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(54) Title: HOLLOW BODY FOR A MOTOR VEHICLE

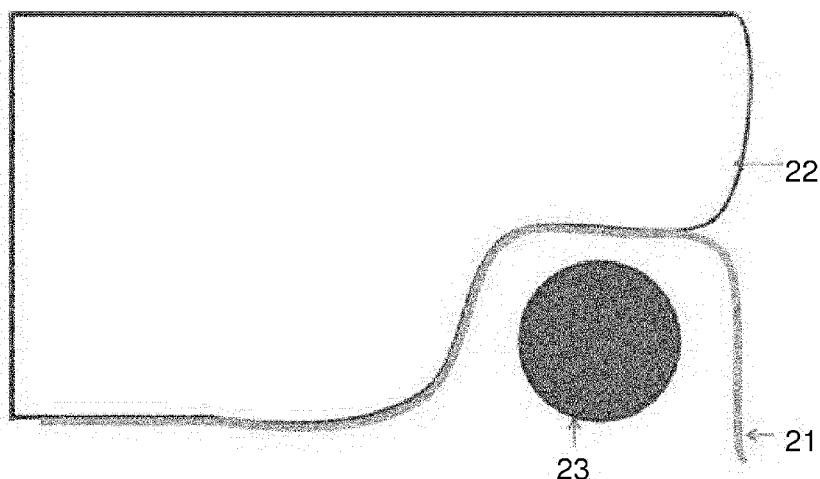


Figure 2

(57) Abstract: It is proposed a thermoplastic hollow body for a motor vehicle comprising a fire protection component made from a thermoplastic material. The fire protection component is chemically bonded to the thermoplastic hollow body and has a labyrinth structure configured to retain droplets of melted thermoplastic coming from the thermoplastic hollow body during fire.



Hollow body for a motor vehicle**Field of the invention**

The present invention relates to a thermoplastic hollow body. The present invention is particularly suitable for tanks and filler pipes.

Background

Thermoplastic hollow bodies, such as fuel tanks and filler pipes, are widely
5 used in motor vehicles.

Such hollow bodies can either be produced by blow moulding or injection moulding.

Thermoplastic hollow bodies for motor vehicles are required to exhibit high safety performance, particularly with regard to fire resistance and impact
10 resistance. Such hollow bodies are required to meet minimum statutory industry specified performance criteria both with respect to creep resistance when the tank is subjected to a fire and crash test resistance when the tank is subjected to an impact.

Generally, fuel tanks for motor vehicles are made of HDPE. HDPE has a
15 low melting point. Thus, such fuel tanks have limited resistance to fire.

It has been proposed different types of fire protection for HDPE fuel tanks.

For example, it is known that the wall of the hollow body must be thick enough to ensure fire resistance, but that increases the weight of the hollow body.

20 For example, a known type of fire protection is based on the use of a plate (or shield) made of thermoset polymers. Such materials have the property to be infusible (i.e. not able to be melted) and after processing, the final part is not transformable anymore; thus, such materials are resistant to heat. However, the attachment of such thermoset plate to the HDPE tank wall is complex. Indeed,
25 such thermoset plate cannot be welded to the HDPE tank wall and specific

mechanical locking means are thus required. For example, the thermoset plate can be screwed to the HDPE tank.

In addition, in some specific cases, the temperature of the fire can be such that the mechanical locking means may detach from the tank. In consequence,
5 the thermoset plate may also detach from the tank, leaving the tank surface unprotected. Thus, when the tank wall starts to melt, droplets of melted thermoplastic can exit towards the environment.

Summary

The object of embodiments of the invention is to provide an improved
10 hollow body which meets the above-stated fire resistance needs. A further object is to provide an improved hollow body on which a fire protection is arranged in an improved manner.

It is, therefore, one aspect of the present invention to provide a thermoplastic hollow body for a motor vehicle comprising a fire protection
15 component made from a thermoplastic material, said fire protection component is chemically bonded to the thermoplastic hollow body and has a labyrinth structure configured to retain droplets of melted thermoplastic coming from the thermoplastic hollow body during fire.

During an exposition to fire, the temperature of the hollow body wall
20 increases progressively. Heat diffuses first through the fire protection component, then through the hollow body wall.

Indeed, in a first stage the fire protection component according to the invention being positioned preferentially on the external wall of the hollow body which is the first area to be melted during fire exposition. Droplets of melted
25 thermoplastic are formed within the fire protection component and are retained by the labyrinth structure of the fire protection. The fire protection component according to the invention is thus configured to act as a trap (i.e. labyrinth) for the droplets of melted thermoplastic.

In a second stage the heat diffuses across the hollow body wall, the thickness of
30 melted thermoplastic material increases. The hollow body wall is thus in molten

state. The droplets of melted thermoplastic from the hollow body wall start penetrating and migrating across the fire protection component according to the invention, where they are delayed and retained by the labyrinth structure of the fire protection component. This delay allows for securing the passengers of the car. Thus, the fire protection component according to the invention provides a two-stages protection. It would be appreciated that the fire protection component allows reduction of the thickness of the wall of the hollow body. In other words, thanks to the fire protection component of the invention the hollow body can be made lighter and meet the fire resistance requirements in automotive industry (i.e.: no leakage observed).

Advantageously, the fire protection component of the invention is chemically bonded on the entire external wall of the hollow body. Thus, all the external wall of the hollow body is protected against fire exposition.

In another embodiment, the fire protection component of the invention is chemically bonded to at least one portion of the external wall of the thermoplastic hollow body. Said at least one portion of the external wall of the thermoplastic hollow body is a predetermined portion of the hollow body external wall susceptible to be exposed to fire. The fire protection component has to be shaped/sized in such way that it covers not only the portion of the hollow body which is susceptible to be exposed to fire but also its surrounding surface. Thus, the fire protection component remains attached during fire exposition and can play its protection function.

