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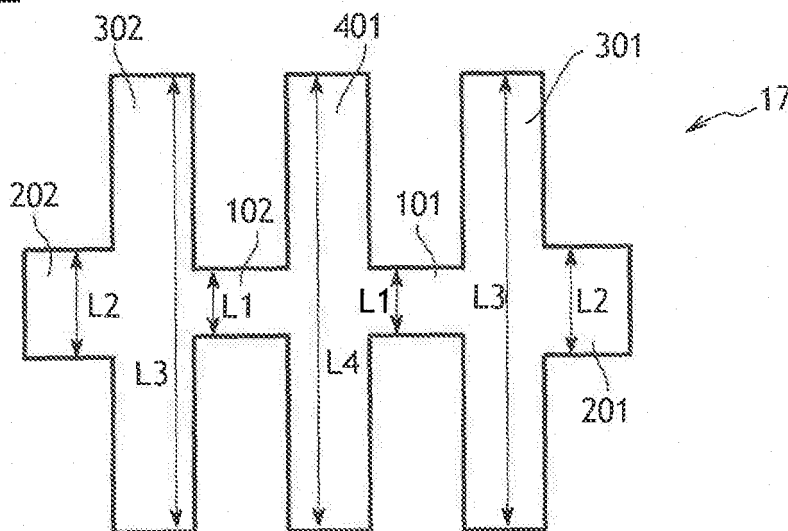
(54) **Electro-pyrotechnic initiator with resistive heating element**

charge,

- a second part (201, 202) situated near one of the contacts (26, 27) and having a second width (L2),
- a third part (301, 302) having a third width (L3) and situated between the first part (101, 102) and the second part (201, 202), to form a thermal dissipation surface of an area greater than that of the first part,

the third width (L3) being greater than the second width (L2), in turn greater than the first width (L1).

FIG. 4



Description

[0001] The invention relates to an electro-pyrotechnic initiator.

[0002] One application field of the invention relates to initiators required to fire pyrotechnic charges in gas generators required to activate devices protecting occupants of automobiles, for example such as airbags. The initiator can also be used in a pyrotechnic igniter that triggers the seat belt.

[0003] One such initiator normally comprises a pyrotechnic ignition charge and a heating resistance element covered by the pyrotechnic ignition charge to ignite it by the Joule effect. Two electrodes are provided to supply electricity to it.

[0004] Operation of electro-pyrotechnic initiators is influenced by the pair consisting of the resistive element and the pyrotechnic ignition charge, and the sensitivity that this pair procures for them.

[0005] Thus, the all-firing threshold is equal to the limiting intensity of electric current passing through the electrodes, beyond which it is certain that the initiator will function, in other words that the pyrotechnic ignition charge will be ignited.

[0006] The non-firing threshold is equal to the limiting intensity of electric current passing through the electrodes, below which it is certain that the initiator will not function, in other words that the pyrotechnic ignition charge will not be ignited.

[0007] Specifications of automobile manufacturers usually require firing pulses of 1.2A / 2ms or 1.75A / 0.5ms and non-firing currents of 0.4A / 10s.

[0008] These functions may be satisfied for example, by resistive elements of the type described in document FR-A-2 866 106.

[0009] A new specification has been issued, namely the AK-LV 16. By questioning all tests normally carried out in the electro-pyrotechnic field and proposing others, it is found that all-firing levels must be reduced and non-firing levels must be increased to satisfy the new tests.

[0010] At the moment, the only known means for reducing the all-firing level is to reduce the width of the resistive element, which has the immediate consequence of also reducing the non-firing level.

[0011] Therefore this means is incompatible with the problem of reducing the difference between the all-firing level and the non-firing level.

[0012] The invention is aimed at obtaining an electro-pyrotechnic initiator that overcomes this disadvantage and is capable of reducing the difference between the non-firing level and the all-firing level.

