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(54) A method for optimising a process for extrusion of an aluminium section

(57) A method for optimising a process for extrusion of an aluminium section, in which the section (1) is obtained using a die with a predetermined shape. Extrusion is performed in such a way that the section (1) has, in cross-section, at least at one portion, alternating zones (2) with a thickness H2, and zones (3) with a thickness H1 greater than the thickness H2 of the zones (2). For the optimised process it is possible to identify an extrusion limit speed VL2 corresponding to the maximum extrusion speed that can be reached without deterioration of the surface of the section (1) obtained according to the optimisation process. The extrusion limit speed VL2 being equal to the limit speed VL1 for a non-optimised section when the weight per unit of length PR2 of the section (1) is lower than the reference weight PR1 of the non-optimised section, and higher than the limit speed VL1 if the weight per unit of length PR2 of the section (1) is equal to or greater than said reference weight PR1.

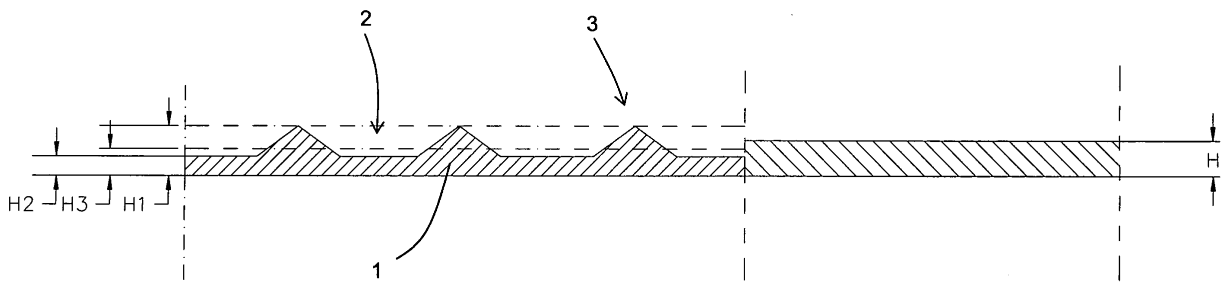

FIG. 6

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Description

[0001] The present invention relates to a method for optimising a process for extrusion of an aluminium section.

[0002] The method according to the present invention was developed relative to the production of panels for industrial vehicle bodies, in particular hollow panels having one or more tubular segments.

[0003] For this reason, specific reference is often made hereinafter to sections constituting body panels. In any case the present invention is intended for application in any sector which uses aluminium sections obtained by means of extrusion.

[0004] As is known, aluminium sections are extruded by forcing the aluminium in the plastic state through a die which gives it the required shape.

[0005] As in all sectors, in the production of extruded aluminium sections, the trend over the years has been to attempt to minimise the cost per unit of length of said sections.

[0006] To summarise, it may roughly be said that the overall cost per unit of length of a section is given by the sum of a fixed cost substantially linked to the existence of the production company with the relative extrusion plant, and a variable cost given by the quantity of material which constitutes the section (therefore, substantially the weight per unit of length).

[0007] Whilst the fixed cost per unit of length of the section produced falls as the productivity of the plant increases, the variable cost, again per unit of length produced, falls as the weight per unit of length of the section falls.

[0008] Over the years the logical consequence has been to increase the speed of extrusion and reduce the weight of the section.

[0009] But these are two factors which, under certain conditions, clash with one another.

[0010] It is known that for each section there is a maximum extrusion speed which is inseparably linked to the friction created between the aluminium extruded and the die which gives it its shape.

[0011] If this limit speed is exceeded, the surface of the product obtained at the end of the extrusion process shows signs of deterioration following the appearance of scratches and/or scoring and/or lacerations and/or deformations and/or undulations which are more or less extensive and/or the extruding die may even be broken.

[0012] However, the limit speed which, as indicated, is determined by friction, depends, all other extrusion plant factors being equal, on the thickness of the section. As the thickness of the section is reduced, the limit speed is also reduced.

[0013] As a result, the limit speed is substantially set by the thickness of the section to be obtained. In general, in sections which do not have uniform thickness, the limit speed is determined by the thickness of the portion of the section with the minimum thickness.

