(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 434 025 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.06.2004 Bulletin 2004/27

(51) Int Cl.[7]: **F42B 3/12**

(21) Application number: **03023549.3**

(22) Date of filing: **15.10.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **27.12.2002 JP 2002380188**

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(54) Initiator and gas generator

(57) In order to provide an initiator that is easy to manufacture and safe in the handling, and a gas generator provided with the initiator, a reaction agent (58) is stored in a casing (56) in an initiator (50). Pins (62, 64) are inserted into a hole (66) of a header (54), and are secured by glass or the like. Extremity surfaces of the pins (62, 64) are flush with the extremity surface of the header (54), and a plasma generating agent (72) is disposed on these surfaces. When a voltage is applied between the pins (62, 64), a high-temperature plasma is generated from the plasma generating agent (72), and the reaction agent (58) initiates a reaction.

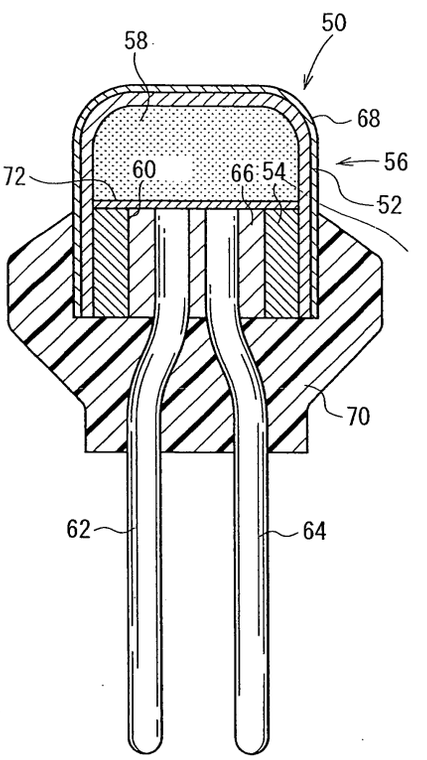

Fig. 1

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Description

[Technical Field of the Invention]

[0001] The present invention relates to an initiator suitable for being built in a gas generator for an airbag system or a seatbelt pretensioner, or the like, and the gas generator having the initiator.

[Description of the Related Art]

[0002] An airbag system provided on a high-speed mobile body such as a vehicle is constructed to deploy a bag-shaped airbag by a gas generator, which is called an inflator. The gas generator includes a gas generating agent and an initiator for initiating a gas generating reaction of the gas generating agent. Conventionally, the initiator includes a reaction agent, and a filament (bridge wire) as a resistance heat generating element for initiating a reaction of the reaction agent (for example, USP No. 5,404,263).

[0003] An example of the initiator in the related art will be described in conjunction with Fig. 8.

[0004] An initiator 10 has a substantially cup-shaped casing 12 opening at the rear (the bottom in Fig. 8). A reaction agent 14 is stored in the casing 12. The rear portion of the casing 12 is closed by an insulating material 16 formed of sintered glass or the like. Extremities of a pair of electrodes 18, 20 passing through the insulating material 16 are exposed in the casing 12.

[0005] A filament 22 extends between the extremities of the electrodes 18, 20. The both ends of the filament 22 are welded to the extremity surfaces of the respective electrodes 18, 20. The filament 22 is in contact with the reaction agent 14 in the casing 12.

[0006] The electrodes 18, 20, and the casing 12 are disposed away from each other so as not to be brought into electrical contact.

[0007] In the initiator 10 so constructed, one of the electrodes 18 is connected to a positive pole of a battery 26 of a motor vehicle via a control circuit 24 having a voltage boosting circuit or the like, and the other electrode 20 is connected to a vehicle body of the motor vehicle (earth connection). The negative pole of the battery 26 is connected to the vehicle body of the motor vehicle.

[0008] In case or emergency such as a vehicle collision or the like, a switch element in the control circuit 24 is turned ON, and a voltage is applied on the filament 22 from the battery 26. Accordingly, the filament 22 generates heat, and the reaction agent 14 is ignited and initiates a reaction. The reaction of the reaction agent 14 generates high pressure gas or heat, whereby the gas generating agent in the gas generator causes a gas generating reaction.

[0009] The reaction agent used here includes a first reaction agent that is a mixture of lead styphnate and aluminum powder disposed so as to surround the filament 22, and a second reaction agent formed of $BKNO_3$ or blasting powder disposed so as to surround the first reaction agent. The first reaction agent quickly reacts exothermally and the second reaction agent starts a reaction upon reception of heat from the first reaction agent, thereby generating a high-pressure and high-temperature gas and minute particles.

