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(72) Inventors:
• **Trani, Giorgio**
30100 Venezia (IT)
• **Sterner, Marion**
30123 Venezia (IT)

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(74) Representative: **Piovesana, Paolo**
Via F. Baracca, 5/a
30173 Venezia-Mestre (IT)

(71) Applicant: **Gruppo X di X Gruppo S. R. L.**
30124 Venezia (IT)

(54) **Forming method for materials in sheet form, particularly papery materials**

(57) A forming method for materials in sheet form, particularly papery materials, characterised in that after laying a sheet of material extensible to at least 5% on a mould cavity, the sheet is subjected to at least partial stretching within the mould, while at the same time being

retained along the edge of said cavity, and in addition the sheet is subjected to at least partial dragging within the mould without it being retained along the edge of said cavity, independently of the order in which the two afore-said operations are carried out and independently of any partial overlapping of said operations.

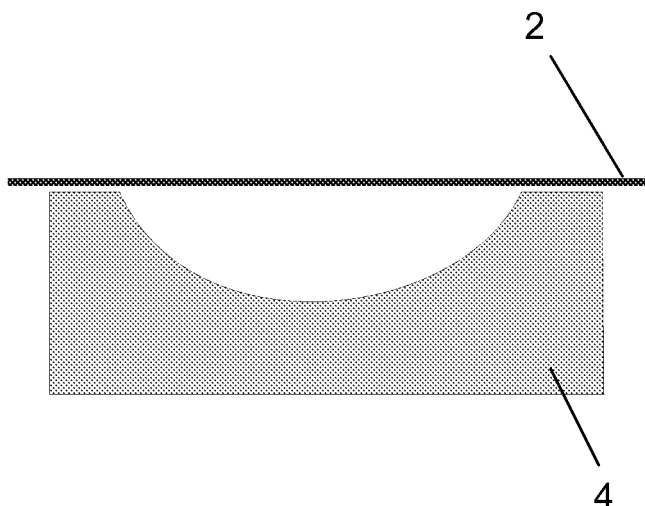


FIG. 1

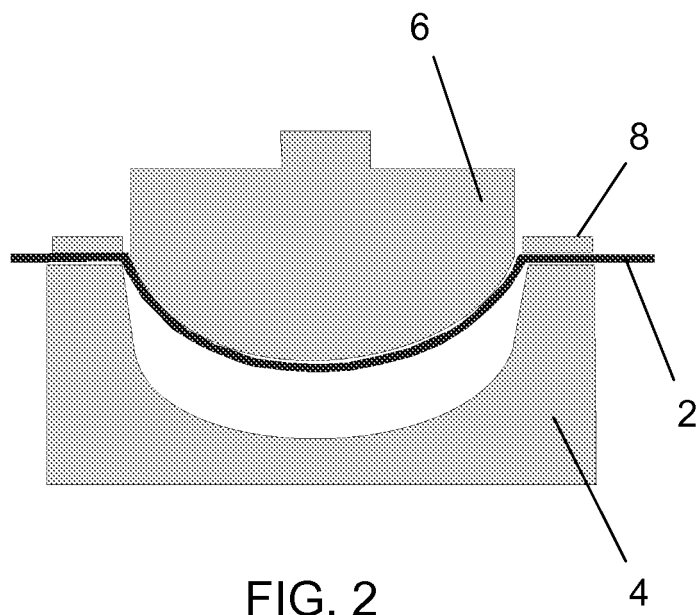


FIG. 2

Description

[0001] The present invention relates to a forming method for materials in sheet form, particularly papery materials.

[0002] Three-dimensional products are known made of papery material starting from sheets and webs of materials of various types, and in particular of papery material.

[0003] These are generally obtained by forming processes, using moulds with more or less deep cavities shaped in accordance with the final form of the container to be obtained, and also using systems of various types for urging a sheet of papery material, previously facing the cavity aperture, to adhere to the inner surface thereof.

[0004] One of these known systems uses a male die or punch of shape complementary to that of the cavity; another known system uses an elastic membrane, which is subjected to pressure until it adheres to the inner surface of the cavity and causes the sheet of papery material to also adhere thereto; in another known method the sheet of papery material is subjected directly to a pressure able to cause it to adhere to the inner surface of the cavity.

[0005] Given the plasticity of the papery material, the final result obtainable, independently of the method used, is always to stably deform the paper sheet and cause its deformed portion to assume the shape of the mould cavity.

[0006] There are substantially two methods of obtaining three-dimensional products starting from a sheet or web of papery or other material which is made to adhere by one of the aforescribed means to the inner surface of a mould cavity.

