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(54) **PULP MOLDED FORMED-ARTICLE AND METHOD FOR MANUFACTURING SAME**

(57) There is provided a technology that enables the production of a pulp molded product having an excellent surface property. The pulp molded product includes a surface that has a region with an arithmetic average roughness Ra of 50 μm or less. A method of producing a pulp molded product includes: preparing a slurry that contains pulp having an average fiber length of less than 3.0 mm and water; depositing the pulp on a paper-making

mold having a solid shape to form a pulp layer; dehydrating the pulp layer to obtain an undried intermediate molded product; and heating the undried intermediate molded product while sandwiching the intermediate molded product between a male mold and a female mold and applying pressure to the sandwiched intermediate molded product.

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Description

[Technical Field]

5 **[0001]** The present invention relates to a pulp molded product.

[Background Art]

10 **[0002]** In recent years, multiple environmental problems associated with increased waste and others have occurred. In view of these problems, plastic containers and metal containers are being replaced with paper containers, for housing toiletry products, beverages, food products, and the like. For example, as a paper container for liquids such as a milk container, there is a so-called gable top paper container, which is a container that is made of a paper board coated with polyethylene resin on both surfaces and that has a gable roof-like top. Such a paper container contributes to not only conservation of natural resources and energy but also to environmental conservation in that recycling and incineration are facilitated when disposed of. Therefore, a paper container is widespread in various fields.

15 **[0003]** However, since the above-described paper container is formed by folding and bonding a paper board, the production process is complicated, and the production cost is increased. Also, since the flexibility in shape of the above-described paper container is low, there has been a problem in that, for example, the appeal of commercial products based on the container shape cannot be sufficiently exerted.

20 **[0004]** One of the techniques for increasing the flexibility in shape of a paper container is a pulp mold technique to produce a molded product from a slurry that contains pulp and water. In a pulp mold technique, pulp in a slurry is generally deposited on a paper-making mold to form a pulp layer, and this pulp layer is dehydrated and thereafter dried in an oven. The molded product obtained in this technique, i.e., a pulp molded product, is excellent in heat resistance, cold resistance, moisture absorption and desorption, and others, which are characteristics in physical properties of paper-based packaging materials. The pulp molded product has been put into wide use as a paper tray container for food products, a fixing and cushioning material for fruits or the like, and others (PTL 1).

[Citation List]

30 [Patent Literature]

[0005] [PTL 1] JP 2008-285188 A

[Summary of the Invention]

35 **[0006]** In general, a pulp molded product includes a surface that has unevenness with a large height difference. Such a pulp molded product is not suitable for a container that is required to have decorative properties in appearance. Also, in the pulp molded product, it is difficult to form a print layer or a coating layer.

40 **[0007]** An object of the present invention is to provide a technology that enables the production of a pulp molded product having an excellent surface property.

[0008] According to a first aspect of the present invention, there is provided a pulp molded product including pulp and a surface having a region with an arithmetic average roughness Ra of 50 μm or less.

45 **[0009]** According to a second aspect of the present invention, there is provided a method of producing a pulp molded product, including: preparing a slurry that contains pulp having an average fiber length of less than 3.0 mm and water; depositing the pulp on a paper-making mold having a solid shape to form a pulp layer; dehydrating the pulp layer to obtain an undried intermediate molded product; and heating the undried intermediate molded product while sandwiching the intermediate molded product between a male mold and a female mold and applying pressure to the sandwiched intermediate molded product.

50 **[0010]** Here, the "arithmetic average roughness Ra" is a surface property parameter defined in JIS B0601:2013. Also, the "average fiber length" is a length-weighted average fiber length L_L defined in JIS P8226-2:2011 and measured by an optical automatic analysis method.

[0011] According to the present invention, there is provided a technology that enables the production of a pulp molded product having an excellent surface property.

55 [Brief Description of the Drawings]

[0012]

Fig. 1 is a diagram schematically illustrating an example of a production apparatus that can be used in producing a pulp molded product according to an embodiment of the present invention.

Fig. 2 is a diagram illustrating a pulp layer forming step in pulp molding using the apparatus in Fig. 1.

Fig. 3 is a cross-sectional view schematically illustrating an example of a pulp layer formed on a paper-making mold.

Fig. 4 is a diagram illustrating a dehydration step in pulp molding using the apparatus in Fig. 1.

Fig. 5 is a diagram illustrating a pulp layer conveying step in pulp molding using the apparatus in Fig. 1.

Fig. 6 is a diagram illustrating a hot pressing step in pulp molding using the apparatus in Fig. 1.

Fig. 7 is a cross-sectional view schematically illustrating an example of a pulp molded product obtained by a hot pressing step.

Fig. 8 is a diagram illustrating a pulp molded product conveying step in pulp molding using the apparatus in Fig. 1.

Fig. 9 is a diagram illustrating a state in which the conveying step of Fig. 8 has been completed.

[Description of Embodiments]

[0013] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings. It is noted that components which have the same or similar functions are given the same reference numerals throughout all the drawings, and duplicate description is omitted.

[0014] Fig. 1 is a diagram schematically illustrating an example of a production apparatus that can be used in producing a pulp molded product according to an embodiment of the present invention.

[0015] A production apparatus 1 illustrated in Fig. 1 includes a support body 10, a first station 20, a second station 30, and a third station 40.

[0016] The support body 10 includes a frame body and a rail which is disposed on the top of the frame body.

[0017] The first station includes a container 210, a raising and lowering device 220, a cover member 230, a paper-making mold 240, a moving device 250, a raising and lowering device 260, and an upper mold 270.

[0018] The container 210 is disposed in the frame body of the support body 10. The container 210 opens at the top. The container 210 houses a slurry S which contains pulp and water.

[0019] The raising and lowering device 220 is attached to the frame body of the support body 10 above the container 210. The raising and lowering device 220 includes, for example, a hydraulic cylinder. The raising and lowering device 220 supports the cover member 230. The raising and lowering device 220 can raise and lower the cover member 230 in the position of the opening of the container 210.

[0020] The cover member 230 is a hollow body which has an opening at the top. The cover member 230 is connected with an unillustrated pump.

[0021] The paper-making mold 240 is fixed to the opening of the cover member 230. Specifically, the paper-making mold 240 is fixed to the opening of the cover member 230 such that a space adjacent to one surface of the paper-making mold 240 is surrounded by the paper-making mold 240 and the cover member 230.

[0022] The paper-making mold 240 is a mold which has liquid permeability. The paper-making mold 240 has a solid shape. That is, the paper-making mold 240 has one or more convex portions and/or one or more concave portions on a surface on which pulp is to be deposited. Specifically, the outer surface of the paper-making mold 240, i.e., the back surface of the surface adjacent to the above-described space, has a shape that corresponds to a pulp molded product. Here, the paper-making mold 240 is a male mold having a projected upper surface.

[0023] The paper-making mold 240 may include, for example, a paper-making mold main body that is disposed with multiple through holes and includes an outer surface having a shape corresponding to a pulp molded product, and a net body that is disposed on and along the outer surface of the paper-making mold main body. The paper-making mold main body contains a hard material such as metal.

[0024] The moving device 250 can move along the rail of the support body 10 between the first station 20 and the second station 30. The moving device 250 contains, as a power source, for example, a motor. The moving device 250 is attached with the raising and lowering device 260 and can transfer this raising and lowering device 260 between the first station 20 and the second station 30.

[0025] The raising and lowering device 260 is, as described above, attached to the moving device 250. The raising and lowering device 260 includes, for example, a hydraulic cylinder. The raising and lowering device 260 supports the upper mold 270. The raising and lowering device 260 can raise and lower the upper mold 270.

[0026] The upper mold 270 is a holder that sandwiches a later-described pulp layer between the upper mold 270 and the paper-making mold 240 and holds the pulp layer by a vacuum suction method. The upper mold 270 contains a hard material such as metal. The lower surface of the upper mold 270 has a shape corresponding to the above-described outer surface of the paper-making mold 240. Here, the upper mold 270 is a female mold having a concave lower surface. The upper mold 270 has, for example, multiple through holes each opening on the lower surface at one end and being connected to the pump at the other end.

[0027] The second station 30 is disposed near the first station 20. The second station 30 includes a base 310, a lower

mold 320, a moving device 330, a press device 340, and an upper mold 350.

[0028] The base 310 is disposed in the frame body of the support body 10. The lower mold 320 is disposed on the base 310.

[0029] The lower mold 320 is a mold that has gas and/or liquid permeability. The lower mold 320 contains a hard material such as metal. The upper surface of the lower mold 320 has a shape corresponding to the above-described outer surface of the paper-making mold 240. Here, the lower mold 320 is a male mold having a projected upper surface. For example, the lower mold 320 has multiple through holes, and the surface having a shape corresponding to the above-described outer surface of the paper-making mold 240 is smooth.

[0030] The moving device 330 can move along the rail of the support body 10 between the second station 30 and an unillustrated fourth station. The moving device 330 contains, as a power source, for example, a motor. When positioned in the second station 30, the up and down, left and right, and back and forth movements of the moving device 330 can be controlled by a locking mechanism. Also, the moving device 330 is attached with the press device 340 and can transfer this press device 340 between the second station 30 and the fourth station.

[0031] The press device 340 is, as described above, attached to the moving device 330. The press device 340 includes, for example, a hydraulic cylinder. The press device 340 supports the upper mold 350. The press device 340 can raise and lower the upper mold 350.

[0032] The upper mold 350 is a mold that has neither gas permeability nor liquid permeability. The upper mold 350 contains a hard material such as metal. The lower surface of the upper mold 350 has a shape corresponding to the above-described outer surface of the paper-making mold 240. Here, the upper mold 350 is a female mold having a concave lower surface. In the upper mold 350, the surface having a shape corresponding to the above-described outer surface of the paper-making mold 240 is smooth.