[0010] Referring now to Fig. 9, an example of the gas generator provided with the initiator 10 will be described. A gas generator 30 includes a container including an outer shell having an upper housing 32 and a lower housing 34, and a cylindrical partitioning member 36 disposed in the outer shell. One end of the partitioning member 36 passes through an opening on the bottom of the lower housing 34 and projects downward. The inner peripheral surface of the opening and the outer peripheral surface of the partitioning member 36 are welded by laser beam welding or the like. An igniting agent (booster propellant) 40 is stored inside the partitioning member 36, and a gas generating agent (main propellant) 42 is stored outer circumferentially of the partitioning member 36.

[0011] The partitioning member 36 is provided with the initiator 10 at the above-described end thereof. When the igniting agent 40 is ignited by the initiator 10, gas is injected from an opening 44 of the partitioning member 36 to ignite the gas generating agent 42, whereby a large amount of gas is quickly generated and is injected through a filter 46 formed of a mesh or the like and through an opening 48 out of the gas generator 30, so that the airbag is deployed. Fig. 9 shows only an example of the gas generator, and various gas generators of the shape other than the one shown in the drawing are used as well.

[Problems to be Solved by the Invention]

[0012] In the conventional initiator shown in Fig. 8, in order to fix an electric resistance of the filament 22, the length or welding conditions of the filament 22 have to be controlled strictly, which takes a lot of trouble in manufacture and causes increase in costs.

[0013] In addition, it is necessary that the reaction agent 14 is sensitive so as to be ignited even with a small amount of energy generated by the filament 22, and handling of such sensitive reaction agent 14 requires a special care.

[0014] An object of the present invention is to provide an initiator which does not use a resistance heat generating element such as a filament or the like, and is able to use a reaction agent which is easy to manufacture and is safe in the handling thereof. Another object of the present invention is to provide a gas generator provided with the initiator.

[Means for Solving the Problems]

[0015] According to the present invention, these objects are achieved by an initiator as defined in claim 1

or claim 2 and a gas generator as defined in claim 3.

[0016] An initiator of the present invention includes a casing, a reaction agent disposed in the casing, an electrode, and a plasma generating agent for generating a plasma by being energized and initiating a reaction of the reaction agent.

[0017] The initiator of the present invention may include a casing, an electrode, and a mixture of a reaction agent and a plasma generating agent disposed in the casing are provided, and may be characterized in that the plasma generating agent generates a plasma in response to energization of the electrode and thus a reaction of the reaction agent is initiated.

[0018] In the initiator according to the present invention, when a voltage is applied to the electrode, the plasma generating agent is turned to a high-temperature plasma state. Heat generated by the plasma generating agent causes the reaction agent to initiate a reaction, and high-pressure gas or heat generated by the reaction ignites the gas generating agent in the gas generator. Since this initiator is provided with the plasma generating agent instead of providing a filament, it may easily be manufactured and may be manufactured at a high yield ratio at a low cost without variations in quality.

[0019] Since heat generating energy of the plasma generating agent is larger than heat generating energy of the filament, a reaction agent which is safer in the handling than the sensitive reaction agent that has been used when using the filament.

[Brief Description of the Drawings]

[0020]

Fig. 1 is a cross-sectional view of an initiator according to an embodiment of the present invention.
Fig. 2 is a cross-sectional view of an initiator according to another embodiment of the present invention.
Fig. 3 is a cross-sectional view of an initiator according to still another embodiment of the present invention.
Fig. 4 is a cross-sectional view of an initiator according to an embodiment of the present invention.
Fig. 5 is a cross-sectional view of an initiator according to an embodiment of the present invention.
Fig. 6 is a cross-sectional view of an initiator according to an embodiment of the present invention.
Fig. 7 is a cross sectional view of an initiator according to an embodiment of the present invention.
Fig. 8 is a cross-sectional view of an initiator according to the related art.
Fig. 9 is a cross-sectional view showing an example of a construction of a gas generator.

[Description of the Embodiments]

[0021] Referring now to the drawings, embodiments will be described. Fig. 1 to Fig. 7 are cross-sectional views of an initiator according to an embodiment of the present invention.

[0022] According to an initiator 50 shown in Fig. 1, a casing 56 is constructed of a cup 52 and a header 54 inserted through an entrance of the cap 52, and a reaction agent 58 is filled in the casing 56. In this embodiment, the cup 52 is a circular container formed of a SUS 304 or the like. The header 54 is a substantially disk-shaped member formed of SUS 304 or the like, and an outer peripheral surface thereof is secured to an inner peripheral surface of the cup 52 by welding or the like.

[0023] The header 54 is provided with a through hole 60 extending in the direction of the thickness of the header at the center thereof. Electrode pins 62, 64 are inserted into the hole 60 at a distance from each other, and these pins 62, 64 are fixed to the header 54 by an insulative fixing material 66 such as glass or the like so as to keep away from the header 54. Extremity surfaces of the pins 62, 64 are flush with an extremity surface of the header 54. A thin plate shaped molding of a plasma generating agent 72 is disposed at the extremity surface (the upper end surface in the drawing) of the header 54 on the inner side of the cap.