[0013] To achieve this, the purpose of the invention is an electro-pyrotechnic initiator comprising a resistive heating element comprising at least one layer conductive of electricity covered by a pyrotechnic ignition charge and connected by two first and second end contacts respectively to two electrodes for powering the resistive heating element for igniting the pyrotechnic charge,

characterised in that

the resistive heating element comprises:

- at least one first part having a first width for definition of an electrical resistance for igniting the pyrotechnic charge,
- at least one second part situated near one of the contacts and having a second width,
- at least one third part having a third width and situated between the first part and the second part, to form a thermal dissipation surface with an area greater than the area of the first part,

the third width being greater than the second width, in turn greater than the first width, the widths being taken on said layer in the direction transverse to the current passing between the contacts.

[0014] According to embodiments of the invention,

- The third part is in the form of a rib.
- At least two first parts are provided, between which are at least one fourth part having a fourth width greater than the first width and having an energy dissipation surface with an area greater than that of the adjacent first parts.
- The fourth part is in the form of a rib.
- The second width of the second part is identical to the width of the adjacent contact.
- The initiator comprises between a resistive heating element support that is electrically insulating, and under at least the resistive heating element:

a heat sink to dissipate heat produced by the resistive heating element to the support;

a heat conducting and electrically insulating glue layer interposed at least between the resistive heating element and the heat sink.

- The contacts are formed by a zone with a lower electrical resistance than that of the second part adjacent to the resistive heating element.
- The resistive heating element is formed by the exposed part of the conductive layer and the contacts are formed by parts of the conductive layer covered by at least one other thickness of electrical conductor.

[0015] The invention will be better understood after reading the following description given solely as a non-limitative example with reference to the attached drawings on which:

- figure 1 diagrammatically shows an axial cross section of an example initiator according to the invention,
- figure 2 diagrammatically shows a vertical axial cross section showing the arrangement of the resistive heating element on its support in one embodiment of the initiator according to figure 1,

- figure 3 diagrammatically shows a top view of an example embodiment of the resistive element according to the invention on its support, and
- figure 4 diagrammatically shows an enlarged top view of the resistive heating element according to figure 3.

[0016] An electro-pyrotechnic initiator 1 according to the invention is shown in figure 1. This initiator 1 comprises a cylindrical container 2, circular around the vertical axis of the initiator, and also fragmentable and open at one of its ends. A massive circular cylindrical casing 3 encloses the open end of the container 2. The sidewall 4 of the casing 3 has an external shoulder 5 on which the open end of the container 2 bears. The container 2 and the casing 3 are gripped in an insert moulding 6 that holds them fixed to each other. The container 2 is thus in the shape of a cylindrical cap with a sidewall 7 and a plane, closed and solid upper face 8. For example, the container 2 also contains a metal tube 20 reinforcing the sidewall 7. The container 2 is composed of a thin lightweight metal like aluminium, and its plane face 8 is advantageously weakened so that it can easily open under the effect of an increase in the pressure inside the container. The insert moulding 6 is preferably made from a thermoplastic resin, for example such as polyethylene terephthalate. The casing 3 is made for example from a dense metal such as steel.

[0017] The casing 3 has a plane upper face 9 and a lower face 15 that is also plane and grips an electrically insulating structure for the passage of two electricity conducting electrodes 12, 13 over its entire height h. This structure for the passage of the two electrodes 12, 13 may for example be vitreous. The two electrodes 12, 13 may for example be in the form of a pin. In the example embodiment shown, this structure for the passage of the two electrodes 12, 13 is formed from two electrically insulating hollow tubes 10, 11, for example made of glass, that themselves grip two electrodes 12, 13. As a variant, the structure for the passage of the two electrodes 12, 13 may include a single tube 10 or 11 gripping the corresponding electrode 12 or 13. In another variant, the casing 3 is electrically insulating and grips the electrodes 12, 13 directly without the use of tubes 10, 11 and for example may be made of glass. In one embodiment not shown, one of the electrodes 12, 13 surrounded by an electrically insulating tube 10, 11 may be of the coaxial type, in other words electrically connected through a connection to the casing 3 located under it.

