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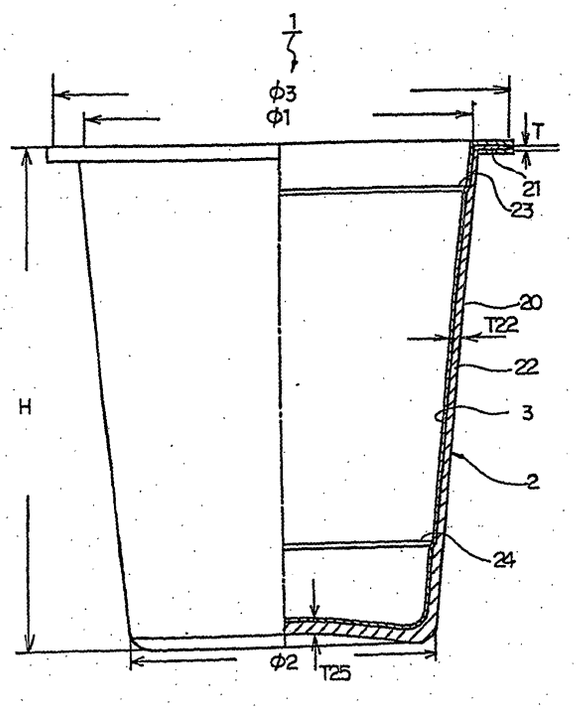
(54) PULP MOLDED ARTICLE AND METHOD AND APPARATUS FOR PRODUCING PULP MOLDED ARTICLE

(57) A pulp molded article having a pulp fiber layer (2) of single layer structure which is formed by paper-making from a single raw material composition and has a density distribution in the thickness direction thereof The pulp fiber layer (2) has such a density distribution that the density increases or decreases in the thickness direction thereof.

Fig.1



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Description

Technical Field:

[0001] The present invention relates to a pulp molded article and a method and an apparatus for producing the same. More particularly, it relates to a thin-walled, lightweight, and yet highly heat-insulating pulp molded article and a method and an apparatus for producing the same.

Background Art:

[0002] Known techniques pertinent to pulp molded heat-insulating containers include the technique disclosed in JP-A-11-301753. This technique relates to a heat-insulating double container comprising a main container and an outer container which is provided on the outside of the main container with a prescribed gap therebetween.

[0003] Such a heat-insulating container must have an outer container provided on the outside of the main container to achieve heat insulation. Accordingly, the container has an increased thickness as a whole. Further, there is a limit in achieving weight reduction of the container because of its double layer structure.

[0004] The present invention provides a novel pulp molded article which is thin, lightweight, and excellent in heat-insulating performance and a method and an apparatus for producing the pulp molded article efficiently.

Disclosure of the Invention:

[0005] The pulp molded article according to the present invention has a pulp fiber layer having a single layer structure which is formed by papermaking from a single raw material composition (stock) and has a density distribution in its thickness direction.

[0006] The present invention relates to a method of producing a pulp molded article comprising a papermaking and dewatering step in which a pulp fiber layer is made from a single stock by papermaking and dewatered and a drying step in which the dewatered pulp fiber layer is fitted into a drying mold and dried while creating a density distribution in the thickness direction thereof. More concretely, the drying mold has evacuation holes connecting to the outside on the inner wall thereof in the portion corresponding to the portion of the pulp fiber layer where a density distribution is not to be created. The pulp fiber layer placed in the drying mold is pressed from its inside onto the inner wall of the drying mold by an elastically deformable pressing member, while the drying mold is forcibly evacuated through the evacuation holes. Then the pressing force by the pressing member is reduced and, at the same time, the evacuation is stopped, whereby the pressing member is separated from the pulp fiber layer to obtain the pulp fiber layer provided with the density distribution.

[0007] The present invention also relates to an apparatus for producing a pulp molded article of the present invention. More concretely, it provides an apparatus for producing a pulp molded article which comprises a drying mold in which a pulp fiber layer is fitted and an elastically deformable pressing member which presses the pulp fiber layer fitted into the drying mold from the inside of the pulp fiber layer toward the inner wall of the drying mold, the drying mold having evacuation holes connecting to the outside on the inner wall thereof in the portion facing the part of the pulp fiber layer where a density distribution is not to be created.

Brief Description of the Drawings:

[0008]

Fig. 1 is a vertical half cross-section of a heat-insulating container as an embodiment of the pulp molded article according to the present invention.

Fig. 2 schematically illustrates an embodiment of the apparatus for producing a pulp molded article according to the present invention.

Fig. 3(a), Fig. 3(b), Fig. 3(c) and Fig. 3(d) schematically illustrates the step of drying a pulp fiber layer which forms the main body of the heat-insulating container, wherein Fig. 3(a) shows a pulp fiber layer formed by papermaking and fitted into a drying mold; Fig. 3(b) shows the pulp fiber layer being pressed in the cavity of the drying mold by a pressing member; Fig. 3(c) shows the pressing member being shrinking; and Fig. 3(d) shows the main body of the container removed from the mold.

Fig. 4(a) and Fig. 4(b) schematically illustrate the step of forming a coating layer of the heat-insulating container, in which Fig. 4(a) shows a resin film which is being superposed on the inner side of the main body of the container by vacuum forming; and Fig. 4(b) is an enlarged view of an essential part of the main body of the container laminated with the resin film.

Best Mode for Carrying out the Invention:

[0009] The present invention will be described based on its preferred embodiments by referring to the accompanying drawings.

[0010] Fig. 1 shows an embodiment of the pulp molded article according to the present invention, which is a heat-insulating container used to hold a food such as an instant noodle. In Fig. 1, numerical reference 1 indicates the heat-insulating container; 23, a line indicative of the level to which hot water is to be poured; and 24, a stacking shoulder.

[0011] As shown in Fig. 1, the heat-insulating container 1 comprises a cup-shaped main body 20 of the container (hereinafter referred to as a container main body) formed of a pulp fiber layer 2. The container has a flange 21 of prescribed thickness formed around its brim. The inner side of the container main body 20 (pulp fiber layer 2) and the flange 21 are coated with the coating layer 3.

[0012] The pulp fiber layer 2 has a single layer structure formed by papermaking from a single slurry (stock) described later. The body 22 of the container main body 20 is provided with a density distribution such that the density of the pulp fiber layer 2 increases from its inside toward the outside.

[0013] The language "the pulp fiber layer has a density distribution" as used throughout the description means that the size of the interstitial voids (void or void volume) between pulp fibers bound in the pulp fiber layer has a distribution in the thickness direction. The larger the voids, the smaller the density of the pulp fiber layer. The smaller the voids, the larger the density. Accordingly, if the interfiber voids are equal in size in the thickness direction, the pulp fiber layer has no density distribution.

