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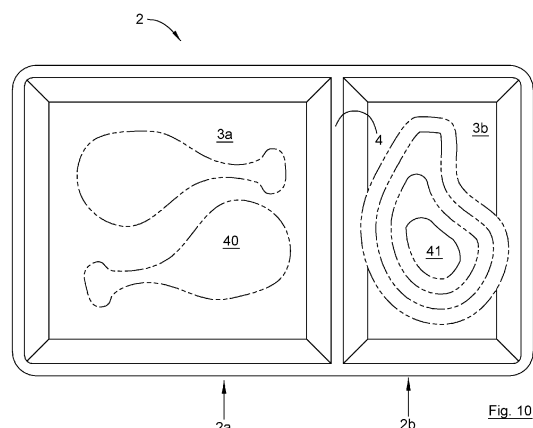
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(54) **METHOD AND APPARATUS FOR DRY MANUFACTURING RIGID CELLULOSE TRAY AND RIGID CELLULOSE TRAY**

(57) The present invention relates to a method for dry manufacturing a rigid cellulose tray (2) having at least two compartments (3a, 3b) separated by a partition (4), the rigid cellulose tray (2) comprising a first sub-tray (2a) and a second sub-tray (2b), wherein the first sub-tray (2a) is connected to the second sub-tray (2b) via said partition (4). The method comprises the steps of: providing an air-laid first cellulose blank segment that comprises a first sub-tray area and a bridging area, pressing the first sub-tray area into a rigid shape and keeping the bridging area in a non-rigid shape, providing an air-laid second cellulose blank segment that comprises a second sub-tray area and a bridging area, pressing the second sub-tray area into a rigid shape and keeping the bridging area in a non-rigid shape, placing the bridging area of the first cellulose blank segment in overlapping contact with the bridging area of the second cellulose blank segment, and joining together the bridging area of the first cellulose blank segment and the bridging area of the second

cellulose blank segment into a rigid partition (4) by applying a predetermined pressure.



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Description

Technical field of the Invention

[0001] The present invention relates in general to the field of method and apparatus for dry manufacturing of rigid cellulose products having non-flat general shape from cellulose blank. Such cellulose products may be used for packaging, storing, transporting and/or displaying other products such as electronics, tools, jewelry, food, dairy products, cosmetics, etc., and/or may be used as single/multiple use disposable articles. The present invention also relates to such rigid cellulose products. By cellulose products means products that mainly consists of the cellulose part of organic matter.

[0002] The present invention relates specifically to an apparatus and a method for dry manufacturing rigid cellulose trays having at least two compartments separated by a partition, the rigid cellulose tray comprising a first sub-tray and a second sub-tray. The first sub-tray comprises a bottom portion for receiving a first item and a circumferential wall connected to and extending in the axial direction upwards from the bottom portion, and wherein the second sub-tray comprises a bottom portion for receiving a second item and a circumferential wall connected to and extending in the axial direction upwards from the bottom portion, and wherein the first sub-tray is connected to the second sub-tray via said partition.

Background of the Invention

[0003] There are many situations where it is desirable to provide two-dimensional (2D) or three-dimensional (3D) shaped objects made of sustainable materials, such as biomaterials, instead of using plastic/polymer materials. A biomaterial commonly used for packaging is wet moulded pulp based on cellulose fibres. Such wet moulded pulp has the advantage of being considered as a sustainable packaging material, since it is produced from biomaterials and can be recycled after use. Wet moulded pulp comprises more or less only water and separated cellulose fibers, and consequently, wet moulded pulp has been popular to use for primary packaging applications (packaging next to the article), for secondary packaging applications (assembly of such primary packages), as well as for manufacturing of disposable articles/products.

[0004] One advantage of using wet-forming techniques is that the moulding tool is filled with a wet cellulose slurry and thereafter the cellulose slurry is dried and obtains the shape of the moulding tool without any risk of cracking of the moulded cellulose product at the transitional portion between adjacent compartments of a multi-compartment cellulose tray.

[0005] However, a common disadvantage with all wet-forming techniques is the need for large amounts of water during the preparations of the cellulose pulp and the need for drying during the manufacturing/moulding of the pro-

duct, which is a time and energy consuming step leading to low production speed and substantial high investment cost in machines and tooling. Meaning that the wet-forming techniques are not feasible to replace fossil-based alternatives neither in small nor large scale production of rigid cellulose products. Thereto, the aesthetic and mechanical properties of a wet-moulded cellulose product are hard to control with desirable precision, due to un-uniform cellulose pulp and due to the wet moulding manufacturing technique *per se*.

[0006] Therefore many actors/companies, starting a few decades ago, have changed their focus and investments towards dry-forming techniques wherein rigid cellulose products are manufactured from separated cellulose fibres that are introduced into a product forming unit in the shape of a cellulose blank/web, wherein the cellulose blank is formed into the shape of the intended cellulose product and wherein the cellulose fibres are bonded to each other using heat and pressure. The dry-forming techniques comprises different steps of generating an air-laid cellulose blank, that is fed into a product forming unit, i.e. a thermo-forming press.

[0007] The technical field of dry manufacturing rigid cellulose products having non-flat general shape, such as trays, lids, or the like, i.e. wherein the forming/pressing is performed in one step using a forming tool having a male mould part and a female mould part configured to cooperate with each other, is well known. However, the technical field of dry manufacturing rigid cellulose trays having at least two compartments separated by a partition, is still exposed to challenges.

[0008] During moulding/pressing of the rigid cellulose trays having a plurality of compartments from the more or less flat cellulose blank, material draw and elongation in the cellulose blank will take place during the insertion of the main projections of the male mould part into the corresponding main recesses of the female mould part, and during the pressing of the cellulose tray having a plurality of compartments. For such multi-compartment cellulose trays, cracks will arise at the transitional region between the compartments. Thereto, uneven thickness of the final cellulose product is a problem. Thus, the possible product shapes/designs that can be manufactured is limited.

[0009] One known way to try to solve the problem of cellulose trays having uneven thickness, is to provide a coating or the like to the projections of the male mould part and to the recesses of the female mould part, in order to decrease the friction between the cellulose blank and the moulding tool in order to counteract material draw and elongation. Such measures may have some positive effect during moulding/pressing of cellulose trays having one compartment. However, the inventors of the present invention have concluded by thorough research that such measures do not have any beneficial effect on the problem concerning material draw and elongation during moulding/pressing rigid cellulose trays having a plurality of compartments, on the contrary it has negative effect

resulting in more cracks at the transitional region between the compartments.

[0010] An alternative technique to dry manufacture rigid cellulose trays having a plurality of compartments, is to separately manufacture each of two sub-trays according to known technique for manufacturing rigid cellulose products. Thereafter these two sub-trays are connected to each other using glue or another adhesive. However, when using glue or other adhesive it is a major risk that the cellulose product is miscoloured/stained, thereto the manufacturing *per se* is made more complex when using such chemicals in the production since it can be harmful for the personal and the environment and adds extra production steps to the manufacturing that are expensive and time consuming (application of glue and drying/curing of the glue), and thereto the glue/adhesive adds extra cost. The glue/adhesive may also have negative effect on the production equipment in the downstream production steps and to the items/food that the rigid cellulose products are intended to be used together with.

[0011] There is still a need in the art for a reliable, cheap and unarmful dry-forming technique/process for dry manufacturing rigid cellulose trays having a plurality of compartments separated by a partition.

Object of the Invention

[0012] The present invention aims at obviating the aforementioned and other disadvantages and failings of previously known methods and apparatus for dry manufacturing rigid multicompartment cellulose trays, and at providing an improved method and apparatus for dry manufacturing rigid cellulose trays having a plurality of compartments separated by a partition.

[0013] A primary object of the present invention is to provide an improved method and apparatus for dry forming/manufacturing rigid cellulose trays having at least two compartments separated by a partition, wherein the environmental benefits as well as time and energy saving benefits of conventional dry-forming techniques are maintained. It is another object of the present invention to provide an improved method and apparatus for dry forming/manufacturing rigid cellulose trays having at least two compartments separated by a partition, wherein the process is free from glue/adhesive. It is another object of the present invention to provide an improved apparatus for dry forming/manufacturing rigid cellulose trays having at least two compartments separated by a partition, wherein the moulded/pressed rigid cellulose product is free from cracks at the transitional region between the compartments. It is another object of the present invention to provide an improved apparatus and method for dry forming/manufacturing rigid cellulose trays having at least two compartments separated by a partition, wherein the final cellulose product has great dimensional accuracy.

Summary of the Invention

[0014] According to the invention at least the primary object is attained by means of the initially defined method and apparatus having the features defined in the independent claims. Preferred embodiments of the present invention are further defined in the dependent claims.