In this way, it is not necessary to protect the entire hollow body against fire exposition if there are only predetermined portions of the hollow body which are involved. However, the fire protection component has to be shaped larger than the portion of the hollow body which need fire protection for an efficient fire protection.

The fire protection component made from a thermoplastic material is chemically bonded to the thermoplastic material of the hollow body. Indeed these two thermoplastic materials have the chemical property to bind strongly

together by forming a chemical bond. Thus, the fire protection component is strongly attached to the hollow body and forms with the hollow body a solid fire resistant hollow body. The chemical bonding between the fire protection component and the hollow body is particularly strong compared to a mechanical
5 adhesion with a mechanical locking means for example. Indeed, contrary to a mechanical adhesion, it is not easy to detach two thermoplastic materials joined together by a chemical bonding.

The chemical bonding between the fire protection component and the hollow body can be made during different types of chemical processes such as
10 and non-limitingly, welding, overmoulding or adhesiving processes.

In a first particular embodiment of the present invention, the fire protection component is chemically bonded to the thermoplastic hollow body by welding, more particularly to the external wall of the thermoplastic hollow body. Thus, the attachment of the fire protection component to the hollow body is easy. The
15 welding takes place after the manufacturing of the thermoplastic hollow body. Further, by welding the fire protection component to the hollow body, deformations of the hollow body at critical location(s) (i.e. weak points) can be significantly reduced.

Such process is disclosed in the patent application EP 2544881 in the name of
20 the Applicant, which is included herein by reference.

In a second particular embodiment of the present invention, the fire protection component is chemically bonded to the thermoplastic hollow body by overmoulding. Thus, the attachment of the fire protection component to the surface of the thermoplastic hollow body can be performed directly during the
25 blow moulding or injection moulding step. By overmoulding the fire protection component, it can be securely integrated into the hollow body. This allows strong fastening of the fire protection component to the hollow body.

Such process is disclosed in the patent application PCT/EP2014/057697 in the name of the Applicant, which is included herein by reference. The fire
30 protection component can be overmoulded with at least one portion of the

external wall or internal wall of the thermoplastic hollow body. However, the attachment of the fire protection component to the external wall of the thermoplastic hollow body is preferred since the temperature is higher on the external wall and the diffusion of the droplets of melted thermoplastic coming from the thermoplastic hollow body during fire is oriented towards the external wall due to gravity. Thus, the fire protection component plays properly its protection function by retaining in a very efficient way the droplets of melted thermoplastic coming from the thermoplastic hollow body during fire.

In a particular embodiment, the fire protection component is chemically bonded to the thermoplastic hollow body by at least one adhesive means, such as an adhesive tape. In this case, the matrix of the fire protection component may be different from the matrix of the hollow body.

Advantageously, the fire protection component comprises at least one fiber filled reinforcement layer. Preferably, the at least one fiber filled reinforcement layer is a pre impregnated fiber composite (prepreg) layer. In other words, the reinforcement layer may comprise a thermoplastic material and fibers. The fibers may be short or long fibers, or woven or non-woven (random) continuous fibers. Uni-directional (UD) tapes could also be used as well as a superposition of several UD tapes (ex: $0^{\circ}+90^{\circ}$). Preferably, the fibers are included in the form of a woven mat of fibers, more preferably a woven mat of glass fibers. However, carbon fibers, natural fibers, metal fibers or polymer fibers, e.g. polyamide fibers, or a combination thereof may also be used. Synthetic fibers are less suitable due to their lower melting point compared to carbon or glass fibers. The thermoplastic material is configured to be chemically bonded to the material of the hollow body and may be a polyolefin material, in particular a polyethylene material, and e.g. high-density polyethylene. Other thermoplastic such as PA6, PA66, PPA, PP, or blends thereof may also be used. To improve the compatibility between the fibers and the thermoplastic material, the surface of the fibers may be treated with a compatibilizer substance such as silane and/or a reactive binder, e.g. the HDPE reactive type. Preferably the thermoplastic material content in the thermoplastic material is lower than 70 percent, more

preferably lower than 55 %. Preferably the fiber content is higher than 30 percent, more preferably higher than 45 percent. More details about suitable reinforcement layers can be found in patent application FR2 957 296-A1 in the name of the Applicant, which is included herein by reference, particularly the
5 fact that the reinforcement layer may also be a multilayer structure.

Most preferably, the fire protection component comprises three superposed layers of entangled woven fibers (e.g. twill fabric). Each of the layers comprises long woven yarns entangled in a cross way. Each yarn is made of continuous fibers. Each of the layers comprises a first plurality of long woven yarns
10 arranged together in the same direction and a second plurality of long woven yarns arranged together in a same direction but perpendicularly and in an alternating manner with the first plurality of long woven yarns. The entangled long woven yarns are arranged together in a tight way such that the entangled long woven yarns arrangement limits the melted thermoplastic material
15 diffusion. The long woven yarns arrangement forms the labyrinth structure for the melted thermoplastic droplets in which the melted thermoplastic droplets are delayed and retained. This delay allows for securing the passengers of the car.

The superposition of such layers allows to increase the complexity of the labyrinth structure and retain trapped the droplets or further the melted
20 thermoplastic material more efficiently.

In a particular embodiment, the fire protection component includes a barrier layer in order to reduce diffusion of hydrocarbons or other liquids or gazes across the hollow body wall. Typical structure could be for example, from the outside to the interface with hollow body wall: (HDPE + glass fibers) /
25 adhesive / EVOH(= barrier layer) / adhesive / HDPE. In this particular example, the chemical bonding between the fire protection component and hollow body wall is improved thanks to the absence of fibers at the interface.

