

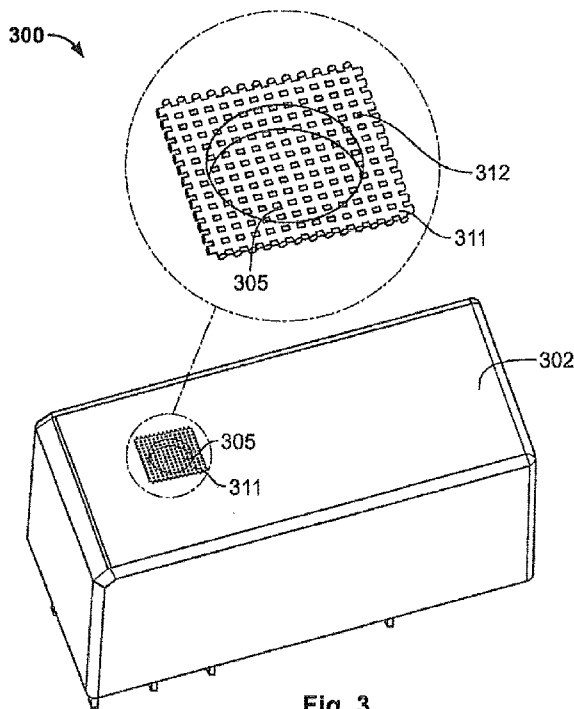


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[Continued on next page]

(54) Title: SWITCH ELEMENT FOR USE IN A POTENTIALLY EXPLOSIVE AREA



(57) Abstract: Switch element for use in a potentially explosive area A switch element, e.g. a relay, for use in a potentially explosive area has a base plate and a top (302), defining a cavity housing the switch contacts. The switch element also has an opening to the outside and is otherwise sealed to the outside. The opening spreads any escaping explosive energy that is released during an explosion within the switch element over a sufficiently long period of time such that the explosive energy escaping to the outside does not ignite the explosive mixture in the potentially explosive area. In preferred embodiments, the opening is a hole (305) covered by a grid (311) or mesh (312). Alternatively, the opening takes the form of a gap (105, 105') in the seam between the base plate (101) and the top (102) or takes the form of a hole (205) with a biconical or meandering form.

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SWITCH ELEMENT FOR USE IN A POTENTIALLY EXPLOSIVE AREA

The present invention relates to a switch element that is used in a potentially explosive area. The present invention also relates to the use of a switch element in a potentially explosive area in order to connect an electrical circuit and thereby prevent ignition of the explosive mixture present in the potentially explosive area due to a switching arc occurring within the switch element.

Switch elements (for example relays) which are used in a potentially explosive area (also called an "ex-protection area") are currently produced such that the explosive gas mixture of the potentially explosive area can not pass into the inside of the switch element. If the explosive mixture were to pass into the inside of the protection element, it could be ignited by a switching spark or a switching arc that occurs between two contacts of the switch element and be caused to explode. The energy released by the explosion would destroy the switch element and be released suddenly into the area surrounding the switch element. As a result, the density of energy in the immediate vicinity of the switch element would be very high, and this could lead to ignition of the explosive mixture in the whole of the ex-protection area.

In order to prevent the explosive mixture from penetrating into the inside of the switch element the latter is hermetically sealed, for example by means of a metal capsule that is welded at the seams. The tightness of the capsule can be achieved technically, but the effort required for this is considerable. However, standard switch elements are produced from synthetic materials and the welded seam is generally an appropriate adhesive. One difficulty relating to tightness is that the welded seam may be damaged by the effect of heat, for example when soldering on the relay connections. Furthermore, relays are electromechanical components which, by their nature, are subject to wear and tear. For example, the contact resistance may increase due to wear and tear of the contacts, and this may lead to an increase in the production of heat and ultimately to leakiness.

Therefore, it is an object of the present invention to provide a switch element, preferably a relay, for use in potentially explosive areas, the inside of which need not be hermetically sealed in order to limit an explosion due to the occurrence of a switching spark or a switching arc in its inside and to prevent propagation to the surrounding inflammable area.

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This object is achieved according to the features of the independent claims. Advantageous further developments of the present invention are the subject matter of the dependent claims.

5 The present invention is based on the idea of providing the switch element with an opening to the outside and otherwise sealing it to the outside. The opening is to be made here such that it spreads any escaping explosive energy that is released during an explosion within the switch element over a sufficiently long period of time, and the sufficiently long period of time is such that the explosive energy escaping to the outside can not ignite the explosive mixture in the potentially explosive area.

