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(54) **IMPELLER, DEVICE FOR COLLECTING LEAVES OF PAPER, AND METHOD FOR PRODUCING IMPELLER**

(57) The invention provides an impeller (52) wherein a protrusion (57) is provided on the inner surface and/or outer surface of blades (56). The protrusion (57) on a first blade (56) of a pair of blades (56) which are adjacent

in the circumferential direction of a base part (54), and a second blade (56) of said pair are overlapping, when seen from the axial direction of the base part (54), and the protrusion (57) of the first blade (56) and the second blade (56) are not in contact.

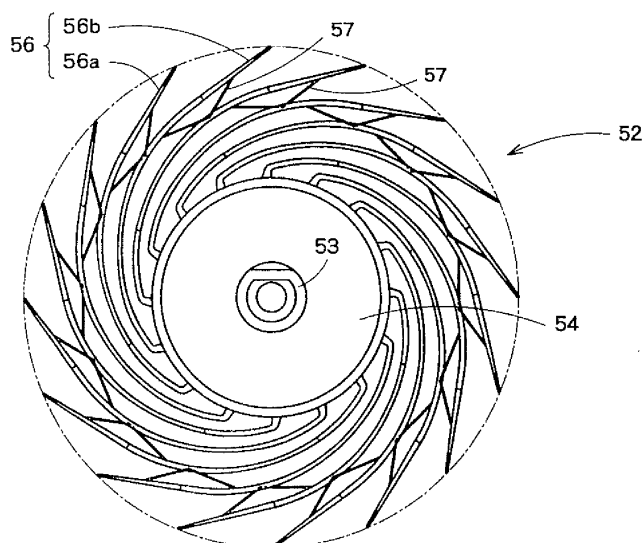


FIG. 8

Description

TECHNICAL FIELD

[0001] The present invention relates to a stacking wheel that is used when paper sheets such as banknotes are stacked, a paper-sheet stacking apparatus including the stacking wheel, and a method of manufacturing the stacking wheel. In particular, the present invention pertains to: a stacking wheel, which is capable of preventing that a paper sheet, which is held and received between a pair of vanes with a suitable holding force, jumps out erroneously from the pair of vanes, regardless of an inherent elastic hardness of the paper sheet; a paper-sheet stacking apparatus; and a method of manufacturing the stacking wheel.

BACKGROUND ART

[0002] In a paper-sheet stacking apparatus in which paper sheets, such as banknotes, which have been taken into an inside of an apparatus body from an outside thereof, are stacked in the apparatus body, provision of a stacking wheel near to a stacking unit, in which the paper sheets are stacked, has been conventionally known. Such a stacking wheel includes a cylindrical base body unit, and a plurality of vanes disposed to extend outward from an outer circumferential surface of the base body unit, at equal intervals therebetween in a circumferential direction of the base body unit. A paper sheet is received between a pair of vanes adjacent to each other in the circumferential direction of the base body unit. When a paper-sheet stacking operation is performed, the stacking wheel is rotated all the time. A paper sheet having been sent from an outside of a stacking unit to the stacking unit is firstly received between a pair of adjacent vanes of the stacking wheel, and then the paper sheet between the pair of vanes of the stacking wheel is released from the stacking wheel so as to be stacked in the stacking unit. Due to the provision of the stacking wheel, paper sheets can be stacked in an aligned state in the stacking unit.

[0003] In a conventionally used stacking wheel, there is a possibility that, in a time period from when a paper sheet has been received between a pair of vanes of the stacking wheel to when the paper sheet is released from the stacking wheel, the paper sheet might erroneously jump out from the pair of vanes. In order to prevent such a paper-sheet jumping-out phenomenon, a mechanism for securely holding a paper sheet, such as a flat spring, is disposed on an end portion of each vane of the stacking wheel, so that when a paper sheet is received between the pair of vanes of the stacking wheel, the paper sheet is securely held by the flat springs on the respective vanes (see, for example, Patent Documents 1 and 2).

[0004] However, in the method for securely holding a paper sheet by a flat spring or the like of each vane when the paper sheet is received between a pair of vanes of a

stacking wheel, there is a possibility that the paper sheet could not be securely held depending on an elastic hardness of the paper sheet. Namely, since a paper sheet having a too low elastic hardness is easily curved, such a paper sheet may yield to an urging force of the flat spring provided on the end portion of each vane, so that the paper sheet cannot enter between the pair of vanes so as to be securely held therebetween.

[0005]

Patent Document 1: JP2574769B

Patent Document 2: JP52-100792U

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above circumstances. The object of the present invention is to provide: a stacking wheel capable of preventing that a paper sheet, which is held and received between a pair of vanes with a suitable holding force, jumps out erroneously from the pair of vanes, regardless of an inherent elastic hardness of the paper sheet; a paper-sheet stacking apparatus including the stacking wheel; and a method of manufacturing the stacking wheel.

[0007] A stacking wheel of the present invention includes: a cylindrical base body unit; and a plurality of vanes disposed outward from an outer circumferential surface of the base body unit, at equal intervals therebetween in a circumferential direction of the base body unit, such that a paper sheet is received between a pair of vanes adjacent to each other in the circumferential direction; wherein a projection is provided on at least one of an inner surface or an outer surface of each vane; and wherein each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from an axial direction of the base body unit, the projection of the one vane and the other vane are overlapped with each other, and that the projection of the one vane and the other vane are not in contact with each other.

[0008] According to such a stacking wheel, a projection is provided on at least one of the inner surface or the outer surface of each vane, and each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from the axial direction of the base body unit, the projection of the one vane and the other vane are overlapped with each other, and that the projection of the one vane and the other vane are not in contact with each other. Thus, when a paper sheet having been sent to the stacking wheel is received between a pair of adjacent vanes, the paper sheet is curved by the projection provided on the inner surface or the outer surface of each vane, so as to be elasticized. In this manner, in either case where an inherent elastic hardness of a paper sheet, which has been sent to the stacking wheel, is high or low, the paper sheet can be securely held between the pair of vanes.

Therefore, it can be restrained that a paper sheet, which is held and received between a pair of vanes with a suitable holding force, jumps out erroneously from the pair of vanes, regardless of an inherent elastic hardness of the paper sheet.

[0009] In the stacking wheel of the present invention, each pair of vanes adjacent to each other in the circumferential direction of the base body unit may be symmetrical in shape in a right and left direction.

[0010] Alternatively, the respective vanes may have the same shape.

[0011] In the stacking wheel of the present invention, each vane may have an opening or a cutout; and a pair of vanes adjacent to each other in the circumferential direction of the base body unit may be configured such that the projection of the one vane is opposed to the opening or the cutout of the other vane when viewed from a normal direction of the base body unit.

[0012] In the stacking wheel in which the respective vanes have the same shape, a pair of vanes adjacent to each other in the circumferential direction of the base body unit may be located on positions displaced from each other in the axial direction of the base body unit.

[0013] In the stacking wheel of the present invention, each vane may have a recess in a surface not provided with the projection, such that the projection of the adjacent vane enters into the recess.

[0014] In this case, the projection may be provided on the inner surface of each vane, and the recess may be provided in the outer surface of each vane.

[0015] In the stacking wheel of the present invention, the vanes may be formed to be resiliently deformable.

[0016] A stacking wheel of the present invention includes: a cylindrical base body unit; and a plurality of vanes disposed outward from an outer circumferential surface of the base body unit, at equal intervals therebetween in a circumferential direction of the base body unit, such that a paper sheet is received between a pair of vanes adjacent to each other in the circumferential direction; wherein each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from an axial direction of the base body unit, a specific portion of the one vane and the other vane are overlapped with each other, and that the specific portion of the one vane and the other vane are not in contact with each other.

[0017] According to such a stacking wheel, each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from an axial direction of the base body unit, a specific portion of the one vane and the other vane are overlapped with each other, and that the specific portion of the one vane and the other vane are not in contact with each other. Thus, when a paper sheet having been sent to the stacking wheel is received between a pair of adjacent vanes, the paper sheet is curved by the specific portion of the one vane so as to be elasticized. In this manner, in either case where an inherent elastic hard-

ness of a paper sheet, which has been sent to the stacking wheel, is high or low, the paper sheet can be securely held between the pair of vanes. Therefore, it can be restrained that a paper sheet, which is held and received between a pair of vanes with a suitable holding force, jumps out erroneously from the pair of vanes, regardless of an inherent elastic hardness of the paper sheet.

