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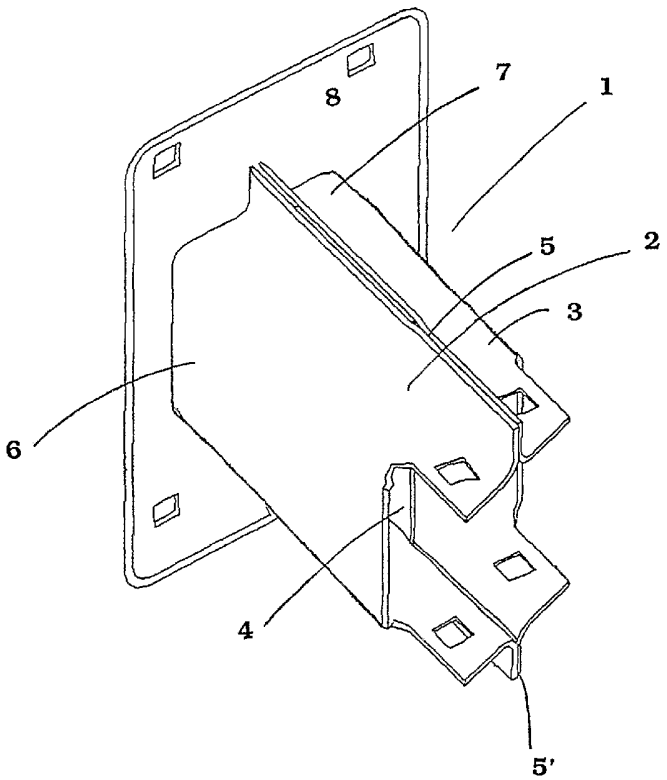
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[Continued on next page]

(54) **Title:** ENERGY ABSORBING MEMBER AND METHOD FOR MAKING AN ENERGY ABSORBING MEMBER



(57) **Abstract:** Energy absorbing member (1) comprising at least two side wall members (2, 3) and a closed space inside said side wall member (2, 3), thereby forming a closed hollow profile. The at least two side wall members (2, 3) are preformed prior to being connected to each other, thereby forming a closed hollow profile. Method for producing an energy absorbing member (1) where at least a part of a sheet material is shaped into a predefined shape thereby making a wall member (2) which is joined in such a way that it forms a closed hollow profile.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"Energy absorbing member and method for making an energy absorbing member"

The present invention relates to a method for making an energy absorbing member and an energy absorbing member made by such method.

To improve the ability to absorb energy in a vehicle during an impact situation such as a car crash, the vehicle is equipped with an energy absorbing system comprising of energy absorbing members such as bumpers, crash boxes, side frames and other safety devices such as air bags and safety belts. The impact absorbing members can be made as hollow profiles provided with one or two chambers or be shaped as a U-profile. The energy of the crash will be absorbed by the deformation of the members.

The closed chamber profiles can be made from extrusions, which are cut and shaped after the extrusion process. One example of such profile is from WO 98/14285, which describes how to produce an impact-absorbing member from an extruded blank. Parts of the extruded blank are cut and/or bended to form an impact-absorbing member. In order to obtain an efficient crash box from such method, the extruded blank is subjected to several forming operations.

There are, however, limitations in the extrusion process which limits the design of an optimised member. There will for example be limited possibilities to form several chambers in the member or differentiate the wall thickness through the member.

In multiple-chamber impact absorbing members, there will be a necessity of recut-operations both in side walls of the profile, but also in the middle plate dividing the two or more chambers of the profile.

Furthermore, in order to produce an extrusion with a specific cross section it is necessary to manufacture specific extrusion dies, which are expensive. The extrusion process also presents thickness tolerance problems. The most common problem with extrusion is

members with middle plates that are too thick and at least two side walls which are too thin.

The U-shaped profiles also present disadvantages. The initial profile has very long flanges, which can cause problems of tolerance in the extrusion process. To produce the final impact member, the flanges are folded to form side walls and may need complex welds in the zones where three surfaces such as two flanges and an end plate, meet. To produce such profiles, a complex production tool is also necessary where several steps are required in the production line.

It is an object of the invention to present a flexible concept enabling the production of multiple types of profiles. It is further an object of the present invention to present an energy absorbing member that has a complicated design using a limited amount of forming operations. It is therefore an object of the invention to present a method for producing an energy absorbing member that is flexible allowing for a plurality of design modifications.

It is also an object of the present invention to present a method for producing an energy absorbing member, which is flexible and easily adjustable. It is an object of the invention to present a method where it is easy to modify the design of the energy absorbing member in the production system without the demand of heavy and expensive tooling.

This is obtained by presenting an energy absorbing member made of reformed flat plates which are preshaped and precut and thereafter attached to each other in such a way that they form a closed hollow profile provided with one or more chambers.

The invention will now be further explained by means of examples which are further explained by figures where:

Fig. 1 shows an energy absorbing member according to the present invention,

Fig. 2 shows a top side view of the energy absorbing member,

Fig. 3 shows a perspective view of a side wall member,

Fig. 4 shows a perspective view of a side wall member assembled with an internal wall,

Fig. 5 shows a cross sectional perspective view of an energy absorbing member,

Figs. 6 a-e show the cross sectional views of different possible wall member assemblies.

