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(54) **A SYSTEM AND A METHOD FOR PRODUCING A MOLDED ARTICLE, SUCH AS A TRAY**

SYSTEM UND VERFAHREN ZUR HERSTELLUNG EINES GEFORMTEN GEGENSTANDES WIE
EINE SCHALE

SYSTÈME ET PROCÉDÉ POUR PRODUIRE UN ARTICLE MOULÉ, TEL QU'UN PLATEAU

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(72) Inventor: **SØLLNER, Kristian**

DK-3550 Slangerup (DK)

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(74) Representative: **Plougmann Vingtoft a/s**

**Rued Langgaards Vej 8
2300 Copenhagen S (DK)**

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(73) Proprietor: **Ecoxpac A/S**

3550 Slangerup (DK)

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Description

BACKGROUND OF THE INVENTION

[0001] Various processes and apparatuses for making tray-shaped articles from a fibrous pulp material are known; see by way of example WO2011/065,911 and GB 550,058. Even though many years have passed since the fundamentals of this technology was developed, there is still room for improvements. In fact, though tray-shaped articles made from pulp would, for environmental reasons, be a highly desirable alternative to plastic containers, one reason for the limited popularity of such articles is believed to be their high costs arising from the relatively high demand for energy required during the production thereof, particularly during the dewatering of the pulp material. The relatively high production time is also a factor as often a processing in a separate drying station of the molded article is required. US 2004/0041305 A1 discloses a system for producing a molded article according to the preamble of claim 1.

OBJECT OF THE INVENTION

[0002] It is an object of the invention to provide a solution to the problem of how to reduce energy consumption and, hence, production costs, and/or production time, in processes where fibrous pulp, such as paper pulp, is molded into tray-shaped articles.

[0003] It is another object of the invention to provide a system and method for producing a moulded article with which the amount of material used can be reduced compared to known methods.

[0004] It is another object of the invention to provide a system and method with which a higher strength of the final moulded article can be obtained.

DISCLOSURE OF THE INVENTION

[0005] In a first aspect the present invention relates to a system for producing a molded article, in particular a tray-shaped article, from pulp, said system comprising:

a split mold with

- a female mold part,
- a pressing tool having a male mold part, and
- a first cavity for said pulp between said female mold part and said male mold part,

a heating device,

- said heating device being configured for heating said male mold part,
- said female mold part comprising one or more further cavities and a first surface facing the interior of said first cavity and being for a layer of said pulp,

- said first surface allowing fluid to flow between said first cavity and said one or more further cavities, and

a first compressor configured for establishing a temporary elevated fluid pressure of more than 1 bar in said one or more further cavities.

This 1 bar is a measure of the surrounding atmospheric pressure at places where the invention will typically be used. By "an elevated fluid pressure of more than 1 bar" is therefore preferably meant "a pressure above the surrounding atmospheric pressure". The elevated fluid pressure results in an increase of the boiling point of the water in the pulp.

[0006] "Pulp" is preferably defined as fibrous material produced by mechanically or chemically reducing woody plants to their component parts and then suspended in a fluid. The fibres may e.g. be cellulose, and the fluid may e.g. be water.

[0007] In some embodiments of the invention, said pressing tool has a hollow and an expandable male mold part, said system further comprising an expanding device configured for expanding said expandable male mold part by establishing an inside pressure in said hollow of said expandable pressing tool.

[0008] In embodiments having an expansion device, said expanding device may be a second compressor.

[0009] In alternative embodiments, said male mold part of the pressing tool is non-expandable. Such a pressing tool may be hollow. Non-expandable pressing tools may be more simple to control and may be an advantageous choice for relatively flat articles where it is sufficient to apply pressure in one direction only, such as vertically. A non-expandable pressing tool may be heated by a number of heating devices, such as gas burners, steam heaters and induction heaters.

[0010] Said first compressor may be configured for establishing a temporary elevated fluid pressure of at least 4 bar in said one or more further cavities.

[0011] Said female mold part may comprise a casing for enclosing said one or more further cavities. A system as described above may include a wall separating said first cavity from said one or more cavities, said wall having said first surface, an opposite second surface of said wall being oriented towards said one or more further cavities. Said one or more cavities may be in an open-celled porous material.

[0012] In embodiments comprising a wall, said wall and said one or more further cavities may be an integral structure.

[0013] In embodiments comprising an expandable male mold part as described above, said heating device and said expanding device may supply a hot fluid heating medium to said hollow, for said heating and expanding of said expandable male part.

[0014] Embodiments comprising an expandable male mold may further comprise a control device operable to

establish simultaneously at the most the same elevated pressure in said one or more further cavities as said inside pressure in said hollow.

[0015] In embodiments comprising a wall, said wall may comprise a porous structure. Said wall may also include bores extending between said first cavity and said one or more further cavities.

[0016] In any of the embodiments as described above, said first surface (23') may be defined by a net.

[0017] The system according to the present invention may include a pump for draining said one or more further cavities.

[0018] Said female mold part and said male mold part may be movable to a spread-apart position, a pulp delivery device for depositing said layer of said pulp onto said wall being movable into position between said spread apart mold parts.

[0019] In embodiments comprising a heating device as described above, said heating device may be located in said hollow, and preferably heating by microwaves.

[0020] In a second aspect, the present invention relates to a method for producing a molded article, in particular a tray-shaped article, from pulp, using a system comprising:

a split mold with

- a female mold part,
- a pressing tool having a hollow and an expandable male mold part, and
- a first cavity for said pulp between said female mold part and said expandable male mold part,

a heating device,

- said heating device being configured for heating said expandable male mold part,
- said female mold part comprising one or more further cavities and a first surface facing the interior of said first cavity and being for a layer of said pulp,
- said first surface allowing fluid to flow between said first cavity and said one or more further cavities,

a first compressor configured for establishing a temporary elevated fluid pressure of more than 1 bar in said one or more further cavities, and an expanding device configured for expanding said expandable male part by establishing an inside pressure in said hollow of said expandable pressing tool, said method comprising the following steps:

- a. placing said layer of said pulp onto said first surface,
- b. then establishing said inside pressure inside said hollow, to press said expandable male part against said layer of pulp placed onto said first

surface,

c. then establishing, in said one or more further cavities, an elevated fluid pressure of more than 1 bar,

d. before, simultaneously or after said step c activating said heating device to heat said male part pressing against said layer,

e. then releasing said pressure inside said one or more further cavities while maintaining a higher inside pressure inside said hollow of said expandable pressing tool pressing against said layer.

After draining the exterior cavity, such as by use of a pump, a compressor is activated to establish an elevated fluid pressure in the exterior cavity which may be equal or essentially equal to, but not higher than, the pressure still being applied against the layer of pulp in the interior cavity. Heating of the layer of pulp is carried out by activating a heating device which may physically be located inside the interior cavity or which is configured to supply a fluid heating medium to the inside of the pressing tool.