[0018] A support 16 is fixed onto the plane upper face 9 of the casing 3, for example by gluing. In the example embodiments shown in the figures, the support 16 is isolated from the electrodes 12, 13 and is made of an electrically insulating material and for example consists of a plate made from a glass / resin mixture, such as a composite epoxy type polymer with a glass fibre filling. Two cylindrical channels 22 and 23 are provided in the support 16 through which the electrodes 12 and 13 pass. Each

electrode 12, 13 has an upper end 12b, 13b respectively that projects beyond the plane upper face 9 of the casing 3 and the face of the support 16, and an end 12c, 13c respectively that projects beyond the lower face 14 of the insert moulding 6.

[0019] The support 16 carries an electrical circuit 18 that comprises a heating resistive element 17 and is electrically connected to the electrodes 12, 13.

[0020] The resistive element 17 is photo-engraved in a manner known in itself. The resistive element 17 has an upper surface 24 that is covered by a pyrotechnic ignition charge contained in the container 2, or in the embodiment shown, in the container 2 and the metallic tube 20. For example, this pyrotechnic ignition charge comprises a pyrotechnic ignition composition 19 that is in contact with the heating resistive element 17 and that for example is based on lead trinitroresorcinate, and an ignition powder or composition 21 that covers the pyrotechnic ignition composition 19 and for example is composed of a powder based on nitrocellulose or a mixture of boron and potassium nitrate. The resistive heating element 17 may for example be flat. As is the case of the initiators in the following table, the pyrotechnic ignition composition 19 may also be a mix of the zirconium and potassium perchlorate and the ignition powder 21 may be a mix of titanium hydride and potassium perchlorate.

[0021] The heating resistive element 17 may for example be metallic and is formed for example by the median part of a electrically conducting layer 25, and for example a nickel-chromium alloy or another alloy such as PtW. Except for its median part that forms the heating resistive element 17, the layer 25 is covered by two separate electrical contacts 26, 27 with the two electrodes 12, 13 respectively. The contacts 26, 27 are covered by the pyrotechnic ignition charge, and form the electrical circuit 18 with layer 25, and for example include a copper layer 28 on the layer 25. This copper layer may for example be covered by another metallisation layer 29. Electrodes 12 and 13 pass through the layer 25 and contacts 26, 27 located outside the resistive heating element 17. Each contact 26, 27 comprises a conducting island 261, 271 surrounding the channel 22, 23 and terminating towards the resistive element 17 by a narrower part 262, 272.

[0022] The width extends along the direction transverse to the passage of electrical current.

[0023] A heat sink 31 is provided between the support 16 and the resistive heating element 17. This heat sink may for example comply with the patent application FR-A-2 866 106 integrated herein by way of reference. This heat sink 31 is electrically insulated from the electrodes 12, 13 and the resistive element 17 by any appropriate means to conduct heat produced by the resistive heating element 17 to the heat sink 31. The heat sink 31 does not touch the resistive heating element 17. The heat sink 31 conducts heat and dissipates heat produced by the resistive element 17 into the support 16. For example, the heat sink may have a thermal conductivity greater

than or equal to 100 mW / cm.K (for Constantan which is the least thermally conducting copper based alloy) or preferably greater than or equal to 200 mW / cm.K.

[0024] The heat sink 31 is located below the resistive heating element 17, for example adjacent to it or it projects beyond this location below the contacts 26 and 27 as shown in dashed lines in figure 3.

[0025] The heat sink 31 may for example be formed from a heat conducting layer 31 with a determined and continuous thickness. For example, the heat sink is for example electrically conducting and is for example metallic, such as copper or aluminium. Obviously, any other heat conducting material could be used for the heat sink 31.

[0026] In the embodiments shown in figures 2 and 3, a first layer 32 of heat conducting and electricity insulating glue is inserted between the resistive heating element 17 and the heat sink 31, so as to electrically isolate the heat sink 31 from the resistive heating element 17. The glue layer 32 maintains physical contact between the heating element 17 and the heat sink 31. Obviously, a second layer of heat conducting and electricity insulating glue may be inserted between the heat sink 31 and the support 16.