10 The present invention makes it possible for the explosive mixture of the potentially explosive area to penetrate into the inside of the switch element and for the latter to be ignited or caused to explode by a switching spark or a switching arc within the switch element. The present invention also makes it possible for the energy released by this explosion to be able to pass out into the potentially explosive area, but not suddenly,
15 rather spread over a longer period of time. In this way the density of energy in the immediate vicinity of the switch element is kept so low that it is not sufficient to ignite the explosive mixture in the potentially explosive area.

The switch element according to the present invention corresponds to standard IEC 60079-15, paragraph 22.4.3, and so is suitable for use in a potentially explosive area.

20 For better understanding of the present invention the latter will be described in more detail by means of the exemplary embodiments shown in the following figures. Here identical parts are provided with the same reference numbers and the same component designations. The figures show as follows:

25 **Fig. 1a** a perspective view of the switch element according to the first exemplary embodiment from below and a detailed view along the seam between the base plate and the top, at the location of a gap;

Fig. 1b a perspective view of the switch element according to the first exemplary embodiment from above and a cross-section through the seam between the base plate and the top at the location of a gap;

30 **Fig. 2** a perspective view of the switch element according to the second exemplary embodiment and a section from a cross-section through the top at the location of the opening/hole;

Fig. 3 a perspective view of the switch element according to the third exemplary embodiment and a detailed top view of the opening with the grid.

The exemplary embodiments of the present invention have a base plate and a top. Here the top covers/encloses a surface of the base plate such that a cavity is produced
5 between this surface of the base plate and the top. Contacts for closing or opening an electrical circuit are provided in the cavity. Voltage can be applied to these contacts by means of connecting terminals which are passed through the base plate. Due to this voltage, upon opening or closing the contacts a switching spark or a switching arc may occur. The latter may ignite an explosive mixture located within the switch element and
10 cause it to explode.

First exemplary embodiment

Figures 1a and 1b show a perspective view of the switch element according to the first exemplary embodiment of the present invention. Here Figure 1a shows a view from below of the base plate 101 of the switch element 100, and Figure 1b shows a view from
15 above of the top 102 of the switch element 100. Reference number 111 identifies the periphery of the base plate 101. As can easily be seen from Figure 1a, the seam extends between the base plate 101 and the top 102 along the periphery 111. With the exception of two gaps/joints 105 and 105', which are disposed on opposite sides of the base plate 101, the switch element 100 is sealed to the outside with a filling compound 104.

Furthermore, Figure 1a shows a detailed view along the seam between the base plate 101 and the top 102 at the location of the gap 105, and Figure 1b shows a cross-section through the seam between the base plate 101 and the top 102 at the location of the gap 105. As can be seen from these figures, the gap 105 extends along the seam between the base plate 101 and the top 102, and is formed by a side face 107 of the base plate
20 101 and a side wall 106 of the top 102. Here the side face 107 of the base plate 101 is fully covered by the side wall 106 of the top 102. The gap 105' is formed similarly to the gap 105. No filling compound 104 is provided at the locations of the base plate 101 where the gaps 105 and 105' are disposed.

According to the present invention the gap 105 has a width (or breadth) 109 which is
30 smaller than 0.1 mm. Likewise, according to the present invention the gap 105 has a height 108 which is greater than one millimetre. Similarly, the gap 105' has a width which is smaller than 0.1 mm and a height which is greater than one millimetre. Furthermore, it is essential for the present invention that the sum of the lengths of the gaps 105 and 105'

is smaller than one third of the length of the periphery 111 of the seam between the base plate 101 and the top 102.

The two gaps 105 and 105' constitute an opening of the switch element 100 to the outside via which the explosive energy, which is released during an explosion within the switch element 100, can escape to the outside, for example in a potentially explosive area. The two gaps 105 and 105' in the first exemplary embodiment of the present invention have dimensions, however, such that they spread the explosive energy escaping into the potentially explosive space over a sufficiently long period of time. The sufficiently long period of time is chosen here such that the explosive energy escaping to the outside is not capable of igniting the explosive mixture of the potentially explosive area or of causing it to explode. In other words, the sufficiently long period of time is such that the explosive energy escaping to the outside does not increase the density of energy in the immediate vicinity of the switch element such that this can trigger an explosion in the potentially explosive area.

In the exemplary embodiment shown in Figures 1a and 1b the switch element 100 has an opening with two joints 105 and 105' and has a substantially rectangular-parallelepipedal form. However, the present invention is not restricted to this exemplary embodiment, but also includes exemplary embodiments in which the switch element has i) just one gap or ii) more than two gaps between the base plate and the top.

In case i) the switch element has an opening which is formed as a gap between the base plate and the top along the seam between the base plate and the top. Here the gap serving as an opening has a length that is smaller than one third of the length of the periphery of the seam between the base plate and the top. The part of the seam between the base plate and the top that is not part of the gap is sealed. Likewise, the seam between the base plate and the connecting terminals is sealed. The width of the gap serving as an opening is smaller than 0.1 mm and its height is greater than one millimetre.