[0018] In the stacking wheel of the present invention, each vane may be integral with the base body unit.

[0019] Alternatively, each vane may be detachably attached to the outer circumferential surface of the base body unit.

[0020] A paper-sheet stacking apparatus of the present invention includes: a stacking unit in which paper sheets are stacked; and the aforementioned stacking wheel disposed on the stacking unit; wherein a paper sheet having been sent from outside the stacking unit to the stacking unit is firstly received between a pair of vanes adjacent to each other in the circumferential direction of the base body unit of the stacking wheel, and then the paper sheet between the pair of vanes of the stacking wheel is released from the stacking wheel so as to be stacked in the stacking unit.

[0021] A method of manufacturing a stacking wheel of the present invention is a method of manufacturing the stacking wheel in which each vane is integral with the base body unit, the method including: preparing a pair of dies each having a cavity therein; die-matching the pair of dies and injecting a molding material into the cavities in the pair of dies; and decoupling the pair of dies to obtain a stacking wheel formed of the molding material.

[0022] In the method of manufacturing a stacking wheel, in obtaining the stacking wheel formed of the molding material, each pair of vanes adjacent to each other in the circumferential direction of the base body unit may be symmetrical in shape in a right and left direction, a projection may be provided on at least one of an inner surface or an outer surface of each vane, a cutout may be provided in each vane, and each pair of vanes adjacent to each other in the circumferential direction of the base body unit may be configured such that, when viewed from an axial direction of the base body unit, the projection of the one vane and the other vane are overlapped with each other, and that the projection of the one vane and the other vane are not in contact with each other.

[0023] According to the stacking wheel of the present invention and the paper-sheet stacking apparatus including the stacking wheel, it can be restrained that a paper sheet, which is held and received between a pair of vanes with a suitable holding force, jumps out erroneously from the pair of vanes, regardless of an inherent elastic hardness of the paper sheet. In addition, according to the method of manufacturing a stacking wheel of the present invention, such a stacking wheel can be manufactured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig. 1 is a perspective view showing an appearance of a banknote handling apparatus in one embodiment of the present invention;

Fig. 2 is a schematic structural view showing a schematic structure of an inside of the banknote handling apparatus shown in Fig. 1;

Fig. 3 is a control block diagram of the banknote handling apparatus shown in Figs. 1 and 2;

Fig. 4 is a perspective view showing an overall structure of a stacking-wheel type stacking mechanism in the banknote handling apparatus shown in Fig. 1 and so on;

Fig. 5 is a perspective view showing a structure of one of stacking wheels of the stacking-wheel type stacking mechanism shown in Fig. 4;

Fig. 6(a) is a view of a first vane disposed on the stacking wheel shown in Fig. 5 and so on when viewed from a normal direction of a base body unit, and Fig. 6(b) is a view of the first vane when viewed from an axial direction of the base body unit;

Fig. 7(a) is a view of a second vane disposed on the stacking wheel shown in Fig. 5 and so on when viewed from the normal direction of the base body unit, and Fig. 7(b) is a view of the second vane when viewed from the axial direction of the base body unit;

Fig. 8 is a view of the stacking wheel shown in Fig. 5 and so on, when viewed from the axial direction of the base body unit;

Fig. 9 is a view of the stacking wheel when viewed from the front, showing a condition when a banknote is sent to a pair of stacking wheels shown in Fig. 4;

Fig. 10 is a perspective view showing another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment;

Fig. 11 is a perspective view showing a structure of a vane disposed on the stacking wheel shown in Fig. 10;

Fig. 12 is a perspective view showing still another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment;

Fig. 13 is a perspective view showing a structure of a vane disposed on the stacking wheel shown in Fig. 12;

Fig. 14 is a side view showing yet another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment;

Fig. 15 is a perspective view showing a structure of a vane disposed on the stacking wheel shown in Fig. 14;

Fig. 16 is a sectional view showing further another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment;

Fig. 17 is a sectional view showing a structure of a vane disposed on the stacking wheel shown in Fig.

16; and

Fig. 18(a) is a perspective view showing a structure of the vane disposed on the stacking wheel shown in Fig. 16 when the vane is viewed from outside, and Fig. 18(b) is a perspective view thereof when the vane is viewed from inside.

MODE FOR CARRYING OUT THE INVENTION

[0025] An embodiment of the present invention will be described herebelow with reference to the drawings. Figs. 1 to 9 are views showing a stacking wheel in this embodiment and a banknote handling apparatus including the stacking wheel. Fig. 1 is a perspective view showing an appearance of the banknote handling apparatus in this embodiment. Fig. 2 is a schematic structural view showing a schematic structure of an inside of the banknote handling apparatus shown in Fig. 1. Fig. 3 is a control block diagram of the banknote handling apparatus shown in Figs. 1 and 2. Figs. 4 to 9 are views showing a structure of a stacking wheel disposed in the banknote handling apparatus shown in Fig. 1 and so on.

[0026] As shown in Figs. 1 and 2, the banknote handling apparatus 10 includes: a housing 12; a placement unit (hopper) 14 in which a plurality of banknotes to be counted are placed in a stacked state; a feeding unit 16 configured to feed, one by one, an undermost banknote in the plurality of banknotes placed on the placement unit 14, into an inside of the housing 12; and a transport unit 18 disposed inside the housing 12 and configured to transport, one by one, the banknote having been fed by the feeding unit 16 into the inside of the housing 12. The transport unit 18 is provided with a recognizing/counting unit 20 configured to recognize and count the banknote having been fed by the feeding unit 16 into the inside of the housing 12.

[0027] The feeding unit 16 includes a kicker roller 16a and a feed roller 16b. The kicker roller 16a is configured to be in contact with a surface of an undermost banknote in a plurality of banknotes placed in a stacked state in the placement unit 14. The feed roller 16b is disposed on a downstream side of the kicker roller 16a in a banknote feeding direction, and is configured to feed a banknote having been kicked by the kicker roller 16a into the inside of the housing 12. In addition, a reversing roller 16c (gate roller) is disposed opposite to the feed roller 16b. A gate unit G is formed between the feed roller 16b and the reversing roller 16c. A banknote having been kicked by the kicker roller 16a passes through the gate unit G so as to be fed, one by one, to the transport unit 18 in the housing 12. In addition, inside the housing 12, a feeding-unit drive mechanism 17 (see Fig. 3) configured to drive the feeding unit 16 is provided.

[0028] The transport unit 18 is composed of a transport belt extended among a plurality of transport rollers and a plurality of rollers combined therebetween. The transport belt is circulated, with a banknote sandwiched between the transport belt and the rollers, so that the bank-

knote is transported along a transport path. In addition, inside the housing 12, a transport-unit drive mechanism 19 (see Fig. 3) configured to drive the transport unit 18 is provided.

[0029] In addition, as described above, the transport unit 18 is provided with the recognizing/counting unit 20 configured to recognize and count a banknote having been fed by the feeding unit 16 into the inside of the housing 12. In more detail, the recognizing/counting unit 20 is configured to recognize an authenticity, a fitness, a denomination and so on of the banknote, configured to recognize whether a banknote abnormal transport occurs or not, and configured to count a banknote(s).

[0030] As shown in Fig. 2, the transport unit 18 is diverged to two transport paths from a position on a downstream side of the recognizing/counting unit 20. A stacking unit 30 is connected to a downstream end of the one transport path, and a reject unit 40 is connected to a downstream end of the other transport path. A banknote, which has been recognized and counted by the recognizing/counting unit 20, is selectively sent to the stacking unit 30 or the reject unit 40. An opening is formed in a front surface (a left surface in Fig. 2) of the stacking unit 30, so that an operator can take out banknotes stacked in the stacking unit 30 through the opening. In addition, an opening is formed in a front surface of the reject unit 40, so that an operator can take out banknotes stacked in the reject unit 40 through the opening.

[0031] As shown in Fig. 2, a diverter 22 composed of a diverging member and a drive unit (not shown) thereof, is disposed on a position where the two transport paths of the transport unit 18 are diverged. Due to the diverter 22, a banknote having been sent from an upstream side of the diverter 22 is selectively sent to any one of the two diverged transport paths.