Fig. 1 shows an energy absorbing member or crash box 1 according to the present invention. A first side wall member 2 is attached to/with a second side wall member 3 in such a way that an open space is formed between the two side wall members thereby forming a closed hollow profile. An internal wall member 4 is attached in at least a part of the joint 5 between the first and second side wall members. The internal wall member will divide at least a part of the internal space between the two side wall members, thereby making a two-chamber profile in at least a part of the profile. The first end sections 6 and 7 of the first and the second side wall members 2 and 3 are attached to an end plate 8, which is placed mainly perpendicular to the surface of the wall members. It should be noted that the internal wall member 4 can be attached anywhere onto the members for example on the side wall member surfaces, to the end plate 8 or in the joint between the end plate and the side wall members.

The wall members can be formed from a sheet. The sheet can be a steel, steel-alloy, aluminium or Al-alloy sheet. The sheet can also be made of any other formable material such as other metals or polymers. The wall members can also be cast into shape, enabling the use of materials such as polymers, fibrous composites or cast steel to form the wall members. The formable material will then be cast directly into shape without being rolled to form a sheet prior to the forming of the wall members.

The side wall members and the internal wall member can be made in different materials, thereby adjusting even better the properties of each wall member.

Protrusions, intrusions, folding and any other forming modifications of the sheet are performed by bending, stamping or otherwise forming the sheet prior to attaching the wall members to each other. Holes, flanges, edges, corners and the like, which are cut, stamped

or otherwise formed in the member, can easily be made in the sheet prior to joining the members. The exact forming process of the wall members is designed according to normal production principles.

The wall members can be joined by different methods. They can be fully welded in the contact area, partly welded of spot welded. The members can also be joined by partly or wholly gluing, soldering, stamping or any other method found suitable for the purpose. It may also be adequate to use different joining methods on one energy absorbing member, thereby optimising the joints between the members.

The first side wall member 2 and the second side wall member 3 can have a similar or differentiated design. The internal wall member 4 can be a plane plate passing from the first joint 5 between the two side wall members 2,3 to the second joint 5'. The internal wall member can follow a part of the joint or divide the internal space between the wall members from the end plate 8 to the second end section of the wall members.

Fig. 2 shows a side view of the impact absorbing member or crash box 1. To optimize the folding of the crash box in an impact situation, the first side wall member 2 can have a different shape from the second side wall member 3. In the present example, an internal wall member 4 is attached between the first and second side wall members 2,3. The internal wall member 4 is situated above the end plate 8 leaving free space between the internal wall 4 and the end plate 8. The internal wall member 4 can also be shorter than the two side wall members 2,3. The internal wall will therefore only partly divide the internal space of the hollow profile formed by the two side wall members. However, the internal wall can have any size and shape. It can divide the whole internal space and even expand beyond the extension of the side walls thereby allowing for the attachment of any object to the impact-absorbing member 1.

Fig. 3 shows a perspective view of another embodiment of a side wall member 2. The side wall member 2 is folded in such a way that the cross section is shaped as an open hat shaped profile with a first end section 6 and second end section 9. The edge of the side wall member in the first end section 6 can be plane enabling a tight contact with the end

plate (not shown). The second end section 9 of the sheet is cut and folded in such a way that two attachment flanges 10, 10' are made. Holes 11, 11' can be made in the attachment flanges 10, 10' to facilitate the attachment to the surroundings, for example a transversal beam (not shown).

Two edges of the side wall member 2 are furthermore provided with longitudinal flanges 12, 12'. The flanges are fit to join the longitudinal flanges of a second side wall member (not shown). The longitudinal flanges 12, 12' can also be adjusted to fit an internal wall that is entered between the first and second side wall member. The wall between the two attachment flanges is folded to form a web flange 13. The web flange adds support to the connection between the impact absorbing member and the surrounding structure.

The side wall member can be shaped with any protrusion, intrusion or other modification found suitable to optimise the attachment to the surroundings and/or the deformation behaviour of the impact-absorbing member. It is furthermore obvious that even if the side wall members are fitted to a tight joint, it is possible to differentiate the design of the wall members forming the final crash box. The final crash box can therefore be either symmetrical, unsymmetrical or conical.

Fig. 4 shows a perspective view of a side wall member assembled with an internal wall. The surface of the longitudinal flanges 12, 12' has minor curves, which enable an internal wall member to be fitted between the longitudinal flanges of the two side wall members.

Fig. 5 shows a cross sectional perspective view of an impact-absorbing member. A first side wall member 2 is joined with a second side wall member 3 along their longitudinal flanges 12. An internal wall 4 can be attached to the side wall members in the joint. The internal wall member 4 in the present example is significantly smaller than the side wall members 2,3.

However, it should be understood that the internal wall could have any size or shape. If this is found suitable, the internal wall can also be folded or provided with protrusions, intrusions, holes or other modifications of the member, in the same way as the side wall

members. It is also possible to provide the crash box with more than one internal wall. The internal wall members can for example be mounted subsequently in the joint with space between each the intern wall. If the cross section of the internal walls is modified it is even possible to attach two or more internal walls at least partly parallel enabling for internal space between the internal wall members.

Figs. 6 a-e show the cross sectional views of different possible wall member assemblies.

Fig. 6a shows a cross sectional view of a first embodiment of a crash box 1 provided with two side wall members, 2, 3 and an internal wall member 4. The side wall members 2,3 are folded to form an open U provided with longitudinal flanges 12, 12'. The internal wall 4 is situated in the joint 5 between the side wall members dividing the internal space between the two side wall members in two.