[0015] According to a first aspect of the present invention, there is provided a method for dry manufacturing rigid cellulose trays having at least two compartments separated by a partition. The method comprises the steps of:

- providing an air-laid first cellulose blank segment, wherein the first cellulose blank segment comprises a first sub-tray area and a bridging area located adjacent the first sub-tray area,
- pressing the first sub-tray area of the first cellulose blank segment into a final rigid non-flat shape by applying a predetermined first pressure P1, and keeping the bridging area of the first cellulose blank segment in a non-final non-rigid shape,
- providing an air-laid second cellulose blank segment, wherein the second cellulose blank segment comprises a second sub-tray area and a bridging area located adjacent the second sub-tray area,
- pressing the second sub-tray area of the second cellulose blank segment into a final rigid non-flat shape by applying a predetermined second pressure P2, and keeping the bridging area of the second cellulose blank segment in a non-final non-rigid shape,
- placing the bridging area of the first cellulose blank segment in overlapping contact with the bridging area of the second cellulose blank segment, whereby the first sub-tray is separated from the second sub-tray by said overlapping bridging areas, and
- joining together the bridging area of the first cellulose blank segment and the bridging area of the second cellulose blank segment into a final rigid partition by applying a predetermined third pressure P3, thereby obtaining the rigid cellulose tray having at least two compartments separated by the partition.

[0016] According to a second aspect of the present invention, there is provided an apparatus for dry manufacturing rigid cellulose trays having at least two compartments separated by a partition. The rigid cellulose tray comprises a first sub-tray and a second sub-tray, wherein the first sub-tray that is pressed from a first sub-tray area of a first cellulose blank segment comprises a bottom portion for receiving a first item and a circumferential wall connected to and extending in the axial direction upwards from the bottom portion, and wherein the second sub-tray that is pressed from a second sub-tray area of a second cellulose blank segment comprises a bottom portion for receiving a second item and a circumferential wall connected to and extending in the axial

direction upwards from the bottom portion, and wherein the first sub-tray is connected to the second sub-tray via said partition, the first cellulose blank segment comprising a bridging area located adjacent the first sub-tray area, and the second cellulose blank segment comprising a bridging area located adjacent the second sub-tray area, the apparatus comprising:

- a first moulding tool having a first mould part and a second mould part configured to press the first sub-tray area of the first cellulose blank segment into a final rigid non-flat shape by applying a predetermined first pressure P1, and to keep the bridging area of the first cellulose blank segment in a non-final non-rigid shape,
- a second moulding tool having a first mould part and a second mould part configured to press the second sub-tray area of the second cellulose blank segment into a final rigid non-flat shape by applying a predetermined second pressure P2, and to keep the bridging area of the second cellulose blank segment in a non-final non-rigid shape, and
- a third moulding tool having a first mould part and a second mould part configured to join together the bridging area of the first cellulose blank segment and the bridging area of the second cellulose blank segment into a final rigid partition by applying a predetermined third pressure P3, thereby obtaining the rigid cellulose tray having at least two compartments separated by the partition.

[0017] According to a third aspect of the present invention, there is also provided a rigid cellulose tray having at least two compartments separated by a partition.

[0018] Thus, the present invention is based on the insight of preparing a plurality of sub-trays that are bonded/joined together, and thereto utilizing the same physical properties when bonding/joining the bridging areas of the pre-pressed first cellulose blank segment and the pre-pressed second cellulose blank segment, as when pressing the individual sub-tray area of the cellulose blank segments. In other words, the bridging area of the respective cellulose blank segment is un-compressed or only partially compressed when the corresponding sub-tray area is pressed, entailing that the cellulose fibers in the boundary layers of the non-rigid bridging areas will create internal bindings (hydrogen bindings) with each other during the final joining/pressing step, whereby a homogenous final rigid partition is provided. It shall be pointed out that the inventive method, apparatus and tray may comprise more than two compartments/sub-trays, however, each pair of compartments/sub-trays is connected and separated by a partition.

[0019] The present invention provides the advantage that all surfaces of the rigid cellulose tray comprise the correct amount of material and that the entire multi-compartment tray is homogeneous and thereby mechanically

stable/robust and free from cracks at the transitional region between the compartments. Another essential advantage of the present invention is that the method, apparatus and tray entails that no glue/adhesive need to be used when joining/bonding the rigid cellulose sub-trays into a cellulose tray having at least two compartments separated by a partition.

[0020] According to various example embodiments of the present invention the following step of said method:

- keeping the bridging area of the first cellulose blank segment in a non-final non-rigid shape, comprises the step of:
- partially compressing the bridging area of the first cellulose blank segment into a non-final non-rigid shape by applying a predetermined fourth pressure P4, wherein $P4 < P1$.

[0021] The advantage of this step of partially compressing the bridging area of the first cellulose blank segment is that the pre-pressed first cellulose blank segment is easier to handle/move without having large amounts of cellulose fibres release, or running the risk of having the bridging area separating from the first sub-tray area of the pre-pressed cellulose blank segment.

[0022] According to various example embodiments of the present invention the following step of said method:

- keeping the bridging area of the second cellulose blank segment in a non-final non-rigid shape, comprises the step of:
- partially compressing the bridging area of the second cellulose blank segment into a non-final non-rigid shape by applying a predetermined fifth pressure P5, wherein $P5 < P2$.

[0023] The advantage of this step of partially compressing the bridging area of the second cellulose blank segment is that the pre-pressed second cellulose blank segment is easier to handle/move without having large amounts of cellulose fibres release, or running the risk of having the bridging area separating from the second sub-tray area of the pre-pressed cellulose blank segment.

[0024] According to various example embodiments of the present invention the third pressure $P3 > P1$, and the third pressure $P3 > P2$. Since the final partition is constituted by two bridging areas joined/bonded together, the surface weight of the final partition is greater than at the first sub-tray area of the first cellulose blank segment and greater than at the second sub-tray area of the second cellulose blank segment, and by using a higher pressure when joining/bonding the bridging areas it is assured that the final partition is homogenous and rigid.

[0025] According to various example embodiments of the present invention, the method before the step of:

- placing the bridging area of the first cellulose blank segment in overlapping contact with the bridging

area of the second cellulose blank segment,

comprises the step of:

- applying a liquid composition comprising cellulose to at least one of the bridging area of the first cellulose blank segment and the bridging area of the second cellulose blank segment.

[0026] The liquid composition comprising cellulose are preferably constituted by separated cellulose fibres that are wet/damp using water. The advantage is to assure that the joining/bonding of the bridging areas generates a homogenous and rigid final partition. By applying extra cellulose and water, also bridging areas that during handling of the pre-pressed cellulose blank segments may have lost cellulose fibres and/or may have dried will be adequately joined/bonded into a homogenous final partition.

[0027] Further advantages with and features of the invention will be apparent from the following detailed description of preferred embodiments.

Brief description of the drawings

[0028] A more complete understanding of the above-mentioned and other features and advantages of the present invention will be apparent from the following detailed description of preferred embodiments in conjunction with the appended drawings, wherein:

- Fig. 1 is a schematic illustration of a production line/apparatus for dry manufacturing rigid cellulose products/trays,
- Fig. 2 is a schematic illustration of a first cellulose blank segment comprising a first sub-tray area and a bridging area,
- Fig. 3 is a schematic illustration of a second cellulose blank segment comprising a second sub-tray area and a bridging area,
- Fig. 4 is a schematic illustration of a first moulding tool, wherein a cellulose blank segment according to figure 2 is loaded therein,
- Fig. 5 is a schematic illustration of the first moulding tool according to figure 4, wherein the first sub-tray area of the first cellulose blank segment is pressed into final rigid non-flat shape and the bridging area is only partially compressed,
- Fig. 6 is a schematic illustration of the first moulding tool according to figures 4 and 5, after the forming/pressing of the first sub-tray area and the first sub-tray is released from the moulding tool,
- Fig. 7 is a schematic illustration of a first sub-tray wherein the scrap area is removed from the first sub-tray,
- Fig. 8 is a schematic illustration of a third moulding

tool, wherein a first pre-pressed first subtray according to figure 7 and a second pre-pressed second sub-tray are loaded therein, having the bridging areas in overlapping contact,

Fig. 9 is a schematic illustration of the third moulding tool according to figure 8, wherein the bridging area of the first cellulose blank segment and the bridging area of the second cellulose blank segment are joined to each other and the multi-compartment rigid cellulose tray is released from the third moulding tool,

Fig. 10 is a schematic illustration of a rigid cellulose product/tray having two compartments separated by the partition, and

Fig. 11 is a schematic illustration of a rigid cellulose product/tray having three compartments separated by partitions.

Detailed description of preferred embodiments of the invention

[0029] As used herein, the term "air/dry moulding/forming or air/dry laying/laid" means a well-known method according to which separated cellulose fibres are formed into a cellulose blank/sheet.

[0030] In air-laying technique, small/short fibres having a normal length in the range of 0,5 to 70 mm, for instance 1 to 10 mm, are separated and captured by an air stream/flow, and then laid on or applied to a forming mesh/surface, usually using a low pressure at the other side of the mesh/surface. The terms "air/dry laying" and "air/dry moulding" are used interchangeably. The cellulose fibre carrying air flow may be generated by suitable device located upstream and/or downstream the forming mesh/surface.