To further improve the heat and fire resistance properties of the fire protection component, different specific chemical agents can be added to the
30 structure/reinforcement layer. These agents can be heat reflective elements or intumescent material or anti-drop agent or any other flame retardant.

In particular, heat stabilized grades can also be used as thermoplastic materials for the fire protection component such as PA6 and PA66 Durethan XTS3 (Xtreme Temperature Stabilization) from Lanxess. Thanks to organic additive, the continuous service temperature is increased by more than 100°C (compared to unstabilized PA6 or PA66) which make it suitable for fire resistance.

Unreinforced materials are preferred for the hollow body in order to ensure impact resistance (fibre reinforced materials are stiffer but also more brittle).

Good results have been obtained with the reinforcement layer based on HDPE containing 47% by weight of continuous woven glass fibers which are distributed in three layers and a total thickness of 1,5mm, without any specific flame retardant. The reinforcement layer was overmoulded (by blow moulding) into the surface of a fuel tank.

Good results can be obtained with a reinforcement layer having a total thickness between 0,1 and 2,5 mm, more preferably between 0,5 and 1,5 mm.

Advantageously, in the particular case where the hollow body of the present invention is a fuel tank of a vehicle fuel system, the fire protection component can be shaped/sized and arranged on the fuel tank so as to define a shield to protect one or several external components of the fuel system, such as for example a filler pipe, an electrical cable, a fuel or a venting line, a drain plug, a filter, etc.

In the particular case where the hollow body is a filler pipe, the bottom of the filler pipe can be protected with the fire protection component of the invention, especially if the filler pipe is connected at the bottom of the tank and can be filled with liquid.

In another particular embodiment, the hollow body of the invention is an ammonia precursor tank or an ammonia tank.

In another particular embodiment, the hollow body of the invention can be a pressurized or a non-pressurized tank.

Brief description of the figures

The accompanying drawings are used to illustrate presently preferred non-limiting exemplary embodiments of devices of the present invention. The above and other advantages of the features and objects of the invention will become more apparent and the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawings, in which:

Figure 1A illustrates schematically an embodiment of a structure of a fire protection component of the invention.

Figure 1B illustrates a microtome section of an embodiment of a structure of a fire protection component of the invention.

Figure 2 illustrates schematically a first embodiment of a fire protection component of the invention chemically bonded to an external wall of a fuel tank.

Figure 3 illustrates schematically a second embodiment of a fire protection component of the invention chemically bonded to an external wall of a fuel tank.

Figure 4 illustrates schematically a third embodiment of a structure of a fire protection component of the invention.

Figure 5 illustrates schematically a process to integrate a fire protection component of the invention on a hollow body.

Figure 6A and 6B illustrate schematically the test set-up used for mini fire tests.

Description of embodiments

Figure 1A illustrates schematically an embodiment of a structure of a fire protection component (10).

The fire protection component comprises three woven fiber layers (11), (12), (13) (e.g. twill fabric) combined together as well as polyethylene and carbon black. Each of the layers comprises long woven yarns entangled in a cross way.

Each yarn is made of long continuous fibers. In other words, each of the layers

- comprises a first plurality of long woven yarns (A1, A2, A3, A1', A2', A3'...) arranged in the same direction and a second plurality of long woven yarns (B1, B2, B3, B1', B2', B3'...) arranged in the same direction, perpendicularly and in an alternating manner with the first plurality of long woven yarns. The long woven yarns are arranged together in a tight way such that the long woven yarns arrangement limits the melted thermoplastic material diffusion. The long woven yarns arrangement forms the labyrinth structure for the melted thermoplastic material in which the melted thermoplastic material is delayed and retained. This delay allows for securing the passengers of the car.
- 10 The superposition of such layers allows to increase the complexity of the labyrinth structure and retain trapped the droplets or the melted thermoplastic material more efficiently.

Figure 1B is a microtome section of the fire protection component comprising layers of entangled woven fibers.

- 15 On the microtome section, the fire protection component comprises three first long woven yarns (A1, A2, A3) arranged in the same direction and two series of two and three other long woven yarns respectively (B1, B2, B3, B2', B3') arranged together in the same direction but perpendicularly to the three first long woven yarns.
- 20 The space between the long woven yarns (A1, A2, A3, B1, B2, B3, B2', B3') delimits the path L in which the melt thermoplastic material can penetrate and migrate. The space between the long woven yarns corresponds in other words to the labyrinth structure L of the fire protection component in which the melted thermoplastic material is retained and delayed.

- 25 Figure 2 illustrates schematically a fuel tank (22) equipped with a fire protection component (21) such as described in Figure 1. As illustrated in this example, the fire protection component (21) is shaped/sized and arranged on the fuel tank so as to define a shield to protect an external component (23).

- 30 Figure 3 illustrates schematically a fuel tank (32) equipped with a fire protection component (31) according to a second particular embodiment of the

invention. As illustrated in this example, the fire protection component (31) is shaped/sized and arranged on the fuel tank so as to define a shield to protect an external component (33). The external component comprises a first portion welded to the fuel tank at a first welding zone (35) and a second portion welded to the fire protection component at a second welding zone (34).

Figure 4 illustrates schematically a third particular embodiment of a structure of a fire protection component of the invention. Figure 4 is a cross section of the fire protection component, the fire protection component being an injection moulded plate or profile filled with short glass fibers (41). The dispersion of short glass fibers (41) in the matrix (40) forms the labyrinth structure for droplets of melted thermoplastic coming from the thermoplastic hollow body during fire where they are efficiently retained. Thus, each fiber limits the diffusion of the droplets of melted thermoplastic.

The short fiber content in the injection molded plate is at least preferably 30%, and more preferably 40% by weight of the total weight of the plate. The thickness of the plate should be between 0,1 mm and 2,5 mm, more preferably between 0,5 and 1,5 mm.

