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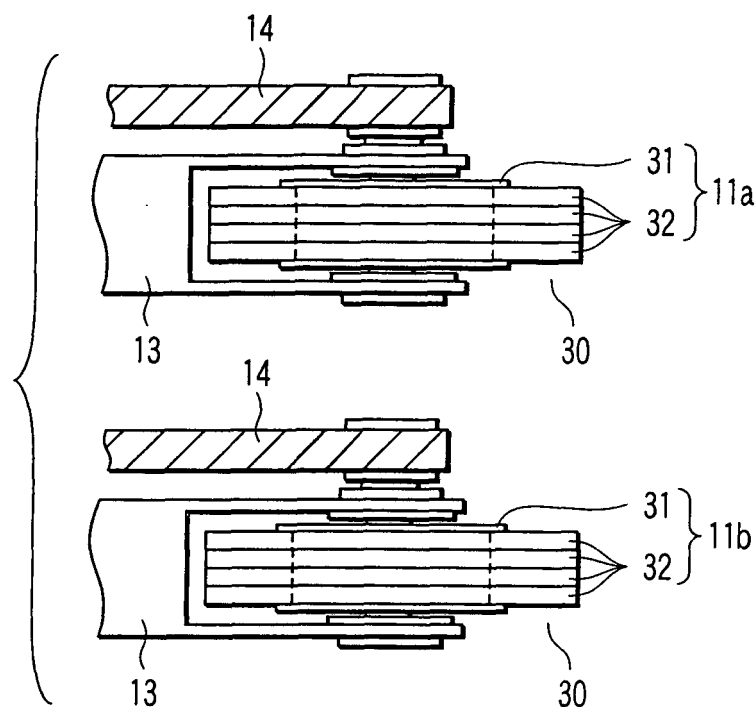
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(54) **Paper sheet take-out apparatus**

(57) A paper take-out apparatus has a plurality of take-out rollers (11a, 11b), which contact mail supplied to the take-out position, and rotate. The take-out rollers have a substantially cylindrical core member (31), and a

substantially cylindrical roller part (30) wound on the outside of the core member. The roller part (30) is formed by closely stacking a plurality of circular rubber rings (32) in the axial direction.



**FIG. 3**

## Description

**[0001]** The present invention relates to a paper sheet take-out apparatus, which takes out paper sheets supplied in a standing state in a horizontal direction.

**[0002]** There is a known conventional paper sheet take-out apparatus, which moves paper sheets set in a standing state in the direction orthogonal to the paper sheet surface by driving a backup plate and a plurality of floor belts, thereby supplying a paper sheet at one end to the take-out position, and takes out the supplied paper sheet in the horizontal direction by making a take-out roller contact with the paper sheet supplied to the take-out position and rotating the take-out roller (e.g., Jpn Pat. Appln. KOKAI Publication No. 2005-145671).

**[0003]** The paper sheet is not necessarily supplied to the take-out position in a state standing upright in the vertical direction. Therefore, in the above apparatus, an auxiliary roller provided at the take-out position detects the inclination of the paper sheet, and the driving of the floor belts is controlled based on the result of the detection, thereby the paper sheet is straightened up in the vertical direction at the take-out position.

**[0004]** The take-out roller is placed at the take-out position with its rotation axis extended vertically so as to come in contact with the surface of the paper sheet straightened up in the vertical direction. The periphery of the roller is also rotated along the vertically extended paper sheet surface. Thus, if the paper supplied to the take-out position is inclined even a little, the periphery of the take-out roller does not sufficiently contact the surface of the paper sheet, and the edge of the take-out roller partially contacts the paper sheet surface. If the paper sheet is taken out in this state, the frictional force of the periphery of the take-out roller to the paper sheet surface is insufficient, the periphery of the take-out roller slips on the paper sheet surface, and the rate of taking out the paper sheets becomes unstable.

**[0005]** It is an object of the invention to provide a paper sheet take-out apparatus, which can apply a sufficient frictional force to a paper sheet supplied to a take-out position, and can stably take out a paper sheet.

**[0006]** In order to achieve the above object, a paper sheet take-out apparatus according to an embodiment of the invention has a supply mechanism which moves paper sheets supplied in a standing state in the direction orthogonal to the paper sheet surface of, and supplies a paper sheet at one end to a take-out position; and at least one take-out roller which contacts the paper sheet supplied to the take-out position in the periphery, rotates about a vertically extended rotation axis to apply a frictional force to the paper sheet, and takes out the paper sheet in the substantially horizontal direction. At least the periphery of the take-out roller is divided into several parts in the direction of the rotation axis.

**[0007]** The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a plane view showing the general construction of a paper sheet take-out apparatus according to an embodiment of the invention;

FIG. 2 is a front view of the take-out apparatus of FIG. 1;

FIG. 3 is a partially enlarged view of a take-out roller incorporated in the take-out apparatus of FIG. 1 according to a first embodiment of the invention;

FIG. 4 is a view depicting the operation of the take-out roller of FIG. 3;

FIG. 5 is a graph depicting the characteristics of the take-out roller of FIG. 3;

FIG. 6 is an external view of a take-out roller according to a second embodiment of the invention;

FIG. 7 is a graph depicting the characteristics of the take-out roller of FIG. 6;

FIG. 8 is a sectional view of a take-out roller according to a third embodiment of the invention; and

FIG. 9 is a graph depicting the characteristics of the take-out roller of FIG. 8.

**[0008]** Hereinafter, embodiments of the present invention will be explained in detail with reference to the accompanying drawings.

**[0009]** FIG. 1 is a top plane view of a paper sheet take-out apparatus 1 (hereinafter called simply a take-out apparatus 1) according to an embodiment of the invention. FIG. 2 is a front view of the take-out apparatus 1. The take-out apparatus 1 is designed to take out one by one a plurality of mail P (paper sheet) set in bulk, and to feed it to a processor in a later stage.

