



(11)

EP 4 201 278 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.06.2023 Bulletin 2023/26

(51) International Patent Classification (IPC):
A47K 10/16 (2006.01)

(21) Application number: **21877566.6**

(52) Cooperative Patent Classification (CPC):
A47K 10/16

(22) Date of filing: **04.10.2021**

(86) International application number:
PCT/JP2021/036648

(87) International publication number:
WO 2022/075267 (14.04.2022 Gazette 2022/15)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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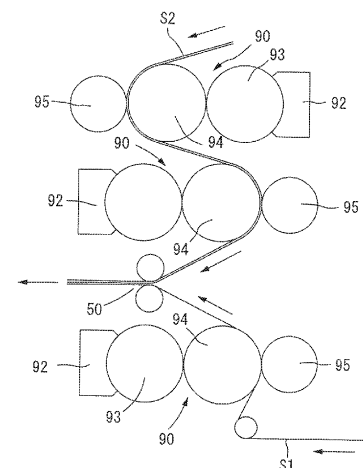
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(54) **METHOD FOR MANUFACTURING TISSUE PAPER AND METHOD FOR MANUFACTURING TISSUE PAPER PRODUCT**

(57) To provide a method for manufacturing three-ply or four-ply tissue paper that reduces a sticky feeling of an outer surface while securing necessary softness.

[FIG.8]

In manufacturing tissue paper including a stacked sheet in which three plies or four plies are stacked, each of the plies contains an aqueous moisturizer exhibiting hygroscopicity, and each of the plies has a difference in magnitude of an arithmetic mean height S_a according to ISO 25718 between both surfaces of each of the plies. A manufacturing method includes: applying the moisturizer to each of the plies such that the moisturizer is applied to an outer surface of each of the plies located on an outer side of the stacked sheet in a state where the outer surface has a small value of the arithmetic mean height S_a ; folding the stacked sheet in which the moisturizer has been applied to each of the plies; and then storing the stacked sheet in the storage body in a folded state.



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Description

Technical Field

5 **[0001]** The present invention relates to a method for manufacturing tissue paper and a method for manufacturing a tissue paper product.

Background Art

10 **[0002]** Two-ply tissue paper is mainly used as tissue paper. However, in recent years, demand for multi-ply tissue paper that provides a thick feeling, such as three-ply or four-ply tissue paper, is also increasing.

[0003] Such multi-ply tissue paper is often formed into a product belonging to a high-grade type with a high product price, and the tissue paper of such a product group is required to have "fluffy bulkiness", "surface smoothness", and "softness" particularly corresponding to the number of plies.

15 **[0004]** In the case of the multi-ply structure, when the basis weight of each ply is increased, the paper thickness can be easily increased by the sum of the plies, and "fluffy bulkiness" can be exhibited.

[0005] However, when the basis weight of each ply is increased as described above, it is important to exhibit "fluffy bulkiness" while securing softness and a smooth quality.

20 **[0006]** Various types of tissue papers are commercially available, and one field thereof is called a moisturizing tissue or a lotion tissue containing an aqueous moisturizer.

[0007] A conventional moisturizing tissue and lotion tissue are manufactured so as to have a soft and smooth quality such that the skin does not become red and does not become painful even when used repeatedly for a person who frequently blows his or her nose with the tissue paper due to pollinosis, cold, or the like.

25 **[0008]** A use form of tissue paper not a little varies depending on a country. This is considered to be based on a difference in life or culture.

[0009] As the moisturizing tissue or the lotion tissue in Japan, two-ply tissue paper is mainly used, but for example, in China, three-ply paper is mainly used.

Citation List

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Patent Literature

[0010] Patent Literature 1: JP 2018-171254 A

Summary of Invention

Technical Problem

40 **[0011]** In a conventional moisturizing tissue or lotion tissue having three plies stacked or manufacture thereof, a moisturizer is applied only to both outer layer sheets, and the moisturizer is not applied to an intermediate layer sheet.

[0012] In the conventional moisturizing or lotion tissue, it is necessary to apply a certain amount of the moisturizer in order for a user to feel softness at the time of use.

[0013] However, on the other hand, when the application amount of the moisturizer is large, stickiness is caused on an outer surface of the outer layer sheet, which is not preferable.

45 **[0014]** Therefore, an object of the present invention is to provide a method for manufacturing three-ply or four-ply tissue paper that reduces a sticky feeling of an outer surface while securing necessary softness, and a method for manufacturing a tissue paper product.

Solution to Problem

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[0015] In a method for manufacturing tissue paper according to the present invention that has solved the above problem,

in manufacturing tissue paper including a stacked sheet in which three plies or four plies are stacked,
each of the plies contains an aqueous moisturizer exhibiting hygroscopicity, and

55 each of the plies has a difference in magnitude of an arithmetic mean height S_a according to ISO 25718 between both surfaces of each of the plies, and
the method includes:

applying the moisturizer to each of the plies such that the moisturizer is applied to an outer surface of each of the plies located on an outer side of the stacked sheet in a state where the outer surface has a small value of the arithmetic mean height S_a ; and
folding the stacked sheet in which the moisturizer has been applied to each of the plies.

[0016] A method for manufacturing a tissue paper product is a method for manufacturing a tissue paper product storing tissue paper including a stacked sheet in which three plies or four plies are stacked in a storage body, in which

each of the plies contains an aqueous moisturizer exhibiting hygroscopicity, and
each of the plies has a difference in magnitude of an arithmetic mean height S_a according to ISO 25718 between both surfaces of each of the plies, and
the method includes:

applying the moisturizer to each of the plies by a flexographic transfer printing method such that the moisturizer is applied to an outer surface of each of the plies located on an outer side of the stacked sheet in a state where the outer surface has a small value of the arithmetic mean height S_a ;
folding the stacked sheet in which the moisturizer has been applied to each of the plies; and
then storing the stacked sheet in the storage body in a folded state.

Advantageous Effects of Invention

[0017] The present invention can provide a method for manufacturing three-ply or four-ply tissue paper that reduces a sticky feeling of an outer surface while securing necessary softness, and a method for manufacturing a tissue paper product.

Brief Description of Drawings

[0018]

Fig. 1 is a schematic cross-sectional view of an embodiment of three-ply paper.
Fig. 2 is a schematic cross-sectional view of an embodiment of four-ply paper.
Fig. 3 is a schematic cross-sectional view of an embodiment of conventional three-ply paper.
Fig. 4 is a schematic cross-sectional view of an embodiment of conventionally assumed four-ply paper.
Fig. 5 is a photograph of an example of a chemical solution applied surface.
Fig. 6 is a photograph of an example of a chemical solution applied surface.
Fig. 7 is a schematic diagram of an example of obtaining a primary continuous sheet.
Fig. 8 is a schematic diagram of an example of application to three-ply paper.
Fig. 9 is a schematic diagram of another example of application to three-ply paper.
Fig. 10 is a schematic diagram of an example of application to four-ply paper.
Fig. 11 is a schematic diagram of another example of application to three-ply paper.
Fig. 12 is a schematic diagram of another example of application to four-ply paper.
Fig. 13 is a schematic diagram of still another example of application to four-ply paper.
Fig. 14 is a schematic diagram of an example of a spray application unit.
Fig. 15 is a schematic diagram of an example of application to three-ply paper using the example of the spray application unit.
Fig. 16 is a schematic diagram of another example of application to three-ply paper using the example of the spray application unit.
Fig. 17 is an explanatory diagram of a folded form.
Fig. 18 is a schematic perspective view of an example of storage in a storage box.
Fig. 19 is a transverse cross-sectional view of the example of storage in the storage box.

Description of Embodiments

[0019] Hereinafter, the present invention will be further described with reference to an embodiment of the present invention.

[0020] An embodiment of tissue paper in which three plies or four plies are stacked will be described.

[0021] The tissue paper is not two-ply tissue paper but three-ply or four-ply tissue paper, and therefore provides "fluffy bulkiness".

[0022] Fig. 1 illustrates an embodiment in which tissue paper has three layers (1R, 2R, and 3R), and Fig. 2 illustrates an embodiment in which tissue paper has four layers (1R, 2R, 3R, and 4R). Fig. 3 illustrates a conventional form in which tissue paper has three layers (1R, 2R, and 3R), and Fig. 4 illustrates a conventional form in which tissue paper has four layers (1R, 2R, 3R, and 4R).

[0023] In addition, a moisturizer (hereinafter, also be referred to as "chemical solution", which is synonymous with moisturizer) applied surface F and a moisturizer non-applied surface W are illustrated. Since there is not a little gradient of a concentration of the contained moisturizer in a thickness direction from the applied surface F toward the non-applied surface W, the concentration gradient is illustrated in gradation.

[0024] To each of the plies, an aqueous moisturizer exhibiting hygroscopicity is applied, and each of the plies contains the moisturizer. As the aqueous moisturizer exhibiting hygroscopicity, it is possible to use a moisturizer containing a polyol as a main component, particularly a moisturizer containing glycerin as a main component, that is, a moisturizer containing more than 50% by mass of glycerin, desirably containing 70% by mass or more of glycerin. Glycerin exhibits hygroscopicity in addition to a moisturizing property.

[0025] Liquid paraffin can be contained in the moisturizer in order to improve surface properties, particularly smoothness. If necessary, 1,3-propanediol can be contained in an amount of 6.1% by mass or more and 12.6% by mass or less.

[0026] The tissue paper may contain a known auxiliary agent in addition to the moisturizer such as glycerin. Examples of the auxiliary agent include a moisturizing auxiliary component such as sorbitol, a hydrophilic polymer gelling agent, a surfactant, and a flexibility improver for enhancing moisture retention in the tissue paper, an oil component for aiding exhibition of smoothness, such as the liquid paraffin, an emulsifier for stabilizing the moisturizer and improving applicability, an antiseptic agent, and an antifoaming agent. Note that the blending amount of a component such as the moisturizing auxiliary component or the hydrophilic polymer gelling agent for enhancing moisture retention is set to such an extent that the blending amount does not excessively affect "fluffy bulkiness", "softness", or "surface smoothness". Specifically, it is desirable that the blending amount is 1.0% by mass or less, preferably 0.6% by mass or less, and more preferably 0.5% by mass or less.

[0027] It is desirable that the basis weight of one ply of the tissue paper of the present embodiment is 15.0 to 22.5 g/m², and particularly 15.5 to 20.5 g/m². When the basis weight of each layer is within this range, "softness" and "fluffy bulkiness" are remarkably exhibited.

[0028] Since paper tends to be hard when the basis weight is high and to be soft when the basis weight is low, it is considered that the basis weight has a large influence on "softness". When the tissue paper is a three-ply or four-ply paper under this basis weight, the tissue paper remarkably provides "fluffy bulkiness". Note that the basis weight is a value measured on the basis of JIS P 8124 (1998).

[0029] The aqueous moisturizer is substantially uniformly contained in each ply. That is, the moisturizer (chemical solution) content percentage of each ply on a dry basis may be within a range of 92.0 to 108.0 when the moisturizer (chemical solution) content percentage of a product on a dry basis is 100. It is desirable that the moisturizer (chemical solution) content percentage of each ply on a dry basis is within a range of 95.0 to 104.0.

[0030] As described above, in a conventional moisturizing tissue (also referred to as a lotion tissue), it is necessary to apply a certain amount of moisturizer in order for a user to feel softness at the time of use. Therefore, since the moisturizer is not applied to an intermediate layer (2R in Fig. 3, and 2R and 3R in Fig. 4) in the conventional embodiments illustrated in Figs. 3 and 4, the application amount of the moisturizer to an outer layer sheet tends to be large, and an outer surface of the outer layer sheet is sticky, which is not preferable.

[0031] On the other hand, in the tissue paper of the embodiment, unlike the conventional multilayer tissue paper, the aqueous moisturizer is also applied to the intermediate layer (intermediate ply).

[0032] An advantage of this configuration is that the intermediate layer (intermediate ply), that is, (2R in Fig. 1, and 2R and 3R in Fig. 2) is soft to make the entire stacked sheet soft because the intermediate layer (intermediate ply) also contains the aqueous moisturizer.

[0033] As a result, the amount of the moisturizer contained in the outer layer sheet can be reduced, and the sticky feeling caused by the moisturizer on an outer surface of the outer layer sheet (exposed surface of the stacked sheet) can be eliminated or suppressed.

[0034] Note that this advantage is exhibited substantially irrespective of the basis weight of each ply and the content of the moisturizer in each ply as long as the moisturizer (chemical solution) content percentage of each ply on a dry basis is within the above range when the moisturizer (chemical solution) content percentage of a product on a dry basis is 100.

[0035] The aqueous moisturizer can be contained also in the intermediate layer (intermediate ply) by directly applying the moisturizer also to the intermediate layer in addition to the outer layer.