[0021] It will be understood that the method steps described above and in the following take place in a very short time in which there preferably is a temperature gradient across the layer of pulp in the mold cavity whereby water in the pulp preferably is in the liquid phase at a temperature above 100°C closest to the pressing tool while at a lower temperature below 100°C closest to the inside surface of the interior cavity. Maintaining water in the liquid phase at a temperature above its normal boiling point is made possible by the simultaneous, doubled-sided pressure on the layer of pulp which gives rise to a super heating of the water in the pulp closest to the pressing tool. When, as a next step, the pressure in the exterior cavity is reduced abruptly, the superheated water evaporates. It will be understood that this evaporation will occur where the layer of pulp is at the highest temperature, viz. where it contacts or is closest to the hot pressing tool located inside the interior cavity. Vapour in this portion of the layer of pulp will seek to escape, and with the impermeable expanded male mold part on one side the only route of escape is through the female mold part, the vapour driving in this process all or much of the remaining water in the layer of pulp into the exterior cavity, from which it is drained.

[0022] With this method, it is largely made possible to avoid a subsequent drying step where the article must be moved to a drying station, after having been removed from the aforementioned mold, since by controlling the pressure in the exterior cavity in the described manner substantially all moisture in the pulp article may be driven out. It is noted that the aforementioned evacuation a pump may be used integrated with the compressor that sets the elevated fluid pressure in the exterior cavity.

[0023] The method may comprise the further steps of:

- f. deactivating said heating device and separating

said mold parts, and
g. removing said molded article from said split mold.

[0024] The method may comprise, before said step b, a step of draining said one or more further cavities.

[0025] In some embodiments of the invention, said inside pressure in said hollow established in step b is higher than 4 bar, said heating in step d being so as to superheat liquid only in a portion of said layer nearest said male part.

[0026] Said elevated fluid pressure may be between 70% and 100%, preferably between 90% and 100%, of said inside pressure in said hollow, said heating in step d being so as to superheat liquid contained in said pulp only in a portion of said layer nearest said male part.

[0027] In some embodiments of the invention, superheated liquid in said pulp nearest said male part drives liquid contained in said pulp into said one or more further cavities.

[0028] Said inside pressure established in step b may be higher than 6 bar, preferably between 7-8 bar, said pressure established in said one or more further cavities in said step c being identical, or substantially identical, to said inside pressure inside said hollow established in step b.

[0029] In some embodiments of the invention, said system includes a wall separating said first cavity from said one or more cavities, said wall having said first surface, an opposite second surface of said wall being oriented towards said one or more further cavities.

[0030] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

[0031] An embodiment of the invention will now be described with reference to the drawing wherein

Fig. 1a shows, in perspective view, an embodiment of a tray made from a pulp material using the system and method of the present invention,

Fig. 1b shows, in perspective view, a male mold part used in a system according to the present invention, for forming the tray of fig. 1a,

Fig. 2a shows, schematically, a cross-sectional view of an embodiment of a system of the invention for making a tray-shaped article, in a configuration with the mold parts moved together,

Fig. 2b shows the system of fig. 2a, in a second configuration with the mold parts in a spread-apart position,

Fig. 3a shows, schematically, a cross-sectional view of a second embodiment of a system of the invention for making a tray-shaped article, in a configuration

with the mold parts moved together, and

Fig. 3b shows the system of fig. 3a, in a second configuration with the mold parts in a spread-apart position.

[0032] The figures show one way of implementing the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0033] The present invention is concerned with the making of articles from a fibrous pulp material, in particular tray-shaped articles such as the article 5 shown in fig. 1a, which article may have a bottom and a peripheral side wall. The side wall may be composed of sides meeting at an angle, as shown in fig. 1a, or may be round. The side wall may also present any type of surface irregularities, such as ribs, that may conveniently result from the pressing method discussed in the following with reference to preferred embodiments of the invention.

[0034] A system 10 for making such an article 5 will be discussed now, with initial reference to figs. 2a and 2b.

[0035] A predetermined amount of pulp slurry in the form of a water dispersion of pulp fibre, such as wood pulp, and, if necessary, other components/additives is contained in a first, central or interior cavity 21 of a split mold 11, shown in a closed configuration in fig. 2a. The other components/additives may e.g. be clay, biobased or non-biobased fibres, colorants, and process catalysts. The pulp slurry has been previously applied as a layer 7 onto an inwardly oriented first surface 23' of a female mold part 12 of the split mold 11, when the latter is in its open configuration shown in fig. 2b. This application or depositing may, by way of example, be either by using an insertable tubular pulp delivery device 15 (see fig. 3b) or by dipping the female mold part 12 in the pulp slurry. The mold may e.g. be made from polymer, ceramic or metal, such as aluminium.

[0036] The amount of solid fibre material in the pulp slurry should be chosen so that it has a pumpable consistency. It should e.g. be above 0 up to 10 weight percent, such as up to 4 weight percent.

[0037] More specifically, the split mold 11 of the system 10 has apart from the female mold part 12 a pressing tool 25 having a hollow H defined by a casing 90 and an impermeable expandable male mold part 13 tightly connected to the casing 90 to depend therefrom, as best seen in fig. 2b. The expandable male part 13 as such is shown in fig. 1b in its slack state and is formed with an overall shape which essentially corresponds or conforms to the overall outline of the recess of the female mold part 12. This recess is defined by the inwardly oriented surface 23' and into which the male mold part 13 is inserted to delimit the first cavity 21.

[0038] The term "expandable" as used herein should be understood in the way that the male mold part 13 may expand elastically on application of a pressure P in the hollow H. When expanded the male mold part 13 will press against the layer 7 of pulp with a uniform pressure corresponding to the aforementioned pressure P. Normally, in the present invention the split mold 11 will be brought to assume its closed configuration with no pressure being applied in the hollow H such that during this operation, the male mold part 13 is in the slack state. In this state, it will largely not contact the layer 7 of pulp on the surface 23' during its insertion into the female mold 12. Such a contact, if the male mold part 13 were a solid structure or already expanded on insertion into the female mold part 12 could damage the inner surface of the article 5 to be molded, and/or drive some of the pulp material towards the bottom of the recess of the female mold 12. By applying a pressure perpendicular to the surface 23', a higher strength of the molded article can be obtained for a given amount of pulp material. Alternatively, a lower amount of material may be used without compromising a given desired strength.