[0014] It is preferred that the density change in the pulp fiber layer 2 be continuous for obtaining high strength or be discontinuous (stepwise) for securing high heat insulation.

[0015] From the standpoint of strength, heat insulation, and lightness of the container, the thickness of the body 22 having the density distribution is preferably 0.5 to 3.0 mm, more preferably 0.5 to 2.0 mm. Strength and heat-insulation required of a noodle container are not secured with a body thickness smaller than 0.5 mm. Containers with a body thickness exceeding 3.0 mm would be too heavy as a noodle container.

[0016] The bulk density (bulk density after drying) of the body 22 having the density distribution preferably ranges from 0.1 to 0.6 g/cm^3, particularly 0.2 to 0.5 g/cm^3. A bulk density less than 0.1 g/cm^3 results in a failure to secure strength necessary for use as a noodle container. A bulk density more than 0.6 g/cm^3 results in insufficient heat-insulating properties so that a user can hardly hold the container by the hand. Where the bottom portion is provided with a density distribution, the bulk density of the bottom portion is preferably in the same range as that of the body.

[0017] The bulk density (bulk density after drying) of the portions other than the body 22 is preferably 0.2 to 0.9 g/cm^3. The density of a portion which needs strength, in particular, is preferably 0.3 to 0.9 g/cm^3.

[0018] The pulp fiber layer 2 is preferably made solely of pulp fiber. The pulp fiber includes wood pulp, such as virgin pulp and recycled pulp; nonwood pulp, such as cotton pulp, linter pulp, bamboo and straw; and hydrophobilized pulp fiber obtained by mercerizing or crosslinking these pulps. In particular, the hydrophobilized pulp fiber preferably includes HBA-LA, HBA-S, and HBA-FF, all available from Weyerhauser, U.S.A. Two or more of these pulp fibers can be used as a mixture in an appropriate ratio.

[0019] The pulp fiber layer 2 preferably contains a bulking agent in addition to the pulp fiber in order to improve heat insulating properties and surface properties. Useful bulking agents include anionic surface active agents, cationic surface active agents, nonionic surface active agents, and amphoteric surface active agents. These bulking agents can be used either individually or as a mixture thereof. In particular, KB-115 or KB-08W available from Kao Corp. is preferably used as a bulking agent bringing about improved heat insulating properties.

[0020] The pulp fiber layer 2 can contain, in addition to the bulking agent, other additives such as pigments, fixing agents, antifungal agents, and sizes.

[0021] The coating layer 3 imparts such functions as waterproofness, oil resistance, and gas barrier properties, to the heat-insulating container 1. The thickness of the coating layer 3 is decided according to the desired function. The coating layer 3 is formed by laminating with a resin film.

[0022] The resin film which can be used as the coating layer 3 includes a film of thermoplastic resins, such as polyolefin resins, e.g., polyethylene and polypropylene, polyester resins, e.g., polyethylene terephthalate, polyamide resins, e.g., nylon, polyvinyl resins, e.g., polyvinyl chloride, and styrene resins, e.g., polystyrene; and a film of biodegradable resins, such as modified polyethylene terephthalate and aliphatic polyesters. Polyolefin resins are preferred for the cost of production and formability, and biodegradable resin films are preferred in view of disposability from the consideration for the environment. The coating layer may be formed by laminating with two or more of these resin films.

[0023] A preferred apparatus for producing the pulp molded article of the present invention will then be described with particular reference to an apparatus for producing the container main body 20 of the heat-insulating container 1 by referring to Fig. 2.

[0024] Fig. 2 shows an embodiment of the apparatus for producing a pulp molded article according to the present invention, applied to the production of a heat-insulating container for holding a food, such as an instant noodle. In Fig.

2, numerical reference 10 indicates the apparatus.

[0025] The apparatus 10 has a drying mold 11 in which a pulp fiber layer 2 is fitted and an elastically deformable pressing member 16 which presses the pulp fiber layer 2 from the inside toward the cavity-forming wall of the drying mold 11.

[0026] The drying mold 11 has a pair of splits 12 and 12. The splits 12 and 12 are joined together to form a cavity 110 corresponding to the contour of the container main body 20.

[0027] Evacuation holes 13 connecting to the outside are made on the inner wall of the drying mold 11 in the portion facing the part of the pulp fiber layer 2 where a density distribution is not to be created.

[0028] In this particular embodiment, the cavity-forming wall of the drying mold 11 has no evacuation holes for steam escape in its portion facing the body 22 of the container main body 20. Evacuation holes 13 for steam escape are made on the cavity-forming wall in the portions facing the flange 21 and the bottom portion (including the base and the rising part of the wall).

[0029] Each evacuation hole preferably has a slit form from the viewpoint of the surface smoothness of the resulting molded article, evacuation efficiency, and prevention of clogging of the evacuation holes. The width of each evacuation hole (slit width) is preferably 0.1 to 0.5 mm, more preferably 0.1 to 0.3 mm. In the present embodiment the total open area of the evacuation holes is preferably 100 to 1500 mm^2, more preferably 200 to 1000 mm^2, for obtaining container strength and preventing stains. Where it is desired to form a molded article with a clear corner or edge, it is preferred to make the evacuation hole 13 open at the part facing to the corner or edge to be formed.

[0030] The evacuation holes 13 are connected to an evacuation line 130 equipped with an on-off valve 131. The end of the evacuation line 130 is connected to an evacuation source (not shown).

[0031] The drying mold 11 has a lid 15 which shuts the upper opening 111. The lid 15 has an opening 14 which connects to the opening 111 and through which a pressing member 16 is let in and out. Each split 12 constituting the drying mold 11 has a heating unit 120 attached thereto.

[0032] The pressing member 16 is a bag which is elastic and therefore expandable and shrinkable. Materials of the pressing member 16 include urethane, fluororubber, silicone rubber, elastomers and etc., which are excellent in tensile strength, impact resilience, and stretchability. The pressing member 16 is connected to a pipe line 17 for feeding a pressurizing fluid into the pressing member 16. The pipe line 17 has an on-off valve 18. The end of the pipe line 17 is connected alternately to an evacuation source (not shown) and a pressurizing source (not shown).

[0033] A preferred method of producing the pulp molded article of the present invention will be described with reference to the production of the heat-insulating container 1.

[0034] The method of producing the heat-insulating container 1 includes the step of papermaking and dewatering the pulp fiber layer 2 forming the container main body 20, the step of drying the dewatered pulp fiber layer 2, and the step of forming the coating layer 3.