[0033] The second station 30 further includes a heater and a pump (both are unillustrated). The heater heats at least one of the lower mold 320 and the upper mold 350. The pump is connected to the bottom space of the lower mold 320.

[0034] The third station 40 is disposed near the second station 30. The third station 40 includes a base 410, a moving device 420, a raising and lowering device 430, and a holder 440.

[0035] The base 410 is disposed in the frame body of the support body 10. A pulp molded product is to be disposed on the base 410.

[0036] The moving device 420 can move along the rail of the support body 10 between the second station 30 and the third station 40. The moving device 420 contains, as a power source, for example, a motor. The moving device 420 is attached with the raising and lowering device 430 and can transfer this raising and lowering device 430 between the second station 30 and the third station 40.

[0037] The raising and lowering device 430 is, as described above, attached to the moving device 420. The raising and lowering device 430 includes, for example, a hydraulic cylinder. The raising and lowering device 430 supports the holder 440. The raising and lowering device 430 can raise and lower the holder 440.

[0038] The holder 440 is a holder that holds a later-described pulp molded product by a vacuum suction method. The lower surface of the holder 440 has a shape corresponding to the above-described outer surface of the paper-making mold 240. Here, the lower surface of the holder 440 has a concave shape. The holder 440 has, for example, multiple through holes each opening on the lower surface at one end and being connected to the pump at the other end.

[0039] In a production method according to an embodiment of the present invention, a pulp molded product is produced, for example, using the above-described production apparatus 1. This will be described with reference to Figs. 1 to 9.

[0040] Fig. 2 is a diagram illustrating a pulp layer forming step in pulp molding using the apparatus in Fig. 1. Fig. 3 is a cross-sectional view schematically illustrating an example of a pulp layer formed on a paper-making mold. Fig. 4 is a diagram illustrating a dehydration step in pulp molding using the apparatus in Fig. 1. Fig. 5 is a diagram illustrating a pulp layer conveying step in pulp molding using the apparatus in Fig. 1. Fig. 6 is a diagram illustrating a hot pressing step in pulp molding using the apparatus in Fig. 1. Fig. 7 is a cross-sectional view schematically illustrating an example of a pulp molded product obtained by a hot pressing step. Fig. 8 is a diagram illustrating a pulp molded product conveying step in pulp molding using the apparatus in Fig. 1. Fig. 9 is a diagram illustrating a state in which the conveying step of Fig. 8 has been completed.

[0041] In this method, a slurry S is firstly prepared.

[0042] The slurry S contains, as described above, pulp and water. The slurry S is a suspension which contains pulp dispersed in water and has a high viscosity.

[0043] The type of pulp used in the slurry S is not particularly limited. As the pulp, chemical pulp is preferably used. Examples of usable pulps are pulps usually used as raw pulps in paper making, including: wood pulps such as needle bleached kraft pulp (NBKP) or needle unbleached kraft pulp (NUKP) and leaf bleached kraft pulp (LBKP) or leaf unbleached kraft pulp (LUKP); and non-wood pulps such as straw, cotton, kenaf, bamboo, and sugarcane. These pulps can be used singly or as a mixture of two or more at an optional ratio.

[0044] Pulp has an average fiber length of less than 3.0 mm. This average fiber length is preferably 1.7mm or less.

[0045] When the average pulp fiber length is long, the pulp is likely to be aggregated in the slurry. As a result, in a hot

pressing step, the pulp layer is dried with the aggregation-derived unevenness maintained on the surface. Therefore, the pulp molded product obtained with pulp having a long average fiber length cannot include a surface that has a region with a small arithmetic average roughness Ra.

[0046] When the average fiber length of pulp is shortened, pulp is unlikely to be aggregated in the slurry. That is, the pulp is likely to be dispersed having a short fiber shape, or a large aggregate is unlikely to occur even if pulp aggregation occurs. Also, when the average fiber length of the pulp is short, the movement of fibers in the in-plane direction in the pulp layer is not excessively restricted in a hot pressing step. Therefore, the pulp molded product obtained by using pulp having a short average fiber length and sequentially performing later-described steps can include a surface that has a region with a small arithmetic average roughness Ra.

[0047] The average fiber length of pulp is preferably 0.5 mm or more and more preferably 0.7 mm or more.

[0048] In this method, a hot pressing step is performed to the undried pulp layer. That is, a hot pressing step is performed to the pulp layer having a large water content. Therefore, when the average fiber length of pulp is excessively short, variation in water evaporation rate is likely to occur in a hot pressing step and cause uneven shrinkage when dried, which can become a factor for wrinkles, cracks, or reduced strength.

[0049] When the average fiber length of pulp is long, the variation in drying of the pulp layer is unlikely to occur in a hot pressing step. This can prevent the production of a pulp molded product which has failures in appearance and reduced strength.

[0050] It is noted that the average fiber length of pulp can be adjusted by an optional method, for example, by a mechanical treatment such as beating or crushing.

[0051] The pulp content of the slurry S is preferably in a range of 0.01 to 3.0% by mass and more preferably in a range of 0.01 to 0.5% by mass. When the pulp content is small, high productivity is unlikely to be achieved. When the pulp content is large, there is a possibility that the thickness variance of the pulp layer may become large.

[0052] The slurry S can further contain an additive. The additive to be used may be an organic polymer, inorganic particles, or a combination thereof. The ratio of the additive relative to the total of pulp and the additive is preferably 10% by mass or less and more preferably 5% by mass or less. That is, the ratio of pulp relative to the total solid content of the slurry S is preferably 90% by mass or more and more preferably 95% by mass or more.

[0053] Next, the slurry S is supplied into the container 210. Subsequently, as illustrated in Fig. 2, the cover member 230 is lowered by the raising and lowering device 220, such that the upper surface of the paper-making mold 240 is positioned sufficiently below the liquid surface of the slurry S. The pump is driven in this state to decompress a space surrounded by the cover member 230 and the paper-making mold 240. This causes the occurrence of a flow of the slurry S crossing the paper-making mold 240, so that pulp is deposited on the paper-making mold 240. In the above-described manner, a pulp layer MP1 is formed on the paper-making mold 240 as illustrated in Fig. 3.

[0054] Next, as illustrated in Fig. 4, while the pump remains driven, the cover member 230 is raised by the raising and lowering device 220, such that the bottom of the paper-making mold 240 is positioned sufficiently above the liquid surface of the slurry S. Accordingly, the pulp layer MP1 is dehydrated under reduced pressure. Next, the raising and lowering device 260 is driven to lower the upper mold 270 until the lower surface thereof is brought into contact with the pulp layer MP1. It is noted that the pulp layer MP1 is not drawn in Fig. 4. This dehydration step is performed without heating either the upper mold 270 or the paper-making mold 240.

[0055] The decompression time in the dehydration step is preferably in a range of 1 to 60 seconds and more preferably in a range of 1 to 10 seconds.

[0056] The water content of the pulp layer MP1 immediately after dehydration is preferably in a range of 40 to 90% by mass and more preferably in a range of 50 to 70% by mass. When the water content is small, there is a possibility that in the hot pressing step, movement of fiber in the in-plane direction in the pulp layer may be insufficient. When the water content is large, there is a possibility that in the hot pressing step, movement of fiber in the in-plane direction in the pulp layer may be excessive, or the shape retention of the pulp layer MP1 may be insufficient in a period from the end of the dehydration step to the start of the hot pressing step.

[0057] After the termination of the above-described decompression of a space and the above-described pressurization, the pump is driven to allow the upper mold 270 to suction and hold the pulp layer MP1. It is noted that the suction by the pump and the upper mold 270 does not cause further dehydration of the pulp layer MP1.

[0058] Subsequently, the raising and lowering device 260 is driven while the upper mold 270 is allowed to suction and hold the pulp layer MP1, to thereby raise the upper mold 270 as illustrated in Fig. 1. Accordingly, the pulp layer MP1 is peeled from the paper-making mold 240.

[0059] Next, the moving devices 250 and 330 are driven to move the press device 340 and the upper mold 350 from the second station 30 to the fourth station as well as the raising and lowering device 260 and the upper mold 270 from the first station 20 to the second station 30, as illustrated in Fig. 5. Subsequently, the raising and lowering device 260 is driven to lower the upper mold 270 until the pulp layer MP1 is brought into contact with the lower mold 320. Thereafter, the suction by the pump and the upper mold 270 is terminated to release the pulp layer MP1 from the upper mold 270. Subsequently, the raising and lowering device 260 is driven to raise the upper mold 270. In this manner, the pulp layer

MP1 is transferred from the first station 20 to the second station 30, and the pulp layer MP1 is placed on the lower mold 320.

[0060] Next, the moving devices 250 and 330 are driven to move the raising and lowering device 260 and the upper mold 270 from the second station 30 to the first station 20 as well as the press device 340 and the upper mold 350 from the fourth station to the second station 30, as illustrated in Fig. 1. Subsequently, the press device 340 is driven to lower the upper mold 350 as illustrated in Fig. 6. Then, the pulp layer MP1 sandwiched between the upper mold 350 and the lower mold 320 is pressurized by the upper mold 350 and the lower mold 320. At the same time, the heater is driven to heat the pulp layer MP1. At the same time, the pump is driven to suction and remove water and/or water vapor from a space sandwiched by the upper mold 350 and the lower mold 320. Accordingly, the surface shape of the pulp layer MP1 is adjusted, and the pulp layer MP1 is densified and dried. In the above-described manner, a pulp molded product MP2 illustrated in Fig. 7 is obtained.