**[0010]** The take-out apparatus 1 has a flat mounting base 2 to mount a plurality of mail P set collectively in a standing state by contacting the lower end side. A backup plate 3 is provided at the right end of the mounting base 2 in the drawing. The backup plate 3 is provided upright substantially vertical to the mounting base 2.

**[0011]** The backup plate 3 urges the mail P in the direction orthogonal to the surface of the mail (in the direction of the arrow T1 in FIG. 1), and supplies all mail P in the direction of the arrow T1. As a result, the mail at the front end of the supplying direction is supplied to a take-out position at the left end of the mounting base 2 in the drawing.

**[0012]** A downstream-side floor belt 4 is provided in proximity to the take-out position. The downstream side floor belt 4 has two endless belts 4a and 4b isolated and aligned parallel to each other in the direction (in the direction of the arrow T2 in FIG. 1) substantially orthogonal to the mail P supplying direction (the direction of the arrow T1). The belts 4a and 4b are wound on and extended over a plurality of pulleys 5, and are partially exposed a little from the mounting base 2 toward the lower end side of the mail P. The downstream-side floor belt 4 having the two belts 4a and 4b is driven by a motor 6, so that the parts of the belts 4a and 4b exposed upward from the mounting base 2 are brought into contact with the lower end side of the mail P, and convey the mail P to

the take-out position.

**[0013]** An upstream-side endless floor belt 7 is provided between the two belts 4a and 4b of the downstream-side floor belt 4. The upstream-side floor belt 7 is wound on and extended over a plurality of pulleys 5, and positioned to have a part exposed a little upward from the mounting base 2. The upstream-side floor belt 7 is driven by a motor 8, so that the exposed part is moved in direction of conveying the mail P toward the take-out position.

**[0014]** The downstream-side floor belt 4 is projected upward from the upstream-side floor belt 7, and the mail P conveyed by the upstream-side floor belt 7 is transferred to and conveyed by the downstream-side belt 4.

**[0015]** While the exposed part of the downstream-side floor belt 4 can convey only several mail close to the take-out position among the mail P mounted on the mounting base 2, the exposed part of the upstream-side floor belt 7 contacts the lower end side of the mail except the several mail close to the take-out position among all mail P mounted on the mounting base 2. Namely, the mail close to the backup plate 3 is conveyed by the upstream-side floor belt 7, transferred to the downstream-side floor belt 4, and supplied to the take-out position.

**[0016]** The backup plate 3 is slidably fixed to a shaft 9 extended along the mail P conveying direction, and the lower end part is connected to the upstream-side floor belt 7. When the upstream-side floor belt 7 is moved, the backup plate 3 is moved in the mail P supplying direction along the shaft 9. Namely, the backup plate 3 is driven by the motor 8, and moved to the take-out position at the same speed as the upstream-side floor belt 7.

**[0017]** The above-mentioned backup plate 3, downstream-side floor belt 4, upstream-side floor belt 7, and motors 6 and 8 driving them serve as a supplying mechanism of the invention.

**[0018]** First and second pickup rollers 11 and 12 are provided at the position of taking out the mail P. The first pickup roller 11 has a lower take-out roller 11a which rotates and contacts the area close to the lower end side of the mail P supplied to the take-out position, and an upper take-out roller 11b which is provided separately and independently above the lower take-out roller 11a, and rotates and contacts the area close to the upper end of the mail P.

**[0019]** The rollers 11a and 11b function as a take-out roller of the invention, and is placed in a position that the rotation axis is extended in the vertical direction, so that the periphery is rotated by contacting the surface of the mail P. By rotating the take-out rollers 11a and 11b in the predetermined direction (in the direction of the arrow in FIG. 1), the mail P supplied to the take-out position is taken out in the direction orthogonal to the supplying direction and substantially horizontal along the mail surface (in the direction of the arrow T2 in FIG. 1) (hereinafter, this direction is called a take-out direction), that is, in the upper direction in FIG. 1.

**[0020]** The rotation axle of the upper take-out roller 11b is rotatably fixed to the distal end of the swinging of

a swing arm 13. The proximal end of the swing arm 13 is provided rotatably about the rotation axle fixed to a not-shown frame of the take-out apparatus 1, and is energized by a not-shown spring in the clockwise direction in FIG. 1. Namely, the swing arm 13 functions to press the upper take-out roller 11b fixed to its distal end, to the mail P supplied to the take-out position, by a constant pressure.

**[0021]** The upper take-out roller 11b is connected to a motor 15 through a plurality of pulleys and a timing belt 14. Namely, when the motor 15 is rotated in a predetermined direction, the upper take-out roller 11b is rotated in the direction of taking out the mail P.

**[0022]** Like the upstream-side take-out roller 11b, the downstream-side take-out roller 11a is rotatably fixed to the distal end of the oscillation arm 13, and positioned to be pressed to the surface of the mail P by a predetermined pressure. The downstream-side take-out roller 11a is also rotated by the motor 15 in the direction of taking out the mail P. Namely, the downstream-side take-out roller 11a is provided movably and independently of the upstream-side take-out roller 11b.

**[0023]** At the position isolated in the upstream side of the first pickup roller 11 along the direction of taking out the mail P supplied to the take-out position, a second pickup roller 12 having the same structure as the first pickup roller 11 is provided. The second pickup roller 12 has a lower take-out roller 12a which rotates and contacts the area close to the lower end side of the mail P supplied to the take-out position, and an upper take-out roller 11b which is provided separately and independently above the lower take-out roller 12a, and rotates and contacts the area close to the upper end of the mail P. The rollers 12a and 12b function as a take-out roller of the invention, and are placed in a position that the rotation axes are extended in the vertical direction, so as to rotate and contact the surface of the mail P by its periphery.