[0039] It will be understood that an expandable male mold part 13 allows for a great versatility in that complex articles may be molded where the male mold part 13 through its expansion may be brought to form article portions having faces oriented towards the bottom of the article. The male mold part 13 may by way of example be made of silicone rubber or any other elastic material capable of withstanding relatively high temperatures while at the same time conforming essentially to the shape of the inner cavity 21.

[0040] In one embodiment of the invention as shown schematically in fig. 2a, a heating device 30 is arranged inside the hollow H to provide for a heating of the male mold part 13 and, hence, the layer 7 of pulp. This heating device 30 may operate on the basis of irradiation. Alternatively, as discussed later, fluid supplied via a port in the pressing tool 25 to the hollow H for setting up the pressure P may be heated by an external heating device to a desired temperature, such that this fluid serves also the purpose of heating the male mold part 13.

[0041] The female mold part 12 also comprises one or more further cavities 24. The aforementioned first surface 23' allows fluid contained in the layer 7 of pulp to flow into the one or more further cavities 24. In fig. 2a and 2b, the female mold part 12 is shown as having a casing 9 which delimits two such cavities 24 separated by a wall structure W, each cavity 24 being connected to a first compressor 16 and a draining pump 16'. As will be explained below, the compressors 16 connected to the one or more further cavities 24 are configured for establishing, in one mode of operation of the system 10, a temporary elevated fluid pressure of more than 1 bar in the one or more further cavities 24 in the female mold part 12 and the draining pump 16' for evacuating the one or more further cavities in another mode of operation of the system 10. As mentioned, with the invention the first,

inwardly oriented surface 23' is such as to allow fluid, in gas or liquid form, to pass between the one or more cavities 24 of the female mold part 12 and the central or first cavity 21 between the male mold part 13 and the female mold part 12. For this purpose, in the embodiment of fig. 2a and 2b, a wall 23 with through-going bores B separates the first cavity 21 from the one or more further cavities 24 within the female mold part 12 and has a surface 23" facing the one or more further cavities 24, opposite the first surface 23'.

[0042] In another embodiment, illustrated schematically in fig. 3a and 3b, the female mold part 12 may be of an open-celled porous material, such as of a sintered material, having the inwardly oriented first surface 23'. It should be understood that the porous material is such that fluid may pass through the surface 23' and flow between the first cavity 21 and a compressor 16/pump 16' connected to the female mold part 12 as was the case in the first embodiment. The inwardly oriented first surface 23' may be defined by a netted structure N applied onto the sintered material portion. The wall 23 may be integral with the open-celled porous material and may not be distinguishable. A netted structure N as mentioned may also have been applied onto the wall 23 in the first embodiment of fig. 2a/2b, to define the inwardly oriented first surface 23' thereof. The purpose of the netted structure N is generally to act as a filter restricting or preventing pulp fibres in the pulp layer 7 from ingressing into the female part 12. Such a net and/or the mold could e.g. be made by 3D-printing and sintering. Other methods of making these components will be well known to a person skilled in the art. The determination of an actual size of the porosity can be based on parameters such as the desired surface pattern and the risk of clogging for a given pulp composition and process parameters used. An optimal choice may e.g. be determined by experimentation.

[0043] In one embodiment, use may be made of an external heating device generating a hot, pressurised fluid, such as a liquid, such as hot oil at a temperature of, by way of example, 100 °C to 350 °C, such as 100 °C to 140 °C, or a gas, and being coupled to a second compressor 17 delivering this fluid to the pressing tool 25 to set up in the hollow H a pressure P, such as 1-30 bar, or even 70-100 bar, via a port in the pressing tool 25.

[0044] The aforementioned pressure P is selected such that on the one hand the deposited pulp material 7 is not damaged by an excessive pressure applied by the expanded male part 13 and, preferably, on the other hand such that the pulp material is sufficiently pressed by the expanded male part 13 against the interior first surface 23' to give rise to an initial dewatering. This dewatering is obtained by water in the pulp being pressed out of the pulp and through the aforementioned channels B or open pores of the female mold part 12. Evacuation or draining of the female mold part 12 by means of the pump 16' may be terminated immediately prior to the temperature of the deposited pulp having reached a pre-set threshold temperature, or when a certain initial dewatering of the

deposited pulp has occurred.

[0045] From the foregoing, the person skilled in the art will understand that with the split mold 11 in the closed configuration, heating of the male mold part 13 and, hence, the pulp deposited on the interior surface 23' against which the male mold part 13 is pressed gives rise to evaporation of some of the water in the pulp. By the compressor 16 supplying a fluid, liquid or gaseous, an elevated fluid pressure is then established in the exterior cavity 24, whether this is as shown in fig. 2b or as shown in fig. 3b. Monitoring is carried out by control unit C such that this elevated pressure acting on one side of the layer 7 of hot pulp is not higher than the pressure acting at the same time on the opposite side closest to the male part 13 of the layer 7 through the expansion of the male part 13 by compressor 17. The applied heat energy is adjusted such that the temperature of the water in the pulp is above the boiling temperature. However, through the double-sided pressure the water remains in the liquid phase, giving, in accordance with the invention, rise to a partial super-heating thereof.

[0046] In a particularly preferred embodiment of the invention, the male mold part 13 is warm before it is hits the deposited pulp. Hereby the large temperature difference between the male mold part 13 and the first surface 23' of the female mold part 12 results in a temperature profile across the pulp material giving rise to super-heating of the water near the male mold part 13.

[0047] As mentioned, the pump 16 connected to a port in the casing 9 of the female mold part 12 is operable to establish the elevated fluid pressure in the one or more further cavities 24. This stands in contrast to the prior art methods and apparatuses where a pump connected to the female mold part 12 is only configured and operated to evacuate the female mold part 12.

[0048] The control device C is preferably configured to provide for an abrupt decrease in the elevated fluid pressure in the female mold part 12, to bring about evaporation of the superheated water. This evaporation will occur where the layer of pulp is at the highest temperature, viz. where it contacts or is closest to the pressing tool; i.e. near the expanded male mold part 13 located inside the first, interior cavity 21. Vapour in this portion of the layer 7 of pulp will seek to escape, and with the male mold part 13 on one side the only route of escape is through the surface 23'. The vapour drives in this process all or much of the remaining water in the layer 7 of pulp into the exterior cavity 24 from which it is subsequently drained by pump 16'. The optimal process parameters and the control thereof for a given product being manufactured can be determined experimentally, possibly in combination with computer modelling. It may furthermore be possible to use input from sensors arranged in the mold to optimize the process.

[0049] Although often not necessary, there may be instances where a secondary drying is required, such as in the case of articles having a particular shape. For such cases, the system 10 may include a separate drying mold

(not shown) having a wall defining a drying mold cavity for receiving the molded article from the split mold 20, and including a hollow expandable molded article pressing tool and a molded article heating device configured for heating the molded article received in the drying mold cavity. It is noted that the present invention may also find use where a preformed and wet article is inserted into the mold, after which pressing and drying as described above takes place.