[0032] In the stacking unit 30, a stacking-wheel type stacking mechanism 50 is disposed on a position on a rear side of the housing 12 (the right side position in the stacking unit 30 of Fig. 2). The stacking-wheel type stacking mechanism 50 is composed of a stacking wheel 52 and a drive unit (not shown) thereof. The stacking wheel 52 is configured to be rotated in a counterclockwise direction in Fig. 2 (the arrow direction in Fig. 2) about a shaft 51 that is perpendicular to a sheet surface of Fig. 2 and extends in substantially the horizontal direction. The stacking wheel 52 includes a cylindrical base body unit 54, and a plurality of vanes extending outward in a direction (the clockwise direction in Fig. 2) opposite to the rotating direction of the stacking wheel 52. As shown in Fig. 2, these vanes 56 are disposed at equal intervals therebetween on an outer circumferential surface of the base body unit 54. A banknote can be received between a pair of vanes 56 that are adjacent to each other in a circumferential direction of the base body unit 54.

[0033] The stacking wheel 52 of the stacking-wheel type stacking mechanism 50 is configured to be rotated by the drive unit in the counterclockwise direction in Fig. 2 at all times during an operation of the banknote handling

apparatus 10. Banknotes are sent, one by one, to the stacking wheel 52 from the transport unit 18. The stacking wheel 52 is configured to receive a banknote having been sent from the transport unit 18 between the two vanes 56, and configured to send the banknote received between the vanes 56 to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, to the stacking unit 30 from the stacking wheel 52 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0034] The structure of the stacking wheel 52 of the stacking-wheel type stacking mechanism 50 will be described in more detail below.

[0035] As shown in Figs. 1 and 2, the banknote handling apparatus 10 is provided with a shutter 34 for closing the opening formed in the front surface of the stacking unit 30. The opening in the front surface of the stacking unit 30 is selectively closed by the shutter 34. In addition, inside the housing 12, a shutter drive mechanism 35 (see Fig. 3) configured to drive the shutter 34 is disposed. The shutter 34 is configured to be moved by the shutter drive mechanism 35 between an opened position (see the dotted lines in Fig. 2) where the shutter 34 is withdrawn below the stacking unit 30 to open the opening of the stacking unit 30, and a closed position (see the solid line in Fig. 2) where the shutter 34 closes the opening in the front surface of the stacking unit 30. Namely, when the shutter 34 is located on the opened position as shown by the dotted lines of Fig. 2, an operator can access banknotes stacked in the stacking unit 30. On the other hand, when the shutter 34 is located on the closed position as shown by the solid line of Fig. 2, the opening in the front surface of the stacking unit 30 is closed by the shutter 34, so that an operator cannot access banknotes stacked in the stacking unit 30.

[0036] Meanwhile, the reject unit 40 is not provided with a shutter for closing the opening in the front surface of the reject unit 40. As shown in Figs. 1 and 2, a pair of right and left banknote aligning members 42 are disposed on the reject unit 40. Each banknote aligning member 42 can be turned over by an operator from a position shown in Fig. 2 to a position in front of the housing 12 (i.e., leftward in Fig. 2). Thus, banknotes having been sent from the transport unit 18 to the reject unit 40 can be stacked in the reject unit 40 in such a manner that the banknotes are aligned by the respective banknote aligning members 42. By turning over the respective banknote aligning members 42 in front of the housing 12, an operator can take out the banknotes from the reject unit 40.

[0037] In addition, as shown in Fig. 1, an operation display unit 62 is disposed on the front surface of the housing 12. The operation display unit 62 includes a display unit 62a formed of, e.g., a LCD, and a plurality of operation keys 62b. The display unit 62a is configured to display a banknote handling condition by the banknote handling apparatus 10, to be more specific, an amount for each denomination of banknotes, which have been counted by the recognizing/counting unit 20, and total

sum information thereof, for example. When an operator presses down the operation keys 62b, various instructions can be given to a control unit 60, which is described below.

[0038] As shown in Fig. 2, inside the housing 12, the control unit 60 for controlling respective constituent elements of the banknote handling apparatus 10 is provided. A structure of such a control unit 60 is described in more detail with reference to Fig. 3. As shown in Fig. 3, connected to the control unit 60 are the feeding-unit drive mechanism 17 configured to drive the feeding unit 16, the transport-unit drive mechanism 19 configured to drive the transport unit 18, the recognizing/counting unit 20, the diverter 22, the stacking-wheel type stacking mechanism 50, the shutter drive mechanism 35 configured to drive the shutter 34, the operation display unit 62 and so on. A banknote recognition result and a banknote count result by the recognizing/counting unit 20 are transmitted to the control unit 60, and the control unit 60 transmits instruction signals to the feeding-unit drive mechanism 17, the transport-unit drive mechanism 19, the diverter 22, the stacking-wheel type stacking mechanism 50, the shutter drive mechanism 35, the operation display unit 62 and so on, so as to control these constituent elements.

[0039] In addition, as shown in Fig. 3, a memory unit 64 is connected to the control unit 60. The memory unit 64 is configured to store a banknote handling condition by the banknote handling apparatus 10, to be more specific, an amount for each denomination of banknotes, which have been counted by the recognizing/counting unit 20, and total sum information thereof, for example.

[0040] Next, a basic operation of the banknote handling apparatus 10 as structured above is described. An operation of the banknote handling apparatus 10 described herebelow is performed by the control unit 60 that controls the respective constituent elements of the banknote handling apparatus 10.

[0041] At first, an operator places banknotes to be counted onto the placement unit 14 in such a manner that the banknote are in a stacked state. Thereafter, by pressing down the operation key 62b (specifically, "START/STOP" key) of the operation display unit 62, the operator gives an instruction for starting counting of the banknotes, to the control unit 60. Then, the stacked banknotes placed on the placement unit 14 are fed, one by one, sequentially from the undermost banknote, by the feeding unit 16 to the transport unit 18 in the housing 12. The banknote, which has been fed by the feeding unit 16 to the transport unit 18 in the housing 12, is transported by the transport unit 18.

[0042] The banknote being transported by the transport unit 18 is recognized and counted by the recognizing/counting unit 20, and a banknote recognition result by the recognizing/counting unit 20 is transmitted to the control unit 60. In the banknote recognition result having been transmitted to the control unit 60, when a banknote is a predetermined banknote, the banknote is further transported by the transport unit 18 so as to be sent to

the stacking unit 30 by the diverter 22. At this time, banknotes are sent, one by one, from the transport unit 18 to the stacking wheel 52 of the stacking-wheel type stacking mechanism 50. The stacking wheel 52 receives the banknote, which has been sent from the transport unit 18, between two vanes 56, and sends the banknote received between the vanes 56 to the stacking unit 30. In this manner, banknotes can be stacked in an aligned state in the stacking unit 30 by the stacking-wheel type stacking mechanism 50. On the other hand, in the banknote recognition result having been transmitted to the control unit 60, when a banknote is a banknote that should not be stacked in the stacking unit 30, the banknote is further transported by the transport unit 18 so as to be sent to the reject unit 40 by the diverter 22.

[0043] While the aforementioned banknote counting process is being performed by the banknote handling apparatus 10, as shown by the solid line of Fig. 2, the opening in the front surface of the stacking unit 30 is closed by the shutter 34. After all the banknotes placed on the placement unit 14 have been sent to the stacking unit 30 or the reject unit 40 so that the banknote counting process by the banknote handling apparatus 10 has ended, as shown by the dotted lines of Fig. 2, the shutter 34 is moved to the withdrawal position so as to open the opening in the front surface of the stacking unit 30. Thus, an operator can take out the banknotes from the stacking unit 30. Meanwhile, since the opening in the front surface of the reject unit 40 is opened all the times, an operator can take out the banknotes from the reject unit 40 by turning over the respective banknote aligning members 40 in front of the housing 12.