[0007] In one of these the material sheet is retained along the edge of the mould cavity during forming; in the other the material sheet is freely dragged into the mould cavity during forming.

[0008] The first case utilizes the extensibility of the material and subjects it to stretching; evidently as the cavity depth increases, the degree of extensibility of the material has to increase, and as this generally presents natural limitations, these result in limitations in the cavity depth, the need to avoid sudden accentuated discontinuities in the surface of the container obtainable, and consequently in limitations in the shape of the container itself. This is valid both for papery material and for other particular composite materials comprising paper, plastic film with poorly extensible crystalline layers, and embossed aluminium acting as a barrier.

[0009] In the second case the material is dragged into the interior of the mould cavity. As in this case the extensibility of the material is not utilized, there are virtually no limitations on the maximum depth of the mould cavity, however the dragging of the material into the mould during moulding results in the formation of a plurality of visible creases on the container. On the one hand these can confer an anti-aesthetic appearance on the three-

dimensional product obtained, and on the other hand prevent the product surface from being printed or decorated by printing. Moreover, in the case of material associated with a plastic layer, these creases prevent hermetic bonding.

[0010] An object of the invention is to produce three-dimensional products by moulding sheet material, practically without limitation on their shape and in particular without any limitation on the depth of the cavity into which the sheet of papery material is inserted to form the three-dimensional product.

[0011] Another object of the invention is to produce three-dimensional products of sheet material with a surface creased to a virtually insignificant extent and in any event such as not to alter any printing on the sheet from which the three-dimensional product is obtained.

[0012] These and other objects which will be apparent from the ensuing description are attained, according to the invention, by a forming method for sheet materials as described in claim 1.

[0013] Some embodiments of the present invention are further clarified hereinafter with reference to the accompanying drawings, in which:

Figure 1 shows a section through a sheet of papery material simply laid on a mould comprising a cavity,

Figure 2 shows a schematic section through the first step of partially stretching a sheet of extensible material within the mould by a punch,

Figure 3 shows a schematic section through the second step of dragging the already partially stretched material into the mould,

Figure 4 shows a schematic section through the first step of partially dragging a sheet of extensible material into the mould by a membrane subjected to a pressure difference across its surfaces,

Figure 5 shows a schematic section through the second step of stretching the sheet in a different mould and with a different membrane punch,

Figure 6 shows schematically a second sheet stretching step, alternative to that illustrated in Figure 5,

Figure 7 shows a schematic section through the first step of dragging a sheet of papery material into a mould by a rubber punch,

Figure 8 shows a schematic section through the second step of dragging the sheet of already partially dragged papery material into the mould and its subsequent stretching by deformation of the rubber punch,

Figure 9 shows a schematic section through a first step of dragging the sheet of papery material into a mould having a certain depth,

Figure 10 shows a second step thereof, in which the peripheral band of the container under for-

- mation is subjected to stretching,
- Figure 11 shows a different mould for producing a container of different shape,
- Figure 12 shows a sheet of punched and crease-lined paper to be inserted into the mould of Figure 11,
- Figure 13 shows the final step of producing the container obtained starting from the sheet of Figure 12 after the first forming step in the mould of Figure 11,
- Figure 14 shows a section through a mould with two half shells in a first step in the formation of a container with two half shells, and
- Figure 15 shows its final step,
- Figure 16 is a plan view of a two-impression mould for continuous application of the method of the invention,
- Figure 17 shows it in section after positioning a web of papery material and before the stretching step,
- Figure 18 is a section through the already stretched web before its transfer into a mould of deeper cavity for effecting the subsequent dragging step, and
- Figure 19 shows it in section on termination of the dragging step in this second mould.

[0014] As can be seen from Figures 1 and 2, in a first embodiment of the method of the invention, a sheet 2 of extensible material, with a degree of extensibility of at least 5%, is positioned over the cavity of a female fixed mould 4, above which a movable male die or punch 6 is positioned, provided with a protruding portion of complementary shape to that of the cavity of the female mould 4.

[0015] The extensible material 2 can consist of extensible paper, metal sheet material (aluminium, embossed aluminium, tin plate, etc.), composite material comprising a layer of extensible paper bonded to one or more plastic film layers, hot-extensible polymer film, etc.

[0016] After the sheet of extensible material 2 has been laid on the female mould 4, it is retained along the cavity edge by traditional systems, for example by a ring 8 pressed against the surface of the mould 4 in a manner suitable for locking it to the edges thereof.