Alternatively, the fire protection component is an injection moulded plate filled with long glass fibers, carbon fibers, synthetic or metal fibers.

In another particular embodiment, the injection moulded plate comprises a pre-impregnated fiber composite layer.

Alternatively, the fire protection component is an extruded plate or profile filled with short or long glass fibers, carbon fibers, synthetic or metal fibers.

In another particular embodiment, the extruded plate or profile filled with short or long glass fibers, carbon fibers, synthetic or metal fibers comprises at least one fiber filled reinforcement layer.

The short fiber content in the extruded plate or profile filled is at least preferably 30%, and more preferably 40% by weight of the total weight of the plate or profile filled. The thickness of the extruded plate or profile filled should be between 0,1 mm and 2,5 mm, more preferably between 0,5 mm and 1,5 mm.

Figure 5 illustrates schematically a process to integrate an injection moulded plate (51) on a hollow body. Figure 5 represents the cross section of a two cavities mould (50) at each step of the process. In this particular embodiment the process comprises four steps (I-IV). The first step I of the process is the closing of the two-cavities mould (50). In a second step II, the fire protection plate (53) is injected in the first cavity (51) of the mould. The third step III is the opening of the mould (50) in order to transfer the fire protection plate injection moulded on the first cavity (51) to the second cavity (52), so that it remains warm. The cooling time in the first cavity (51) should be as short as possible. The step four IV is the closing of the mould (50) in order to form the hollow body while overmoulding the plate (53). .. The plate (53) is then overmoulded on the second cavity (52) by an impact resistant and compatible thermoplastic material, the thermoplastic material being compatible with the fire protection component. A chemical bonding is then obtained between the plate and the hollow body. For example, the thermoplastic material can be a un-reinforced PPA (ex: Amodel AT1001LNT from Solvay combines impact resistance at -40°C and fuel barrier) or un-reinforced HDPE (ex: Lupolen 4261AIM from Lyondellbasell) in such a way as to form a hollow body or at least one part of a hollow body (54).

Alternatively, the plate can be injection moulded on a separate mould and left to cool. During a second step, the plate is pre-heated (ex: by IR radiations) and then transferred into a second mould to be overmoulded (ex: by a robot or by an automatic gripping system). A pre-forming of the plate can be performed during heating or during transfer or during placement in the mould. The second mould may include a heated insert in order to increase locally the temperature, so that the plate remains warm enough to be chemically bonded during overmoulding.

Advantageously, the injection moulded plate can easily integrate one or more additional functions or components (ex: fixation clip for a canister or an external filter or a line (fuel line, vapour line) or an electrical cable, or a fixation

bracket). In the case of an ammonia precursor tank, such as AdBlue® tank, the injection moulded plate can integrate a heating element.

Fusible ribs can also be integrated on the surface of the plate, in order to achieve a better weld interface between the plate and the external surface of the tank.

Example:

The fire resistance of test specimens cut out of tank shells in PE and PE associated with the fire protection component has been compared. The comparison is based on a lab-scale experiment “mini fire test” with standard flat square samples. Consequently, the results of this lab-scale test cannot be compared directly with the performances required by ECE34 directive. The objective of the mini fire test is to highlight the positive effect of the fire protection component on the tank during fire exposition.

Figures 6A and 6B illustrate the test set-up used for mini fire tests.

Figure 6A illustrates the mini fire test without metallic balls (i.e. effect of the weight of the fuel is not taken into account):

A 700 °C flame (61) of a Bunsen burner (62) has been placed under 10 test specimens (63) cut out of tank shells composed of PE only (= reference sample) and under 10 other test specimens (63) cut out of tank shells composed of PE in association with the fire protection component. The surface of the test specimens (63) exposed to fire is 89mm*89mm. The test specimens (63) are placed on a support device (64). The support device (64) is positioned above a Bunsen burner (62) thanks to a holding device (65).

The PE test specimens have a thickness of 5.15 mm and the PE combined with the fire protection component test specimens have a thickness of 7.45 mm.

After an average time of 7 minutes 35 seconds, every of the 10 PE test specimens had holes whereas none of the 10 test specimens composed of PE in association with the fire protection component had hole after one hour test.

Figure 6B illustrates mini fire test with metallic balls (66) (i.e. effect of the weight of the fuel is taken into account):

The real fire resistance of a fuel tank is influenced by the weight of the fuel contained in such tank. Indeed, a hydraulic pressure is applied by the fuel, especially on the bottom surface of the tank. This, combined with high temperature, leads to high deformation of the tank shell, up to rupture of the wall. It is thus important to take this effect into account. According to ECE R34 directive, the tank is filled at 50% of its capacity. The resulting pressure has been simulated by 1 kg of metallic balls (66) (diameter 3.5mm) placed on the top side (surface: 89mm*89mm) of 5 test specimens (63) cut out of tank shells composed of PE only and of 5 other test specimens (63) cut out of tank shells composed of PE in association with the fire protection component.

A 700 °C flame (61) of a Bunsen burner (62) has been placed under them.

The PE test specimens have a thickness of about 5.5mm and the PE combined with the fire protection component test specimens have a thickness of 7.5mm.

After an average time of 4 minutes 40 seconds, every of the 5 PE test specimens had holes whereas the 5 test specimens composed of PE in association with the fire protection component had no hole after an average time of 28 minutes 08 seconds test.

The improvement of fire resistance is thus confirmed by these experiments.

CLAIMS

1. A thermoplastic hollow body for a motor vehicle comprising a fire protection component made from a thermoplastic material, said fire protection component is chemically bonded to the thermoplastic hollow body and has a labyrinth structure configured to retain droplets of melted thermoplastic coming from the thermoplastic hollow body during fire.

