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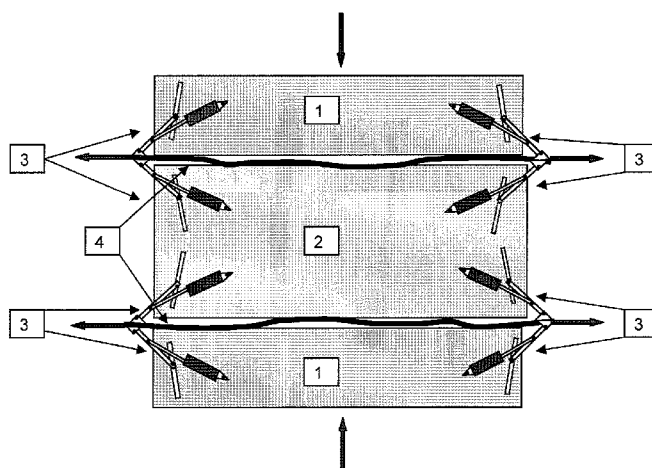


Fig. 2

(57) Abstract: Process for manufacturing a plastic hollow body by moulding two sheets of molten plastic in a mould comprising two cavities, said process comprising the following steps : a) two molten plastic sheets are manufactured; b) these sheets are introduced between the mould cavities; c) the mould is closed and the hollow body is manufactured by conforming these two sheets to the mould cavities. In this process, when the mould is closed, a device that is attached to this mould automatically stretches the sheets and/or smoothes the sheets. Equipment for carrying out such a process.

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Process and equipment for manufacturing a plastic hollow body from two sheets

The present invention relates to a process for manufacturing a plastic hollow body, and in particular, a plastic fuel tank, from two sheets. It also relates to equipment suitable for said process.

Fuel systems on board vehicles of various types generally comprise
5 devices for the ventilation of hydrocarbons contained in the tank. They may also include devices for supplying the engine with fuel. Such devices form the link between elements contained in the tank (valves, fuel pump, etc.) and elements positioned outside the tank (canister, fill pipe, etc.). Penetration through the wall of the tank must take into account the sealing requirements laid down by current
10 environmental standards (LEV II and PZEV for example). For this purpose, the reduction in the number and size of the openings in the wall of the tank constitutes a favourable factor in reducing evaporative losses. However, this makes it more difficult to insert components into the tank and position them therein.

15 Application EP 1110697 in the name of the Applicant discloses a process for moulding a fuel tank using a parison in several sections so as to be able to insert the accessories into the tank at the same time as it is moulded. For this purpose, a tubular parison is extruded, then, on exiting the die, two longitudinal cuts are made in it, along two opposing generatrices. This document
20 recommends the use of a device for guiding and separating the two parison sections thus obtained, and this with a view to being able to introduce the accessories into the tank at the same time as it is moulded.

Ideally, this device should also make it possible to substantially flatten the two parison sections and keep them free of creases so as to be able to apply them
25 correctly between the mould cavities. This may be carried out using straight cylindrical rollers or rolls, the separation of which is set as desired. This simple (and theoretically adequate) technique has, however, the disadvantage that the sheets obtained on exiting the rolls remain, after all, curved and that their separation cannot be well controlled. This is because the plastic begins to set as
30 soon as it exits the die and tends to remain in the shape that the die gives it.

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Moreover, these sheets hang freely between the cavities of the mould before it is closed in order to mould the FT and hence creases may form again at this stage. This phenomenon is even more marked when the thickness of the sheets is uneven and when the sheets are long. It is in particular significant when the sheets have a thickness that has been intentionally varied in a controlled manner. This phenomenon is responsible for a not insignificant percentage of scrap and therefore affects the profitability of industrial processes.

Application FR 0610966 in the name of the Applicant proposes to solve this problem by guiding the free end of the sheets (which hang via gravity between the mould cavities) via jaws or clamps (preferably made of cooled or PTFE-coated metal, for example) enabling them to be flattened out and preventing the formation of creases. Such a device must however be started up at each cycle, when the sheets are inserted between the mould cavities. Automatic (robotized) devices may be used for this purpose, but these are generally relatively complex and expensive.

Hence the object of the invention is to provide a process and equipment which make it possible to solve this problem using a smoothing device which automatically starts up when the mould is closed.

For this purpose the invention relates to a process for manufacturing a plastic hollow body by moulding two sheets of molten plastic in a mould comprising two cavities, said process comprising the following steps :

- a) two molten plastic sheets are manufactured;
- b) these sheets are introduced between the mould cavities;
- c) the mould is closed and the hollow body is manufactured by conforming these two sheets to the mould cavities.

In this process, when the mould is closed, a device that is attached to this mould automatically stretches the sheets and/or smoothes the sheets (i.e. to tauten them, flatten them).