[0024] The plasma generating agent 72 is formed, for example, of water glass (Na_2O/SiO_2, K_2O/SiO_2), $KClO_3$, $KClO_4$, KCl and the like, and powder, such as $KClO_3$, $KClO_4$, KCl and the like, is formed into a thin plate shape by being pressed. The extremities of the pins 62, 64 are in contact with the plasma generating agent 72.

[0025] There is a gap between an extremity surface of the plasma generating agent 72 and a ceiling surface of the cup 52 and a reaction agent 58 is stored therein.

[0026] The outer surface of the cap 52 is covered with a resin cover 68 formed of nylon, polypropylene or the like. The rear side of the cup 52 and the rear end surface of the header 54 are covered with a resin cover 70 formed of nylon, polybutylene terephtalate, or the like. The pins 62, 64 projects outward through the resin cover 70.

[0027] The reaction agent 58 may be formed only of a first reaction agent (igniting agent), and may be formed of a mixture of the first reaction agent and a second reaction agent (particles of an oxidizing agent). Though the kind of the first reaction agent is not specifically limited, a single metal, such as Mg, Zr, Ti, W, B, Si, C, Be, Li, Al, V, CaC_2, Ca, Ce, La or the like, or an alloy thereof, or a compound thereof are used. Though the kind of the second reaction agent is not specifically limited, $KClO_4$, $KClO_3$, K 10_4, NH_4ClO_4, NH_4NO_3, KNO_3, Fe_2O_3, Fe_3O_4, Sr $(NO_3)_2$, CuO, NiO, and the like are used.

[0028] In the initiator 50 so constructed, when a voltage is applied between the pins 62, 64, a high-temperature plasma is generated from the plasma generating agent 72 provided between these two pins 62, 64. Then, the reaction agent 58 initiates a reaction by heat from the plasma, and then gas containing a high pressure and high-temperature minute particles is generated. When the reaction agent 58 contains particles of an ox-

idizing agent, the metallic particles are quickly oxidized and thus generate heat due to oxidizing action of the particles of the oxidizing agent, thereby promoting the reaction.

[0029] In this embodiment, a filament (wire bridge) is not used, and thus a lot of trouble during manufacturing may be significantly reduced.

[0030] In this embodiment, a high-temperature plasma is stably generated by the plasma generating agent 72. Therefore, a reaction agent that is less sensitive than the reaction agent (igniting agent) which is used when using the filament may be used, whereby the handling of the reaction agent is facilitated.

[0031] In an initiator 50A shown in Fig. 2, material of a header 54A is changed into plastic (synthetic resin).

[0032] The initiator 50A in Fig. 2, a casing 56A is constructed of a metallic cup 52A and the plastic header 54A inserted through the entrance of the cup 52A. The electrode pins 62, 64 are inserted into the header 54A. An extremity surface of the header 54A is flush with the extremity surfaces of the pins 62, 64. The plasma generating agent 72 is disposed so as to be superimposed on the extremity surface of the header 54. The cup 52A is covered by a resin cover, not shown. Other constructions are the same as the initiator 50 shown in Fig. 1, and the same parts are represented by the same reference numerals.

[0033] In this initiator 50A, when the portion between the pins 62, 64 is energized, a high-temperature plasma is generated from the plasma generating agent 72, and the reaction agent 58 initiates a reaction by heat therefrom.

[0034] An initiator 50B shown in Fig. 3 includes a plasma generating agent formed by mixing a plasma generating agent and a reaction agent. A mixture 72B is fixed to the extremities of the pins 62, 64 in a ball shape or in a small block shape by using a binder such as water glass or the like.

[0035] In this embodiment, the extremities of the electrode pins 62, 64 projects from the extremity surface of the header 54A, and a mixture 72B is attached to the pins 62, 64 so as to cover the extremities thereof. The mixture 72B is attached to the extremities of the pins 62, 64 so as to straddle therebetween. Other constructions are the same as the initiator 50A in Fig. 2, and the same parts are represented by the same reference numerals.

[0036] In the initiator 50B thus constructed, when a voltage is applied between the pins 62, 64, a high-temperature plasma is generated from the plasma generating agent contained in the mixture 72B provided between the two pins 62, 64. Then, the reaction agent contained in the mixture 72B initiates a reaction by heat from the high-temperature plasma, and then the reaction agent 58 provided outside the mixture 72B initiates a reaction by reaction heat therefrom.

[0037] Fig. 4 shows an initiator 50C of a single-pin structure. A header 54C is constructed of a column portion 54a, and a flange portion 54b projecting from the lower peripheral surface of the column portion 54a. A casing 56C is constructed of the header 54C and a cup 52C fitted on the column potion 54a of the header 54C. The header 54C and the cup 52C are both formed of metal.