**[0024]** A support roller 16 to support the mail P is provided in the area close to the rear end of the direction of taking out the mail P to be taken out from the take-out position. The support roller 16 is rotatably fixed to the distal end of the oscillation of the arm 17. The part close to the proximal end of the arm 17 is rotatably fixed to a not-shown frame of the take-out apparatus, and the arm 17 is energized by a spring 18 in the counterclockwise direction in FIG. 1. Namely, the support roller 16 is energized by a spring 18 in the direction of pressing the mail P, and functions to straighten up the mail P supplied to the take-out position.

**[0025]** Further, in the downstream side of the direction of taking out the mail P supplied to the take-out position, a feed roller 21 and a reverse roller 22 are provided. The feed roller 21 is provided at the position to rotate and contact the surface of the mail P, which the pickup roller 11 rotates and contacts the mail P supplied to the take-out position, and feeds the mail P in the take-out direction by rotating together with the reverse roller 22 by holding the mail P therebetween. The reverse roller 22 applies a

load onto the mail P in the reverse direction to the take-out direction (in the direction of the arrow in the drawing), and functions to separate the 2<sup>nd</sup> and following mail taken out together with the mail P fed by the feed roller 21.

**[0026]** In the operation of taking out the mail P in the take-out apparatus 1 configured as described above, when a plurality of mail P set upright on the mounting base 2 is moved to the take-out position by the backup plate 3 and floor belts 4 and 7, the mail at the front end of the supplying direction is pressed to the take-out rollers 11a, 11b, 12a and 12b of the two pairs of pickup rollers 11 and 12. At this time, the mail at the front end of the supplying direction is rarely supplied in an upright state to the vertical surface parallel to the rotation axes of the take-out roller 11a, 11b, 12a and 12b, and is highly likely to be supplied to the take-out position in at least a slightly inclined state. Namely, the mail P supplied to the take-out position contacts the periphery of the take-out rollers 11a, 11b, 12a and 12b in a slightly inclined state.

**[0027]** Therefore, if the take-out rollers 11a, 11b, 12a and 12b are made of cylindrical solid rubber, the periphery of each roller does not sufficiently contact the surface of the mail P at the take-out position, only the edge portion partially contacts the mail surface, and a sufficient frictional force is not applied to the mail P. This causes slippage between the mail P and the rollers 11a, 11b, 12a and 12b, and the interval of taking out the mail P becomes uneven, and the take-out speed is decreased.

**[0028]** To solve the above problem, this invention utilizes a different structure of the take-out rollers 11a, 11b, 12a and 12b.

**[0029]** Hereinafter, the first pickup roller 11 will be explained with reference to FIG. 3. The second pickup roller 12 has the same structure, and a detailed explanation of the second pickup roller will be omitted. The pickup roller 11 has a lower take-out roller 11a and an upper take-out roller 11b. These take-out rollers 11a and 11b are the same in structure, and only one of the rollers will be explained. The other roller is given the same reference numeral, and detailed explanation will be omitted.

**[0030]** The upper take-out roller 11b according to a first embodiment of the invention (hereinafter simply called a take-out roller 11b) is constructed by bonding a substantially cylindrical roller part 30 formed by closely stacking a plurality of circular rubber ring 32 in the axial direction, to the periphery of a substantially cylindrical core member 31 fixed to a rotation axle. In this embodiment, the roller part 30 having a width of 15 mm in the axial direction is constructed by closely stacking four equally-sized rubber rings 32, 3.75 mm in thickness in the axial direction, 60 mm in outer diameter, and 7 mm in thickness in the radial direction, in the axial direction. In this embodiment, each rubber ring 32 is made of the same rubber material, SUMITOMO RUBBER EM601 (EPDM) with a hardness of A60/S.

**[0031]** The thickness of the rubber ring 32 in the axial direction is designed to be 3.75 mm in this embodiment, as described above, but is desirably 2 mm - 4 mm. If the

thickness of the rubber ring 32 is set to 2 mm or less, for example, a sufficient mechanical strength will not be obtained when the rubber is elastically deformed, and the ring may be damaged by the bending. If the thickness of the rubber ring 32 is set to 4 mm or more, a satisfactory elastic deformation will not be obtained, and the effect of the invention describe later will not be obtained.

**[0032]** Namely, it is important for the roller part 30 of the take-out roller 11b in this embodiment to design the thickness of one rubber ring 32 in the axial direction to be 2 mm - 4 mm, and the number of rubber rings can be optionally changed depending on the thickness in the axial direction required as a roller part 30. The outside diameter of the roller part 30 can also be changed according to the operating conditions. Further, by adjusting the thickness of each rubber ring 32 in the radial direction, the coefficient of elasticity of the roller part 30 can be adjusted, and the characteristics of the take-out roller 11b can be changed according to the kind of mail P to be processed.

**[0033]** Next, an explanation will be give on the function and effects of the take-out roller 11b with reference to FIG. 4. The other take-out rollers 11a, 12a and 12b have the same function, and a detailed explanation on the function and effects of these rollers will be omitted.

**[0034]** When the mail P supplied to the take-out position is supplied in the state inclined to the vertical surface as described above, the roller part 30 of the take-out roller 11b is elastically deformed to the state shown in the drawing, for example, following the position of the mail P. Particularly, in FIG. 4, the upper end side of the mail P supplied to the take-out position and isolated from the mounting base 2 is inclined to the take-out roller 11b. Here, the take-out roller 11a is omitted, and the size of the mail P is shown smaller than the actual size.