The process according to the invention is suitable for any hollow body and, in particular, for any hollow body on the inside of which it is desired to introduce at least one accessory. It advantageously applies to the manufacture of fuel tanks (FTs). The expression "fuel tank" is understood to mean a leakproof tank, able to store fuel under diverse and varied usage and environmental conditions. An example of this tank is that with which motor vehicles are fitted. In the remainder of the description, the terms "hollow bodies" and "tanks" are used interchangeably.

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The hollow body obtained by the process according to the invention is made with a plastic wall, generally comprising an internal face on its concave portion and an external face on its convex portion.

5 The term "plastic" is understood to mean any material comprising at least one synthetic resin polymer.

Any type of plastic may be suitable. Particularly suitable plastics belong to the category of thermoplastics.

10 The term "thermoplastic" is understood to mean any thermoplastic polymer, including thermoplastic elastomers, and also blends thereof. The term "polymer" is understood to mean both homopolymers and copolymers (especially binary or ternary copolymers). Examples of such copolymers are, non-limitingly : random copolymers, linear block copolymers, other block copolymers and graft copolymers.

15 Any type of thermoplastic polymer or copolymer, the melting point of which is below the decomposition temperature, is suitable. Synthetic thermoplastics having a melting range spread over at least 10 degrees Celsius are particularly suitable. Examples of such materials include those that exhibit polydispersion in their molecular weight.

20 In particular, it is possible to use polyolefins, thermoplastic polyesters, polyketones, polyamides and copolymers thereof. A blend of polymers or copolymers may also be used, similarly it is also possible to use a blend of polymeric materials with inorganic, organic and/or natural fillers such as, for example but non-limitingly : carbon, salts and other inorganic derivatives, natural or polymeric fibres. It is also possible to use multilayer structures
25 composed of stacked and joined layers comprising at least one of the polymers or copolymers described above.

One polymer often used for fuel tanks is polyethylene. Excellent results have been obtained with high-density polyethylene (HDPE).

30 Preferably, the hollow body for which the process according to the invention is intended has a multilayer structure comprising at least one layer of a thermoplastic and at least one additional layer which, advantageously, may consist of a material that is a barrier to liquids and/or gases.

35 Preferably, the nature and the thickness of the barrier layer are chosen so as to minimize the permeability of the liquids and gases in contact with the wall of the hollow body. Preferably, in the case of a fuel tank, this layer is based on a barrier material, i.e. on a fuel-impermeable resin such as, for example, EVOH

(a partially hydrolysed ethylene/vinyl acetate copolymer). Alternatively, the tank may be subjected to a surface treatment (fluorination or sulphonation) for the purpose of making it impermeable to the fuel.

5 According to the invention, a tank is moulded from two sheets of molten plastic. These sheets may have been obtained by extrusion through two sheet dies, preferably just before the moulding of the hollow body (to avoid having to reheat/melt them). However, most particularly preferably, these sheets are obtained by cutting a parison.

10 The term "parison" is understood to mean an extruded preform of any shape, generally substantially cylindrical or tubular, which is intended to form the wall of the tank after moulding.

The term "extruded" is understood to mean that the parison is derived from the melting and/or plasticization of the plastic in an extruder, then from its expulsion of this plastic through an extrusion head, which generally gives it a
15 cylindrical shape. The expression "extrusion head" is understood to mean an assembly of metal blocks and a core comprising a passage for at least one stream of molten plastic exiting an extruder. Such an assembly generally comprises at least one block (or distributor) for distributing the material in the form of an annular stream, and in the case of a coextrusion head, it generally comprises at
20 least one distributor per layer of material.

The distributor or distributors, where appropriate, have passing right through them an orifice of which the outlet end is generally substantially annular and which determines, with the core, an annular outlet flow area for the molten plastic. The stream of molten plastic which is fed by the extruder to the
25 extrusion head is generally a solid cylindrical stream of pressurized plastic. In the case of a coextrusion head (intended for extruding multilayer structures), there are generally as many feed orifices as cylindrical streams of material.

Generally, a die is fixed to the extrusion head in order to give the parison, the desired shape and thicknesses.

30 According to this variant of the invention, the tubular parison has to be converted into two sheets, i.e. it has to undergo at least one transverse cutting operation and two longitudinal cutting operations.

The transverse cutting operation may be carried out by relative movement of the core and the mantle of the die, so as to momentarily interrupt the flow of
35 material and therefore cut the parison. Alternatively, it is possible to deposit

under the die (or optionally integrate into its lower surface), hooks or blades to carry out this cutting operation.

As regards the longitudinal cutting operations, these are generally carried out either using two knives which may or may not be attached to (fixed onto) the die, or be carried out inside the die itself. The latter variant is preferred as it makes it possible to automate the process as much as possible and to facilitate the stopping/starting of production runs. In this variant, preferably, the parison is first cut using flow dividers integrated into the die and then the two cut sections of the parison are gradually flattened due to a gradual modification of the inner passage of the die through which the stream or streams of plastic of the parison flow. This variant is the subject of the aforementioned Application FR 0610966, the content of which is, for this purpose, incorporated by reference into the present application.

