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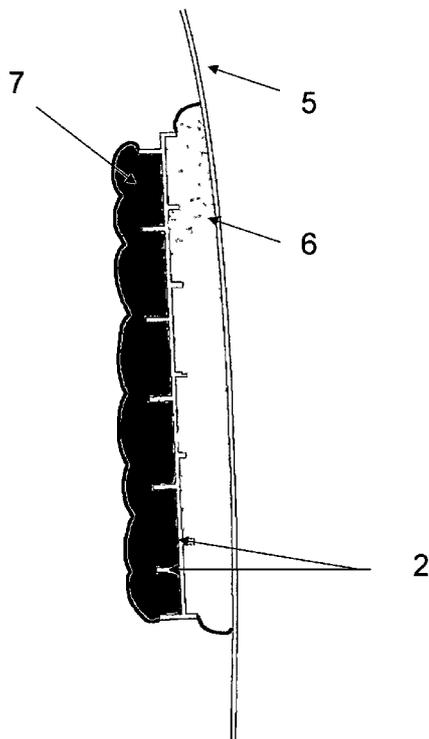
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(54) **Title:** MULTIFUNCTIONAL VEHICLE COMPONENTS

(57) **Abstract:** A multifunctional component for a vehicle comprises a carrier (1) having two surfaces provided with one foamable material (3) on a first surface and a second different foamable material (4) on the other surface both foamable materials (3,4) being formulated to expand during vehicle assembly and construction.

FIGURE 3



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MULTI FUNCTIONAL VEHICLE COMPONENTS

The present invention relates to the provision of light weight reinforcement and/or insulation and/or sealing and/or part fixing in transportation vehicles. The insulation
5 may be one or more of thermal insulation, acoustic insulation, sealing and baffling. It is well known to provide reinforcement and/or insulation in transportation vehicles by forming foams within the vehicle structures. The foams may be formed within hollow cavities in the vehicle frames or they may be bonded to various parts of the metal structure of the vehicle.

10

It is also well known that the foams can be formed in situ during the vehicle assembly and manufacture process. For example, heat activated foamable materials may be incorporated into the vehicle during assembly and the materials may be formulated so that foaming will occur at the temperatures employed in subsequent
15 manufacturing steps such as those experienced in the paint ovens or anticorrosion (sometimes known as e-coat) ovens. It is also known that the foamable materials can be formulated to have heat activated adhesive properties which develop as the material expands so that the foam produced can bond to the surface of the metal component with which it is used. Further the materials may be formulated to achieve
20 the desired degree of expansion and foam structure for the purpose required. For example, high expansion soft materials, such as those based on ethylene copolymers may be employed when insulation properties are required whereas lower expansion rigid cross-linkable materials, such as those based on epoxy resins may be employed when reinforcement is required.

25

It is also known that the foamable material may be provided on a carrier which may be metal or plastic and that the carrier itself can provide additional strength to the structure. The carriers can be provided with means for attachment to the metal structure of the vehicle such as clips or through holes.

30

The present invention relates to improvement in such technology and provides multifunctional components which provide several of the features previously provided by different techniques in a single solution. The invention is applicable to the provision of reinforcement and /or insulation in vehicles such as automobiles, trucks,
35 busses, aircraft, railroad vehicles and boats.

The invention is particular concerned with the provision of both reinforcement and insulation and is also particularly concerned with the provision of both reinforcement and insulation in relation to door's flaps and panels that are employed in the manufacture of automobiles, aircraft and railroad vehicles.

5

The present invention therefore provides a structure for inclusion in a vehicle comprising a carrier having a first and a second surface with a first foamable material provided on at least part of the first surface and a second foamable material provided on at least part of the second surface wherein both foamable materials are heat
10 activated and will foam at temperature experienced in the vehicle assembly and/or manufacturing process.

The structure is such that it may be incorporated into a vehicle during assembly and the foamable materials can be foamed to provided insulation and/or reinforcement
15 during other processes of the vehicle manufacture and assembly such as in the paint or e-coat ovens.

The invention may be used in parts such as doors which comprise two panels one of which comes as an attachment such as a door hinge and the other is an external
20 panel. The component of the invention may be used to provide reinforcement and strength to the hinge and to provide an acoustic baffle and/or a seal between the two panels.

Alternatively or in addition the foam can also serve a fixing function such as the
25 binding of the nut on a door hinge. In this respect the component can serve three functions, reinforcement, acoustic baffling and fixing.