[0038] The header 54C is provided with a hole 60C extending in the direction of thickness of the header at the center thereof. A single electrode pin 62C is inserted into the hole 60C, and fixed to the head 54C by an insulative fixing material 66 such as glass or the like. An extremity of the pin 62C is flush with an extremity of the header 54C, and the plasma generating agent 72 is disposed on the extremity surface of the header 54C.

[0039] The flange portion 54b of the header 54C is provided with a plurality of bolt holes 54c.

[0040] In the initiator 50C of a single pin structure thus constructed, the header 54C serves as a positive electrode. In other words, when a voltage is applied between the header 54C and the pin 62C, a high-temperature plasma is generated from the plasma generating agent 72, and the reaction agent 58 initiates a reaction by the heat therefrom.

[0041] In an initiator 50D in Fig. 5, a casing 56D is constructed of a metallic cup 52D and a metallic header 54D inserted through the entrance of the cup 52D. An outer peripheral surface of an insulative sleeve 80 formed of a insulating material abuts against the inner peripheral surface of the cup 52D. One end (upper end in the drawing) of the insulative sleeve 89 is in contact with a ceiling surface of the cup 52D, and the other end (lower end) thereof is fitted into a recess 54a curved around the outer peripheral surface of the header 54D. A plate shaped molding of a mixture 58D of MgPP (magnesium parchlorate (reaction agent)) and a plasma generating agent is disposed at the ceiling portion of the inner surface of the cup 52D. The mixture is formed into a plate shape by using a binder or by being pressed. The mixture 58D is held by the ceiling surface of the cup 52D by using the binder or by being pressed. A gap 82 formed between the mixture 58D and the header 54D is filled with air or oxygen in a tightly sealed manner.

[0042] The header 54D is formed with a through hole 60D in the direction of the thickness of the header at the center thereof. An electrode pin 62D is inserted into the hole 60D, and is fixed to the header 54D by an insulative fixing material 66D such as glass or the like. An extremity of the pin 62D is pointed, and the pointed extremity is disposed away from the mixture 58D so as to be brought into contact therewith. An electrode pin 64D is fixed to the rear surface of the header 54D by welding or the like.

[0043] Though it is not shown, the outer surface of the cap 52D is covered with a resin cover, and the rear side of the cup 52D and the rear end surface of the header 54D are covered by a resin cover (similar to the resin cover 70 shown in Fig. 1 and Fig. 2). The pins 62D, 64D project through the resin cover outward.

[0044] In the initiator 50D so constructed, when a volt-

age is applied between the pins 62D, 64D, arc discharge toward the ceiling of the cup 52D occurs from the tip of the pin 62D. In this case, since the insulative sleeve 80 is provided on the inner peripheral surface of the cap 52D, arc discharge occurs only between the pin 62D and the ceiling surface of the cup 52. When the arc passes trough the mixture 58D, a plasma generating agent contained in the mixture 58D reacts and generates a high-temperature plasma, and MgPP in the layer of mixture 58D initiates a reaction.

[0045] In an initiator 50E in Fig. 6, an extremity of a pin 62E is covered by a mixture 88. The mixture 88 is fixed to the extremity of the pin 62 E by soaking the extremity of the pin 62E in a slurry mixture of MgPP and a plasma generating agent, then taking out the pin 62E therefrom, and dip drying the same.

[0046] A reaction agent 86 of MgPP formed by press forming is attached to the extremity surface of the header 54D. A gap 82 formed between the reaction agent 86 and the ceiling surface of the cap 52D is filled with a metallic sleeve (metallic wool) formed of metal such as Zr, Mg, Ti, W, Al and the like. Other constructions of the initiator 50E shown in Fig. 6 are the completely same as the initiator 50D shown in Fig. 5, and the same parts are represented by the same reference numerals.

[0047] In the initiator 50E so constructed, when a voltage is applied between the pin 62E and 64D, ark discharge occurs between the pin 62E and the ceiling surface of the cap 52D, and a high-temperature plasma is generated from a plasma generating agent in the mixture 88. MgPP in the mixture initiates reaction by heat therefrom. Heat generated in the mixture 88 is transmitted to the reaction agent 86 via the metallic sleeve 84, and heat generated in the mixture 88 causes combustion of the metallic sleeve 84, combustion heat of which is also transmitted to the reaction agent 86. Transmitted heat as such initiates a reaction of the reaction agent 86.

[0048] An initiator 50F in Fig. 7 includes the metallic cup 52D, and a resin cover 70F provided at the rear end (opening) of the cup 52D. The reaction agent 86 formed of MgPP by press molding is provided on the ceiling surface of the cup 52D. A gap 82F is formed between the reaction agent 86 and the resin cover 70F.

[0049] Two electrode pins 62F, 64F are passed through the resin cover 70F in the fore-and-aft direction (vertical direction in Fig. 7). The portions of the pins 62F, 64F located in the gap 82F are covered by mixtures 90a, 90b, respectively.