In case ii) the switch element has an opening which is in the form of a plurality of gaps between the base plate and the top along the seam between the base plate and the top. Here the plurality of gaps have a total length which is smaller than one third of the length of the periphery of the seam between the base plate and the top. The part of the seam between the base plate and the top which does not form part of the plurality of gaps is sealed. Likewise, the seam between the base plate and the connecting terminals is

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sealed. The width of each gap of the plurality of gaps is smaller than 0.1 mm and its height is greater than one millimetre.

Furthermore, the exemplary embodiment shown in Figures 1a and 1b is formed such that the seam between the base plate 101 and the top 102 extends along the periphery 111 of the base plate 101 and the side walls 106 of the top 102 totally cover the side faces 107 of the base plate. However, the present invention is not restricted to this exemplary embodiment, but also includes exemplary embodiments wherein the top, along the seam, only partially covers the side faces of the base plate. In this case, at least at the point where the gap or the gaps are provided, the base plate must have a thickness which is greater than one millimetre. The present invention also includes exemplary embodiments wherein the lower edge of the top is placed on the surface of the base plate with the contacts for closing and opening an electrical circuit. In this case the periphery of the seam between the top and the base plate is substantially predetermined by the periphery of the lower edge of the top.

15 *Second exemplary embodiment*

Figure 2 shows a perspective view of the switch element 200 according to the second exemplary embodiment of the present invention. The second exemplary embodiment has in the base plate (this is not shown in Figure 2) or in the top 202 an opening or hole 205. In Figure 2 the hole or the opening 205 is provided in the top 302. Otherwise, the switch element 200 is sealed to the outside. In particular, the seam between the base plate and the top 202 and the seam between the base plate and the connecting terminals (these are not shown in Figure 2) is sealed with filling compound.

Furthermore, Figure 2 shows a section of a cross-section through the cap at the point at which the opening/hole 205 is provided. In the second exemplary embodiment the hole 205 is cylindrical. The hole 205 has a diameter 209 which is smaller than 0.4 mm and a height/depth 208 that is greater than 1.2 mm.

In the switch element 200 according to the second exemplary embodiment the explosive energy which is released during an explosion within the switch element 200 can escape via the hole 205 to the outside, for example into a potentially explosive area. However, the hole 205 has dimensions such that it spreads the explosive energy escaping into the potentially explosive space over a sufficiently long period of time; and it is spread such that the explosive energy escaping to the outside can not cause the explosive mixture of the potentially explosive area to explode.

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In the exemplary embodiment shown in Figure 2 the hole is provided in the middle of the top 202. However, the position of the hole 205 on the top 202 or the base plate is not crucial for the present invention. In fact, the hole 205 can be located at any point on the top 202 or at any point on the base plate.

- 5 Furthermore, the present invention is not restricted to a cylindrical hole 205. In fact, the cross-sectional area of the may be of any form, for example oval, rectangular or square. In these cases it is also essential for the present invention that the cross-sectional area of the hole has a surface area smaller than 0.1256 mm^2 and a height or a depth that is greater than 1.2 mm.
- 10 The present invention also includes exemplary embodiments wherein the hole (or the opening) is conical in form in the longitudinal direction. Preferably, in this case the hole tapers inwardly or outwardly. The hole can also have a biconical or meandering form in the longitudinal direction. Preferably, the hole tapers in the middle part or at its ends if the hole has a biconical form.
- 15 It is essential for the present invention that in all cases in which the hole has cross-sectional areas with different surface areas, the cross-sectional area of the hole has at its narrowest point a surface area that is smaller than 0.1256 mm^2 and a height or depth that is greater than 1.2 mm.

Third exemplary embodiment

- 20 Figure 3 shows a perspective view of the switch element 300 according to the third exemplary embodiment of the present invention. The third exemplary embodiment has in the base plate (this is not shown in Figure 3) or in the top 202 an opening or hole 305 that is covered from the outside with a metal grid 311 and that has a mesh size of less than 0.1 mm. In Figure 3 the hole or the opening 305 is provided in the top 302.
- 25 Otherwise, the switch element 300 is sealed to the outside. In particular, the seam between the base plate and the top 302 and the seam between the base plate and the connecting terminals are sealed with filling compound.

- Furthermore, Figure 3 shows a detailed top view of the opening 305 with the metal grid 311. In the third exemplary embodiment the metal grid 311 has rectangular or square
- 30 meshes which have a surface area smaller than 0.01 mm^2 . The shape of the opening or of the hole 305, its height or depth, and the surface area of the cross-sectional area at its narrowest point are not essential for the present invention. However, the hole 305 may

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not be too small. The position of the hole 305 on the base plate or on the top 302 is not essential for the present invention either.