[0014] Therefore, to attempt to increase the speed of extrusion of a predetermined section, its thickness would have to be increased.

[0015] However, on the other hand, to attempt to reduce the costs linked to the weight of the material, it has been increasingly necessary to reduce section thickness as far as possible.

[0016] These two opposing requirements have led to the identification, for each type of section and plant, of an optimum combination of extrusion speed and section thickness (at least in the portion with the minimum thickness) which minimises the costs of the section to be produced.

[0017] However, the present invention is a result of the discovery that, for many applications, the limit thickness determined based on the minimum cost of the section to be produced is greater than that which would be sufficient to guarantee the mechanical strength required in the end use of the section.

[0018] For example, in the case of panels for industrial vehicle bodies, in particular hollow panels with one or more tubular segments, at present sections with a minimum thickness of around 1.7 mm can be produced.

[0019] Mechanical assessments have highlighted how sufficient mechanical strength could be achieved even with thicknesses that are significantly lower (even 30% or more) if produced using the method disclosed which involves limited zones of greater thickness that promote the flow of aluminium through the die but which also act as a support - rest immediately after extrusion when the section is still hot and very weak, as well as stiffening the section during the subsequent practical end use.

[0020] In this situation the technical need which forms the basis of the present invention is to perfect a method for optimising a process for extrusion of an aluminium section which overcomes the above-mentioned disadvantages.

[0021] In particular, the technical need of the present invention is to perfect a method for optimising a process for extrusion of an aluminium section which allows extrusion, at least at the same speed as the current plants, of sections with a weight (for the same unit of length) lower than the methods of extrusion currently known and/or which at least allows an increase in the speed of extrusion if the weight is the same per unit of length.

[0022] Another technical need of the present invention is to perfect a method for optimising a process for extrusion of an aluminium section in which the reduction in the overall weight per unit of length is achieved by reducing the thickness of the section currently considered the minimum with current extrusion methods.

[0023] A further technical need of the present invention is to perfect a method for optimising a process for extrusion of an aluminium section in which the reduction in the overall weight per unit of length is achieved by reducing the minimum thickness of the section to be produced but substantially maintaining and/or improving the resistance to bending of the section, in particular if it is to be used for example as a panel for industrial vehicle bodies with one or more tubular segments.

[0024] The technical need specified and the aims indicated are substantially achieved by a method for optimising a process for extrusion of an aluminium section as described in the claims herein.

[0025] Further characteristics and advantages of the invention are more clearly illustrated in the detailed description of several preferred embodiments of a method for optimising a process for the extrusion of an aluminium section, described with reference to the accompanying drawings, provided by way of example and without limiting the scope of application, and in which:

- Figure 1 is a cross-section of a section constituting a panel of an industrial vehicle body, made according to the prior art;
- Figure 2 is a cross-section of the section illustrated in Figure 1 obtained with an extrusion method optimised according to a first embodiment of the present invention;
- Figure 3 is a cross-section of the section illustrated in Figure 1 obtained with an extrusion method optimised according to a second embodiment of the present invention;
- Figure 4 is a cross-section of the section illustrated in Figure 1 obtained with an extrusion method optimised according to a third embodiment of the present invention;
- Figure 5 is a cross-section of the section illustrated in Figure 1 obtained with an extrusion method optimised according to a fourth embodiment of the present invention; and
- Figure 6 is a schematic cross-section of a comparison between the non-optimised section illustrated in Figure 1 and a section optimised according to another embodiment of the present invention.

[0026] With reference to the accompanying drawings, the numeral 1 denotes as a whole an optimised aluminium section obtained with an extrusion method optimised according to several non-limiting embodiments of the present invention.

[0027] In Figures 2 to 5 the optimised section 1 consists of a panel for an industrial vehicle body, but this is only an example of application of the optimisation method disclosed, which may, in general, be used for the production of any type of section.

[0028] The extrusion process in general involves, in the known way, the section to be produced being obtained by extrusion through a die with a predetermined shape.

[0029] As said, the present invention relates to the optimisation of an extrusion process which, each time may be used for the production of any type of optimised section 1 designed for the purpose or, as a non-limiting example, the one illustrated in Figure 2 deriving from a non-optimised section (as a non-limiting example, the one illustrated in Figure 1).