[0050] The mixtures 90a, 90b are fixed to the pins 62F, 64F by soaking the extremities of the pins 62F, 64F into a slurry mixtures of MgPP and a plasma generating agent, taking them out and dried.

[0051] The metallic sleeve 84 is filled in the space 82F, and the outer surface of the cup 52D is covered by a resin cover, not shown.

[0052] In the initiator 50F thus constructed, when a voltage is applied between the pin 62F and the pin 64F, a current is flown between the pin 62F, 64F via the metallic sleeve 84, and a plasma generating agent in the mixture 90a, 90b generates a high-temperature plasma, and MgPP in the mixtures 90a, 90b initiate a reaction. Heat generated from the mixtures 90a, 90b are transmitted to the reaction agent 86 via the metallic sleeve 84, and causes combustion of the metallic sleeve 84 to generates heat. Heat thus generated heat causes initiation of reaction of the reaction agent 86.

[0053] The initiator of the present invention may be applied to various gas generators. The gas generators may be built in various airbag systems for a driver's seat, for a front seat, for a rear seat, for a side, for protecting a head, and for protecting a pedestrian, or in a seat belt tensioner.

[Advantages]

[0054] As described above, according to the present invention, since a bridge wire is not used, an initiator in which a trouble of welding may be omitted, and a reaction agent that can easily be manufactured and is safe in the handling, and a gas generator using such initiator are provided.

Claims

1. An initiator comprising:

a casing (56; 56A; 56C);
a reaction agent (58) disposed in the casing (56; 56A; 56C);
an electrode (62; 62C; 64); and
a plasma generating agent (72) disposed in the casing (56; 56A; 56C) for generating a plasma in response to energization of the electrode (62; 62C; 64) and causing the reaction agent (58) to initiate a reaction.

2. An initiator comprising:

a casing (56A; 56D);
an electrode (62; 62D; 62E; 62F; 64; 64D; 64F); and
a mixture (72B; 58D; 88; 90a; 90b) of a reaction agent and a plasma generating agent,

characterized in that the plasma generating agent generates a plasma in response to energization of the electrode (62; 62D; 62E; 62F; 64; 64D; 64F) and thus a reaction of the reaction agent is initiated.

3. A gas generator comprising:

a gas generating agent; and
an initiator (50; 50A; 50B; 50C; 50D; 50F) for initiating a gas generating reaction of the gas

generating agent,

characterized in that the initiator (50; 50A; 50B; 50C; 50D; 50F) is the initiator according to Claim 1 or Claim 2.

