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(54) **Low thermal EMF switching unit**

(57) Disclosed is a switching unit 100, such as a relay and in particular a reed relay, for switching between a first and a second state, e.g. an on- and an off-state. The switching unit comprises at least one thermo-electrically active junction. For reducing or avoiding a resulting thermo-electric voltage, the temperature at the at least one junction is kept substantially constant during the first and the second state. Preferably, the power dissipation of the switching unit is kept substantially constant during the first and the second state.

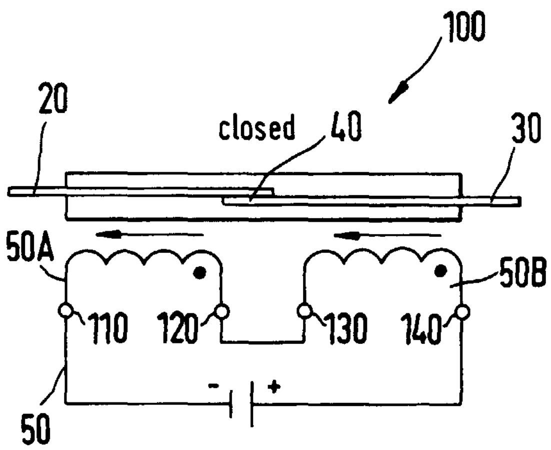

Fig.2A

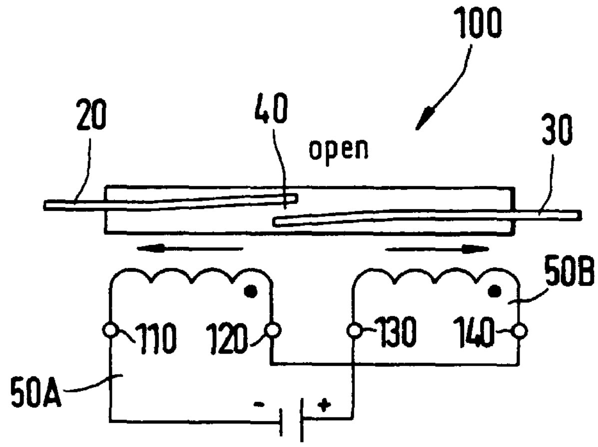

Fig.2B

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to switching units for switching between a first and a second state, whereby the switching unit comprises at least one thermo-electrically active junction.

[0002] An example for a switching unit or device is a relay applying the solenoid principle for opening and closing electrical circuits. Fig. 1A shows a principle structure of a so-called reed relay 10, which is generally used for switching low power circuits. The reed relay 10 consists of two contact plates 20 and 30 of typically 50-50 nickel-iron alloy that overlap with a gap between the two contact plates 20 and 30 in a contact overlap 40. When a magnetic field by an exciting coil 50 is applied along the length of the plates 20 and 30, opposite magnetic poles are induced in the overlapping parts of the contacts 20 and 30 and they are attracted together, making electrical contact. On removal of the magnetic field, the springiness of the contact plates 20 and/or 30 opens the contact. The overlap region is normally plated on each plate 20 and 30 with gold to ensure good electrical contact. An enclosing glass capsule 60 is normally filled with dry nitrogen to prevent corrosion and maintain high insulation resistance even under high humidity conditions. The magnetic field required to operate the reed relay 10 generally depends on the mechanical construction of the relay 10.

[0003] When switching very low voltages in the microvolt-range, thermo-electric voltages represent the most important sources for errors in those applications. Fig. 1B depicts thermo-electric voltage sources in the reed relay 10 (e.g. of Fig. 1A) in its closed state, i.e. when the contact plates 20 and 30 are in contact. At the transitions of the contact plates 20 and 30, normally of a nickel-iron alloy, to contact pins 70 and 80, normally made of copper, a thermo-electric voltage (or thermal electromotive force — EMF) occurs at a junction 90 (at the left side) and a junction 95 (at the right side) of the contact plates 20 and 30. The thermo-electric voltage depends on the particular metals in contact and the temperature of the junction. If the left and right junctions 90 and 95 are provided by the same metal contact and held exactly at the same temperature, the thermo-electric voltage of the junctions 90 and 95 have the same magnitude, but opposing polarities and cancel out each other in the sum of the circuit.