[0050] To summarise, in one embodiment of the invention, the followings method steps are taken, using a system 10 as discussed above:

First, a layer 7 of the pulp is deposited onto the first surface 23', following which the expandable male part 13 is inserted into the female mold part 12. Then an inside pressure P inside the male mold part 13 is established using the compressor 17 to press the expandable male part 13 against the layer 7 of pulp. As a next step, using the first compressor 16 connected to a port of the female mold part 12, a positive elevated fluid pressure of more than 1 bar is established in the one or more further cavities 24. This elevated pressure is, by way of example, between 70% and 100% of the aforementioned pressure P inside the male mold part 13 previously established. By way of example, with an inside pressure P of five bar, the pressure in the one or more further cavities 24 may be four bar. With a very high pressure P inside the expandable male mold part 13, such as in the order of 10-100 bar, the elevated pressure in the one or more further cavities 24 may be in the order of 10%-90% of the aforementioned pressure P.

[0051] In a next step, the heating device 30 is activated to heat the expanded male mold part 13 which is pressing against the layer 7 of pulp, and to superheat some of the water of the pulp. Then the pressure inside the one or more further cavities 24 is released by disconnecting the compressor 16 while maintaining a higher inside pressure inside the expanded male mold part 13 pressing against the layer 7 of pulp. In a final step, the heating device 30 is deactivated and the male mold part 13 is withdrawn from the first, central cavity 21, preferably after release of the pressure P to bring it into the slack state. The molded article 5 is then removed from the split mold 20.

[0052] Preferably, the inside pressure P inside the expandable expansion member 25 generated by the second compressor 17 is higher than 4 bar. In work performed during the development of the present invention, this size of the pressure has been found as providing the desired surface roughness and compression of the fibres. However, other pressures will also be covered by the scope of the invention and may be more appropriate for other types of pulps, product dimensions and desired surface appearances.

[0053] From the above it will be understood that to reduce process time and reduce energy consumption, the heating is so as to superheat liquid only in a portion of the layer 7 of pulp nearest the expandable male part 13.

Hereby it is obtained that this superheated liquid in the pulp nearest the male part 13 drives liquid/water in the liquid phase into the one or more further cavities 24. Preferably, the inside pressure P is higher than 6 bar, preferably between 7-8 bar, and the elevated fluid pressure established in the one or more further cavities 24 may be less than or identical therewith.

[0054] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set.

Claims

1. A system (10) for producing a molded article, in particular a tray-shaped article (5), from pulp, said system (10) comprising:
a split mold (11) with

- a female mold part (12),
- a pressing tool (25) having a male mold part (13), and
- a first cavity (21) for said pulp between said female mold part (12) and said male mold part (13), and a heating device (30), said heating device (30) being configured for heating said male mold part (13), wherein said female mold part (12) comprises one or more further cavities (24) and a first surface (23') facing the interior of said first cavity (21) and being for a layer (7) of said pulp, said first surface (23') allowing fluid to flow between said first cavity (21) and said one or more further cavities (24), **characterized by** a first compressor (16) configured for establishing a temporary elevated fluid pressure of more than 1 bar in said one or more further cavities (24).

2. The system of claim 1, said pressing tool (25) having a hollow (H) and said male mold part (13) being expandable, said system further comprising an expanding device (17) configured for expanding said expandable male mold part (13) by establishing an inside pressure (P) in said hollow (H) of said pressing tool (25).

3. The system of claim 2, said expanding device (17) being a second compressor (17).

4. The system of any of the preceding claims, said first compressor (16) being configured for establishing a temporary elevated fluid pressure of at least 4 bar in said one or more further cavities (24).

5. The system according to any of the previous claims, including a wall (23) separating said first cavity (21) from said one or more cavities, said wall (23) having

said first surface (23'), an opposite second surface (23'') of said wall (23) being oriented towards said one or more further cavities (24).

6. The system according to any of the previous claims, said one or more cavities (24) being in an open-celled porous material.

7. The system according to claim 2 or any of claims 3-6 when dependent on claim 2, said heating device (30) and said expanding device (17) supplying a hot fluid heating medium to said hollow (H), for said heating and expanding of said expandable male part (13).

8. The system according to claim 2 or any of claims 3-7 when dependent on claim 2, including a control device (C) operable to establish simultaneously at the most the same elevated pressure in said one or more further cavities (24) as said inside pressure (P) in said hollow (H).

9. The system according to claim 5 or any of claims 6-8 when dependent on claim 5, said wall (23) comprising a porous structure.

10. The system according to claim 5 or any of claims 6-9 when dependent on claim 5, said wall (23) including bores (B) extending between said first cavity (21) and said one or more further cavities (24).

11. The system according to any of the previous claims, said first surface (23') being defined by a net.

12. The system according to any of the previous claims, including a pump (16') for draining said one or more further cavities (24).

13. The system according to claim 2 or any of claims 3-12 when dependent on claim 2, said heating device (30) being located in said hollow (H), and preferably heating by microwaves.

14. A method for producing a molded article, in particular a tray-shaped article (5), from pulp, using a system comprising:

a split mold (11) with

- a female mold part (12),
- a pressing tool (25) having a hollow (H) and an expandable male mold part (13), and
- a first cavity (21) for said pulp between said female mold part (12) and said expandable male mold part (13), said female mold part (12) comprising one or more further cavities (24) and a first surface (23') facing the interior of said first cavity (21) and being for a layer of pulp, said first surface (23')

allowing fluid to flow between said first cavity (21) and said one or more cavities (24),

a heating device (30), said heating device being configured for heating said expandable male mold part (13), a first compressor (16) configured for establishing a temporary elevated fluid pressure of more than 1 bar in said one or more further cavities (24), and
an expanding device (17) configured for expanding said expandable male part (13) by establishing an inside pressure (P) in said hollow (H) of said pressing tool (25), said method comprising the following steps:

- a. placing said layer (7) of said pulp onto said first surface (23'),
- b. then establishing said inside pressure (P) inside said hollow (H), to press said expandable male part (13) against said layer (7) of pulp placed onto said first surface (23'),
- c. then establishing, in said one or more further cavities (24), an elevated fluid pressure of more than 1 bar,
- d. before, simultaneously or after said step c activating said heating device (30) to heat said male part (13) pressing against said layer (7),
- e. then releasing said pressure inside said one or more further cavities (24) while maintaining a higher inside pressure inside said hollow (H) of said expandable pressing tool pressing against said layer (7).