[0027] In the embodiment shown in figure 2, the second glue layer 33 is omitted under the heat sink 31 and the heat sink 31 is in direct contact with the support 16. To achieve this, the heat sink 31 was placed at the required location on the support 16 having a plane upper surface, and the glue layer 32 and then the circuit 18 are deposited on the heat sink 31 and the support 16. The first glue layer 32 surrounds the top and sides of the heat sink 31 between the support 16, the resistive heating element 17 and the channels 22, 23 through which the electrodes 12, 13 pass and joins the support 16 between each channel 22, 23 and the heat sink 31. The first layer 32 surrounds the channels 22, 23, where it acts as a support to the electricity conducting layer 25.

[0028] The resistive element 17 is obtained by etching in two main steps. The layer 25 and layer 28 are etched on the stack formed by support 16, layer 31, glue layer 32, layer 25 and layer 28, to define the global shape of the resistive element 17 and the connection zones 26, 27. The layer 28 is then etched to expose the layer 25 and define the resistive element 17. The layer 29 is then deposited so that the connection zones 26, 27 can be soldered.

[0029] The resistive element 17 is considered as being formed from a conducting zone directly covered by the pyrotechnic charge and not covered by the contacts 26, 27.

[0030] Between the contact parts 262, 272, the resistive heating element 17 comprises a first central part 101, 102 with a first determined width L1. These first parts 101, 102 define an electric resistance R calculated to heat the pyrotechnic charge located above it in the presence of a current respecting the all-firing level. Consequently, the first parts 101, 102 define a part of the elec-

trical resistance located between contacts 26 and 27 and form sensitive elements that define the all-firing level, that is normally a current pulse of the order of one millisecond. This all-firing level of the resistive element 17 is defined directly by the first width L1 of these parts 101, 102. Since there are two sensitive parts 101, 102, there is a redundancy effect which increases the operating safety of the initiator. Obviously, a single first part 101 or 102 could be used.

[0031] The resistive element 17 also comprises two second parts that are connected to the contacts 26, 27. Therefore, the two second parts 201 and 202 are the end parts of the resistive element 17. The second parts 201, 202 have a width L2 that is wider than the central part(s) 101, 102. Therefore the second parts 201, 202 have a larger intrinsic all-firing level than the first parts 101, 102, and thus do not interfere in the global all-firing level. The second parts 201, 202 participate in the definition of the resistance of the resistive element 17.

[0032] Since the two parts 201, 202 are wider than the first part(s) 101, 102, they enable a more precise definition of the global resistance than in the case of a single bar forming the resistive element. In the case of a single bar, the etching variability has a direct influence on the variability of the bar width, which has a direct influence on the variability of the resistance of the resistive element.

[0033] In the case of the invention, the variability over the width of the first parts 101, 102 is the same in absolute terms as the variability of the second parts 201, 202, but the variability of the second parts 201, 202 is lower in relative terms, and this is particularly true when the difference in width between the first parts 101, 102 and the second parts 201, 202 is high.

[0034] There is a third part 301, 302 of the resistive element 17 between each first part 101, 102 and each second part 201, 202, namely there are two third parts 301, 302 in the embodiment shown in figures 3 and 4. The third part 301, 302 has a third width L3 larger than the second width L2 of the second part 201, 202 and larger than the first width L1 of the first parts 101, 102. In the embodiment shown in figures 3 and 4, the third parts 301, 302 may for example be in the form of ribs.

[0035] The heat dissipation area of each of the third parts 301 and 302 is larger than the heat dissipation area of their first adjacent part 101, 102.

[0036] The third parts 301, 302 define a stable thermal mass. The thermal mass of the third parts 301, 302 has a direct impact on the all-firing value. The advantage of these third parts 301, 302 is that they make the all-firing value independent of the thickness of the conducting layers 28, 29 of the contacts 26, 27. The all-firing value on a resistive element composed of a single bar is defined by the temperature reached at the centre of the bar when the bar carries an electrical current. This temperature depends on the width of the bar but also the cooling of the thermal mass of the ends of the resistive elements. This thermal mass is defined by the geometry and thickness of material and the composition of these materials.

With the two parts 301, 302, the geometry is massive and the thickness of the resistive element 17 is constant. This can give a stable mass and therefore a more stable all-firing level than with a resistive element composed of a single bar.