[0031] Reference is initially made to figures 1 and 10, wherein figure 1 disclose a schematic illustration of a generic production line/apparatus for dry manufacturing rigid cellulose products, wherein said apparatus is generally designated 1. The production line 1 is configured for manufacturing rigid cellulose products, generally designated 2, having essentially non-flat general shape from separated cellulose fibres. Such a production line 1 may be arranged and set-up according to different well-known ways. Figure 10 disclose a rigid cellulose tray 2 having at least two compartments 3a, 3b separated by a partition 4. The apparatus 1 may have automatized transfer/handling between the different process steps, and/or may have manual transfer/handling between the different process steps, and thereto the apparatus 1 may have intermediate storing and/or additional process steps between the disclosed process steps.

[0032] Cellulose raw material 5, i.e. comprising mainly of the cellulose part of organic matter, is provided to the production line, and is fed to a separating/disintegrating unit 6 in order to obtain individualized/separated cellulose fibres. The separated cellulose fibres are thereafter

transported by an air stream/flow to a dispenser of a cellulose blank/sheet forming unit 7. The cellulose fibres are laid by the dispenser on a moving or stationary perforated surface of the cellulose blank forming unit 7. The cellulose fibre carrying air flow may be generated by suitable device located upstream and/or downstream the perforated surface. Thereafter the generated cellulose blank, generally designated 8, is transported to a product forming unit 9, whereby rigid cellulose products/trays 2 are formed and discharged from the product forming unit 9.

[0033] The cellulose blank forming unit 7 may be configured to generate a continuous cellulose blank/web and/or discontinuous/discrete cellulose blanks. Discontinuous/discrete cellulose blanks are fed into the product forming unit 9. Figure 2 disclose a first cellulose blank segment 10 and figure 3 disclose a second cellulose blank segment 11, which both are made of a cellulose blank 8. The first cellulose blank segment 10 and the second cellulose blank segment 11 may have the same or different size.

[0034] The cellulose raw material 5 may be in the form of reeled pulp or paper, bale of cellulose pulp, paper, etc. and/or sheets of paper, cellulose pulp, etc. In case said cellulose raw material 5 is in the form of sheets and/or reeled pulp or paper, it can be fed directly into the separating unit 6. However, in case said cellulose raw material 5 is in the form of a bale or compact stacks of sheets, etc. one or more shredders and/or one or more additional separating/disintegrating units 6 may be necessary to be used for separating and dosing said cellulose raw material 5 from said bale or sheets in smaller quantities. The shredder(s) prepare cellulose raw material 5 to be accepted by said separating unit 6. The separating unit 6 disintegrates the cellulose raw material 5 into separated cellulose fibres. Said one or plurality of shredder(s) are arranged before said one or a plurality of separating unit(s) 6, so that an output of one of said shredder is connected to an input of one of said separating units 6. The shredders may be arranged in parallel to each other or in series with each other, and the disintegrating units 6 may be arranged in parallel to each other or in series with each other. The shredders and the disintegrating units 6 together constitute a cellulose fibre separating unit, arranged upstream the cellulose blank forming unit 7.

[0035] Said cellulose raw material 5 may be constituted by virgin cellulose fibres and/or recycled cellulose fibres and may originate from wood pulps such as kraft pulp, sulphite pulp, mechanical pulp, thermomechanical pulp (TMP), chemical treated mechanical pulp, chemi-thermomechanical pulp (CTMP), and/or from non-wood pulps such as bagasse, bamboo, abaca, hemp, flax, cotton.

[0036] The separating unit 6 may according to various embodiments be constituted by a hammer mill. In said separating unit 6 the cellulose raw material is separated into fibres having a normal length in the range of 0,5-70 mm, preferably less than 10 mm. The length of said fibres

may be customized by adjusting the internal properties of the separating unit 6 and/or by choosing a different separating unit 6 and/or choosing different cellulose raw material. The fibre length for wood pulp is according to various embodiments in the range 0,5-4 mm, preferably in the range 1,7-3,6 mm. According to various embodiments the fibre length for non-wood pulp is in the range 0,5-70 mm.

[0037] The production line 1 may comprise a pre-compression and/or imprinting unit 12, located downstream the cellulose blank forming unit 7 and upstream the product forming unit 9. In the pre-compression and/or imprinting unit 12, an air-laid fluffy cellulose blank 8 having a first thickness may be compressed into a cellulose blank 8 having a second thickness, wherein said second thickness is thinner than said first thickness, and/or may be provided with an imprinting pattern. During the pre-compression/imprinting the cellulose blank is made more coherent and easier to handle, since the pre-compression/imprinting generates internal bindings between individual cellulose fibres preventing mutual separation of the cellulose fibres.

[0038] The product forming unit 9 comprises a press unit 13, and may optionally comprise a pre-heating unit 14 arranged upstream the press unit 13. According to various example embodiments said cellulose blank 8 may be heated to an elevated temperature before being fed into the press unit 13 of the product forming unit 9. In such embodiment(s) where the cellulose blank 8 is pre-heated before being fed into the press unit 13, said press unit 13 may or may not comprise heating. According to various example embodiment said press unit 13 may be a heated press unit 13 for heating said cellulose blank 8 during pressing. In the case of a heated press unit 13, preheating of said cellulose blank 8 using a pre-heating unit 14 is optional. According to various example embodiments preheating of the cellulose blank 8 in said pre-heating unit 14 may be combined with a heated press unit 13. Having a pre-heating unit 14 in combination with a heated press unit 13 will speed up the manufacturing process in the product forming unit 9, and improve the quality/rigidity of the final rigid cellulose product/tray 2. In the product forming unit 9 the cellulose blank 8 is heated to a temperature in the range 120 - 200 °C in order to obtain adequate rigidity and strength in the final cellulose product/tray 2.

[0039] Reference is now especially made to figures 2 and 3. Figure 2 disclose a first type of cellulose blank 8 constituted by a first cellulose blank segment 10, and figure 3 disclose a second type of cellulose blank 8 constituted by a second cellulose blank segment 11. The first cellulose blank segment 10 and the second cellulose blank segment 11 may be of the same type or of different type, i.e. regarding surface weight, material, thickness, size, general shape, etc.

[0040] The first cellulose blank segment 10 comprises a first sub-tray area 15 and a bridging area 16 located adjacent the first sub-tray area 15. Outside the first sub-

tray area 15 and the associated bridging area 16, the first cellulose blank segment 10 may comprise a scrap/residual area 17. The second cellulose blank segment 11 comprises a second sub-tray area 18 and a bridging area 19 located adjacent the second sub-tray area 18. Outside the second sub-tray area 18 and the associated bridging area 19, the second cellulose blank segment 11 may comprise a scrap/residual area 20. Said scrap areas 17, 20 are preferably as small as possible in order to minimize scrap from the product forming unit 9. However, it is important that the entire sub-tray areas 15, 18 and the associated bridging areas 16, 19 all have the correct and intended surface weight. It shall be pointed out that the cellulose blank 8 according to figures 2 and 3 having one sub-tray area, but each may comprise a plurality of sub-tray areas and associated bridging areas.

[0041] Reference is now made to figures 4-7. The press unit 13 comprises a first moulding tool having a first mould part 21 and a second mould part 22 having cooperating designs, wherein at least one of the first mould part 21 and the second mould part 22 is/are displaceable in the axial direction in relation to each other, i.e. reciprocating back and forth in relation to each other, in order to exert pressure to the cellulose blank 8 loaded therebetween. In the figures the mutual displacement is disclosed as being vertical, however the mutual displacement may be horizontal or any other suitable angle. The cellulose blank 8 loaded into the first moulding tool, is constituted by the air-laid first cellulose blank segment 10. The air-laid first cellulose blank segment 10 may be generated upstream the product forming unit 9 in the same apparatus/production line and provided/transferred to the product forming unit 9, or may be generated at a separate location and provided/transferred to the product forming unit 9 via intermediate handling and storage.

[0042] According to various embodiments the first mould part 21 of the first moulding tool is a female mould part, i.e. having a recess 23 for receiving the first sub-tray area 15 of the first cellulose blank segment 10, and the second mould part 22 of the first moulding tool is a male mould part, i.e. having a protrusion 24 for cooperation with said recess 23, such that the first sub-tray area 15 of the first cellulose blank segment 10 is pressed into a final rigid non-flat shape, i.e. a first sub-tray of any conceivable shape. According to the disclosed embodiment the female mould part 21 is located above the male mould part 22, but according to alternative embodiments the male mould part 22 may be located above the female mould part 21. During the pressing of the first sub-tray 2a, as disclosed in figure 5, a predetermined first pressure P1 is applied by the first moulding tool between the recess 23 and the protrusion 24. Thus, the first sub-tray area 15 of the first cellulose blank segment 10 obtains its final rigid non-flat shape, which may have any conceivable tray design/shape.