[0030] As a result, for each extrusion process to be optimised, all operating parameters are known, such as the type of plant, the material used to make the die, which determines the friction between the aluminium and the die, the type of aluminium alloy to be extruded, its ideal extrusion temperature and anything else necessary for the success of the entire extrusion process.

[0031] Therefore, given a type of section (for example, that illustrated in Figure 1) which can be produced with the non-optimised method, the main specifications for it are known. In particular, the (non-optimised) section will have a reference weight per unit of length PR1, at least a portion with practically uniform minimum thickness SM1, used as the basis for calculation, for the extrusion process, of an extrusion limit speed VL1 corresponding to the maximum extrusion speed which can be achieved without section surface deterioration, which generally occurs at the portion with the minimum thickness (which is the critical portion).

[0032] In one embodiment of the present invention, extrusion is performed in such a way that the optimised section 1 has, in cross-section, at least at its portion which in the case of a non-optimised section is the one with the minimum thickness SM1, alternating zones 2 with thickness less than the minimum thickness SM1, and zones 3 with thickness greater than that of said zones 2.

[0033] This alternation of zones 2, 3 may be achieved either only at the portion with minimum thickness, or at some or all of the other portions of the section 1.

[0034] At a practical level the alternation of zones 2, 3 may be easily achieved by preparing a suitable die. For all practical purposes, the zones 3 constitute, during extrusion, outlets for the aluminium which allow the zones 2 adjacent to them to be obtained without surface deterioration.

[0035] Hereinafter, a section 1 obtained according to the present invention will be indicated as an optimised section 1, or more simply as a section 1, whilst a section obtained using the non-optimised process will be indicated as a non-optimised section.

[0036] For the optimised process described above an extrusion limit speed VL2 can be identified, corresponding to the maximum extrusion speed that can be reached without surface deterioration of the section 1 obtained according to the above description.

[0037] According to choices made during definition of the configuration and dimensions of the zones 2, 3, the extrusion limit speed VL2 will be equal to the extrusion limit speed VL1 defined for the non-optimised section, if the weight per unit of length PR2 of the optimised section 1 is lower than the weight per unit of length or reference weight PR1 of the non-optimised section, whilst it will be greater than the limit speed VL1 if the weight per unit of length PR2 of the optimised section 1 is greater than the reference weight PR1 of the non-optimised section.

[0038] In general, the optimised section 1 will have a weight per unit of length PR2 non greater than the weight for the same unit of length PR1 of the non-optimised section.

[0039] This circumstance is clearer with reference to Figure 6, where on the right there is a non-optimised section with minimum thickness H, whilst on the left there is a section 1 optimised according to an embodiment of the present invention in which the zones 2 are stretches of optimised section 1 with uniform thickness H2, less than the minimum thickness H of the non-optimised section, and the zones 3 have a triangular cross-section with the thickness of the optimised section 1 measured at the vertex of the triangle with value H1.

[0040] In general, whilst H2 will always be less than H, H1 may have any value even if the best results are obtained with H1 greater than H.

[0041] Figure 6 also shows, with a dashed line, a thickness H3 corresponding to the average thickness of the optimised portion illustrated.

[0042] This thickness H3 corresponds to the theoretical average thickness that the optimised section 1 would have if it had a constant thickness, the same volume and the same weight for the same unit of length.

[0043] In general, according to the preferred embodiment of the present invention H3 will be less than or equal to H (as will the weight per unit of length). If H3 and H are equal, thanks to the optimisation method described above, the optimised section 1 could be extruded, with equal weight per unit of length (PR1=PR2), at a limit speed VL2 greater than the limit speed VL1 identified for the non-optimised section and, since the thickness H1 of the zones 3 is greater than H, it will also have a transversal resistance to bending RF2 greater than the transversal resistance RF1 verifiable on the non-optimised section.

[0044] In contrast, when H3 is less than H it will in general be possible both to maintain an extrusion speed VL2 equal to the limit speed VL1, saving only on the quantity of material, and to reach an extrusion limit speed VL2 greater than the limit speed VL1 up to the maximum speed achievable without defects, therefore saving both on the weight and on production times per unit of length or it will be possible to reach an ideal compromise between the saving in terms of weight and production time.