In the switch element 300 according to the third exemplary embodiment, the explosive energy which is released during an explosion within the switch element 300 can escape
5 to the outside via the hole 305 covered by the grid 311, for example into a potentially explosive area. However, the grid 311, in particular its mesh size 312, has dimensions such that it first of all spreads the explosive energy escaping into the potentially explosive space over a sufficiently long period of time, and secondly absorbs/stores part of the explosive energy itself. The combination of these two effects ultimately leads to the
10 explosive energy escaping to the outside not being able to cause the explosive mixture of the potentially explosive area to explode.

The grid 311 used in the third exemplary embodiment need not be made of metal. In fact, the grid can be produced from a plastic that is covered with a metal or contains metal; or else the grid can be a ceramic grid that is covered with metal or contains metal. The form
15 of the mesh 312 is not essential for the present invention either. In fact, this mesh can be of any form, for example circular, oval or diamond-shaped. In all of these cases it is essential for the invention that the surface area of the mesh 312 is smaller than 0.01 mm².

Switch elements according to the present invention are preferably relays. Relays
20 according to the first, second and third exemplary embodiment of the present invention have been tested in special laboratories according to standard IEC 60079-15, paragraph 22.4.3. The tests showed that these relays correspond to standard IEC 60079-15, paragraph 22.4.3, and are therefore suitable for use as switch elements in a potentially explosive area.

25 Switch elements according to the present invention are used, for example, for connecting mains voltages (230 V for single-phase or 400 V for three-phase alternating voltages) in potentially explosive areas in order to prevent ignition of the mixture present in the potentially explosive area due to a switching spark/switching arc occurring within the switch element.

30

List of reference numbers:

| Reference number | Description |
|-------------------------|--|
| 100 | Switch element according to the first exemplary embodiment |
| 101 | Base plate |
| 102 | Top |
| 103 | Filling compound for sealing |
| 104 | Connecting terminal |
| 105, 105' | Gap between the base plate and the top |
| 106 | Side wall of the top |
| 107 | Side face of the base plate |
| 108 | Height of the gap |
| 109 | Width/Breadth of the gap |
| 110 | Length of the gap along the peripheral direction of the base plate |
| 111 | Periphery of the base plate |
| 200 | Switch element according to the second exemplary embodiment |
| 202 | Top |
| 205 | Opening/Hole |
| 208 | Depth/Height of the opening |
| 209 | Diameter of the opening |
| 300 | Switch element according to the third exemplary embodiment |
| 302 | Top |
| 305 | Opening/Hole |
| 311 | Close meshed grid |
| 312 | Mesh of the grid |

Claims:

1. A switch element for use in a potentially explosive area that has a base plate and a top, the top covering/enclosing a surface of the base plate such that there is produced between a surface of the base plate and the top a cavity in which there are contacts for closing and opening an electrical circuit, and

5 the switch element also having an opening to the outside and otherwise being sealed to the outside, the opening being made such that it spreads any escaping explosive energy that is released during an explosion within the switch element over a sufficiently long period of time, the sufficiently long period of time being such that the explosive energy escaping to the outside does not ignite the explosive mixture in the potentially explosive area.

2. The switch element (200) according to Claim 1, characterised in that the opening (205) is provided either in the base plate or in the top (202), the cross-sectional area of the opening (205) has at its narrowest point a surface area that is smaller than 0.1256 mm^2 , at the point at which the opening (205) is provided, the base plate or the top (202) has a thickness which is greater than 1.2 mm so that the depth (208) of the opening (205) is greater than 1.2 mm.

3. The switch element according to Claim 2, characterised in that a cross-sectional area of the opening (205) is round, in particular oval or circular.

20 4. The switch element according to Claim 2, characterised in that a cross-sectional area of the opening is angular, in particular square or rectangular.

5. The switch element according to Claim 3 or 4, characterised in that the opening (205) is cylindrical in form, or the opening is in the form of a cone which tapers either inwardly or outwardly, or the opening has a biconical form which is tapered in the middle part or at the ends, or the opening is of a meandering form.

6. The switch element (300) according to Claim 1, characterised in that the opening (305) is provided either in the base plate or in the top (302) and is covered from the outside with a grid (311) the mesh (312) of which has a surface area which is smaller than 0.01 mm^2 .

30 7. The switch element according to Claim 6, characterised in that the mesh (312) of the grid (311) is square and has a mesh size which is smaller than 0.1 mm.