[0035] In the step of papermaking and dewatering the pulp fiber layer 2, the pulp fiber 2 having a single layer structure is formed by papermaking from a single slurry (a single stock). In this papermaking step, a papermaking mold composed of a pair of splits is used, the splits being joined together to form a cavity of prescribed shape corresponding to the container main body 2. The cavity has an opening at the top.

[0036] Each split constituting the papermaking mold has a plurality of interconnecting passageways which connect the cavity and the outside. Each interconnecting passageway is led to a sucking unit, such as a suction pump (not shown).

[0037] The total open area ratio of the interconnecting passageways on the inner wall of the splits (the cavity-forming side) is preferably 4 to 20%, more preferably 3 to 50%, in view of reduction of drain time and moldability.

[0038] The cavity-forming wall preferably has drainage channels leading to each interconnecting passageway. The total open area ratio of the drainage channels on the cavity-forming wall is preferably 50 to 90%, more preferably 60 to 80%, from the standpoint of prevention of deformation of a papermaking screen, molding capabilities, drainage, and prevention of clogging of the papermaking screen. The width of the drainage channel is preferably 1 to 10 mm, more preferably 2 to 5 mm, from the standpoint of prevention of deformation of a papermaking screen, molding capabilities, drainage, and prevention of clogging of the papermaking screen. The drainage channels are preferably formed in a checkered pattern so as to connect the interconnecting passageways to each other.

[0039] The inner wall of each split is covered with a prescribed papermaking screen. The papermaking screen includes a single net fabricated of natural fiber, synthetic fiber or metal fiber or a combination of a plurality of these nets. Synthetic fiber is preferred of these materials for ease of fabricating into a net and durability. The natural fiber includes vegetable fiber and animal fiber. The synthetic fiber includes synthetic resin fibers made of thermoplastic resins, thermosetting resins or semi-synthetic resins. The metal fiber includes stainless steel fiber and copper fiber. The fibers of the papermaking screen are preferably surface-modified to improve slip and durability.

[0040] Taking into consideration papermaking properties, durability, easy pass of solid matter of the slurry, and prevention of clogging, the wire diameter of the papermaking screen is preferably 0.05 to 1.0 mm, more preferably 0.05 to 0.5 mm, and the distance between wires is preferably 0.15 to 2.0 mm, more preferably 0.15 to 1.5 mm.

[0041] A predetermined amount of the slurry is injected into the cavity, and the cavity is sucked by means of a suction pump through the drainage channels and the interconnecting passageways. Thus, the water content of the slurry is removed by suction, and a pulp fiber layer is deposited on the papermaking screen covering the cavity-forming wall.

[0042] The injection pressure of the slurry into the cavity is preferably 0.05 to 1.0 MPa, more preferably 0.05 to 0.5 MPa, for shortening the slurry injection time and securing moldability.

[0043] The inner pressure of the cavity evacuated through the interconnecting passageways is preferably 10 to 90 kPa, more preferably 20 to 70 kPa, for shortening the dewatering time and securing moldability.

[0044] The single slurry used to form the pulp fiber layer 2 by papermaking preferably consists of pulp fiber and water.

[0045] The pulp fiber includes wood pulp, such as virgin pulp and recycled pulp; nonwood pulp, such as cotton pulp, linter pulp, bamboo and straw; and hydrophobilized pulp fiber obtained by mercerizing or crosslinking these pulps. The hydrophobilized pulp fiber is particularly preferred. Examples of preferred hydrophobilized pulp fiber are HBA-LA, HBA-S, and HBA-FF, all available from Weyerhauser, U.S.A. Two or more of these pulp fibers can be used as a mixture in an appropriate ratio.

[0046] The pulp fiber content in the slurry is preferably 0.05 to 10 wt%, more preferably 0.05 to 4 wt%.

[0047] Additives, such as the above-recited bulking agents, sizes, pigments, fixing agents, and antifungal agents, can be added to the single slurry used to form the pulp fiber layer 2 by papermaking in appropriate ratios.

[0048] After a predetermined amount of the slurry has been injected into the cavity, a pressurizing fluid is fed into the cavity while continuing evacuating the cavity through the interconnecting passageways, whereby the pulp fiber layer 2 is dewatered.

[0049] The pressurizing fluid used for dewatering includes air, steam, and superheated steam.

[0050] The pressure of the pressurizing fluid for dewatering is preferably 0.05 to 1.0 MPa, more preferably 0.05 to 0.5 MPa, from the standpoint of dewatering efficiency.

[0051] The water content of the pulp fiber layer 2 after dewatering is preferably 50 to 85%, more preferably 60 to 80%, from the viewpoint of drying efficiency, surface smoothness and heat insulating properties of the container after drying, and for preventing the container from suffering surface scorching on drying.

[0052] After the pulp fiber layer 2 is dewatered to a desired water content, the pulp fiber layer 2 is separated from the cavity-forming wall, and the undried pulp fiber layer 2 is transferred into the drying mold 11.

[0053] In making the container main body 20 with the flange 21 as in the present embodiment, the cavity-forming wall of the drying mold 11 has no evacuation holes for steam escape in its portion facing the body 22 of the container main body 20, while evacuation holes 13 for steam escape, which are led to the outside, are provided on the cavity-forming wall in the portions facing the flange 21 and the bottom portion (including the base and the rising part of the wall). As shown in Fig. 3(b), the pulp fiber layer 2 is set in the drying mold 11, and the upper opening 111 of the drying mold 11 is shut by the lid 15 having the insertion opening 14. The drying mold 11 is then heated to a prescribed temperature by the heating unit 120.

[0054] The temperature of the drying mold 11 (mold temperature) is preferably 150 to 300°C, more preferably 170 to 250°C, for preventing the pulp fiber layer 2 from scorching and for improving drying efficiency.

[0055] While the pulp fiber layer is dried in the drying mold as shown in Fig.3(b), the pressing member 16 is inserted into the cavity 110 of the drying mold 11 through the insertion opening 14 of the lid 15 to close the cavity 110. A pressurizing fluid is supplied into the pressing member 16 to inflate the pressing member 16 within the cavity 110, whereby the pulp fiber layer 2 is heat dried while being pressed to the cavity-forming wall.

[0056] The pressing force of the pressing member 16 during heat drying is preferably 0.05 to 1.0 MPa, more preferably 0.1 to 0.3 MPa, from the standpoint of heat insulating properties, drying efficiency, and surface smoothness.