Preferably, the parison has a controllable thickness (i.e. one that can be varied, in a controlled manner, longitudinally (along a generatrix) and/or transversely (over a same section)) and this using at least one known device such as WDS (vertically displaceable core), PWDS (deformable ring), SFDR (machined core of variable profile or pin of variable shape) or "die slide" (part inserted locally into the die : see Patent US 5,057,267 in the name of the Applicant), integrated into the die. With respect to moulding a parison whose thickness is constant, this way of proceeding makes it possible to take into account the reduction in thickness which occurs during moulding (and in particular, blow moulding) at certain places in the parison, as a result of the non-constant deformation rates of the material in the mould.

When sheets that are already cut and partially flattened are obtained at the die outlet, their handling and their transfer to the mould are markedly easier than in the processes of the prior art. It is therefore possible to reduce the height required between the die outlet and the mould cavities. This will reduce the dwell time of the extruded material in the ambient air and thus will increase the temperature of the sheets, which will facilitate the subsequent moulding process, in particular when this comprises a step of fastening component(s) (accessory(accessories)) to the inside of the parison, onto its inner face, before the final moulding of the hollow body. Such a fastening of components, which is advantageous within the scope of the present invention, is for example described in Applications WO 2006/008308, WO 2006/032672 and WO2007/000454 in

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the name of the Applicant, the content of which is, for this purpose, incorporated by reference in the present application.

The transfer of the sheets to the mould may take place in any known manner. However, according to one preferred variant, the mould cavities are
5 positioned underneath the die and the parison (sheets) is/are extruded continuously between the cavities of the mould that is then closed over said sheets just before they are cut transversely and moulded.

In the process according to the invention, a device that is attached to the mould automatically stretches the sheets (preferably at least sideways) and/or
10 smoothes the sheets when the mould is closed (i.e. when its cavities come together in order to finally be bracketed together over their perimeter while trapping the edges of the sheets therein).

The term "automatically" is understood to mean that it is the closure of the mould which starts the device and that no other intervention is necessary for this
15 purpose.

The term "attached" is in fact understood to mean that the device is either integrated into the mould (as a single part with its cavities and/or its core, where appropriate (see further on), or fixed on top), or is directly actuated by the
20 mould, i.e. the movement of closing the mould gives rise to the actuation (starting) of the device. In order to reduce the number of parts and to simplify the system, the device is preferably integrated into the mould. This device is preferably located in a portion of the mould outside of the moulding zone and which is generally removed (trimmed) in the form of scrap.

In a first variant, the shape of the inner surface of the cavities and/or of the
25 outer surface of a core inserted between the mould cavities outside of the moulding zone (generally in the lower portion of the mould) is such that these parts themselves produce the smoothing effect. For this purpose, these parts may be equipped with reliefs such as corresponding curved portions (concave and convex portions respectively) and/or bear jaws, clamps, etc. or other surface(s)
30 having mechanical anchoring.

In a second variant, the mould also comprises a core (part which is by definition intended to be inserted between the mould cavities and the role of which will be explained further on) and the cavities and the core are equipped with complementary parts that are intended to cooperate when the mould is
35 closed in order to stretch/smooth the sheets. Preferably, these parts are located in

the lower portion of the mould outside of the moulding zone. Most particularly preferably, they are located on the lower face of the cavities and of the core.

There are preferably 8 complementary parts, i.e. 2 parts on each cavity (4 parts in total) intended to cooperate with a complementary part on the core in front of them (i.e. 4 complementary parts on the core too). The 4 pairs of parts are preferably each located opposite a lower corner of the sheets so that each sheet has its lower edge stretched by 2 pairs of parts. It would also be possible to use 8 pairs of parts (4 in the top and 4 in the bottom of the mould/core assembly).

These stretching (smoothing) parts are preferably parts that can be moved by rotation, by pivoting around at least one axis and/or by translation. The pivoting axis - where appropriate - generally passes through a point for fastening the part to the mould. Generally, a return device (a spring, for example) makes it possible to return these parts to the initial position, during the re-opening of the mould/core. Preferably, they are articulated arms (made up of several articulated parts, like certain windscreen wipers, for example) terminated by a sort of slider (a part that may or may not be smooth), of a point/counter-point (or cone) system, of serrated jaws, of grippers, etc. or of any other part(s) that have mechanical anchoring. They may also be wheels with a perimeter that is toothed, knurled, etc.

It should be noted that these two variants (shape of the cavities/core and movable parts) may be combined.

