic structure view of Example 6 of the present invention. Example 6 is substantially the same with Example 5 in structure, with the exceptions that the conductor 4 is cancelled, two outer electrodes 2-1, 2-2 are separately arranged along the axial direction on the outer wall of the voltage dependent resistor chip, a gap not coated with an electrode is kept between the adjacent electrodes, both the end surfaces of the tubular voltage dependent resistor chip are coated with an insulating layer 6, and the two metal terminal caps 5-0 are connected to the outer electrodes 2-1, 2-2 respectively. A protective tandem type device is thus formed. Figure 12 is the equivalent circuit diagram of Figure 11.

Example 7:

[0036] Figure 13 is a schematic structure view of Example 7 of the present invention. Example 7 is substantially the same with Example 6 in structure, with the exceptions that there are three outer electrodes 2-1, 2-2, 2-3, arranged on the outer wall of the tubular voltage dependent resistor, a metal clamp (clamping ring) 11 on the outer electrode 2-3 is used as the outer extraction electrode thereof and fastened by a screw 12. A star-shaped device having fuse is thus formed. Figure 14 is the equivalent circuit diagram of Figure 13.

[0037] The third type is a self-protecting tubular voltage dependent resistor and characterized in that a fuse in tandem connection is provided in the device. The power can be cut off to stop the operation before the malfunction of the tubular voltage dependent resistor, so as not to affect the normal operation of the equipment(s). The third type of the tubular voltage dependent resistors is described below by way of Examples 8 to 13.

Example 8

[0038] Figure 15 is a schematic structure view of Example 8 of the present invention. Example 8 is substantially the same with Example 5 in structure, with the exceptions that an insulating layer 6 is arranged on both ends of the tubular voltage dependent resistor chip; the fuse tube 10 has one lead 10-1 welded to the inner electrode 3 and the other lead 10-2 welded to the metal terminal cap 5-0 that is used as the inner extraction electrode for the inner electrode 3; and the metal terminal cap 5-1 at the other end is clamped (welded) to and used as the outer extraction electrode for the outer electrode 2. The device as a whole is a protective tandem one. Figure 16 is the equivalent circuit diagram of Figure 15.

Example 9:

[0039] Figure 17 is a schematic structure view of Example 9 of the present invention. Example 9 is substantially the same with Example 6 in structure, with the exceptions that two inner electrodes 3-1, 3-2 separately arranged along the axial direction of the voltage dependent resistor chip are arranged on the inner wall of the voltage dependent resistor chip, the fuse tube has two leads 10-1, 10-2 welded respectively to the two inner electrodes 3-2, 3-1, and no inner extraction electrode(s) is necessary. A device having a fuse tube in tandem connection therein is thus formed. Figure 18 is the equivalent circuit diagram of Figure 17.

Example 10:

[0040] Figure 19 is a schematic structure view of Example 10 of the present invention. Example 10 is substantially the same with Example 1 in structure, with the exceptions that the outer extraction electrode arranged on one end of the voltage dependent resistor chip is a metal terminal cap 5-2 with an warped edge connected to the outer electrode 2 by the low temperature alloy 7, and an insulating layer is coated between the metal terminal cap 5-2 and the voltage dependent resistor chip in order to separate the inner wall of the metal terminal cap 5-2 and the outer electrode 2. The metal terminal cap 5-2 is connected to the power end. The low temperature alloy 7 will melt before the malfunction of the tubular voltage dependent resistor, by which the tubular voltage dependent resistor is cut off from the power supply and stops the operation. Figure 20 is the equivalent circuit diagram of Figure 19.

Example 11

[0041] Figure 21 is a schematic structure view of Example 11 of the present invention. Example 11 is substantially the same with Example 2 in structure, with the exceptions that the metal terminal caps on the ends of the voltage dependent resistor chip are both metal terminal caps with an warped edge, the warped edge of the two metal terminal cap 5-2, 5-3 are respectively welded to outer electrodes 2-1, 2-2 by the low-temperature alloy 7, which forms a device having the fuse function at both ends, and an insulating layer 6 separating the inner wall of the metal terminal cap 5-2 and the outer electrode 2 is coated at both ends of the voltage dependent resistor chip to prevent the conduction caused by the outer electrodes being too close to the inner electrode. Figure 22 is the equivalent circuit diagram of Figure 21.