**[0035]** Namely, when the mail P is inclined from the state indicated by a broken line to the state indicated by a solid line in FIG. 4, the area close to the periphery remote from the core member 31 of each rubber ring 32 constituting the roller 30 is bent downward, and the edge of each rubber ring 32 is elastically deformed to come into contact with the surface of the mail P. Namely, the edge of each rubber ring 32 is pressed and touched to the surface of the mail P, providing an edge effect at several points on the surface of the mail P.

**[0036]** Therefore, compared with the conventional case, in which the roller part 30 is not divided into several rubber rings, a frictional force can be applied to the inclined mail P at several points, and a relatively large frictional force can be applied to the inclined mail P. Namely, by adopting the take-out roller 11b of this embodiment, slippage can be prevented between the periphery of the roller part 30 and the surface of the inclined mail P, the mail P can be stably taken out, and the take-out speed can be increased.

**[0037]** To prove the effect of the take-out roller 11b of the first embodiment, we supplied the mail P by changing the inclination angle to the periphery of the take-out roller

11b, and examined the coefficient of dynamic friction between the mail P and the take-out roller 11b at each inclination angle. FIG. 5 shows the results compared with the conventional take-out roller whose roller part is not divided. At this time, bond paper used for an envelope is used as the mail P.

**[0038]** As shown in FIG. 5, when the inclination angle of the mail P to the take-out roller is 0°, the conventional take-out roller not divided in the roller part provides a coefficient of dynamic friction to the mail P higher than the take-out roller 11b of this embodiment. This is considered to be caused by the fact that the surface of the mail P sufficiently contacts the periphery of the take-out roller. However, the surface of the mail P rarely contacts a sufficient peripheral area of the take-out roller.

**[0039]** Contrarily, when the inclination angle of the mail P to the take-out roller is over 1°, the coefficient of dynamic friction of the take-out roller 11b of this embodiment is higher than the conventional take-out roller. In addition, when the take-out roller 11b of this embodiment is used, the coefficient of dynamic friction is gradually increased in a range of inclination angle 0° - 6°. This is caused by the edge effect that acts on several points on the mail P, as explained in FIG. 4.

**[0040]** Namely, by using the take-out roller 11b of this embodiment, after the angle of the mail P supplied to the take-out position exceeds 1°, in most cases the frictional force applied to the mail P can be increased; therefore, sufficient frictional force can be applied to the mail P. Therefore, slippage between the roller and mail P, an uneven take-out pitch, and a drop in the take-out speed can be prevented.

**[0041]** Further, we conducted a continuous mail take-out test in the take-out apparatus described here provided with the take-out roller 11b (11a, 12a, 12b), by using paper sheets including a post card of 140 mm x 90 mm, a C-5 size envelop (229 mm x 162 mm) and an elongate envelop of 220 mm x 110 mm, and by varying the weight between 2g - 50g by changing the amount of contents, and by adjusting the quantity ratio of paper sheets to 25g on average. We set the mail take-out speed to 3.6m/s, the take-out interval to a constant gap of 110 mm (38.2K pass/h). As a result, we could stably take out the mail P at an average take-out gap of 113.2 mm and with an accuracy of standard deviation of 16 mm.

**[0042]** As described above, according to this embodiment, by forming the roller part 30 of each take-out roller 11a, 11b, 12a and 12b by stacking a plurality of rubber rings 32, a sufficient frictional force can be applied to the mail P supplied to the take-out position in the inclined state, slippage between the take-out roller and mail P can be prevented, the mail take-out gap can be stabilized, and the problem of decreased take-out speed caused by an insufficient frictional force can be prevented.

**[0043]** Next, an explanation will be given on a take-out roller 40 according to a second embodiment of the invention with reference to FIG. 6. The take-out roller 40 is incorporated into the take-out apparatus 1, instead of the

take-out rollers 11a, 11b, 12a and 12b described hereinbefore. The take-out roller 40 has the same structure and substantially the same function as the take-out rollers 11a, 11b, 12a and 12b, except for the structure of the roller part. Therefore, the components having the same functions are given the same reference numerals, and a detailed explanation will be omitted.

**[0044]** As shown in FIG. 6, the take-out roller 40 is provided with a roller part 41 formed by stacking rubber rings 42 and 44 around the outer periphery of the core member 31. One rubber ring 42 is made of relatively hard rubber, functions as a second rubber ring of the invention, and is 3 mm in the thickness in the axial direction. Except for the thickness in the axial direction, the ring 42 is made of the rubber material, and formed to have the same outside diameter and thickness in the radial direction, as those of the rubber ring 32 of the take-out roller 11b of the first embodiment. The other rubber ring 44 is made of rubber material with a hardness of A60/S, is softer than the rubber ring 42, functions as a first rubber ring of the invention, and has the same thickness in the axial direction (3 mm), same outside diameter (60 mm), and same thickness in the radial direction (7 mm), as those of the rubber ring 42.

**[0045]** The roller part 41 of the take-out roller 40 is formed by alternately stacking the same-size rubber rings 42 and 44 in the axial direction. More concretely, as shown in FIG. 6, the roller part 41 is formed by alternately stacking three rubber rings 42 and two rubber rings 44, so that a relatively hard rubber ring 42 is placed at both ends of the axial direction of the roller part 41. By stacking total five rubber rings 42 and 44 having the same thickness of 3 mm in the axial direction, the roller part 41 having the thickness of 15 mm in the axial direction is constructed. By arranging the relatively hard rubber ring 42 at both ends in the axial direction, the edge of the roller part 41, which is easily worn, is increased in the wear resistance, and the useful life of the take-out roller 40 can be extended.

**[0046]** When the mail P contacts the rotation axle of the take-out roller 40 in the inclined state, as in the first embodiment, the rubber rings 42 and 44 are elastically deformed, and pressed to contact the surface of the mail P at several points. Therefore, by using the take-out roller 40 of this embodiment, the edge effect can also be obtained at several points on the surface of the mail P, and the same effect as the first embodiment can be obtained.