2. Thermoplastic hollow body according to claim 1, wherein the fire protection component is chemically bonded to at least one portion of an external wall of the thermoplastic hollow body.

3. Thermoplastic hollow body according to claim 1 or 2, wherein the fire protection component is chemically bonded to the thermoplastic hollow body by welding.

4. Thermoplastic hollow body according to claim 1 or 2, wherein the fire protection component is chemically bonded to the thermoplastic hollow body by overmoulding.

5. Thermoplastic hollow body according to claim 1 or 2, wherein the fire protection component is chemically bonded to the thermoplastic hollow body by at least one adhesive means.

6. Thermoplastic hollow body according to any one of claims 1 to 5, wherein the fire protection component comprises at least one fiber filled reinforcement layer.

7. Thermoplastic hollow body according to claim 6, wherein said at least one fiber filled reinforcement layer is a pre impregnated fiber composite (prepreg) layer.

8. Thermoplastic hollow body according to any one of claims 1 to 7, wherein the fire protection component is an injection moulded plate filled with short or long glass fibers, synthetic fibers, carbon fibers or metal fibers.

9. Thermoplastic hollow body according to any one of claims 1 to 6, wherein the fire protection component is an extruded plate or profile filled with short or long glass fibers, synthetic fibers, carbon fibers or metal fibers.

10. Thermoplastic hollow body according to any one of claims 1 to 9,
5 wherein the hollow body is a fuel tank, an ammonia precursor tank or a filler pipe.