[0057] Steam generated from the pulp fiber layer 2 during the heat drying is expelled by forcible evacuation through the evacuation holes 13. In the portions of the pulp fiber layer 2 facing the cavity-forming wall with no evacuation holes, water remaining among fibers partially vaporizes before reaching the evacuation holes and expands the interfiber voids. It follows that the density of the pulp fiber layer in the inner side of these portions is lowered. On the other hand, in the opening portion and the bottom portion of the container main body 20, where the evacuation holes 13 are formed, since the vaporized water is allowed to immediately escape through the evacuation holes, the pulp layer 2 increases its density while being compressed by the pressing force of the pressing member.

[0058] The pressure for the forcible evacuation is preferably 4 to 60 kPa, more preferably 4 to 10 kPa, for securing drying efficiency and making the container bulky.

[0059] On sufficiently drying the pulp fiber layer 2, the pressurizing fluid is withdrawn from the pressing member 16. And the forcible evacuation through the evacuation holes 13 is stopped while the pressing member 16 shrinks to reduce the inner pressure of the cavity 110 as shown in Fig. 3(c).

[0060] The step of pressing the pulp fiber layer 2 by the pressing member 16 with forcible evacuation and the step of stopping the forcible evacuation and shrinking the pressing member 16 can be conducted repeatedly if needed.

[0061] After a sufficient density distribution is created in the body 22 of the container main body 20, the splits 12 and 12 are separated apart to take out the container main body 20 as shown in Fig. 3(d). If necessary, the container main

body is finished by trimming and the like.

[0062] In the step of forming the coating layer 3, the inner surface and the flange 21 of the container main body 20 (i.e., the pulp fiber layer 2) is coated with the coating layer 3.

[0063] The above-described resin film can be formed into the coating layer 3 by known' techniques, such as pressure forming and vacuum forming.

[0064] Where vacuum forming is adopted, the coating layer can be formed by use of a vacuum forming mold 5 and a plug 6 having a heater 60 as shown in Figs. 4(a) and (b). The vacuum forming mold 5 is substantially the same size as the drying mold 10 used in the pulp fiber layer 2 drying step. It has air flow channels 51 arranged in a checkered pattern on the cavity-forming wall 50 and an evacuation path 52 connecting the air flow channels and the outside. The container main body 20 is fitted into the vacuum forming mold 5, and a preheated and softened resin film 30 is set on the opening of the container main body 20 to cover the opening. A plug 6 is brought down to press the resin film 30 into the container main body 20. At the same time, the container main body 20, being air permeable, is evacuated through the air flow channels 51 and the evacuation path 52 to thereby bring the resin film 30 into intimate contact with the inner surface and the flange 21 of the container main body 20. The unnecessary part of the resin film 30 is cut off to complete the production of the heat-insulating container 1.

[0065] Since the container main body 20 is formed of a single-layered pulp fiber layer 2 having, in its body 22, distribution of density increasing from the inner side toward the outer side in the thickness direction, it is thin, lightweight, and excellent in heat insulating properties and exhibits desired strength on its outer side. The heat-insulating container, which contains no blowing agent for lowering the density, can be made environmentally friendly by using a biodegradable material to form the pulp fiber layer and the coating layer. Further, because the flange 21, the body 22, and the bottom are integrally molded with no joint seams in the body 22 and the bottom, the container is excellent in mechanical strength (compressive strength and durability). Additionally, the outer surface of the pulp fiber layer 2 has a high density and smoothness and is therefore excellent in printability.

[0066] Since the container main body 20 is made of the pulp fiber layer 2 formed by a single papermaking operation using a single slurry, the production of the heat-insulating container 1 enjoys simplification and time reduction compared with conventional methods. Accordingly, the production efficiency of the heat-insulating container 1 is greatly improved over the conventional methods.

[0067] The present invention is not limited to the heat-insulating container 1 according to the above-described embodiment, and appropriate changes and modifications can be made therein without departing from the spirit thereof

[0068] In cases where the pulp molded article of the present invention is the heat-insulating container 1 as in the above-described embodiment, while it is preferred that the density distribution in the pulp fiber layer be provided in the body of the container main body, the portion where the density distribution is to be provided can be decided according to the use, the shape, etc. of the pulp molded article.

[0069] Where the pulp molded article is a container which requires heat insulation as a whole, such as a bowl or a tray, the pulp fiber layer can be designed to have the density distribution over the entire pulp fiber layer.

[0070] The density distribution of a single-layered pulp fiber layer of the pulp molded article of the present invention is preferably such that the density increases in the thickness direction from the inner side to the outer side as in the heat-insulating container 1 of the above-described embodiment. In contrast, containers which are primarily intended to protect the contents, industrial parts having a sound absorbing function, and like articles may have a single-layered pulp fiber layer with such a density distribution that the density decreases in the thickness direction from the inner side toward the outer side.

[0071] It is preferred that the flange 21 of the pulp molded article of the invention be formed while the pulp fiber layer 2 is being deposited by papermaking as in the aforementioned embodiment, while the flange may be formed by bending the pulp fiber layer. The shape of the flange is not limited to the outward curl at a prescribed curvature, and other shapes can be formed.

[0072] While the coating layer 3 of the pulp molded article of the invention is preferably formed of a resin film as in the aforementioned embodiment, it may be formed by applying a coating composition. Coating methods include spreading a coating composition and dipping the container main body 2 in a coating composition, and like techniques.

[0073] The outer surface of the pulp molded article of the present invention may be coated with another pulp fiber layer having a higher density than the fiber layer 2 thereby to improve printability, strength, water resistance, and like properties.

[0074] The pulp fiber layer of the pulp molded article of the present invention is preferably formed by papermaking by use of a papermaking mold composed of a set of splits which are joined to form a cavity of prescribed shape as in the above-mentioned embodiment, but use of such a split mold is not always necessary for producing some shapes of pulp molded articles. Further, other papermaking methods are employable. For example, papermaking can be carried out by using a male mold. The male mold comprises a projected papermaking part corresponding to the contour of a container main body and having a large number of liquid flow holes open to the outer surface thereof and a prescribed papermaking screen covering the papermaking part. The male mold is immersed in the slurry, and the slurry is sucked

up through the liquid flow holes to deposit the pulp fiber on the surface of the papermaking screen to form the pulp fiber layer. The male mold may be made of a rigid material or an elastic material.

[0075] In producing the pulp molded article of the present invention, while it is preferred to use a hollow pressing member to heat dry the pulp fiber layer 2 because of the capability of applying uniform pressure to the pulp fiber layer 2 however complicated the pulp fiber layer may be shaped, it is possible to use a solid pressing member to heat dry the pulp fiber layer 2.

[0076] The pulp molded article of the present invention can also be produced by placing the pulp fiber layer formed by papermaking into a female mold configured to the contour of the pulp fiber layer and fitting a heated male mold having a given clearance with the female mold into the female mold to effect drying the pulp fiber layer.