[0043] The main projection 24 of the male mould part 22 has a bottom surface 25 and a wall surface 26 connected to the bottom surface 25 and extending essen-

tially in the axial direction. The main recess 23 of the female mould part 21 has a bottom surface 27 and a wall surface 28 connected to the bottom surface 27 and extending essentially in the axial direction. The first sub-tray area 15 of the first cellulose blank segment 10 is pressed between the surfaces of the male mould part 22 and the surfaces of the female mould part 21 into final shape. During the pressing of the first sub-tray area 15 of the first cellulose blank segment 10, the bridging area 16 of the first cellulose blank segment 10 is kept in a non-final non-rigid shape, i.e. the first mould part 21 and/or the second mould part 22 comprise(s) local recesses 29 adjacent the recess 23 and/or the projection 24. Such local recesses 29 in the mould parts entails that the mutual distance between the surfaces of the first mould part 21 and the second mould part 22 at the first sub-tray area 15 is less than the mutual distance between the surfaces of the first mould part 21 and the second mould part 22 at the bridging area 16, whereby the bridging area 16 is un-compressed or only partially compressed when the first sub-tray area 15 is pressed/formed. The mutual distance at the bridging area 16 is preferably equal to or more than 20 % greater than the mutual distance at the first sub-tray area 15, and preferably equal to or less than 100 % greater than the mutual distance at the first sub-tray area 15. Thereby the bridging area 16 remains un-compressed or is only partially compressed, in the first moulding tool, i.e. kept in a non-final non-rigid shape when the first sub-tray area 15 of the first cellulose blank segment 10 is pressed/formed into final rigid shape. When the bridging area 16 of the first cellulose blank segment 10 is partially compressed into a non-final non-rigid shape, it is performed by applying a predetermined forth pressure P4, wherein $P4 < P1$. At the scrap area 17 the mutual distance between the first mould part 21 and the second mould part 22 is equal to or more than the mutual distance at the first sub-tray area 15. The scrap area 17 may be left entirely uncompressed, be partially compressed by applying for instance the predetermined forth pressure P4 or be fully compressed by applying for instance the predetermined first pressure P1.

[0044] In figure 6 the first cellulose blank segment 10 is released by opening the first moulding tool, wherein the first sub-tray area 15 is pressed into final rigid non-flat shape and the bridging area 16 is kept in a non-final non-rigid shape. Figure 7 disclose a schematic illustration of a first sub-tray 2a wherein the scrap area 17 is removed from the first sub-tray 2a. The scrap area 17 may be removed in a separate step in the first moulding tool, in a subsequent step outside the first moulding tool, or in a step concurrent with the pressing of the first sub-tray 2a.

[0045] The first sub tray 2a comprises a circumferential wall 30 and an opening 31 defined by a circumferential rim/brim 32 located at the upper/free end of the wall 30. According to figure 7 embodiment the brim 32 has an angled shape having an essentially radially extending upper surface and a turned-down outer edge, however it shall be pointed out that the cross-section of the brim 32

may have other shapes. The first sub tray 2a may have truncated cone shape having straight wall 30, narrowing in the direction away from the opening 31, in accordance with figure 7 embodiment, or may for instance have curved-shaped wall 30 seen in the axial plane. Thereby multiple such first sub trays 2a are stackable one inside the other when they are empty. The cross section of the wall 30 in the radial plane may have any suitable shape, circular, oval, rectangular, polygonal, etc., and may differ in shape and/or dimension along the axial extension of the first sub tray 2a. The first sub tray 2a comprise a bottom portion 33, wherein the bottom portion is flat or the bottom may comprise local ribs, projections, etc., for strength and rigidity of the cellulose product. The bottom 33 may be located at the very lower end of the wall 30, according to figure 7 embodiment, or be located at a distance from the lower end of the wall 30, or a combination thereof. The circumferential wall 30 is connected to and extends in the axial direction upwards from the bottom portion 33. The walls of the moulding tool has to be inclined in order to obtain a release angle for the cellulose product, and in order to obtain adequate press force to the wall region of the cellulose product.

[0046] Regarding the second cellulose blank segment 11 the invention comprises various embodiments, but common for all embodiments is that a second cellulose blank segment 11 is loaded into a second moulding tool that is part of the press unit 13. It shall be pointed out that the second moulding tool does not need to be arranged at the same location as the first moulding tool. It shall also be pointed out that the second moulding tool may be constituted by the first moulding tool, or by a moulding tool of the same type/design as said first moulding tool. During the pressing of the second sub-tray 2b, the second sub-tray area 18 of the second cellulose blank segment 11 is pressed into a final rigid shape by applying a predetermined second pressure P2. The predetermined second pressure P2 is preferably equal to the predetermined first pressure P1.

[0047] According to various embodiments the second moulding tool is identical to, or is constituted by, the first moulding tool. Nonetheless, the same steps are performed mutatis mutandis in order to generate the second sub-tray 2b having a pressed second sub-tray area 18 as described above to generate the first sub-tray 2a. The bridging area 19 of the second sub-tray 2b is kept/maintained in a non-final non-rigid shape. When the bridging area 19 of the second cellulose blank segment 11 is partially compressed into a non-final non-rigid shape, it is performed by applying a predetermined fifth pressure P5, wherein $P5 < P2$. Everything described in connection with the first moulding tool is also applicable to the second moulding tool, and everything described in connection with the first sub-tray 2a is mutatis mutandis applicable to the second sub-tray 2b. The second sub-tray 2b comprises a bottom portion 34 and a circumferential wall 35 connected to and extending in the axial direction upwards from the bottom portion 34. The second sub-tray 2b also

comprises an opening 36 defined by a circumferential rim/brim 37 located at the upper/free end of the wall 35. Thus, the compartments 3a, 3b are open upwards in order to receive objects/items.

[0048] Reference is now made to figures 8-9, disclosing the joining/bonding of the rigid cellulose tray 2. Figures 8-9 disclose a third moulding tool having a first mould part 38 and a second mould part 39, wherein the third moulding tool is part of the pressing unit 13. The third moulding tool is configured to join together the bridging area 16 of the first cellulose blank segment 10 and the bridging area 19 of the second cellulose blank segment 11 into a final rigid partition 4 by applying a predetermined third pressure P3, thereby obtaining the rigid cellulose tray 2 having at least two compartments 3a, 3b separated by the partition 4. The predetermined third pressure P3 is preferably greater than the predetermined first pressure P1. It shall be pointed out that only parts of the third moulding tool is disclosed in figures 8-9, for instance the third moulding tool comprises a support (non-disclosed) for the first sub-tray 2a and the second sub-tray 2b.

[0049] In figure 8 the first cellulose blank segment 10 having pre-pressed first sub-tray area 15 and the second cellulose blank segment 11 having pre-pressed second sub-tray area 18 are introduced/loaded in the third moulding tool. Thereto the bridging area 16 of the first cellulose blank segment 10 is placed in overlapping contact with the bridging area 19 of the second cellulose blank segment 11, and the first sub-tray 2a of the first cellulose blank segment 10 is placed besides the second sub-tray 2b of the second cellulose blank segment 11, i.e. the first sub-tray 2a is separated from the second sub-tray 2b by said overlapping bridging areas 16, 19. The first mould part 38 and the second mould part 39 correspond in shape and location to the bridging area 16 of the first cellulose blank segment 10 and of the bridging area 19 of the second cellulose blank segment 11.

[0050] According to various embodiments, before the step of placing the bridging area 16 of the first cellulose blank segment 10 in overlapping contact with the bridging area 19 of the second cellulose blank segment 11, a liquid composition comprising cellulose or starch may be applied to at least one of the bridging area 16 of the first cellulose blank segment 10 and the bridging area 19 of the second cellulose blank segment 11. The liquid composition is preferably constituted by cellulose fibres that are wetted/dampened by water. Alternatively, only water is applied to at least one of the bridging area 16 of the first cellulose blank segment 10 and the bridging area 19 of the second cellulose blank segment 11. During the joining/bonding of the final rigid partition 4 it becomes homogeneous. In figure 9 the joined/bonded rigid cellulose tray 2 having at least two compartments 3a, 3b separated by the partition 4 is released by opening the third moulding tool.

[0051] Reference is now made to figures 10 and 11, disclosing a rigid cellulose tray 2 from above. According

to figure 10, at least one first item 40 is received at the bottom portion 33 of the first compartment 3a/first sub-tray 2a, and at least one second item 41 is received at the bottom portion 34 of the second compartment 3b/second sub-tray 2b. In the disclosed embodiment the partition 4 is a straight line, however the partition may have any suitable shape such as curved, wave-shaped. The rigid cellulose tray 2 may have a rectangular shape as in the disclosed embodiment, or may have any suitable shape such as circular, polygonal, etc. According to figure 11, the cellulose tray 2 comprises three compartments 3a, 3b and 3c, i.e. the rigid cellulose tray 2 may comprise more than two compartments, wherein each pair of bridging areas are joined as described above. Thus, also a third sub-tray 2c is pre-pressed in the same way as the first sub-tray 2a and all three pre-pressed sub-trays are joined in the third moulding tool.

[0052] According to various embodiments, the partition 4 may comprise one or more folding groove(s)/notch(es) extending along the partition such that the second sub-tray 2b may be easily folded in relation to the first sub-tray 2a, for instance in order to mix the second item 41 with the first item 40.

[0053] According to various embodiments the partition 4 may comprise a perforation line extending along the partition such that the first sub-tray 2a and the second sub-tray 2b can be separated from each other by tearing at the perforation line.