[0036] For example, when the moisturizer is applied to the outer layer sheet of the stacked sheet, the moisturizer on the outer layer sheet behaves so as to permeate and diffuse to the entire stacked sheet from the applied surface over time. However, when an external pressure due to calendering or the like is applied to the stacked sheet, a part of the moisturizer applied to the outer layer sheet of the stacked sheet is transferred to an adjacent sheet. However, when the

application amount of the moisturizer is small, the amount of the moisturizer transferred to an adjacent sheet is small.

[0037] Meanwhile, when the applied amount of the moisturizer is large, although the amount of the moisturizer transferred to an adjacent sheet is large, there is a limit to the transfer, and a clear difference is observed between the content of the moisturizer in the outer layer sheet to which the moisturizer is applied and the content of the moisturizer in the adjacent sheet.

[0038] Therefore, in order to contain a moisturizer necessary for securing softness also in the intermediate layer (intermediate ply), it is necessary to directly apply the moisturizer also to the intermediate layer in addition to the outer layer.

[0039] Conversely, when an excessive amount of the moisturizer is applied to the outer layer sheet in order to transfer the moisturizer to the intermediate layer and to secure softness, a large amount of the moisturizer remains on the outer surface (exposed surface) of the outer layer sheet, and causes stickiness.

[0040] However, by directly applying the moisturizer also to the intermediate layer (intermediate ply), the application amount of the moisturizer to an outer surface (exposed surface) of the outer layer sheet can be reduced, and occurrence of stickiness can be eliminated or suppressed.

[0041] It is common to crepe ply base paper in order to impart flexibility to tissue paper. Also in the embodiment, it is desirable to perform creping.

[0042] It is desirable that the number of crepes is 38 to 54 crepes/cm.

[0043] The number of crepes (crepes/cm) measured by one-shot 3D can be represented by a value obtained by drawing a linear shape in MD (Machine Direction) direction, counting the number of mountains in the paper surface having a mountain and valley shape of 1.0 to 2.0 cm in MD direction, and dividing the counted number by a measured length in MD direction.

[0044] When the shape is measured by one-shot 3D and a height profile on an X-Y plane is indicated on a screen, the height of a surface of the tissue paper is represented by a color tone. The shape of the crepe in the height direction can be confirmed from a measured cross-sectional curve profile. Here, since the crepe has mountains and valleys formed in a direction 90 degrees perpendicular to MD direction, the number of crepes (crepes/cm) refers to a value obtained by counting the number of mountains in the paper surface having a mountain and valley shape of 1.0 to 2.0 cm in MD direction and dividing the counted number by a measured MD length. An average value of the measured values at five points is defined as a value for one sample.

[0045] It is desirable that the degree of sharpness of an irregular peak portion "arithmetic mean curvature Spc of a peak" is 2.8 to 3.5 (1/mm) (the larger the value is, the sharper a fine protrusion on a surface is).

[0046] By such creping, a surface roughness is made different between one surface and the other surface of the ply base paper.

[0047] When the moisturizer is applied to the ply base paper, the moisturizer is preferably applied to a surface having smaller irregularities due to creping.

[0048] That is, in a ply in which a surface roughness is expressed as a difference in magnitude of an arithmetic mean height Sa according to ISO 25718, it is desirable to apply the moisturizer to a surface having a smaller arithmetic mean height Sa.

[0049] When the moisturizer is applied to a surface having a smaller arithmetic mean height Sa, since the surface has a smaller arithmetic mean height Sa and contains a sufficient amount of the moisturizer, a smooth hand feel and softness are imparted.

[0050] Since the outer layer contains the chemical solution, it is desirable that the stacked sheet is calendered after the application of the moisturizer. As a result, the paper is calendered by an external pressure applied to an outer surface of the outer layer, and the applied moisturizer uniformly diffuses to a surface. As a result, the surface is smooth, and more "surface smoothness" is exhibited.

[0051] In the tissue paper to which the moisturizer has been applied, it is desirable that the arithmetic mean height Sa of an outer surface (in particular, an exposed surface of the stacked sheet) under no pressure is 0.005 to 0.012 mm, particularly 0.006 to 0.008 mm. When the arithmetic mean height Sa is within the range, the surface is smooth and has moderate irregularities, and therefore wipeability of, for example, lipstick or foundation is excellent.

[0052] Here, "under no pressure" means that measurement is performed in a generated state.

[0053] Conversely, when the moisturizer is applied to a surface of the base paper ply having larger irregularities due to creping, the moisturizer is also hygroscopic, and therefore wrinkles are largely generated on the surface due to moisture absorption over time, the surface shrinks, and the surface smoothness is impaired.

[0054] The arithmetic mean height Sa is defined in ISO 25718, and represents an average of absolute values of differences in height between points with respect to an average surface of surface in a definition region. The smaller the numerical value is, the smaller the absolute value of the difference in height between points with respect to the average surface of surface is, and the flatter the surface is. The larger the numerical value is, the rougher the surface is.

[0055] Note that when the arithmetic mean height Sa is measured for a tissue paper product in which a tissue paper bundle is stored in a packaging body in a pop-up manner, a measurement surface of a sample taken out from the tissue paper bundle is a surface having a mountain side of a fold (the same applies to the arithmetic mean curvature Spc of a

peak).

[0056] It is desirable that the tissue paper according to the embodiment has an arithmetic mean curvature (Spc) of 2.8 to 3.5 (1/mm) at a peak of an outer surface thereof under no pressure. The arithmetic mean curvature at a peak represents an arithmetic mean of principal curvatures at a peak in a defined region. The smaller the numerical value is, the more rounded a point in contact with another object is. The larger the numerical value is, the sharper a point in contact with another object is.

[0057] Note that a measurement surface of a sample obtained from the pop-up type bundle is a surface having a mountain side of a fold. When the arithmetic mean curvature (Spc) at a peak of an outer surface under no pressure is 2.8 to 3.5 (1/mm), wipeability of lipstick, foundation, or the like is excellent while a surface is felt to be smooth.

[0058] The "arithmetic mean height Sa" and "the arithmetic mean curvature (Spc) at a peak" in the present specification are values measured using a "one-shot 3D shape measuring machine VR-3200 (manufactured by KEYENCE CORPORATION)" (hereinafter, also referred to as "3D microscope") and its equivalent machine (non-contact three-dimensional measuring instrument).

[0059] The "3D microscope" can measure a shape from a fringe projection image of an object projected on a monochrome C-MOS camera by structured illumination light emitted from a light projecting unit, and in particular, can measure the height, length, angle, volume, and the like of any part using the obtained fringe projection image. For observing, measuring, and analyzing an image obtained by the "3D microscope", software "VR-H2A" and its equivalent software can be used. Note that measurement is performed under conditions of a visual field area of 24 mm × 18 mm and a magnification of 12 times.

[0060] A specific procedure for measuring the arithmetic mean height (Sa) and the arithmetic mean curvature (Spc) of an outer surface under no pressure is as follows.

[0061] Tissue paper in a form of a ply, which is a sample (having a size of about 50 mm in MD direction and 50 mm in CD (Cross Direction) direction), is placed on a measuring table in a generated state while a measuring machine is in front of the tissue paper and a depth direction is MD direction. Note that a test piece used for the measurement is a flat portion of a product.

[0062] A screen of the software ("VR-H2A") is operated to obtain three images of a main image (texture), a main image (height), and a 3D image of a sample surface. Next, a "texture" image displayed, for example, by selecting "surface roughness" of the software is converted into a "height" image (an image represented by a shade of a color tone color-coded in a height direction).

[0063] Next, at least a maximum height (Sz), the arithmetic mean height (Sa), and the arithmetic mean curvature (Spc) at a peak are set as measurement parameters, and measurement is performed. The size of the measurement range is 3.0 mm × 3.0 mm. With the above software, the measurement range can be set by selecting "designate numerical value" in "add region". The measurement range is set so as not to include an embossed portion, and the measurement range is set such that a shade of a color tone within each measurement range on a screen visually approaches a constant shade.

[0064] The measured values of the maximum height (Sz), the arithmetic mean height (Sa), and the arithmetic mean curvature (Spc) at a peak are checked, and when the maximum height (Sz) exceeds 0.1000 mm, the value is discarded, and another measurement range is set. Note that the maximum height (Sz), the arithmetic mean height Sa, and the arithmetic mean curvature (Spc) at a peak are parameters of surface roughness defined in ISO 25178. In the measurement, in order to remove a large undulation of a sheet, the measurement is performed under conditions that a filter has a Gaussian correction, an S-filter is not used, an F-operation has a two-dimensional curved surface, a 0.8 mm L-filter is used, and end point processing is performed.

[0065] Plane roughness is measured for the "maximum height (Sz)", the "arithmetic mean height (Sa)", and the "arithmetic mean curvature of peak (Spc) at a peak" in a range of 3.0 mm square as a measurement range. The plane roughness is measured in the range of 3.0 mm square in this image at a total of five places while the position is changed, and an average value at the five places is taken as a measurement value of each of the "maximum height (Sz)", the "arithmetic mean height (Sa)", and the "arithmetic mean curvature (Spc) at a peak" of the measurement sample. The range of 3.0 mm square, which is the measurement range, is located in a central portion with small distortion in a visual field area of 24 mm × 18 mm. Note that selection of each of the above five measurement ranges and the "maximum height (Sz)", the "mean arithmetic roughness (Sa)", and the "arithmetic mean curvature (Spc) at a peak" may be measured simultaneously, or may be measured while a range Z to be measured is changed.

[0066] It is desirable that the content of the moisturizer in each ply is 10.0 to 35.0% by mass, in particular, 17.0 to 30.0% by mass. When the content is small, softness is not sufficient. When the content is large, stickiness occurs on an exposed surface, and a paper strength is easily reduced.

[0067] It is desirable that the tissue paper is tissue paper having three plies stacked, the basis weight of one ply is 15.0 to 22.5 g/m², and the paper thickness of the three-ply paper is 140 to 270 μm, particularly 176 to 230 μm. In a multi-ply structure such as three-ply paper, the paper thickness particularly affects "softness" and "fullness". In the tissue paper of the present embodiment, when the paper thickness is within this range, "softness", "fluffy bulkiness", and

"surface smoothness" are remarkable.

[0068] When the tissue paper is tissue paper having four plies stacked, it is desirable that the basis weight of one ply is 15.0 to 22.5 g/m², and the paper thickness of the four-ply paper is 180 to 360 μm, particularly 220 to 320 μm.

[0069] The paper thickness is a value obtained by sufficiently subjecting a test piece to humidity control under conditions of JIS P 8111 (1998), and then measuring the paper thickness using a dial thickness gauge (thickness measuring instrument) "PEACOCK G type" (manufactured by Ozaki MFG. Co. Ltd.) under the same conditions. Specifically, it is confirmed that there is no rubbish, dust, or the like between a plunger and a measuring table, the plunger is placed on the measuring table, a scale of the dial thickness gauge is moved to adjust a zero point, then the plunger is raised, a test piece is placed on the measuring table, the plunger is lowered slowly, and the current gauge is read. During the measurement, care is taken such that a terminal of the metallic plunger (a circular plane having a diameter of 10 mm) strikes against a paper plane perpendicularly. Note that a load is about 70 gf when the paper thickness is measured. The paper thickness is an average value of measured values obtained by performing this measurement 10 times at different sites. As the test piece, a three-ply product sheet is collected and measured while a fold line, a ply-bonding portion, and the like are avoided.

[0070] It is desirable that the tissue paper of the present embodiment has a dry strength of 220 to 420 cN/25 mm for three plies or four plies in a longitudinal direction. When the dry strength in the longitudinal direction is within this range, "softness", "fluffy bulkiness", and "surface smoothness" are remarkable. In addition, when the dry strength in the longitudinal direction is within this range, the strength is within a range of strength sufficient to withstand use.

[0071] When ply base paper having excessively high dry strength for three plies in the longitudinal direction, that is, ply base paper in which fibers are densely arranged in the longitudinal direction and compacted at a high pressure is used, softness is poor, and stickiness is likely to occur on an exposed surface because (it is predicted that) the moisturizer does not penetrate between the fibers.

[0072] It is desirable that the dry strength for three plies or four plies in a lateral direction is 60 to 160 cN/25 mm. When the dry strength in the lateral direction is within this range, "softness", "fluffy bulkiness", and "surface smoothness" are remarkable. In addition, when the dry strength in the longitudinal direction is within this range, the strength is within a range of strength sufficient to withstand use.

[0073] Furthermore, although not clear, a "dry tensile strength in the lateral direction" does not affect individual functionality such as "softness" or "fullness", but affects overall functionality of "skin texture". It has been found that there is a certain correlation between evaluation of the "skin texture" and the "dry strength in the lateral direction" when a subject freely touches a sample and then evaluates whether the tissue paper is good or bad on the basis of a comprehensive evaluation criterion of "skin texture" without evaluation based on a specific evaluation criterion of "softness" or "fullness".

[0074] It is desirable that the tissue paper of the present embodiment has a wet paper strength of 50 to 90 cN/25 mm for three plies or four plies in the lateral direction.