The carrier may be of any suitable material and can be designed according to the function it is to perform. For example it may be made of metal such as steel or
30 aluminium and may be produced by stamping or extrusion. Alternatively it may be produced from thermoplastic materials by injection moulding or extrusion. We particularly prefer to employ carriers that are produced by injection moulding of rigid thermoplastics such as polypropylene and polyamides in particular filled polymers such as polyamides filled with glass, metal or aramid fibres. The carrier may be
35 shaped according to the function it is to perform and may be provided with ribs and/or a cellular or honeycomb structure in order to enhance any reinforcing effect. For example, if a structure of the present invention is to reinforce a panel such as the

door panel of an automobile it may be provided with ribs or a honeycomb structure on the surface that will face the panel in order to provide reinforcement to the panel.

5 The carrier may also be provided with protrusions and/or indentations on one or both of its surfaces that carry the foamable material in order to key the foamable material to the surfaces. In a further embodiment the carrier may be provided with means to enable the structure to be attached within the vehicle and held in the desired position. The means for attachment can be holes in the carrier for receipt of clips or bolts in the vehicle structure or clips that are provided as part of the structure for insertion
10 into holes provided in the vehicle structure. Where the carrier is produced by the extrusion or injection moulding of thermoplastic materials the means for attachment may be integrally moulded with the carrier.

15 We have found that a carrier provided with a plurality of cavities may conveniently be produced by the injection moulding of synthetic materials.

The carrier of the system of the present invention may be a skeleton member adapted for stiffening the structure to be reinforced and helping to redirect applied loads. In a preferred use, the skeleton member is in contact, over at least a portion
20 of its outer surface with energy absorbing foam. In a particular preferred embodiment, the member could be an injection moulded nylon carrier, an injection moulded polymer, or a moulded metal (such as aluminium, magnesium and titanium, an alloy derived from the metals, and even metallic foam). Still further, the member adapted for stiffening the structure to be reinforced could comprise a stamped and
25 formed cold-rolled steel, a stamped and formed high strength low alloy steel, a stamped and formed transformation induced plasticity (TRIP) steel, a roll formed cold rolled steel, a roll formed high strength low alloy steel, or a roll formed transformation induced plasticity (TIP) steel.

30 The nature of the foamable materials can be chosen so that they will adhere to at least one of the surfaces of the vehicle structure with which the structure of the present invention is employed. The materials are also chosen according to the functions that the component is desired to perform after foaming. For example if one of the functions of the structure is to perform a reinforcing and strengthening function
35 then a rigid foam is preferred. Examples of suitable rigid foams include epoxy foams such as the materials available from Core Products of Strasbourg, polyurethane foams particularly blocked polyurethane foams which are provided with blocking

groups designed to be liberated to enable reaction at the temperature at which foaming is desired to take place.

5 If the carrier has a skeleton structure the skeleton can provide cavities at least some of which may contain a foamable or expandable material, which can foam and bond to both the carrier and the structure to be reinforced where the function of the structure is to reinforce materials useful for the production of reinforcing foams are epoxy-based resins, such as L5204, L5206, L5207, L5208 or L5209 structural foam commercially available from L & L Products, Inc. of Romeo, Michigan. Additional
10 foamable or expandable materials that could be utilised in the present invention include other materials which are suitable as bonding mediums and which may be heat activated foams which activate and expand to fill a desired cavity or occupy a desired space or function when exposed to temperatures typically encountered in automotive e-coat and other paint operations.

15

If however one of the functions the structure is to provide is as an insulant and for a sealant for example to prevent the flow of moisture or air the foamable material may have a high expansion ratio to produce a soft closed cell foam. Alternatively if one of the functions of the structure is to serve as an acoustic baffle the foamable material
20 may have a high expansion ratio and the foam may be soft and open cell. For example foams produced from thermoplastic ester containing polymers and copolymers may be used for these applications. Though other heat-activated materials are possible, a preferred heat activated material for these applications may be an expandable or flowable polymeric formulation, and preferably one that is
25 activated to foam, flow or otherwise change states when exposed to the heating operation of a typical automotive assembly painting operation. For example, without limitation, in one embodiment, one of the polymeric foam is based on ethylene copolymer or terpolymer that may possess an alpha-olefin. As a copolymer or terpolymer, the polymer is composed of two or three different monomers, i.e. small
30 molecules with high chemical reactivity that are capable of linking up with similar molecules. Examples of particularly preferred polymers include ethylene vinyl acetate, EPDM, or a mixture thereof. Without limitation, other examples of preferred foam formulations that are commercially available include polymer-based material commercially available from L & L Products, Inc. of Romeo, Michigan, under the
35 designations as L-2105, L-2100, L-7005 or L-2018, L-7101, L-7102, L-241 1, L-2412, L-4141 etc and may comprise either open or closed cell polymeric base material.