[0017] The punch 6 is then made to descend onto the female mould 4 until its protruding portion partially stretches into the mould cavity the sheet 2 of extensible material retained along the cavity edge.

[0018] Because of the extensibility of the sheet 2, this operation causes it to partially deform, by an extent related to the descent stroke of the punch 6.

[0019] When this travel has been completed and the sheet 2 has been partially deformed in the mould 4 by stretching, the ring 8, which can be flat or frusto-conical and retains the sheet adhering to the surface of the female mould 4, is raised and the punch 6 is made to continue its stroke until its protruding portion has completely entered the cavity of the female mould 4 and has dragged

a part of the sheet 2 into it.

[0020] It is evident that in this step all the material 2 which enters the cavity of the mould 4 gives rise, along that face adjacent to the flat part, to a plurality of creases the extent of which, in terms both of length and depth, is related to the extent of the sheet portion dragged into the mould 4 and the inclination of that band of the cavity close to its free edge.

[0021] Depending on the shape of the punch 6 at that band, the creases which form can have a free or ordered arrangement, but in any event, during the final stage of the stroke of the punch 6 they become flattened between the surface thereof and the surface of the cavity of the female mould 4, and be virtually invisible under certain conditions.

[0022] With the same equipment it is however possible to invert the two steps of the treatment, in the sense that in the first step the punch 6 can drag a part of the sheet of papery material 2 into the cavity of the female mould 4, but as in this step said sheet is not retained against the female mould, its entry into the cavity does not result in any substantial stretching, but only its dragging with the formation of creases.

[0023] In the next step the sheet 2 is retained along the cavity edge, the continuation of the stroke of the punch 6 causing stretching of the sheet and the consequent partial elimination of the previously formed creases.

[0024] Moulding can also be effected not with only two steps, namely a stretching step and a step of dragging the sheet of papery material 2, but with several steps, by alternating a stretching step with a dragging step and then another stretching step and so on until the final container has been obtained.

[0025] Depending on the shape of the container to be obtained, it may also be advantageous to use several different punches and different materials, to effect the two different steps of the method; this enables a precise shape to be given to the container under formation on termination of the first moulding step, and can be particularly advantageous, especially to minimize the presence of creases and to localize them within a precise region of the container. For example Figures 4 and 5 schematically show the two steps of the method, specifically the first sheet dragging step and the second sheet stretching step. If a punch 6 with a flat protruding portion is used in the first step, creases will definitely not form in that flat surface, hence the band within which these creases are allowed to form can be controlled with greater precision.

[0026] Then after the sheet 2 deformed in this manner has been transferred into a different female mould 4' and has been retained along the edge by a ring 8, it is made to adhere to the cavities of said moulds 4' by stretching with a membrane punch 6', which is able to assume the shape of any female mould (see Figure 5).

[0027] Alternatively, the sheet 2 deformed in the first dragging step can be transferred (see Figure 5) into a

still different female mould 4", where it is stretched by a different punch 6" consisting of an inflatable balloon, able to also expand laterally to generate in this manner a container with an undercut.

[0028] With reference to Figures 7 and 8, it can be seen that the two dragging and stretching steps can also be carried out by utilizing the deformability of the punch 6, which in the first step is limited to dragging the sheet 2 of extensible material into the female mould 4, while in the second step, after the sheet is retained along the edge of the ring 8, it makes it adhere to the female mould cavity by stretching.

[0029] This solution has the advantage of not requiring a different punch 6 for each container form to be obtained, but enables different containers to be obtained with different female moulds 4, but with a single deformable punch 6.

[0030] In the aforescribed and illustrated embodiments the sheet of papery material 2 is moulded by mechanical effect between a complementary mould and die, in which case the only characteristic required of the sheet of papery material is a degree of extensibility of at least 5%.

[0031] However, different moulding techniques can be used. For example, a female mould can be used in which the cavity comprises a plurality of channels communicating with a vacuum source and, in combination or as an alternative thereto, the protruding portion of the punch 4 can comprise a plurality of other channels communicating with a pressure source.

[0032] In this manner a more accentuated and more uniform moulding effect can be obtained over the entire surface of the sheet to be deformed.

[0033] Again in this case the only characteristic required of the sheet of papery material is to have a degree of extensibility of at least 5%.

[0034] A different moulding technique uses, in place of the punch, a deformable membrane associated with a pressure source on the opposite surface to that facing the female mould cavity. In this manner the sheet of papery material is deformed by the elastic membrane, itself deformed by pneumatic effect.