[0075] It is desirable that a ratio of wet tensile strength in the lateral direction/dry tensile strength in the lateral direction is 0.62 to 0.76. Note that this value is a measurement value with three plies as they are. With such a difference in strength, for example, when a user blows his or her nose, the user feels "robustness (strength and sense of security)" in a usage mode changing from a dry state to a wet state. Furthermore, it is difficult for the user to feel a change in strength of the paper in such a usage mode, which affects how to feel "smoothness" during use.

[0076] Note that the longitudinal direction of paper is also referred to as MD direction and is a flow direction during papermaking. The lateral direction of paper is also referred to as CD direction, and is a direction perpendicular to the flow direction (MD direction) during papermaking.

[0077] The dry (tensile) strength of the tissue paper of the embodiment is a value measured on the basis of JIS P 8113, and is a value measured as follows. As a test piece, tissue paper cut into a size of about 25 mm (± 0.5 mm) (width) × about 150 mm (length) in both the longitudinal and lateral directions is used. Multi-ply tissue paper is measured with multiple plies. As a tester, a load cell tensile tester TG-200N manufactured by Minebea Co., Ltd. and its equivalent machine are used. Note that a grip interval is set to 100 mm, and a tensile speed is set to 100 mm/min. The measurement is performed by tightening both ends of the test piece to a grip of the tester, applying a tensile load to the paper piece in an up-down direction, and reading an indicated value (digital value) when the paper breaks. Five sets of samples are prepared in each of the longitudinal direction and the lateral direction, and each sample is measured five times. An average of the measured values is defined as a dry tensile strength in each of the directions. A sample is adjusted according to JIS P 8111 (1998).

[0078] The wet (tensile) strength of the tissue paper according to the embodiment is a value measured according to JIS P 8135 (1998), and is a value measured as follows. As a test piece, tissue paper cut into a size of about 25 mm (± 0.5 mm) (width) × about 150 mm (length) in both the longitudinal and lateral directions is used. Multi-ply tissue paper is measured with multiple plies. As a tester, a load cell tensile tester TG-200N manufactured by Minebea Co., Ltd. and its equivalent machine are used. Note that a grip interval is set to 100 mm, and a tensile speed is set to 50 mm/min. The test piece used has been cured for 10 minutes in a dryer at 105°C. The measurement is performed by tightening both ends of the test piece to a grip of the tester, then horizontally adding water to a central portion of the test piece with a

width of about 10 mm using a flat brush containing water, immediately thereafter applying a tensile load to the paper piece in an up-down direction, and reading an indicated value (digital value) when the paper breaks. Five sets of samples are prepared in each of the longitudinal direction and the lateral direction, and each sample is measured five times. An average of the measured values is defined as a wet tensile strength in each of the directions.

[0079] The dry tensile strength and the wet tensile strength can be adjusted by internally adding a dry paper strength enhancer or a wet paper strength enhancer to a paper material or wet paper. Examples of the dry paper strength enhancer include starch, polyacrylamide, carboxymethyl cellulose (CMC) or sodium carboxymethyl cellulose as a salt of CMC, calcium carboxymethyl cellulose, and zinc carboxymethyl cellulose. Examples of the wet paper strength enhancer include a polyamide polyamine epichlorohydrin resin, a urea resin, an acid colloid/melamine resin, and a thermally crosslinkable coating PAM. Note that when the dry paper strength enhancer is internally added, the addition amount thereof with respect to pulp slurry is about 1.0 kg/pulp t or less. The wet paper strength enhancer is desirably cationic, and the addition amount thereof with respect to pulp slurry is about 5.0 to 20.0 kg/pulp t.

[0080] A fiber material constituting the tissue paper is a pulp fiber, and it is desirable that the pulp fiber is needle bleached kraft pulp (NBKP) or leaf bleached kraft pulp (LBKP) used for tissue paper. The tissue paper may contain waste paper pulp. However, it is extremely desirable that the tissue paper is constituted only by NBKP and LBKP which are each virgin pulp because it is difficult for the waste paper pulp to exhibit "softness". A blending ratio is NBKP : LBKP = 25 : 75 to 40 : 60 in terms of mass ratio. Within this range, it is possible for a user to remarkably feel "softness" and "smoothness" while feeling paper strength necessary for blowing his or her nose and "fluffy bulkiness".

[0081] It is desirable that a compression work amount is 1.85 to 2.50 gf/cm/cm², particularly 2.18 to 2.35 gf/cm/cm² for a total of 12 plies including four sets of three plies or a total of 12 plies including three sets of four plies.

[0082] Furthermore, it is desirable that compression recoverability is 46.0 to 54.5%, particularly 48.0 to 53.0%

[Method for manufacturing tissue paper]

[0083] The tissue paper according to the present embodiment and a tissue paper product obtained by bundling sheets of the tissue paper and storing the bundle in a packaging body can be manufactured by the following manufacturing procedure.

[0084] First, using a papermaking unit example X2 illustrated in Fig. 7, a primary original fabric roll JR (also referred to as a jumbo roll) is manufactured as follows.

[0085] A paper material prepared in advance by adding an appropriate chemical to a pulp slurry is supplied from a head box 31 onto a wire 32w of a wire part 32 to form wet paper W (forming step). Next, the wet paper W is transferred to a felt 34 of a press part 33, and then sandwiched by a pair of dehydrating rollers 34 and 35 to be dehydrated (dehydrating step).

[0086] Next, the dehydrated wet paper is attached to a surface of a Yankee dryer 36 to be dried, and then scraped off by a doctor blade 37 to form dry base paper S1 (a primary continuous sheet described later) having a crepe (creping/drying step).

[0087] Then, the dry base paper S1 is wound by a winding unit 38 including a winding drum 39 such that a back surface of the dry base paper S1 faces a shaft side of the primary original fabric roll JR (such that a back surface of the dry base paper S1 is a winding inner surface) to form the primary original fabric roll JR (primary original fabric winding step).

[0088] The primary original fabric roll JR generally has a diameter of 1000 to 5000 mm, a length (width) of 1500 to 9200 mm, and a winding length of 5000 to 80000 m although these values vary depending on performance of the papermaking unit X2.

[0089] Note that a calendering step (not illustrated) may be performed on the dry base paper S1 scraped off by the doctor blade 37 to perform calendering on front and back surfaces before the primary original fabric winding step.

[0090] Here, the back surface of the dry base paper S1 means a surface of the dry base paper S1 opposite to a surface in contact with a cylinder of the Yankee dryer 36. Note that, in general, a surface in contact with a mirror surface of the Yankee dryer is smoother and has better surface properties although depending on presence or absence of the calendering step.

[0091] As described above, at least the outer surface (exposed surface) of the outer layer of the stacked sheet is a surface (smooth and excellent in surface properties) in contact with the mirror surface of the Yankee dryer, and the moisturizer is applied to the smooth surface having excellent surface properties. As a result, the outer surface (exposed surface) of the outer layer can have a small arithmetic mean height Sa according to ISO 25178.

[0092] As a result, the stacked sheet provides a smooth and soft feel of use to a consumer.

[0093] Here, it is desirable that the primary continuous sheet S1 (ply base paper) constituting the primary original fabric roll JR specifically has a basis weight according to JIS P 8124 of 10 to 25 g/m², preferably 12 to 20 g/m², more preferably 13 to 16 g/m². A basis weight of less than 10 g/m² is preferable from a viewpoint of softness of tissue paper 1, but makes it impossible to secure appropriate strength. Meanwhile, a basis weight of more than 25 g/m² makes the tissue paper 1 too hard, and deteriorates texture.

[0094] The primary continuous sheet S1 may have a crepe ratio of 10 to 30%, preferably 12 to 25%, more preferably 13 to 20%. When the crepe ratio is less than 10%, the tissue paper 1 is easily cut at the time of processing in a subsequent stage and has little stretch and no elasticity. Meanwhile, when the crepe ratio is more than 30%, it is difficult to control tension of a sheet at the time of processing, and the sheet is easily cut off, and after manufacture, wrinkles are generated due to moisture absorption of the moisturizer, and the tissue paper 1 tends to have a poor appearance.

[Ply step [method and unit for manufacturing secondary original fabric roll]]

[0095] The three (or four in a case of four plies) primary original fabric rolls JR manufactured in the papermaking step are set in a stacking unit also referred to as a ply machine. A single-layer continuous sheet is unwound from each of the primary original fabric rolls, and the moisturizer is applied thereto, for example, according to an application form described later.

[0096] In the case of three plies, the moisturizer is applied to each of the single-layer continuous sheets, or single-layer continuous sheets are superimposed on each other into two layers, then the moisturizer is applied to both surfaces of the two layers, and the moisturizer is applied to the other layer in a state of a single layer.

[0097] In the case of four plies, it may be possible that the moisturizer is applied to each of the single-layer continuous sheets, or single-layer continuous sheets are superimposed on each other into two layers, then the moisturizer is applied to both surfaces of the two layers, similarly, the other single-layer continuous sheets are superimposed on each other into two layers, and then the moisturizer is applied to both surfaces of the two layers.

(Calendering)

[0098] After application of the moisturizer, a stacked continuous sheet can be calendered.

[0099] The type of calendering is not particularly limited, but is preferably soft calendering or chilled calendering for the reason of improving smoothness of a surface and adjusting a paper thickness. The soft calendering is calendering using a roller coated with an elastic material such as a urethane rubber, and the chilled calendering is calendering using a metal roller.

[0100] The number of calendering portions can be appropriately changed. When a plurality of calendering portions is disposed, there is an advantage that sufficient calendering can be performed even if a processing speed is high, and when one calendering portion is disposed, there is an advantage that the calendering portion can be disposed even if a space is narrow.

[0101] Calendering is performed considering also a calendering type, a nip linear pressure, the number of nips, and the like in calendering as control factors, and these control factors are preferably appropriately changed depending on the quality of tissue paper to be required, that is, a paper thickness and surface properties.

[0102] Thereafter, if necessary, embossing can be performed in order to integrate the stacked sheet and to impart designability.

(Folding step)

[0103] A folding step is preferably performed subsequently to the moisturizer application step or the calendering step performed after the moisturizer application step.

[0104] In this folding step, the obtained stacked sheets are sequentially folded in a form in which one side of a preceding stacked sheet S1 and one side of a following stacked sheet S3 are inserted into a valley folded portion of a stacked sheet S2 as illustrated in Fig. 17 in a known folding unit or the like also referred to as a rotary interfolder (not illustrated), and stacked as a bundle.

(Packaging step)

[0105] The bundle of stacked sheets is cut into a short bundle by a predetermined length, the short bundle of stacked sheets is stored in a housed packaging body (a paper packaging box, a plastic packaging bag, or the like), and the stacked sheets can be sequentially taken out from the packaging body by a pop-up method at the time of use.

[Moisturizer application form]

[0106] The moisturizer application form can be performed with a roller transfer apparatus such as a flexographic printing machine or a gravure printing machine, a spray application apparatus, or the like.

[0107] In a case of applying an aqueous moisturizer (chemical solution) containing glycerin exhibiting hygroscopicity as a main component, and in a case of applying the moisturizer to a sheet traveling at a high speed, a flexographic

printing method or spray application is particularly preferable.

[0108] Also in the embodiment, the flexographic printing method can be adopted.

[0109] When the chemical solution application is performed by the flexographic printing method, there are an advantage that an application amount can be stabilized corresponding to irregularities of crepe paper since an engraved roller (transfer roller) is made of resin even when a processing speed is high, and an advantage that the application amount can be easily stabilized corresponding to a wide range of viscosities of the chemical solution by changing a line number and a cell capacity of an anilox roller and a line number and a vertex area ratio of a flexographic engraved roller.

[0110] Note that the chemical solution application in the chemical solution application step is particularly preferably performed by a flexographic printing method using a doctor chamber. In the doctor chamber method, since a chemical solution is directly applied to a surface of an anilox roller (transfer recessed roller) to form a film, paper dust or air is hardly mixed into the chemical solution, physical properties of the chemical solution are easily stabilized, and the chemical solution transferred from the anilox roller is uniform. Therefore, the chemical solution can be suitably applied even in a case of low amount application.

(Flexographic printing)

[0111] An example in which a flexographic printing machine is used as a chemical solution imparting unit 90 in the chemical solution application step is illustrated. When a chemical solution is imparted to the stacked continuous sheet, it is particularly desirable that a material of the flexographic engraved roller is a silicon rubber.

[0112] The line number of the flexographic engraved roller is 10 to 60, preferably 15 to 40, and particularly preferably 20 to 35. When the line number is less than 10, application unevenness occurs a lot. Meanwhile, when the line number is more than 60, clogging with paper dust easily occurs.

[0113] The line number of the anilox roller is 10 to 300, preferably 25 to 200, and particularly preferably 50 to 100. When the line number is less than 10, application unevenness occurs a lot. Meanwhile, when the line number is more than 300, clogging with paper dust easily occurs. The cell capacity of the anilox roller is 10 to 100 cc, preferably 15 to 70 cc, and particularly preferably 30 to 60 cc. When the cell capacity is less than 10 cc, a desired application amount cannot be obtained. Meanwhile, when the cell capacity is more than 100 cc, a scattering amount of the chemical solution is large.