15. The method according to claim 14, said inside pressure (P) in said hollow (H) established in step b being higher than 4 bar, said heating in step d being so as to superheat liquid only in a portion of said layer (7) nearest said male part (13).
16. The method according to claim 14 or 15, wherein superheated liquid in said pulp nearest said male part (13) drives liquid contained in said pulp into said one or more further cavities (24).

Patentansprüche

1. System (10) zum Herstellen eines geformten Gegenstands, insbesondere eines schalenförmigen Gegenstands (5), aus Brei, wobei das System (10) Folgendes umfasst:

eine geteilte Form (11) mit

- einem Matrizenteil (12),
- einem Druckwerkzeug (25) mit einem Patrizenteil (13), und

- einem ersten Hohlraum (21) für den Brei zwischen dem Matrizenteil (12) und dem Patrizenteil (13),

und eine Heizvorrichtung (30), wobei die Heizvorrichtung (30) zum Heizen des Patrizenteils (13) konfiguriert ist,

wobei das Matrizenteil (12) einen oder mehrere weitere Hohlräume (24) und eine erste Oberfläche (23'), die ins Innere des ersten Hohlrums (21) zeigt und für eine Schicht (7) des Breis bestimmt ist, umfasst, wobei es die erste Oberfläche (23') ermöglicht, dass Fluid zwischen dem ersten Hohlraum (21) und dem einem oder den mehreren weiteren Hohlräumen (24) strömt,

gekennzeichnet durch

einen ersten Kompressor (16), konfiguriert zum Herstellen eines vorübergehend erhöhten Fluiddrucks von mehr als 1 bar in dem einen oder den mehreren Hohlräumen (24).

2. System nach Anspruch 1, wobei das Druckwerkzeug (25) eine Aushöhlung (H) aufweist und der Patrizenteil (13) erweiterbar ist, wobei das System ferner eine Erweiterungsvorrichtung (17) umfasst, die zum Erweitern des erweiterbaren Patrizenteils (13) durch Herstellen eines Innendrucks (P) in der Aushöhlung (H) des Druckwerkszeugs (25) konfiguriert ist.
3. System nach Anspruch 2, wobei die Erweiterungsvorrichtung (17) ein zweiter Kompressor (17) ist.
4. System nach einem der vorhergehenden Ansprüche, wobei der erste Kompressor (16) zum Herstellen eines vorübergehend erhöhten Fluiddrucks von zumindest 4 bar in dem einen oder den mehreren Hohlräumen (24) konfiguriert ist.
5. System nach einem der vorhergehenden Ansprüche, beinhaltend eine Wand (23), die den ersten Hohlraum (21) von dem einen oder den mehreren Hohlräumen trennt, wobei die Wand (23) eine erste Oberfläche (23') aufweist, wobei eine gegenüberliegende zweite Oberfläche (23'') der Wand (23) in Richtung des einen oder der mehreren Hohlräume (24) ausgerichtet ist.
6. System nach einem der vorhergehenden Ansprüche, wobei der eine oder die mehreren Hohlräume (24) in einem offenzelligen porösen Material vorliegen.
7. System nach Anspruch 2 oder einem der Ansprüche 3-6, wenn von Anspruch 2 abhängig, wobei die Heizvorrichtung (30) und die Erweiterungsvorrichtung (17) ein Heißfluid-Heizmedium an die Aushöhlung (H) für das Heizen und Erweitern des erweiterbaren Patrizenteils (13) liefern.

8. System nach Anspruch 2 oder einem der Ansprüche 3-7, wenn von Anspruch 2 anhängig, beinhaltend eine Steuervorrichtung (C), die dazu betreibbar ist, gleichzeitig höchstens den gleichen erhöhten Druck in der einen oder den mehreren weiteren Hohlräumen (24) wie den Innendruck (P) in der Aushöhlung (H) herzustellen. 5
9. System nach Anspruch 5 oder einem der Ansprüche 6-8, wenn von Anspruch 5 abhängig, wobei die Wand (23) eine poröse Struktur umfasst. 10
10. System nach Anspruch 5 oder einem der Ansprüche 6-9, wenn von Anspruch 5 abhängig, wobei die Wand (23) Bohrungen (B) beinhaltet, die zwischen dem ersten Hohlraum (21) und dem einen oder den mehreren Hohlräumen (24) verlaufen. 15
11. System nach einem der vorhergehenden Ansprüche, wobei die erste Oberfläche (23') durch ein Netz definiert ist. 20
12. System nach einem der vorhergehenden Ansprüche, beinhaltend eine Pumpe (16') zum Entleeren des einen oder der mehreren weiteren Hohlräume (24). 25
13. System nach Anspruch 2 oder einem der Ansprüche 3-12, wenn von Anspruch 2 abhängig, wobei sich die Heizvorrichtung (30) in der Aushöhlung (H) befindet und bevorzugt durch Mikrowellen heizt. 30
14. Verfahren zum Herstellen eines geformten Gegenstands, insbesondere eines schalenförmigen Gegenstands (5), aus Brei, unter Verwendung eines Systems, das Folgendes umfasst: 35
- eine geteilte Form (11) mit
- einem Matrizenteil (12), 40
 - einem Druckwerkzeug (25) mit einer Aushöhlung (H) und einem erweiterbaren Patrizenteil (13), und
 - einem ersten Hohlraum (21) für den Brei zwischen dem Matrizenteil (12) und dem erweiterbaren Patrizenteil (13), 45
- wobei das Matrizenteil (12) einen oder mehrere weitere Hohlräume (24) und eine erste Oberfläche (23'), die ins Innere des ersten Hohlraums (21) zeigt und für eine Schicht des Breis bestimmt ist, umfasst, wobei es die erste Oberfläche (23') ermöglicht, dass Fluid zwischen dem ersten Hohlraum (21) und dem einem oder den mehreren weiteren Hohlräumen (24) strömt, 50
- eine Heizvorrichtung (30), wobei die Heizvorrichtung zum Heizen des erweiterbaren Patrizenteils (13) konfiguriert ist, 55

einen ersten Kompressor (16), konfiguriert zum Herstellen eines vorübergehend erhöhten Fluiddrucks von mehr als 1 bar in dem einen oder den mehreren Hohlräumen (24), und eine Erweiterungsvorrichtung (17), konfiguriert zum Erweitern des erweiterbaren Patrizenteils (13) durch Herstellen eines Innendrucks (P) in der Aushöhlung (H) des Druckwerkzeugs (25), wobei das Verfahren die folgenden Schritte umfasst:

- a. Platzieren der Schicht (7) des Breis auf der ersten Oberfläche (23'),
- b. dann Herstellen des Innendrucks (P) innerhalb der Aushöhlung (H), um den Patrizenteil (13) gegen die Schicht (7) von Brei, die auf der ersten Oberfläche (23') platziert ist, zu drücken,
- c. dann Herstellen, in dem einen oder den mehreren weiteren Hohlräumen (24), eines erhöhten Fluiddrucks von mehr als 1 bar,
- d. vor, gleichzeitig mit oder nach dem Schritt c, Aktivieren der Heizvorrichtung (30), um den Patrizenteil (13), der gegen die Schicht (7) drückt, zu heizen,
- e. dann Ablassen des Drucks innerhalb des einen oder der mehreren weiteren Hohlräume (24) unter aufrechterhaltung eines höheren Innendrucks innerhalb der Aushöhlung (H) des erweiterbaren Druckwerkzeugs, das gegen die Schicht (7) drückt.