[0035] This technique evidently requires the use of a pneumatic pump, but enables different containers to be produced using different female moulds 4 but only a single membrane punch, even enabling the formation of undercuts.

[0036] Another technique, again based on the principle of effecting moulding in two stretching and dragging steps or vice versa, consists of deforming the sheet of papery material 2 directly by pneumatic effect. In this case it is convenient to apply to the sheet of papery material already positioned on the cavity of the female mould 4 a bell cap which with its edge retains the sheet adhering to the female mould while at the same time providing a pneumatic seal along the cap edge.

[0037] Compressed air is then fed into the bell cap to stretch the paper.

[0038] It is apparent that this technique requires the sheet of papery material 2 to be made impermeable to air, which can be achieved either by introducing an impermeabilizing agent into the material during its production, or by applying to the sheet of extensible papery material an impermeabilizing film having a degree of extensibility not less than that of the paper.

[0039] It is also apparent that this technique enables only the stretching step to be effected, while for the dragging step it requires a different punch, which leaves the sheet of papery material 2 free to be dragged into the mould.

[0040] Independently of the technique used to carry out the two steps of the method of the invention, it can be advantageous to accompany these steps with mould heating, this making the deformation of the papery material more regular, with a more stable result.

[0041] It can also be advantageous to pretreat the sheet of extensible material to be then subjected to the treatment of the invention. This pre-treatment can consist of preheating the flat sheet, if consisting of papery material bonded to plastic film, and then deforming it in cold moulds, which in this manner nullify the memory effect of the plastic film.

[0042] It can again be advantageous to moisten the paper prior to its introduction into the mould, to facilitate its deformation.

[0043] From the foregoing it is apparent that the method of the invention is particularly advantageous, in that it enables three-dimensional containers of extensible material subjected to deep moulding to be obtained, without this moulding depth causing visible creases in the container, and indeed enabling these to be localized and homogeneously distributed in controlled regions different from those carrying printing.

[0044] A different embodiment, illustrated in Figures 9 and 10, comprises a first step of dragging the sheet 2 into the mould 4 having a cavity of a certain depth, with the formation of creases, which can then be smoothed in a subsequent step within a mould 4' having a less deep cavity, in this manner they being totally or partially eliminated. In this embodiment, two different female moulds are used, as are two different punches, of which the purpose of the second is to retain the container under formation with its base adhering to the base of the cavity of the female mould. Again in this case, the stretching step is achieved by a ring 8, for example of rubber, operating on that container band emerging from the cavity of the second female mould 4' to turn it outwards.

[0045] A different embodiment of the invention is shown in Figures 11-13. In this case a first female mould 4 is used in which a punched and crease-lined sheet 2 of extensible papery material bonded to a polythene film is placed (see Figure 12). A punch 6 drags the sheet 2 into the female mould until it assumes the shape of the mould cavity (see Figure 11). The stability of the shape is obtained by welding the polymer layers of the sheet 2 by the heating and thermowelding mould 4 and punch 6.

[0046] The formed three-dimensional container is then transferred into a different female mould 4', is retained along the edge b y the ring 8 and subjected to stretching action by a different punch 6' (see Figure 13).

[0047] To obtain closed three-dimensional shapes formed from two coupled half-containers, the invention uses double impression moulds provided with two female portions hinged together to pass from an open position to a facing position.

[0048] In this case, after each half-container has been obtained by one of the aforesaid techniques, the two female portions are closed together to enable the two half-containers to be welded together along their contacting edges.

[0049] If the method used to obtain the each half-container comprises a first step of dragging the sheet into the cavity in the female mould and a second stretching step, the two female mould portions can be closed together before the stretching step. This is illustrated schematically in Figures 14 and 15.

[0050] The method of the invention can also be continuously applied (see Figures 16-19) using a web of extensible material 2 and a multiple mould 4, i.e. with several impressions and several portions.

[0051] Previously, the starting web 2 is pre-incised along transverse lines 10 partially separating portions corresponding to the individual products to be formed (see Figure 16).

[0052] After the web 2 predisposed in this manner has been pre-folded along the separation lines 10, so as to form material enrichment creases 12, it is positioned on the impressions of the female mould 4 and retained in the correct position by corresponding rings 8 (see Figure 17).

[0053] It is then stretched to adhere to the impressions (see Figure 18) and then transferred to a different female mould 4', in which forming is completed by dragging by a different multiple punch (not shown). During this step the excess material forming the creases 12 is used (see Figure 19).