Fig. 6b shows a cross sectional view of a second embodiment of a crash box 1. The side wall members 2,3 are folded to a U-shape. The internal wall 4 is provided with internal flanges 14, 14'. The side wall members 2,3 and internal wall 4 are assembled in such a way that the internal wall is connecting the edges 15, 15' of the side wall members thereby forming a closed hollow shape.

Figs. 6c and d show a cross sectional view of a third and fourth embodiment of a crash box. The wall members can be attached to each other in any way found suitable to obtain the desired final shape of the crash box.

Fig. 6e shows a cross sectional view of a fifth embodiment of a crash box. If this is found suitable, it is possible to fold a side wall member to a closed hollow profile and optionally attach an internal wall member inside the closed side wall member.

As can be seen, the present invention presents an impact-absorbing member, which has a flexible design and is easy to produce. Even if the invention is described by way of examples only connected to impact absorbing members such as crash boxes, it should be noted that the present invention can be equally useful in the design of other impact

absorbing members such as transversal beams, side members or other beam where a complex design provided in an simple production process is desired.

If the invention is used for a transversal beam, the side wall members can form the outer walls of the beam and can be provided with an optional internal wall dividing the internal space in the whole length of the beam or only a part of it. As described above, it is also possible to provide the beam with more than one internal wall member where the internal wall members are mounted next to each other over at least a part of the length of the beam with or without space between the internal wall members or partly overlapping thereby enabling for additional internal space between the internal wall members.

Claims

1. Energy absorbing member (1) comprising at least two side wall members (2, 3) and a closed space inside said side wall member (2, 3) thereby forming a closed hollow profile,
characterised in that
the at least two side wall members (2, 3) are preformed prior to being connected to each other, thereby forming a closed hollow profile.

2. Energy absorbing member according to claim 1,
characterised in that
an internal wall member (4) is provided between the first side wall member (2) and the second side wall member (3) thereby at least partly dividing the open space between the first and second side wall member.

3. Energy absorbing member according to any of the preceding claims 1 or 2,
characterised in that
the wall members are shaped from a sheet material.

4. Energy absorbing member according to any of the preceding claims 1 or 2,
characterised in that
the sheet material is made of aluminium or an aluminium alloy.

5. Energy absorbing member according to any of the preceding claims 1 or 2,
characterised in that
the sheet material is made of steel or a steel alloy.

6. Energy absorbing member according to any of the preceding claims 1-3,
characterised in that
at least one wall member is provided with at least one flange (12).

7. Energy absorbing member according to any of the preceding claims 1-4,
characterised in that
the wall members are provided with longitudinal flanges (12, 12') which are joined, thereby forming the closed hollow profile.

8. Energy absorbing member according to any of the preceding claims 1-4,
characterised in that
the wall members are at least partly welded in the joints (5, 5').

9. Energy absorbing member according to any of the preceding claims 1-4,
characterised in that
the wall members are at least partly glued in the joints (5, 5').

10. Energy absorbing member according to any of the preceding claims 1-5,
characterised in that
at least one wall member (2) is provided with at least one hole (11).

11. Method for producing an energy absorbing member (1),
characterised in that
at least a part of a sheet material is shaped into a predefined shape thereby making a wall member (2) which is joined in such a way that it forms a closed hollow profile.

12. Method according to claim 7,
characterised in that
at least two side wall members (2, 3) are shaped from sheet material to a predefined shape and thereafter connected to form a closed hollow profile.

13. Method according to claim 7 or 8,
characterised in that
an internal wall (4) is attached between the two side wall members (2, 3).

14. Method according to any of the preceding claims 7-9,
characterised in that
the wall members are at least partly connected by being welded.

15. Method according to any of the preceding claims 7-9,
characterised in that
the sheet material is made of aluminium or an aluminium alloy.

16. Method according to any of the preceding claims 7-9,
characterised in that
the sheet material is made of steel or a steel alloy.