[0054] The partition 4 is preferably equal to or more than 5 millimetres and equal to or less than 20 millimetres, preferably equal to or less than 10 millimetres. The width of the partition 4 is measured as the width of the overlapping part before joining of the bridging areas.

[0055] According to various embodiments. When the compartments of the rigid cellulose tray 2 are filled with objects, a film/cover/lid may be attached to the circumferential rim/brim of the cellulose tray 2 and to the partition 4, for instance using heat lamination. The lid film may be constituted by a multilayer film comprising polymer, metal, and/or paper.

[0056] According to various embodiments. Before any items are placed in the compartments of the rigid cellulose tray, the rigid cellulose tray 2 may be provided with a liner film adhered to at least to the circumferential rim/brim and to the partition(s), and preferably also to the walls and/or bottom of the sub-trays. The liner film may be constituted by a multilayer film comprising polymer and/or metal. The adhesion of the liner film to the tray is preferably heat activated.

[0057] According to various embodiments, the cellulose blanks may comprise barrier additives, such that the rigid cellulose tray 2 withstand grease, fat, water, vapour, etc.

[0058] The predetermined pressures P1-P5 is in the range 40-10000N/cm², preferably in the range 100-4000N/cm². According to various embodiments said predetermined pressures are above 1000 N/ cm², and according to various embodiments said predetermined

pressures are below 2500 N/ cm². The holding time during the different pressing steps is in equal to or more than 1 second and equal to or less than 10 seconds, preferably less than 5 seconds, and most preferably less than 3 seconds.

Feasible modifications of the Invention

[0059] The invention is not limited only to the embodiments described above and shown in the drawings, which primarily have an illustrative and exemplifying purpose. This patent application is intended to cover all adjustments and variants of the preferred embodiments described herein, thus the present invention is defined by the wording of the appended claims and the equivalents thereof. Thus, the equipment may be modified in all kinds of ways within the scope of the appended claims.

[0060] Throughout this specification and the claims which follows, unless the context requires otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or steps or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

[0061] It shall be pointed out that the final rigid cellulose product may be constituted by three or more segments, wherein each pair of neighbouring segments are joined/connected to each other according to the present invention.

Claims

1. Method for dry manufacturing a rigid cellulose tray (2) having at least two compartments (3a, 3b) separated by a partition (4), the rigid cellulose tray (2) comprising a first sub-tray (2a) and a second sub-tray (2b), wherein the first sub-tray (2a) comprises a bottom portion (33) for receiving a first item (40) and a circumferential wall (30) connected to and extending in the axial direction upwards from the bottom portion (33), and wherein the second sub-tray (2b) comprises a bottom portion (34) for receiving a second item (41) and a circumferential wall (35) connected to and extending in the axial direction upwards from the bottom portion (34), and wherein the first sub-tray (2a) is connected to the second sub-tray (2b) via said partition (4), the method comprising the steps of:

- providing an air-laid first cellulose blank segment (10), wherein the first cellulose blank segment (10) comprises a first sub-tray area (15) and a bridging area (16) located adjacent the first sub-tray area (15),
- pressing the first sub-tray area (15) of the first cellulose blank segment (10) into a final rigid

non-flat shape by applying a predetermined first pressure P1, and keeping the bridging area (16) of the first cellulose blank segment (10) in a non-final non-rigid shape,

- providing an air-laid second cellulose blank segment (11), wherein the second cellulose blank segment (11) comprises a second sub-tray area (18) and a bridging area (19) located adjacent the second sub-tray area (18),

- pressing the second sub-tray area (18) of the second cellulose blank segment (11) into a final rigid non-flat shape by applying a predetermined second pressure P2, and keeping the bridging area (19) of the second cellulose blank segment (11) in a non-final non-rigid shape,

- placing the bridging area (16) of the first cellulose blank segment (10) in overlapping contact with the bridging area (19) of the second cellulose blank segment (11), whereby the first sub-tray (2a) is separated from the second sub-tray (2b) by said overlapping bridging areas (16, 19), and

- joining together the bridging area (16) of the first cellulose blank segment (10) and the bridging area (19) of the second cellulose blank segment (11) into a final rigid partition (4) by applying a predetermined third pressure P3, thereby obtaining the rigid cellulose tray (2) having at least two compartments (3a, 3b) separated by the partition (4).

2. The method according to claim 1, wherein the at least two compartments (3a, 3b) are open upwards.

3. The method according to any preceding claim, wherein the step of:

- keeping the bridging area (16) of the first cellulose blank segment (10) in a non-final non-rigid shape,

comprises the step of:

- partially compressing the bridging area (16) of the first cellulose blank segment (10) into a non-final non-rigid shape by applying a predetermined fourth pressure P4, wherein $P4 < P1$.

4. The method according to any preceding claim, wherein the step of:

- keeping the bridging area (19) of the second cellulose blank segment (11) in a non-final non-rigid shape,

comprises the step of:

- partially compressing the bridging area (19) of

the second cellulose blank segment (11) into a non-final non-rigid shape by applying a predetermined fifth pressure P5, wherein $P5 < P2$.

5. The method according to any preceding claim, wherein the third pressure $P3 > P1$, and wherein the third pressure $P3 > P2$.

6. The method according to any preceding claim, wherein the method before the step of:

- placing the bridging area (16) of the first cellulose blank segment (10) in overlapping contact with the bridging area (19) of the second cellulose blank segment (11),

comprises the step of:

- applying a liquid composition comprising cellulose to at least one of the bridging area (16) of the first cellulose blank segment (10) and the bridging area (19) of the second cellulose blank segment (11).

7. Apparatus for dry manufacturing rigid cellulose trays (2) having at least two compartments (3a, 3b) separated by a partition (4), the rigid cellulose tray (2) comprising a first sub-tray (2a) and a second sub-tray (2b), wherein the first sub-tray (2a) that is pressed from a first sub-tray area (15) of a first cellulose blank segment (10) comprises a bottom portion (33) for receiving a first item (40) and a circumferential wall (30) connected to and extending in the axial direction upwards from the bottom portion (33), and wherein the second sub-tray (2b) that is pressed from a second sub-tray area (18) of a second cellulose blank segment (11) comprises a bottom portion (34) for receiving a second item (41) and a circumferential wall (35) connected to and extending in the axial direction upwards from the bottom portion (34), and wherein the first sub-tray (2a) is connected to the second sub-tray (2b) via said partition (4), the first cellulose blank segment (10) comprising a bridging area (16) located adjacent the first sub-tray area (15), and the second cellulose blank segment (11) comprising a bridging area (19) located adjacent the second sub-tray area (18), the apparatus comprising:

- a first moulding tool having a first mould part (21) and a second mould part (22) configured to press the first sub-tray area (15) of the first cellulose blank segment (10) into a final rigid non-flat shape by applying a predetermined first pressure P1, and to keep the bridging area (16) of the first cellulose blank segment (10) in a non-final non-rigid shape,

- a second moulding tool having a first mould part

and a second mould part configured to press the second sub-tray area (18) of the second cellulose blank segment (11) into a final rigid non-flat shape by applying a predetermined second pressure P2, and to keep the bridging area (19) of the second cellulose blank segment (11) in a non-final non-rigid shape, and
 - a third moulding tool having a first mould part (38) and a second mould part (39) configured to join together the bridging area (16) of the first cellulose blank segment (10) and the bridging area (19) of the second cellulose blank segment (11) into a final rigid partition (4) by applying a predetermined third pressure P3, thereby obtaining the rigid cellulose tray (2) having at least two compartments (3a, 3b) separated by the partition (4).

8. A rigid cellulose tray (2) having at least two compartments (3a, 3b) separated by a partition (4), manufactured by the method according to any of claims 1-6, the rigid cellulose tray (2) comprising a first sub-tray (2a) and a second sub-tray (2b), wherein the first sub-tray (2a) that is pressed from a first sub-tray area (15) of a first cellulose blank segment (10) comprises a bottom portion (33) for receiving a first item (40) and a circumferential wall (30) connected to and extending in the axial direction upwards from the bottom portion (33), and wherein the second sub-tray (2b) that is pressed from a second sub-tray area (18) of a second cellulose blank segment (11) comprises a bottom portion (34) for receiving a second item (41) and a circumferential wall (35) connected to and extending in the axial direction upwards from the bottom portion (34), and wherein the first sub-tray (2a) is connected to the second sub-tray (2b) via said partition (4), wherein a bridging area (16) of the first cellulose blank segment (10) that is adjacent the first sub-tray area (15) of the first cellulose blank segment (10) and a bridging area (19) of the second cellulose blank segment (11) that is adjacent the second sub-tray area (18) of the second cellulose blank segment (11), are joined into a final rigid partition (4).
9. The rigid cellulose tray (2) according to claim 8, wherein the rigid cellulose tray (2) comprises cellulose fibres from a cellulose raw material (5) constituted by virgin cellulose fibres and/or recycled cellulose fibres, wherein the cellulose fibres originate from wood pulps such as kraft pulp, sulphite pulp, mechanical pulp, thermomechanical pulp, chemical treated mechanical pulp, chemi-thermomechanical pulp, and/or from non-wood pulps such as bagasse, bamboo, abaca, hemp, flax, cotton.