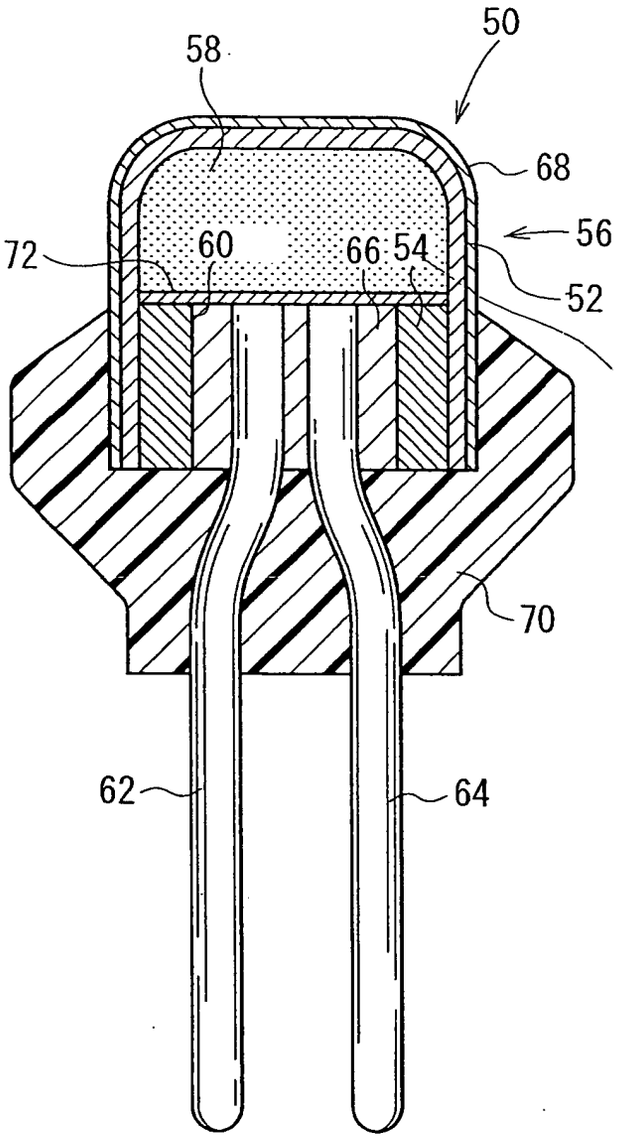


Fig. 1

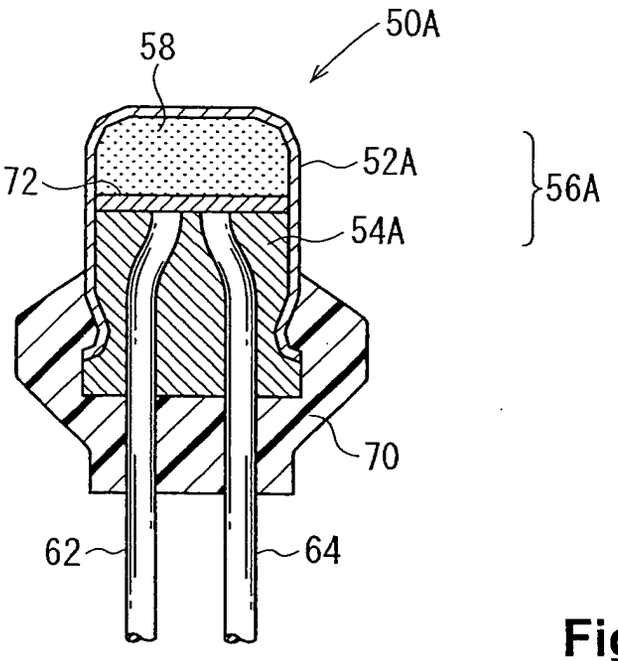


Fig. 2

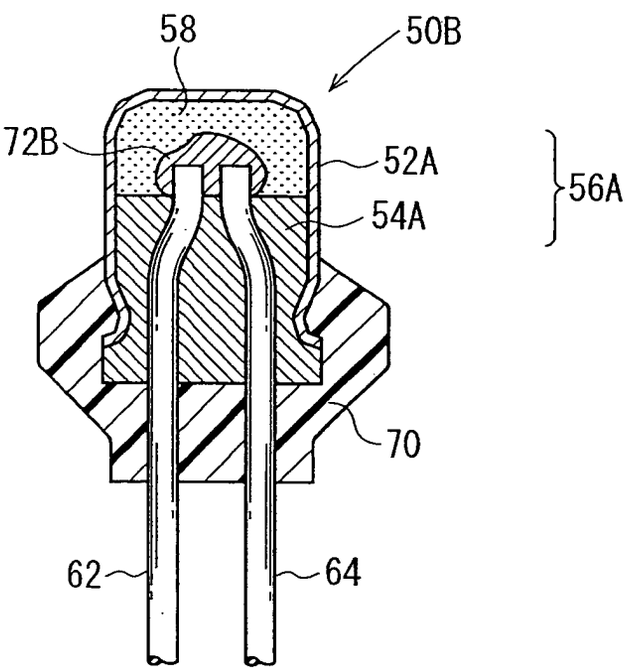
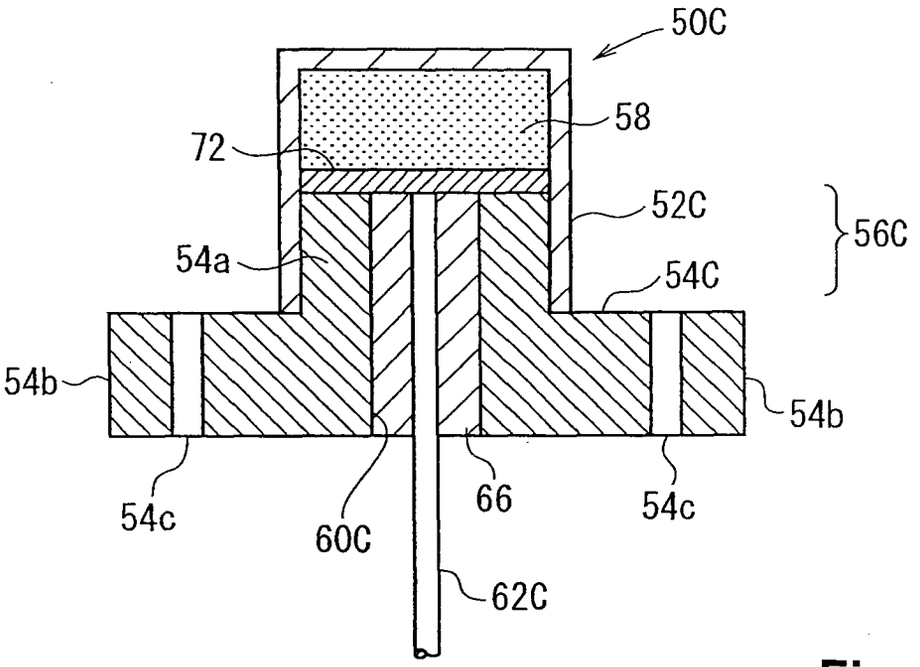