[0061] It is noted that the water content of the pulp layer MP1 immediately before the start of this hot pressing step is substantially equal to the water content of the pulp layer MP1 immediately after the end of the dehydration step.

[0062] The press pressure in this hot pressing step is preferably 0.1 MPa or more and more preferably 0.3 MPa or more. When the press pressure is low, there is a possibility that the pulp molded product MP2 including a surface that has a region with a small arithmetic average roughness Ra may not be obtained. The press pressure is preferably 1.5 MPa or less and more preferably 1.0 MPa or less. When the press pressure is excessively high, the pulp molded product MP2 is likely to have variation in thickness.

[0063] In this hot pressing step, the heating temperature of the pulp layer MP1, i.e., the temperature of the upper mold 350 or the lower mold 320 for heating by the heater, is preferably in a range of 120 to 250°C and more preferably in a range of 150 to 210°C. When the heating temperature is low, a long time is required to dry the pulp layer MP1. When the heating temperature is increased, there is a possibility that the shrinkage of the pulp layer MP1 associated with drying may increase and consequently the distortion in the pulp molded product MP2 may increase.

[0064] As described above, heating by the heater may be performed to either only one or both of the upper mold 350 and the lower mold 320. When heating by the heater is performed to only one of the upper mold 350 and the lower mold 320, the temperatures of the upper mold 350 and the lower mold 320 become substantially equal by heat conduction from one to the other. Therefore, in either case, drying of the pulp layer MP1 proceeds substantially simultaneously over the entire thickness. Accordingly, distortion caused by a difference in drying rate does not occur in the pulp molded product MP2.

[0065] The press time in the hot pressing step is preferably in a range of 10 to 300 seconds and more preferably in a range of 20 to 200 seconds, depending on the heating temperature, the shape of a molded product, and others.

[0066] In completing the above-described hot pressing step, the press device 340 is driven to raise the upper mold 350 so that the pulp molded product MP2 is peeled from the upper mold 350.

[0067] Next, the moving devices 330 and 420 are driven to move the press device 340 and the upper mold 350 from the second station 30 to the fourth station as well as the raising and lowering device 430 and the holder 440 from the third station 40 to the second station 30, as illustrated in Fig. 8. Subsequently, the raising and lowering device 430 is driven to lower the holder 440 until the holder 440 is brought into contact with the pulp molded product MP2. Thereafter, the pump is driven to allow the holder 440 to suck and hold the pulp molded product MP2.

[0068] Subsequently, the raising and lowering device 430 is driven while the holder 440 is allowed to suction and hold the pulp molded product MP2, to thereby raise the holder 440. Subsequently, the moving devices 330 and 420 are driven to move the raising and lowering device 430 and the holder 440 from the second station 30 to the third station 40 as well as the press device 340 and the upper mold 350 from the fourth station to the second station 30, as illustrated in Fig. 9. Then, the suction by the pump and the holder 440 is terminated to release the pulp molded product MP2 from the holder 440. In this manner, the pulp molded product MP2 is transferred from the second station 30 to the third station 40, and the pulp molded product MP2 is placed on the base 410.

[0069] In the above-described manner, the pulp molded product MP2 is produced.

[0070] Thereafter, the pulp molded product MP2 is subjected to post-treatment, for example, printing such as picture printing or plain printing, coating, or a combination thereof, as necessary. Examples of a coating layer to be formed by post-treatment include a layer that contains an agent to add water resistance or oil resistance, a layer that is filled with a material to add heat insulation, a layer that is foamed by a foaming agent, and a combination thereof. Performing post-treatment enables, for example, further enhancement of the decorative properties of the pulp molded product MP2 or impartation of a new function to the pulp molded product MP2.

[0071] The pulp molded product MP2 obtained by the above-described method has an excellent surface property. Reasons thereof will be described below.

[0072] When drying with an oven is performed in place of the hot pressing step, the surface of the pulp layer becomes uneven with a large height difference because of its shrinkage. Also, in such a method, the pulp layer is not sufficiently densified and therefore the pulp molded product has high porosity. Accordingly, in this case, a pulp molded product having an excellent surface property cannot be produced.

[0073] When the dehydration step is followed by drying the product with an oven, humidifying the dried product as

necessary, and performing a hot pressing treatment to this product, the height difference of unevenness which occurred on the surface in association with drying can be reduced by the subsequent humidification and hot pressing treatment. Also, the porosity can be decreased by the humidification and hot pressing treatment. However, since the height difference of unevenness that occurs on the surface in association with drying with an oven is extraordinarily large, it cannot be sufficiently reduced by the subsequent humidification and hot pressing treatment. Also, even when drying is followed by humidification and hot pressing treatment, it is difficult to sufficiently decrease the porosity.

[0074] In the method described with reference to Fig. 1 to Fig. 9, the pulp layer MP1 is dried in a hot pressing step. That is, in the above-described method, a hot pressing step is performed after a dehydration step without undergoing a drying step. Also, as pulp, pulp having an average fiber length in the above-described range is used.

[0075] Since a drying step is not performed before a hot pressing step, unevenness with a large height difference does not occur on the surface of the pulp layer MP1. In the hot pressing step, deformation of the pulp layer MP1 associated with drying is prevented by the upper mold 350 and the lower mold 320. Also, since a hot pressing step is performed to the pulp layer MP1 which has a high water content and an average fiber length of pulp in the above-described range, movement of fibers in the in-plane direction in the pulp layer MP1 can occur appropriately. The pulp layer MP1 can be densified without the occurrence of variation in thickness.

[0076] Therefore, according to the method described with reference to Fig. 1 to Fig. 9, the pulp molded product MP2 having an excellent surface property can be produced. Specifically, there can be obtained the pulp molded product MP2 including a surface that has a region with an arithmetic average roughness Ra of 50 μm or less. Such a pulp molded product MP2 is excellent in decorative properties and facilitates the formation of a print layer and a coating layer.

[0077] The arithmetic average roughness Ra is preferably 40 μm or less. The lower limit of this arithmetic average roughness Ra is not particularly limited but usually 20 μm or more.

[0078] In the pulp molded product MP2, the entire surface may have the above-described surface property, or only a partial region of the surface may have the above-described surface property. For example, only a region that contains a portion to be subjected to a post-treatment such as printing may have the above-described surface property, and other regions may not have the above-described surface property. Alternatively, one surface of the pulp molded product MP2 may have the above-described surface property, and the back surface thereof may not have the above-described surface property. Such a structure can be achieved when, for example, a surface property differs between a partial region and the remaining region of the surfaces of the upper mold 350 and the lower mold 320 which are in contact with the pulp layer MP1.

[0079] Also, according to the method described with reference to Fig. 1 to Fig. 9, there can be produced a pulp molded product MP2 having a sufficiently small standard deviation of basis weight. The standard deviation of basis weight of the pulp molded product MP2 is preferably less than 30 g/m², more preferably 25 g/m² or less, and further preferably 20 g/m² or less. The lower limit of this standard deviation is zero, 5 g/m² in one example, 8 g/m² in another example, and 10 g/m² in still another example.

[0080] Here, the standard deviation of basis weight of the pulp molded product MP2 is a value obtained by the following method.

[0081] Firstly, nine test pieces are cut out from multiple regions positioned in a certain in-plane of the pulp molded product MP2. Each of the test pieces has a strip shape with a width of 15 mm and a length of 40 mm. Next, the masses of these test pieces are measured. Thereafter, the basis weight of each of the test pieces is calculated from the mass and area (600 mm²). From the thus-obtained basis weight, a standard deviation is calculated.

[0082] Next, similarly to the above, nine test pieces are cut out from multiple regions positioned in another in-plane of the pulp molded product MP2. For these test pieces, measurement of mass and calculation of basis weight and its standard deviation are similarly performed.

[0083] When the pulp molded product MP2 further has other planes, each of the remaining planes is also subjected to cutting out of test pieces, measurement of mass, and calculation of basis weight and its standard deviation, similarly to the above.

[0084] Then, the maximum value of these standard deviations is defined as the standard deviation of basis weight of the pulp molded product MP2.

[0085] The present inventors consider that the pulp molded product MP2 having a small standard deviation of basis weight can be produced according to the method (hereinafter, referred to as a first method) described with reference to Fig. 1 to Fig. 9, for the following reasons.

[0086] The pulp molded product can also be produced by, for example, the below-described method (hereinafter, referred to as a second method).

[0087] In the second method, a female mold is firstly prepared as a paper-making mold. This paper-making mold includes a paper-making mold main body that is disposed with multiple through holes and includes an upper surface having a shape corresponding to a pulp molded product, and a net body that is disposed on and along the inner surface of the paper-making mold main body.

[0088] Next, this paper-making mold is disposed with its opening facing upward. Subsequently, a slurry that contains

pulp and water is supplied into the cavity of the paper-making mold and fills the inside of the paper-making mold. Furthermore, the supply of the slurry into the paper-making mold is continued to deposit pulp on the net body. The supply of the slurry into the paper-making mold is performed such that the slurry in the paper-making mold is pressurized.

[0089] After a sufficient amount of pulp has been deposited on the net body, the supply of the slurry into the paper-making mold is terminated. Subsequently, water remaining in the paper-making mold is drained from the paper-making mold. For example, compressed air may be applied into the paper-making mold to allow water remaining in the paper-making mold to be drained from the paper-making mold.

[0090] Next, the pulp layer is pressed by the paper-making mold and an upper mold as a male mold to dehydrate the pulp layer. This dehydration step is performed without heating either the upper mold or the paper-making mold. The water content of the pulp layer immediately after dehydration corresponds to the water content of the pulp layer MP1 immediately after dehydration in the first method.