[0054] In the various embodiments of the method of the invention, independently of the sequence in which the two dragging and stretching steps are carried out they are always separate, in the sense that each takes place after the preceding step has been terminated. However according to the invention, a certain part of the two steps can take place simultaneously, i.e. they can partially overlap in the sense that one of them can start before the other has finished. This is possible for example by varying the times and extent of retention of the sheet 2 by the ring 8.

[0055] If the two dragging and stretching steps are completely separate, it is also possible for the dragging step to simultaneously involve several superposed sheets, which are then fed individually to the subsequent stretching step.

Claims

1. A forming method for materials in sheet form, particularly papery materials, **characterised in that** after laying a sheet of material extensible to at least 5% on a mould cavity, the sheet is subjected to at least partial stretching within the mould, while at the same time being retained along the edge of said cavity, and in addition the sheet is subjected to at least partial dragging within the mould without it being retained along the edge of said cavity, independently of the order in which the two aforesaid operations are carried out and independently of any partial overlapping of said operations.
2. A method as claimed in claim 1 in which the two stretching and dragging steps are mutually separate, **characterised in that** the dragging step involves a plurality of superposed sheets.
3. A method as claimed in claim 1, **characterised in that** the stretching and/or dragging step are effected by mechanical action within moulds comprising a female half-mould provided with at least one cavity and at least one punch of complementary shape.
4. A method as claimed in claim 1, **characterised in that** the stretching and/or dragging step are effected by subjecting the material sheet to a pressure difference between its two faces.
5. A method as claimed in claim 4, **characterised by** using a female mould in which the cavity comprises a plurality of channels connected to a vacuum source.
6. A method as claimed in claim 4, **characterised by** using a punch the surface of which comprises a plurality of channels connected to a pressure source.
7. A method as claimed in claim 3, **characterised by** using a punch made of elastically deformable material.
8. A method as claimed in claim 1, **characterised by** carrying out the stretching step using a punch consisting of an inflatable membrane.
9. A method as claimed in claim 1, **characterised by** carrying out the stretching and/or dragging step on a material sheet subjected to heating.
10. A method as claimed in claim 1, **characterised in that** during the stretching step the material sheet is retained by an elastically deformable ring.
11. A method as claimed in claim 1, **characterised by** carrying out the two different stretching and dragging

steps using two different moulds.

12. A method as claimed in claim 1, **characterised by** 5
subjecting the material sheet to crease-lining before
subjecting it to deformation.
13. A method as claimed in claim 1, **characterised by**
using a sheet of metal material.
14. A method as claimed in claim 1, **characterised by** 10
using a sheet of extensible paper bonded to at least
one plastic film.
15. A method as claimed in claim 1, **characterised by** 15
carrying out the two stretching and dragging steps
within a mould with two cavities which after the drag-
ging step are brought face to face to subject the sheet
to the stretching step within a closed cavity.

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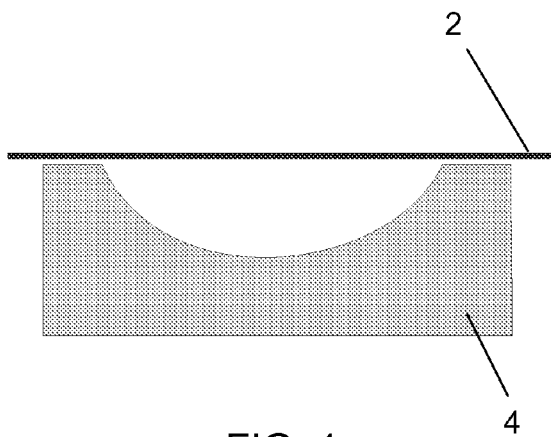