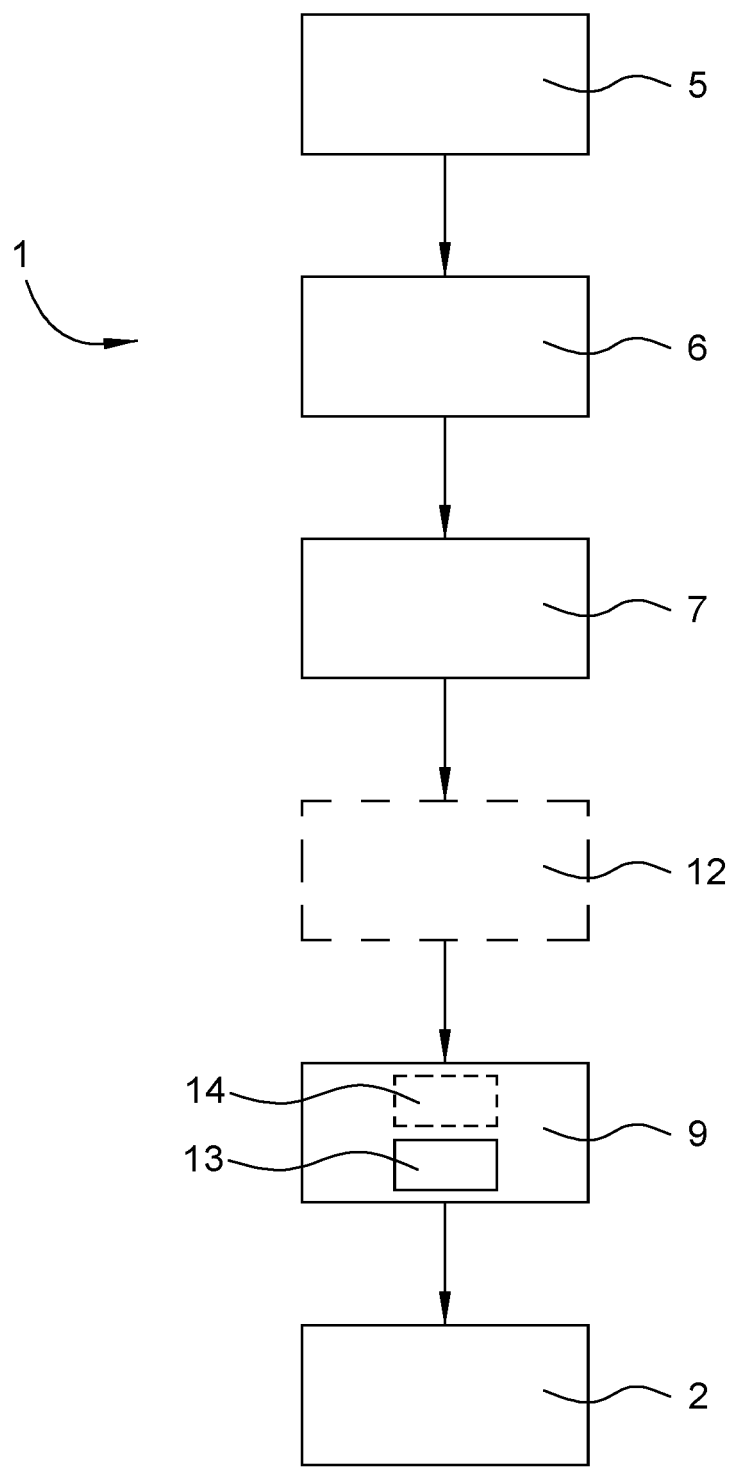
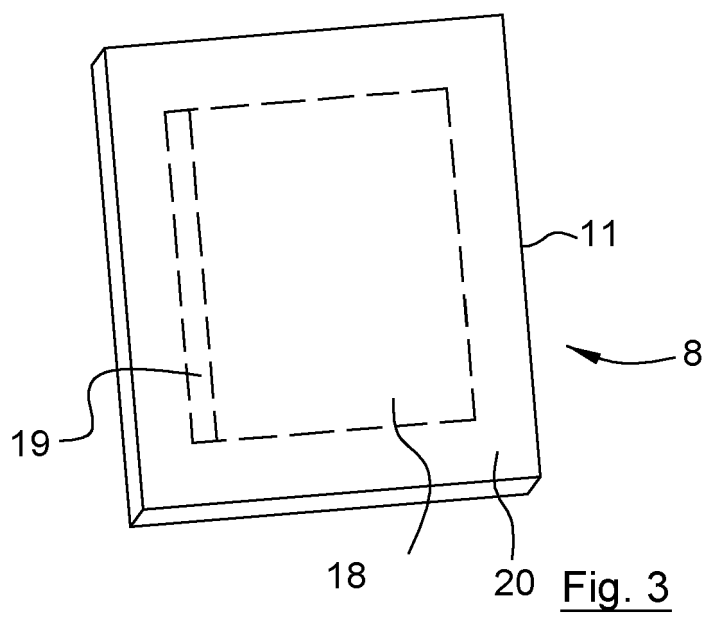
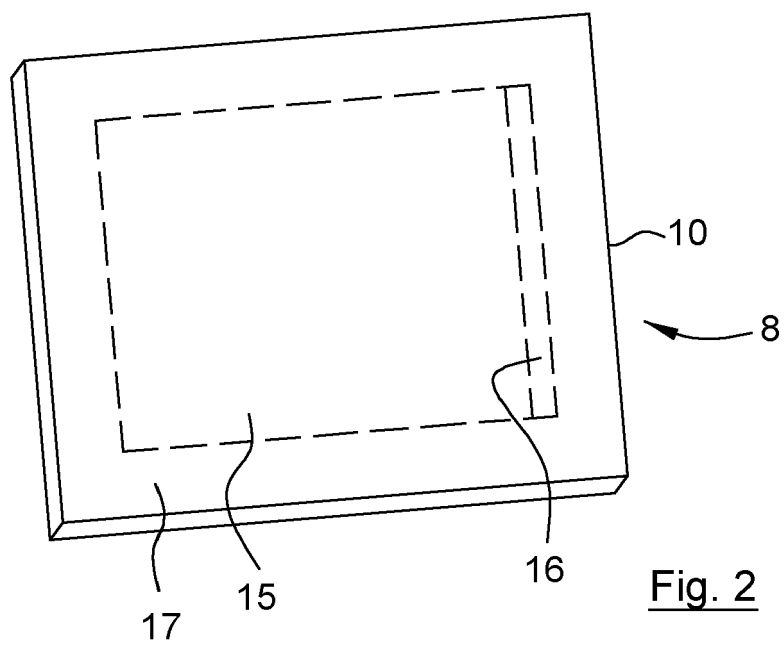