[0114] Here, it is important that the chemical solution can be stably applied in the chemical solution imparting step, and the line numbers of the engraved roller and the anilox roller related to operational stability are important. Note that, as a method for transferring a chemical solution stored in a storage tank to the anilox roller, an appropriate method such as a doctor chamber type method or a touch roller type method is adopted. An example of a form in which each of these methods in the flexographic printing method is adopted will be described in detail.

<Example of embodiment of doctor chamber method>

[0115] In a flexographic printing machine 90 of a doctor chamber type in flexographic printing, a doctor chamber 92 containing a chemical solution is disposed so as to face a rotatable anilox roller 93, and the chemical solution is transferred from the doctor chamber 92 to the anilox roller 93B. In addition, an engraved (transfer) roller 94 in contact with the anilox roller 93 and in contact with a sheet S1 or S2 is rotatably disposed, and the chemical solution is transferred from the anilox roller 93 to the engraved roller 94.

[0116] Then, the chemical solution is applied from the engraved roller 95 to a stacked continuous sheet while pressure is applied to the sheet S1 or S2 interposed between the engraved roller 94 and an elastic roller 95 facing the engraved roller 94.

[0117] As described later, the elastic roller 95 can be used, or without using the elastic roller 95, the chemical solution can also be applied from the engraved rollers 95 to a stacked continuous sheet while the engraved (transfer) rollers 94 are disposed so as to face each other and pressure is applied to the sheet interposed therebetween.

[0118] The application amount of the moisturizer is suitably controlled based on the degree of a difference in peripheral speed of the anilox roller 93 with respect to the engraved roller 94 because the application amount of the moisturizer can be controlled during an operation process.

<First moisturizer application form of three-ply paper>

[0119] Various forms can be adopted as a moisturizer application form.

[0120] The example of Fig. 8 illustrates a moisturizer application form of three-ply paper, in which among single-layer sheets unwound from three primary original fabric rolls, a two-layer sheet S2 joined into two layers in the middle and a single-layer sheet S1 as it is are supplied to an application apparatus including the three flexographic printing machines 90.

[0121] The chemical solution is applied to each outer surface of the two-layer sheet S2. The chemical solution is also

applied to an outer surface of the single-layer sheet S1.

[0122] The two-layer sheet S2 and the single-layer sheet S1 are joined at a joining portion 50 to form a three-layer stacked sheet S3. Thereafter, as described above, the three-layer stacked sheet S3 is subjected to calendering or embossing, and is guided to an interfolder.

[0123] Here, according to the present invention, in order to apply the moisturizer (chemical solution) to an outer surface of each ply located outside the stacked sheet S3 in a state where the outer surface has a small arithmetic mean height S_a , it is only required to consider an arrangement of the sheets, and a three-layer stacked sheet as illustrated in Fig. 1 can be obtained.

[0124] Fig. 9 illustrates a moisturizer application form of three-ply paper, in which single-layer sheets unwound from three primary original fabric rolls are joined into a three-layer sheet in the middle, separated into a two-layer sheet S2 and a single-layer sheet S1 at a separation portion 51, and supplied to an application apparatus including the three flexographic printing machines 90.

[0125] The chemical solution is applied to each outer surface of the two-layer sheet S2. Thereafter, the two-layer sheet S2 is joined to the single-layer sheet S1 at the joining portion 50 to form a three-layer sheet. Thereafter, the chemical solution is also applied to an outer surface of the single-layer sheet S1 by another flexographic printing machine 90 to form a three-layer stacked sheet S3.

<First moisturizer application form of four-ply paper>

[0126] Fig. 10 illustrates a moisturizer application form of four-ply paper, in which two single-layer sheets unwound from four primary original fabric rolls are joined into a two-layer sheet in the middle, and the chemical solution is applied to each outer surface of the two-layer sheet S2.

[0127] Similarly, the other two single-layer sheets are joined into a two-layer sheet in the middle, and the chemical solution is applied to each outer surface of the two-layer sheet S2.

[0128] Thereafter, the two-layer sheets S2 are joined into a four-layer stacked sheet S4 at the joining portion 50.

<Second moisturizer application form>

[0129] A sheet to which an aqueous moisturizer (chemical solution) containing glycerin exhibiting hygroscopicity as a main component has been applied tends to stretch and decrease in strength.

[0130] When this application is performed particularly at a high speed, in the first moisturizer application form, there is a so-called free-run portion where the sheet is not bound to anything between application positions.

[0131] As a result, the sheet to which the aqueous moisturizer (chemical solution) has been applied stretches and decrease in strength to be cut.

[0132] On the other hand, a second moisturizer application form, that is, an application form is desirable in which at least each sheet is in contact with a roller traveling at the same speed as the sheet in a process from each chemical solution application position to a three-ply stacking position.

<Second moisturizer application form of three-ply paper>

[0133] Fig. 11 illustrates an example of a second moisturizer application form of three-ply paper, and each flexographic printing machine 90 does not include the elastic roller 95 unlike the example of the first moisturizer application form.

[0134] Instead, a sheet is nipped by an engraved (transfer) roller 94 of a first flexographic printing machine 90A and an engraved (transfer) roller 94 of a second flexographic printing machine 90B, and a sheet is nipped by the engraved (transfer) roller 94 of the second flexographic printing machine 90B and an engraved (transfer) roller 94 of a third flexographic printing machine 90C.

[0135] The chemical solution is applied to both surfaces of a two-layer sheet S2 by the first flexographic printing machine 90A and the second flexographic printing machine 90B, and then the chemical solution is applied to an outer surface of a single-layer sheet S1 by the third flexographic printing machine 90C.

<Second moisturizer application form of four-ply paper>

[0136] Fig. 12 illustrates an example of a second moisturizer application form of four-ply paper.

[0137] As illustrated in Fig. 12, a sheet is nipped by an engraved (transfer) roller 94 of a first flexographic printing machine 90A and an engraved (transfer) roller 94 of a second flexographic printing machine 90B, a sheet is nipped by the engraved (transfer) roller 94 of the second flexographic printing machine 90B and an engraved (transfer) roller 94 of a third flexographic printing machine 90C, and a sheet is nipped by the engraved (transfer) roller 94 of the third flexographic printing machine 90C and an engraved (transfer) roller 94 of a fourth flexographic printing machine 90D.

[0138] The chemical solution is applied to both surfaces of a two-layer sheet S2 by the first flexographic printing machine 90A and the second flexographic printing machine 90B, meanwhile, the chemical solution is applied to both surfaces of the other two-layer sheet S2 by the fourth flexographic printing machine 90D and the third flexographic printing machine 90C, and the two-layer sheet S2 are joined into a four-layer sheet S4.

[0139] Fig. 13 illustrates an example of the second moisturizer application form of four-ply paper.

[0140] As illustrated in Fig. 13, a sheet is nipped by an engraved (transfer) roller 94 of a first flexographic printing machine 90A and an engraved (transfer) roller 94 of a second flexographic printing machine 90B, a sheet is nipped by the engraved (transfer) roller 94 of the second flexographic printing machine 90B and an engraved (transfer) roller 94 of a fourth flexographic printing machine 90D, and a sheet is nipped by the engraved (transfer) roller 94 of the second flexographic printing machine 90B and an engraved (transfer) roller 94 of a third flexographic printing machine 90C.

[0141] At these nip positions, the chemical solution is applied to each of both surfaces of a two-layer sheet S2, a single-layer sheet S1 to be an intermediate sheet, and a single-layer sheet S1 to be an outer layer sheet.

<Third moisturizer application form>

[0142] Spray application is also possible as a third moisturizer application form.

[0143] For the spray application, specifically, a nozzle type spraying method, a rotor dampening spraying method, or the like can be adopted. Examples of the type of a spray nozzle in the nozzle type spraying method include an empty conical shape nozzle that sprays annularly, a full conical shape nozzle that sprays circularly, a full pyramidal shape nozzle that sprays in a square shape, a full rectangular shape nozzle, and a fan shape nozzle. A nozzle diameter, the number of nozzles, a nozzle arrangement pattern, the number of nozzle arrangement, a spray distance, a spray pressure, a spray angle, a concentration and a viscosity of a spray liquid, and the like can be appropriately selected and used such that the chemical solution is uniformly sprayed in a width direction of a secondary continuous sheet.

[0144] In addition, as a method of atomization in a nozzle type spraying apparatus, two types of methods, that is, a one-fluid method and a two-fluid method can be selected and used. Among these methods, the one-fluid spraying method is a method for directly applying pressure to a chemical solution to be sprayed using compressed air and injecting mist droplets from a nozzle, or a method for sucking air into a nozzle from a fine hole formed in a nozzle side surface near an ejection port and injecting mist droplets. Examples of the two-fluid spraying method include: an internal mixing type method in which compressed air is mixed with a liquid to be sprayed inside a nozzle to perform atomization; an external mixing type method in which compressed air is mixed with a liquid to be sprayed outside a nozzle to perform atomization; and a collision type method in which atomized mist droplet particles are caused to collide with each other to be further homogenized and atomized.

[0145] Meanwhile, in the rotor dampening spraying method, a liquid to be sprayed is delivered onto a high-speed rotating disk, and the liquid is finely atomized by centrifugal force of the disk. The diameter of the mist droplet particle is controlled by changing a rotation speed of the disk, and the amount of a spray liquid (imparting amount) is controlled by changing a liquid delivery amount onto the disk. A rotor dampening spraying apparatus has an advantage that a small amount of spray liquid can be uniformly applied to a surface of pigment-applied paper while scattering of mist droplets is suppressed, and a spray speed, a particle diameter of the mist, and the like can be easily adjusted.

[0146] Fig. 14 is an example of a rotor dampening spraying apparatus 100. In this configuration, a rotary rotor 100A is disposed in a cover storing chamber (not illustrated) disposed as necessary, and a chemical solution is sprayed and imparted onto a stacked continuous sheet from an ejection port 100B of the rotary rotor.

[0147] Figs. 15 and 16 illustrate an aspect of obtaining a three-ply stacked sheet using the rotor dampening spraying apparatus 100.

[0148] It is not necessary to describe an application form in more detail, and the application form will be easily understood.

[0149] A tissue paper bundle in which sheets are folded and stacked by an interfolder, for example, a rotary interfolder, is stored in a packaging body, for example, a paper packaging box or a film container according to a conventional method.

[0150] Figs. 18 and 19 illustrate a tissue paper product X1. A tissue paper bundle 10 in which a plurality of stacked sheets of the tissue paper 1 is folded and superimposed is stored in a storage box in which an outlet or an outlet forming portion is formed on an upper surface 20U, and when one sheet of the tissue paper 1 is taken out from the outlet at the time of use, a part of one sheet in a lower layer stacked adjacently is exposed from the outlet.

[Storage box]

[0151] The storage box in which the bundle 10 of the tissue paper 1 is stored is a rectangular hexahedral box body also called a carton box. The storage box has a product appearance, and includes a paper box 20 having an annular perforated line 25 serving as an outlet forming portion on the upper surface 20U, and a resin film 22 covering a portion surrounded by the perforated line 25 from the inside of the paper box.

[0152] The tissue paper 1 stored in the storage box as a bundle is taken out one by one from the outlet through the slit 24. Then, a part of the tissue paper exposed from the outlet is supported by the slit 24, and the tissue paper exposed from the outlet is prevented from falling into the carton box.

[0153] The bundle 10 of the tissue paper 1 is formed by folding and stacking the tissue paper 1. More specifically, as can be understood from Fig. 17, a square sheet of the tissue paper 1 is substantially folded in two, and sheets of the tissue paper 1 are stacked while being alternately superimposed on each other such that an edge of the folded piece is located on a folded inner surface of a vertically adjacent sheet of the tissue paper. Here, "substantially" means that slight folding of an edge portion formed in manufacturing is allowed.

[0154] In the bundle 10 of the tissue paper 1 having the present stacked structure, when a folded piece of one sheet located at the uppermost position is pulled upward, a folded piece of another sheet adjacent immediately below the one sheet is dragged upward by friction and lifted up. Then, the bundle 10 of the tissue paper 1 having such a structure is stored with the uppermost surface thereof facing the upper surface of the storage box having an outlet or the like on the above-described upper surface 20U, and when the first sheet (one sheet located on the uppermost surface) is pulled out from the outlet, particularly the slit 24, a part of another sheet located immediately below the first sheet is exposed. Note that the number of sheets of the tissue paper 1 stacked in the present invention is not limited, but the number of sheets of tissue paper stacked in this type of product is 120 to 240, for example.

[0155] The interfolder that performs folding may be, in addition to the above-described rotary interfolder, a unit that performs folding using a folding plate also referred to as a multi-stand type, a stand type, or a folding plate type, or may be a unit that performs folding using a pair of folding rollers also referred to as a rotary type.