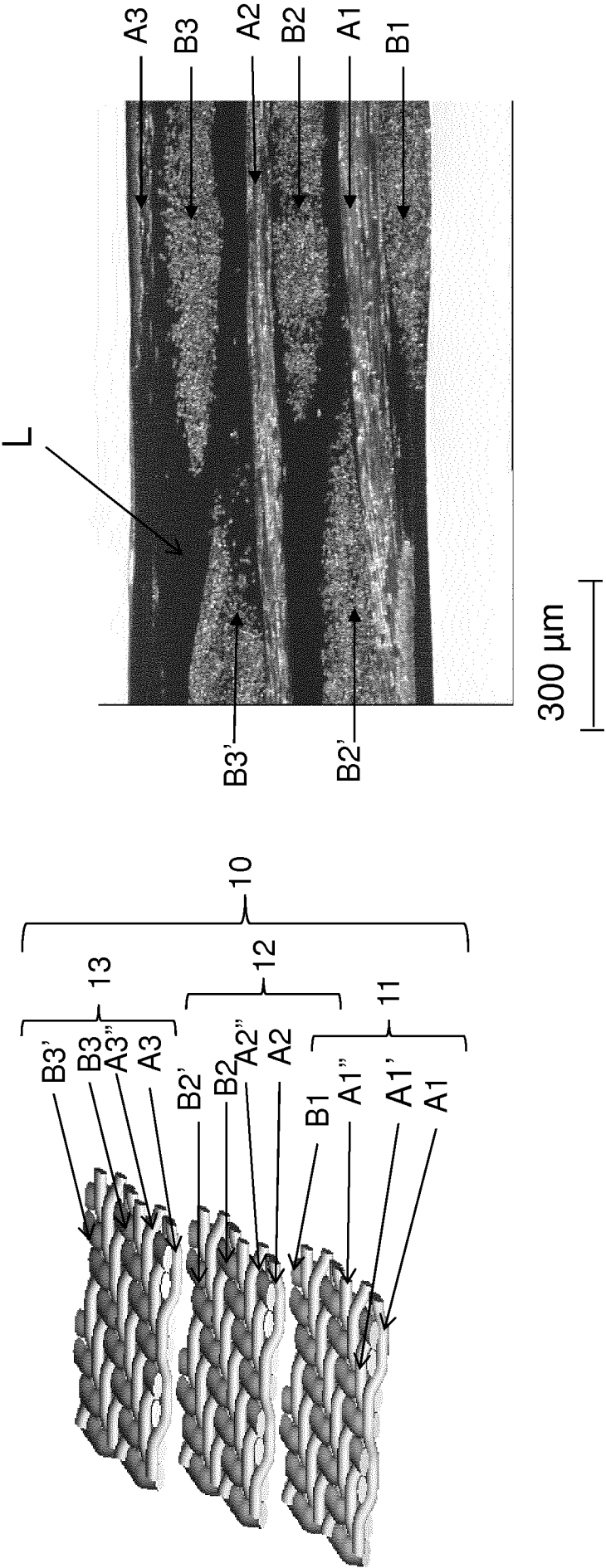


Figure 1A

Figure 1B

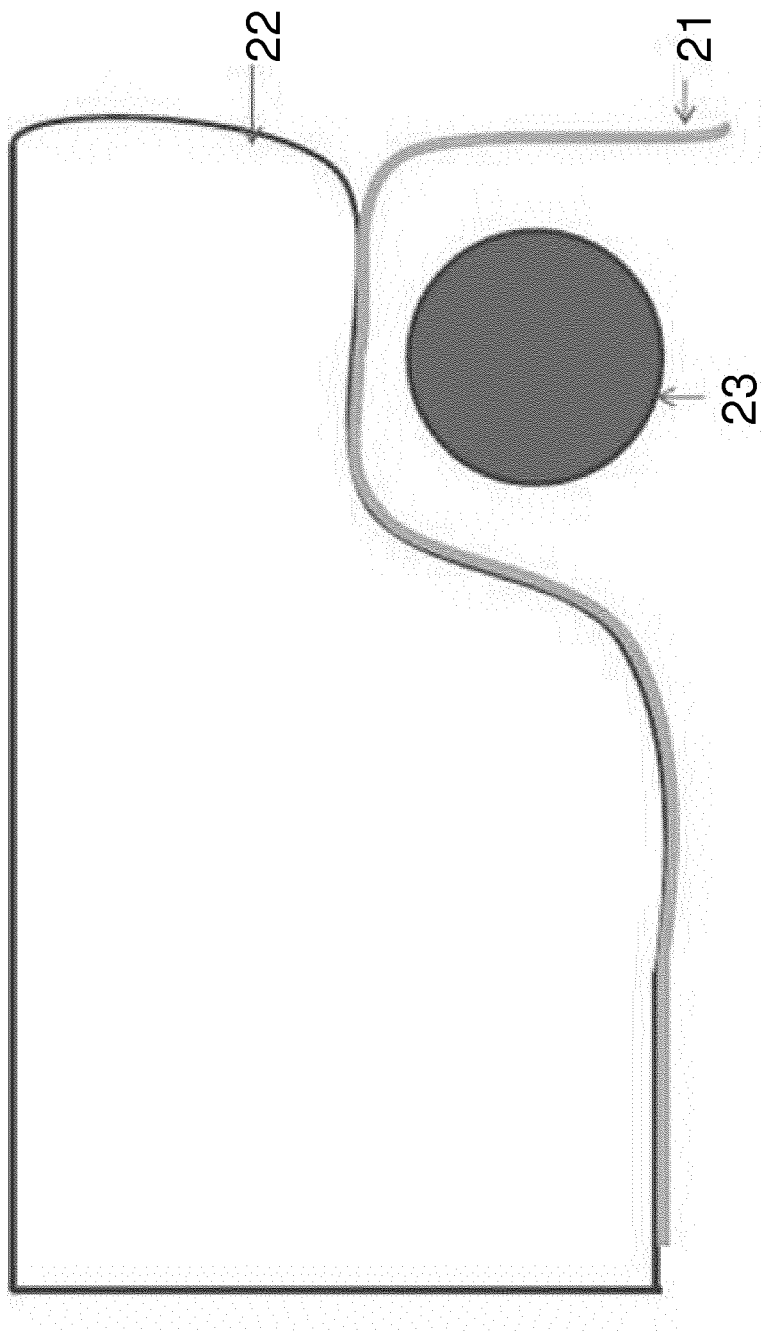


Figure 2

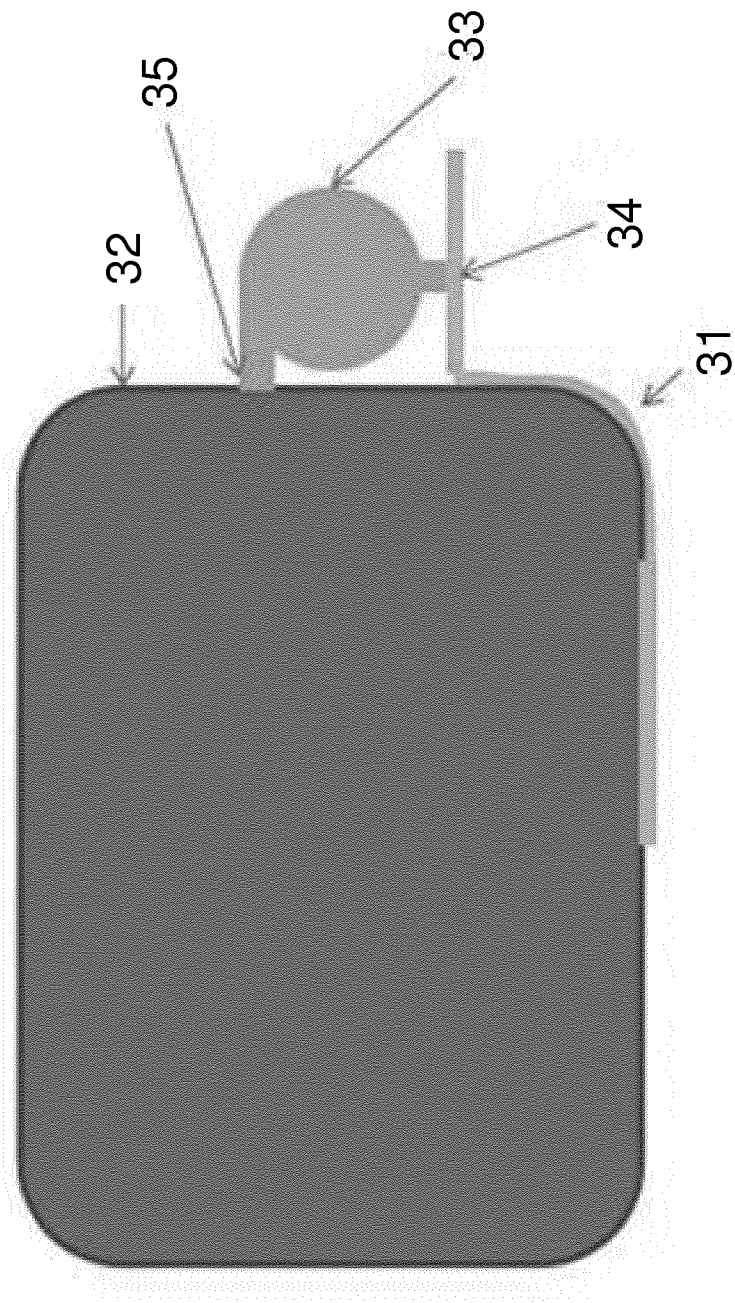


Figure 3

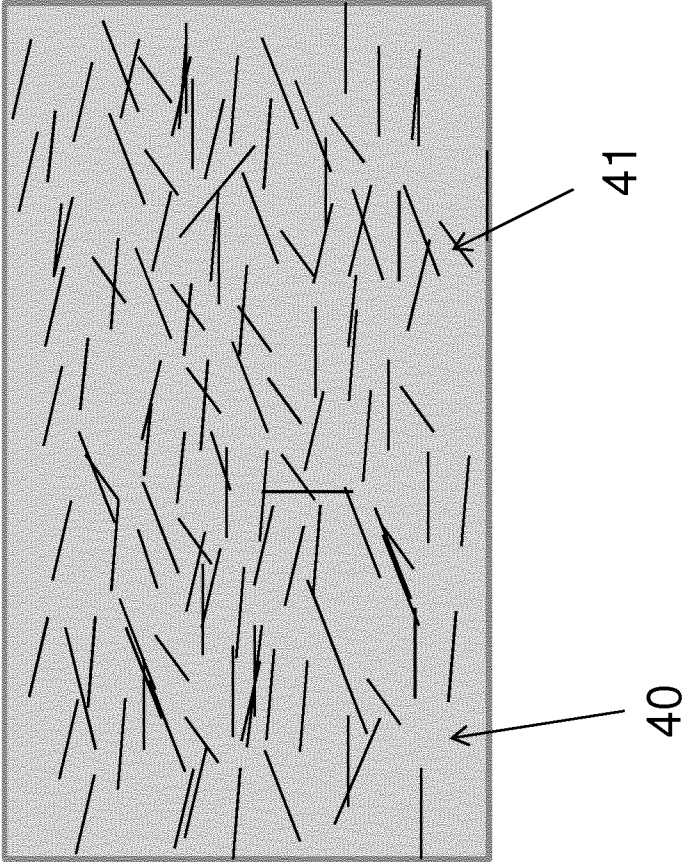


Figure 4

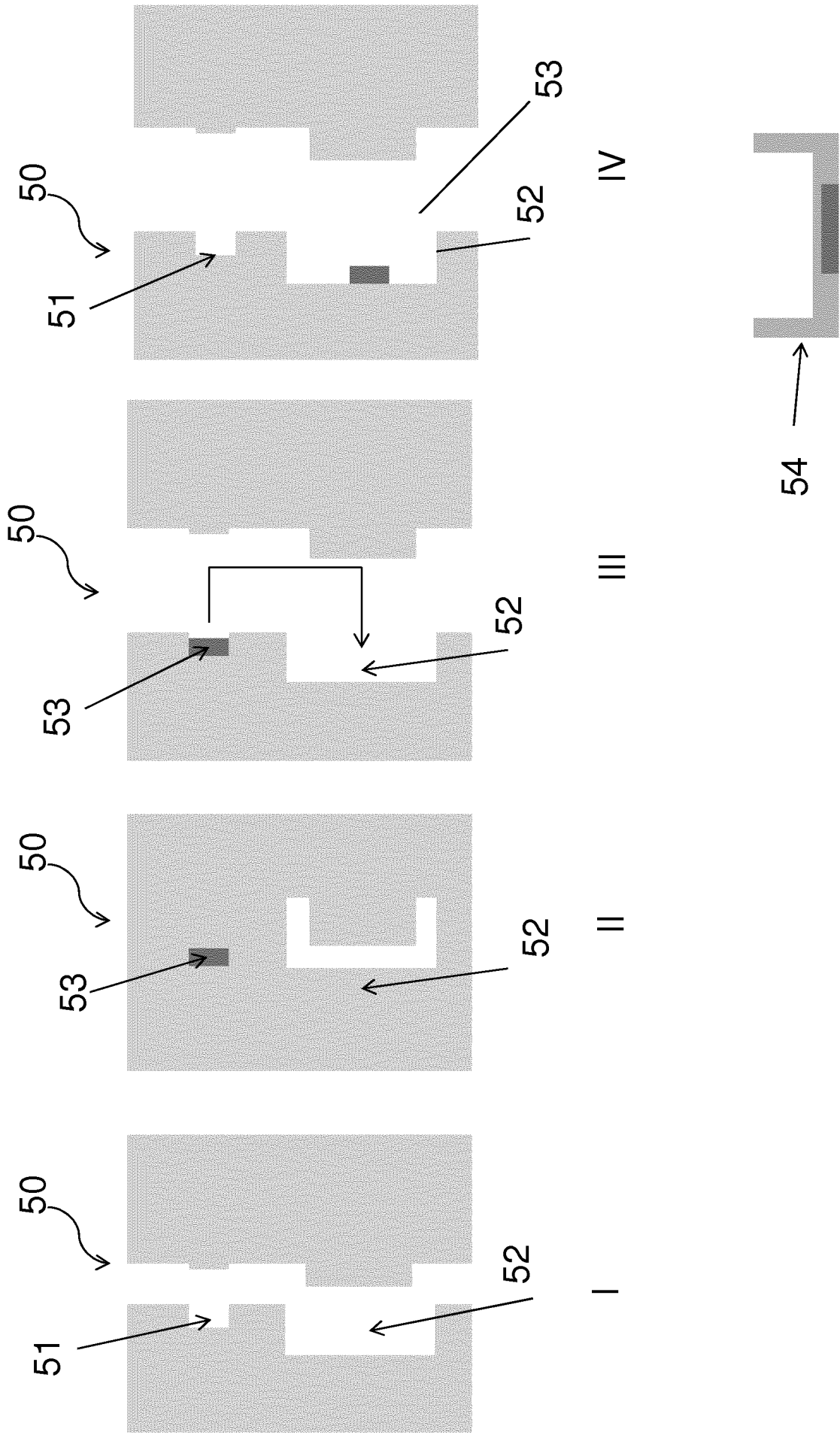


Figure 5

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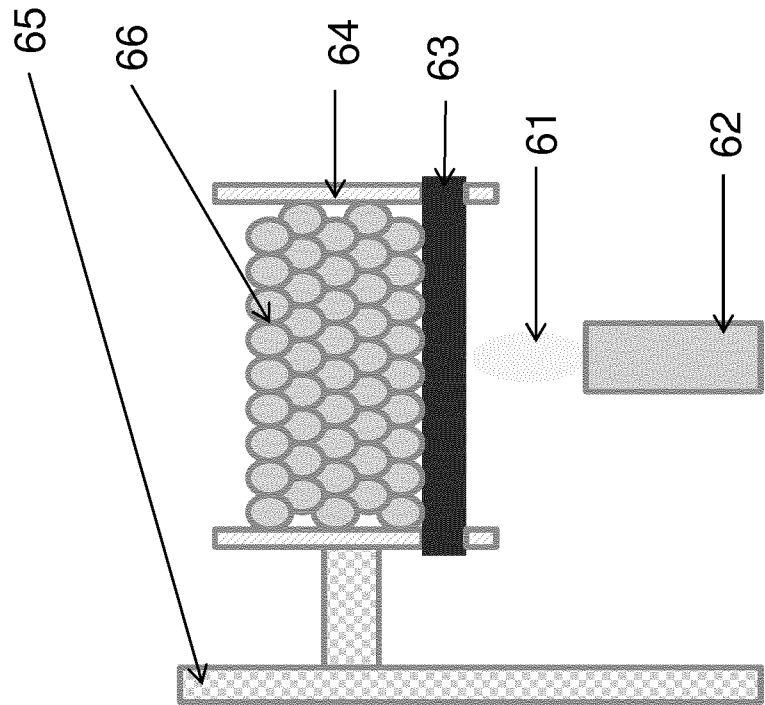


Figure 6B

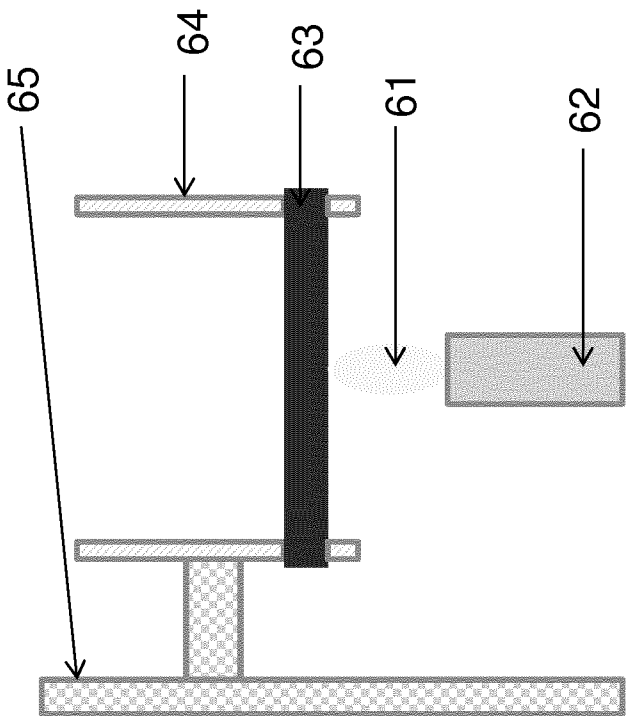


Figure 6A

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/057838

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60K15/03
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)
B60K

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	WO 99/03792 A1 (NU CHEM INC [US]; THORPE ALLEN W [US]; TAYLOR EDWARD W JR [US]; FELDMA) 28 January 1999 (1999-01-28) the whole document	1,2,4, 6-10