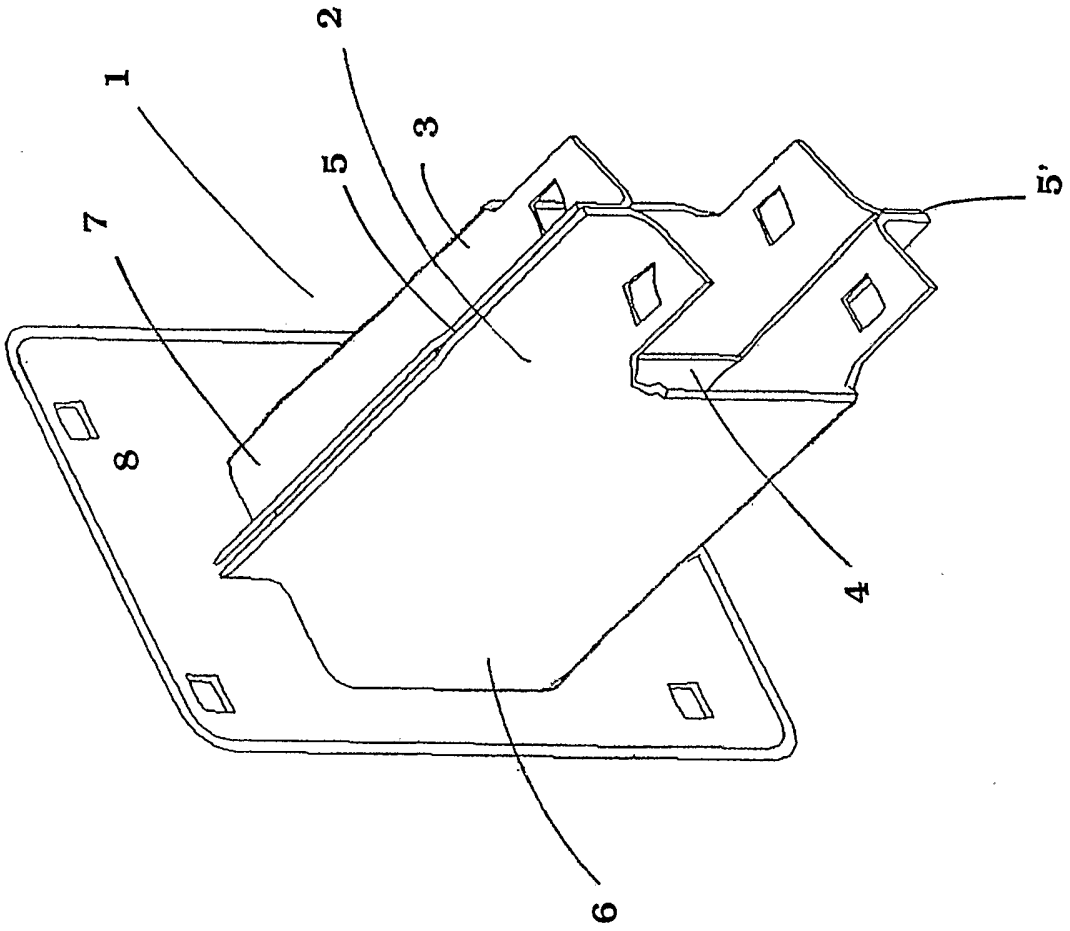


Fig. 1

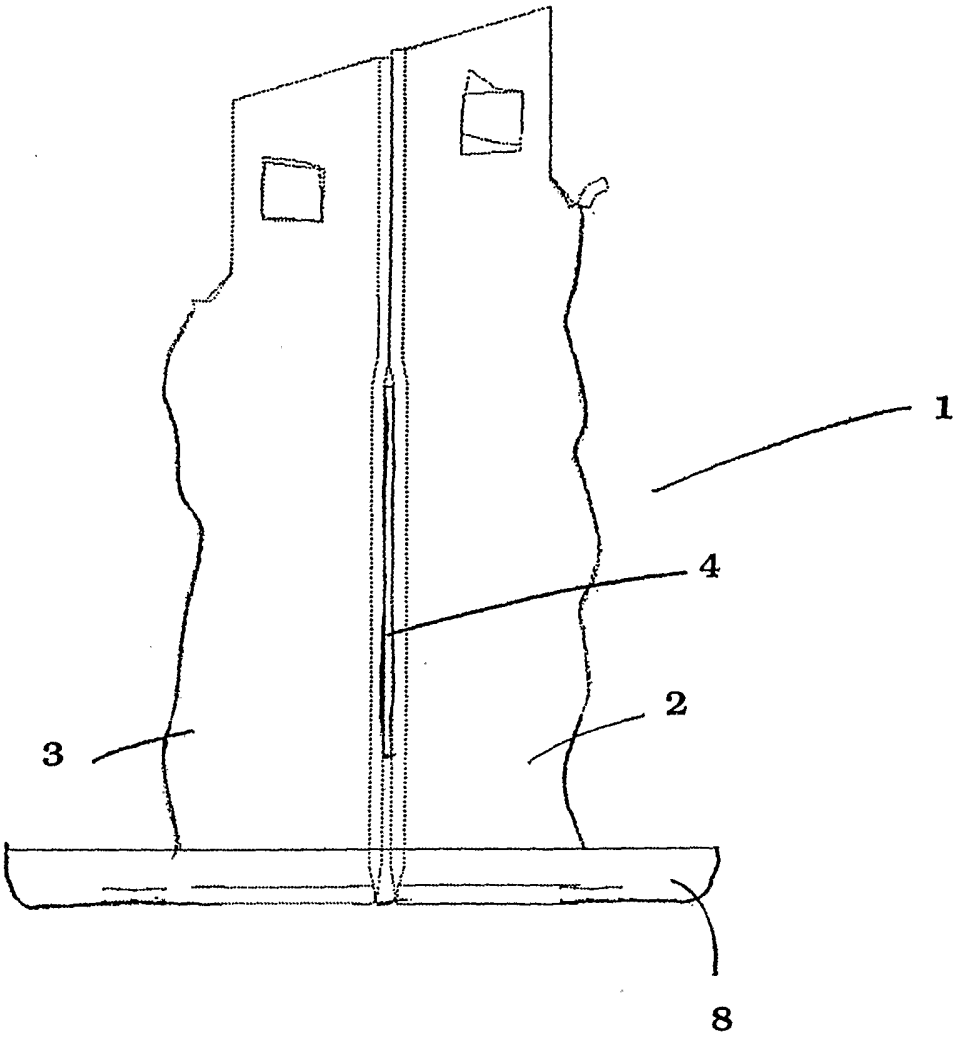


Fig. 2

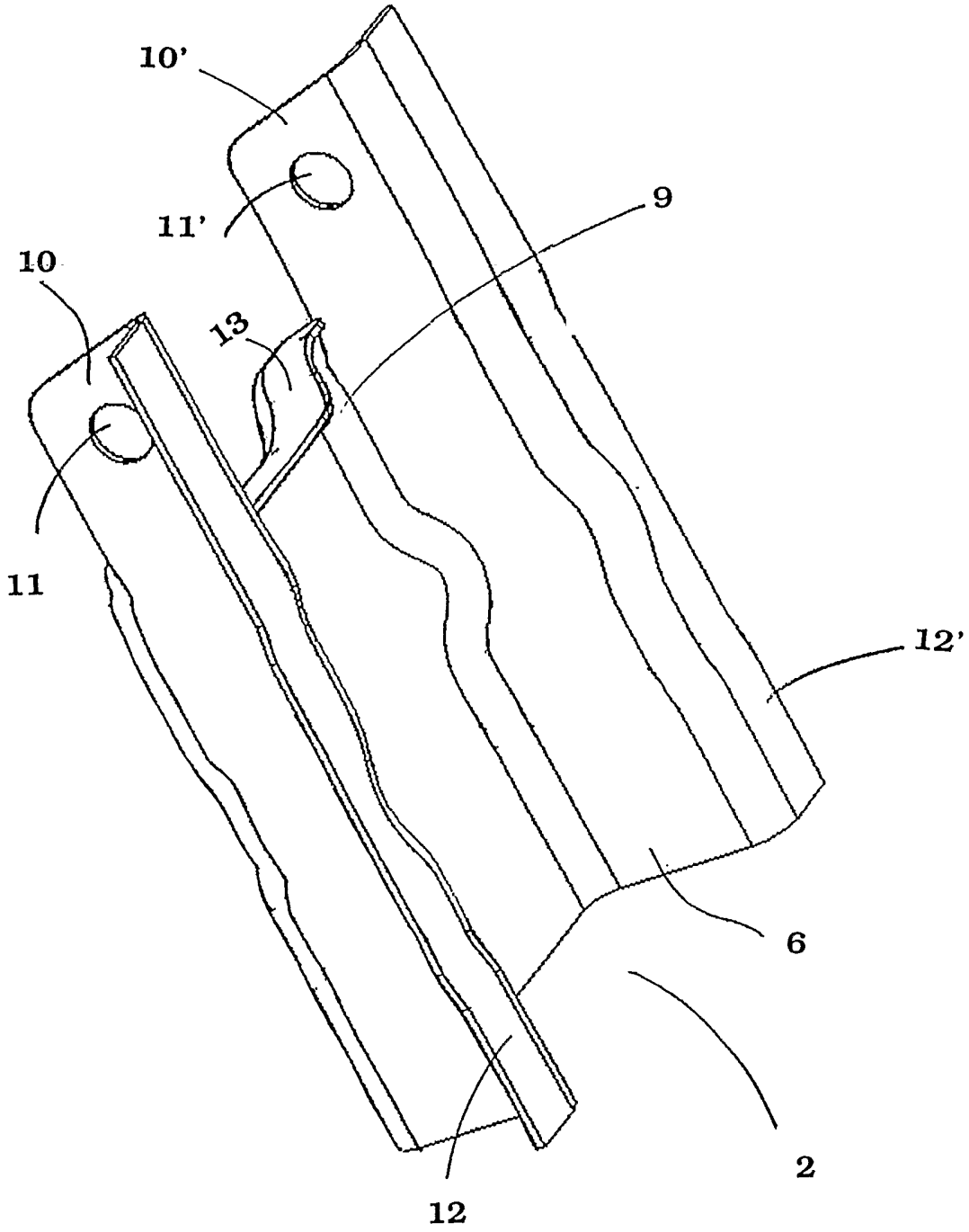


Fig. 3

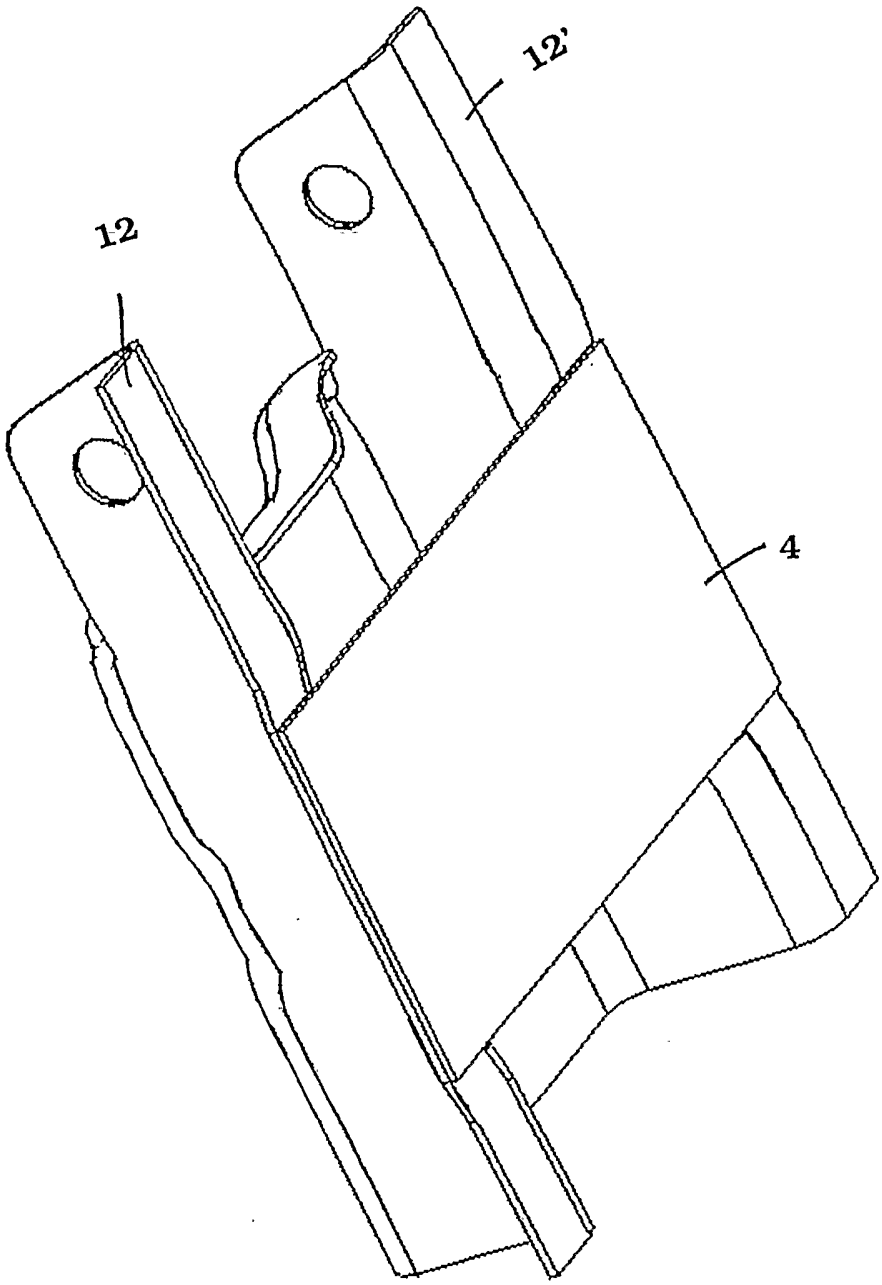


Fig. 4

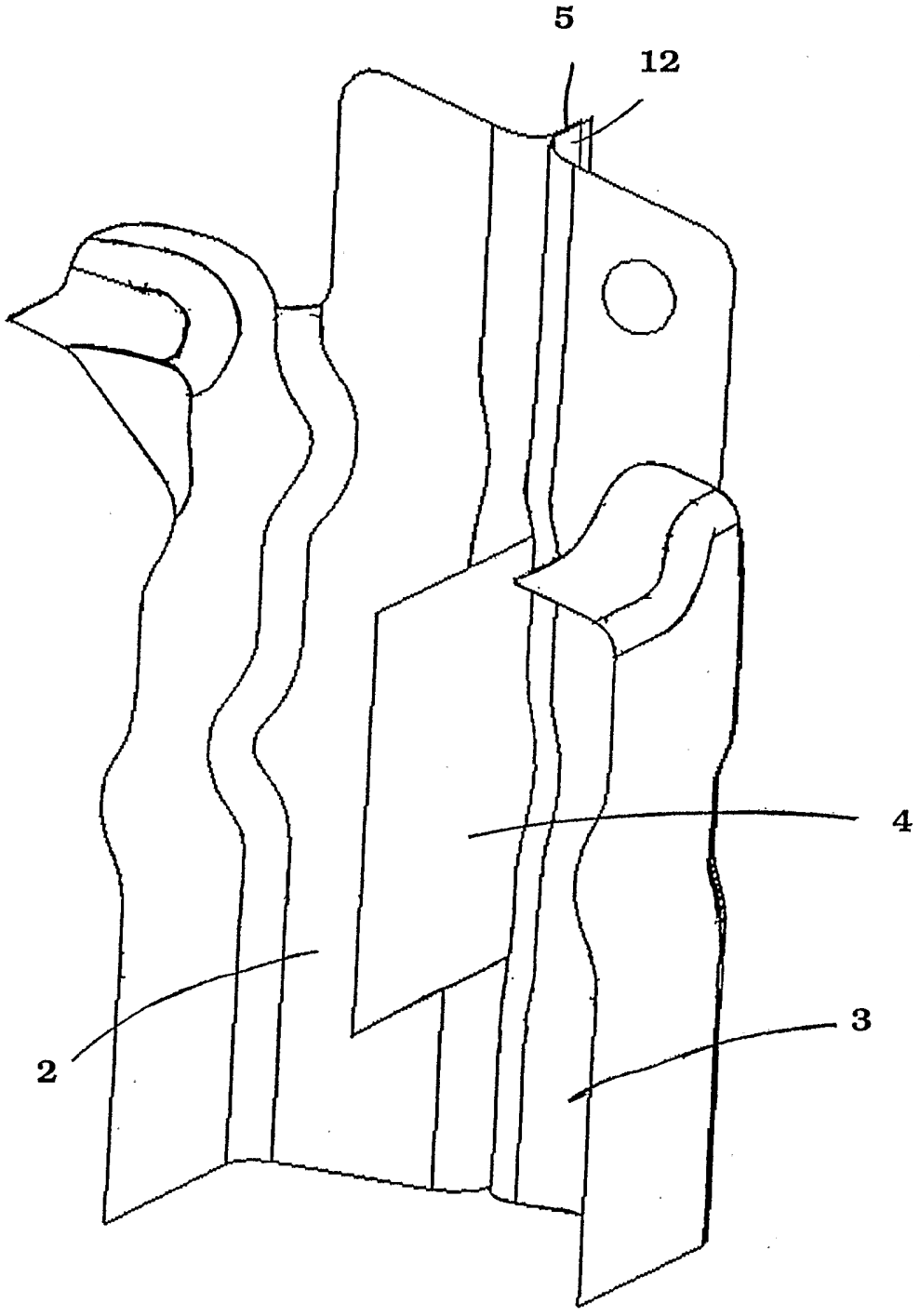


Fig. 5

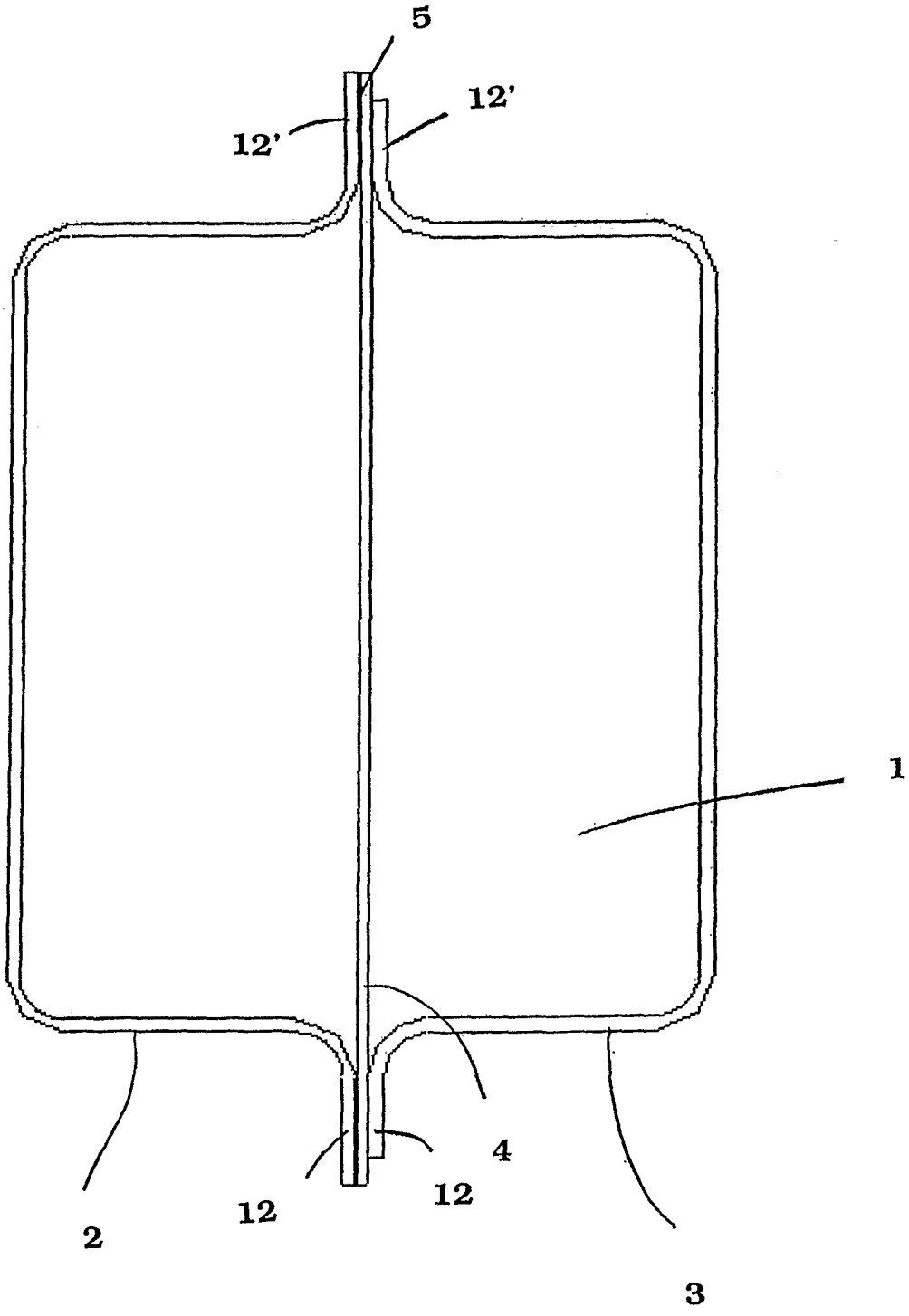


Fig. 6a

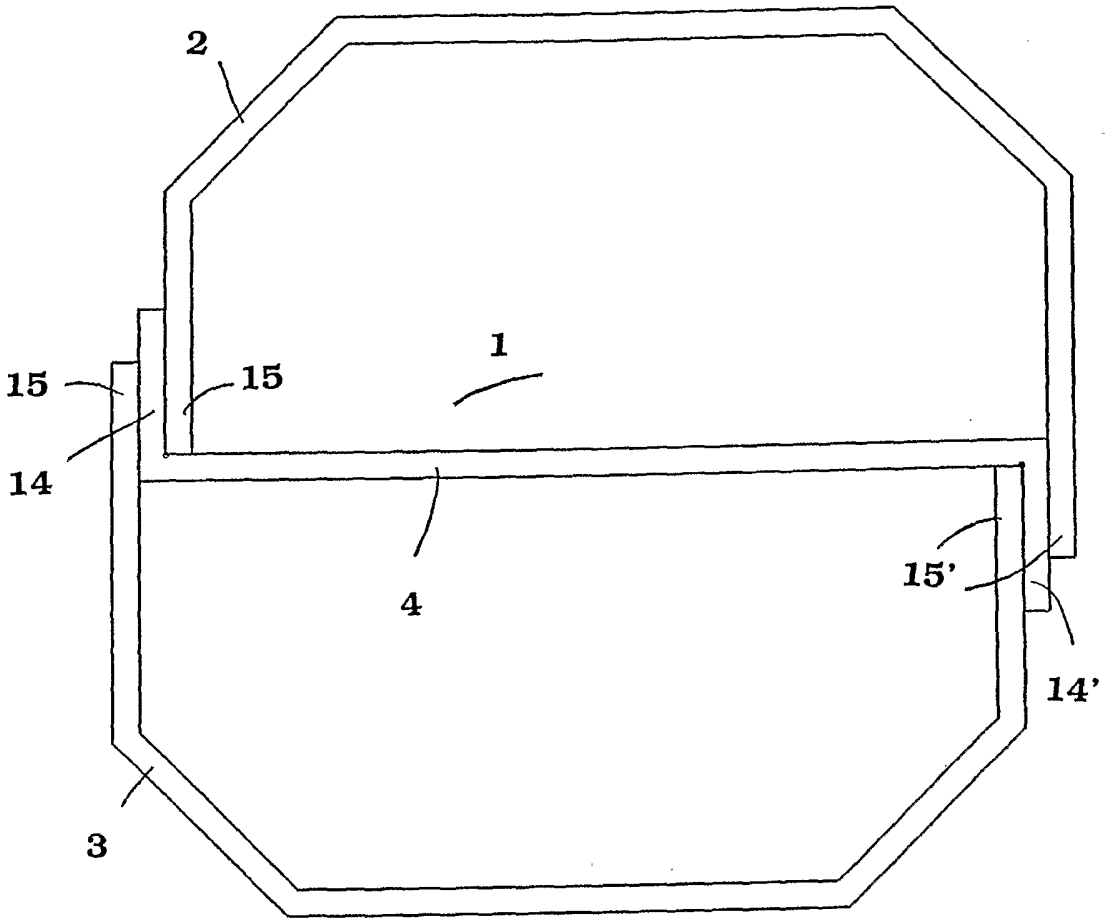
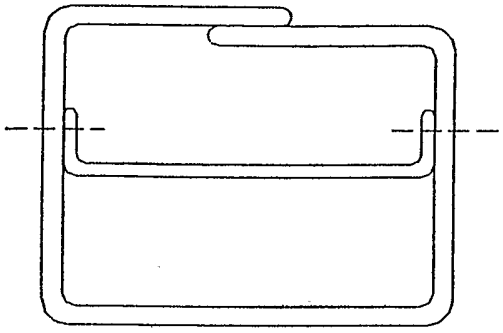
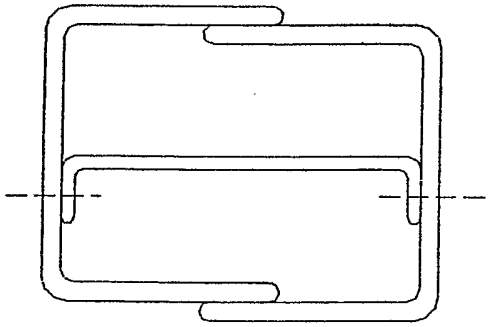


Fig. 6b



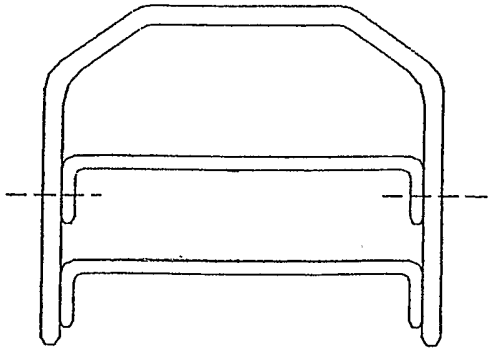
Example 3

Fig. 6e