In the process according to the invention, the tank is preferably moulded as a single part (in a single step, after which a one-piece tank is obtained, without recourse to an additional step of assembling separate shells), generally by welding the sheets over their perimeter when the mould is closed. In particular, the tank is advantageously moulded by :

- blow-moulding, i.e. by expanding the cut parison and pressing it against the mould cavities using a pressurized fluid (as described in Application EP 1110697, the content of which is, for this purpose, incorporated by reference into the present application);
- thermoforming the parison, i.e. by pressing the latter against the mould cavities, for example by providing suction (creating a vacuum) behind said cavities.

Preferably, the tank is moulded by blow-moulding. This is because thermoforming generally involves heating the mould at a high temperature so as to be able to achieve deep deformations (corners of the tank for example, where

the parison is highly stretched). This results in cycle times that are longer than with blow-moulding, in which this constraint does not exist.

The process according to the invention may involve the use of a core which is used during a first closure of the mould to fasten accessories to the inner surface of the sheets. In this variant, there is preferably a device that prevents the edges of the sheets from being welded together during this first mould closure (when the parison is pressed against the cavities in order to fasten the accessories to the parison). This device is advantageously integrated into the core. Hence, this core is preferably an insert having a suitable shape and size for being able to be partly (generally, over at least one portion of its periphery) inserted between the sheets to be welded. To facilitate the welding, the mould cavities are advantageously equipped with a thermal control device that makes it possible to heat the weld zone during the steps relating to the first mould closure (in order to fasten one or more components thereto), where appropriate.

The core may also integrate such a (thermal control) device in its zone(s) of contact with the parison, and this, in particular, in the aforementioned weld zone. This variant could further improve the quality of the welding of the tank (by reducing the inner bead and therefore by improving the impact resistance of the tank). Such a device is for example described in Application FR 04 13407 in the name of the Applicant, the content of which is, for this purpose, incorporated by reference into the present application.

In this variant of the process according to the invention, during the first closure of the mould the sheets are first pressed against the mould cavities (by blowing through the core and applying suction behind the cavities) and then devices on the core (for example, actuators) fasten the accessories to the pressed sheets. Next, the mould is re-opened, the core is removed and the mould is resealed to weld the pre-moulded sheets and produce the tank by a final blow-moulding operation.

The present invention also relates to equipment for implementing the process as described previously. This equipment is made up of a mould comprising :

- two cavities each capable of moulding one plastic sheet; and
- a device attached to the mould which, when the latter is closed, is capable of automatically stretching and/or smoothing the sheets before they are moulded.

All the preferred features described above in the section of the description relating to the process can be applied for this equipment (presence of a core, nature of the smoothing device, etc.).

5 The objective of Figures 1 to 6 is to illustrate certain concrete aspects of the invention, without wishing to restrict the scope thereof in any way. They illustrate schematic bottom views of equipment according to certain variants of the invention respectively at the start of mould closure (odd-numbered figures) and at the end of mould closure (even-numbered figures).

10 Figures 1 and 2 illustrate the equipment in its entirety; Figures 3 to 6 only illustrate one corner of it.

In these figures, identical numbers represent identical components, namely :

1. the mould cavities
2. its core
- 15 3. 4 pairs of moveable parts fixed to the lower face of the cavities (1) and the core (2)
4. the lower edge of the sheets to be moulded which hangs via gravity between the mould cavities and core.

20 The direction of mould closure is illustrated by vertical arrows on the two figures and the smoothing direction is indicated by horizontal arrows in Figure 2.

Figures 1 and 2 illustrate a variant where the moveable parts (3) are articulated arms attached to sliders. When the mould cavities (1) are closed over the sheets (4) and over the core (2), the sliders of each pair of arms (3) clamp the lower corners of the sheets (4). When the mould continues to close, the
25 sliders (3) slide towards the outside and in doing so smooth the lower edge of these sheets (4) thus enabling possible creases that could be formed therein to be removed.

Figures 3 and 4 illustrate a variant where the movable parts (3) comprise complementary jaws (5) one that is attached to a slider that moves in a straight
30 line (6) and the other to an articulated arm (7). In Figure 4, arrows indicate the respective movement of the slider (6) and of the arms (7) and also the manner in which this movement causes the jaws (5) to come together in order to smooth out the sheets (4).

Finally, Figures 5 and 6 illustrate a variant where the moveable parts (3)
35 comprise off-centred wheels (8) equipped with a return spring (9). In Figure 6, arrows indicate the rotational direction of the wheels (8) and it is possible to see

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therein the smoothing effect that these wheels (8) exert on the sheets (4). These wheels have a toothed or knurled perimeter and they are based on PTFE.

CLAIMS

1. – Process for manufacturing a plastic hollow body by moulding two sheets of molten plastic in a mould comprising two cavities, characterized in that said process comprises the following steps :

5 a) two molten plastic sheets are manufactured;

b) these sheets are introduced between the mould cavities;

c) the mould is closed and the hollow body is manufactured by conforming these two sheets to the mould cavities,

10 and is characterized in that, when the mould is closed, a device that is attached to this mould automatically stretches the sheets and/or smoothes the sheets.