[0044] Next, the detailed structure of the stacking wheel 52 of the stacking-wheel type stacking mechanism 50 is described with reference to Figs. 4 to 9. Fig. 4 is a perspective view showing an overall structure of the stacking-wheel type stacking mechanism 50 in the banknote handling apparatus 10 in this embodiment. Fig. 5 is a perspective view of a structure of one of the stacking wheels 52 of the stacking-wheel type stacking mechanism 50 shown in Fig. 4. Fig. 6(a) is a view of a first vane 56a disposed on the stacking wheel 52 shown in Fig. 5 and so on, when viewed from a normal direction of the base body unit 54. Fig. 6(b) is a view of the first vane 56a when viewed from an axial direction of the base body unit 54. Fig. 7(a) is a view of a second vane 56b disposed on the stacking wheel 52 shown in Fig. 5 and so on, when viewed from the normal direction of the base body unit 54. Fig. 7(b) is a view of the second vane 56b when viewed from the axial direction of the base body unit 54. Fig. 8 is a view of the stacking wheel 52 shown in Fig. 5 and so on, when viewed from the axial direction of the base body unit 54. Fig. 9 is a view of the stacking wheel 52 when viewed from the front, showing a condition when a banknote is sent to a pair of stacking wheels 52 shown in Fig. 4.

[0045] As shown in Fig. 4, the stacking-wheel type stacking mechanism 50 includes a pair of right and left

stacking wheels 52. These stacking wheels 52 are supported by one shaft 51. The pair of right and left stacking wheels 52 have the same shape. When a drive unit (not shown) of the stacking-wheel type stacking mechanism 50 rotates the shaft 51, the pair of right and left stacking wheels 52 are synchronically rotated.

[0046] As shown in Fig. 4 and 5, each stacking wheel 52 includes the cylindrical base body unit 54, and the plurality of vanes 56 extending from an outer circumferential surface of the base body unit 54 in a direction opposite to a rotating direction of the stacking wheel 52. As shown in Fig. 2, these vanes 56 are disposed at equal intervals therebetween on the outer circumferential surface of the base body unit 54. A banknote can be received between each pair of vanes 56 adjacent to each other in the circumferential direction of the base body unit 54. In addition, a bearing unit 53 is disposed on a center of the base body unit 54, so that the shaft 51 is borne by the bearing unit 53.

[0047] The vanes 56 disposed on the stacking wheel 52 include a first vane 56a as shown in Fig. 6 and a second vane 56b as shown in Fig. 7, which are alternately disposed in the circumferential direction of the base body unit 54. Namely, the first vanes 56a and the second vanes 56b are invariably adjacent to each other in the circumferential direction of the base body unit 54. Thus, a banknote, which has been sent from the transport unit 18 to the stacking wheel 52, is received between the first vane 56a and the second vane 56b, and the received banknote is sent to the stacking unit 30. The first vane 56a and the second vane 56b may be integral with the base body unit 54, or the first vane 56a and the second vane 56b may be detachably attached to the outer circumferential surface of the base body unit 54. In addition, as shown in Figs. 6(a) and 7(a), the first vane 56a and the second vane 56b are symmetrical in shape in the right and left direction, when viewed from the normal direction of the base body unit 54.

[0048] In the pair of right and left stacking wheels 52 shown in Fig. 4, an angular position at which the first vane 56a is disposed and an angular position at which the second vane 56b is disposed are completely identical to each other. Namely, as shown in Fig. 9, a first vane 56a disposed on the one stacking wheel 52 of the pair of right and left stacking wheels 52 is opposed to a first vane 56a disposed on the other stacking wheel 52, and a second vane 56b disposed on the one stacking wheel 52 is opposed to a second wheel 56b disposed on the other stacking wheel 52.

[0049] The pair of right and left stacking wheels 52 in this embodiment are not limited to the above. For example, in the pair of right and left stacking wheels 52, an angular position at which the first vane 56a is disposed on the one stacking wheel 52 may be identical to an angular position at which the second vane 56b is disposed on the other stacking wheel 52, and an angular position at which the second vane 56b is disposed on the one stacking wheel 52 may be identical to an angular position

at which the first vane 56a is disposed on the other stacking wheel 52. In this case, the first vanes 56a disposed on the one stacking wheel 52 of the pair of right and left stacking wheels 52 are opposed to the second vanes 56b disposed on the other stacking wheel 52, and the second vanes 56b disposed on the one stacking wheel 52 are opposed to the first vanes 56a disposed on the other stacking wheel 52.

[0050] In addition, as shown in Figs. 6 and 7, projections 57 are respectively provided on an inner surface of the first vane 56a and an inner surface of the second vane 56b. Further, cutouts 58 are respectively provided in the first vane 56a and the second vane 56b. As shown in Figs. 5 and 8, each pair of vanes 56 (i.e., the first vane 56a and the second vane 56b) adjacent to each other in the circumferential direction of the base body unit 54 is configured such that, when viewed from the normal direction of the base body unit 54, the projection 57 of the one vane is opposed to the cutout 58 of the other vane. To be specific, the first vane 56a and the second vane 56b adjacent to each other are configured such that the projection 57 of the first vane 56a extends up to the cutout 58 of the second vane 56b or extends through the cutout 58, and that the projection 57 of the second vane 56b extends up to the cutout 58 of the first vane 56a or extends through the cutout 58. Thus, the projection 57 of the first vane 56a is not in contact with the second vane 56b, and the projection 57 of the second vane 56b is not in contact with the first vane 56a.

[0051] In this manner, as shown in Fig. 8, the first vane 56a and the second vane 56b adjacent to each other are configured such that, when viewed from the axial direction of the base body unit 54, the projection 57 of the first vane 56a overlaps with the second vane 56b, and that the projection 57 of the second vane 56b overlaps with the first vane 56a. In addition, the first vane 56a and the second vane 56b adjacent to each other are configured such that, when viewed from the normal direction of the base body unit 54, the projection 57 of the first vane 56a is positioned within a range of the cutout 58 of the second vane 56b, and that the projection 57 of the second vane 56b is positioned within a range of the cutout 58 of the first vane 56a. Thus, the projection 57 of the first vane 56a is not in contact with the second vane 56b and the projection 57 of the second vane 56b is not in contact with the first vane 56a.

[0052] In the stacking wheel 52 in this embodiment, instead of the structure in which the projections 57 are respectively provided on the inner surfaces of the first vane 56a and the second vane 56b, the projections 57 may be respectively provided on outer surfaces of the first vane 56a and the second vane 56b. When the projections 57 are disposed on the outer surfaces of the first vane 56a and the second vane 56b, the positions of the projection 57 and the cutout 58 are reversed. Namely, the projection 57 and the cutout 58 are formed in this order from the side of the base body unit 54 to a distal end of the vane. Also in this case, each pair of vanes 56

adjacent to each other in the circumferential direction of the base body unit 54 is configured such that, when viewed from the normal direction of the base body unit 54, the projection 57 of the one vane is opposed to the cutout 58 of the other vane.

[0053] In addition, in the stacking wheel 52 in this embodiment, instead of the structure in which the cutouts 58 are respectively provided in the first vane 56a and the second vane 56b, openings may be respectively provided in the first vane 56a and the second vane 56b. Also in this case, the first vane 56a and the second vane 56b adjacent to each other are configured such that, the projection 57 of the first vane 56a extends up to the opening formed in the second vane 56b or extends through the opening, and that the projection 57 of the second vane 56b extends up to the opening formed in the first vane 56a or extends through the opening.

[0054] In addition, in the stacking wheel 52 in this embodiment, the first vane 56a and the second vane 56b are formed to be resiliently deformable. Specifically, the first vane 56a and the second vane 56b are formed of a resiliently deformable material such as resin rubber, or the first vane 56a and the second vane 56b are attached to the base body unit 54 so as to be resiliently deformable.

[0055] Next, there is described an operation when a banknote is sent from the transport unit 18 to the stacking-wheel type stacking mechanism 50 as structured above.

[0056] As described above, during the operation of the banknote handling apparatus 10, the stacking wheels 52 of the stacking-wheel type stacking mechanism 50 are rotated all the time by the drive unit in the counterclockwise direction in Fig. 2. When a banknote is sent from the transport unit 18, a right end portion and a left end portion of the banknote are respectively received between the first vanes 56a and the second vanes 56b provided respectively on the pair of right and left stacking wheels 52. At this time, the first vane 56a and the second vane 56b adjacent to each other are configured such that the projection 57 of the first vane 56a extends up to the cutout 58 of the second vane 56b or extends through the cutout 58, and that the projection 57 of the second vane 56b extends up to the cutout 58 of the first vane 56a or extends through the cutout 58. Thus, as shown in Fig. 9, the banknote P received between the first vane 56a and the second vane 56b is curved by the projection 57 so as to be elasticized.