[0004] The reed relay 10 is normally switched on by driving a current through the coil 60, which also starts heating up the relay 10. Due to the normally non-homogeneous thermal flow inside of the relay 10, a temperature difference between the left and right junctions 90 and 95 appears over the time, thus leading to an effective thermo-electric voltage of the reed relay 10 over the time, as long as thermal balance is not reached.

[0005] There are different approaches known in the art to reduce a resulting thermo-electric voltage in the reed relay 10. One approach is to use a low power relay construction, thus generating less heat. Another approach is to use a latching (bi-stable) relay, which only consumes power during switching, thus avoiding heating up and down caused by switching on and off. A further approach is to add another junction with an opposite thermo-electric voltage close to one of the junctions 90 or 95. Yet a further approach is provided by a potted construction with a good thermal conductivity which holds the temperature on both sides of the relay at nearly equal temperatures. All of these approaches, either alone or in combination, lead to a relay 10 with a very low thermo-electric voltage, however at the cost of size and prize.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide an improved switching unit with a reduced influence of thermo-electric voltages. It is another object of the present invention to provide a small size and/or low prize current switch that can be used for switching low voltages. These objects are solved by the independent claim. Preferred embodiments are shown by the dependent claims.

[0007] The invention provides a switching unit, such as a relay and in particular a reed relay, for switching between a first and a second state, e.g. an on- and an off-state. The switching unit comprises at least one thermo-electrically active junction. For reducing or avoiding a resulting thermo-electric voltage, the temperature at the at least one junction is kept substantially constant during the first and the second state. This is preferably accomplished in that the power dissipation of the switching unit is kept substantially constant during the first and the second state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other objects and many of the attendant advantages of the present invention will be readily appreciated and become better understood by reference to the following detailed description when considering in connection with the accompanied drawings in which:

Fig. 1A	shows a principle structure of a reed relay 10,
Fig. 1B	depicts thermo-electric voltage sources in the reed relay 10 of Fig. 1A in its closed state, and
Figs. 2A, 2B, 3A, 3B	show preferred embodiments of a reed switch or relay 100 according to a first aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Figs. 2A and 2B show preferred embodiments of a reed switch or relay 100 according to a first aspect of the invention. The relay 100 can be built up in the same way as the relay 10 depicted in Fig. 1A with exception of the exciting coil 50. According to the invention, the coil 50 is provided by a first coil 50A and a second coil 50B.

[0010] Fig. 2A depicts a "closed" state wherein the relay 100 is closed. The coils 50A and 50B are connected in a way that the magnetic fields thereof are added or, at least, that a contact between the contacts 20 and 30 of the relay 100 can be ensured. In an "open" state, as depicted in Fig. 2B, wherein the relay 100 is open, the coils 50A and 50B are connected in a way that the magnetic fields thereof cancel out each other or, at least, that a contact between the contacts 20 and 30 of the relay 100 can be avoided. However, the power dissipation of coils 50A and 50B is kept substantially constant as well in the "closed" state as in the "open" state. This is can be easily accomplished by maintaining the same current flow in both states.

[0011] In the "open" state of Fig. 2B, the resulting magnetic field from the coils 50A and 50B should ideally be zero, or, at least, to be as low as possible to ensure an open contact between the contacts 20 and 30. This can be preferably accomplished in that the magnetic fields generated by the coils 50A and 50B are substantially equal in magnitude, however opposite in orientation. This can be achieved by switching (preferably identical) coils 50A and 50B in series with opposite coil orientation as depicted in Fig. 2B. Alternatively, the coils 50A and 50B can be connected anti-parallel as depicted in Fig. 3B. Accordingly, the coils 50A and 50B can be connected in the "closed" state in a series connection as shown in Fig. 2A or in a parallel connection as shown in Fig. 3A. In order to cancel the resulting magnetic fields of the coils 50A and 50B to a high degree, the two coils 50A and 50B are preferably wound bifilar.