[0091] Subsequently, the upper mold is allowed to suction and hold the pulp layer, and the upper mold is raised in this state. Accordingly, the pulp layer is peeled from the paper-making mold.

[0092] Next, the upper mold, which suctions and holds the pulp layer, is moved to the position of a lower mold as a female mold. Subsequently, the upper mold is lowered until the pulp layer is brought into contact with the lower mold. Thereafter, the suction is terminated to release the pulp layer from the upper mold. In this manner, the pulp layer is placed on the lower mold.

[0093] Next, the pulp layer is placed between an upper mold and the lower mold for hot pressing, and the sandwiched pulp layer is pressurized. At the same time, a heater is driven to heat the pulp layer. At the same time, a pump is driven to suction and remove water and/or water vapor from a space sandwiched by the upper mold and the lower mold. In the second method, a pulp molded product is obtained in the above-described manner.

[0094] In the second method, the flow of the slurry circulating in the paper-making mold can occur, in a period from when the supply of the slurry into the paper-making mold starts until the inside of the paper-making mold is completely filled with the slurry. This circulating flow can prevent the sedimentation of pulp. However, in the second method, the inside of the paper-making mold needs to be filled with the slurry and therefore the structure of allowing water to be quickly drained cannot be adopted for the paper-making mold. Therefore, after the inside of the paper-making mold has been completely filled with the slurry, sufficient circulating flow of the slurry to prevent sedimentation of pulp does not occur even when the pressure of the slurry is increased, and sedimentation of pulp occurs in the slurry in the paper-making mold.

[0095] As a result, the amount of pulp deposited on the side wall of the paper-making mold is larger in the lower part than in the upper part. When the slurry is supplied until a sufficient amount of pulp is deposited above the side wall of the paper-making mold, an excessive amount of pulp comes to be deposited on the bottom of the paper-making mold. When pulp is excessively deposited, the deposited amount of pulp increases in variance. For example, a large difference in the deposited amount of pulp can occur between vicinities of the through holes disposed to the paper-making mold main body and positions further from the through holes.

[0096] In this manner, a large variance in the deposited amount of pulp occurs in the second method. During the hot pressing treatment, fibers can move in the in-plane direction in the pulp layer. However, the movement of each fiber is restricted to a narrow range. That is, the variance in the deposited amount of pulp is not eliminated by the movement of fibers during the hot pressing treatment. Therefore, according to the second method, the pulp molded product having a sufficiently small standard deviation of basis weight cannot be produced.

[0097] On the other hand, in the first method, the paper-making mold 240 is disposed on the top of the cover member 230, and a composite thereof is immersed in the slurry S. The depth of the slurry S is far larger than the height of the paper-making mold 240. Therefore, even if the sedimentation of pulp occurs in the slurry S, the concentration of pulp does not significantly differ between the position of the top of the paper-making mold 240 and the position of the bottom of the paper-making mold 240. Therefore, according to the first method, pulp can be substantially uniformly deposited on the paper-making mold 240 and thus the pulp molded product MP2 having a sufficiently small standard deviation of basis weight can be produced.

[0098] The pulp molded product MP2 has an opening and is not enlarged in diameter toward a direction away from this opening. Here, the pulp molded product MP2 has an opening and tapers toward a direction away from this opening. According to such a shape, the volume of a laminate obtained by laminating a plurality of pulp molded products MP2 can be reduced.

[0099] It is noted that when in the first method, the pulp layer MP1 is sandwiched between one of the upper mold 350 and the lower mold 320 and an elastic body and then pressurized, instead of pressurizing the pulp layer MP1 by the upper mold 350 and the lower mold 320, the elastic body is deformed. Therefore, sufficient pressure is not applied to the pulp layer MP1 and thus the pulp molded product having an excellent surface property cannot be obtained.

[0100] Similarly, when in the second method, an elastic body is used as one of the upper mold and the lower mold used for a hot pressing treatment, the pulp molded product having an excellent surface property cannot be obtained. Furthermore, in this case, the standard deviation of basis weight increases as described above.

[0101] The pulp molded product MP2 is, for example, a container. The pulp molded product MP2 may be an article other than a container. The pulp molded product MP2 is not particularly limited as long as it is a solid molded product, i.e., a molded product that does not have a two-dimensional shape such as a sheet but has a three-dimensional shape.

[0102] It is noted that Fig. 1 to Fig. 9 are for facilitating understanding of the method of producing a pulp molded product according to an embodiment of the present invention. The above-described method can also be performed using a production apparatus having other structures. For example, in the production apparatus 1, the upper mold 270 and the upper mold 350 are female molds, and the paper-making mold 240 and the lower mold 320 are male molds. The upper mold 270 and the upper mold 350 may be male molds, and the paper-making mold 240 and the lower mold 320 may be female molds. In this manner, the above-described production apparatus 1 and production method can be variously modified.

[0103] Hereinafter, concrete examples of the present invention will be described. The present invention is not limited to these concrete examples.

<1> Production of pulp molded product

(Example 1)

[0104] Using a pulper, a slurry that contains pulp and water was prepared. As pulp, softwood pulp having an average fiber length of 2.3 mm was used. The slurry was prepared such that the pulp content was 0.3% by mass.

[0105] With this slurry, a pulp molded product was produced by the first method described with reference to Fig. 1 to Fig. 9. Here, the dehydration step was performed such that the water content of the pulp layer immediately after dehydration became 65% by mass. The hot pressing step was performed under the conditions of a heating temperature of 150°C, a press pressure of 0.5 MPa, and a press time of 180 seconds.

[0106] In the above-described manner, a container was produced as a pulp molded product.

(Example 2)

[0107] A pulp molded product was produced by the same method as in Example 1, except that bamboo pulp having an average fiber length of 1.6 mm was used instead of softwood pulp having an average fiber length of 2.3 mm.

(Example 3)

[0108] A pulp molded product was produced by the same method as in Example 1, except that hardwood pulp having an average fiber length of 0.9 mm was used instead of softwood pulp having an average fiber length of 2.3 mm.

(Example 4)

[0109] Softwood pulp having an average fiber length of 2.3 mm was beaten until the Canadian Standard Freeness (CSF) became 400 mL, to thereby obtain pulp having an average fiber length of 1.8 mm. A pulp molded product was produced by the same method as in Example 1, except that the above-described pulp having an average fiber length of 1.8 mm was used instead of softwood pulp having an average fiber length of 2.3 mm.

(Example 5)

[0110] Using a pulper, a slurry that contains pulp and water was prepared. As pulp, bamboo pulp having an average fiber length of 1.6 mm was used. The slurry was prepared such that the pulp content was 0.3% by mass.

[0111] With this slurry, a pulp molded product was produced by the above-described second method. Here, the dehydration step was performed such that the water content of the pulp layer immediately after dehydration became 65% by mass. The hot pressing step was performed under the conditions of a heating temperature of 150°C, a press pressure of 0.5 MPa, and a press time of 180 seconds.

[0112] In the above-described manner, a container was produced as a pulp molded product.

(Comparative Example 1)

[0113] A pulp molded product was produced by the same method as in Example 1, except that softwood pulp having an average fiber length of 3.0 mm was used instead of softwood pulp having an average fiber length of 2.3 mm.

(Comparative Example 2)

[0114] A pulp molded product was produced in the same method as in Example 1, except that the press pressure was set to 0 MPa instead of 0.5 MPa.

☐2 ☐ Measurement of surface property

[0115] From each of the pulp molded products produced in Examples 1 to 5 and Comparative Examples 1 and 2, a strip-like test piece having a width of 2 cm and a length of 5 cm was cut out. For each test piece, a surface corresponding to the outer surface of the pulp molded product was measured using a laser displacement meter to obtain the profile curve of the surface. This measurement was performed along the center line that halves the width of the test piece. From each profile curve, an arithmetic average roughness Ra was calculated. The result is described in the following table.

☐3 ☐ Printability test

[0116] A picture was printed, by a silk-screen printing method, on the outer surface of each of the pulp molded products produced in Examples 1 to 5 and Comparative Examples 1 and 2. The printed picture was visually observed to check the presence or absence of chipping in the picture and the presence or absence of rubbing in the picture. An evaluation "A+" was assigned when neither chipping nor rubbing occurred in the picture. An evaluation "A" was assigned when chipping did not occur in the picture, but rubbing did occur. An evaluation "B" was assigned when chipping occurred in the picture. The result is described in the following table.

☐4 ☐ Measurement of standard deviation of basis weight

[0117] For each of the pulp molded products produced in Examples 1 to 5 and Comparative Examples 1 and 2, a standard deviation of basis weight was measured by the above-described method. The result is described in the following table.

[Table 1]

	Average fiber length (mm)	Press pressure (MPa)	Ra (μm)	Chipping	Rubbing	Printability	Standard deviation of basis weight (g/m^2)
Ex. 1	2.3	0.5	48	No	Yes	A	24
Ex. 2	1.6	0.5	33	No	No	A+	18
Ex. 3	0.9	0.5	20	No	No	A+	11
Ex. 4	1.8	0.5	41	No	Yes	A	15
Ex. 5	1.6	0.5	40	Yes	Yes	B	30
Comp. Ex. 1	3.0	0.5	53	Yes	Yes	B	23
Comp. Ex. 2	2.3	0.0	220	Yes	Yes	B	21

[0118] As apparent from a comparison between Examples 1 to 5 and Comparative Example 2, the arithmetic average roughness Ra was able to be reduced by pressing the pulp layer during drying. Also, as apparent from a comparison between Examples 1 to 5 and Comparative Example 1, the arithmetic average roughness Ra decreased when the average fiber length was shortened. Further, when pulp having an average fiber length of less than 3.0 μm was used in the first method, chipping did not occur in the picture, and practically sufficient printability was achieved. In particular, when pulp having an average fiber length of 1.7 μm or less was used in the first method, neither chipping nor rubbing occurred in the picture, and significantly excellent printability was achieved. Furthermore, as apparent from a comparison between Example 1 and Example 5, the standard deviation of basis weight was able to be reduced according to the first method, compared to according to the second method.