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8. The switch element according to Claim 6 or 7, characterised in that the grid (311) is produced from a metal or the grid (311) is produced from a plastic that is covered with a metal or contains metal, or the grid (311) is a ceramic grid that is covered with a metal or contains metal.

5 9. The switch element (100) according to Claim 1, characterised in that the opening is made as a gap (105) between the base plate and the top along the seam between the base plate (101) and the top (102),

the gap (105) serving as an opening has a length (110) that is smaller than one third of the length of the periphery of the seam between the base plate (101) and the top (102),

10 the part of the seam between the base plate (101) and the top (102) that is not part of the gap (105) is sealed,

the width (109) of the gap (105) serving as an opening is smaller than 0.1 mm, and

the height (108) of the gap (105) is greater than one millimetre.

10. The switch element (100) according to Claim 1, characterised in that the opening is
15 made as a plurality of gaps (105, 105') between the base plate and the top along the seam between the base plate (101) and the top (102),

the sum of the plurality of gaps (105, 105') serving as the opening have a length which is smaller than one third of the length of the periphery of the seam between the base plate (101) and the top (102),

20 the part of the seam between the base plate (101) and the top (102) which do not form part of the plurality of gaps (105, 105') is sealed,

the width (109) of each gap of the plurality of gaps (105, 105') is smaller than 0.1 mm, and

the height (108) of each gap of the plurality of gaps (105, 105') is greater than one
25 millimetre.

11. The switch element according to Claim 9 or 10, characterised in that the seam between the base plate (101) and the top (102) extends along the periphery (111) of the base plate (101), and

along the seam, the top (102) at least partially covers the side faces (107) of the base plate (101).

12. The switch element according to Claim 11, characterised in that the base plate (101) and the top (102) are substantially in the form of a rectangular parallelepiped, and

5 the four side walls (106) of the top (102) totally cover the four side faces (107) of the base plate (101).

13. The switch element according to any of Claims 1 to 12, characterised in that the switch element is a relay.

14. The use of a switch element (200) in a potentially explosive area in order to connect
10 an electrical circuit and thereby prevent ignition of the explosive mixture present in the potentially explosive area due to a switching arc occurring within the switch element,

the switch element (200) having a base plate and a top (202), the top (202) covering/enclosing a surface of the base plate such that there is produced between a surface of the base plate and the top (202) a cavity in which are located contacts for
15 closing or opening an electrical circuit,

the switch element (200) being sealed apart from an opening (205),

the opening (205) being provided either in the base plate or in the top (202),

the cross-sectional area of the opening (205) having a surface area of less than 0.1256 mm² at its narrowest point, and

20 at the point at which the opening (205) is provided, the base plate and the top (202) having a thickness which is greater than 1.2 mm so that the depth (208) of the opening is greater than 1.2 mm.

15. The use of a switch element (300) in a potentially explosive area in order to connect
25 an electrical circuit and thereby prevent ignition of the explosive mixture present in the potentially explosive area due to a switching arc occurring within the switch element,

the switch element (300) having a base plate and a top (302), the top (302) covering/enclosing a surface of the base plate such that there is produced between a surface of the base plate and the top (302) a cavity in which there are contacts for closing and opening an electrical circuit,

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the switch element (300) being sealed apart from an opening (305),

the opening (305) being provided either in the base plate or in the top (302) and being covered from the outside with a grid (311) the mesh (312) of which has a surface area smaller than 0,01 mm².

5 16. The use of a switch element (100) in a potentially explosive area in order to connect an electrical circuit and thereby prevent ignition of the explosive mixture present in the potentially explosive area due to a switching arc occurring within the switch element,

the switch element (100) having a base plate (101) and a top (102), the top (102) covering/enclosing a surface of the base plate (101) such that there is produced between
10 a surface of the base plate (101) and the top (102) a cavity in which there are contacts for closing and opening an electrical circuit,

a gap (105) or a plurality of gaps (105, 105') being formed between the base plate and the top along the seam between the base plate (101) and the top (102),

the gap (105) having a length (110) and the plurality of gaps (105, 105') having a total
15 length (110) which is smaller than one third of the length of the periphery of the seam between the base plate (101) and the top (102),

the part of the seam between the base plate (101) and the top (102) not forming part of the gap (105) or the plurality of gaps (105, 105') being sealed,

the switch element (100) also otherwise being sealed, for example at the seam between
20 the base plate (101) and the connecting terminals (104),

the width (107) of the gap (105) or the width of each gap of the plurality of gaps (105, 105') being smaller than 0.1 mm, and

the height (108) of the gap (105) or the height of each gap of the plurality (105, 105') of gaps being greater than one millimetre.