**[0047]** In particular, according to the take-out roller 40 of this embodiment, as the thickness of one rubber ring in the axial direction is made thin, and the rubber ring 44 is made of rubber material softer than the rubber ring 32 of the first embodiment, the take-out roller is elastically deformed more easily than the take-out roller 11b of the first embodiment. Further, as the roller part 41 is formed by alternately stacking the rubber rings 42 and 44 with different hardness in the axial direction, and the contact pressure acting on the mail P can be made discontinuous in the axial direction. Therefore, the roller part 41 can

contact more areas on the surface of the mail P by decreasing the contact pressure a little at each contact area, and the contact pressure can be evenly distributed.

**[0048]** Further, to prove the effect of the take-out roller 40, we examined the relation between the mail P inclination angle and the coefficient of dynamic friction under the same conditions as in the first embodiment, and obtained the results as shown in FIG. 7. FIG. 7 shows the characteristics of the take-out roller 11b of the first embodiment together with the characteristics of a conventional take-out roller not divided in the roller part, for purposes of comparison.

**[0049]** As seen from the drawing, the coefficient of dynamic friction of the take-out roller 40 of this embodiment is slightly lower than the take-out roller 11b of the first embodiment when the inclination angle of the mail P to the periphery of the roller is in a range of  $0^\circ - 1.5^\circ$ , but the coefficient of dynamic friction is increased above that of the take-out roller 11b of the first embodiment when the inclination angle is increased. Namely, the take-out roller 40 of this embodiment has a characteristic such that a frictional force larger than that of the take-out roller 11b of the first embodiment is applied to the mail P under the condition that the inclination angle of the mail P is relatively large (over  $1.5^\circ$ ). As in the first embodiment, we conducted a continuous mail take-out test in the take-out apparatus 1 provided with the roller 40 under the same conditions as in the first embodiment. As a result, the mail P could be stably taken out at an average take-out gap of 114.3 mm and with an accuracy of standard deviation of 13 mm.

**[0050]** As described above, according to this embodiment, the same effects as the first embodiment can be obtained, a sufficient frictional force can be applied to the mail P supplied to the take-out position in the inclined state, and the mail P can be stably taken out.

**[0051]** Next, an explanation will be given on a take-out roller 50 according to a third embodiment of the invention with reference to FIG. 8. The take-out roller 50 has the same structure and substantially the same function as the take-out rollers 11a, 11b, 12a and 12b, except for the structure of the roller part. Therefore, the components having the same functions are given the same reference numerals, and a detailed explanation will be omitted.

**[0052]** As shown in FIG. 8, the take-out roller 50 is provided with a substantially cylindrical roller part 51 wound on the periphery of the core member 31. The roller part 51 is formed cylindrical, made of the same rubber material as the take-out roller 11b of the first embodiment, and sized to 15 mm in thickness in the axial direction, 7 mm in thickness in the radial direction, and 60 mm in outside diameter. The roller part 51 has four circular slits 52 (cuts) dividing the periphery with equal intervals (3 mm). The depth of each slit in the radial direction is set to half the thickness of the roller part 51, 3.5 mm, not reaching the core member 31.

**[0053]** When the mail P is pressed to contact the periphery of the take-out roller 50 in the state inclined to the

rotation axis of the roller, as in the second embodiment, the areas divided by the slits 52 are elastically deformed to come in contact with the surface of the mail P. Therefore, by using the take-out roller 50 of this embodiment, the edge effect can be obtained at several points on the surface of the mail P, and the same effects as the first embodiment can be obtained.

**[0054]** Particularly, according to the take-out roller 50 of this embodiment, by adjusting the number and depth of the slits 52 dividing the periphery of the roller part 51, the effects and characteristics of the take-out roller 50 on the mail P can be optionally changed according to the kind of the mail P to be processed.

**[0055]** Further, to prove the effect of the take-out roller 50, we examined the relation between the mail P inclination angle and the coefficient of dynamic friction under the same conditions as in the first embodiment, and obtained the results as shown in FIG. 9. FIG. 9 shows the characteristics of the take-out roller 11b of the first embodiment together with the characteristics of the conventional take-out roller not divided in the roller part, for purposes of comparison.

**[0056]** As seen from the figure, when using the take-out roller 50 of this embodiment, the coefficient of dynamic friction is slightly higher than the take-out roller 11b of the first embodiment when the inclination angle of the mail P to the periphery of the roller is in a range of  $0^\circ - 1.3^\circ$ , but the coefficient of dynamic friction is slightly lower than the take-out roller 11b of the first embodiment when the inclination angle is increased. However, the take-out roller 50 of this embodiment has the characteristic in which a frictional force larger than that of the take-out roller 11b of the first embodiment is applied to the mail P under the condition that the inclination angle of the mail P is over  $1.3^\circ$ .

**[0057]** As in the first embodiment, we conducted a continuous mail take-out test in the take-out apparatus 1 provided with the roller 50 under the same conditions as in the first embodiment. As a result, the mail P could be stably taken out at an average take-out gap of 113.2 mm and with an accuracy of standard deviation of 18 mm.

**[0058]** As described above, according to this embodiment, the same effects as the first embodiment can be obtained, a sufficient frictional force can be applied to the mail P supplied to the take-out position in the inclined state, and the mail P can be stably taken out. Further, by adjusting the number and depth of the slits dividing the periphery of the roller part 51, the characteristics of the take-out roller 50 can be changed relatively easily, and the characteristics can be optionally changed according to the specifications of the apparatus and the kind of the mail P to be processed. Further, the take-out roller 50 of this embodiment is formed by machining the shape of the roller part 51, and the number of parts can be decreased compared with the first and second embodiments.