[0156] In the embodiment, a rotary interfolder is desirably adopted. In a case of a tissue paper product having a multiply structure of three or more plies, the number of stacked layers is large, and deviation between the layers is likely to occur. However, in the rotary interfolder, for example, since a tension applied to a continuous sheet is weaker than that of another unit, deviation between the layers is less likely to occur, and a folding quality is likely to be good. Therefore, "fullness" is less likely to deteriorate particularly during processing.

[0157] Furthermore, it is desirable to perform calendering on the stacked sheets. By calendering the stacked sheets, a paper thickness difference between the outer layer and the intermediate layer is easily generated. In particular, when folding is performed by a rotary interfolder, it is desirable to add the moisturizer in the interfolder. Furthermore, when a first calendering step is performed before the moisturizer is added, and a second calendering step is performed after the moisturizer is added, it is easy to obtain tissue paper in which "softness" and "smoothness" are remarkably felt while "fluffy bulkiness" is felt.

[0158] Incidentally, a reason why "arithmetic mean roughness Sa" of a surface measured by one-shot 3D and "compression work amount" and "compression recoverability" are suitable for "tissue off" is roughly considered as follows.

[0159] A small value of the "arithmetic mean height Sa" imparts a smooth surface property.

[0160] A large value of "compression work amount" quickly starts compression and performs compression for a long time, which imparts good softness.

[0161] A small value of "compression recoverability" means that it is difficult to return to an original state once pushed, and therefore improves pressure controllability, which contributes to easy control of a level of force for wiping off lipstick or foundation.

Examples

[0162] Samples of the tissue paper of the embodiment and conventional tissue paper were prepared, and the following sensory tests were performed for items in the columns of the sensory tests as evaluation items. A physical property value, a composition value, and the like of each sample were measured as follows. A physical property value, a composition value, and a test result of each sample are as presented in Tables 1 and 2 for three plies, and as presented in Tables 3 and 4 for four plies.

[Basis weight]

[0163] A basis weight was measured according to JIS P 8124 (1998).

[Paper thickness]

[0164] As described above, a paper thickness was measured according to the above thickness measuring method using a dial thickness gauge (thickness measuring instrument) "PEACOCK G type" (manufactured by Ozaki MFG. Co. Ltd.) under conditions of JIS P 8111 (1998).

[Dry tensile strength]

[0165] Already described.

5 [Wet tensile strength]

[0166] A wet tensile strength was measured according to a tensile test of JIS P 8135 (1998).

[0167] As a test piece, tissue paper cut into a size of about 25 mm (± 0.5 mm) (width) $\times$ about 150 mm (length) in both the longitudinal and lateral directions was used. Multiply tissue paper was measured with multiple plies. As a tester, a load cell tensile tester TG-200N manufactured by Minebea Co., Ltd. was used. A grip interval was set to 100 mm. The measurement was performed by tightening both ends of the test piece which had been cured for 10 minutes with a dryer at 105°C to a grip of the tester, then horizontally adding water to a central portion of the test piece with a width of about 10 mm using a flat brush containing water, immediately thereafter applying a tensile load to the paper piece in an up-down direction, and reading a value (digital value) when the paper broke. A tensile speed was 50 mm/min. Five sets of samples were prepared in each of the longitudinal direction and the lateral direction, and each sample was measured five times. An average of the measured values was defined as a wet tensile strength in each of the directions.

[Softness]

[0168] Softness was measured by a handle-o-meter method according to a JIS L 1096 E method. However, a test piece had a size of 100 mm $\times$ 100 mm, and measurement was performed with a clearance of 5 mm. Measurement was performed five times in each of a longitudinal direction and a lateral direction with one-ply tissue paper, and an average value of all the ten values was represented in unit of cN/100 mm. Softness is one of indicators of softness.

25 [MMD]

[0169] While a contact surface of a friction element is brought into contact with a surface of a measurement sample to which a tension of 20 g/cm is applied in a predetermined direction at a contact pressure of 25 g, the measurement sample is moved by 2 cm in substantially the same direction as the direction in which the tension is applied at a speed of 0.1 cm/s, and a friction coefficient at this time is measured using a friction sense tester KES-SE (manufactured by Kato Tech Co., Ltd.). A value obtained by dividing the friction coefficient by a friction distance (moving distance = 2 cm) is MMD. The friction element is formed by adjoining 20 piano wires P each having a diameter of 0.5 mm, and has a contact surface formed such that the length and the width are both 10 mm. On the contact surface, a unit bulging portion having a tip formed with 20 piano wires P (radius of curvature: 0.25 mm) is formed.

[0170] Note that MMD is measured while a ply-bonding portion and a wrinkled portion are not included in advance.

[0171] On the other hand, the measurement sample is an average value obtained by taking one arbitrary odd number set from three positions of an upper portion, a central portion, and a lower portion of the bundle of the stacked sheets for measurement. From a valley side of the three-layer (three-ply) sheet, the sheet is defined as a first layer (outer layer), a second layer (intermediate layer), and a third layer (outer layer).

[0172] Note 1 in Tables (Determination of chemical solution applied surface): Two test pieces cut into 2 cm square from each sheet were floated in water with a front surface side and a back surface side facing up on a spoon, and after 30 seconds, a side with less moisture on the test piece was defined as an applied surface (described as "CT"), and the other side was defined as a non-applied surface (described as "NCT"). When the applied surface is not clear, it is described as "-".

[0173] Note 2 in Tables is a value obtained by plane roughness measurement measured by one-shot 3D.

[Sensory test]

[0174] Evaluation for a result of Comparative Example 2 was set to "4.0", and a result is indicated by an average value of scores of score 1 to score 7 by 12 evaluators on the basis of the result of Comparative Example 2. The higher the score, the higher the evaluation.

[0175] Comparative Examples 1 to 4 are commercially available products in China. Reference Example is a prototype by the applicant.

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[Table 1]

Item		Unit	Example 1	Comparative Example 1	Comparative Example 2	Comparative Example 3
Basis weight (one sheet)		g/m ²	17.6	17.7	16.2	18.1
Paper thickness (product)		μm	212	236	200	163
Number of plies		-	3	3	3	3
Dry strength (longitudinal)		cN/25 mm	278	343	579	869
Dry strength (lateral)		cN/25 mm	89	170	120	128
Wet strength (lateral)		cN/25 mm	64	87	62	75
Softness (one sheet), Average of values for layers		cN/100 mm	1.02	1.20	0.90	1.10
MMD	First layer valley folded surface and third layer mountain folded surface (-)		6.6	6.9	8.2	6.6
Moisture percentage		%	13.0	13.2	13.5	16.1
Ratio of dry chemical solution content percentage of each layer when dry chemical solution content percentage of product is 100	First layer Outer layer	%	99.4	103.5	104.3	106.2
	Second layer Intermediate layer	%	100.8	90.1	90.9	89.2
	Third layer Outer layer	%	99.8	106.3	104.7	104.6
Dry chemical solution content percentage of product		%	22.0	21.6	23.2	25.3
Chemical solution application ratio (to mass of base paper)		%	28.0	27.5	-	-

[Table 2]

Item	Unit	Example 1	Comparative Example 1	Comparative Example 2	Comparative Example 3
Basis weight (one sheet)	g/m ²	17.8	17.7	16.2	18.1
Paper thickness (product)	μm	211	236	200	163
Number of plies	-	3	3	3	3
Dry strength (longitudinal)	cN/25 mm	329	343	579	869
Dry strength (lateral)	cN/25 mm	113	170	120	128
Wet strength (lateral)	cN/25 mm	74	87	62	75
Softness (one sheet), Average of values for layers	cN/100 mm	1.02	1.20	0.90	1.10

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(continued)

Item	Unit	Example 1	Comparative Example 1	Comparative Example 2	Comparative Example 3
MMD	First layer valley folded surface and third layer mountain folded surface (-)	7.5	6.9	8.2	6.6
Moisture percentage	%	13.0	13.2	13.5	16.1
Ratio of dry chemical solution content percentage of each layer when dry chemical solution content percentage of product is 100	First layer Outer layer	%	99.4	103.5	104.3
	Second layer Intermediate layer	%	100.8	90.1	90.9
	Third layer Outer layer	%	99.8	106.3	104.7
Dry chemical solution content percentage of product	%	22.0	21.6	23.2	25.3
Chemical solution application ratio (to mass of base paper)	%	28.0	27.5	-	-

[Table 3]

Item	Unit	Example 2	Comparative Example 4
Basis weight (one sheet)	g/m ²	16.5	16.2
Paper thickness (product)	μm	271	266
Number of plies	-	4	4
Dry strength (longitudinal)	cN/25 mm	356	380
Dry strength (lateral)	cN/25 mm	114	122
Wet strength (lateral)	cN/25 mm	83	88
Softness (one sheet), Average of values for layers	cN/100 mm	0.99	1.14
MMD	First layer valley folded surface and third layer mountain folded surface (-)	6.9	7.3
Moisture percentage	%	13.6	12.9
Ratio of dry chemical solution content percentage of each layer when dry chemical solution content percentage of product is 100	First layer Outer layer	%	99.8
	Second layer First intermediate layer	%	102.1
	Third layer Second intermediate layer	%	98.0
	Fourth layer Outer layer	%	99.2
Dry chemical solution content percentage of product	%	21.9	21.6
Chemical solution application ratio (to mass of base paper)	%	28.3	27.8

[Table 4]

Determination of applied surface/non- applied surface *Note 1	First layer	Valley folded surface Mountain folded surface	CT NCT	CT NCT	
	Second layer	Valley folded surface Mountain folded surface	NCT CT	- -	
	Third layer	Valley folded surface Mountain folded surface	NCT CT	- -	
	Fourth layer	Valley folded surface Mountain folded surface	NCT CT	NCT CT	
Sa Arithmetic mean height *Note 2	First layer	Valley folded surface mm	0.0064	0.0062	
		Mountain folded surface mm	0.0070	0.0070	
	Second layer	Valley folded surface mm	0.0071	0.0062	
		Mountain folded surface mm	0.0066	0.0065	
	Third layer	Valley folded surface mm	0.0063	0.0062	
		Mountain folded surface mm	0.0066	0.0069	
	Fourth layer	Valley folded surface mm	0.0070	0.0065	
		Mountain folded surface mm	0.0063	0.0060	
Compression characteristic KES-G5 4 plies x 3 sets	Compression work amount		gf/cm/cm ²	2.24	2.10
	Compression recoverability		%	49.8	53.9

25	Sensory evaluation	Softness	1 to 7	5.2	4.9
		Smoothness	1 to 7	5.2	4.5
		Sticky feeling of surface	1 to 7	5.7	4.4
		Thick feeling	1 to 7	5.3	4.8

[0176] According to the above result, it is possible to obtain three-ply or four-ply tissue paper that reduces a sticky feeling of an outer surface while securing necessary softness.

[0177] In the above experimental example, the determination of the chemical solution applied surface is simply performed, but more specifically, it has been found that it is desirable to perform the determination as follows.

(1) A pan containing 500 mL of water, a spoon, and a sample are prepared.

(2) A three-layer or four-layer stacked sheet is cut into 2 cm × 2 cm excluding embossed and wrinkled portions, and one piece thereof is divided into the sheets (three sheets or four sheets).

(3) A valley side surface of each divided sheet is defined as a surface A (test piece A), and a back surface side thereof is defined as a surface B (test piece B). The surface A is marked with a red ballpoint pen.

(4) On a bowl of a chemical agent spoon (about 20 cm in length), for each sheet, the test piece A with the surface A facing upward and the test piece B with the surface B facing upward are placed.

(5) The test piece A and the test piece B are gently floated on a water surface in the pan at the same time.

(6) After 30 seconds, a state of a water film on the test piece and a light reflection state are observed visually (by photograph).

(7) A surface (test piece) of the test piece where reflection of water is clearly large is defined as a chemical solution non-applied surface "NCT", and a surface (test piece) opposite to NCT is defined as a chemical solution applied surface "CT".

(8) When there is no apparent difference as determined by visual observation (photograph), both surfaces are described as "-".

[0178] Test examples are illustrated in Figs. 5 and 6.

[0179] When the case of Fig. 5 for the test piece A is looked at, the surface viewed is the surface A = chemical solution applied surface, and the back surface is wetted, but there are few portions where water is exposed on the upper surface (surface A = chemical solution applied surface).

[0180] It is considered that moisture that has passed through a gap (pore) of the paper from the bottom reaches the upper surface but is less likely to spread to the upper surface because the surface tension of the chemical solution is low.

[0181] On the other hand, when the case of Fig. 6 for the test piece B is looked at, the surface viewed is the surface B = chemical solution not applied surface, the back surface is wetted, and there are many portions where water is exposed on the upper surface (surface B = chemical solution not applied surface). It is considered that since the amount of the chemical solution on the upper surface is relatively small, moisture that has passed through a gap (pore) of the paper from the bottom has a high surface tension and easily spreads to the upper surface.

[0182] As for "chemical solution content", the chemical solution is contained in an amount of 10.0 to 35.0% by mass in each sheet moisture-controlled at 23°C and 50% R.H in the standard state of JIS P 8111.