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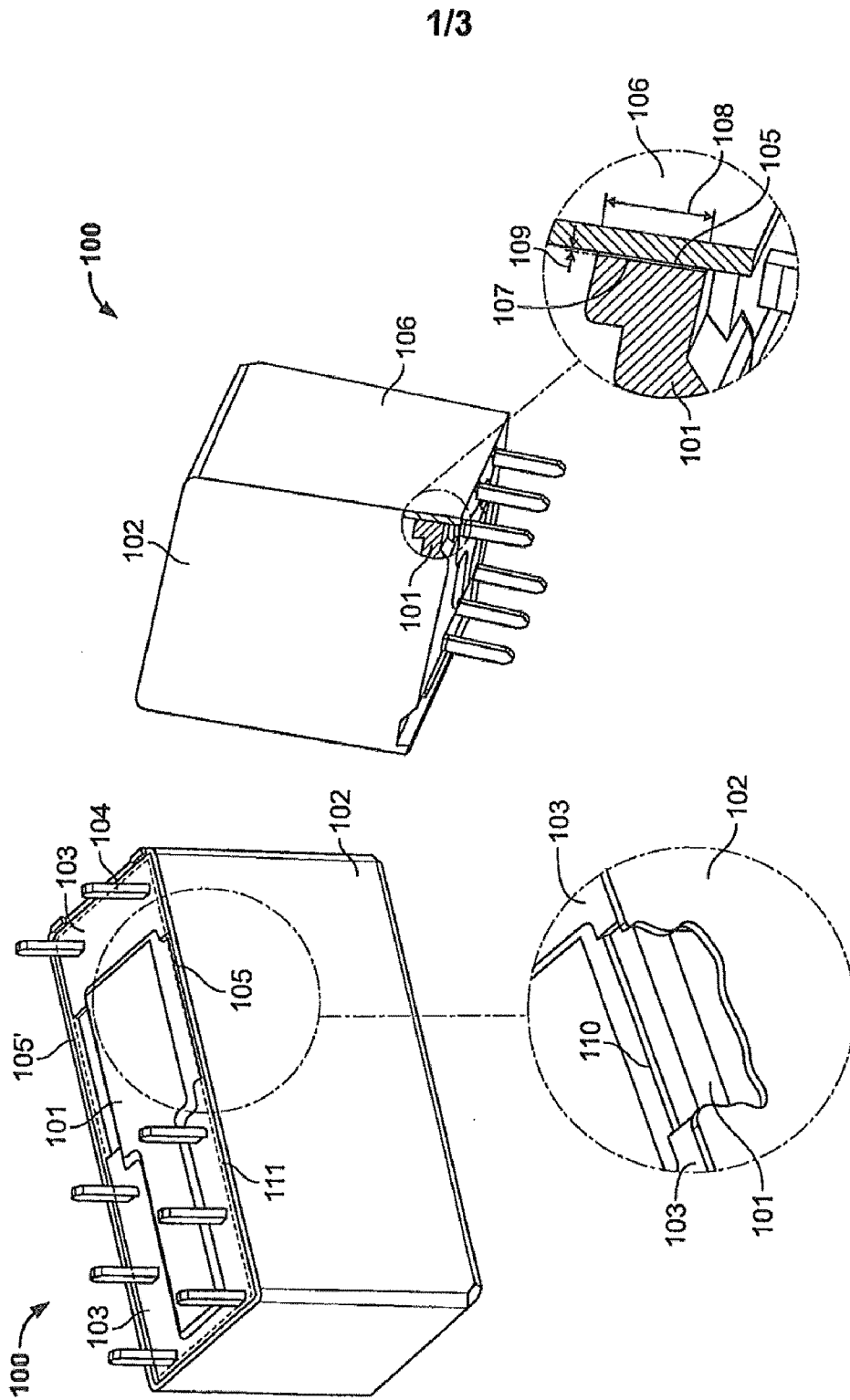