Example 12

[0042] Figure 23 is a schematic structure view of Example 12 of the present invention. Example 12 is substantially the same with Example 11 in structure, with the

exceptions that three outer electrodes 2-1, 2-2, 2-3 are arranged on the outer wall of the voltage dependent resistor chip, the warped edges of the two metal terminal caps 5-2, 5-3 are welded to the outer electrodes 2-1, 2-2 by a low-temperature alloy 7, respectively, the outer electrode 2-3 is jacketed by a U-shaped insulating sleeve 9-1, at the opening of which is arranged a low temperature alloy block 7-1, a clamp 11 is further jacketed to allow the low-temperature alloy block 7-1 pressing the outer electrode 2-3 with one side and pushing the clamp 11 with the other side, and the clamp 11 is fastened by a screw 12. A device with triple insurance is thus formed. Figure 24 is the equivalent circuit diagram of Figure 23.

Example 13

[0043] Figure 25 is a schematic structure view of Example 13 of the present invention. Example 13 is substantially the same with Example 11 in structure, with the exceptions that two inner electrodes 3-1, 3-2 are arranged on the inner wall of the voltage dependent resistor chip, which are extracted respectively by a pin 8. A device with two separate parts having the fuse function is thus formed to facilitate the combined use by the user. Figure 26 is the equivalent circuit diagram of Figure 25.

[0044] The forth type is a tubular voltage dependent resistor having both the circuit- and self-protection, and characterized in the combined characteristics of a circuit-protecting voltage dependent resistor and a self-protecting voltage dependent resistor. It will be described below by way of Examples 14 to 15.

Example 14

[0045] Figure 27 is a schematic structure view of Example 14 of the present invention. Example 14 is substantially the same with Example 11 in structure, with the exceptions that a fuse tube 10 is arranged in the tubular voltage dependent resistor chip with a lead 10-2 welded to the pin 8 to be used as the power output end Lout and another lead 10-1 extending out of the ring-shaped insulating sleeve 9 arranged at the metal terminal cap 5-3 to be used as the power input end Lin. A tubular voltage dependent resistor having both circuit- and self-protection is thus formed. Figure 28 is the equivalent circuit diagram of Figure 27.

Example 15

[0046] Figure 29 is a schematic structure view of Example 15 of the present invention. Example 15 is substantially the same with Example 12 in structure, with the exceptions that a fuse tube 10 is arranged in the inside cavity space of the tubular voltage dependent resistor chip with a lead 10-2 welded to the metal terminal cap 5-2 to be used as the power output end Lout and another lead 10-1 extending out of the ring-shaped insulating sleeve 9 arranged at the metal terminal cap 5-3 to be

used as the power input end Lin. A tubular voltage dependent resistor having both circuit- and self- protection is thus formed. Figure 30 is the equivalent circuit diagram of Figure 29.