15. Verfahren nach Anspruch 14, wobei der Innendruck (P) in der Aushöhlung (H), der in Schritt b hergestellt wird, höher als 4 bar ist, wobei das Heizen in Schritt d so erfolgt, dass Flüssigkeit nur in einem Abschnitt der Schicht (7), die am nächsten zu dem Patrizenteil (13) liegt, überhitzt wird.

16. Verfahren nach Anspruch 14 oder 15, wobei überhitzte Flüssigkeit in dem Brei am nächsten zu dem Patrizenteil (13) Flüssigkeit, die in dem Brei enthalten ist, in den einen oder die mehreren weiteren Hohlräume (24) treibt.

Revendications

1. Système (10) pour produire un article moulé, en particulier un article en forme de plateau (5), à partir de pâte, ledit système (10) comprenant :

un moule à coins (11) avec

- une partie de moule femelle (12),
- un outil de pression (25) possédant une partie de moule mâle (13), et
- une première cavité (21) pour ladite pâte

- entre ladite partie de moule femelle (12) et ladite partie de moule mâle (13),
- et un dispositif de chauffage (30), ledit dispositif de chauffage (30) étant conçu pour chauffer ladite partie de moule mâle (13),
ladite partie de moule femelle (12) comprenant une ou plusieurs cavités supplémentaires (24) et une première surface (23') faisant face à l'intérieur de ladite première cavité (21) et étant pour une couche (7) de ladite pâte, ladite première surface (23') permettant au fluide de s'écouler entre ladite première cavité (21) et ladite ou lesdites cavités supplémentaires (24),
caractérisé par
un premier compresseur (16) configuré pour établir une pression de fluide élevée temporaire supérieure à 1 bar dans ladite ou lesdites cavités supplémentaires (24).
2. Système selon la revendication 1, ledit outil de pression (25) possédant un creux (H) et ladite partie de moule mâle (13) pouvant être dilatée, ledit système comprenant en outre un dispositif d'expansion (17) configuré pour dilater ladite partie de moule mâle expansible (13) en établissant une pression interne (P) dans ledit creux (H) dudit outil de pression (25).
 3. Système selon la revendication 2, ledit dispositif d'expansion (17) étant un second compresseur (17).
 4. Système selon l'une quelconque des revendications précédentes, ledit premier compresseur (16) étant configuré pour établir une pression de fluide élevée temporaire supérieure ou égale à 4 bars dans ladite ou lesdites cavités supplémentaires (24).
 5. Système selon l'une quelconque des revendications précédentes, comprenant une paroi (23) séparant ladite première cavité (21) de ladite ou desdites cavités, ladite paroi (23) possédant ladite première surface (23'), une seconde surface opposée (23'') de ladite paroi (23) étant orientée vers ladite ou lesdites cavités supplémentaires (24).
 6. Système selon l'une quelconque des revendications précédentes, ladite ou lesdites cavités (24) étant dans un matériau poreux à cellules ouvertes.
 7. Système selon la revendication 2 ou l'une quelconque des revendications 3 à 6 lorsque elles dépendent de la revendication 2, ledit dispositif de chauffage (30) et ledit dispositif d'expansion (17) délivrant un milieu chauffant de fluide chaud audit creux (H) pour ledit chauffage et ladite expansion de ladite partie mâle expansible (13).
 8. Système selon la revendication 2 ou l'une quelconque des revendications 3 à 7 lorsqu'elles dépendent de la revendication 2, comprenant un dispositif de commande (C) pouvant fonctionner pour établir simultanément, au maximum, la même pression élevée dans ladite ou lesdites cavités supplémentaires (24) que ladite pression interne (P) dans ledit creux (H).
 9. Système selon la revendication 5 ou l'une quelconque des revendications 6 à 8 lorsqu'elles dépendent de la revendication 5, ladite paroi (23) comprenant une structure poreuse.
 10. Système selon la revendication 5 ou l'une quelconque des revendications 6 à 9 lorsqu'elles dépendent de la revendication 5, ladite paroi (23) comprenant des alésages (B) s'étendant entre ladite première cavité (21) et ladite ou lesdites cavités supplémentaires (24).
 11. Système selon l'une quelconque des revendications précédentes, ladite première surface (23') étant définie par un filet.
 12. Système selon l'une quelconque des revendications précédentes, comprenant une pompe (16') pour drainer ladite ou lesdites cavités supplémentaires (24).
 13. Système selon la revendication 2 ou l'une quelconque des revendications 3 à 12 lorsqu'elles dépendent de la revendication 2, ledit dispositif de chauffage (30) étant situé dans ledit creux (H) et de préférence chauffant par microondes.
 14. Procédé pour la production d'un article moulé, en particulier un article en forme de plateau (5), à partir de pâte, en utilisant un système comprenant :
un moule à coins (11) avec
 - une partie de moule femelle (12),
 - un outil de pression (25) possédant un creux (H) et une partie de moule mâle expansible (13), et
 - une première cavité (21) pour ladite pâte entre ladite partie de moule femelle (12) et ladite partie de moule mâle expansible (13),
 ladite partie de moule femelle (12) comprenant une ou plusieurs cavités supplémentaires (24) et une première surface (23') faisant face vers l'intérieur de ladite première cavité (21) et étant pour une couche de pâte, ladite première surface (23') permettant au fluide de s'écouler entre ladite première cavité (21) et ladite ou lesdites cavités supplémentaires (24),
un dispositif de chauffage (30), ledit dispositif de

chauffage étant configuré pour chauffer ladite partie de moule mâle expansible (13),
 un premier compresseur (16) configuré pour établir une pression de fluide élevée temporaire supérieure à 1 bar dans ladite ou lesdites cavités supplémentaires (24), et
 un dispositif d'expansion (17) configuré pour l'expansion de ladite partie de moule mâle expansible (13) en établissant une pression interne (P) dans ledit creux (H) dudit outil de pression (25),
 ledit procédé comprenant les étapes suivantes :