Fig. 1



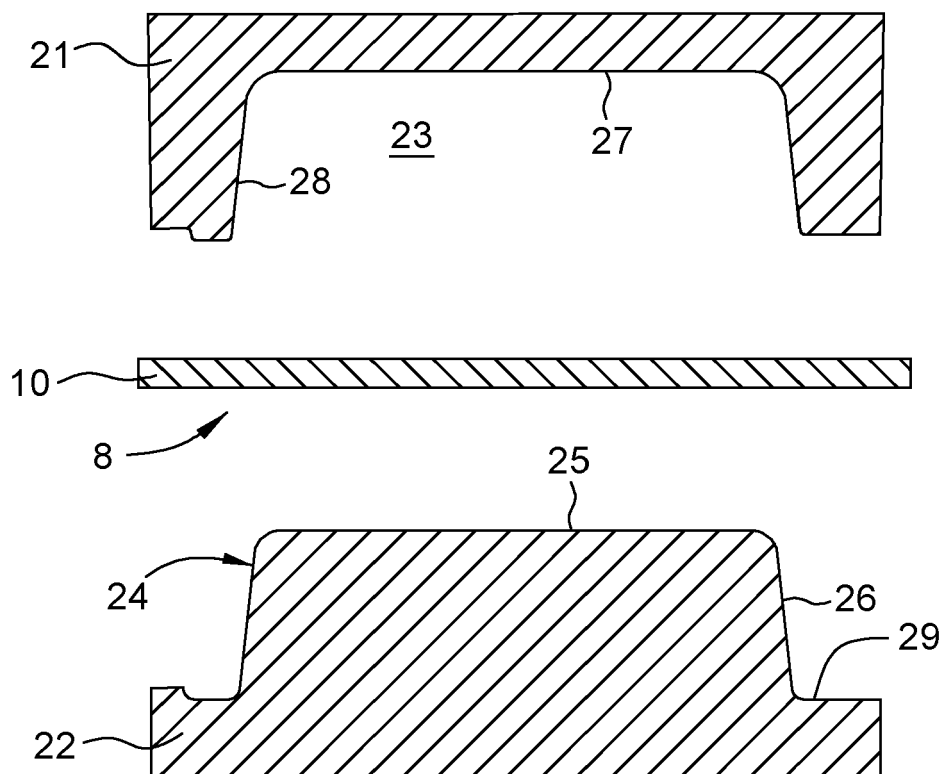


Fig. 4

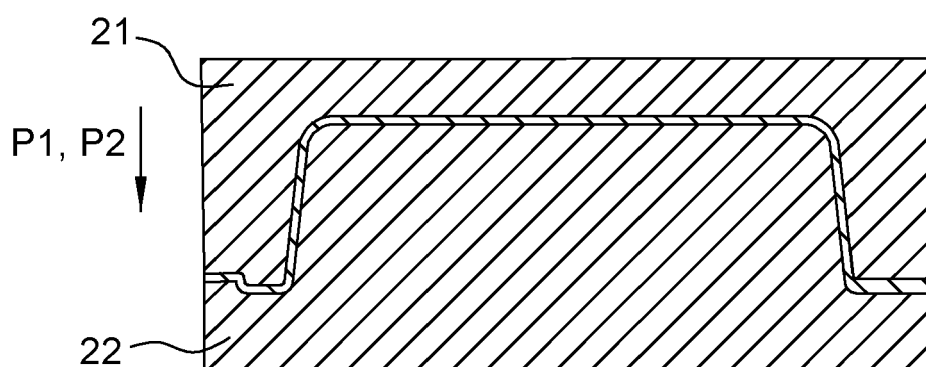


Fig. 5

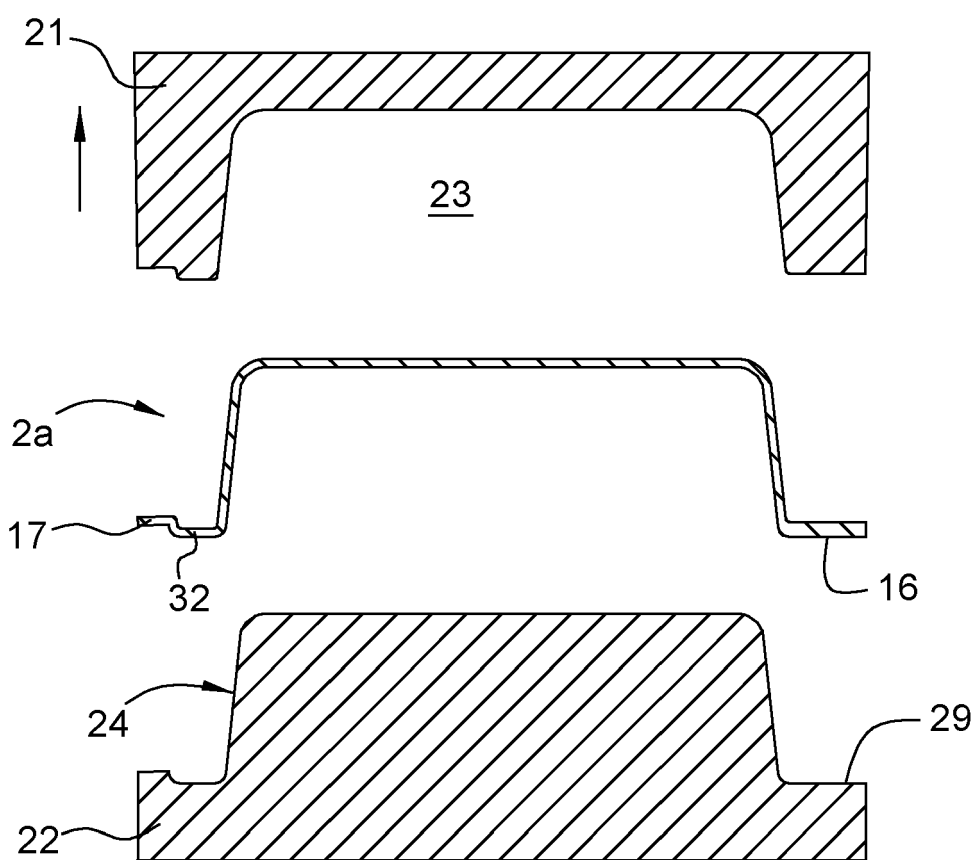


Fig. 6

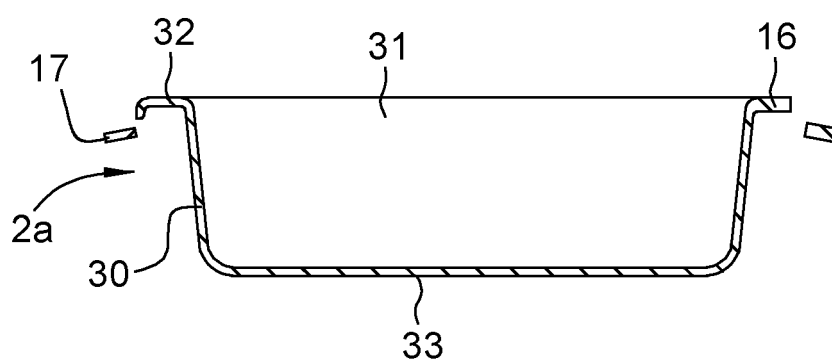


Fig. 7

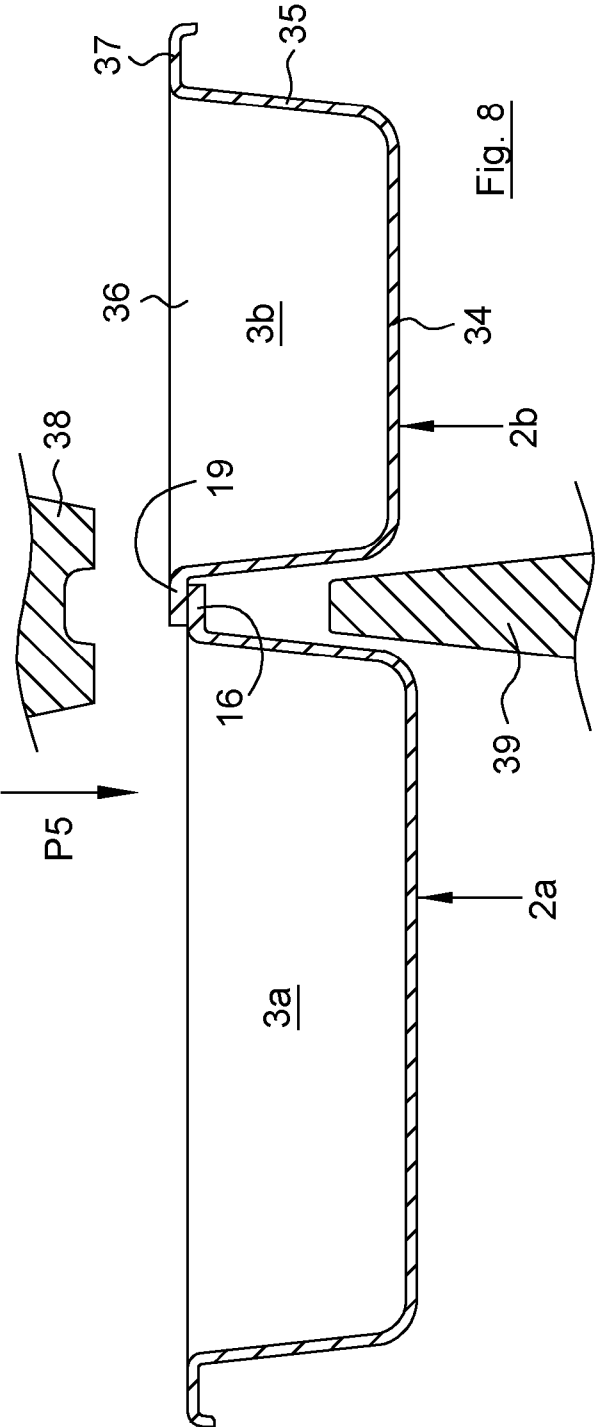


Fig. 8

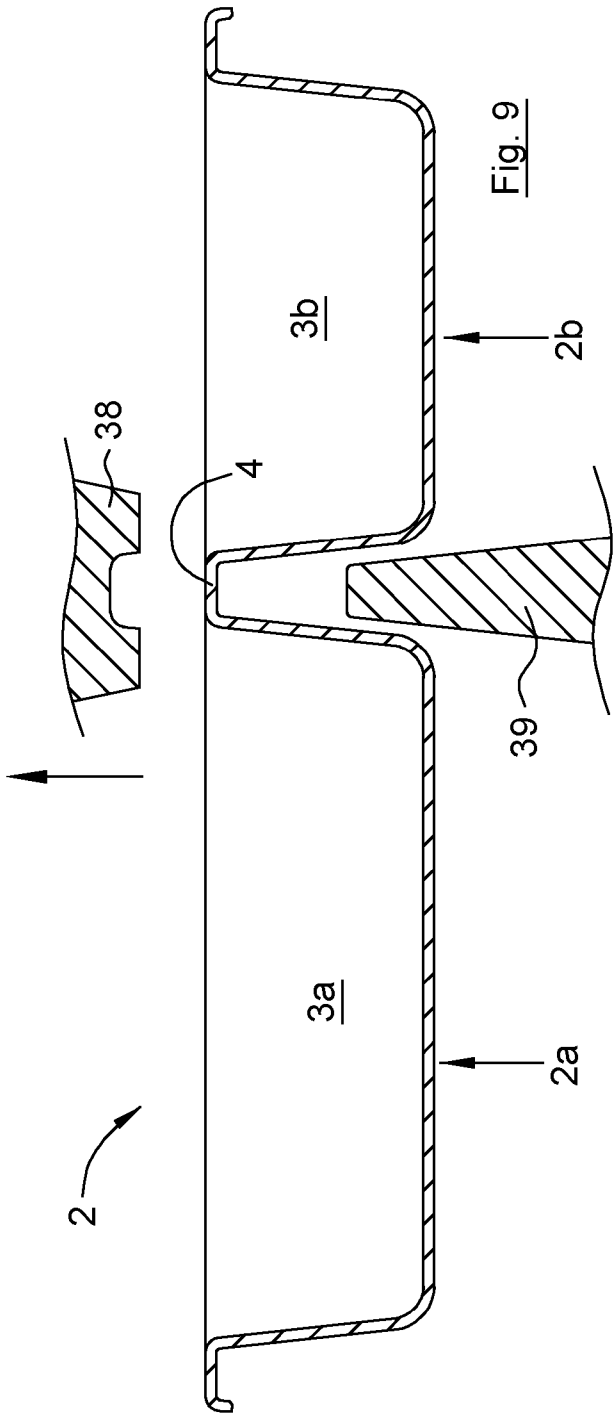


Fig. 9