[0077] The pulp molded article of the present invention can also be produced by setting a dried high-density pulp molded article (another pulp fiber layer) in a female mold, uniting a wet pulp fiber layer formed by papermaking with the another pulp fiber layer, fitting a heated male mold having a given clearance with the female mold into the female mold to dry the united two pulp fiber layers. According to this drying method, the wet pulp fiber layer is dried while being expanded by steam generated from the wet pulp fiber layer. As a result, there is obtained a pulp molded article having its outer side covered with a high-density pulp fiber layer and having its density increased from the outer side toward the inner side. The resulting pulp molded article is very excellent in printability, strength, and water resistance and also excellent in inner surface properties. The "another pulp fiber layer" as referred to above is formed by an ordinary papermaking method using the fiber employable to form the pulp fiber layer 2.

[0078] While the pulp molded article of the present invention is especially suitable as a flanged heat-insulating container as in the above-described embodiment, the application of the present invention is not limited thereto. For example, the present invention is applicable to containers of various shapes, such as bowls, bottles, and trays; hollow articles, such as cylindrical shapes; and plate-shaped articles.

[0079] The present invention will now be illustrated in greater detail with reference to Examples.

[0080] Heat-insulating containers were made according to Example 1 and Comparative Example 1 and evaluated for performance. The results of evaluation are shown in Table 1.

EXAMPLE 1

Geometry of container main body:

[0081]

Height H: 106 mm
Inner diameter of opening (ϕ1): 90 mm
Outer diameter of bottom (ϕ2): 68.5 mm
Maximum outer diameter of flange (ϕ3): 96 mm
Flange thickness T: 3 mm
Body thickness T22: 1.4 mm
Bottom thickness T25: 1.2 mm

[0082] A pulp fiber layer was formed by papermaking under the following conditions using a papermaking mold having the following specification. The papermaking mold was composed of a pair of splits which were joined to form a cavity corresponding to the container main body having the above-described geometry.

Papermaking mold:

[0083]

Material: aluminum
Total open area of interconnecting passageways: 1287 mm^2 (54 holes x ϕ 3 (= 382 mm^2) in the portions corresponding to the body and the bottom and 3 mm wide slits (905 mm^2) in the portion corresponding to the whole peripheral surface of the flange)
Total open area of drainage channels (in checkered pattern): 25071 mm^2
Drainage channel width: 3 mm
Total open area ratio of drainage channels on cavity-forming wall: 75%
Papermaking screen: double screen composed of a 20 mesh PET net and a 80 mesh PET net

Slurry composition:

[0084]

Pulp slurry concentration: 0.1 wt%
Pulp fiber: crosslinked pulp (50 wt% HBA-LF supplied by Weyerhauser, U.S.A + 50 wt% bleached kraft pulp (BKP))
Bulking agent: KB115 available from Kao Corp. (5% based on the pulp fiber weight)
Size: AS262 available from Japan PMC Corp. (2% based on the pulp fiber weight)

Papermaking conditions:

[0085]

Slurry feed: 15 liters (once)
Slurry feed pressure: 0.2 MPa
Cavity suction pressure: 0.06 MPa

[0086] A pressurizing fluid was fed into the cavity under the following conditions to dewater the pulp fiber layer to a water content of 75%.

Dewatering conditions:

[0087]

Pressurizing fluid: compressed air
Pressing force: 0.2 MPa x 15 seconds
Cavity suction pressure: 0.06 MPa

[0088] A drying mold having evacuation holes specified below was prepared. The evacuation holes were provided in the portions corresponding to the periphery of the flange and the bottom (including the base and the rising part of the wall) of the container main body to be produced. The pulp fiber layer was fitted into the drying mold and pressed by a pressing member having the following specification simultaneously with forcible evacuation through the evacuation holes. The forcible evacuation was stopped, and the pressing member was shrunken to produce the container main body.

Drying mold:

[0089]

Material: aluminum
Slit width of each evacuation hole: 0.15 mm
Portion corresponding to flange: 4 slits arranged in the vertical direction at a 3 mm pitch around the peripheral surface of the flange, one of which was open to the part corresponding to the edge between the peripheral surface and the lower side of the flange.
Portion corresponding to bottom: 4 slits at a 5 mm pitch on the base (per split); 5 slits arranged in the vertical direction at a 3 mm pitch over the whole peripheral surface of the part rising from the base.
Total open area of evacuation holes on cavity-forming wall: 396 mm^2
Total open area ratio of evacuation holes on cavity-forming wall: 1.2%

Pressing member:

[0090]

Material: silicone rubber
Pressurizing fluid: compressed air

Drying conditions:

[0091]

Mold temperature: 200°C
Pressing force of pressing member: 0.2 MPa x 15 seconds
Forcible evacuation pressure: 5 kPa

Formation of coating layer:

[0092] A coating layer was formed on the resulting container main body under the following conditions to produce a heat-insulating container.

Resin film: polyethylene (LDPE/HDPE double layer structure)
Resin film thickness: 150 μm
Vacuum forming apparatus: PLAVAC-FE36PHS supplied by Sanwa-Kogyo Co., Ltd.
Film heating system: infrared heater (heater-to-resin film distance: 110 mm)
Film heating temperature: 255°C (temperature displayed on forming machine)
Film heating time: 35 seconds
Plug dimension: 60 mm in diameter x 127 mm in length
Plug material: aluminum, surface-coated with Teflon (registered trade name)
Plug temperature: 110°C (measured surface temperature)
Vacuum forming mold: opening diameter ϕ, 89.8 mm; bottom diameter ϕ, 68.5 mm; height, 93.5 mm
Vacuum forming mold temperature: 100°C (measured temperature of the inner surface)
Forming time: 8 seconds

COMPARATIVE EXAMPLE 1

[0093] A heat-insulating container was produced in the same manner as in Example 1, except for using a drying mold additionally having evacuation holes on the portion corresponding to the body of the container main body (0.15 mm wide slits over the whole circumference arranged in the vertical direction at a 10 mm interval).

1) Evaluation on density

[0094] Pieces cut out of different portions of the resulting container main body were measured for apparent volume and weight, from which a bulk density was calculated.

2) Evaluation on density distribution

[0095] Different portions of the resulting container were observed under a field emission scanning electron microscope (Model S-4000, supplied by Hitachi, Ltd.) at a magnification of 50 times to examine density distribution.

3) Evaluation on weight

[0096] The resulting container was dried at 100°C for 1 hour in a low-humidity chamber and then weighed.