Claims

1. A tubular voltage dependent resistor, comprising: a voltage dependent resistor chip, wherein the voltage dependent resistor chip is tubular, and an inner electrode and an outer electrode are respectively arranged on the inner wall and the outer wall of the tubular voltage dependent resistor chip.
2. The tubular voltage dependent resistor according to claim 1, **characterized in that** the tubular voltage dependent resistor chip has a tubular length of from 8 mm to 100 mm, an inner diameter of from 3.5 mm to 50 mm, and an outer diameter of from 4.5 mm to 80 mm.
3. The tubular voltage dependent resistor according to claim 1 or 2, **characterized in that** the tubular voltage dependent resistor chip is in the shape of a circular tube or a rectangular tube.
4. The tubular voltage dependent resistor according to claim 1, **characterized in that** an inner extraction electrode and an outer extraction electrode are arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip respectively, with the inner extraction electrode and the outer extraction electrode connected to the inner electrode and the outer electrode respectively.
5. The tubular voltage dependent resistor according to claim 4, **characterized in that** the inner electrode is connected to the inner extraction electrode directly or by a conductor.
6. The tubular voltage dependent resistor according to claim 5, **characterized in that** the inner electrode and the outer electrode independently have a number of from 1 to 3.
7. The tubular voltage dependent resistor according to claim 1, **characterized in that**, when there is one inner electrode and two or more outer electrodes, a plurality of outer extraction electrodes are arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip with each outer extraction electrode connected to each outer electrode correspondingly.
8. The tubular voltage dependent resistor according to claim 1, **characterized in that** an outer extraction electrode, being connected to the outer electrode correspondingly, is arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip, and a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end passing through one end of the tubular voltage dependent resistor chip and the other end connected to one outer extraction electrode, thereby forming a circuit-protecting type tubular voltage dependent resistor.
9. The tubular voltage dependent resistor according to claim 8, **characterized in that** the end of the fuse tube connected to the outer extraction electrode is used as the power output end, and the other end of the fuse tube is used as the power input end, or vice versa.
10. The tubular voltage dependent resistor according to claim 1, **characterized in that** an outer extraction electrode and an inner extraction electrode are arranged on the ends of the tubular voltage dependent resistor chip respectively, with the outer extraction electrode connected to the outer electrode correspondingly, and a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end connected to the inner electrode and the other end connected to the inner extraction electrode, thereby forming a self-protecting type tubular voltage dependent resistor.
11. The tubular voltage dependent resistor according to claim 1, **characterized in that** an outer extraction electrode, being connected to the outer electrode correspondingly, is arranged on the end(s) and/or periphery of the tubular voltage dependent resistor chip, there are two inner electrodes separately arranged along the axial direction of the voltage dependent resistor chip, and a fuse tube is arranged in the inside cavity space of the voltage dependent resistor chip with the ends connected to the two inner electrodes respectively, thereby forming a self-protecting type tubular voltage dependent resistor.
12. The tubular voltage dependent resistor according to claim 4, **characterized in that** the outer extraction electrode is correspondingly connected to the outer electrode by a low temperature alloy, thereby forming a self-protecting type tubular voltage dependent resistor.
13. The tubular voltage dependent resistor according to claim 12, **characterized in that** a fuse tube is arranged in the inside cavity space of the tubular voltage dependent resistor chip with one end passing through one end of the tubular voltage dependent resistor chip and the other end connected to the inner extraction electrode, thereby forming a circuit- and self-protecting type tubular voltage dependent resistor.

tor.

14. The tubular voltage dependent resistor according to claim 8, **characterized in that** the outer extraction electrode is connected to the outer electrode by a low temperature alloy, thereby forming a circuit- and self-protecting type tubular voltage dependent resistor. 5
15. The tubular voltage dependent resistor according to claim 4, 5, or 6, **characterized in that** the inner extraction electrode is a metal terminal cap, a metal clamp, a metal clamping ring, or a pin, and the outer extraction electrode is a metal terminal cap, a metal clamp, or a metal clamping ring. 10 15
16. The tubular voltage dependent resistor according to claim 4, **characterized in that** the outer extraction electrode, as a metal terminal cap, is arranged on both ends of the tubular voltage dependent resistor chip, and the inner extraction electrode is a pin extracted insulatingly from the metal terminal cap. 20
17. The tubular voltage dependent resistor according to claim 8, 9, 13, or 14, **characterized in that** the outer extraction electrode is a metal terminal cap, a metal clamp, or a metal clamping ring. 25
18. The tubular voltage dependent resistor according to claim 12, 13, or 14, **characterized in that** the outer extraction electrode is a metal terminal cap with an warped edge correspondingly connected to the outer electrode by a low temperature alloy, a metal clamp, or a metal clamping ring. 30 35
19. The tubular voltage dependent resistor according to claim 8, 9, 10, or 11, **characterized in that** the fuse tube is a temperature-dependent type, a current-dependent type, or a voltage-dependent type. 40