- a. la mise en place de ladite couche (7) de ladite pâte sur ladite première surface (23'),
 - b. l'établissement ensuite de ladite pression interne (P) à l'intérieur dudit creux (H) afin de presser ladite partie mâle expansible (13) contre ladite couche (7) de pâte placée sur ladite première surface (23'),
 - c. l'établissement alors, dans ladite ou lesdites cavités supplémentaires (24), d'une pression de fluide élevée supérieure à 1 bar,
 - d. avant, en même temps ou après ladite étape c l'activation dudit dispositif de chauffage (30) pour chauffer ladite partie mâle (13) exerçant une pression contre ladite couche (7),
 - e. puis le relâchement de ladite pression à l'intérieur de ladite ou lesdites cavités supplémentaires (24) tout en maintenant une pression interne élevée à l'intérieur dudit creux (H) dudit outil de pression expansible exerçant une pression contre ladite couche (7).
15. Procédé selon la revendication 14, ladite pression interne (P) dans ledit creux (H) établie à l'étape b étant supérieure à 4 bars, ledit chauffage de l'étape d étant de façon à surchauffer le liquide uniquement dans une partie de ladite couche (7) la plus proche de ladite partie mâle (13).
16. Procédé selon la revendication 14 ou 15, ledit liquide surchauffé dans ladite pâte la plus proche de ladite partie mâle (13) entraînant le liquide contenu dans ladite pâte dans ladite ou lesdites cavités supplémentaires (24).

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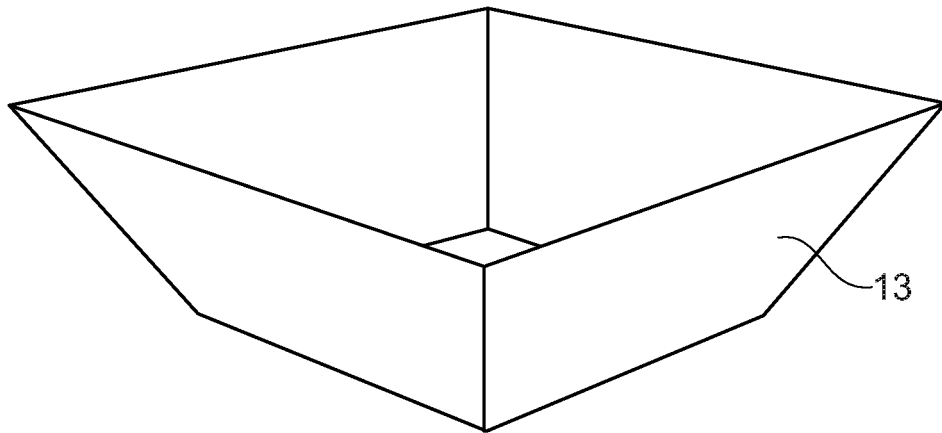