[0057] To be more specific, in a case where a banknote, which has been transported from the transport unit 18 to the stacking wheel 52, has a high elastic hardness, when the banknote is received between the first vane 56a and the second vane 56b of the stacking wheel 52, the first vane 56a or the second vane 56b is resiliently deformed, so that the banknote is firmly held between the first vane 56a and the second vane 56b. At this time, the banknote is slightly curved by the projection 57 so as to be elasticized.

[0058] On the other hand, in a case where a banknote, which has been transported from the transport unit 18 to

the stacking wheel 52, has a low elastic hardness, when the banknote is received between the first vane 56a and the second vane 56b of the stacking wheel 52, the banknote is inserted deeply between the first vane 56a and the second vane 56b. At this time, the banknote is lightly held between the first vane 56a and the second vane 56b. In addition, at this time, the banknote is widely curved by the projection 57 so as to be elasticized.

[0059] In this manner, in either case where an elastic hardness of a banknote, which has been transported from the transport unit 18 to the stacking wheel 52, is high or low, the banknote can be securely held between the first vane 56a and the second vane 56b.

[0060] Thereafter, the banknote, which has been received between the first vane 56a and the second vane 56b in each of the pair of right and left stacking wheels 52, is brought into contact with a bottom surface of the stacking unit 30, and is released from between the vanes 56a and 56b so as to be sent to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, from the stacking wheel 52 to the stacking unit 30 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0061] As described above, according to the stacking wheel 52 in this embodiment, the projection 57 is provided on at least one of the inner surface and the outer surface of each vane 56. Each pair of vanes 56 (first vane 56a and second vane 56b) adjacent to each other in the circumferential direction of the base body unit 54 is configured such that, when viewed from the axial direction of the base body unit 54, the projection 57 of one vane 56 (e.g., the first vane 56a) and the other vane 56 (e.g., the second vane 56b) are overlapped with each other (see Fig. 8), and that the projection 57 of the one vane 56 (e.g., the first vane 56a) and the other vane 56 (e.g., the second vane 56b) are not in contact with each other (see Fig. 5). Thus, when a banknote having been sent to the stacking wheel 52 is received between a pair of adjacent vanes 56 (the first vane 56a and the second vane 56b), the banknote is curved by the projection 57 provided on the inner surface or the outer surface of each vane 56 so as to be elasticized (see banknote P in Fig. 9). In this manner, in either case where an elastic hardness of a banknote, which has been sent from the transport unit 18 to the stacking wheel 52, is higher or low, the banknote can be securely held between the first vane 56a and the second vane 56b. Accordingly, it can be restrained that a banknote received between the pair of vanes 56 jumps out erroneously from the pair of vanes 56 (the first vane 56 and the second vane 56b), regardless of an inherent elastic hardness of the banknote.

[0062] In addition, in the stacking wheel 52 in this embodiment, as shown in Figs. 6(a) and 7(a), a pair of vanes 56, i.e., the first vane 56a and the second vane 56b, which are adjacent to each other in the circumferential direction of the base body unit 54 are symmetrical in shape in the right and left direction, when viewed from the normal direction of the base body unit 54. In addition,

at this time, the first vane 56a and the second vane 56b are respectively provided with the cutouts 58 or the openings (not shown). When viewed from the normal direction of the base body unit 54, the projection 57 of the one vane 56 is opposed to the cutout 58 or the opening of the other vane 56. Thus, a banknote having been sent to the stacking wheel 52 can be securely curved by the projection 57, which extends up to the cutout 58 or the opening, or extends through the cutout 58 or the opening, so as to be elasticized.

[0063] In addition, in the stacking wheel 52 in this embodiment, the first vane 56a and the second vane 56b are formed to be resiliently deformable. Thus, even when a banknote sent to the stacking wheel 52 has a high elastic hardness, since the first vane 56a and the second vane 56b are resiliently deformed, the banknote can be securely held between the first vane 56a and the second vane 56b.

[0064] The structure of the stacking wheel disposed in the banknote handling apparatus 10 is not limited to the embodiment shown in Figs. 4 to 9. Herebelow, another embodiment of the stacking wheel disposed in the banknote handling apparatus 10 is described with reference to Figs. 10 and 11. Fig. 10 is a perspective view showing another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment, and Fig. 11 is a perspective view showing a structure of a vane disposed on the stacking wheel shown in Fig. 10.

[0065] As shown in Fig. 10, a stacking wheel 72 in this alternative example includes a cylindrical base body unit 74, and a plurality of vanes 76 extending outward from an outer circumferential surface of the base body unit 74 in a direction opposite to a rotating direction of the stacking wheel 72. A banknote can be received between a pair of vanes 76 adjacent to each other in a circumferential direction of the base body unit 74. All the vanes 76 disposed on the stacking wheel 72 have the same shape, and a pair of vanes 76 adjacent to each other in the circumferential direction of the base body unit 74 are located on positions displaced from each other in an axial direction of the base body unit 74. That is to say, when viewed from a normal direction of the base body unit 74, a pair of adjacent vanes 76 are not overlapped with each other. In other words, when viewed from the normal direction of the base body unit 74, one vane 76 of the pair of adjacent vanes 76 is disposed on a right half area of the base body unit 74, and the other vane 76 is disposed on a left half area of the base body unit 74. In addition, a bearing unit 73 is disposed on a center of the base body unit 74, so that a shaft (not shown) is borne by the bearing unit 73. When a drive unit (not shown) rotates the shaft, the stacking wheel 72 is rotated.

[0066] Each vane 76 on the stacking wheel 72 in the alternative example may be integral with the base body unit 74, or each vane 76 may be detachably attached to the outer circumferential surface of the base body unit 74.

[0067] In addition, as shown in Fig. 10 and 11, a projection 77 is provided on an inner surface of each vane

76. Each pair of vanes 76 adjacent to each other in the circumferential direction of the base body unit 74 are configured such that, when viewed from the axial direction of the base body unit 74, the projection 77 of the one vane 76 is overlapped with the other vane 76. Since the pair of adjacent vanes 76 are located on positions displaced from each other in the axial direction of the base body unit 74, the projection 77 of the one vane 76 is not in contact with the other vane 76.

[0068] Instead of the structure in which the projection 77 is provided on the inner surface of each vane 76, the projection 77 may be provided on an outer surface of each vane 76. Also in this case, each pair of vanes 76 adjacent to each other in the circumferential direction of the base body unit 74 is configured such that, when viewed from the axial direction of the base body unit 74, the projection 77 of the one vane 76 is overlapped with the other vane 76.

[0069] In addition, in the stacking wheel 72 in the alternative example, each vane 76 is formed to be resiliently deformable. Specifically, each vane 76 is formed of a resiliently deformable material such as resin rubber, or each vane 76 is attached to the base body unit 74 so as to be resiliently deformable.

[0070] When a banknote is sent from the transport unit 18 to the stacking wheel 72 shown in Figs. 10 and 11, the banknote is received between a pair of adjacent vanes 76. At this time, the pair of adjacent vanes 76 are configured such that, when viewed from the axial direction of the base body unit 74, the projection 77 of the one vane 76 is overlapped with the other vane 76. Thus, the banknote received between the pair of vanes 76 is curved by the projection 77 so as to be elasticized.

[0071] To be more specific, in a case where a banknote, which has been sent from the transport unit 18 to the stacking wheel 72, has a high elastic hardness, when the banknote is received between a pair of vanes 76 of the stacking wheel 72, the vanes 76 are resiliently deformed, so that the banknote is firmly held between the pair of vanes 76. At this time, the banknote is slightly curved by the projection 77 so as to be elasticized.

[0072] On the other hand, in a case where a banknote, which has been transported from the transport unit 18 to the stacking wheel 72, has a low elastic hardness, when the banknote is received between a pair of vanes 76 of the stacking wheel 72, the banknote is inserted deeply between the vanes 76. At this time, the banknote is lightly held between the vanes 76. In addition, at this time, the banknote is widely curved by the projection 77 so as to be elasticized.