45

50

55

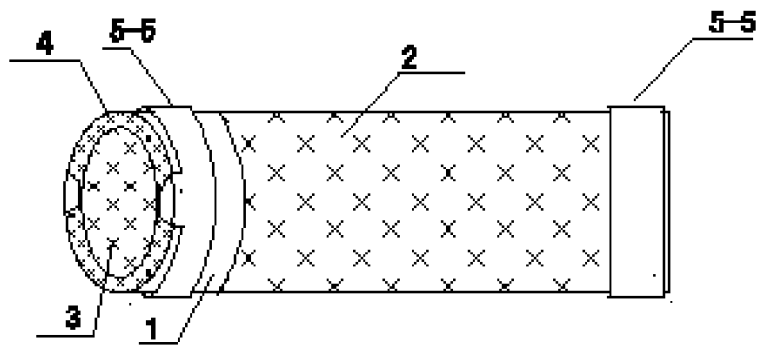


Fig. 1

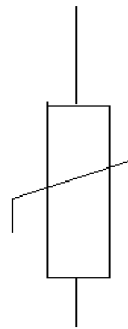


Fig. 2

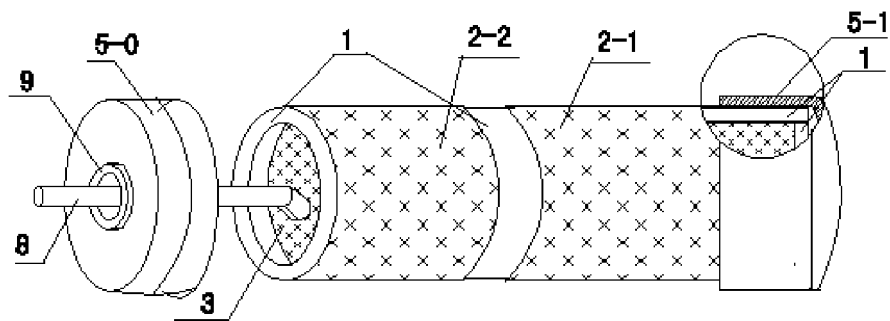


Fig. 3

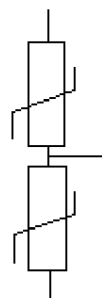


Fig. 4

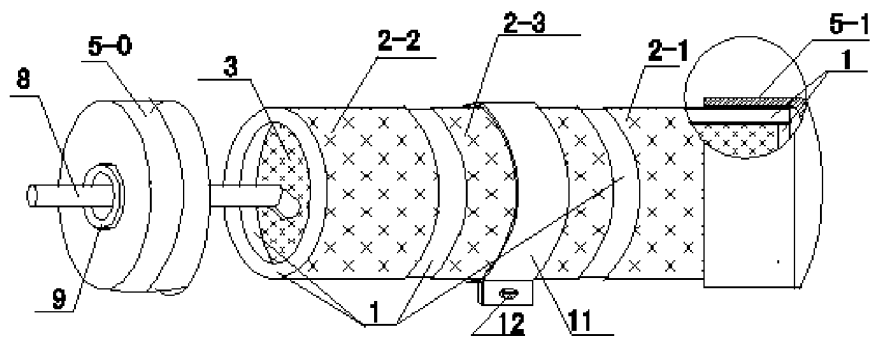


Fig. 5

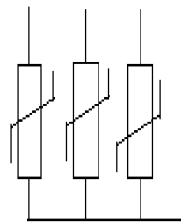


Fig. 6

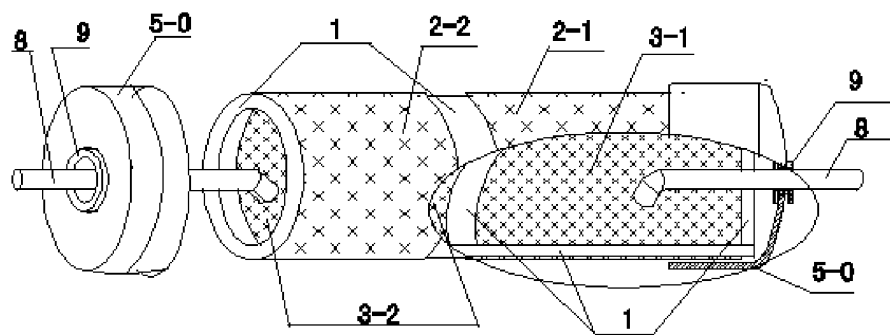


Fig. 7

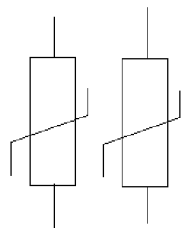


Fig. 8

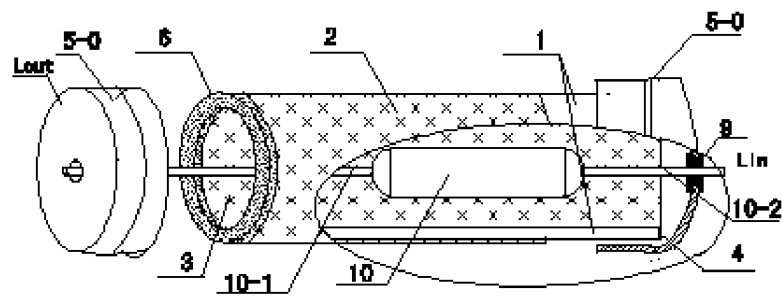


Fig. 9

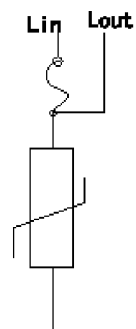


Fig. 10

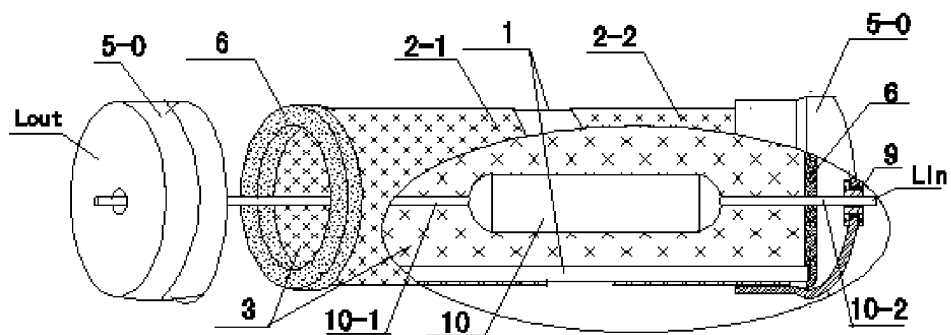


Fig. 11