FIG. 1

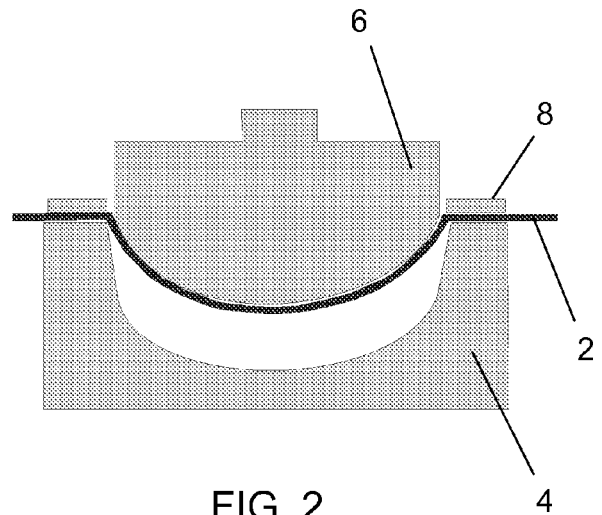


FIG. 2

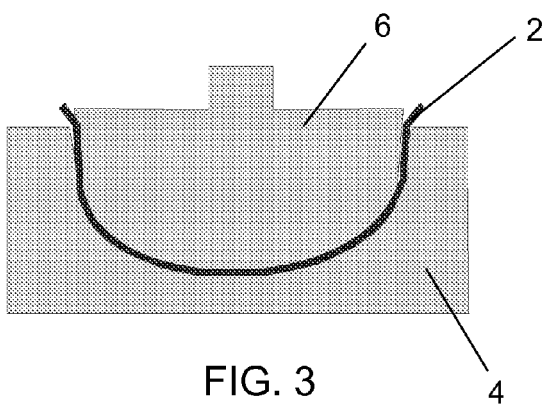


FIG. 3

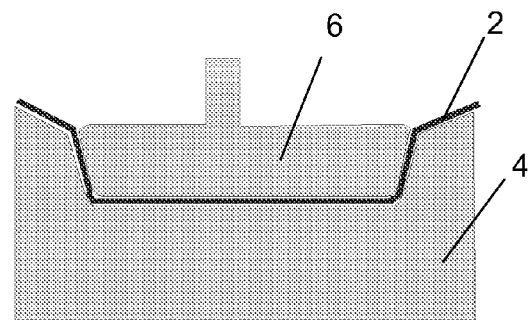


FIG. 4

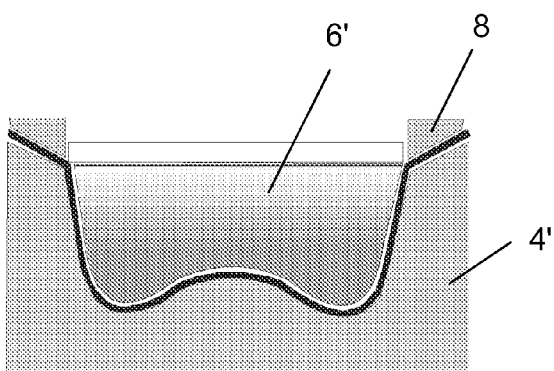


FIG. 5

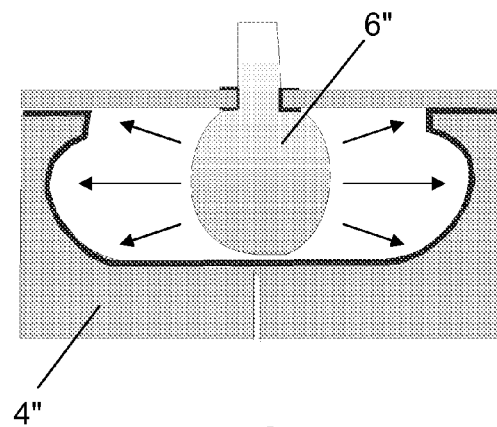