[0045] By way of example, Figures 2 to 6 illustrate some of the many possible embodiments of the present invention.

[0046] In particular:

- in Figure 2 the zones 2 have a constant thickness whilst the zones 3 have, seen in cross-section, a dome shape;
- in Figure 3 the alternation of zones 2, 3 forms, in cross-section, a curved undulating profile;
- in Figure 4 the alternation of zones 2, 3 forms, in cross-section, a saw tooth profile in which the second zones 3 have the shape of an isosceles triangle;
- in Figure 5 the alternation of zones 2, 3 forms, in cross-section, a square wave profile; and
- in Figure 6, in the part on the left relative to the optimised section 1, the zones 2 have a constant thickness, whilst the zones 3 have, seen in cross-section, a triangular shape.

[0047] In the embodiments of the present invention illustrated, in which the optimised section 1 is a panel of an industrial vehicle body, the alternation of zones 2, 3 is obtained on most of the section 1, whilst in the non-optimised embodiment, the non-optimised section has a thickness that is practically constant all over.

[0048] In general, the present invention may be applied both to solid sections (without tubular cavities), and to hollow sections, as is the case for panels for vehicle bodies, with one or more tubular segments.

[0049] In the latter case, if the optimised section 1 is tubular, advantageously, the alternation of zones 2, 3 may be achieved inside the section 1.

[0050] Obviously, the optimisation method disclosed may be applied only when the section 1 optimised or to be optimised has, at least at a portion with the limit thickness, at least one surface (visible or hidden because it is inside, as in the case of the panels illustrated in Figures 2 to 5) which can be produced in accordance with the present invention, without conditioning the subsequent use of the optimised section 1.

[0051] In general, depending on the type of section 1 to be obtained, a technician in the field will be able to define, with simple tests, the most suitable configuration and alternation of the zones 2, 3, for the best optimisation of the extrusion process. A technician in the field can also immediately check whether or not, once a section has been produced according to the optimisation method described above, the latter really constitutes an optimisation, even when he does not know the limit speed VL1 and the limit thickness SM1 of the non-optimised products.

[0052] It is sufficient to substitute the die considered optimised with an equivalent die in which the portions which in the optimised die have alternating zones 2, 3 have a uniform thickness equal to the thickness of the zones 2 of the optimised section, and to perform the entire extrusion process under the same operating conditions used for the previous optimised die.

[0053] In this way, if the previous process was effectively optimised, with the new die one would obtain a non-optimised section with a deteriorated surface, following the appearance of scratches and/or scoring and/or lacerations and/or deformations and/or undulations which are more or less extensive and/or breakage of the extrusion die and for example in the non-limiting case of a section for panels for vehicle bodies with one or more tubular segments, with the optimisation process disclosed applied in the tubular cavities as indicated in the non-limiting example in Figures 2 - 5, lower resistance to bending following forces applied perpendicular to the 2 largest walls. In contrast, if the process was not optimised, one would obtain a non-optimised section with a surface that had not deteriorated and again in the non-limiting case of a section for panels for vehicle bodies with one or more tubular segments, an equal resistance to transversal bending following forces applied perpendicularly to the 2 largest walls.

[0054] The present invention brings important advantages.

[0055] Thanks to the present invention, a method for optimising a process for extrusion of an aluminium section 1 has been perfected, which allows extrusion, at the same speed as current plants, of sections with a lower weight for the same unit of length compared with the extrusion methods currently known, with a consequent economic saving in terms of the cost of the material.

[0056] Alternatively, thanks to the present invention the extrusion speed can be increased with the same weight per unit of length or an ideal compromise can be reached between weight and extrusion speed.

[0057] Another advantage of the present invention is seen when the section 1 has, at the zones 3, a thickness H1 equal to or greater than the thickness H of an equivalent non-optimised section. In this case, the zones 3 form a kind of ribbing for the section 1, guaranteeing the optimised section 1 a mechanical strength substantially equal to (if the thickness of H1 is equal to H) or greater than (when the thickness of H1 is greater than H) the non-optimised sections. The advantage just described is particularly appreciable in the production of hollow sections, with one or more tubular segments, for example such as those of panels for vehicles bodies with the optimisation disclosed applied in the cavities in the section 1, therefore, in a zone that is not visible during use of the finished product.