[Reference Signs List]

[0119]

- 5 1: Production apparatus
 10: Support body
 20: First station
 30: Second station
 40: Third station
 10 210: Container
 220: Raising and lowering device
 230: Cover member
 240: Paper-making mold
 250: Moving device
 15 260: Raising and lowering device
 270: Upper mold
 310: Base
 320: Lower mold
 330: Moving device
 20 340: Press device
 350: Upper mold
 410: Base
 420: Moving device
 430: Raising and lowering device
 25 440: Holder
 MP1: Pulp layer
 MP2: Pulp molded product
 S: Slurry

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Claims

1. A pulp molded product comprising:

35 pulp; and
 a surface having a region with an arithmetic average roughness Ra of 50 μm or less.

2. The pulp molded product according to claim 1, wherein:
 the pulp has an average fiber length of less than 3.0 mm.

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3. The pulp molded product according to claim 2, wherein:
 the average fiber length is 0.5 mm or more.

4. The pulp molded product according to any one of claims 1 to 3, wherein:
 45 a standard deviation of a basis weight of the pulp molded product is less than 30 g/m².

5. The pulp molded product according to any one of claims 1 to 4, which has an opening and tapers in a direction away from the opening.

- 50 6. The pulp molded product according to any one of claims 1 to 5, which is a container.

7. A method of producing a pulp molded product, comprising:

55 preparing a slurry that contains pulp having an average fiber length of less than 3.0 mm and water;
 depositing the pulp on a paper-making mold having a solid shape to form a pulp layer;
 dehydrating the pulp layer to obtain an undried intermediate molded product; and
 heating the undried intermediate molded product while sandwiching the intermediate molded product between a male mold and a female mold and applying pressure to the sandwiched intermediate molded product.

8. The method of producing a pulp molded product according to claim 7, wherein the step of depositing the pulp on a paper-making mold includes

5 preparing a cover member as a hollow member having an opening,
 fixing the paper-making mold to the opening,
 immersing in the slurry the paper-making mold fixed to the opening, and
 decompressing a space surrounded by the cover member and the paper-making mold immersed in the slurry.

- 10 9. The method of producing a pulp molded product according to claim 8, comprising, as the step of immersing in the
 slurry the paper-making mold fixed to the opening, immersing the paper-making mold in the slurry such that the
 paper-making mold is positioned above the cover member.