4) Evaluation on heat insulating properties

[0097] A thermocouple was attached to the outer side of the body of the resulting container. Hot water at 80°C was poured into the container. After 3 minutes from the pouring, the temperature of the outer side of the body was measured, and whether the container containing the hot water could be held by the hand (graspability) was examined.

Temperature measurement with thermocouple:

[0098]

○ ... Lower than 60°C
Δ ... 60 to 65°C

X ... Higher than 65°C

Graspability test:

[0099]

○ ... The container felt warm.
Δ ... The container felt slightly hot and yet was graspable.
X ... The container felt hot and was not graspable.

5) Evaluation on strength

[0100] The resulting container was measured for vertical compressive strength and transverse compressive strength with a compression tester (Tensilon RTA-500, supplied by Orientec) in accordance with the following methods.

5-1) Vertical compressive strength

[0101] The resulting container was placed upside down on a stage. An indenter was pressed down from the bottom of the container at a crosshead speed of 20 mm/min to obtain the compressive strength of the container body.

○ ... 25 kgf or higher (the strength required in packaging, transportation, and use)
X ... Lower than 25 kgf

5-2) Transverse compressive strength

[0102] The resulting container was placed on its side on a stage having a groove, into which the flange was fitted. A rounded rod indenter having a diameter of 10 mm was pressed down from the container body at a crosshead speed of 20 mm/min to obtain the compressive strength of the body. The measured strength was rated as follows in comparison with the value of a commercially available foamed polystyrene container.

○ ... Equal to or higher than the strength of a foamed polystyrene container (the strength necessary for withstanding packaging, transportation, and use).
X ... Lower than the strength of a foamed polystyrene container.

TABLE 1

	Example 1	Compara. Example 1
Layer structure*1	double layer	double layer
Density distribution*2	yes	no
Each layer thickness*3 (mm)	1.4/0.03	0.6/0.03
Bulk density*4 (g/cm^3)	0.4/0.25/0.35	-
Heat insulating properties	○	X
Strength	○	○
Absolute dry weight*5 (g)	13	13

*1 Container main body + coating layer
*2 Density distribution in the container main body (body)
*3 Container main body (body)/coating layer
*4 Flange/body/bottom
*5 Dried at 105°C for 1 hour

[0103] As is shown in Table 1, the heat-insulating container of Example 1 was confirmed to be thinner, lighter, and more heat-insulating than that of Comparative Example 1 and sufficiently usable as a container for instant noodles.

Industrial Applicability:

[0104] The present invention provides a novel pulp molded article which is thin, lightweight, and excellent in heat-insulating performance and a method and an apparatus for producing the pulp molded article efficiently.

Claims

1. A pulp molded article having a pulp fiber layer of single layer structure which is formed by papermaking from a single raw material composition and has a density distribution in the thickness direction thereof.

2. The pulp molded article according to claim 1, wherein said pulp fiber layer has a density distribution such that the density increases or decreases in the thickness direction thereof.

3. The pulp molded article according to claim 1, wherein at least one of the inner surface and the outer surface of said pulp fiber layer is coated with a coating layer.

4. The pulp molded article according to claim 1, wherein the outer surface of said pulp fiber layer is coated with another pulp fiber layer.

5. The pulp molded article according to claim 4, wherein said another pulp fiber layer has a density higher than the highest density of said pulp fiber layer.

6. The pulp molded article according to claim 1, wherein said pulp fiber layer and said coating layer are each made from a biodegradable material.

7. The pulp molded article according to claim 1, wherein said pulp fiber layer is the main body of a cup-shaped container and has a flange around the brim of the main body.

8. The pulp molded article according to claim 7, wherein the body portion of said main body is provided with said density distribution.

9. The pulp molded article according to claim 7, wherein said flange and the bottom portion of said main body has a higher density than the body portion of said main body.

10. A method of producing a pulp molded article comprising a papermaking and dewatering step in which a pulp fiber layer is made from a single raw material composition by papermaking and dewatered and a drying step in which the dewatered pulp fiber layer is fitted into a drying mold and dried while creating a density distribution in the thickness direction thereof, wherein:

    said drying mold has evacuation holes connecting to the outside on the inner wall thereof in the portion corresponding to the portion of said pulp fiber layer where a density distribution is not to be created,
    said pulp fiber layer fitted in said drying mold is pressed onto the inner wall of said drying mold by an elastically deformable pressing member, while the drying mold is forcibly evacuated through said evacuation holes,
    the pressing force by said pressing member is reduced and, the evacuation through said evacuation holes is stopped to separate said pressing member from said pulp fiber layer to obtain said pulp fiber layer provided with a density distribution in the thickness direction thereof.

11. The method of producing a pulp molded article according to claim 10, wherein the step of pressing said pulp fiber layer by said pressing member and the step of reducing the pressing force of said pressing member and stopping the evacuation are repeated to dry said pulp fiber layer.

12. The method of producing a pulp molded article according to claim 10, which further comprises a step of coating at least one of the inner surface and the outer surface of said pulp fiber layer with a coating layer.

13. An apparatus for carrying out the method of producing a pulp molded article according to claim 10, which comprises a drying mold into which a pulp fiber layer is fitted and an elastically deformable pressing member which presses the pulp fiber layer fitted into said drying mold from the inside of the pulp fiber layer toward the inner wall of said

drying mold, said drying mold having evacuation holes connecting to the outside on the inner wall thereof in the portion corresponding to the part of the pulp fiber layer where a density distribution is not to be created.