X	----- EP 0 454 978 A1 (BUDD CO [US]) 6 November 1991 (1991-11-06) the whole document	1,2,4, 6-8,10
A	----- EP 2 544 881 A1 (INERGY AUTOMOTIVE SYSTEMS RES [BE]) 16 January 2013 (2013-01-16) cited in the application abstract; figure 1 ----- -/-	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

15 June 2016

Date of mailing of the international search report

29/06/2016

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
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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.
A	WO 2014/170358 A2 (INERGY AUTOMOTIVE SYSTEMS RES [BE]; DE KEYZER PIERRE [BE]; VAN SCHAFTI) 23 October 2014 (2014-10-23) cited in the application abstract -----	1-10
A	FR 2 957 296 A1 (INERGY AUTOMOTIVE SYSTEMS RES [BE]) 16 September 2011 (2011-09-16) cited in the application -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/057838

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9903792	A1	28-01-1999	AR 013233 A1 13-12-2000
		AU 8492898 A 10-02-1999	
		BR 9811103 A 18-07-2000	
		CA 2294738 A1 28-01-1999	
		EP 0998433 A1 10-05-2000	
		JP 2001510138 A 31-07-2001	
		US 6001437 A 14-12-1999	
		WO 9903792 A1 28-01-1999	
EP 0454978	A1	06-11-1991	BR 9101720 A 10-12-1991
		CA 2039553 A1 03-11-1991	
		DE 69102487 D1 21-07-1994	
		DE 69102487 T2 27-10-1994	
		EP 0454978 A1 06-11-1991	
		JP H0790556 B2 04-10-1995	
		JP H06339932 A 13-12-1994	
EP 2544881	A1	16-01-2013	CN 102892568 A 23-01-2013
		EP 2544881 A1 16-01-2013	
		JP 5899121 B2 06-04-2016	
		JP 2013522066 A 13-06-2013	
		KR 20130006645 A 17-01-2013	
		US 2013037549 A1 14-02-2013	
		WO 2011110519 A1 15-09-2011	
WO 2014170358	A2	23-10-2014	EP 2799202 A2 05-11-2014
		WO 2014170358 A2 23-10-2014	
FR 2957296	A1	16-09-2011	NONE