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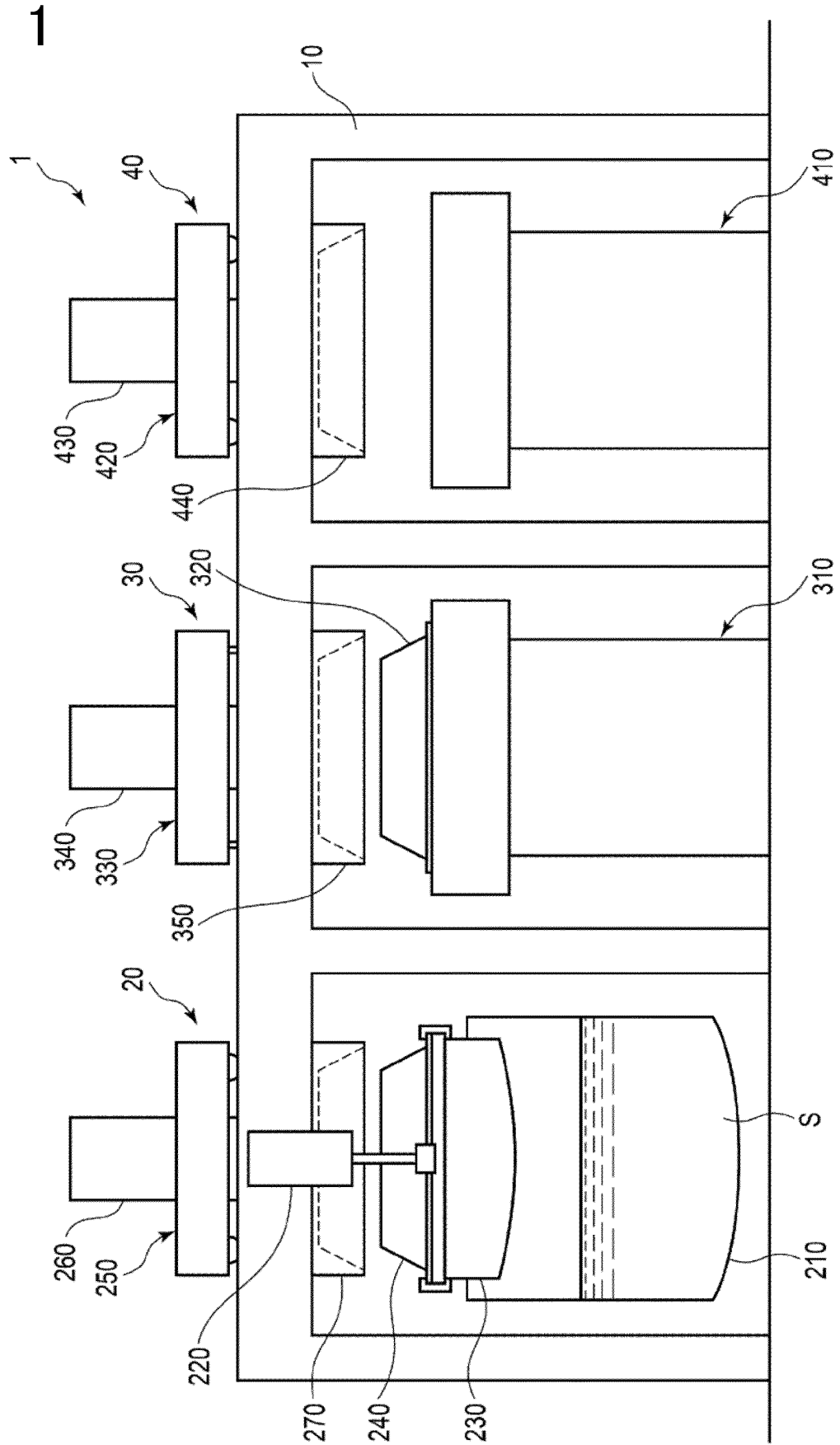
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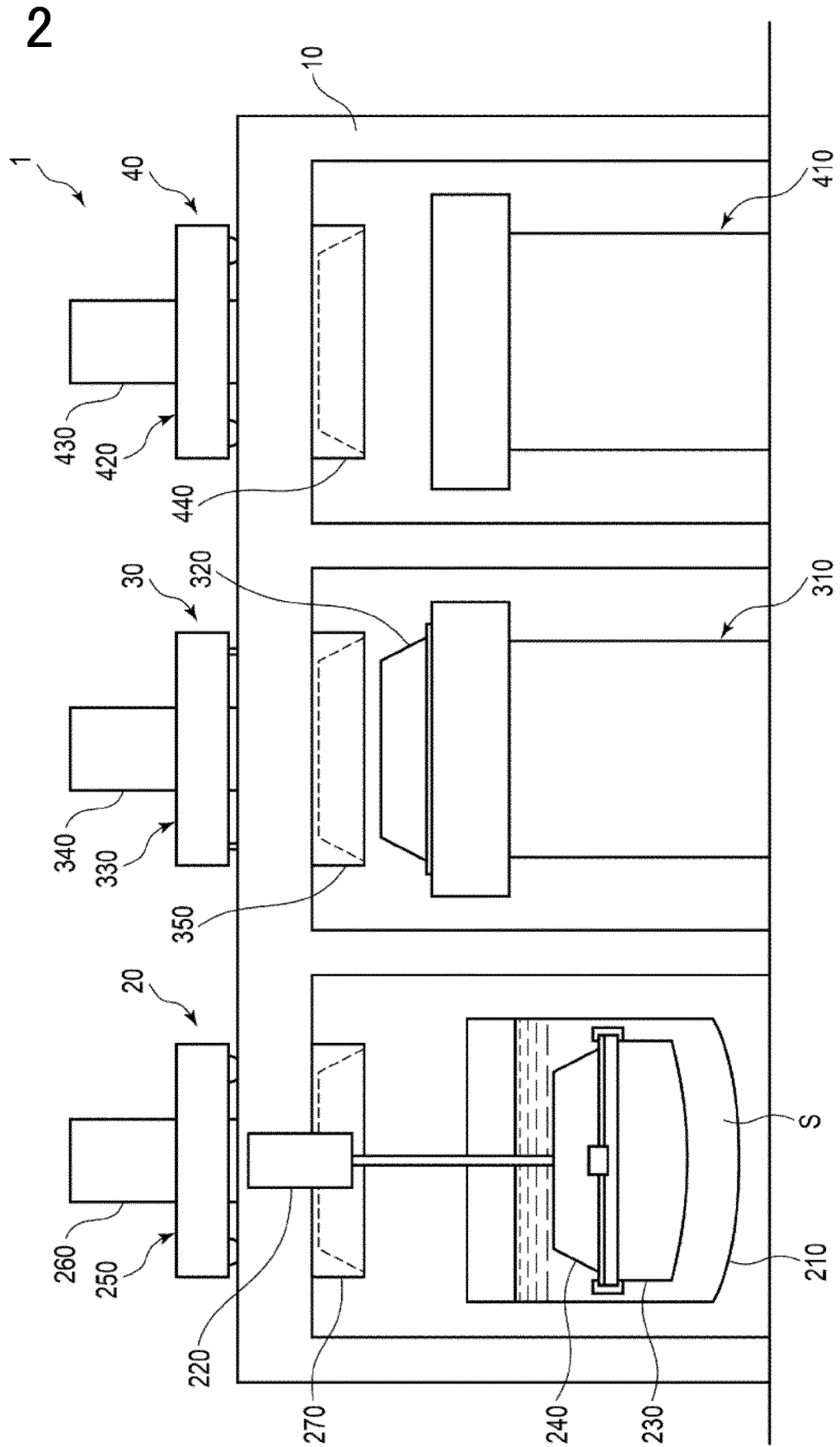
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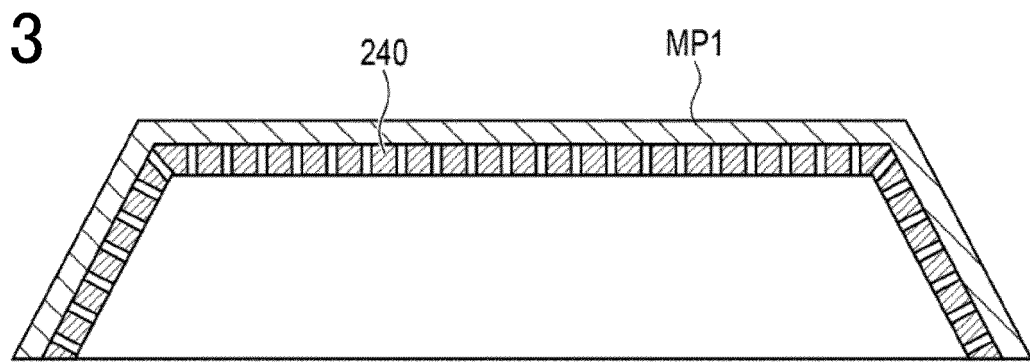