Fig.1

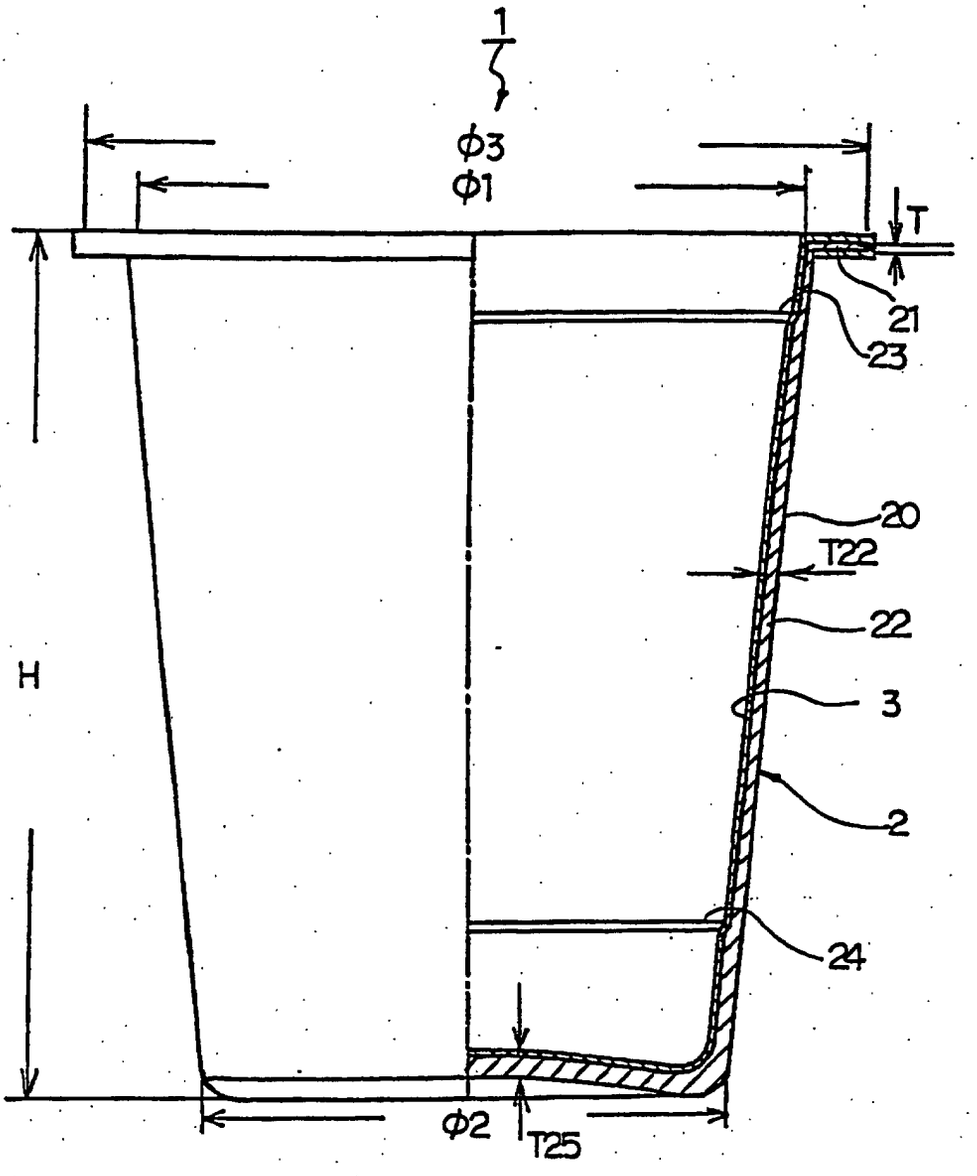
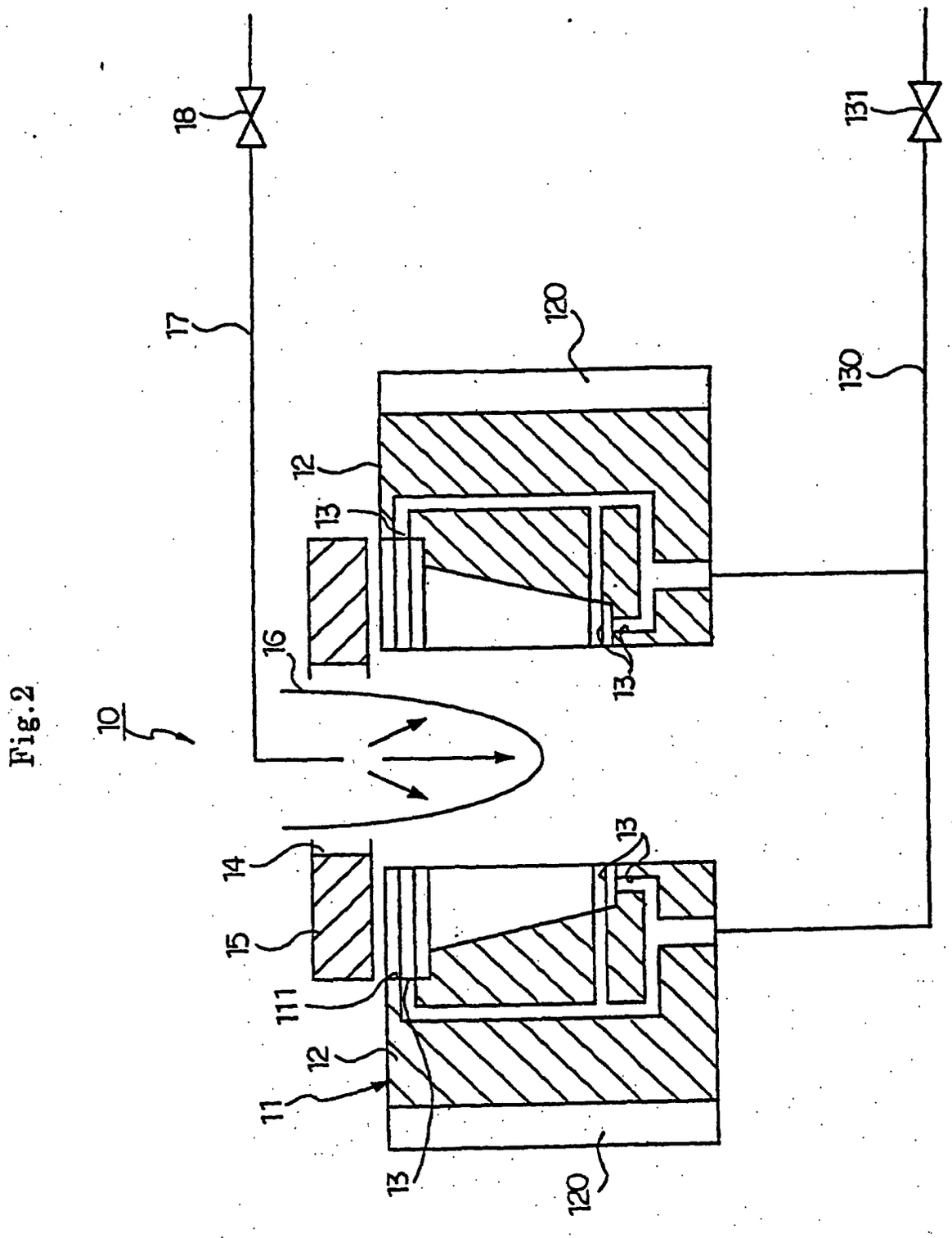