A number of other suitable materials are known in the art and may also be used if one of the functions that the structure is to perform is a vibration reduction function. One such foam preferably includes a polymeric base material, such as an ethylene-based polymer which, when compounded with appropriate ingredients (typically a blowing and curing agent), expands and cures in a reliable and predictable manner upon the application of heat or the occurrence of a particular ambient condition. From a chemical standpoint for a thermally activated material, the vibration reducing foam is usually initially processed as a flowable thermoplastic material before curing. It will cross-link upon curing, which makes the material resistant of further flow or change of final shape.

The foamable materials may be provided on the carrier in any suitable manner. They may be deposited directly onto the carrier by an applicator such as extrusion in place equipment which is particularly useful when the carrier is of material. Alternatively the foamable materials may be over moulded by injection onto the carrier.

A particular advantage of the present invention is that different foamable materials are used on different sides of the carrier to provide a component serving more than one function after foaming. For example it may be desirable to provide strengthening and reinforcement on one side of the component and a sealing function on the other side of the component; furthermore it may be desirable to provide a fixing function for certain components such as nuts, bolts and other similar items. This may be accomplished according to the present invention by providing a foamable material suitable for reinforcement and/or fixing on one side of the carrier and foamable material suitable for providing a sealant on the other side of the carrier.

The techniques of the present invention provide multiple functions in the vehicle. In this application the provision of the component may be integrated into the car manufacturing process in that the component containing the foamable materials may be assembled into the vehicle. In the preferred process the structure should be assembled in the vehicle in a manner that leaves a gap between the surface of the foamable material that faces the metal and the surface of the metal, the gap allows flow of the e-coat fluid to ensure good cover of the metal and also provides the space for the expansion of that material. Once the structure is in place the vehicle body may be subjected to the conventional electro coat anticorrosion coating, sometimes known as "e-coat" in which the vehicle is passed through a bath of anticorrosion material and a coating is deposited electrolytic ally on the metal. After the coating

has been deposited it is then dried, typically at a temperature of from 150°C to 180°C. The foamable materials of the component are formulated through choice of blowing agent and blowing agent activator (if required) so that they will foam at the conditions employed to dry the e-coat and will also bond to the carrier and an internal surface of the metal of the vehicle structure. Typically e-coat is dried by passing the coated body through an oven and the foamable formulation is developed according to the residence time and temperature profile of the oven. In this way the foamable materials will expand filling the gap between the component and the interior surface of the metal section to bond the two together and impart the desired function to the system.

The invention is particularly useful for imparting certain functions, to panels and flaps in automobiles, rail transportation and aircraft. In particular the invention allows panels to be provided firstly with reinforcement such as against crash by employing reinforcing foam to bond the carrier to a surface of the panel, door or flap and secondly with insulating foam on the other side of the carrier can allow the structure to provide noise and vibration reductions in addition to reinforcement. The use of the heat activated foamable materials allows the desirable properties to be imparted to non-planar panels, doors or flaps as the expansion of the heat softened material allows it to mould to the shape of the gap provided between the unfoamed material at the surface of the panel door or flap.

The invention is illustrated but not limited by reference to the accompanying drawings in which in Figure 1 is a section of part of a component according to the present invention.

Figure 2 shows the component of Figure 1 mounted (by means not shown) adjacent to an outer door panel of an automobile.

Figure 3 shows the system shown in Figure 2 after the two foamable materials shown in Figure 2 have been foamed.

Figure 4 is a cross section of the system established by Figure 3.

Figure 5 shows a carrier that may be useful in a component of the present invention for use in vehicle door reinforcement.

Figure 6 shows how the structure of the present invention employing a carrier as shown in Figure 5 may be assembled in the side door of a vehicle.

5 Figure 7 shows a section of an automobile door provided with a component of the present invention.

Figure 1 shows an injection moulded nylon carrier (1) provided with integrally moulded ribs (2) and having foamable material (3) which can be foamed to produce a reinforcement provided on one side of the carrier and that can be foamed to produce
10 a sound insulating and vibration absorbing foam material (4) provided on the other side of the carrier. Figure 2 shows how the structure of figure 1 can be provided adjacent to the outer section (5) of an automotive door panel.