2. – Process according to the preceding claim, characterized in that the sheets are obtained by cutting a parison that has a variable thickness.

3. – Process according to any one of the preceding claims, characterized in that the stretching/smoothing device is integrated into the mould.

15 4. – Process according to the preceding claim, characterized in that the stretching/smoothing device is located outside of the moulding zone of the mould.

20 5. – Process according to the preceding claim, characterized in that the stretching/smoothing is at least partly carried out via a suitable shape of the inner surface of the cavities and/or of the outer surface of a core inserted between them, outside of the moulding zone.

25 6. – Process according to any one of the preceding claims, characterized in that the mould comprises a core that is intended to be inserted between the mould cavities and in that the cavities and the core are equipped with complementary parts that are intended to cooperate when the mould is closed in order to stretch/smooth the sheets.

7. – Process according to the preceding claim, characterized in that the complementary parts are located on the lower face of the cavities and of the core.

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8. – Process according to Claim 6 or 7, characterized in that there are 8 complementary parts, i.e. 2 parts on each cavity (4 parts in total), which are intended to cooperate with a complementary part on the core in front of them (i.e. 4 complementary parts on the core too) and in that these 8 parts constitute 4
5 pairs of parts, each located opposite a lower corner of the sheets so that each sheet has its lower edge stretched by 2 pairs of parts.

9. – Process according to any one of Claims 6 to 8, characterized in that the complementary parts are attached to a return device.

10. – Equipment for carrying out a process according to any one of the
10 preceding claims and being composed of a mould comprising :

- two cavities each capable of moulding one plastic sheet; and
- a device attached to the mould which, when the latter is closed, is capable of automatically stretching and/or smoothing the sheets before they are moulded.

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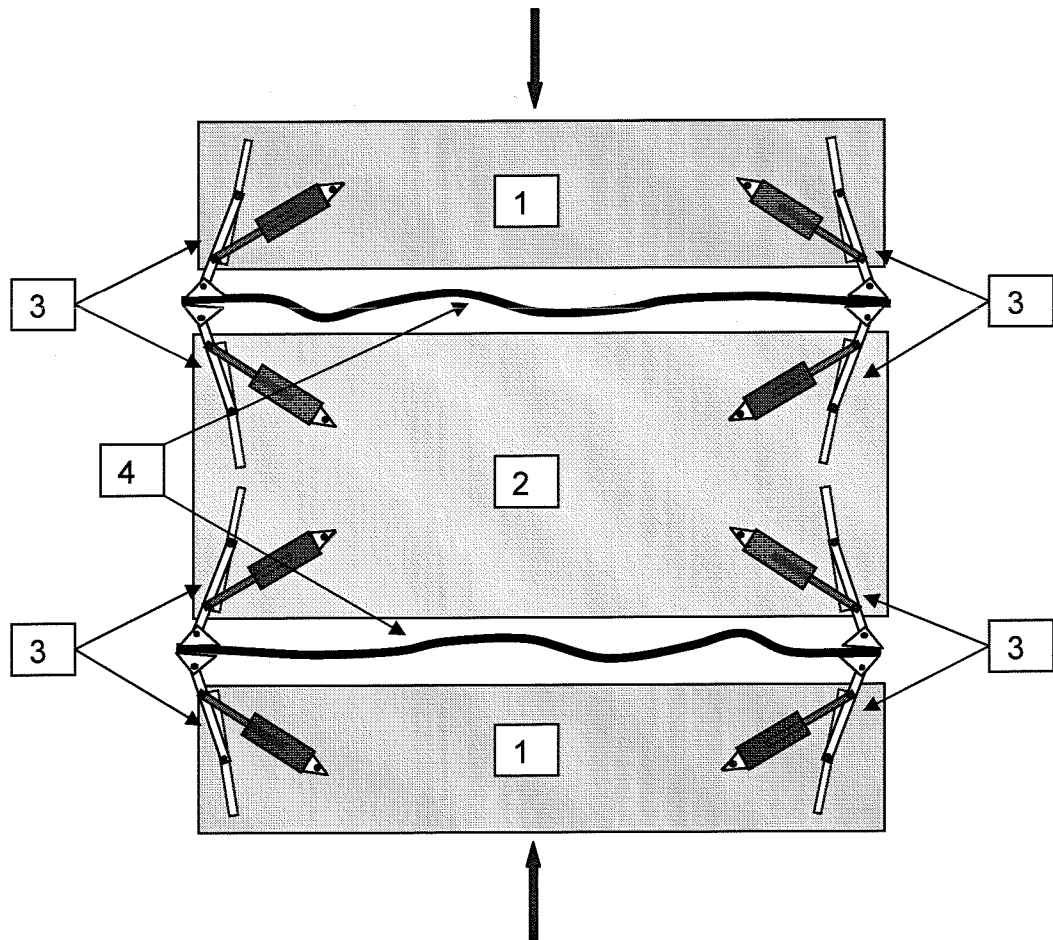