[0073] Thereafter, the banknote having been received between the pair of vanes 76 of the stacking wheel 72 is released from between the vanes 76 and is sent to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, from the stacking wheel 72 to the stacking unit 30 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0074] As described above, similarly to the stacking

wheel 52 shown in Figs. 4 to 9, in the stacking wheel 72 shown in Figs. 10 and 11, the projection 77 is provided on at least one of the inner surface and the outer surface of each vane 76. Each pair of vanes 76 adjacent to each other in the circumferential direction of the base body unit 74 is configured such that, when viewed from the axial direction of the base body unit 74, the projection 77 of the one vane 76 is overlapped with the other vane 76, and that the projection 77 of the one vane 76 and the other vane 76 are not in contact with each other. Thus, when a banknote having been sent to the stacking wheel 72 is received between a pair of adjacent vanes 76, the banknote is curved by the projection 77 provided on the inner surface or the outer surface of each vane 76 so as to be elasticized. In this manner, in either case where an elastic hardness of a banknote, which has been transported from the transport unit 18 to the stacking wheel 72, is high or low, the banknote can be securely held between the pair of vanes 76. Accordingly, it can be restrained that a banknote received between the pair of vanes 76 jumps out erroneously from the pair of vanes 76, regardless of an inherent elastic hardness of the banknote.

[0075] In addition, still another embodiment of the stacking wheel disposed in the banknote handling apparatus 10 is described with reference to Figs. 12 and 13. Fig. 12 is a perspective view showing still another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment, and Fig. 13 is a perspective view showing a structure of a vane disposed in the stacking wheel shown in Fig. 12.

[0076] As shown in Fig. 12, a stacking wheel 82 in another alternative example includes a cylindrical base body unit 84, and a plurality of vanes 86 extending outward from an outer circumferential surface of the base body unit 84 in a direction opposite to a rotating direction of the stacking wheel 82. A banknote is received between a pair of vanes 86 adjacent to each other in a circumferential direction of the base body unit 84. All the vanes 86 disposed on the stacking wheel 82 have the same shape. A bearing unit 83 is disposed on a center of the base body unit 84 so that a shaft (not shown) is borne by the bearing unit 83. When a drive unit (not shown) rotates the shaft, the stacking wheel 82 is rotated.

[0077] Each vane 86 on the stacking wheel 82 in the alternative example may be integral with the base body unit 84, or each vane 86 may be detachably attached to the outer circumferential surface of the base body unit 84.

[0078] In addition, as shown in Figs. 12 and 13, a projection 87 is provided on an inner surface of each vane 86. In addition, each vane 86 is provided with an opening 88. As shown in Fig. 12, each pair of vanes 86 adjacent to each other in the circumferential direction of the base body unit 84 is configured such that, when viewed from a normal direction of the base body unit 84, the projection 87 of the one vane 86 is opposed to the opening 88 of the other vane 86. To be specific, the pair of adjacent vanes 86 are configured such that the projection 87 of

the one vane 86 extends up to the opening 88 of the other vane 86 or extends through the opening 88. Thus, the projection 87 of the one vane 86 is not in contact with the other vane 86.

[0079] In this manner, each pair of adjacent vanes 86 is configured such that, when viewed from an axial direction of the base body unit 84, the projection 87 of the one vane 86 is overlapped with the other vane 86. In addition, each pair of adjacent vanes 86 is configured such that, when viewed from the normal direction of the base body unit 84, the projection 87 of the one vane 86 is positioned within a range of the opening 88 of the other vane 86. Thus, the projection 87 of the one vane 86 is not in contact with the other vane 86.

[0080] In the stacking wheel 82 in the alternative example, instead of the structure in which the projection 87 is provided on the inner surface of the vane 86, the projection 87 may be provided on an outer surface of the vane 86. When the projection 87 is provided on the outer surface of the vane 86, the positions of the projection 87 and the opening 88 are reversed. Namely, the projection 87 and the opening 88 are formed in this order from the side of the base body unit 84 to a distal end of the vane. Also in this case, each pair of vanes 86 adjacent to each other in the circumferential direction of the base body unit 84 is configured such that, when viewed from the normal direction of the base body unit 84, the projection 87 of the one vane 86 is opposed to the opening 88 of the other vane 86.

[0081] In addition, in the stacking wheel 82 in the alternative example, instead of the structure in which the opening 88 is provided in each vane 86, a cutout may be provided in each vane 86. Also in this case, each pair of adjacent vanes 86 is configured such that the projection 87 of the one vane 86 extends up to the cutout formed in the other vane 86 or extends through the cutout.

[0082] In addition, in the stacking wheel 82 in the alternative example, each vane 86 is formed to be resiliently deformable. Specifically, each vane 86 is formed of a resiliently deformable material such as resin rubber, or each vane 86 is attached to the base body unit 84 so as to be resiliently deformable.

[0083] When a banknote is sent from the transport unit 18 to the stacking wheel 82 shown in Figs. 12 and 13, the banknote is received between a pair of adjacent vanes 86. At this time, the pair of adjacent vanes 86 are configured such that, when viewed from the axial direction of the base body unit 84, the projection 87 of the one vane 86 is overlapped with the other vane 86. Thus, the banknote received between the pair of vanes 86 is curved by the projection 87 so as to be elasticized.

[0084] To be more specific, in a case where a banknote, which has been sent from the transport unit 18 to the stacking wheel 82, has a high elastic hardness, when the banknote is received between the pair of vanes 86 of the stacking wheel 82, the vanes 86 are resiliently deformed, so that the banknote is firmly held between the pair of vanes 86. At this time, the banknote is slightly

curved by the projection 87 so as to be elasticized.

[0085] On the other hand, in a case where a banknote, which has been transported from the transport unit 18 to the stacking wheel 82, has a low elastic hardness, when the banknote is received between a pair of vanes 86 of the stacking wheel 82, the banknote is inserted deeply between the vanes 86. At this time, the banknote is lightly held between the vanes 86. In addition, at this time, the banknote is widely curved by the projection 87 so as to be elasticized.

[0086] Thereafter, the banknote having been received between the pair of vanes 86 of the stacking wheel 82 is released from between the vanes 86 and is sent to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, from the stacking wheel 82 to the stacking unit 30 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0087] As described above, similarly to the stacking wheel 52 shown in Figs. 4 to 9, in the stacking wheel 82 shown in Figs. 12 and 13, the projection 87 is provided on at least one of the inner surface and the outer surface of each vane 86. Each pair of vanes 86 adjacent to each other in the circumferential direction of the base body unit 84 is configured such that, when viewed from the axial direction of the base body unit 84, the projection 87 of the one vane 86 is overlapped with the other vane 86, and that the projection 87 of the one vane 86 and the other vane 86 are not in contact with each other. Thus, when a banknote having been sent to the stacking wheel 82 is received between a pair of adjacent vanes 86, the banknote is curved by the projection 87 provided on the inner surface or the outer surface of each vane 86 so as to be elasticized. In this manner, in either case where an elastic hardness of a banknote, which has been transported from the transport unit 18 to the stacking wheel 82, is high or low, the banknote can be securely held between the pair of vanes 86. Accordingly, it can be restrained that a banknote received between the pair of vanes 86 jumps out erroneously from the pair of vanes 86, regardless of an inherent elastic hardness of the banknote.

[0088] Next, yet another alternative example in which all the vanes disposed on the stacking wheel have the same shape is described with reference to Figs. 14 and 15. Fig. 14 is a side view showing yet another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment, and Fig. 15 is a perspective view showing a structure of a vane disposed on the stacking wheel shown in Fig. 14.

[0089] As shown in Fig. 14, a stacking wheel 92 in yet another alternative example includes a cylindrical base body unit 94, and a plurality of vanes 96 extending outward from an outer circumferential surface of the base body unit 94 in a direction opposite to a rotating direction of the stacking wheel 92. A banknote is received between a pair of vanes 96 adjacent to each other in a circumferential direction of the base body unit 94. As described above, all the vanes 96 disposed on the stacking wheel

92 have the same shape. In addition, a bearing unit 93 is disposed on a center of the base body unit 94 so that a shaft (not shown) is borne by the bearing unit 93. When a drive unit (not shown) rotates the shaft, the stacking wheel 92 is rotated.

[0090] Each vane 96 on the stacking wheel 92 in the further alternative example may be integral with the base body unit 94, or each vane 96 may be detachably attached to the outer circumferential surface of the base body unit 94.