Figure 3 shows the system of Figure 2 after the foaming of the two materials. The
15 reinforcing foamable material (3) has expanded to produce a foam (6) filling the gap between the carrier (1) and the outer skin (5) of the automotive door. The sound insulating and vibrating absorbing foamable material (4) has expanded to produce the insulating foam (7) on the back of the carrier.

20 Figure 4 shows how the system can be assembled to allow a gap (8) in certain areas between the reinforcing foam (6) and the outer skin (5) of the automotive door.

Figure 5 shows a carrier (without foam) which may be used in the present invention to provide a structure which can be used to provide reinforcement and sound
25 insulation and vibration damping to an automotive door. Figure 5a showing one side of the carrier and figure 5b showing the other side of the carrier. The carrier shown carries a series of ribs (9) providing a honeycomb structure (10) on each surface, the ribs being provided in a manner that faces the panel that is to be reinforced so that they provide strength to the panel. Attachment means (11) are integrally moulded
30 within the carrier to allow the structure to be mounted in the vehicle.

Figure 6 shows how a component based on the carrier shown in Figure 5 can be mounted in a door to provide reinforcement to the outer panel.

35 Figure 7 shows an automobile door comprising two panels (12) and (13) with a hinge (14) welded to panel (13). The component of this invention comprising a carrier (15) provided with a reinforcing foam (16) to strengthen the hinge and an acoustic foam

(17) between the panels. The reinforcing foam is preferably an epoxy based structural foam whereas the acoustic foam is preferably a high expansion open cell foam. The reinforcing foam can, in addition aid in fixing the nut on the hinge tightly in place.

CLAIMS

1. A component for inclusion in a vehicle comprising a carrier having a first and a second surface with a first foamable material provided on at least part of the first surface and a second foamable material provided on at least part of the second surface wherein both foamable materials are heat activated and will foam at temperatures experienced in the vehicle assembly and/or manufacturing process.
2. A component according to Claim 1 in which the carrier is produced by injection moulding of rigid thermoplastics
3. A component according to Claim 1 or Claim 2 in which the carrier is provided with ribs and/or a cellular or honeycomb structure.
4. A component according to Claim 3 having ribs or a honeycomb structure on the surface that will face the panel in order to provide reinforcement to the panel.
5. A component according to any of the preceding claims in which the foamable materials are chosen so that they will adhere to at least one of the surfaces of the vehicle structure with which the component is employed.
6. A component according to any of the preceding claims in which one of the foams is rigid foam.
7. A component according to any on the preceding claims in which one of the foamable materials has a high expansion ratio to produce soft closed cell foam.
8. A component according to any of the preceding claims having a foamable material suitable for reinforcement on one side of the carrier and foamable material suitable for providing a sealant on the other side of the carrier.
9. A structure comprising a metal panel, or flap bonded to a reinforcing foam which is bonded to a carrier which carries an insulating foam on the surface of the carrier remote from the surface bonded to the reinforcing foam.

10. A structure according to Claim 9 in which the panel is an automotive door panel.
- 5 11. A structure according to Claim 9 in which the panel is part of an aircraft.
12. A structure comprising a door comprising two panels one of which carries a hinge in which one panel is provided with a component comprising a carrier with a first and second surface with a first foamable material on the first surface and a second foamable material on the second surface wherein the first foamable material can be foamed to provide strength to the hinge and the second foamable material can be foamed to provide an acoustic baffle and/or a seal between the panels.
- 10 13. A structure according to Claim 12 in which the first foamable material aids in fixing in place components associated with the hinge.
- 15 14. A structure according to Claim 14 in which the component associated with the hinge is a nut.
- 20 15. A structure according to any of Claims 12 to 14 in which both of the foamable materials are foamed.