[0058] In addition, the present invention for the production of sections with low thickness allows a reduction in the pressure which acts on the die by improving the flow of aluminium through the die thanks to the presence of the zones 3, significantly reducing the risk of the die breaking compared with the current extrusion methods.

[0059] It should also be noticed that the present invention is relatively easy to produce and even the cost linked to implementation of the invention is not very high.

[0060] The invention described may be subject to modifications and variations without thereby departing from the scope of the inventive concept.

[0061] All details of the invention may be substituted by other technically equivalent elements and in practice all of the materials used, as well as the shapes and dimensions of the various components, may be any according to requirements.

Claims

1. A method for optimising a process for extrusion of an aluminium section, in which process a section is obtained using a die with a predetermined shape, for said process there being, for the section having, at least at a portion with minimum thickness (H), a practically uniform thickness, and a reference weight per unit of length (PR1), an extrusion limit speed (VL1) corresponding to the maximum extrusion speed that can be reached without deterioration of the surface of the section, the method being **characterised in that** said extrusion is performed in such a way that the optimised section (1) has, in cross-section, at least at one portion, alternating zones (2) having a thickness (H2) less than the minimum thickness (H), and zones (3) having a thickness (H1) greater than the thickness (H2); it being possible to identify for said optimised process an extrusion limit speed (VL2) corresponding to the maximum extrusion speed that can be reached without deterioration of the surface of the section (1) obtained according to said optimisation method, said extrusion limit speed (VL2) being equal to the limit speed (VL1) when the weight for the same unit of length (PR2) of the section (1) is less than the reference weight (PR1), and greater than the limit speed (VL1) if the weight for the same unit of length (PR2) of the section (1) obtained according to the optimisation method is greater than the reference weight (PR1) of the non-optimised section.

2. The optimisation method according to claim 1, **characterised in that** the zones (3) have a triangular shape in cross-section.

3. The optimisation method according to claim 1, **characterised in that** the zones (3) have a rectangular shape in cross-section.

4. The optimisation method according to claim 1, **characterised in that** the zones (3) have a dome shape in cross-section.

5. The optimisation method according to claim 1, **characterised in that** the alternation of zones (2), (3) forms an undulating profile in cross-section.

6. The optimisation method according to claim 1, **characterised in that** the alternation of zones (2), (3) forms a square wave profile in cross-section.

7. The optimisation method according to claim 1, **characterised in that** the alternation of zones (2), (3) forms a saw tooth profile in cross-section.

8. The optimisation method according to claim 1, **characterised in that** the alternation of zones (2), (3) forms a profile of any shape and/or height in cross-section.

9. The optimisation method according to any of the foregoing claims, **characterised in that** the alternation of zones (2), (3) is achieved on most of the sec-

tion (1).

10. The optimisation method according to any of the foregoing claims, **characterised in that** the alternation of zones (2), (3) is also only separately present on part of the section (1).

11. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) is solid, without tubular segments.

12. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) is hollow, with one or more tubular segments.

13. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) has a mixed configuration, solid and hollow, with one or more tubular segments.

14. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) is a panel for an industrial vehicle body.

15. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) is hollow, with one or more tubular segments, the alternation of first and second zones (2), (3) being achieved inside one or more tubular segments of the section (1).

16. The optimisation method according to any of the foregoing claims, **characterised in that** the section (1) is a panel for an industrial vehicle body.