[0037] Obviously, a single third part could be provided. A number of first parts greater than two could be provided. A number of third parts greater than two could be provided.

[0038] In the embodiment shown in figures 3 and 4, the resistive element 17 comprises a fourth part 401 between the two first parts 101, 102. This fourth part 401 has a fourth width L4 greater than the first width L1 and greater than the second width L2, and for example is in the shape of a rib. The fourth part 401 has an energy dissipation surface with an area greater than the corresponding area of each first part 101, 102. The fourth part 401 thus carries a part of the energy when the resistive element 17 carries a non-firing current. The embodiment shown to scale in figure 4 enables to increase the non-firing level by about 100 mA, for a non-firing current formed by a pulse length of 10 seconds.

[0039] The third part or parts 301, 302, and the fourth part 401 when there is one, provide cooling.

[0040] The geometry of the first, second and third parts makes it possible to reduce the all-firing level, and to more easily adjust the total electrical resistance of the resistive element and to make the all-firing level independent of the thickness of the metal layers in the zones forming the contacts 26, 27, in other word the tinned zones in the example described above. The fourth part can also increase the non-firing level.

[0041] The second parts 201, 202 have a second width L2, for example identical to the width of the end parts 262, 272 of the contacts 26, 27.

[0042] For example, one and/or the other of the parts of the resistive element 17 may have a constant width in the length direction between contacts 26 and 27. One and/or the other of the parts of the resistive element 17 is for example delimited by straight edges, for example parallel to the longitudinal direction and the transverse direction of the width respectively.

[0043] One and/or the other of the ribs 301, 302 and / or 401 may for example be composed of two side tabs projecting on either side from the adjacent parts in the direction of the width. One and/or the other of the tabs is for example rectangular.

Claims

1. An electro-pyrotechnic initiator comprising a resistive heating element (17) comprising at least one layer conductive of electricity covered by a pyrotechnic ignition charge and connected by two first and second end contacts respectively to two electrodes (12, 13) for powering the resistive heating element (17) for igniting the pyrotechnic charge,

characterised in that

the resistive heating element (17) comprises :

- at least one first part (101, 102) having a first width (L1) for definition of electrical resistance for igniting the pyrotechnic charge,
- at least one second part (201, 202) situated near one of the contacts (26, 27) and having a second width (L2),
- at least one third part (301, 302) having a third width (L3) and situated between the first part (101, 102) and the second part (201, 202), to form a thermal dissipation surface of an area greater than that of the first part,

the third width (L3) being greater than the second width (L2), in turn greater than the first width (L1), the widths being taken on said layer in the transversal direction to passage of the current between the contacts.

2. The initiator as claimed in Claim 1, **characterised in that** the third part (301, 302) has the form of a wing.

3. The initiator as claimed in any one of the preceding claims, **characterised in that** at least two first parts (101, 102) are provided, between which are at least one fourth part (401) having a fourth width (L4) greater than the first width (L1) and having an energy dissipation surface of an area greater than that of the adjacent first parts (101, 102).

4. The initiator as claimed in Claim 3, **characterised in that** the fourth part (401) has the form of a wing.

5. The initiator as claimed in any one of the preceding claims, **characterised in that** the second width (L2) of the second part (201, 202) is identical to the width of the adjacent contact (26, 27).

6. The initiator as claimed in any one of the preceding claims, **characterised in that** it comprises, between a resistive heating element support (16), insulating electricity, and under at least the resistive heating element (17) :

- a thermal dissipater (31) for dissipating the heat produced by the resistive heating element (17) to the support (16) ;
- a conductive adhesive layer (32) of heat and insulating electricity interposed at least between the resistive heating element (17) and the thermal dissipater (31).

7. The initiator as claimed in any one of the preceding claims, **characterised in that** the contacts (26, 27) are formed by a zone (262, 272) of electrical resistance smaller than that of the second part (201, 202)

adjacent to the resistive heating element (17).

8. The initiator as claimed in any one of the preceding claims, **characterised in that** the resistive heating element (17) is formed by the denuded part of the conductive layer (25) and the contacts (26, 27) are formed by parts of the conductive layer (25) covered by at least one other thickness (28, 29) of electrical conductor.