FIGURE 3

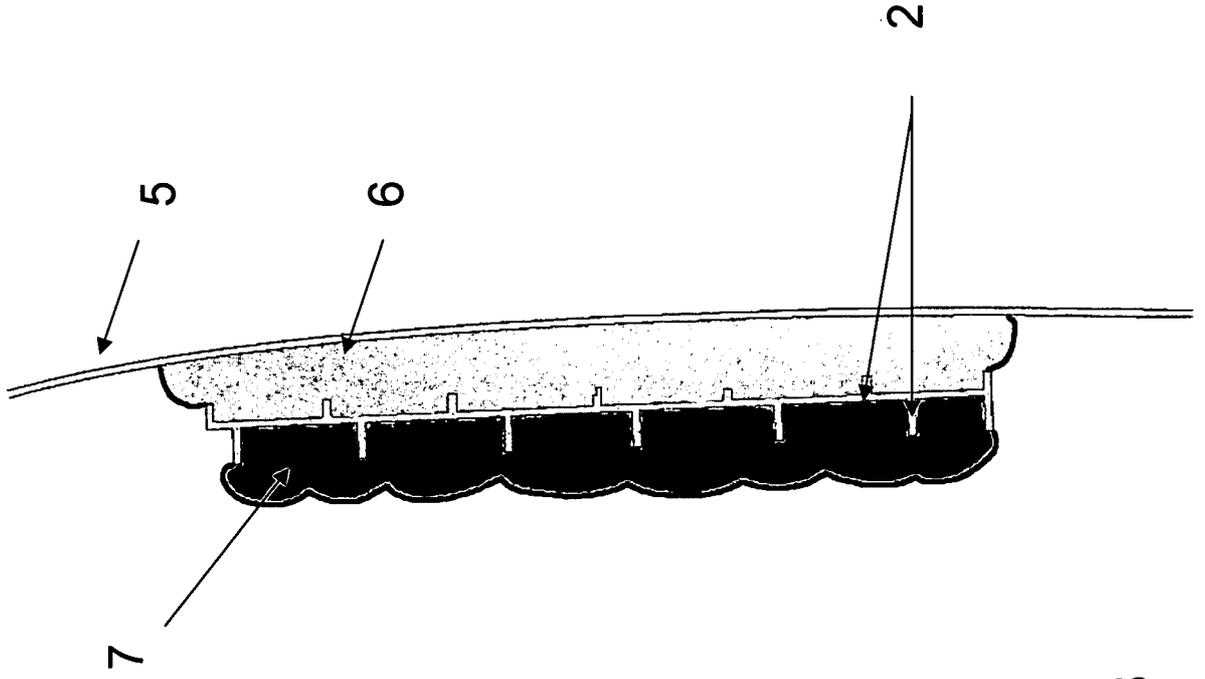


FIGURE 1

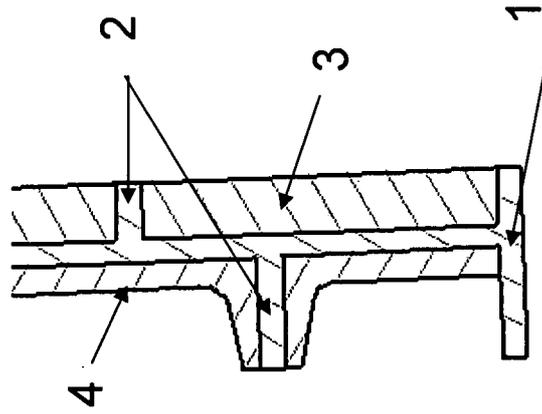


FIGURE 2

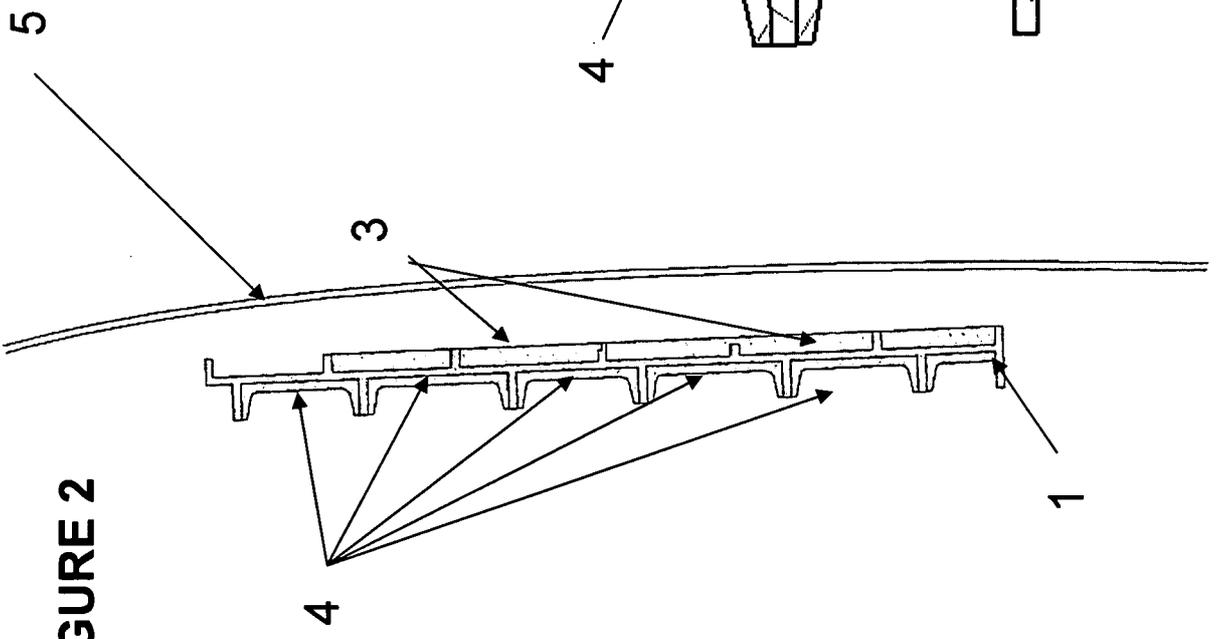
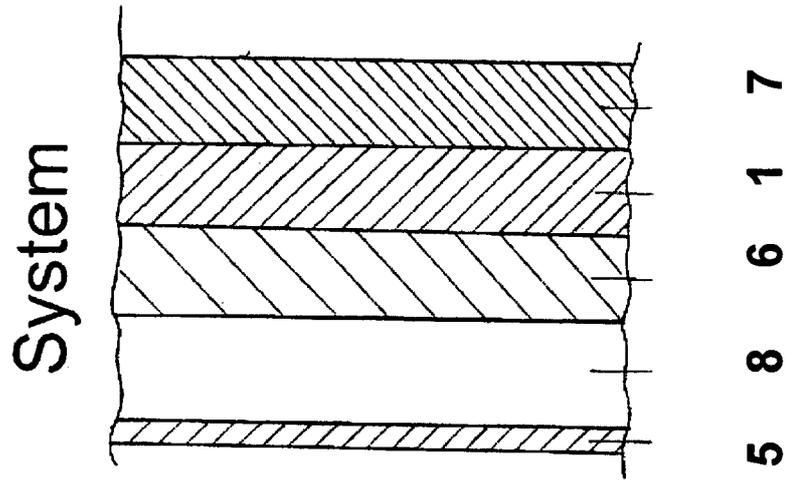