[0012] In a preferred embodiment, the coils 50A and 50B are provided substantially identical, i.e. having the same number of windings and the same wire diameter. In the "closed" state of Fig. 2A, the coils 50A and 50B are connected in series with the same orientation of the magnetic field onto the contacts 20 and 30. In the "open" state of Fig. 2B, the current flow in coil 50A is in the opposite direction of the current flow of coil 50B. Thus, the magnetic fields of the coils 50A and 50B are cancelled in the "open" state and added in the "closed" state. The current is maintained substantially equal as well in the "open" as in the "closed" state, so that the power dissipation of the coils 50A and 50B, and thus the temperature of the relay 100, is kept substantially constant and independent of the "closed" or "open" state of the relay 100.

[0013] The coils 50A and 50B are preferably embodied as spatially fixed coils within the relay 100, whereby the connection between the coils 50A and 50B is changed when going from the "open" to the "closed" state, and vice versa. In the example of Figs. 2A and 2B, the first coil 50A has a first end 110 and a second end 120 and the second coil 50B has a first end 130 and a second end 140. In the "closed" state, the ends 120 and 130 are coupled together and a power source is connected between the ends 110 and 140. In the "open" state, the ends 120 and 140 are coupled together and the power source is connected between the ends 110 and 130. In the example of Figs. 3A and 3B, the first coil 50A is connected to a power source 160A and the second coil 50B is connected to a power source 160B. For switching from the "open" state to the "closed" state, or vice versa, the polarity of one of the power sources 160A or 160B has to be changed. Alternatively, the first and second coils 50A and 50B can be connected to one power source. .For switching from the "open" state to the "closed" state, or vice versa, the connections of one of the first or second coils 50A or 50B to the power source have to be exchanged.

[0014] The two contact junctions 90 and 95, where the two different metals are connected, should be kept substantially at the same temperature, otherwise a transient thermo-electric voltage is generated after closing the switch 100. Heat flows from the hotter to the colder contact side until thermal balance along the contacts is given. A uniform temperature at the junctions 90 and 95 can be achieved with a symmetrical mechanical design and a relay housing (not shown) with well-defined mechanical contacts or stand-offs e.g. to a PC-Board. In a preferred embodiment, the junctions 90 and 95 are placed as closed together as possible to achieve a substantially equal temperature at those points.

[0015] It is clear that any possible winding ratio can be provided for the coils 50A and 50B, however, the winding ratio 1:1 (i.e. the same number of windings for coils 50A and 50B) provides the simplest solution, in particular when wound bifilar. Accordingly, the coils 50A and 50B can be driven from the same or different power sources, in series or parallel connections.

[0016] According to a second aspect of the invention, only one coil 50 is provided, however in combination with a heating element (not shown). During the "closed" state, the relay is operated in the same way as described for Fig. 1A. However, during the "open" state, the heating element provides substantially the same heating as provided by the coil 50 during the "closed" state. This can be accomplished by any means as known in the art such as a resistive heating element.

[0017] It is clear that the invention is not limited to relays, or more specifically to reed relays, but that the principle of the invention can be applied to any switching unit as known in the art. Also, it is apparent that the principle of the invention is independent of the switching characteristics, i.e. whether the switch will be closed or opened when applying switching energy.

Claims

1. A switching unit (100) for switching between a first and a second state, the switching unit (100) comprising at least one thermo-electrically active junction, characterized in that the temperature at the at least one junction is kept substantially constant during the first and the second state.

2. The switching unit (100) of claim 1, characterized in that the power dissipation of the switching unit is kept substantially constant during the first and the second state.

3. The switching unit (100) of claim 1 or 2, further comprising a first (20) and a second (30) contact, wherein the first state ('on'-state) represents an electrical contact between the first (20) and the second (30) contact, and the second state ('off'-state) represents no electrical contact between the first (20) and the second (30) contact.