Example 2

Fig. 6d



Example 1

Fig. 6c

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P04042	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/NO 2005/000329	International filing date *(day/month/year)* 9 Sept 2005	(Earliest) Priority Date *(day/month/year)* 27 Sept 2004
Applicant Norsk Hydro ASA et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II)

3. ☐ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings,**
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2005/000329

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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)

IPC: B60R, B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2341149 A (ROVER GROUP LTD), 8 March 2000 (08.03.2000), page 5, line 9 - page 6, line 13, figure 3, abstract --	1-16
X	US 5803517 A (SHIBUYA), 8 Sept 1998 (08.09.1998), column 3, line 13 - column 4, line 7, figure 5 --	1,3-6,8-12, 14-16
X	DE 19545069 A1 (ITT AUTOMOTIVE EUROPE GMBH), 30 April 1997 (30.04.1997), figure 1, abstract --	1-6,8-16

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 January 2005	04-01-2006
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Hans Nordström/EK Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2005/000329

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 10014469 A1 (BENTELER AG), 11 October 2001 (11.10.2001), column 2, line 4 - line 30, figure 1, abstract ---	1,3-6,8-12, 14-16
X	US 20010013706 A1 (ARTNER), 16 August 2001 (16.08.2001), paragraph [0031], fig 1, abstract ---	1,3-6,8-12, 14-16
X	US 3779592 A (GOLZE ET AL), 18 December 1973 (18.12.1973), column 2, line 6 - line 47, figure 2, abstract ---	1,3-6,8-12, 14-16
X	US 6520552 B2 (SCHROTER ET AL), 18 February 2003 (18.02.2003), figure 3, abstract --- --------	1,3-6,8-12, 14-16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2005/000329

INTERNATIONAL PATENT CLASSIFICATION (IPC):

B60R 19/34 (2006.01)
B60R 19/02 (2006.01)
B62D 21/15 (2006.01)

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