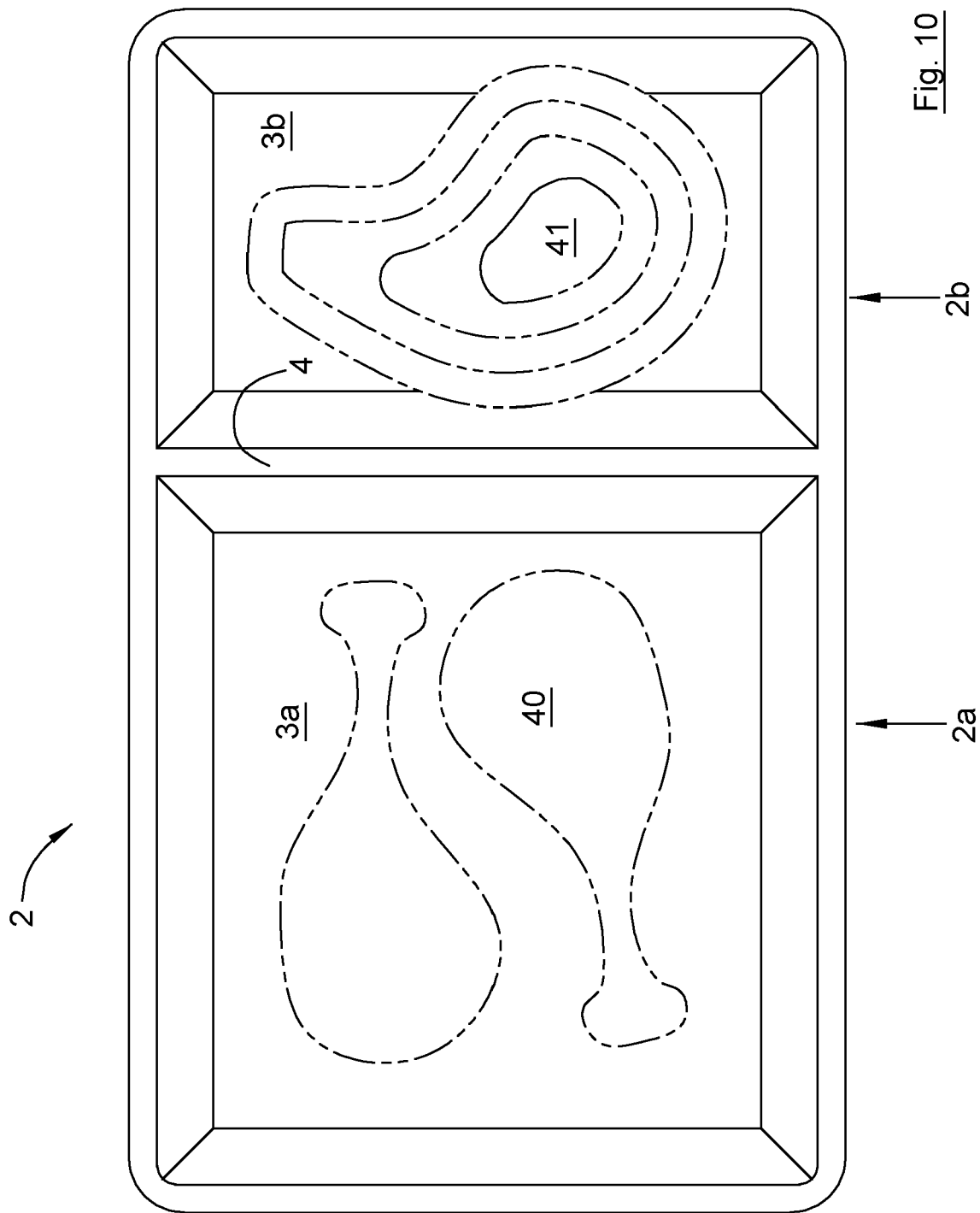


Fig. 10

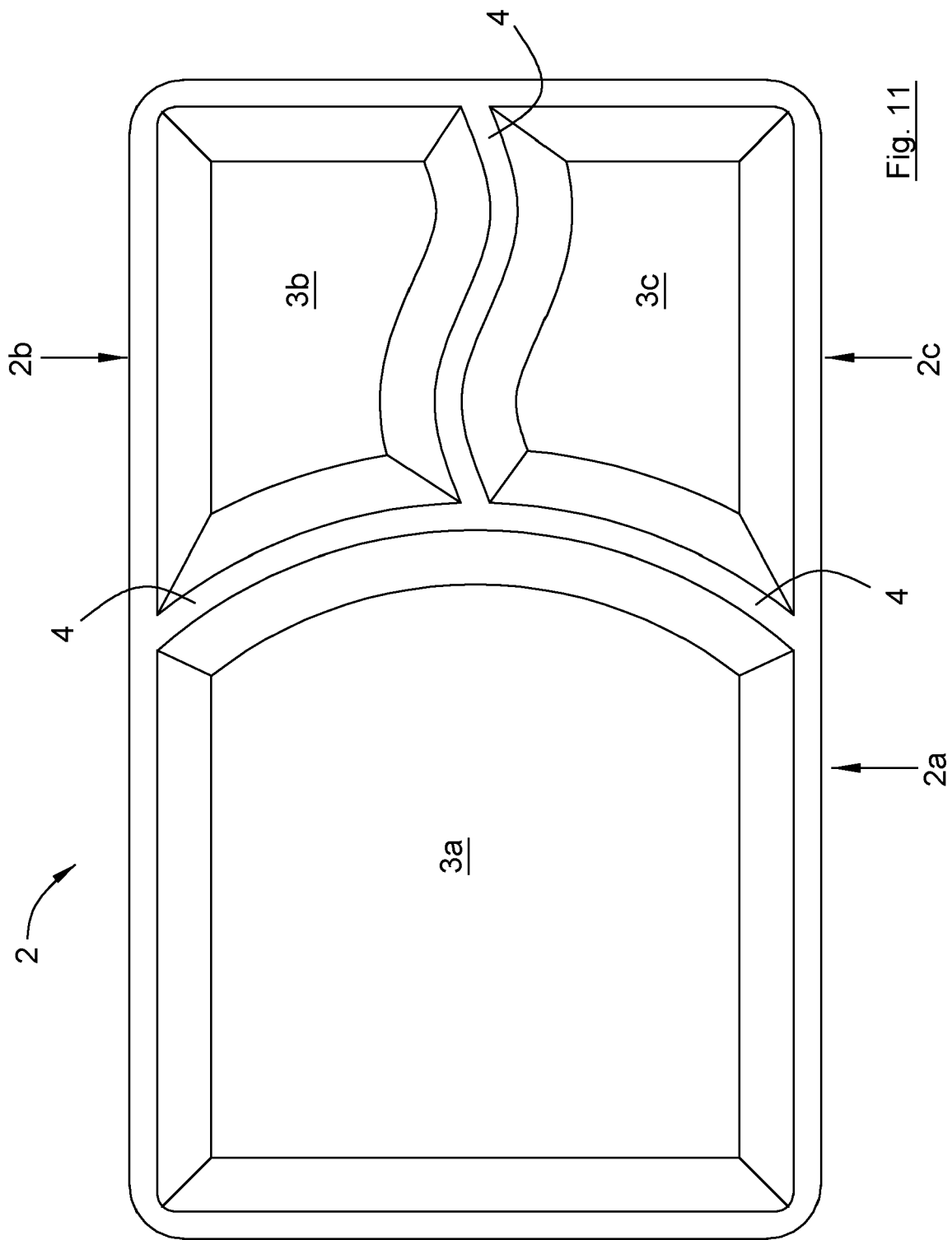


Fig. 11



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Application Number

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 June 2024	Examiner Zeiler, Johannes
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