[0183] For measurement of the content of the chemical solution, each sheet of chemical solution applied multilayer sanitary tissue paper is peeled off, the weight (a) thereof is measured in the standard state of JIS P 8111, a test piece is put in a solvent in which a ratio of ethyl alcohol : acetone is set to 50 : 50 by a Soxhlet extractor, and a chemical solution applied to the chemical solution applied multilayer sanitary tissue paper is eluted while the solvent is lightly boiled for about three hours. The test piece is taken out, dried at 60°C until a comparative amount is reached, and the weight (b) is measured.

Reference Signs List

[0184]

90 Chemical solution application unit
100 Rotor dampening spraying apparatus
1R to 4R Ply
F Applied surface
S1 to S4 Sheet (ply)
W Non-applied surface.

Claims

1. A method for manufacturing tissue paper including a stacked sheet in which three plies or four plies are stacked, each of the plies containing an aqueous moisturizer exhibiting hygroscopicity, and each of the plies having a difference in magnitude of an arithmetic mean height Sa according to ISO 25718 between both surfaces of each of the plies, the method comprising:
 - applying the moisturizer to each of the plies such that the moisturizer is applied to an outer surface of each of the plies located on an outer side of the stacked sheet in a state where the outer surface has a small value of the arithmetic mean height Sa; and
 - folding the stacked sheet in which the moisturizer has been applied to each of the plies.
2. The method for manufacturing tissue paper according to claim 1, wherein a content of the moisturizer in each of the plies is 10.0 to 35.0% by mass.
3. The method for manufacturing tissue paper according to claim 1, wherein the application is performed by a flexographic transfer printing method.
4. A method for manufacturing a tissue paper product storing tissue paper including a stacked sheet in which three plies or four plies are stacked in a storage body,
 - each of the plies containing an aqueous moisturizer exhibiting hygroscopicity, and
 - each of the plies having a difference in magnitude of an arithmetic mean height Sa according to ISO 25718 between both surfaces of each of the plies,
 - the method comprising:
 - applying the moisturizer to each of the plies by a flexographic transfer printing method such that the moisturizer is applied to an outer surface of each of the plies located on an outer side of the stacked sheet in a state where the outer surface has a small value of the arithmetic mean height Sa;
 - folding the stacked sheet in which the moisturizer has been applied to each of the plies; and

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then storing the stacked sheet in the storage body in a folded state.

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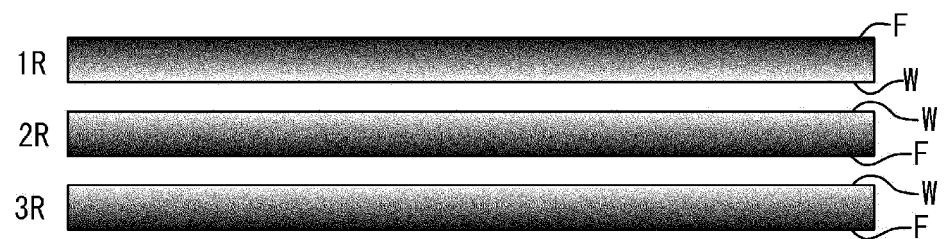
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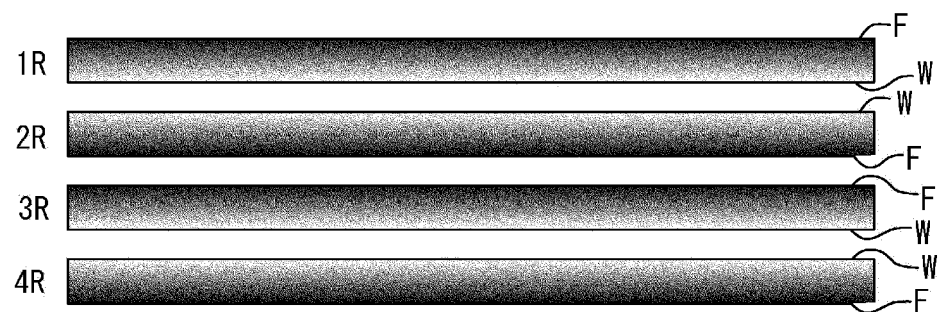
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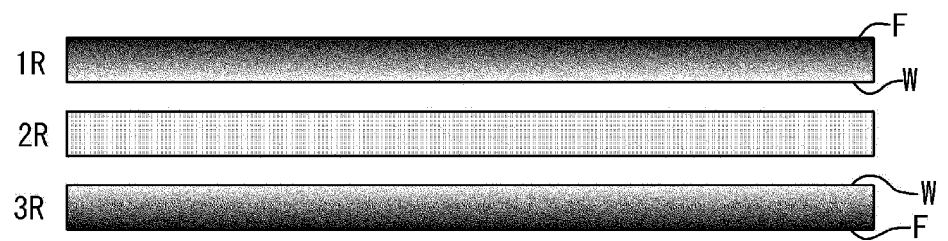
[FIG.1]



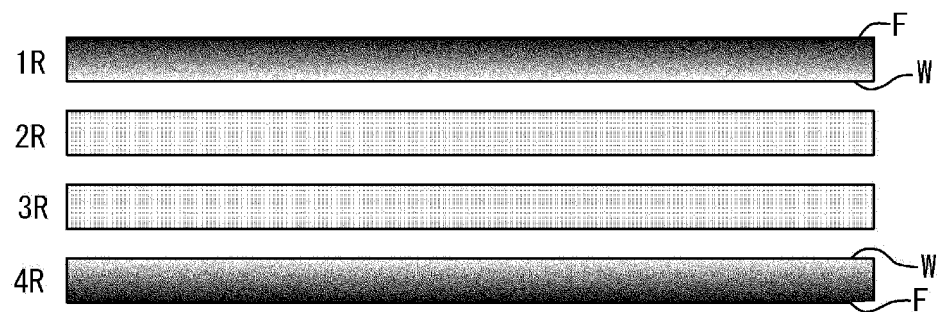
[FIG.2]



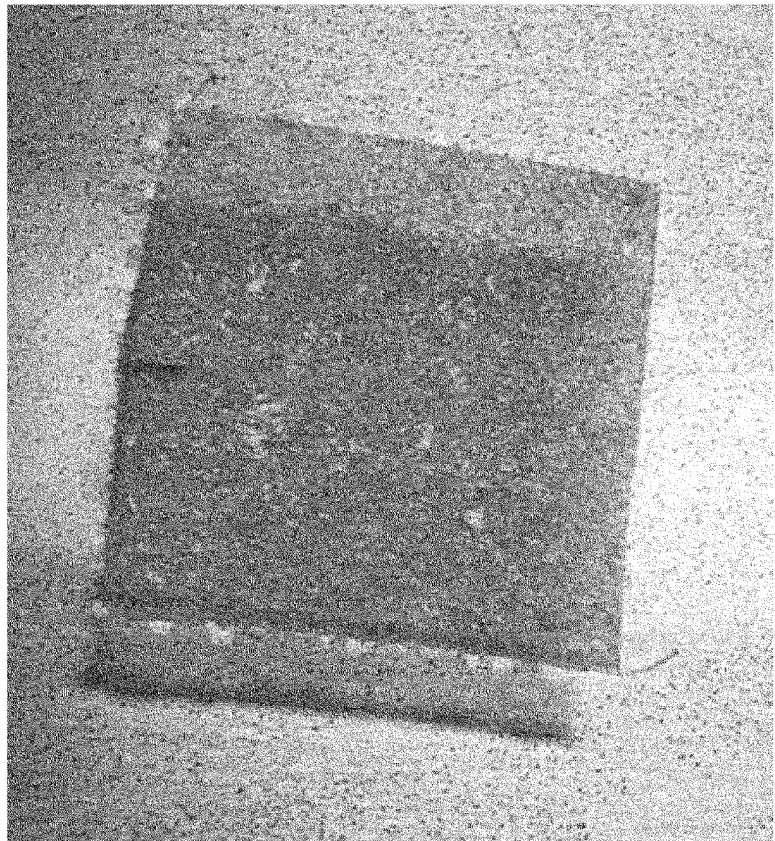
[FIG.3]



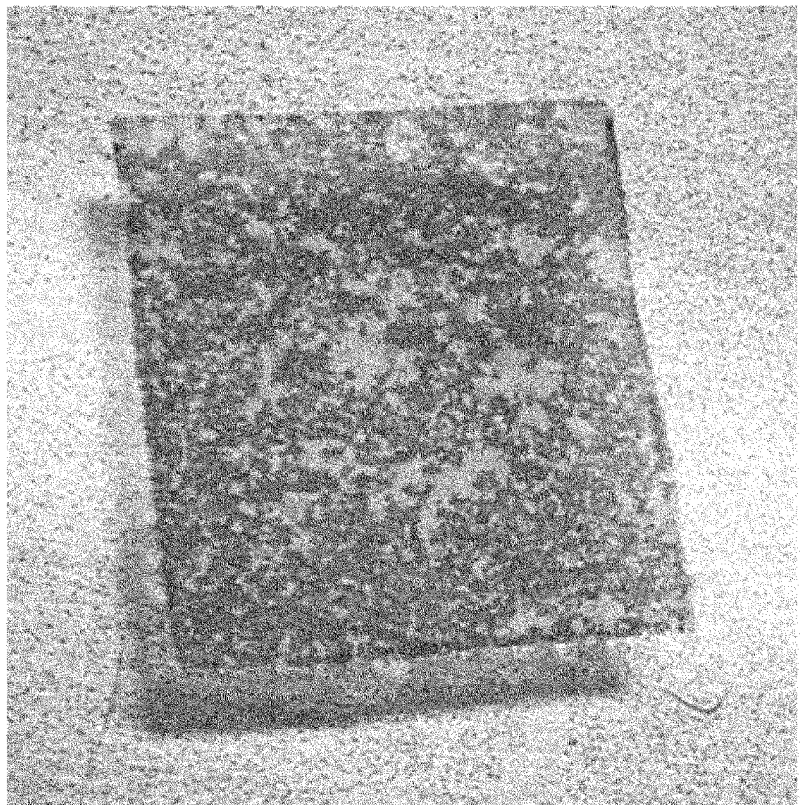
[FIG.4]



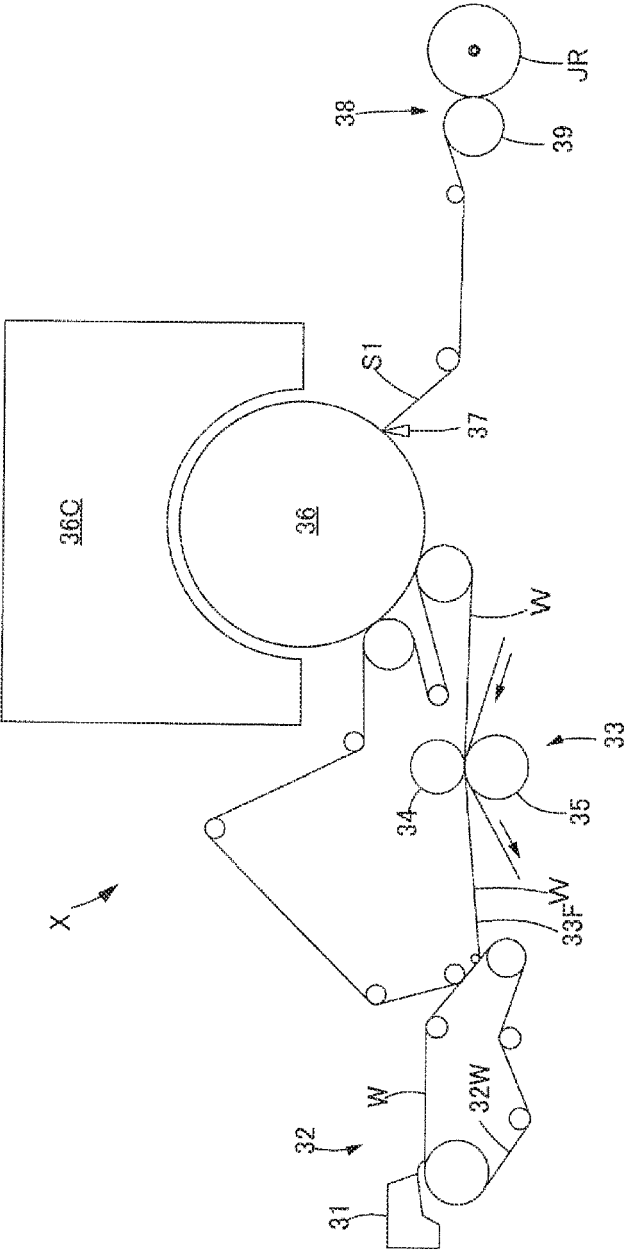
[FIG.5]