FIGURE 4



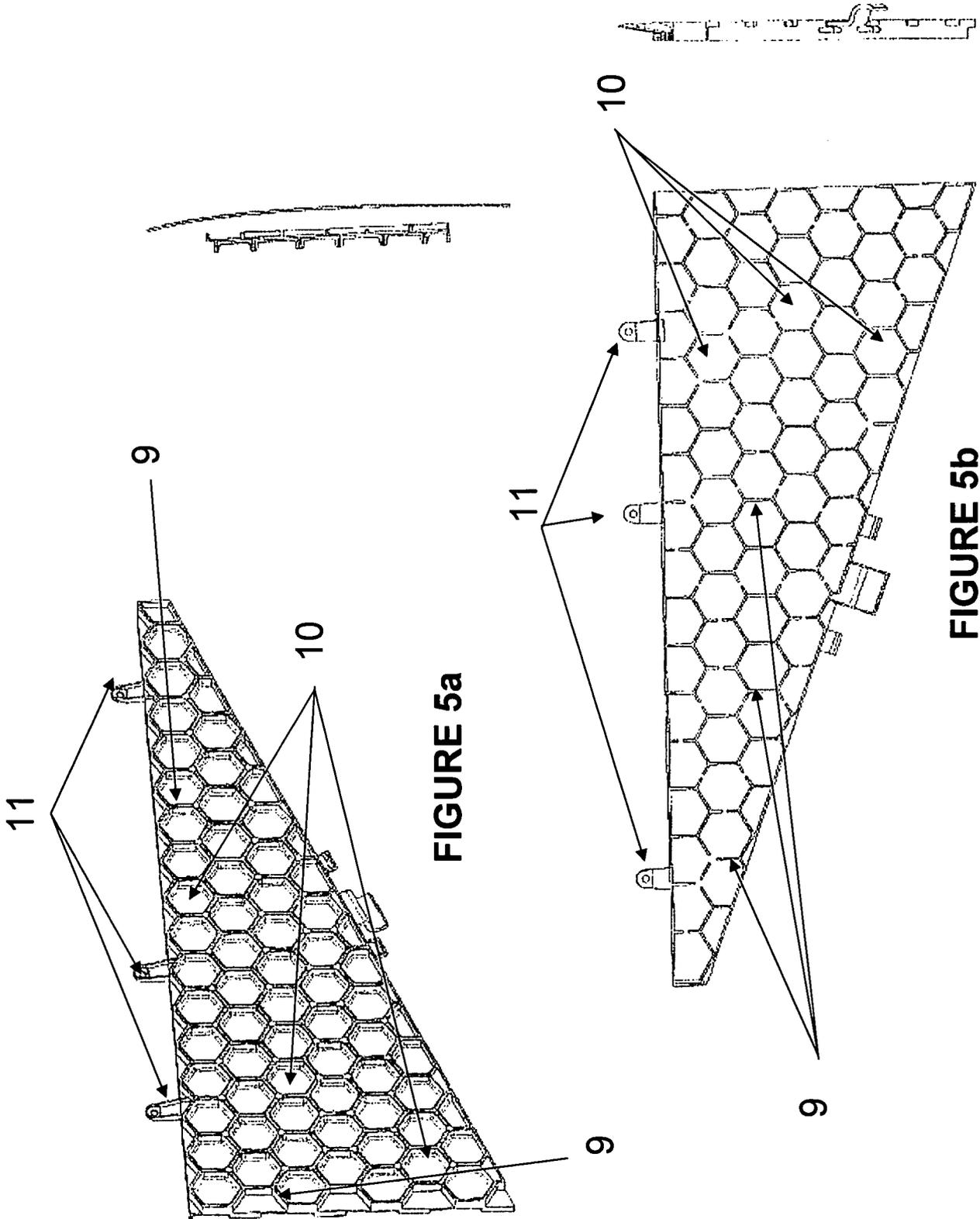