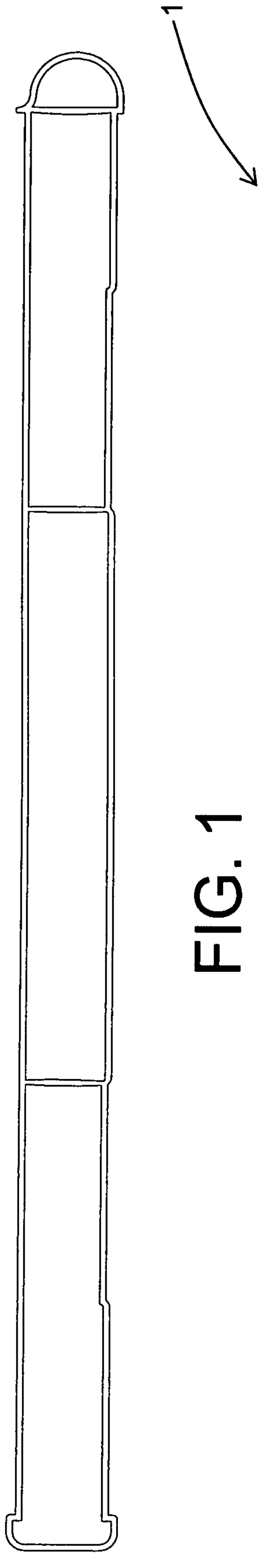

FIG. 1

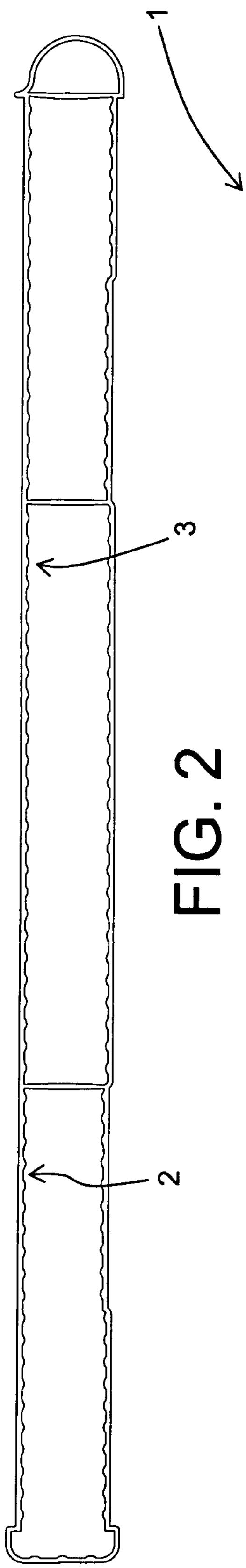

FIG. 2

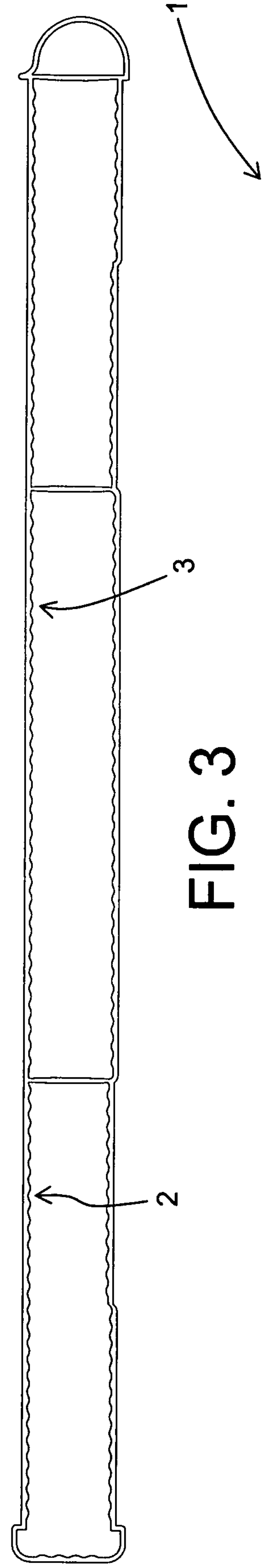

FIG. 3

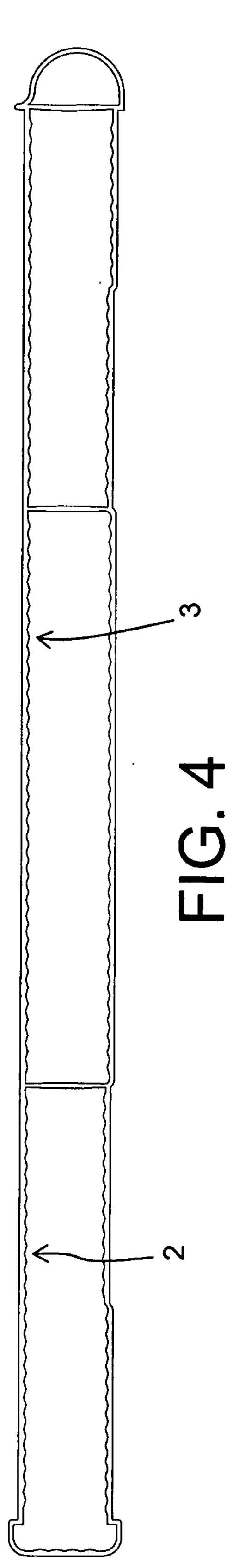

FIG. 4

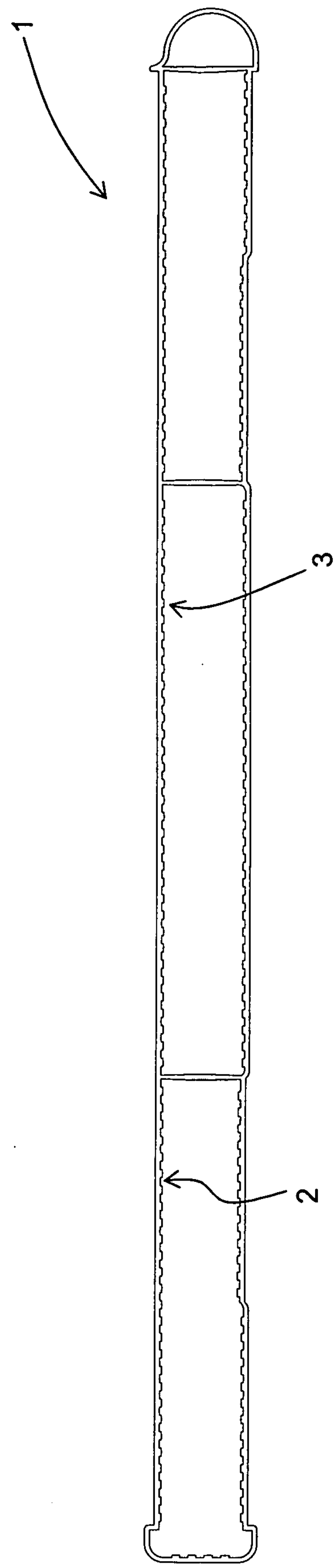

FIG. 5

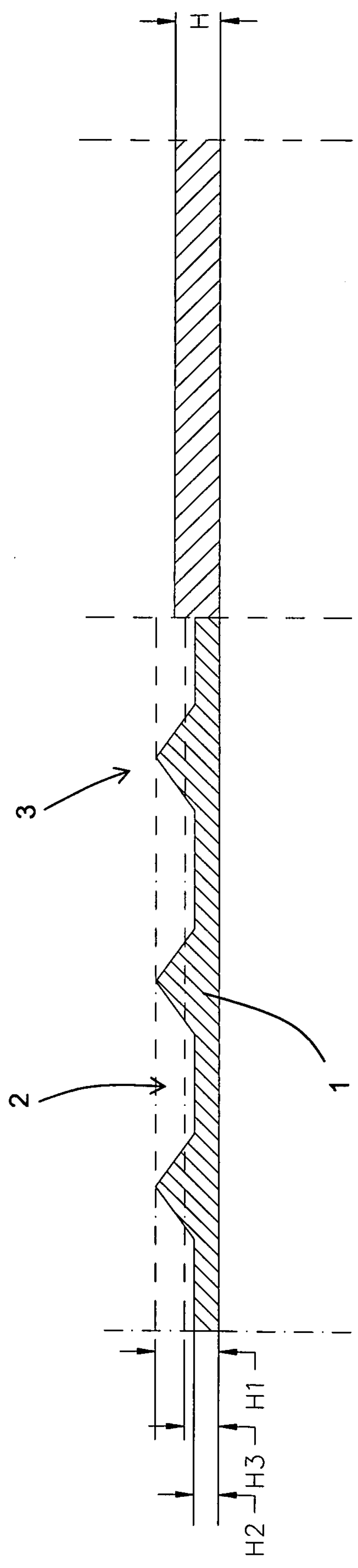

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 05 00 9433

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	5 October 2005	Barrow, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
The Hague	5 October 2005	Barrow, J

CATEGORY OF CITED DOCUMENTS

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