Fig. 1b

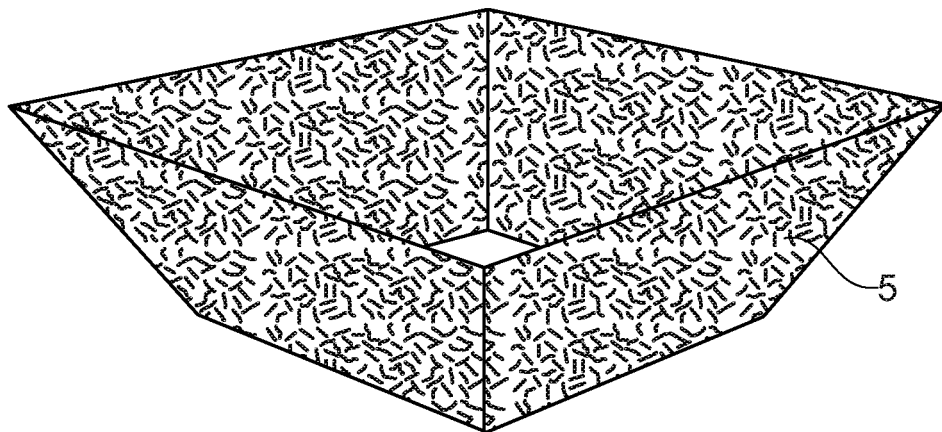


Fig. 1a

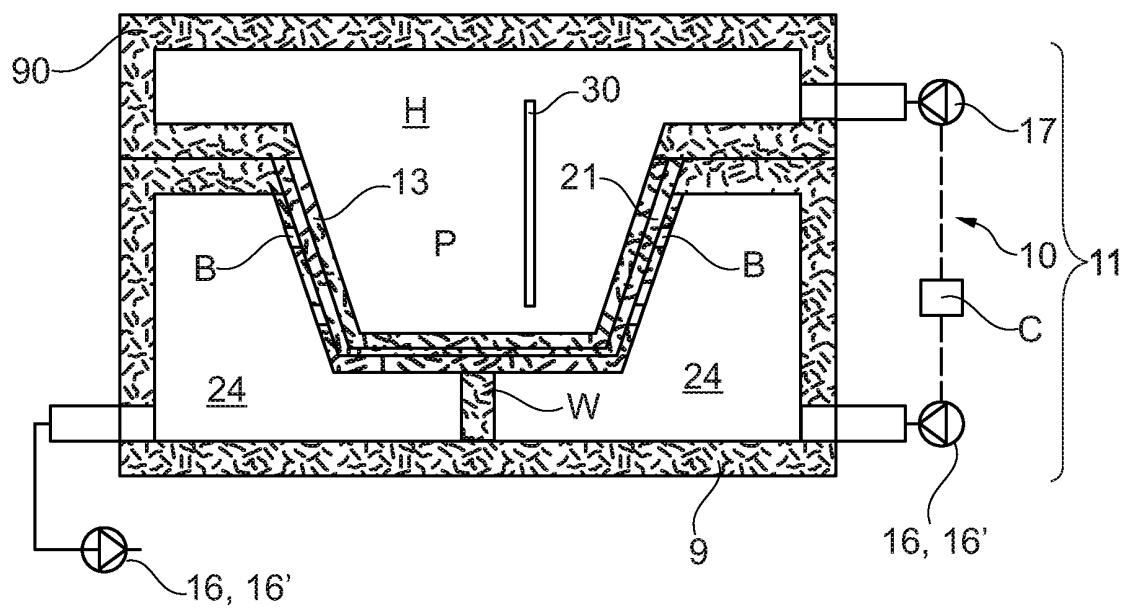


Fig. 2a

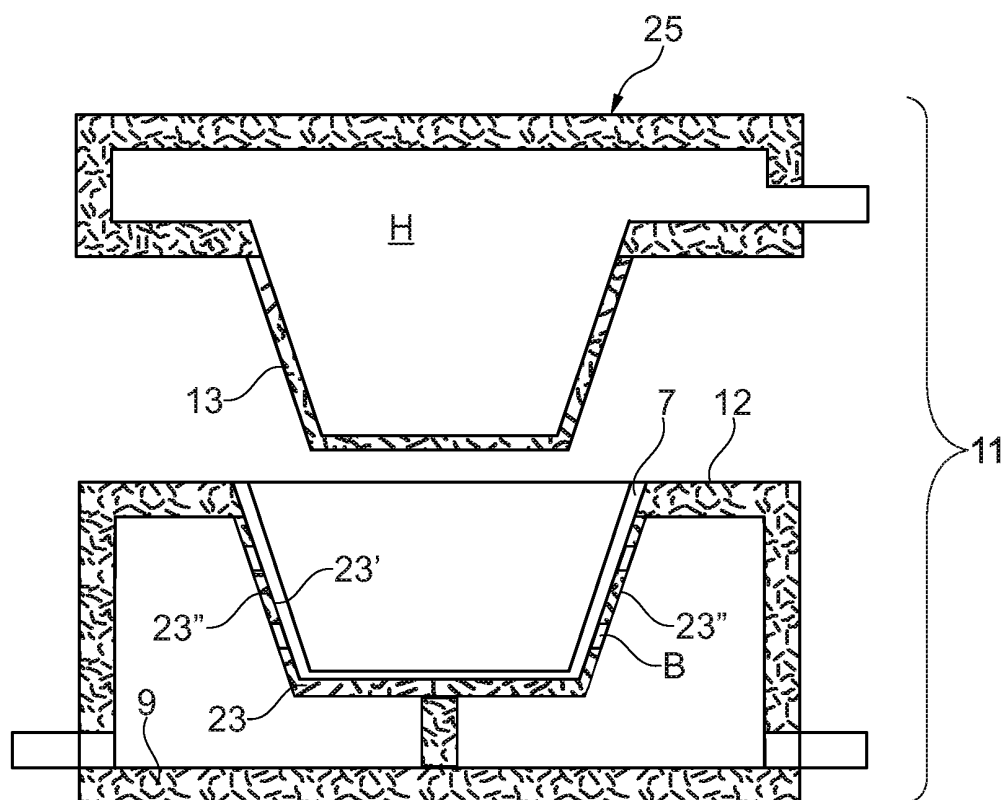


Fig. 2b

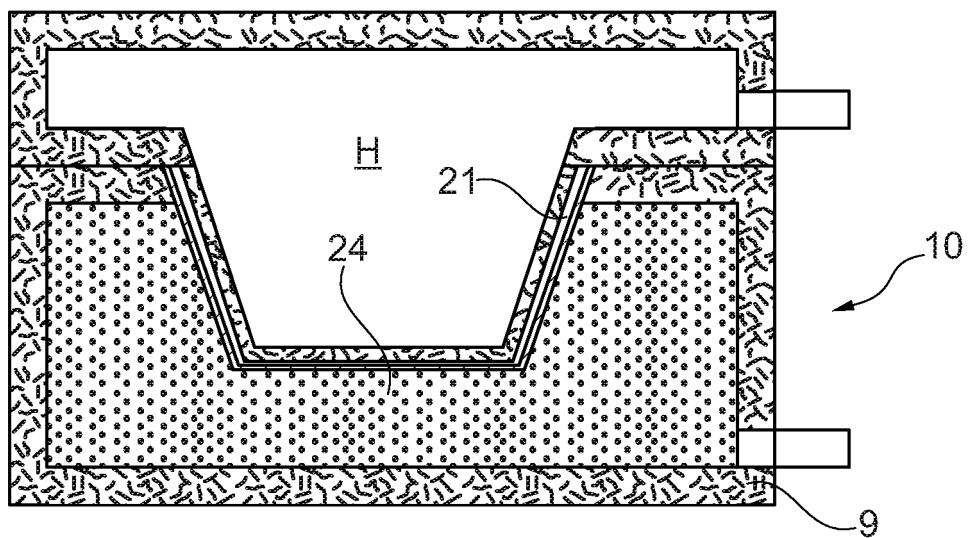


Fig. 3a

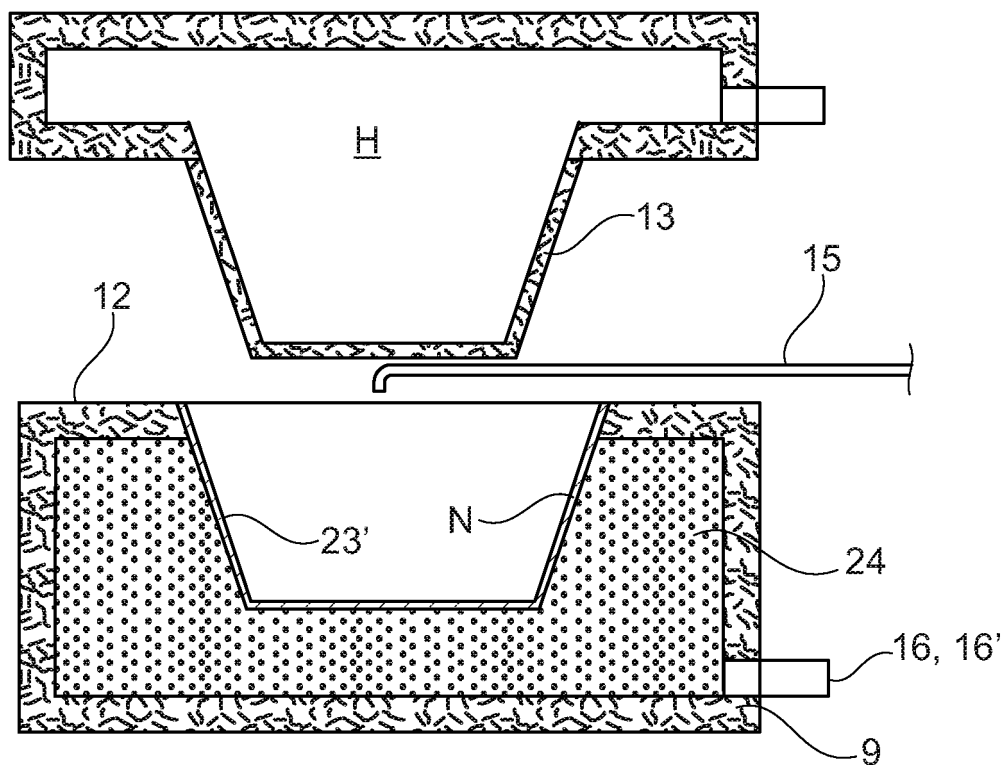


Fig. 3b

REFERENCES CITED IN THE DESCRIPTION

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