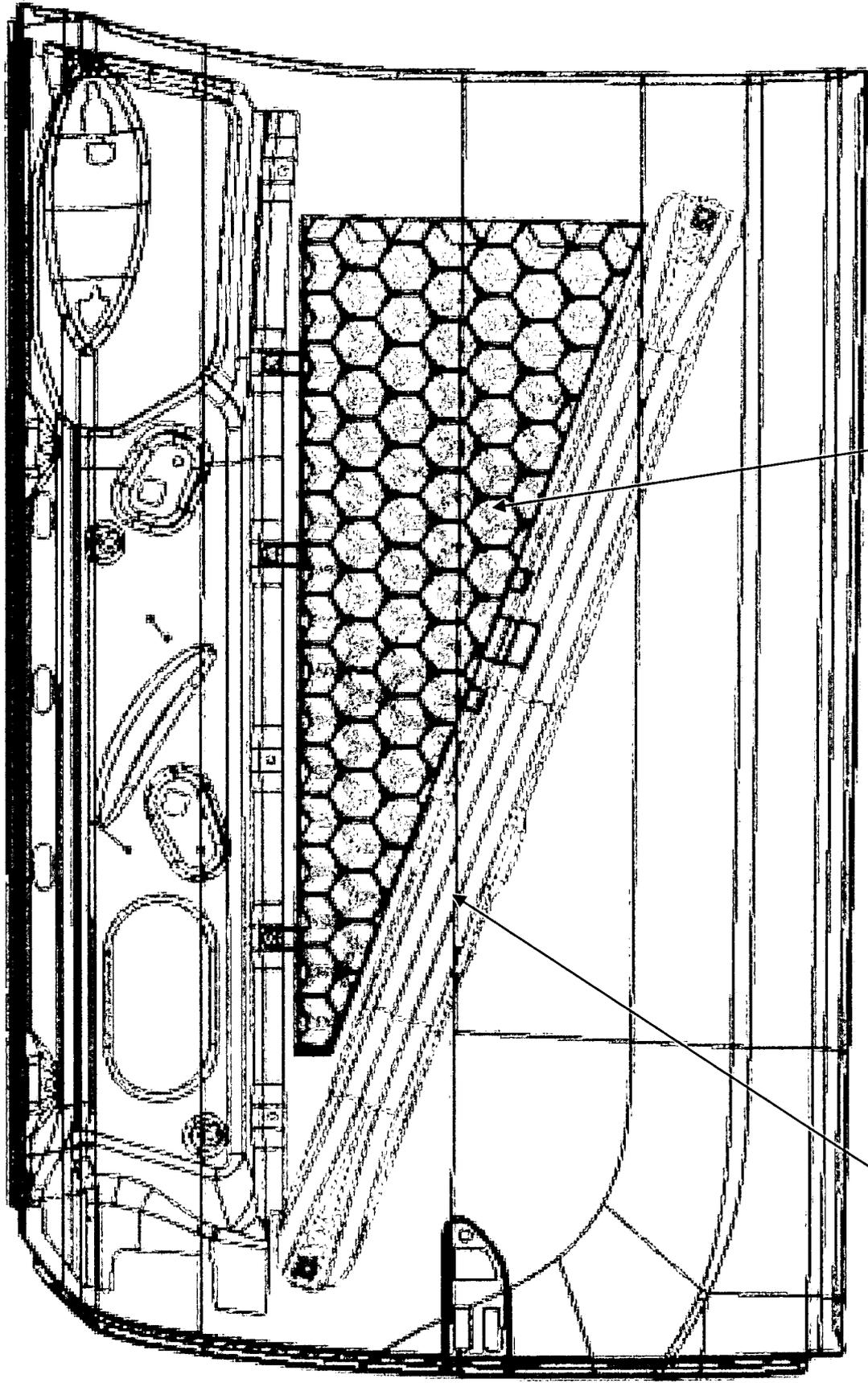