4. The switching unit (100) of claim 3, characterized in that a first thermo-electrically active junction (90) of the first contact (20) and a second thermo-electrically active junction (95) of the second contact (30) are placed together as close as possible.

5. The switching unit (100) according to any one of the above claims, wherein the switching unit (100) comprises switching means (50) for maintaining the switching unit (100) in either the first or the second state, characterized in that the power dissipation of the switching means (50) is kept substantially constant during the first and the second state.

6. The switching unit (100) according to claim 5, characterized in that the switching means (50) comprises a first (50A) and a second (50B) coil, whereby a first magnetic field from the first coil (50A) is substantially cancelled by a second magnetic field from the second coil (50B) during the second state, and the power dissipation of the first (50A) and second (50B) coils switching means (50) is kept substantially constant during the first and the second state.

7. The switching unit (100) according to claim 6, characterized in that the first coil (50A) comprises a first (110) and a second (120) contact and the second coil (50B) comprises a third (130) and a fourth (140) contact, whereby, during the first state, the first contact (110) is connected to the fourth contact (140) and the second contact (120) is connected to the third contact (130), and, during the second state, the first contact (110) is connected to the third contact (130) and the second contact (120) is connected to the fourth contact (140).

8. The switching unit (100) according to claim 6, characterized in that the first coil (50A) is connected to a first power source (160A) and the second coil (50B) is connected to a second power source (160B), whereby the polarity of one of the first or second power sources (160A, 160B) is changed for switching from the first to the second state and vice versa.

9. The switching unit (100) according to any one of the claims 1 to 4, characterized by further comprising a heating element for generating, during the second state. substantially the same amount of heating as provided during the first state.