Fig.2



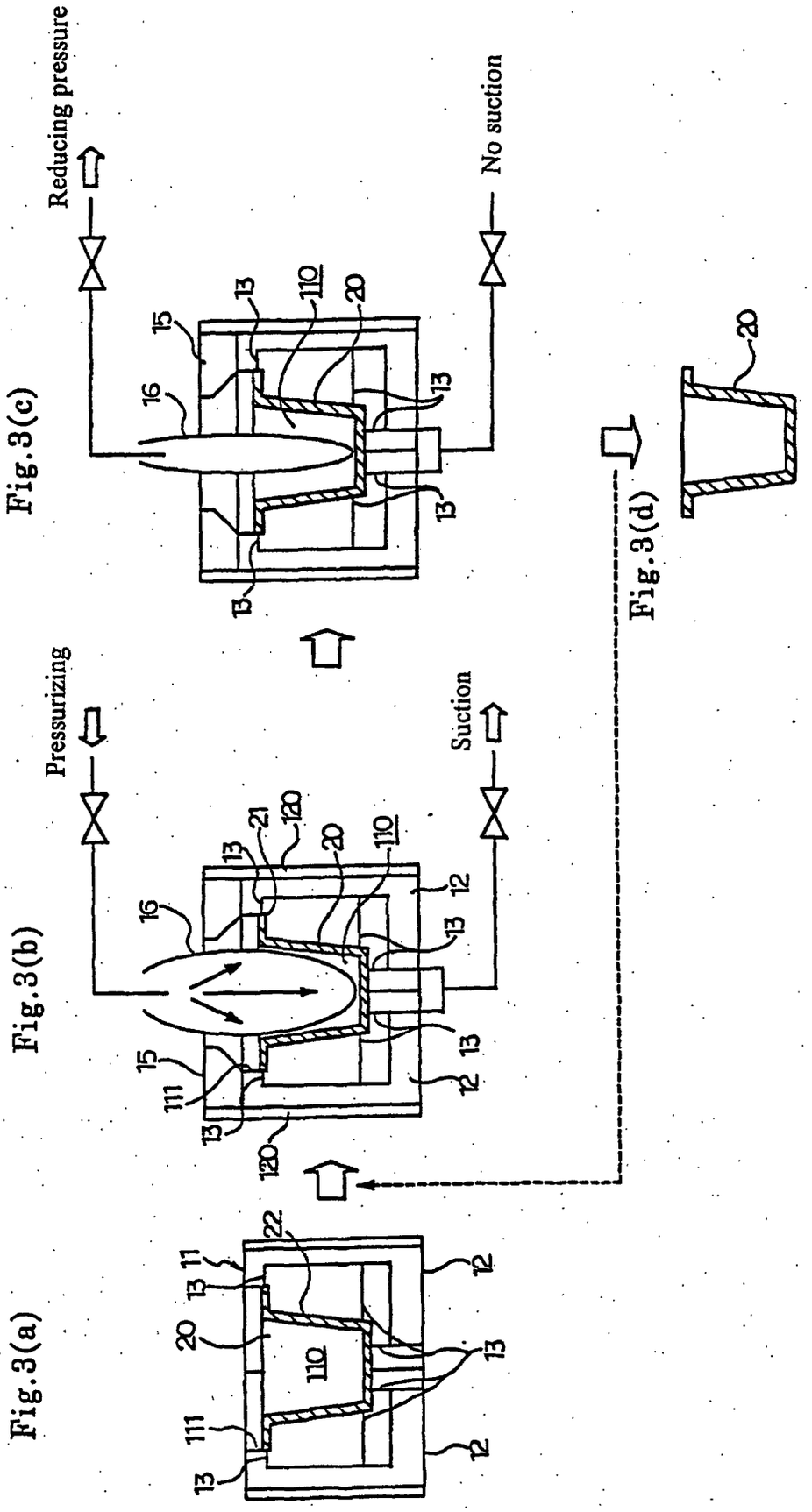


Fig.3(a)
Fig.3(b)
Fig.3(c)
Fig.3(d)
Pressurizing
Suction
Reducing pressure
No suction

Fig.4(a)

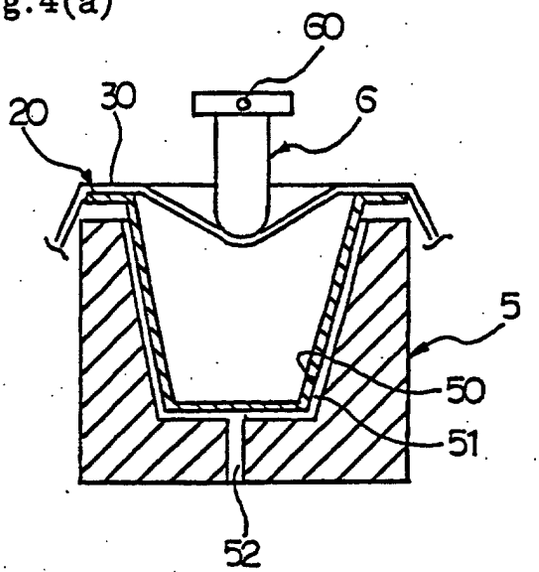
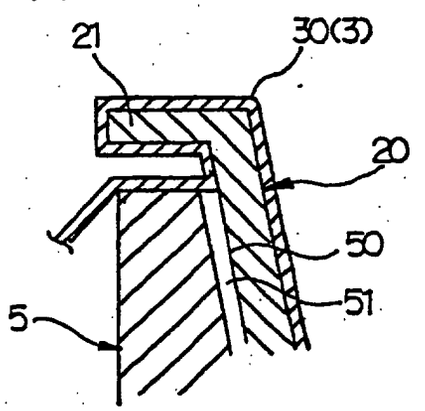


Fig.4(b)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/07757

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D21J3/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D21J3/00-7/00, B65D1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2002
Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2000-34699 A (Oji Paper Co., Ltd.), 02 February, 2000 (02.02.00), Comparative examples (Family: none)	1,2,6 3-5,7-13
X A	JP 2001-49598 A (Kao Corp.), 20 February, 2001 (20.02.01), Par. Nos. [0018] to [0022] (Family: none)	13 10-12
X X A	JP 2001-55695 A (Kao Corp.), 27 February, 2001 (27.02.01), Comparative examples (Family: none) Comparative examples; drawings Full text	1,2,6 13 10-12

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 October, 2002 (22.10.02)	05 November, 2002 (05.11.02)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

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PCT/JP02/07757

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 51-139838 A (Kabushiki Kaisha Daishowa Giken Kogyo), 02 December, 1976 (02.12.76), Claims (Family: none)	3
A	JP 11-301753 A (Toppan Printing Co., Ltd.), 02 November, 1999 (02.11.99), Claims; drawings (Family: none)	7
A	JP 2000-192400 A (Oji Paper Co., Ltd.), 11 July, 2000 (11.07.00), Par. No. [0019] (Family: none)	6
A	JP 48-50003 A (Torio Kabushiki Kaisha), 14 July, 1973 (14.07.73), Claims (Family: none)	4

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