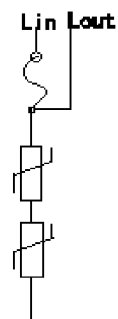


Fig. 12

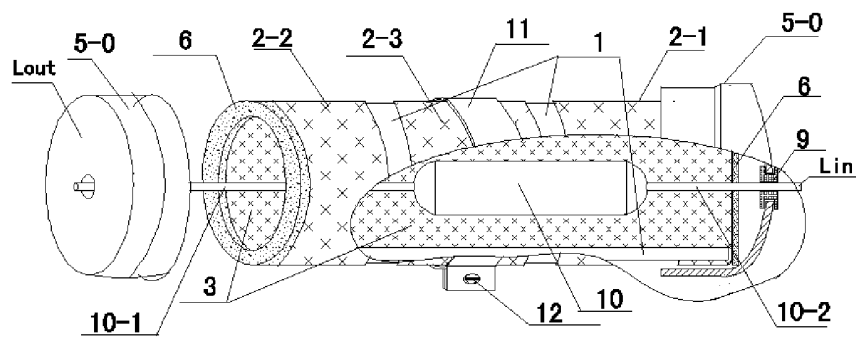


Fig. 13

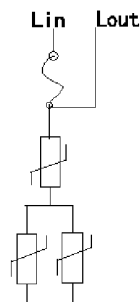


Fig. 14

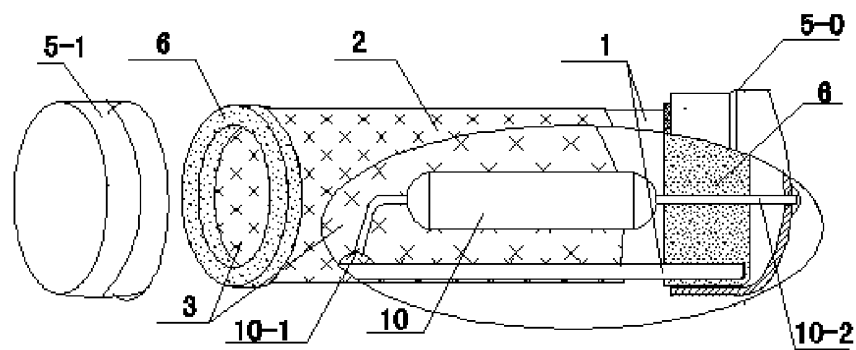


Fig. 15

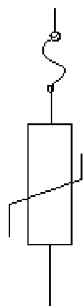


Fig. 16

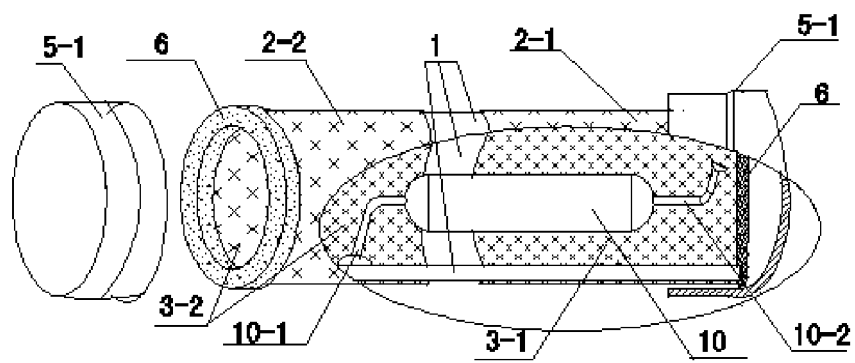


Fig. 17



Fig. 18

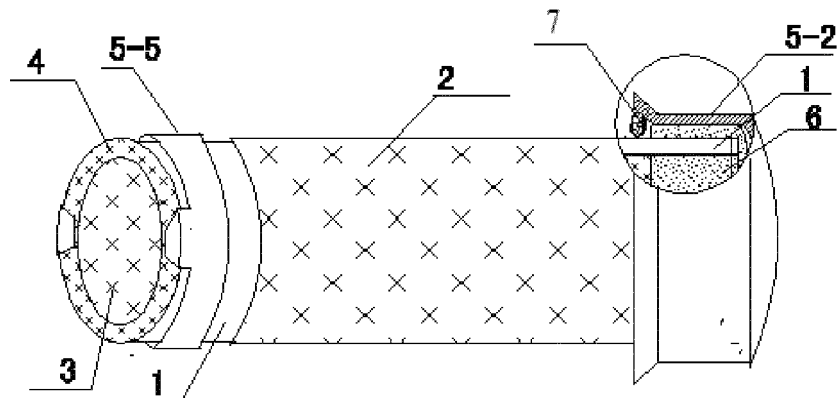


Fig. 19



Fig. 20

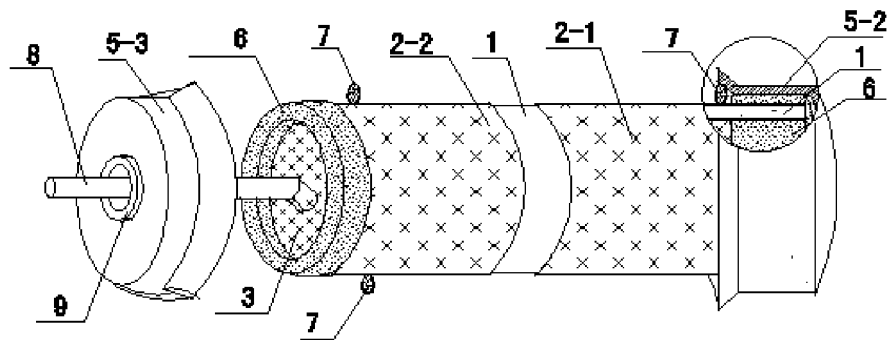


Fig. 21

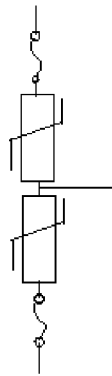


Fig. 22

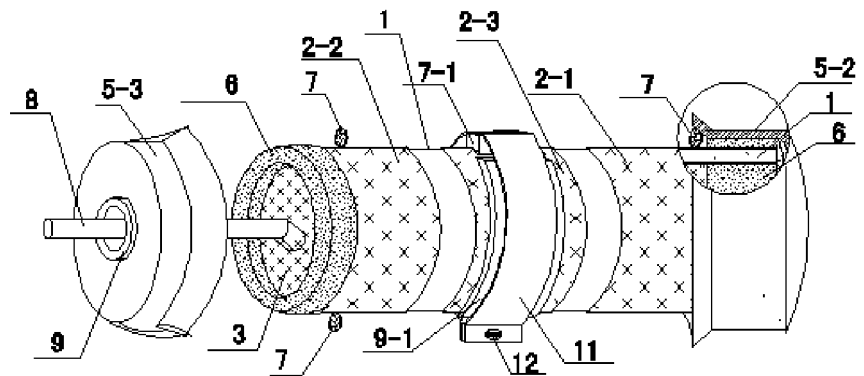


Fig. 23

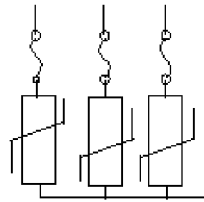