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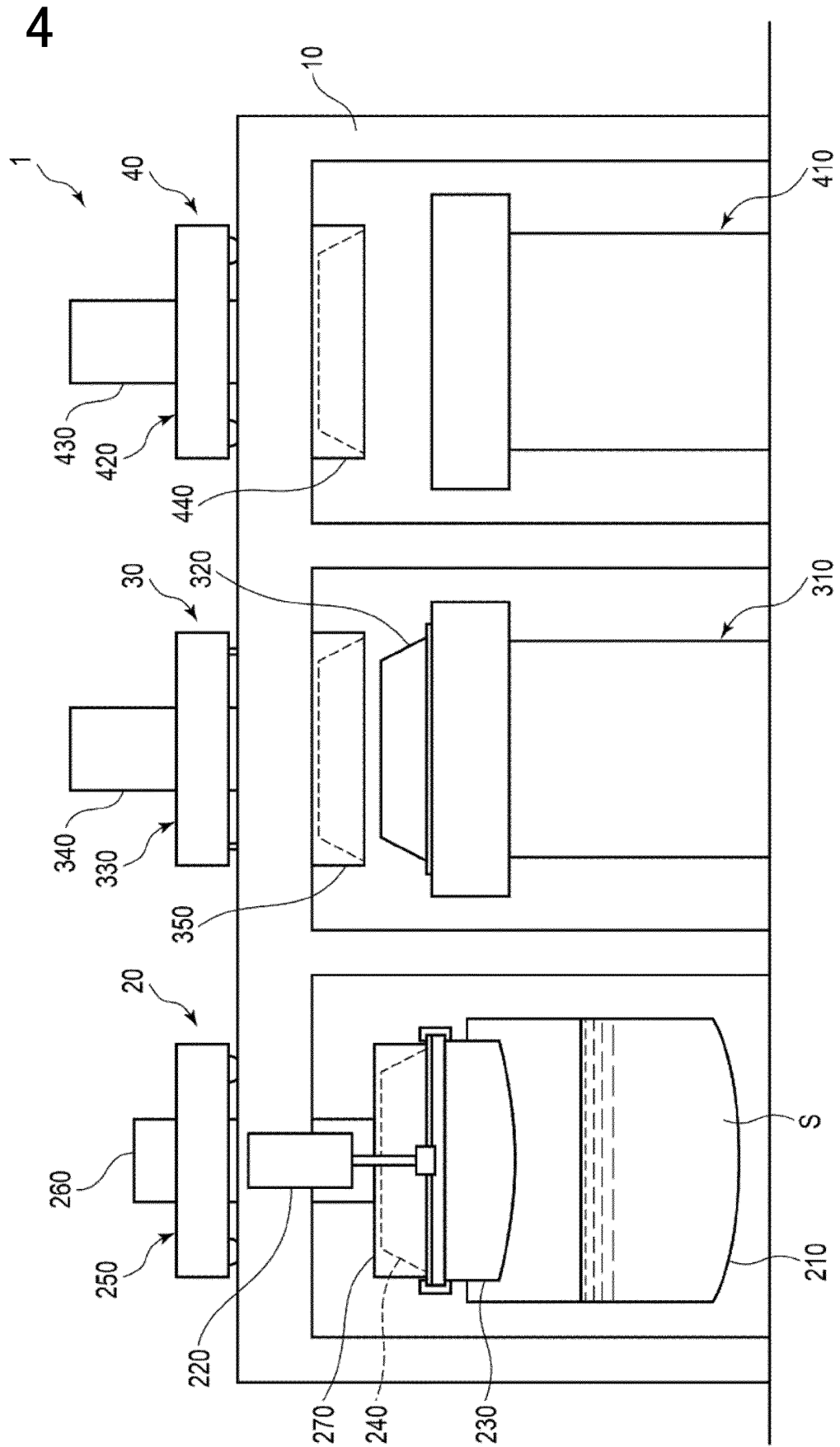
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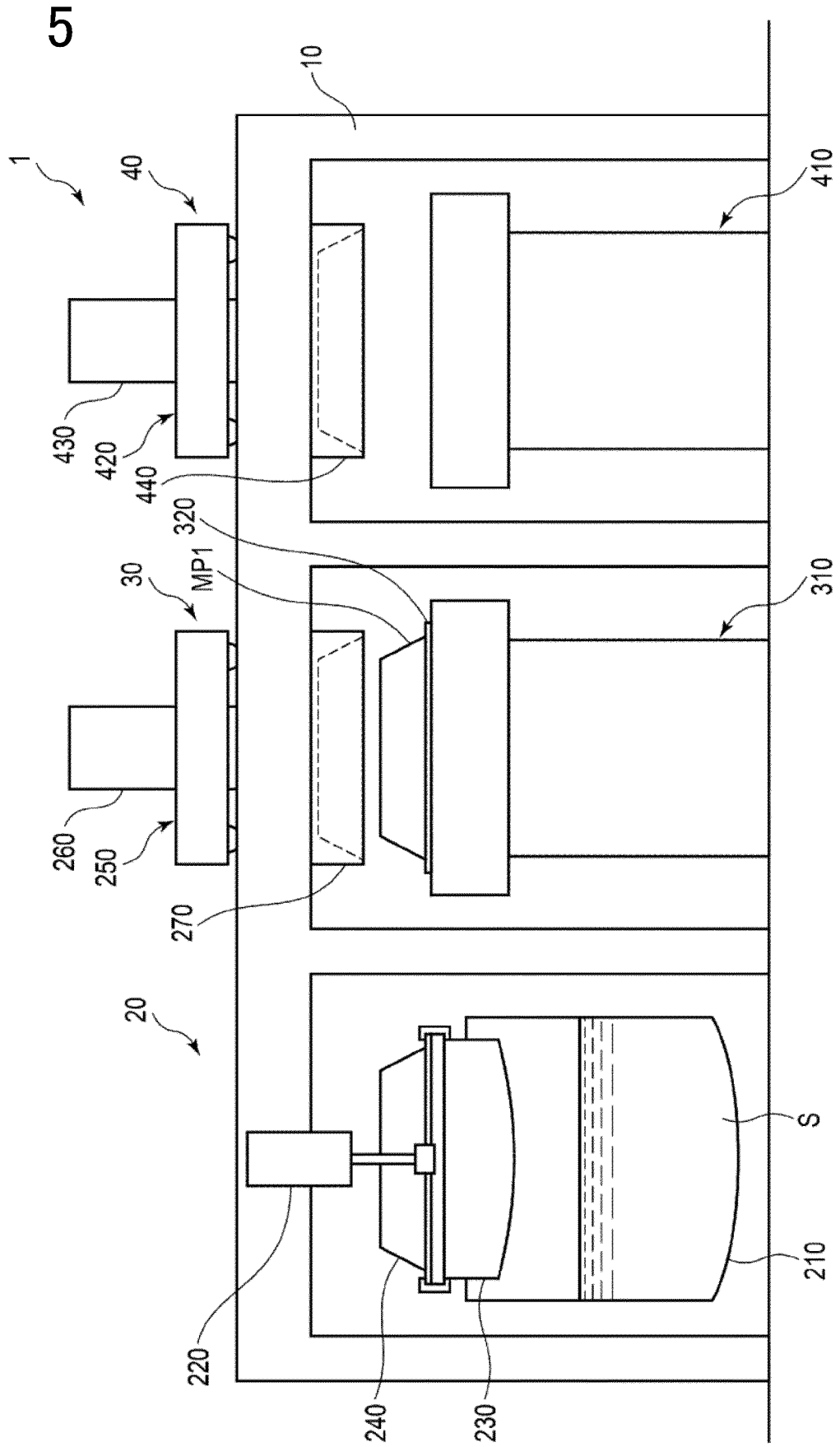
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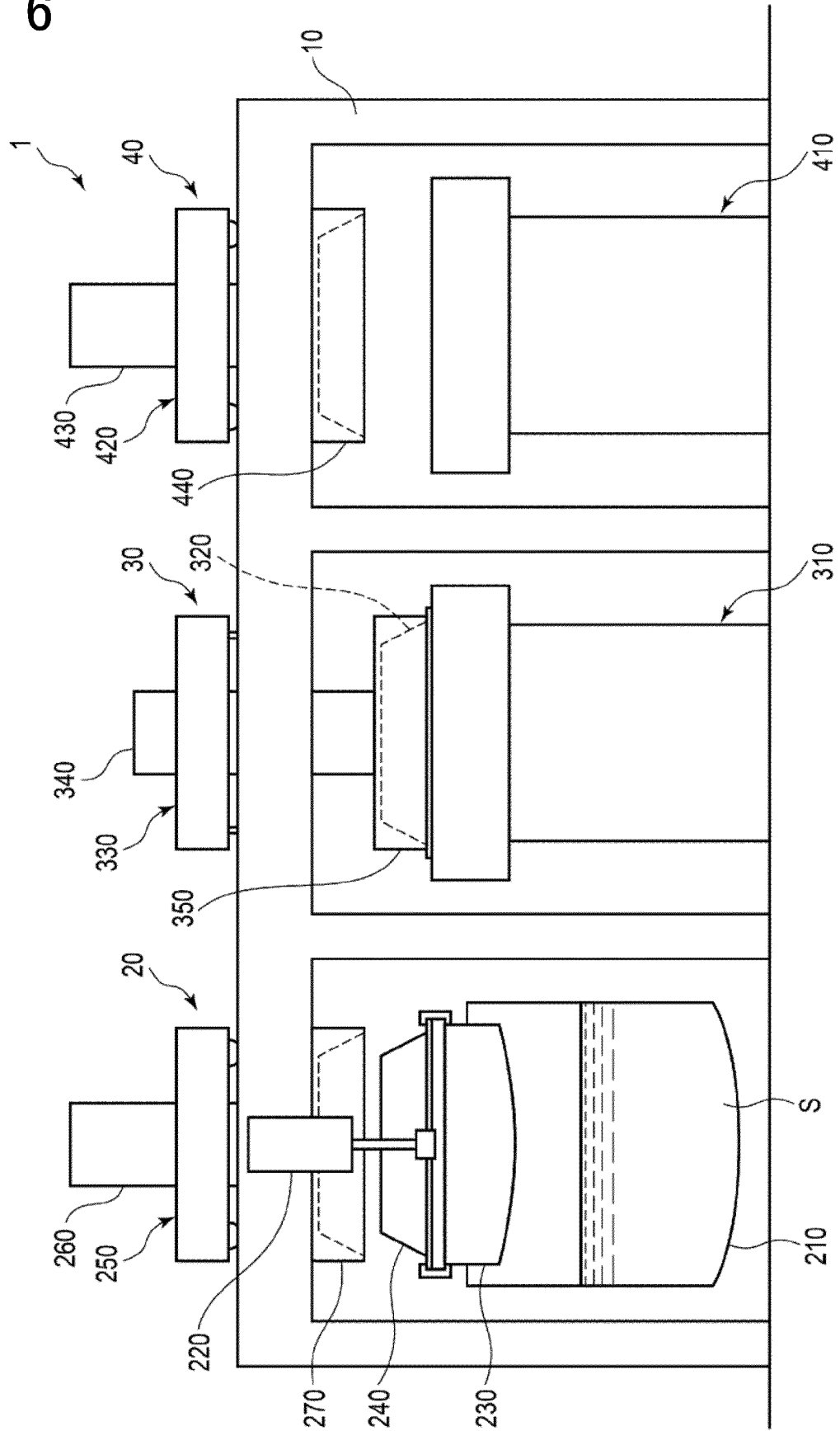