10. A relay comprising a switching unit (100) according to any one of the above claims.

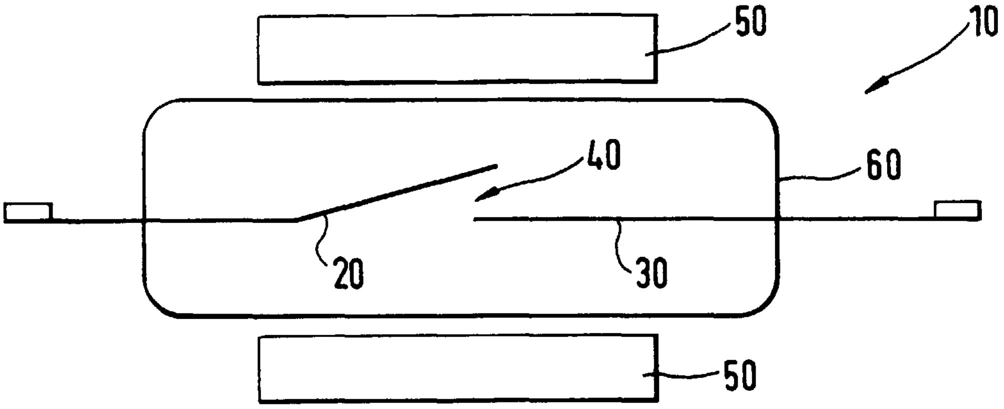

Fig.1A

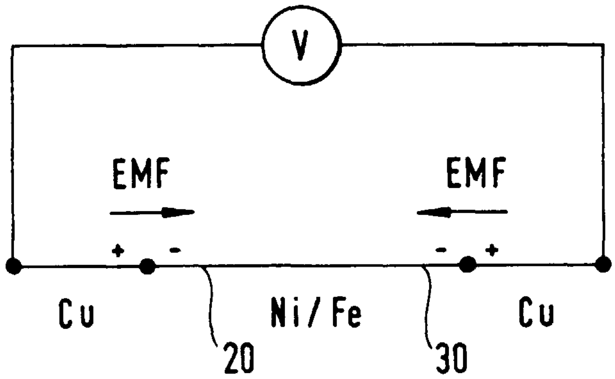

Fig.1B

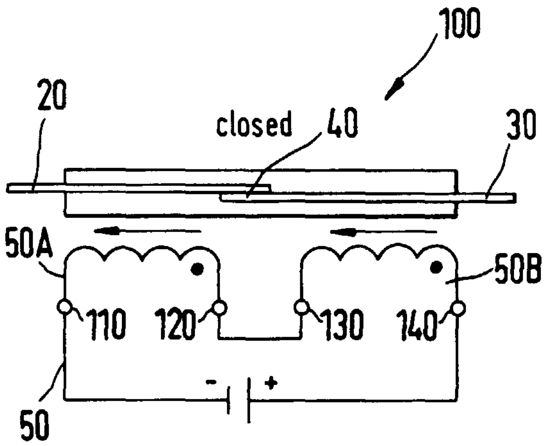

Fig.2A

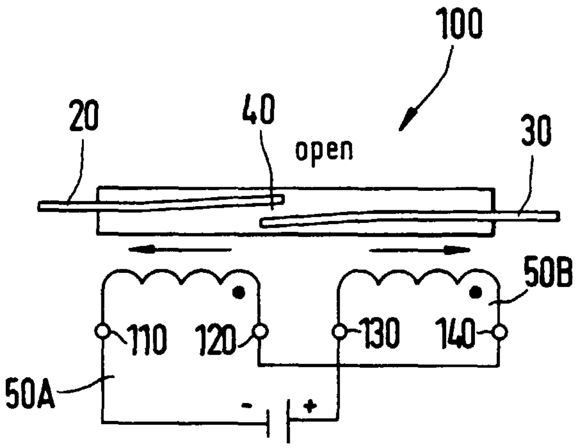

Fig.2B

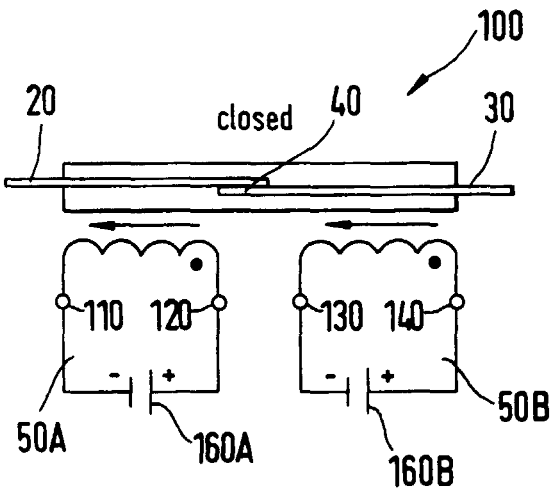

Fig.3A

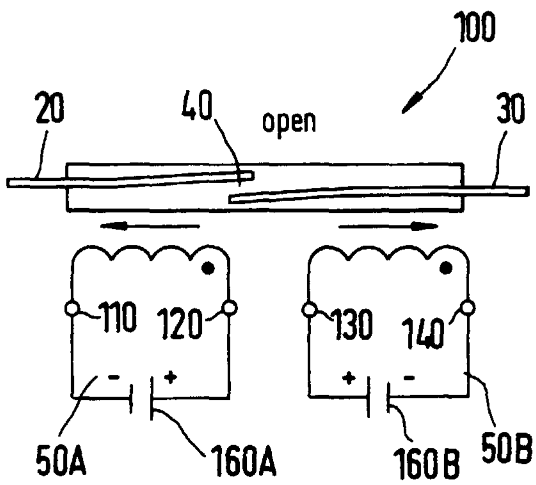

Fig.3B

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EUROPEAN SEARCH REPORT

Application Number
EP 98 11 4408

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE 17 64 597 A (EMS LEO SCHMIDT) 17 February 1972 * page 3, last paragraph - page 4, paragraph 2 *	1-10	H01H1/66 H01H51/28
A	US 3 488 760 A (JULIE LOEBE) 6 January 1970 * column 2, line 24 - line 54 *	4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 December 1998	Libberecht, L

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 11 4408

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 1764597 A	17-02-1972	NONE	
US 3488760 A	06-01-1970	NONE	

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