Fig. 1b

Fig. 1a

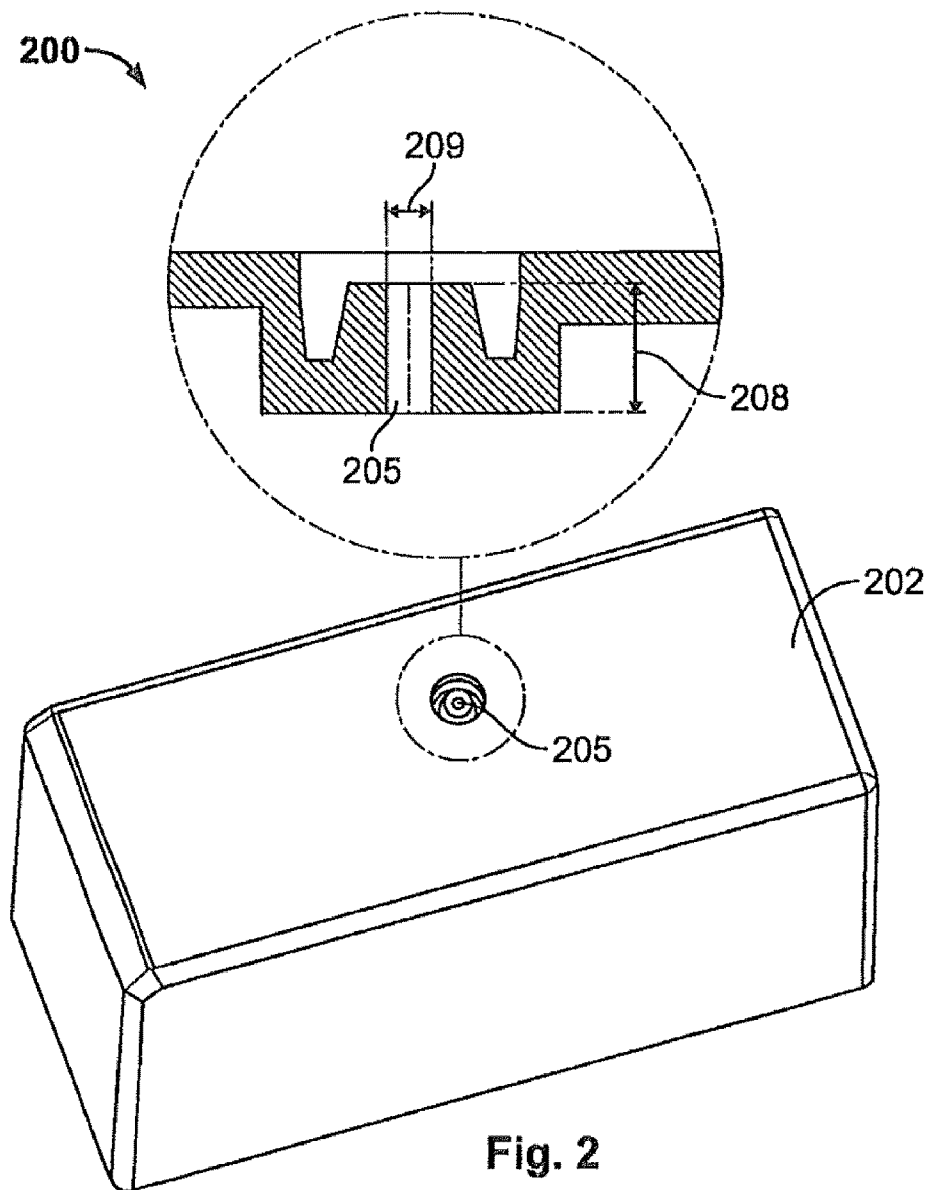
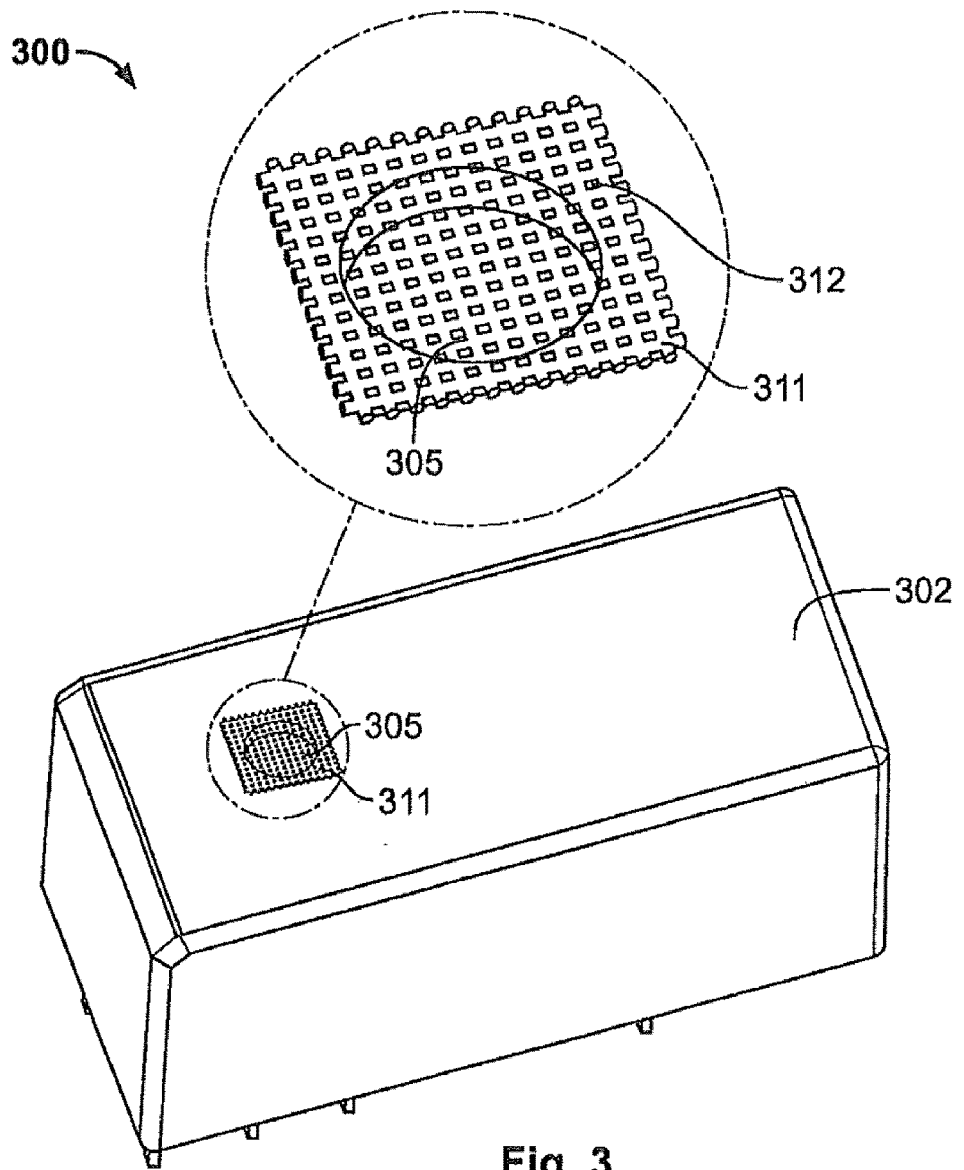