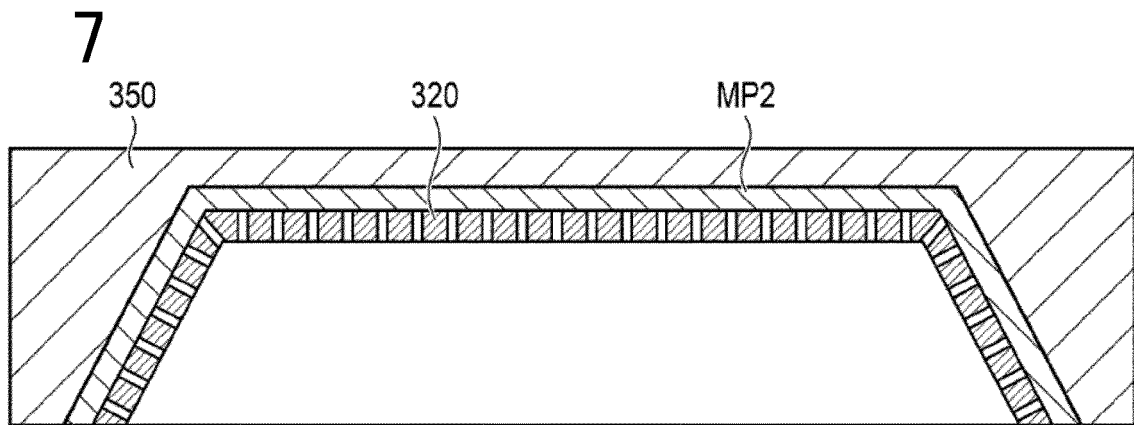


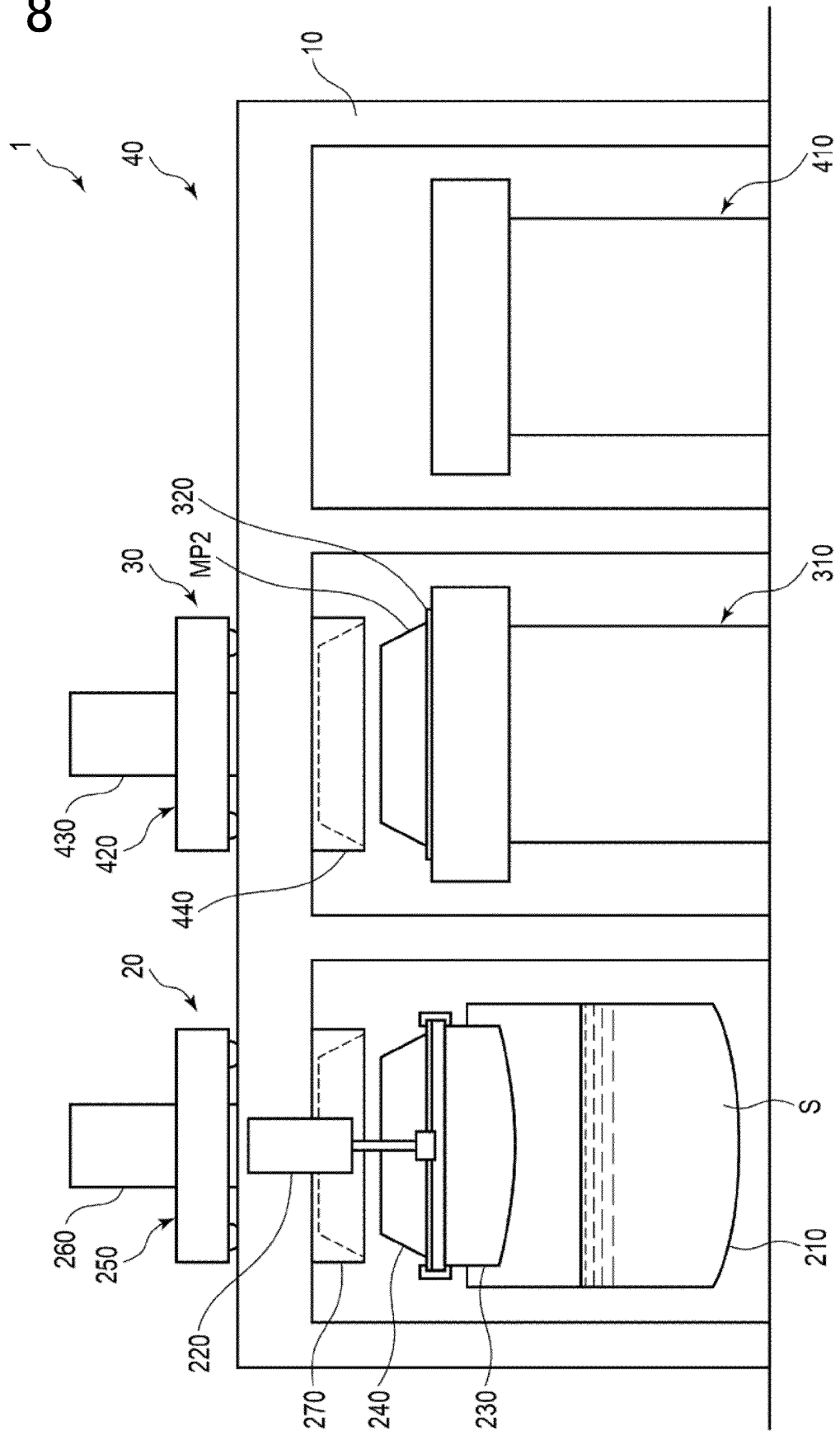


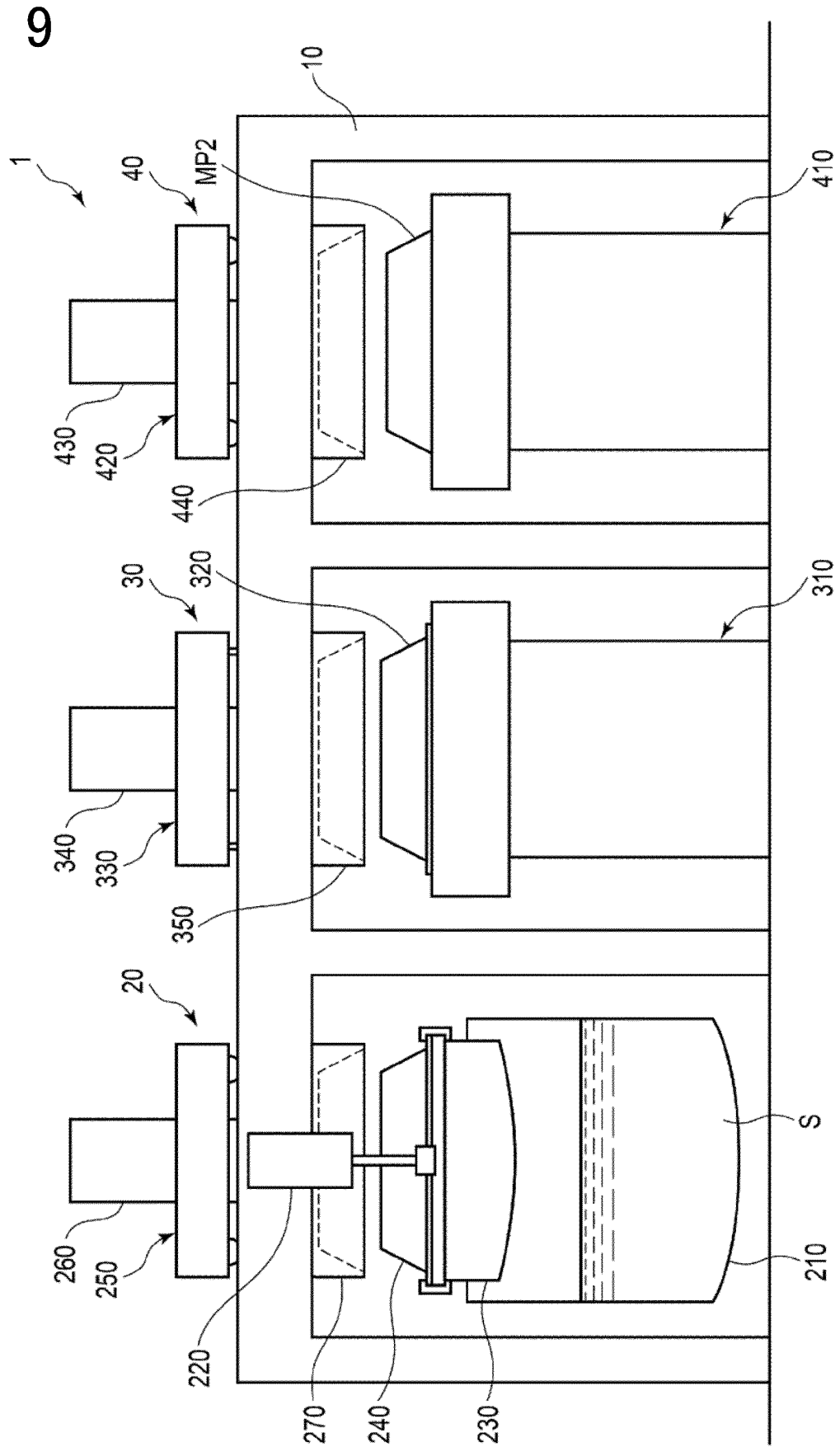


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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/047034

A. CLASSIFICATION OF SUBJECT MATTER <i>D21J 3/00</i> (2006.01)i; <i>B65D 1/00</i> (2006.01)i FI: D21J3/00; B65D1/00 110 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) D21J1/00-7/00; B65D1/00																								
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2022 Registered utility model specifications of Japan 1996-2022 Published registered utility model applications of Japan 1994-2022																								
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																								
C. DOCUMENTS CONSIDERED TO BE RELEVANT																								
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>JP 2000-303399 A (KAO CORP.) 31 October 2000 (2000-10-31) claims 1-4, paragraphs [0001], [0013], [0019]-[0021], fig. 2, examples 1-5</td> <td>1-7</td> </tr> <tr> <td>Y</td> <td>claims 1-4, paragraphs [0001], [0013], [0019]-[0021], fig. 2, examples 1-5</td> <td>8-9</td> </tr> <tr> <td>Y</td> <td>JP 8-158299 A (HONSHU PAPER CO., LTD.) 18 June 1996 (1996-06-18) paragraph [0017]</td> <td>8-9</td> </tr> <tr> <td>X</td> <td>JP 2002-105898 A (KAO CORP.) 10 April 2002 (2002-04-10) claims 1-6, paragraphs [0001], [0016], [0026], fig. 2, examples 1-4</td> <td>1-7</td> </tr> <tr> <td>X</td> <td>WO 99/57373 A1 (KAO CORP.) 11 November 1999 (1999-11-11) claims 1-11, examples 1-11</td> <td>1-4, 6-7</td> </tr> <tr> <td>X</td> <td>JP 2002-102109 A (KAO CORP.) 09 April 2002 (2002-04-09) claims 1-4, example 1</td> <td>1-4, 6-7</td> </tr> <tr> <td>A</td> <td>JP 2001-123400 A (OJI PACKAGING SYSTEMS CO., LTD.) 08 May 2001 (2001-05-08) paragraphs [0010], [0014], [0015], fig. 1-5</td> <td>1-9</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	JP 2000-303399 A (KAO CORP.) 31 October 2000 (2000-10-31) claims 1-4, paragraphs [0001], [0013], [0019]-[0021], fig. 2, examples 1-5	1-7	Y	claims 1-4, paragraphs [0001], [0013], [0019]-[0021], fig. 2, examples 1-5	8-9	Y	JP 8-158299 A (HONSHU PAPER CO., LTD.) 18 June 1996 (1996-06-18) paragraph [0017]	8-9	X	JP 2002-105898 A (KAO CORP.) 10 April 2002 (2002-04-10) claims 1-6, paragraphs [0001], [0016], [0026], fig. 2, examples 1-4	1-7	X	WO 99/57373 A1 (KAO CORP.) 11 November 1999 (1999-11-11) claims 1-11, examples 1-11	1-4, 6-7	X	JP 2002-102109 A (KAO CORP.) 09 April 2002 (2002-04-09) claims 1-4, example 1	1-4, 6-7	A	JP 2001-123400 A (OJI PACKAGING SYSTEMS CO., LTD.) 08 May 2001 (2001-05-08) paragraphs [0010], [0014], [0015], fig. 1-5	1-9
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																								
<table border="0"> <tr> <td style="vertical-align: top;"> * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> </tr> </table>	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																						
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<table border="1"> <tr> <td>Date of the actual completion of the international search 07 February 2022</td> <td>Date of mailing of the international search report 22 February 2022</td> </tr> </table>	Date of the actual completion of the international search 07 February 2022	Date of mailing of the international search report 22 February 2022																						
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<table border="1"> <tr> <td>Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan</td> <td>Authorized officer Telephone No.</td> </tr> </table>	Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.																						
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/047034

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-183135 A (KAO CORP.) 02 July 2004 (2004-07-02) claims 1-7, paragraph [0031], fig. 1, 2, example 1	1-9
A	JP 2006-077371 A (KAO CORP.) 23 March 2006 (2006-03-23) claims 1-5, fig. 3, example 1	1-9

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/047034

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The claims are classified into the two inventions below.

(Invention 1) claims 1-6

Documents 1 and 3-5 each describe an invention found to satisfy all of the matters defined in claims 1-4 of the present application. In light of documents 1 and 3-5, the invention of claims 1-4 of the present application lacks novelty, and thus does not have a special technical feature. However, claim 5 of the present application that depends from claims 1-4 of the present application has the special technical feature of "becoming thinner toward a direction heading away from the opening" in addition to the matters defined in claims 1-4 of the present application. Accordingly claims 1-5 of the present application are classified as invention 1. Claim 6 of the present application depends from claims 1-5 and has a link of invention to claims 1-5, and thus is classified as invention 1.

(Invention 2) Claims 7-9

Although the invention of claims 7-9 of the present application has the common technical feature between this invention and the invention of claims 1 and 5 of the present application classified as invention 1 of relating to "a pulp molded article", this technical feature does not make a contribution over the prior art in light of the disclosure of documents 1 and 3-5, as mentioned above, and thus cannot be considered a special technical feature. Apart from this feature, there are not the same or corresponding special technical features between claims 7-9 of the present application and claims 1 and 5 of the present application. Furthermore, claims 7-9 of the present application do not depend from any of claims 1-6 of the present application, and are not substantially identical to or similarly closely related to any of the claims classified as invention 1.

Accordingly claims 7-9 of the present application cannot be identified as invention 1, and thus are classified as invention 2.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2021/047034

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2000-303399 A	31 October 2000	(Family: none)	
JP 8-158299 A	18 June 1996	(Family: none)	
JP 2002-105898 A	10 April 2002	(Family: none)	
WO 99/57373 A1	11 November 1999	EP 1126083 A1 claims 1-11, examples 1-11 CN 1299428 A	
JP 2002-102109 A	09 April 2002	(Family: none)	
JP 2001-123400 A	08 May 2001	(Family: none)	
JP 2004-183135 A	02 July 2004	(Family: none)	
JP 2006-077371 A	23 March 2006	(Family: none)	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008285188 A [0005]