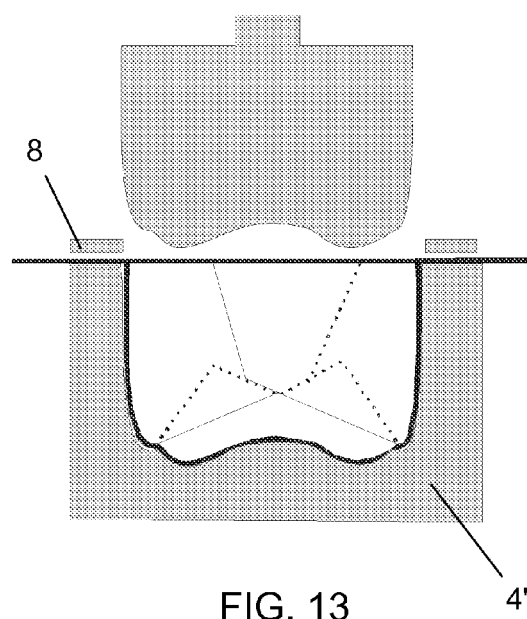
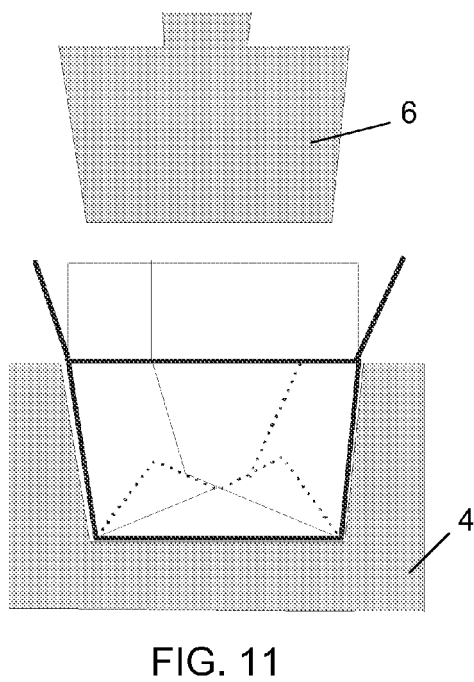
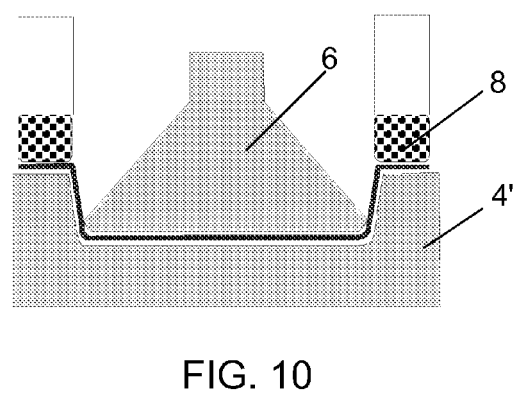
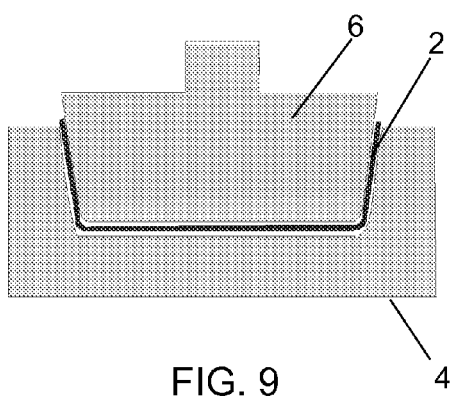
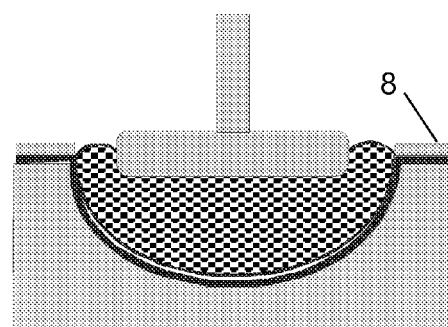
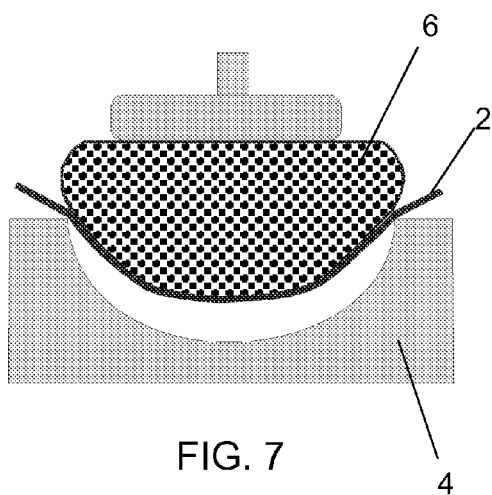