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FIG.1

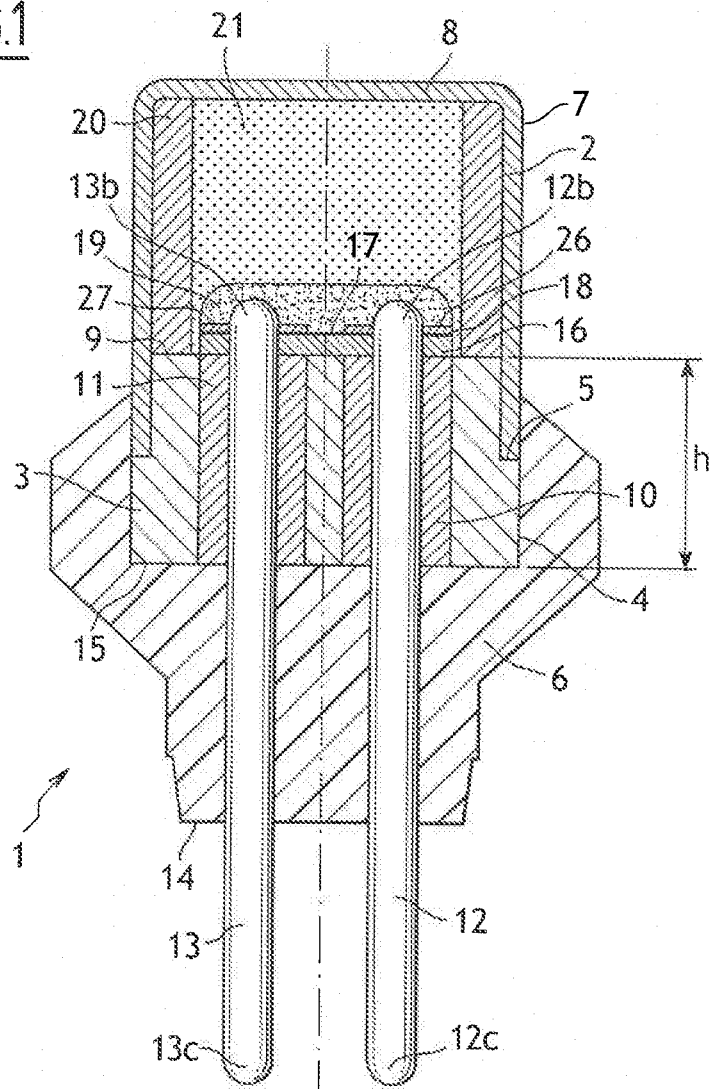


FIG.2

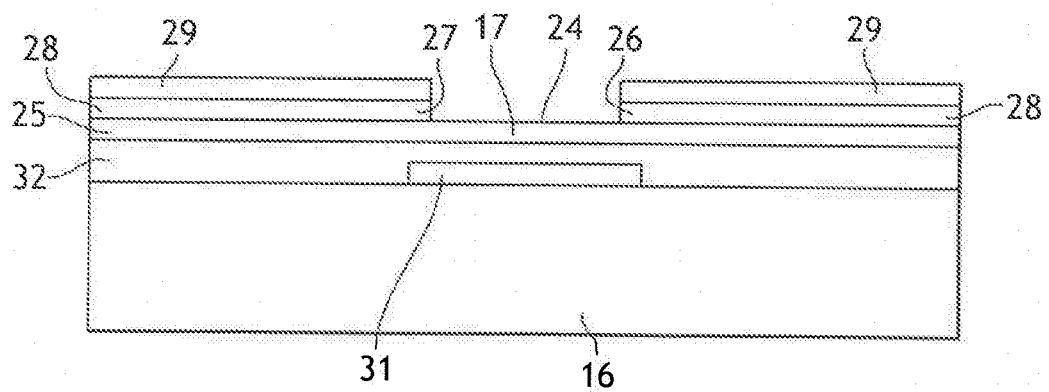


FIG. 3

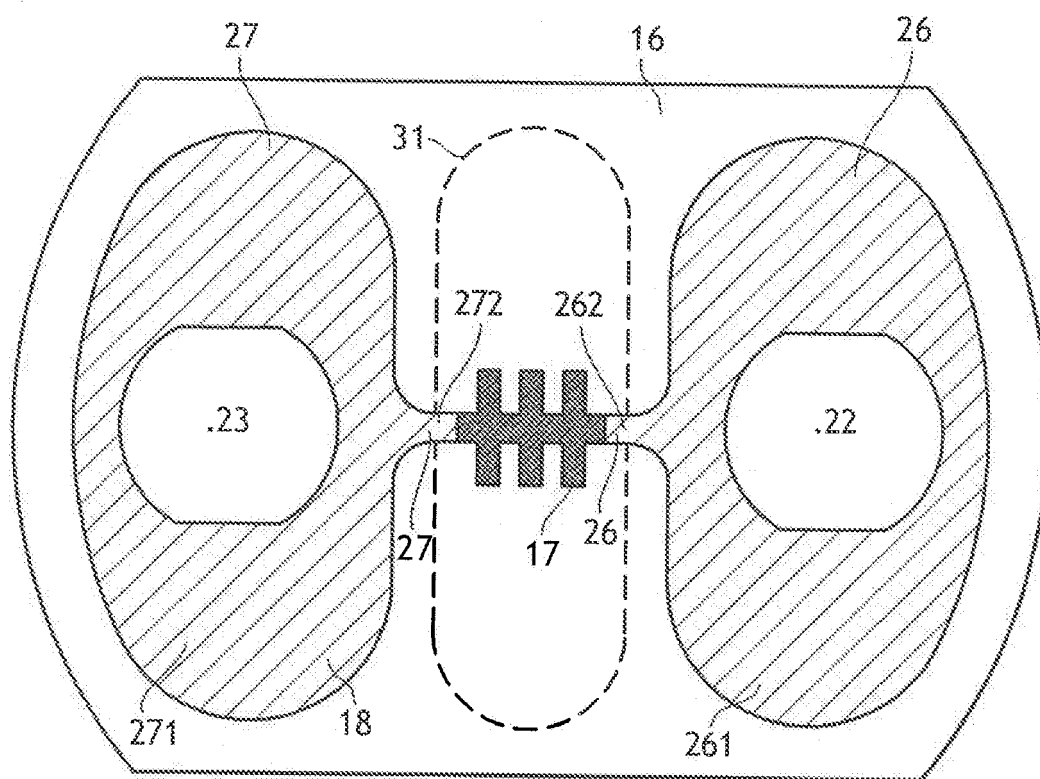
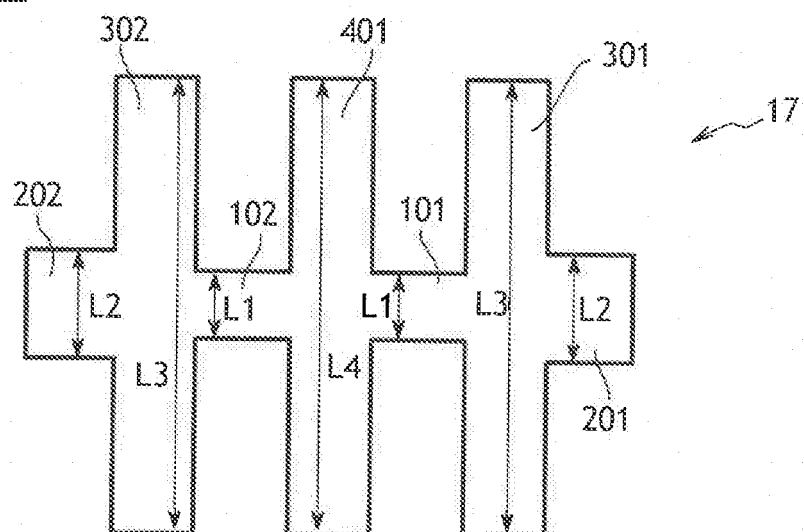


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 08 16 7834

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
The Hague		13 February 2009	Gex-Collet, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03-02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 08 16 7834

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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13-02-2009

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