**[0059]** For example, in the embodiments described above, the take-out apparatus 1 having two pairs of pick-

up rollers 11 and 12 along the direction of taking out the mail P supplied to the take-out position, is explained. The number of pickup rollers and take-out rollers is not limited, and may be optionally changed.

## Claims

### 1. A paper sheet take-out apparatus comprising:

a supply mechanism (3, 4, 6, 7, 8) which moves paper sheets (P) supplied in a standing state in a direction orthogonal to the paper sheet surface, and supplies a paper sheet at one end to a take-out position; and

at least one take-out roller (11a, 11b, 12a, 12b, 40, 50) which contacts the paper sheet supplied to the take-out position in the periphery, rotates about a vertically extended rotation axis to apply a frictional force to the paper sheet, and takes out the paper sheet in a substantially horizontal direction;

**characterized in that** at least the periphery of the take-out roller is divided into several parts in the direction of the rotation axis.

2. The paper sheet take-out apparatus according to claim 1, **characterized in that** the take-out roller (11a, 11b, 12a, 12b, 40, 50) has a substantially cylindrical core member (31), and a substantially cylindrical roller part (30, 41, 51) wound on the outside of the core member and made of a rubber material, and at least one circular slit (52) is made on the periphery of the roller part to divide the periphery into several parts in the axial direction.

3. The paper sheet take-out apparatus according to claim 2, **characterized in that** the slit (52) has a depth not reaching the core member.

4. The paper sheet take-out apparatus according to claim 1, **characterized in that** the take-out roller (11a, 11b, 12a, 12b, 40) has a substantially cylindrical core member (31), and a substantially cylindrical roller part (30, 41) wound on the outside of the core member and made of rubber material, and the roller part is formed by closely stacking a plurality of circular rubber rings (32, 42, 44) in the axial direction.

5. The paper sheet take-out apparatus according to claim 4, **characterized in that** the plurality of rubber rings (32) are made of the same rubber material, and formed to have the same size.

6. The paper sheet take-out apparatus according to claim 5, **characterized in that** the thickness of the plurality of rubber rings (32) in the axial direction is

2 mm - 4 mm.

7. The paper sheet take-out apparatus according to claim 4, **characterized in that** the plurality of rubber rings (42, 44) includes a first rubber ring (44), and a second rubber ring (42) harder than the first rubber ring, and the roller part (41) is formed by alternately stacking the first rubber ring and second rubber ring.

8. The paper sheet take-out apparatus according to claim 7, **characterized in that** the rubber rings (42, 44) are stuck in an odd-number order, and the second rubber ring (42) is provided at both ends of the axial direction of the roller part (41).