Fig. 1

- 2 / 6 -

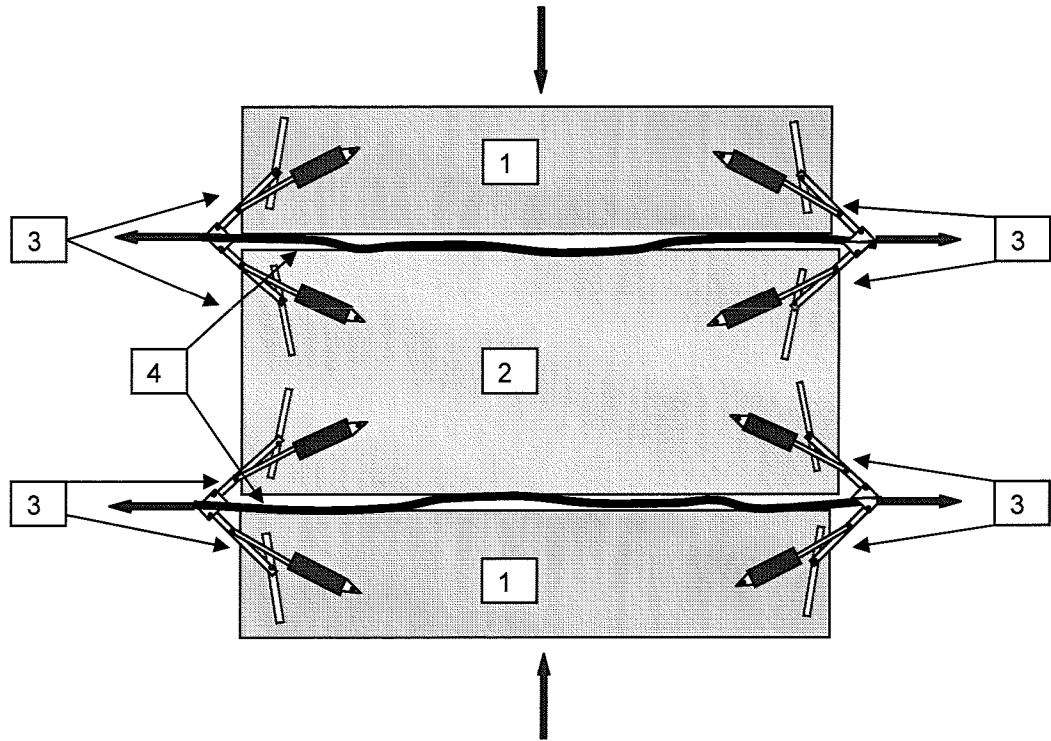


Fig. 2

- 3 / 6 -

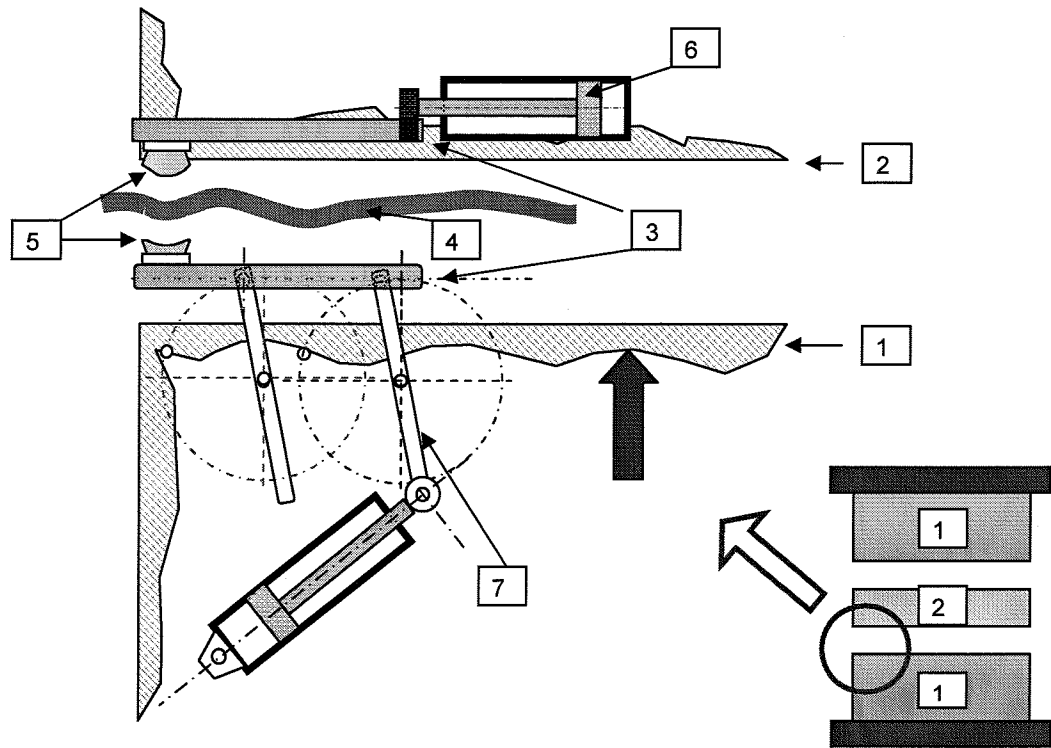


Fig. 3

- 4 / 6 -

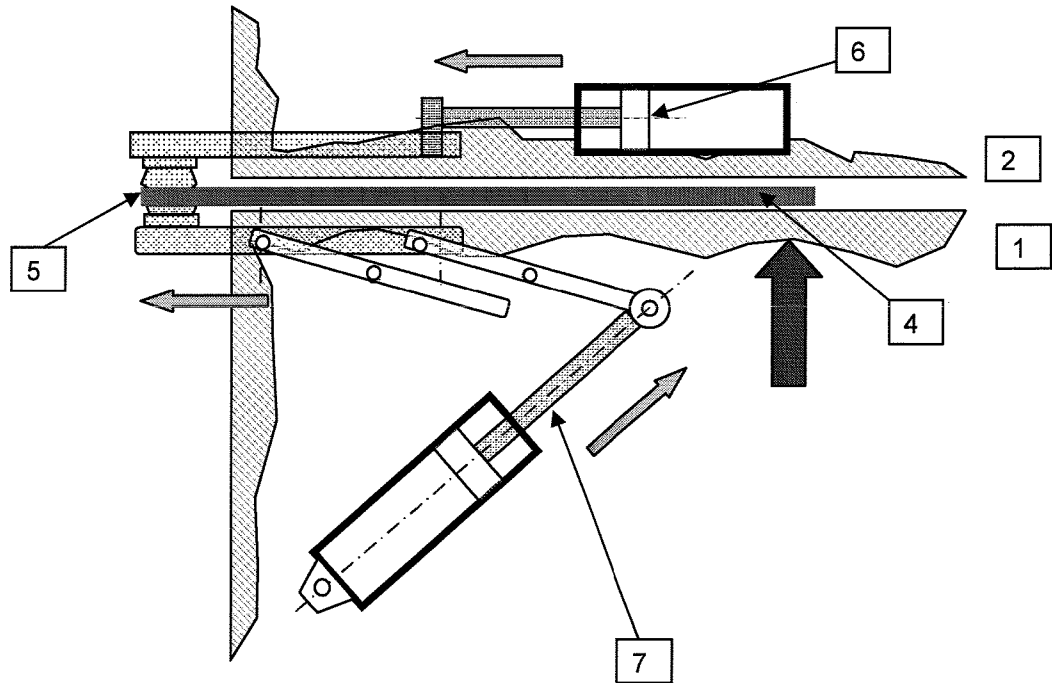


Fig. 4

- 5 / 6 -

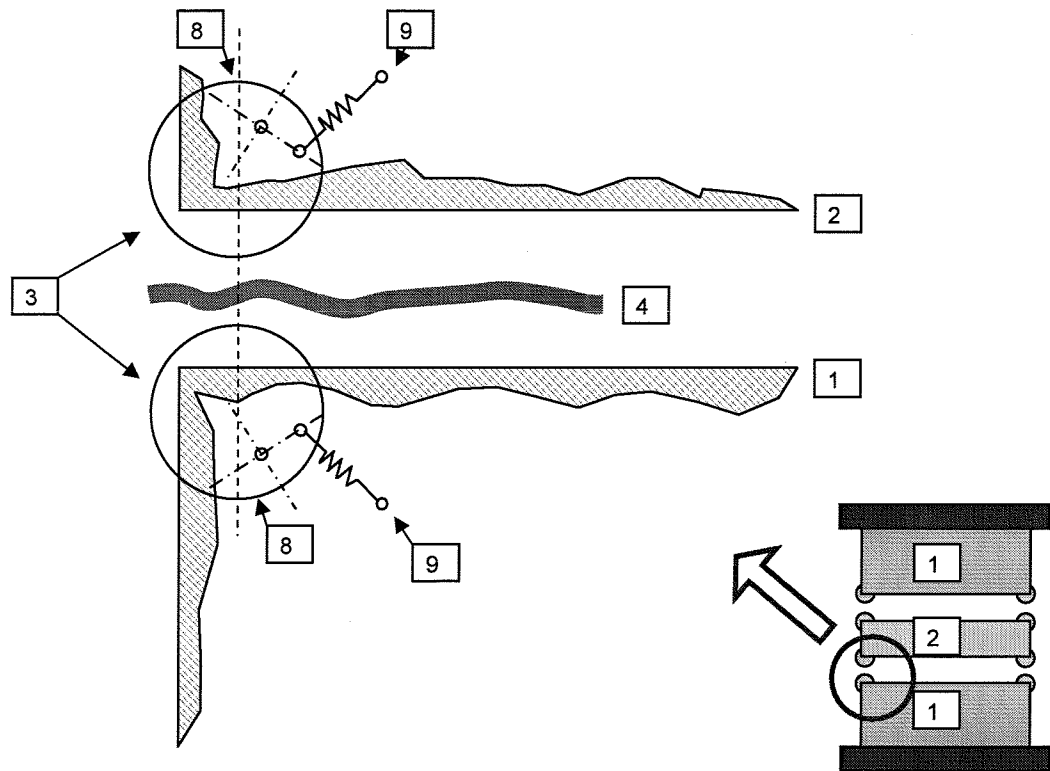


Fig. 5

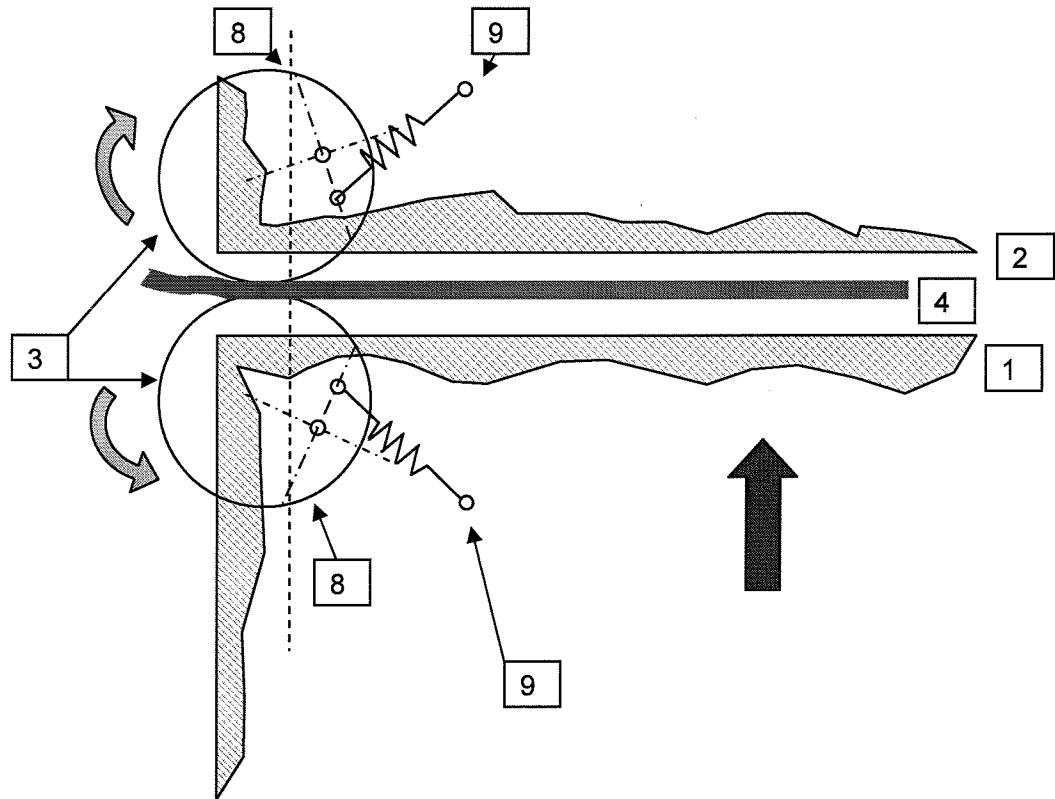


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/058884

A. CLASSIFICATION OF SUBJECT MATTER

INV. B29C49/00

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 110 697 A (SOLVAY [BE] INERGY AUTOMOTIVE SYSTEMS RES [BE]) 27 June 2001 (2001-06-27) cited in the application paragraphs [0001], [0003], [0004], [0017], [0019], [0023], [0025], [0030] figure 1	1-10
A	WO 99/64221 A (FISCHER & PAYKEL LTD [NZ]; WITTEN HANNAH DANIEL [NZ]; VAUGHAN STEWART) 16 December 1999 (1999-12-16) pages 1,2,4,10	1-10
A	JP 61 148023 A (KYORAKU CO LTD) 5 July 1986 (1986-07-05) abstract	1-10
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☒ 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 September 2008

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25/09/2008

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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	FR 2 879 494 A (INERGY AUTOMOTIVE SYSTEMS RES [BE]) 23 June 2006 (2006-06-23) cited in the application claim 1	1-10
A	JP 2001 239824 A (INOUE MTP KK) 4 September 2001 (2001-09-04) abstract	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/058884

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