[0091] In the stacking wheel 92 in the further alternative example shown in Figs. 14 and 15, a projection is not provided on each vane 96. However, a portion of each vane 96 near to a distal end of each vane 96 is curved in a V-shape or U-shape toward an inside of the vane 96. In Figs. 14 and 15, the portion of the vane 96, which is near to the distal end and is curved inward in a V-shape or U-shape, is indicated by the reference number 97. In addition, each vane is provided with an opening 98. The curved portion 97, which is a specific portion in one vane 96, is opposed to the opening 98 of the other vane 96. Specifically, each pair of adjacent vanes 96 is configured such that the curved portion 97 of the one vane 96 extends up to the opening 98 of the other vane 96 or extends through the opening 98. Thus, the curved portion 97 of the one vane 96 is not in contact with the other vane 96.

[0092] In this manner, each pair of adjacent vanes 96 is configured such that, when viewed from an axial direction of the base body unit 94, the curved portion 97 of the one vane 96 is overlapped with the other vane 96. In addition, each pair of adjacent vanes 96 is configured such that, when viewed from a normal direction of the base body unit 94, the curved portion 97 of the one vane 96 is positioned within a range of the opening 98 of the other vane 96. Thus, the curved portion 97 is not in contact with the other vane 96.

[0093] In the stacking wheel 92 in the further alternative example, instead of the structure in which the opening 98 is provided in each vane 96, a cutout may be provided in each vane 96. Also in this case, each pair of adjacent vanes 96 may be configured such that the curved portion 97 of the one vane 96 extends up to the opening formed in the other vane 96 or extends through the opening.

[0094] In addition, in the stacking wheel 92 in the alternative example, each vane 96 is formed to be resiliently deformable. Specifically, each vane 96 is formed of a resiliently deformable material such as resin rubber, or each vane 96 is attached to the base body unit 94 so as to be resiliently deformable.

[0095] When a banknote is sent from the transport unit 18 to the stacking wheel 92 shown in Figs. 14 and 15, the banknote is received between a pair of adjacent vanes 96. At this time, the pair of adjacent vanes 96 are configured such that, when viewed from the axial direction of the base body unit 94, the curved portion 97 of the one vane 96 is overlapped with the other vane 96. Thus, the banknote received between the pair of vanes 96 is curved by the curved portion 97 of the one vane 96

so as to be elasticized.

[0096] To be more specific, in a case where a banknote, which has been sent from the transport unit 18 to the stacking wheel 92, has a high elastic hardness, when the banknote is received between the pair of vanes 96 of the stacking wheel 92, the vanes 96 are resiliently deformed, so that the banknote is firmly held between the pair of vanes 96. At this time, the banknote is slightly curved by the curved portion 97 of the one vane 96 so as to be elasticized.

[0097] On the other hand, in a case where a banknote, which has been transported from the transport unit 18 to the stacking wheel 92, has a low elastic hardness, when the banknote is received between a pair of vanes 96 of the stacking wheel 92, the banknote is inserted deeply between the vanes 96. At this time, the banknote is lightly held between the vanes 96. In addition, at this time, the banknote is widely curved by the curved portion 97 of the one vane 96 so as to be elasticized.

[0098] Thereafter, the banknote having been received between the pair of vanes 96 of the stacking wheel 92 is released from between the vanes 96 and is sent to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, from the stacking wheel 92 to the stacking unit 30 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0099] As described above, in the stacking wheel 92 shown in Figs. 14 and 15, each pair of vanes 96 adjacent to each other in the circumferential direction of the base body unit 94 is configured such that, when viewed from the axial direction of the base body unit 94, the curved portion 97 which is a specific portion of the one vane 96 is overlapped with the other vane 96, and that the aforementioned curved portion 97 of the one vane 96 and the other vane 96 are not in contact with each other. Thus, when a banknote having been sent to the stacking wheel 92 is received between a pair of adjacent vanes 96, the banknote is curved by the curved portion 97 of each vane 96 so as to be elasticized. In this manner, in either case where an elastic hardness of a banknote, which has been transported from the transport unit 18 to the stacking wheel 92, is high or low, the banknote can be securely held between the pair of vanes 96. Accordingly, it can be restrained that a banknote received between the pair of vanes 96 jumps out erroneously from the pair of vanes 96, regardless of an inherent elastic hardness of the banknote.

[0100] Next, further another structure of the stacking wheel disposed in the banknote handling apparatus 10 is described with reference to Figs. 16 to 18. Fig. 16 is a sectional view showing further another structure of the stacking wheel disposed in the banknote handling apparatus in this embodiment. Fig. 17 is a sectional view showing a structure of a vane disposed on the stacking wheel shown in Fig. 16. Fig. 18(a) is a perspective view showing a structure of the vane disposed on the stacking wheel shown in Fig. 16 when the vane is viewed from outside, and Fig. 18(b) is a perspective view thereof when the

vane is viewed from inside.

[0101] As shown in Fig. 16, a stacking wheel 102 in further another alternative example includes a cylindrical base body unit 104, and a plurality of vanes 106 extending outward from an outer circumferential surface of the base body unit 104 in a direction opposite to a rotating direction of the stacking wheel 102. A banknote is received between a pair of vanes 106 adjacent to each other in a circumferential direction of the base body unit 104. All the vanes 106 disposed on the stacking wheel 102 have the same shape. A bearing unit 103 is disposed on a center of the base body unit 104 so that a shaft (not shown) is borne by the bearing unit 103. When a drive unit (not shown) drives the shaft, the stacking wheel 102 is rotated.

[0102] Each vane 106 on the stacking wheel 102 in the further alternative example may be integral with the base body unit 104, or each vane 106 may be detachably attached to the outer circumferential surface of the base body unit 104.

[0103] In addition, as shown in Figs. 17 and 18(b), in the stacking wheel in the further alternative example, a projection 107 is provided on an inner surface of each vane 106. In addition, as shown in Figs. 17 and 18(a), each vane 106 is provided with a recess 108 in a surface not provided with the projection 107, i.e., in an outer surface of the vane 106, into which the projection 107 of the adjacent vane 106 can enter. To be more specific, as shown in Fig. 16, each pair of vanes 106 adjacent to each other in the circumferential direction of the base body unit 104 is configured such that, when viewed from a normal direction of the base body unit 104, the projection 107 of the one vane 106 is opposed to the recess 108 of the other vane 106. Each pair of adjacent vanes 106 is configured such that the projection 107 of the one vane 106 enters into the recess 108 of the other vane 106. Thus, the projection 107 of the one vane 106 is not in contact with the other vane 106.

[0104] In this manner, each pair of adjacent vanes 106 is configured such that, since the projection 107 of the one vane 106 enters into the recess 108 of the other vane 106, when viewed from an axial direction of the base body unit 104, the projection 107 of the one vane 106 is overlapped with the other vane 106. In addition, the projection 107 of the one vane 106 is not in contact with the other vane 106.

[0105] In the stacking wheel 102 in the alternative example, instead of the structure in which the projection 107 is provided on the inner surface of the vane 106, the projection 107 may be provided on an outer surface of the vane 106. When the projection 107 is provided on the outer surface of the vane 106, the positions of the projection 107 and the recess 108 are reversed. Namely, the projection 107 and the recess 108 are formed in this order from the side of the base body unit 104 to a distal end of the vane. Also in this case, each pair of vanes 106 adjacent to each other in the circumferential direction of the base body unit 104 is configured such that the

projection 107 of the one vane 160 enters into the recess 108 of the other vane 106.

[0106] In addition, in the stacking wheel 102 in the alternative example, each vane 106 is formed to be resiliently deformable. Specifically, each vane 106 is formed of a resiliently deformable material such as resin rubber, or each vane 106 is attached to the base body unit 104 so as to be resiliently deformable.

[0107] When a banknote is sent from the transport unit 18 to the stacking wheel 102 shown in Figs. 16 to 18, the banknote is received between a pair of adjacent vanes 106. At this time, the pair of adjacent vanes 106 are configured such that, when viewed from the axial direction of the base body unit 104, the projection 107 of the one vane 106 is overlapped with the other vane 106. Thus, the banknote received between the pair of vanes 106 is curved by the projection 107 so as to be elasticized.