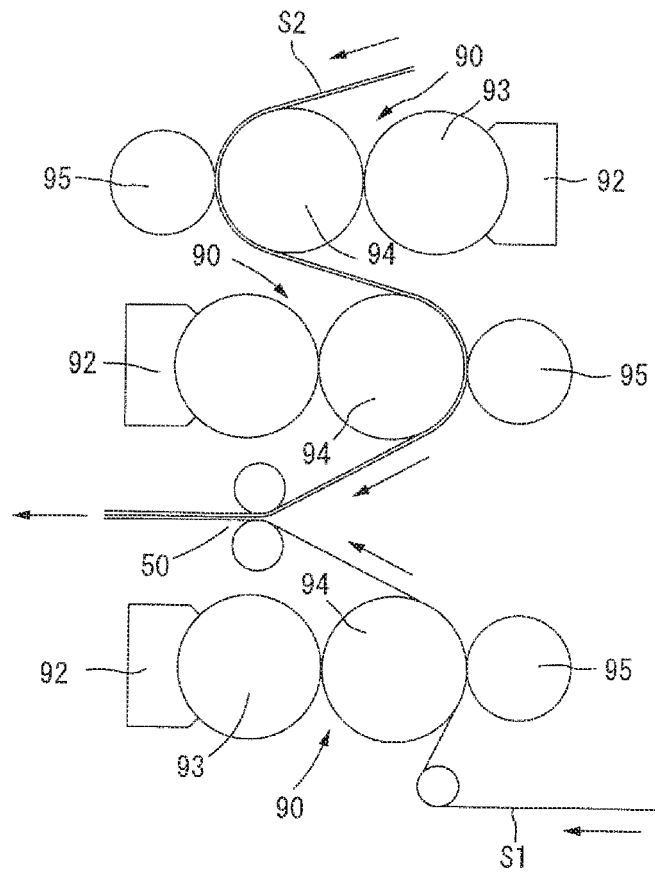
[FIG.6]



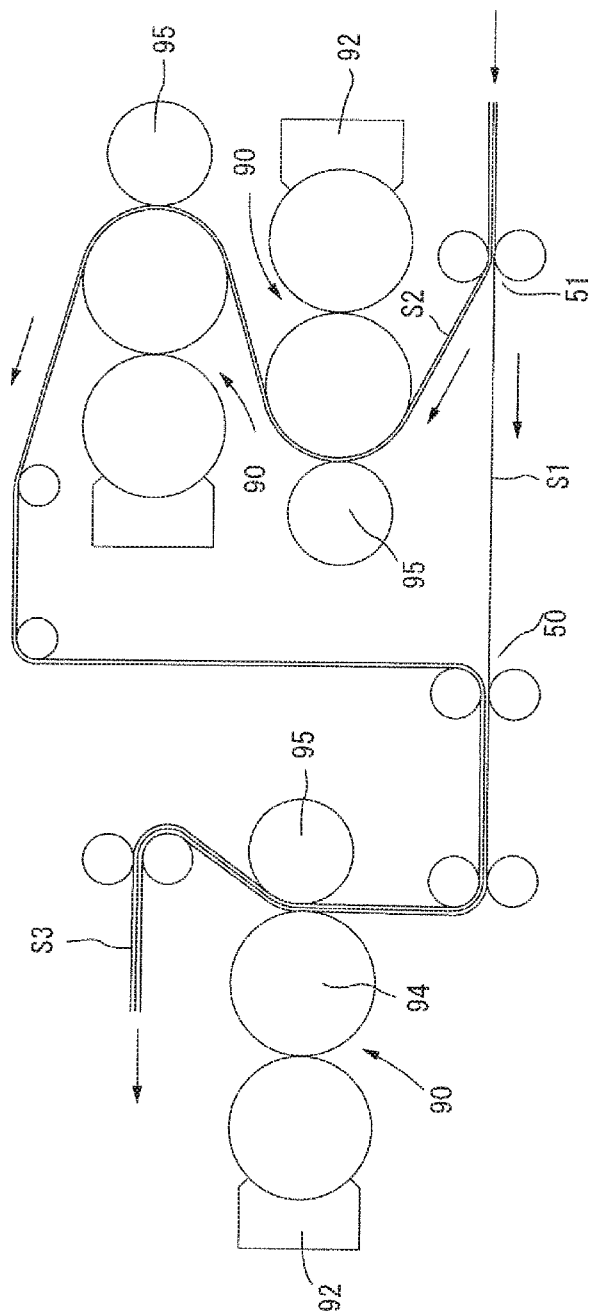
[FIG.7]



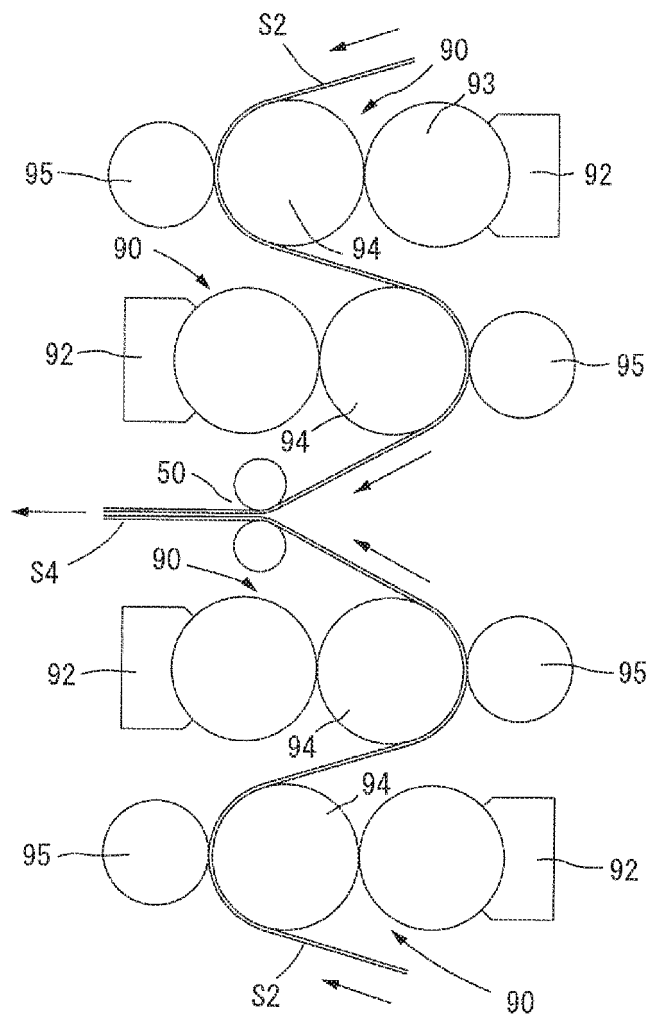
[FIG.8]



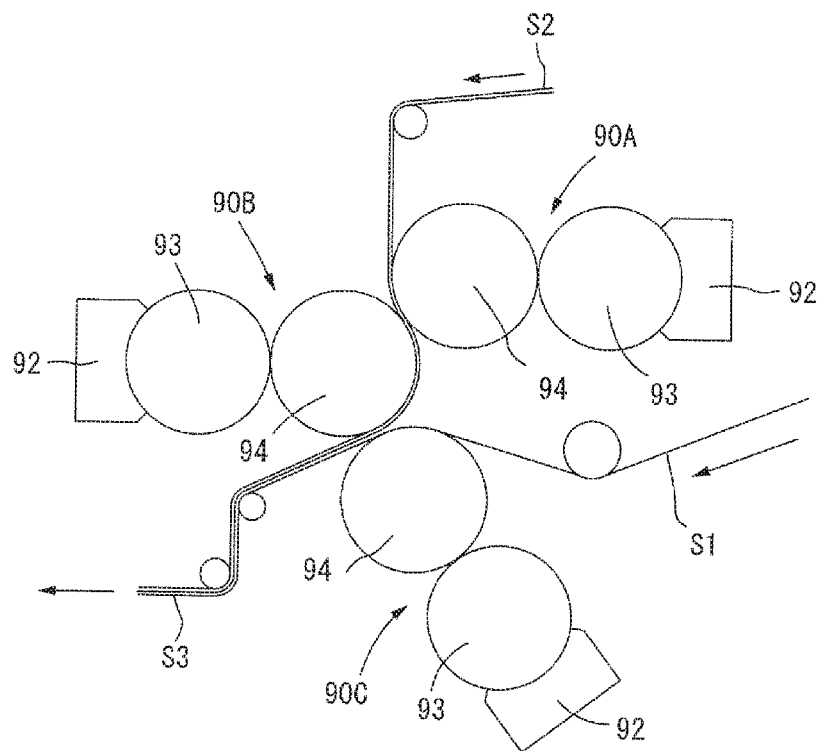
[FIG.9]



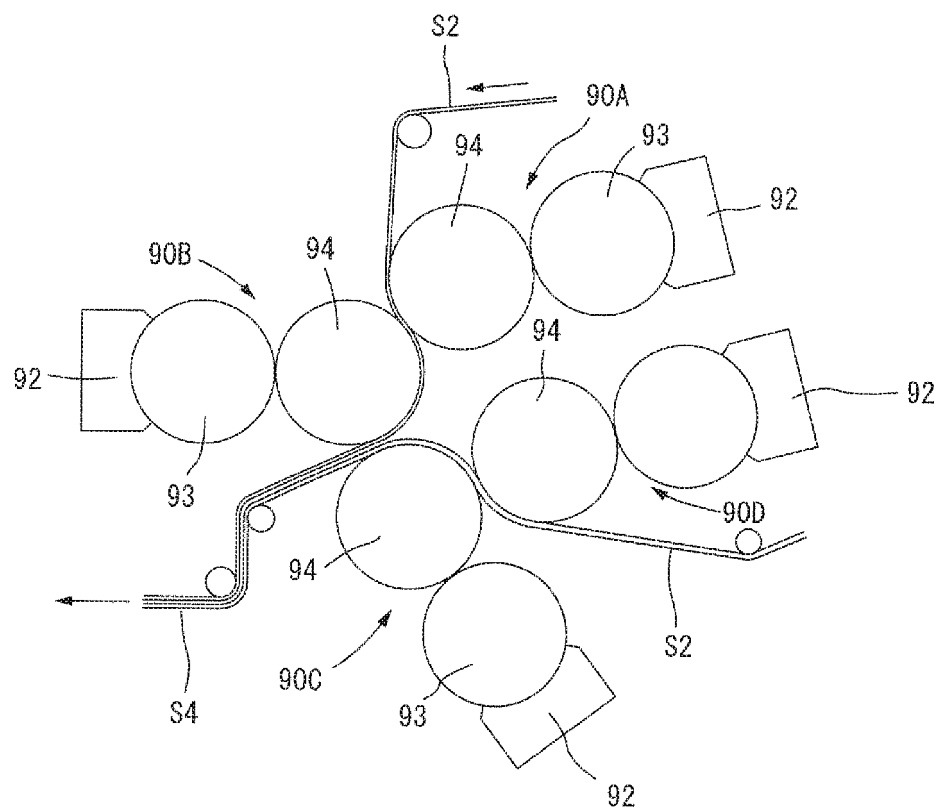
[FIG.10]



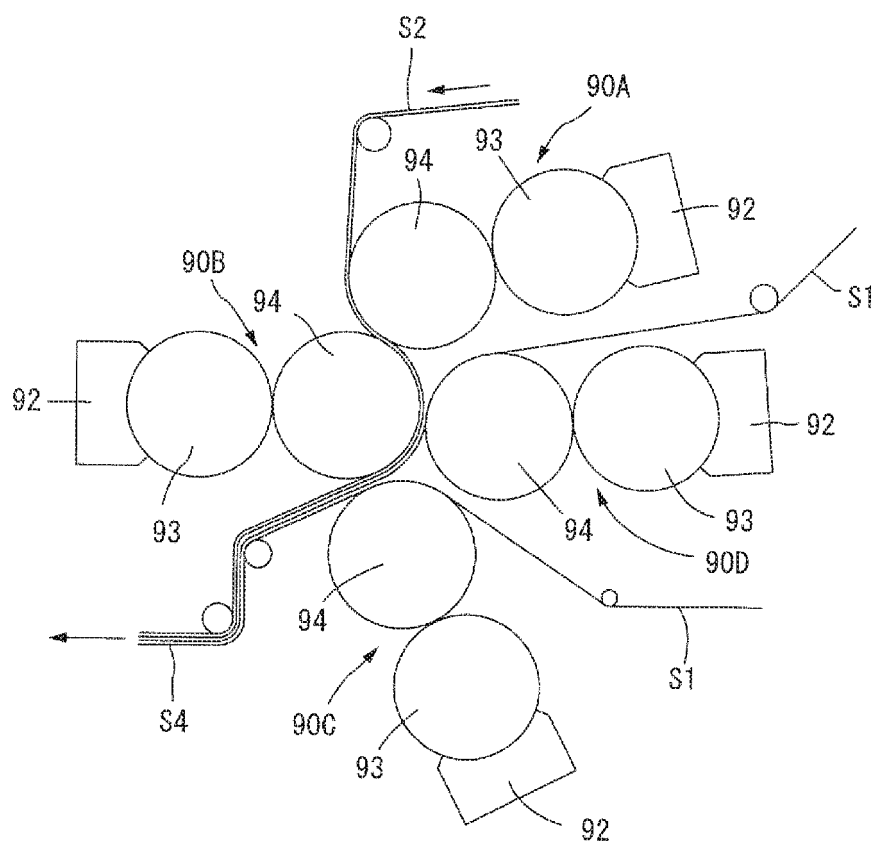
[FIG.11]