Fig. 3


50C
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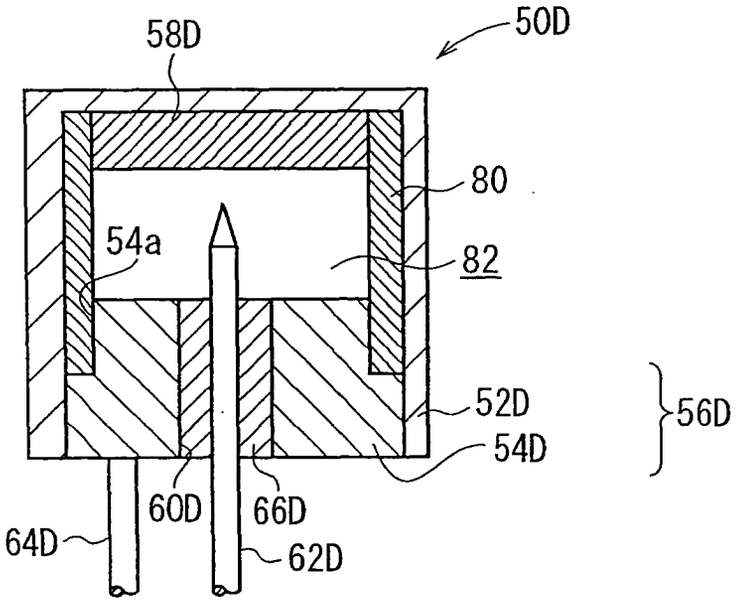
72
52C
56C
54a
54C
54b
54b
54c
54c
66
60C
62C

Fig. 4


58D
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54a
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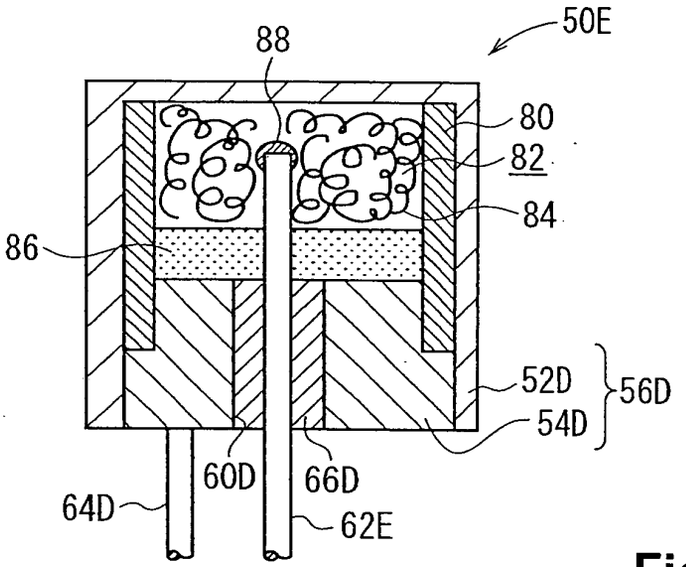
52D
56D
54D
60D
66D
64D
62D

Fig. 5


50E
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84
86
52D
56D
54D
60D
66D
64D
62E