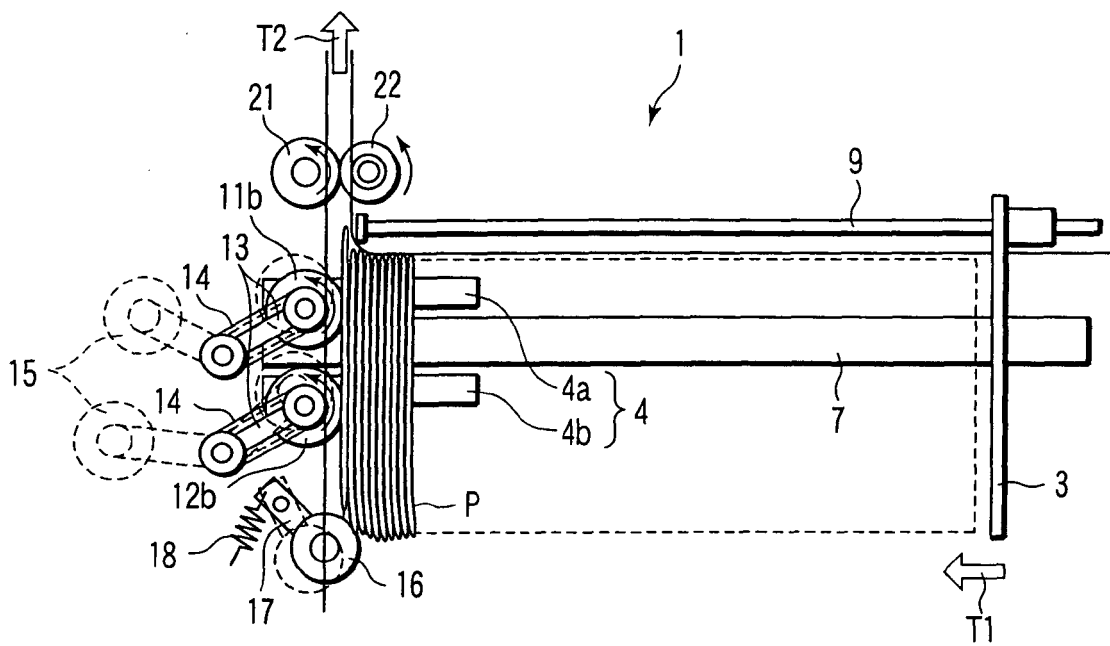


FIG. 1

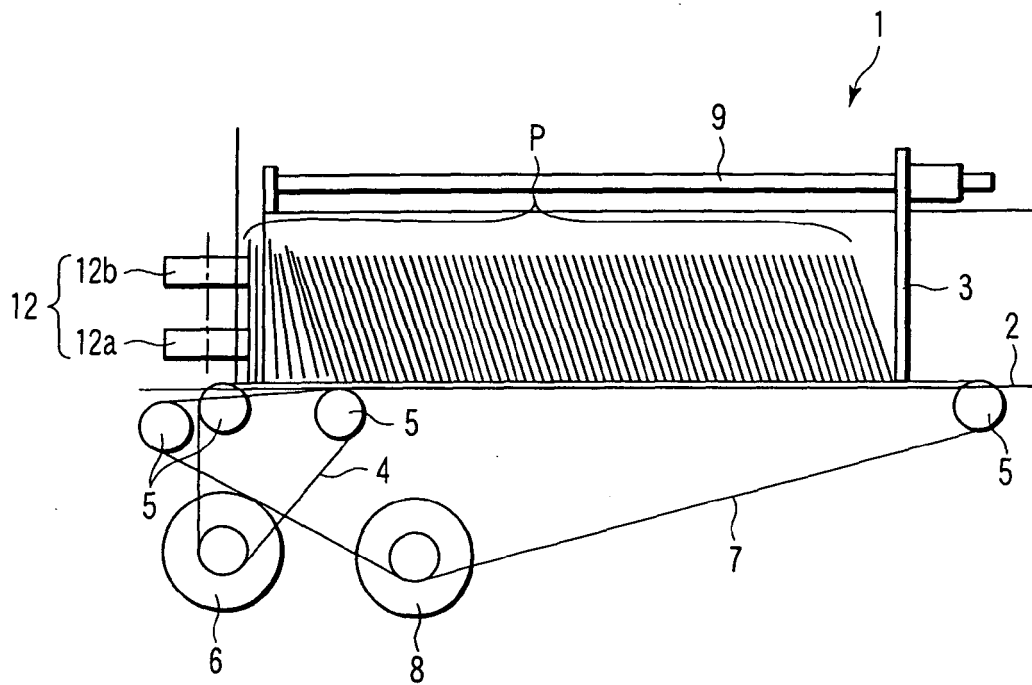


FIG. 2



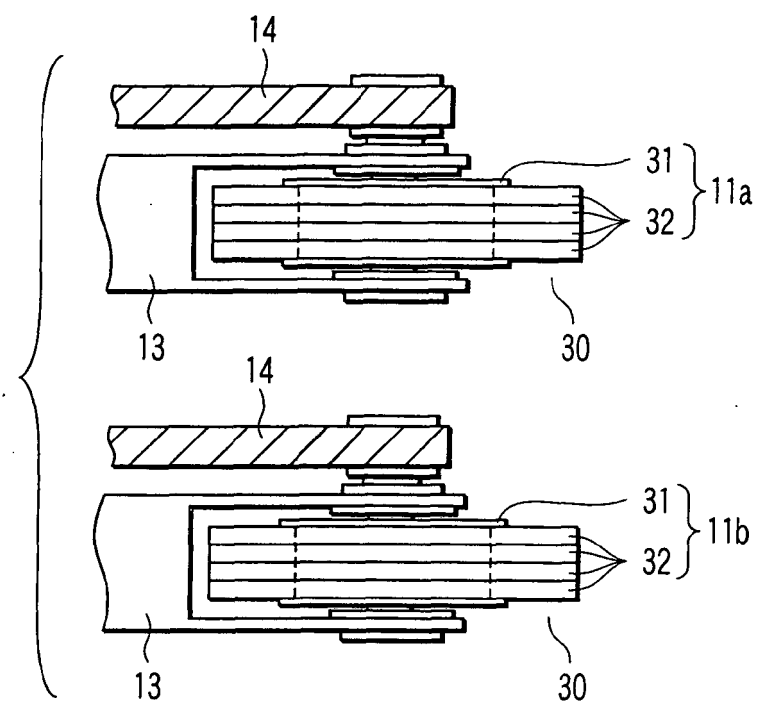


FIG. 3

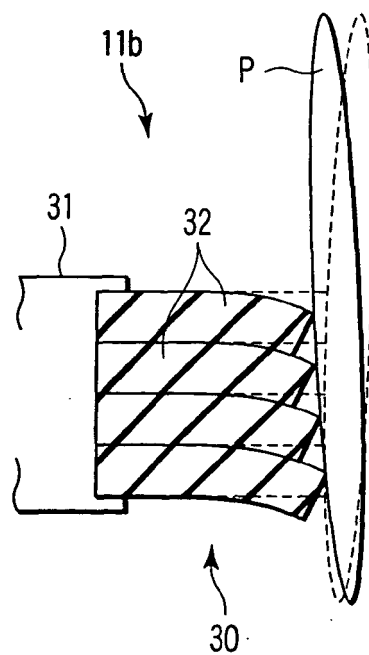


FIG. 4

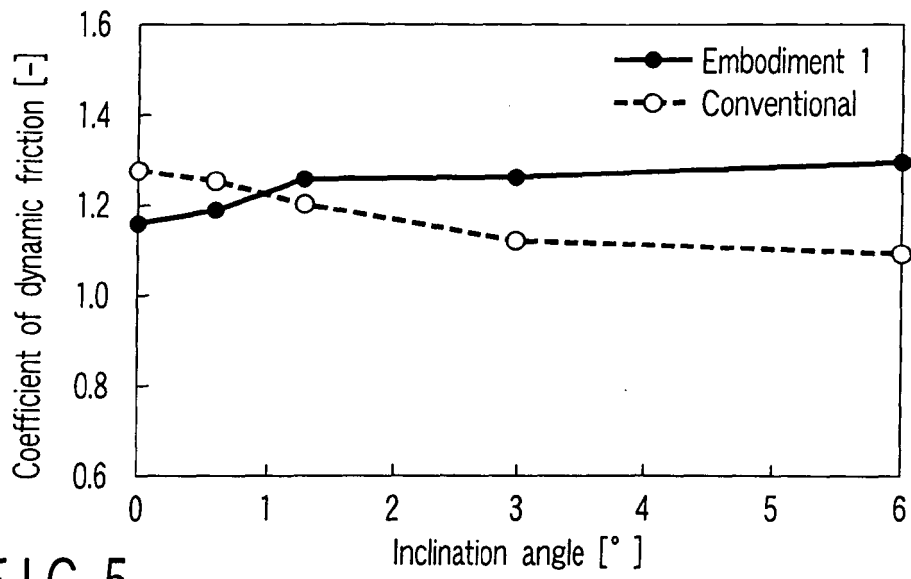


FIG. 5

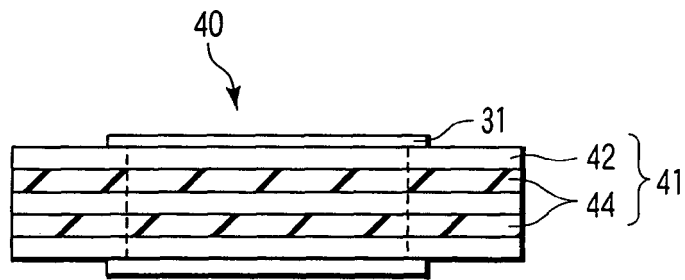


FIG. 6

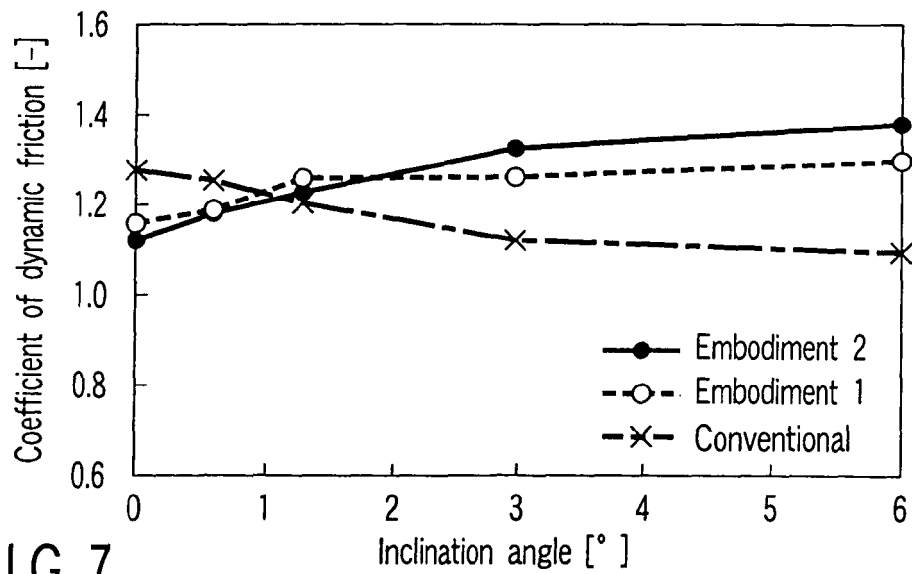


FIG. 7

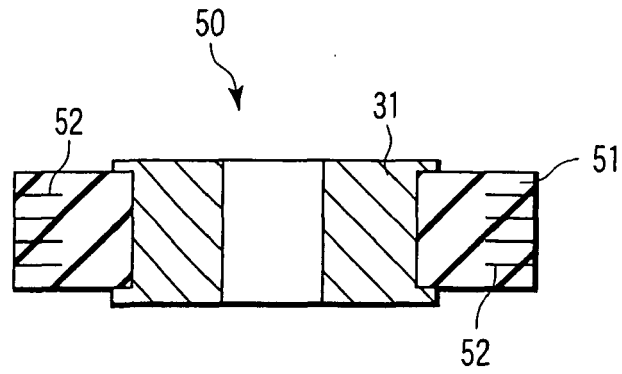


FIG. 8

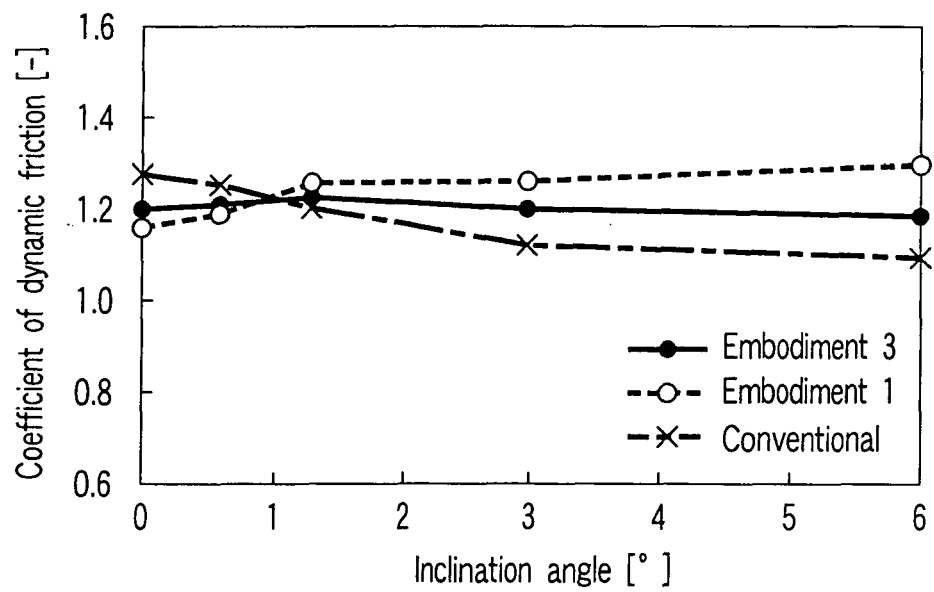


FIG. 9



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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                  |                                                     |                                         |
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| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                  | Date of completion of the search<br>29 January 2007 | Examiner<br>Rupperecht, Anja            |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons</p> <p>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                  |                                                     |                                         |

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