FIGURE 6



Hybrid insert

door beam

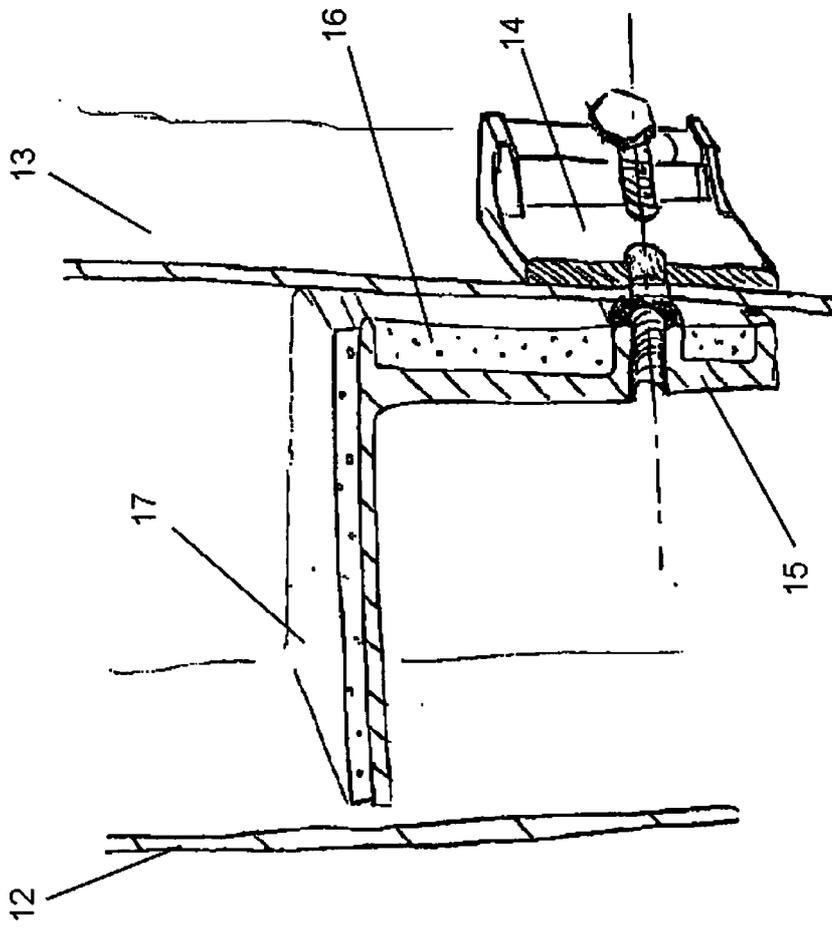


FIGURE 7

INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER
 INV. B29C44/18 B60R13/08

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)
 B29C G1OK B62D B60R B60J

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 practical, 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	US 5 506 025 A (OTTO DAVID J [US] ET AL) 9 April 1996 (1996-04-09) column 3, line 28 - column 5, line 10 column 6, lines 1-27 figures 1-3	1-15
X	EP 1 790 554 A (L & L PRODUCTS INC [US]) 30 May 2007 (2007-05-30)	1-5, 8-10, 12-15
A	paragraphs [0006], [0007], [0010], [0011], [0013], [0016], [0019], [0025], [0026], [0060], [0062], [0064], [0069], [0081] figures 13a, 16c, 19a	6,7,11

Further documents are listed in the continuation of Box C

See patent family annex

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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.
X	DE 101 48 770 A1 (VOLKSWAGEN AG [DE]) 17 April 2003 (2003-04-17) paragraphs [0006], [0007], [0016] - [0018] figures 1,2d -----	1-4,9,10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/008768

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5506025	A	09-04-1996	NONE
EP 1790554	A	30-05-2007	NONE
DE 10148770	A1	17-04-2003	NONE