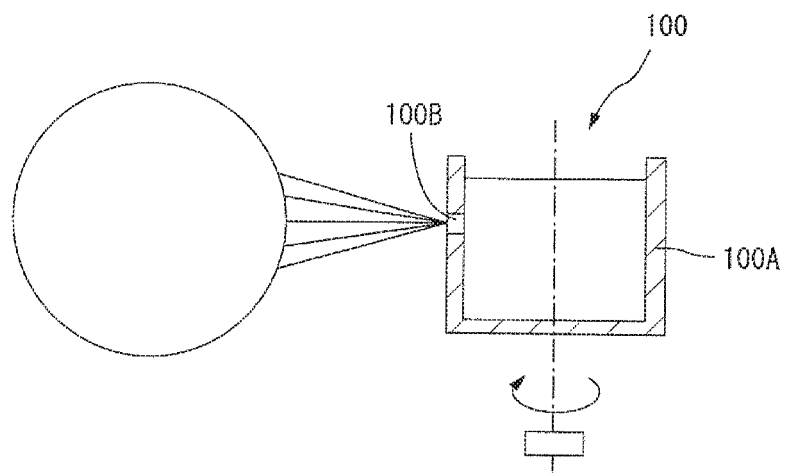
[FIG.12]



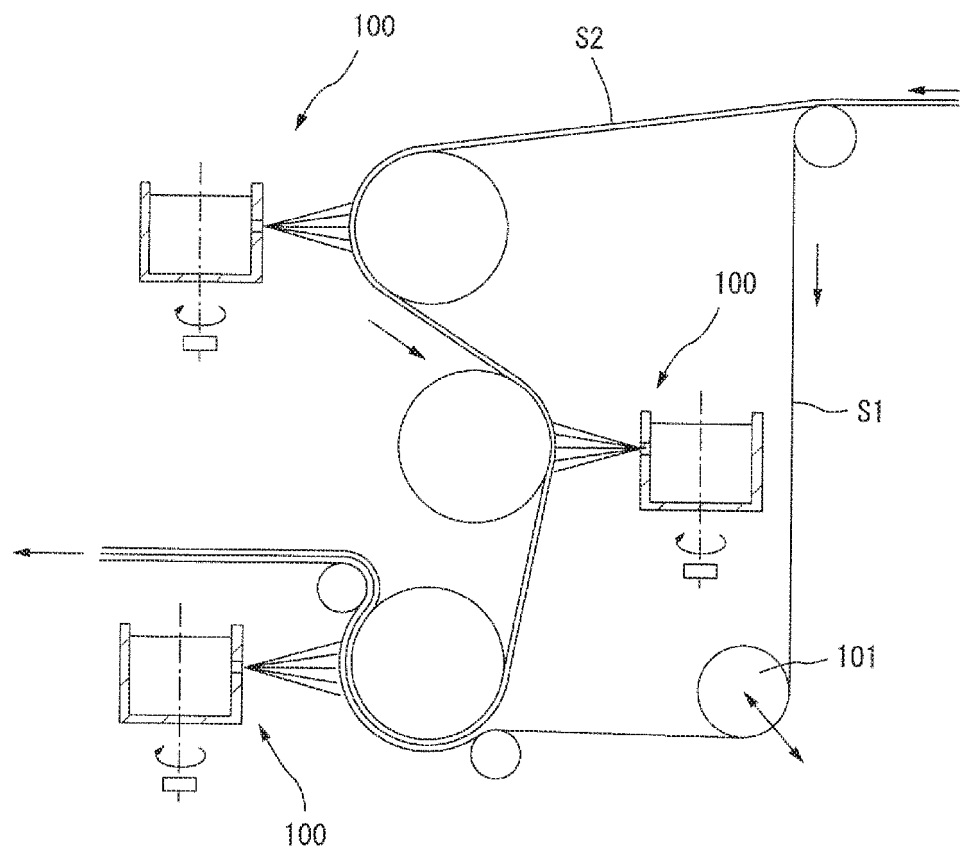
[FIG.13]



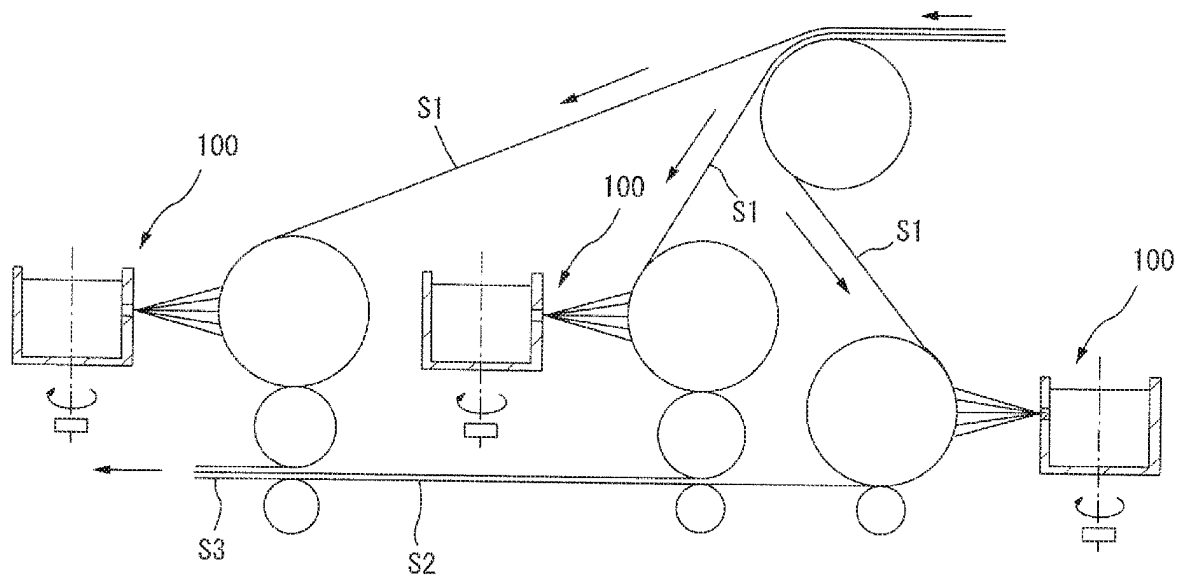
[FIG.14]



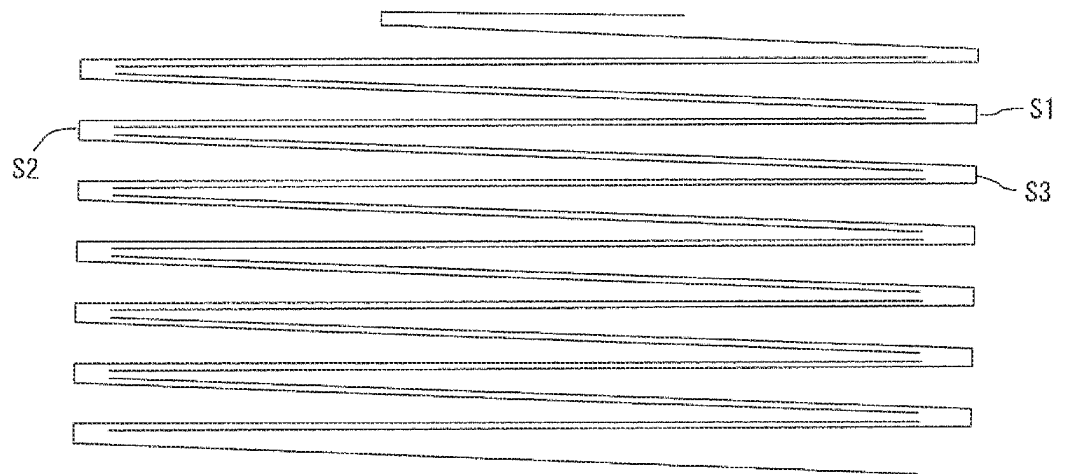
[FIG.15]



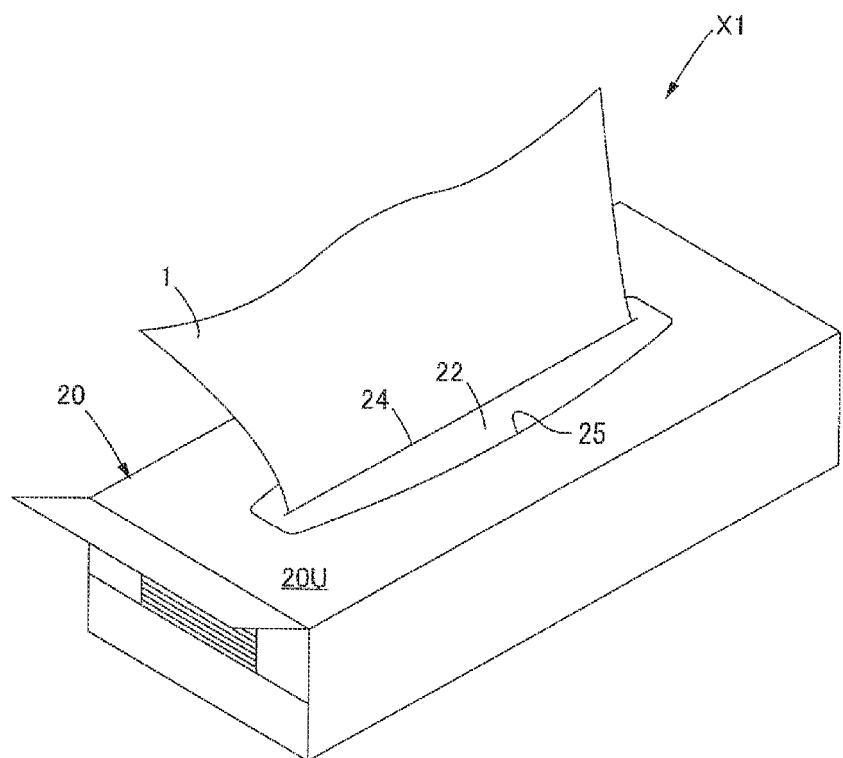
[FIG.16]



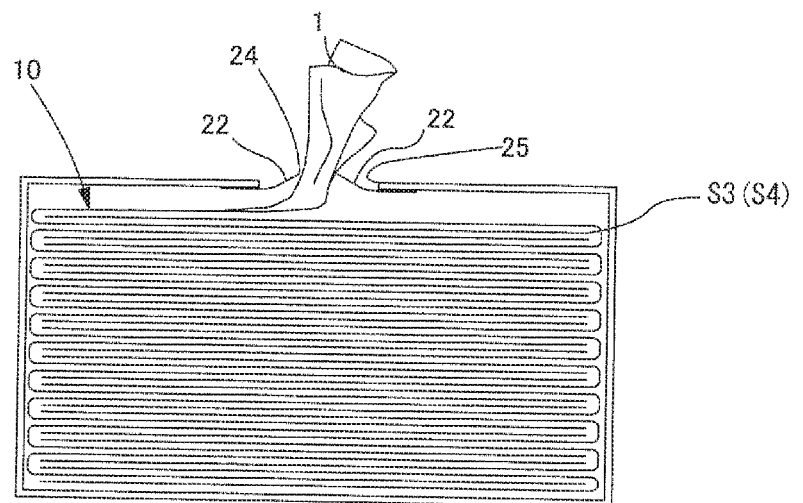
[FIG.17]



[FIG.18]



[FIG.19]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/036648

A. CLASSIFICATION OF SUBJECT MATTER**A47K 10/16**(2006.01)i

FI: A47K10/16 D; A47K10/16 C

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)

A47K10/16, D21H27/00, D21H27/40, A47K7/00, B65D83/08, B65D25/52

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 1971-2021
 Registered utility model specifications of Japan 1996-2021
 Published registered utility model applications of Japan 1994-2021

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.
Y	JP 5496590 B2 (DAIO PAPER CORP.) 21 May 2014 (2014-05-21) paragraphs [0019]-[0028]	1-4
Y	WO 2017/168931 A1 (DAIO PAPER CORP.) 05 October 2017 (2017-10-05) paragraph [0029]	1-4
A	JP 6393997 B2 (OJI HOLDINGS CORP.) 26 September 2018 (2018-09-26) entire text, all drawings	1-4

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Date of the actual completion of the international search

26 October 2021

Date of mailing of the international search report

07 December 2021

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 Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/036648

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	5496590	B2	21 May 2014	(Family: none)	
WO	2017/168931	A1	05 October 2017	JP 2017-176761 A	paragraph [0029]
JP	6393997	B2	26 September 2018	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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