Fig. 24

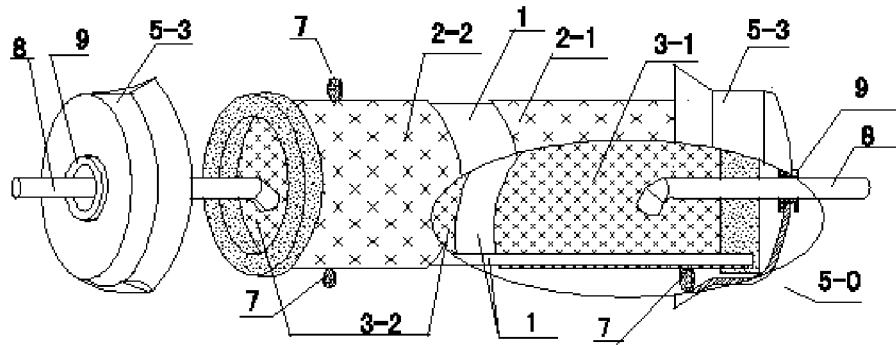


Fig. 25

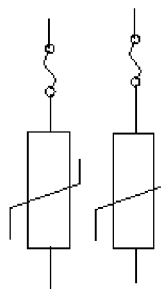


Fig. 26

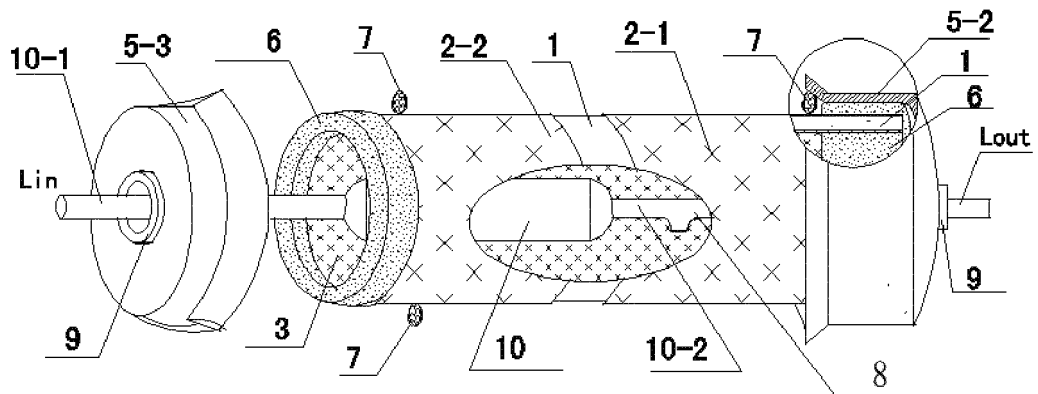


Fig. 27

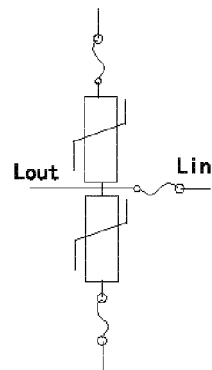


Fig. 28

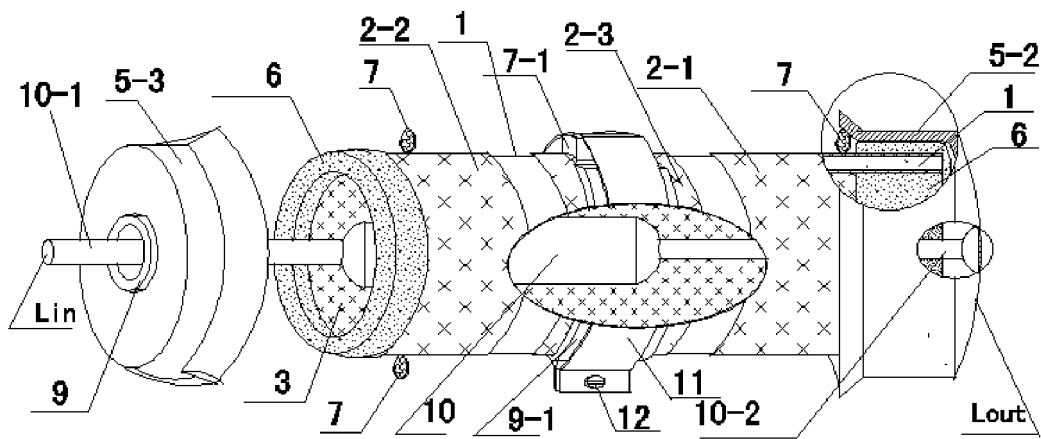


Fig. 29

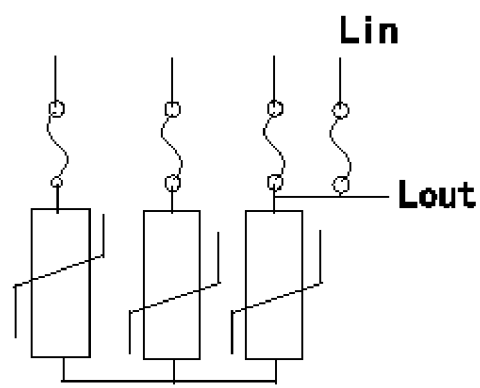


Fig. 30

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/077263

A. CLASSIFICATION OF SUBJECT MATTER

H01C 7/105 (2006.01) i

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: H01C 7/-

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)

CNPAT, CNTXT, CNKI, DWPI: tubular, resistance, pressure sensitive, electrode, insurance, zinc oxide, nonlinear, nonlinear, resistor, chip, tube

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1681052 A (ABB RESEARCH LTD.), 12 October 2005 (12.10.2005), description, page 7, line 7	1-19
A	CN 1205625 C (GUANGZHOU SUNRISE ELECTRONIC CO., LTD.), 08 June 2005 (08.06.2005), the whole document	1-19

☐ 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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 05 December 2013 (05.12.2013)	Date of mailing of the international search report 12 December 2013 (12.12.2013)
Name and mailing address of the ISA/CN: 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 ZHANG, Ying Telephone No.: (86-10) 62411621

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2013/077263

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 1681052 A	12.10.2005	EP 1585146 B1	06.08.2008
		CN 1681052 B	13.10.2010
		DE 602004015567 E	18.09.2008
		US 7651636 B2	26.01.2010
		US 2005218380 A1	06.10.2005
		EP 1585146 A1	12.10.2005
CN 1205625 C	08.06.2005	CN 1417813 A	14.05.2003

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