FIG. 6



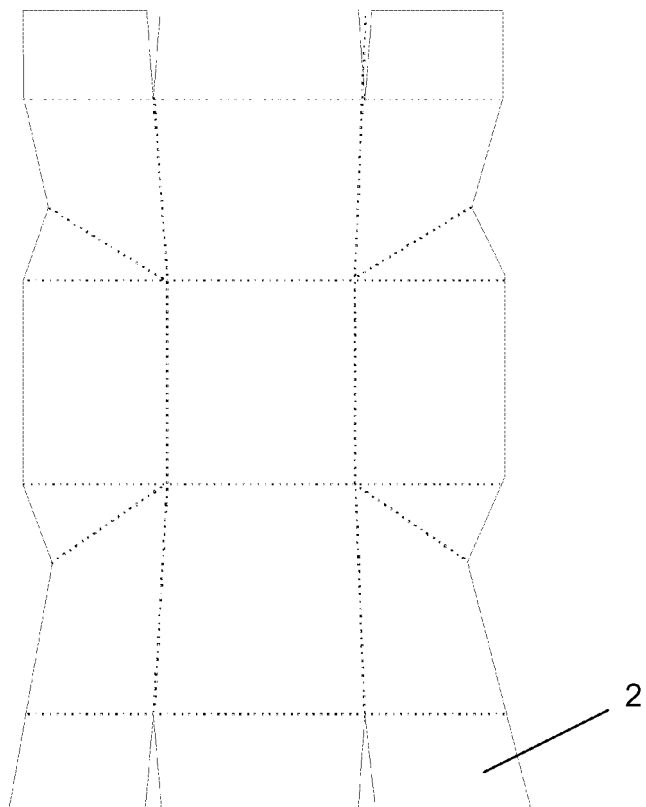


FIG. 12

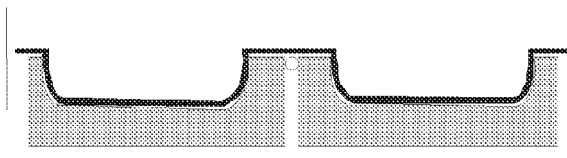


FIG. 14

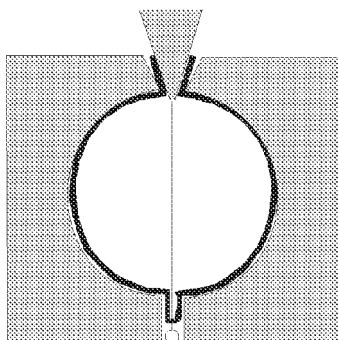


FIG. 15

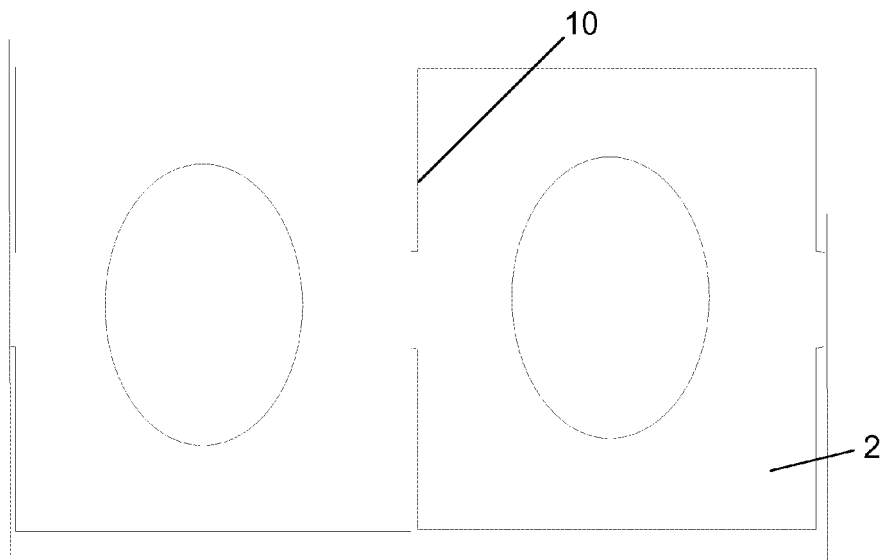


FIG. 16

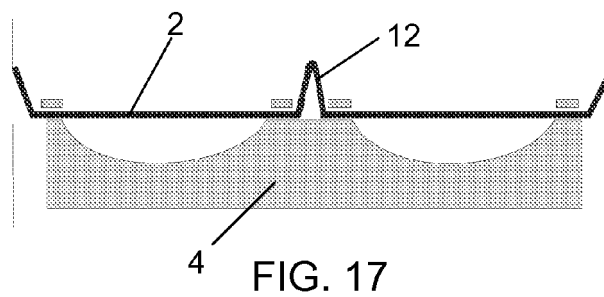


FIG. 17

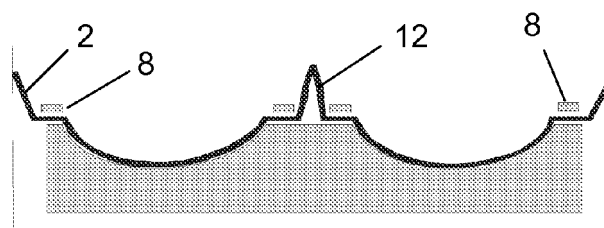


FIG. 18

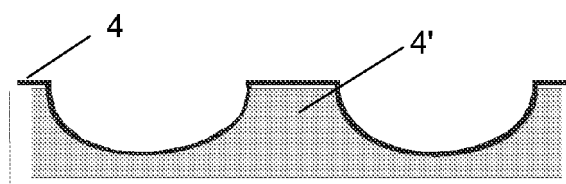


FIG. 19