Fig. 6

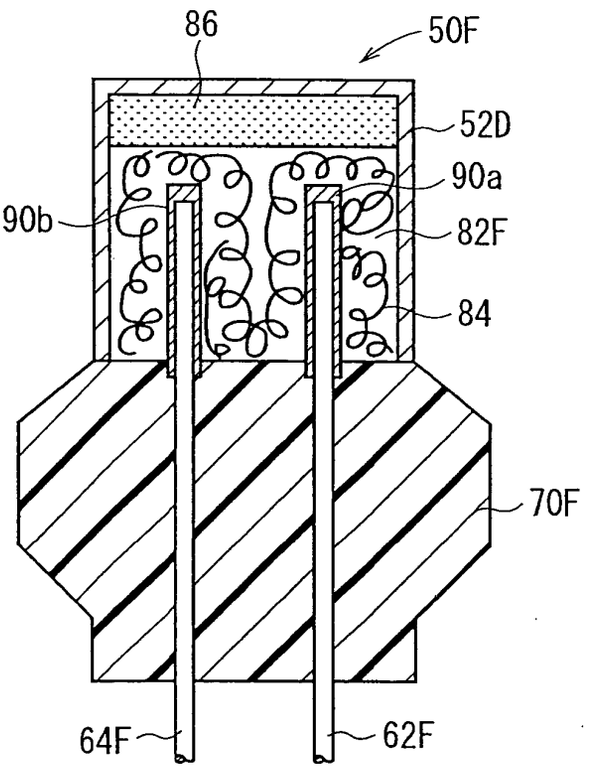
86
50F
52D
90a
90b
82F
84
70F
64F
62F

Fig. 7

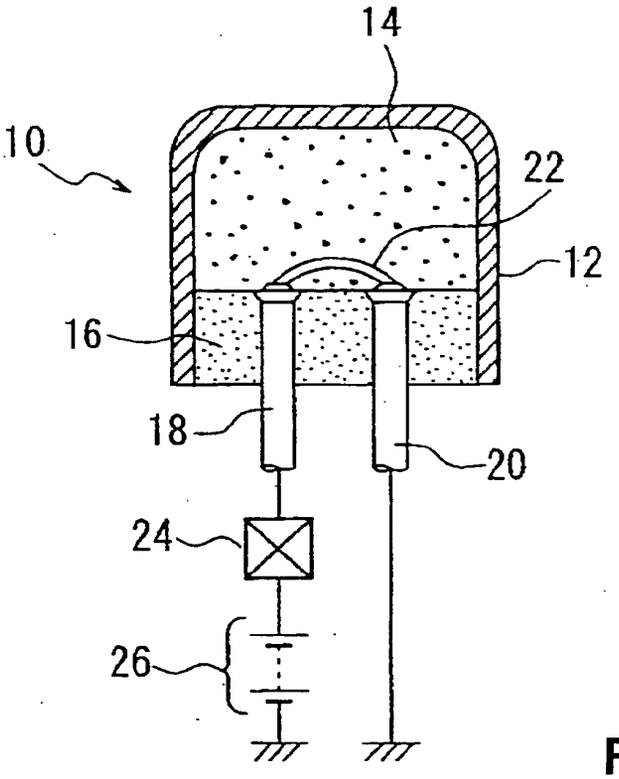

Fig. 8

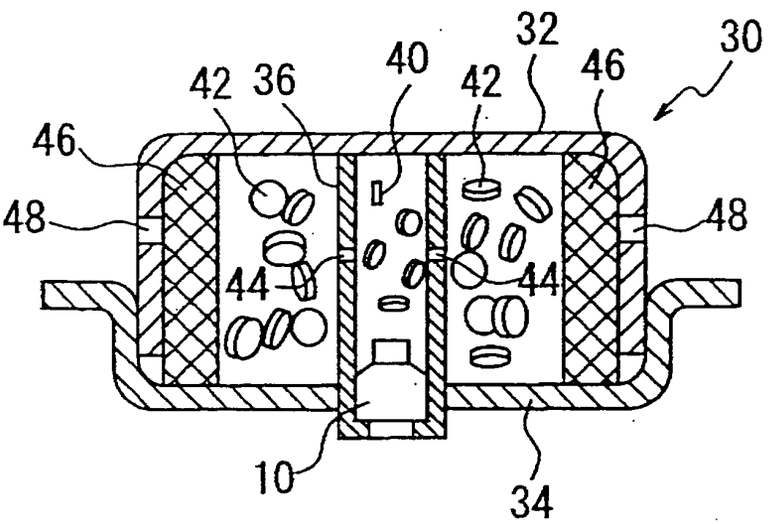

Fig. 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 3549

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.7)
X	US 2002/023567 A1 (POULARD ERIC ET AL) 28 February 2002 (2002-02-28) * paragraphs [0012],[0018] * * figures *	1,3	F42B3/12
X	WO 90/13529 A (OLIN CORP) 15 November 1990 (1990-11-15) * page 1, line 19 - page 2, line 4 * * page 5, line 5 - line 10 * * page 9, line 24 - page 10, line 4 * * abstract * * figures *	2	
P,X	DE 102 11 348 A (LELL PETER) 9 October 2003 (2003-10-09) * column 4, line 57 - line 65 * * figure 1 *	1,3	
X	US 6 272 965 B1 (BAGINSKI THOMAS A ET AL) 14 August 2001 (2001-08-14) * column 5, line 19 - line 21 * * column 7, line 5 - line 17 * * abstract * * figure 6 *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F42B B60R
X	US 3 181 464 A (PARKER THEODORE C ET AL) 4 May 1965 (1965-05-04) * column 3, line 63 - column 4, line 6 * * column 5, line 41 - column 6, line 3 * * figure 3 *	1,3	
A	US 6 338 500 B1 (PEROTTO CHRISTIAN) 15 January 2002 (2002-01-15) * column 5, line 10 - column 6, line 8 * * figures *		

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 April 2004	Gex-Collet, A-L

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
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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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.7)
A	DE 882 970 C (DYNAMIT NOBEL AG) 13 July 1953 (1953-07-13) * page 2, line 29 - line 32 * * page 2, line 68 - line 78 * * abstract * ---		
A	US 1 832 052 A (OTTO SCHMITT ET AL) 17 November 1931 (1931-11-17) * the whole document * ---		
A	GB 821 586 A (NOBEL BOZEL) 7 October 1959 (1959-10-07) * the whole document * -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 April 2004	Gex-Collet, A-L

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