Fig. 2

3/3



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/059688

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H9/04 H01H50/02
ADD.
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)
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)
EPO-Internal, WPI Data

| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|--|---|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| X | EP 2 214 192 A2 (ANDEN CO LTD [JP]) 4 August 2010 (2010-08-04) | 1-5,13, 14 |
| Y | paragraph [0003] - paragraph [0005] paragraph [0012] - paragraph [0035]; figures 1,2 | 6-8,15 |
| | ----- | |
| X | US 2010/066471 A1 (NAGURA HIROSHI [JP] ET AL) 18 March 2010 (2010-03-18) | 1-5,13, 14 |
| Y | paragraph [0007] - paragraph [0008] paragraph [0018] - paragraph [0037]; figures 1,5 paragraph [0059] - paragraph [0065] | 6-8,15 |
| | ----- | |
| X | US 4 260 863 A (APPLETON ARTHUR I) 7 April 1981 (1981-04-07) | 1 |
| Y | column 1, line 13 - line 52 column 2, line 18 - column 3, line 40; figures 1-4 | 9-12,16 |
| | ----- | |
| | -/-- | |

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

- "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
- "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)
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| Date of the actual completion of the international search 15 July 2015 | Date of mailing of the international search report 24/07/2015 |
| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016 | Authorized officer Dobbs, Harvey |

INTERNATIONAL SEARCH REPORT

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| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|--|--|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y | GB 750 374 A (LICENTIA GMBH) 13 June 1956 (1956-06-13) page 1, line 9 - line 83; figures 1,2 ----- | 6-8,15 |
| Y | EP 2 469 564 A1 (FUJI ELEC FA COMPONENTS & SYS [JP]) 27 June 2012 (2012-06-27) paragraph [0023]; figure 7 ----- | 9-12,16 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/059688

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| EP 2214192 | A2 | 04-08-2010 | CN 101794680 A |
| | | | EP 2214192 A2 |
| | | | EP 2287868 A2 |
| | | | JP 5131219 B2 |
| | | | JP 2010177165 A |
| | | | US 2010193475 A1 |
| ----- | | | |
| US 2010066471 | A1 | 18-03-2010 | CN 101673641 A |
| | | | JP 5131218 B2 |
| | | | JP 2010092829 A |
| | | | US 2010066471 A1 |
| ----- | | | |
| US 4260863 | A | 07-04-1981 | NONE |
| ----- | | | |
| GB 750374 | A | 13-06-1956 | BE 526254 A |
| | | | GB 750374 A |
| | | | NL 184696 C |
| ----- | | | |
| EP 2469564 | A1 | 27-06-2012 | CN 102473552 A |
| | | | EP 2469564 A1 |
| | | | JP 5018845 B2 |
| | | | JP 2011044287 A |
| | | | US 2012139672 A1 |
| | | | WO 2011021337 A1 |
| ----- | | | |