[0108] To be more specific, in a case where a banknote, which has been sent from the transport unit 18 to the stacking wheel 102, has a high elastic hardness, when the banknote is received between the pair of vanes 106 of the stacking wheel 102, the vanes 106 are resiliently deformed, so that the banknote is firmly held between the pair of vanes 106. At this time, the banknote is slightly curved by the projection 107 so as to be elasticized.

[0109] On the other hand, in a case where a banknote, which has been transported from the transport unit 18 to the stacking wheel 102, has a low elastic hardness, when the banknote is received between a pair of vanes 106 of the stacking wheel 102, the banknote is inserted deeply between the vanes 106. At this time, the banknote is lightly held between the vanes 106. In addition, at this time, the banknote is widely curved by the projection 107 so as to be elasticized.

[0110] Thereafter, the banknote having been received between the pair of vanes 106 of the stacking wheel 102 is released from between the vanes 106 and is sent to the stacking unit 30. In this manner, a plurality of banknotes are sent, one by one, from the stacking wheel 102 to the stacking unit 30 in such a manner that the banknotes are stacked in an aligned state in the stacking unit 30.

[0111] As described above, similarly to the stacking wheel 52 shown in Figs. 4 to 9, in the stacking wheel 102 shown in Figs. 16 to 18, the projection 107 is provided on at least one of the inner surface and the outer surface of each vane 106. Each pair of vanes 106 adjacent to each other in the circumferential direction of the base body unit 104 is configured such that, when viewed from the axial direction of the base body unit 104, the projection 107 of the one vane 106 is overlapped with the other vane 106, and that the projection 107 of the one vane 106 and the other vane 106 are not in contact with each other. In addition, each vane 106 is provided with the recess 108 in a surface not provided with the projection 107, into which the projection 107 of the adjacent vane 106 enters. Thus, when a banknote having been sent to

the stacking wheel 102 is received between a pair of adjacent vanes 106, the banknote is curved by the projection 107 provided on the inner surface or the outer surface of each vane 106 so as to be elasticized. In this manner, in either case where an elastic hardness of a banknote, which has been transported from the transport unit 18 to the stacking wheel 102, is high or low, the banknote can be securely held between the pair of vanes 106. Accordingly, it can be restrained that a banknote received between the pair of vanes 106 jumps out erroneously from the pair of vanes 106, regardless of an inherent elastic hardness of the banknote.

[0112] Next, a method of manufacturing the stacking wheel in this embodiment is described. As an example of the method of manufacturing the stacking wheel in this embodiment, a method of manufacturing the stacking wheel 52 shown in Fig. 5, which is of a type where the first vane 56a and the second vane 56b are integral with the base body unit 54, is described herebelow.

[0113] A pair of dies each having a cavity therein are firstly prepared. A shape defined by the cavities formed in the pair of dies corresponds to the stacking wheel 52 shown in Fig. 5.

[0114] Then, the pair of dies are die-matched, and a molding material is injected into the cavities of the pair of dies. A resiliently deformable material, such as resin rubber, is used as the molding material.

[0115] After the molding material has been injected into the cavities in the pair of dies, the molding material is solidified by cooling these dies. Thereafter, the pair of dies are decoupled, so that the stacking wheel 52 made of the molding material, such as a resiliently deformable material, can be obtained. Specifically, in the thus obtained stacking wheel 52, a pair of vanes 56a and 56b, which are adjacent to each other in the circumferential direction of the base body unit 54, are symmetrical in shape in the right and left direction. The projection 57 is provided on at least one of the inner surface or the outer surface of each of the vanes 56a and 56b. Each of the vanes 56a and 56b is provided with a cutout. Each pair of vanes 56a and 56b adjacent to each other in the circumferential direction of the base body unit 54 is configured such that, when viewed from the axial direction of the base body unit 54, the projection 57 of the one vane (e.g., the first vane 56a) and the other vane (e.g., the second vane 56b) are overlapped with each other, and that the projection 57 of the one vane (e.g., the first vane 56a) and the other vane (e.g., the second vane 56b) are not in contact with each other.

[0116] In the method of manufacturing the stacking wheel including: preparing a pair of dies each having a cavity therein; die-matching the pair of dies and injecting a molding material into the cavities in the pair of dies; and decoupling the pair of dies to obtain a stacking wheel formed of the molding material, in addition to the stacking wheel 52 shown in Fig. 5, various stacking wheels as described above, for example, the stacking wheel 72 shown in Fig. 10 can be manufactured.

[0117] In the stacking wheel and the paper-sheet stacking apparatus according to the present invention, an object to be handled is not limited to a banknote. Another type of paper sheet, such as a check, may be used as an object to be handled.

Claims

1. A stacking wheel comprising:

a cylindrical base body unit; and
a plurality of vanes disposed outward from an outer circumferential surface of the base body unit, at equal intervals therebetween in a circumferential direction of the base body unit, such that a paper sheet is received between a pair of vanes adjacent to each other in the circumferential direction;
wherein:

a projection is provided on at least one of an inner surface or an outer surface of each vane; and
each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from an axial direction of the base body unit, the projection of the one vane and the other vane are overlapped with each other, and that the projection of the one vane and the other vane are not in contact with each other.

2. The stacking wheel according to claim 1, wherein a pair of vanes adjacent to each other in the circumferential direction of the base body unit are symmetrical in shape in a right and left direction.

3. The stacking wheel according to claim 1, wherein the respective vanes have the same shape.

4. The stacking wheel according to any one of claims 1 to 3, wherein:

each vane has an opening or a cutout; and
a pair of vanes adjacent to each other in the circumferential direction of the base body unit are configured such that the projection of the one vane is opposed to the opening or the cutout of the other vane when viewed from a normal direction of the base body unit.

5. The stacking wheel according to claim 3, wherein a pair of vanes adjacent to each other in the circumferential direction of the base body unit are located on positions displaced from each other in the axial direction of the base body unit.

6. The stacking wheel according to claim 1, wherein each vane has a recess in a surface not provided with the projection, such that the projection of the adjacent vane enters into the recess.

7. The stacking wheel according to claim 6, wherein the projection is provided on the inner surface of each vane, and the recess is provided in the outer surface of each vane.

8. The stacking wheel according to any one of claims 1 to 7, wherein the vanes are formed to be resiliently deformable.

9. A stacking wheel comprising:

a cylindrical base body unit; and
a plurality of vanes disposed outward from an outer circumferential surface of the base body unit, at equal intervals therebetween in a circumferential direction of the base body unit, such that a paper sheet is received between a pair of vanes adjacent to each other in the circumferential direction;
wherein each pair of vanes adjacent to each other in the circumferential direction of the base body unit is configured such that, when viewed from an axial direction of the base body unit, a specific portion of the one vane and the other vane are overlapped with each other, and that the specific portion of the one vane and the other vane are not in contact with each other.

10. The stacking wheel according to any one of claims 1 to 9, wherein each vane is integral with the base body unit.

11. The stacking wheel according to any one of claims 1 to 9, wherein each vane is detachably attached to the outer circumferential surface of the base body unit.

12. A paper-sheet stacking apparatus comprising:

a stacking unit in which paper sheets are stacked; and
the stacking wheel according to any one of claims 1 to 11 disposed on the stacking unit;
wherein a paper sheet having been sent from outside the stacking unit to the stacking unit is firstly received between a pair of vanes adjacent to each other in the circumferential direction of the base body unit of the stacking wheel, and then the paper sheet between the pair of vanes of the stacking wheel is released from the stacking wheel so as to be stacked in the stacking unit.

13. A method of manufacturing the stacking wheel ac-

according to claim 10, the method comprising;
preparing a pair of dies each having a cavity therein;
die-matching the pair of dies and injecting a molding
material into the cavities in the pair of dies; and
decoupling the pair of dies to obtain a stacking wheel 5
formed of the molding material.

14. The method of manufacturing the stacking wheel according to claim 13, wherein
in obtaining the stacking wheel formed of the molding material, each pair of vanes adjacent to each other 10
in the circumferential direction of the base body unit are symmetrical in shape in a right and left direction,
a projection is provided on at least one of an inner surface or an outer surface of each vane, a cutout 15
is provided in each vane, and each pair of vanes adjacent to each other in the circumferential direction
of the base body unit is configured such that, when viewed from an axial direction of the base body unit,
the projection of the one vane and the other vane 20
are overlapped with each other, and that the projection of the one vane and the other vane are not in
contact with each other.

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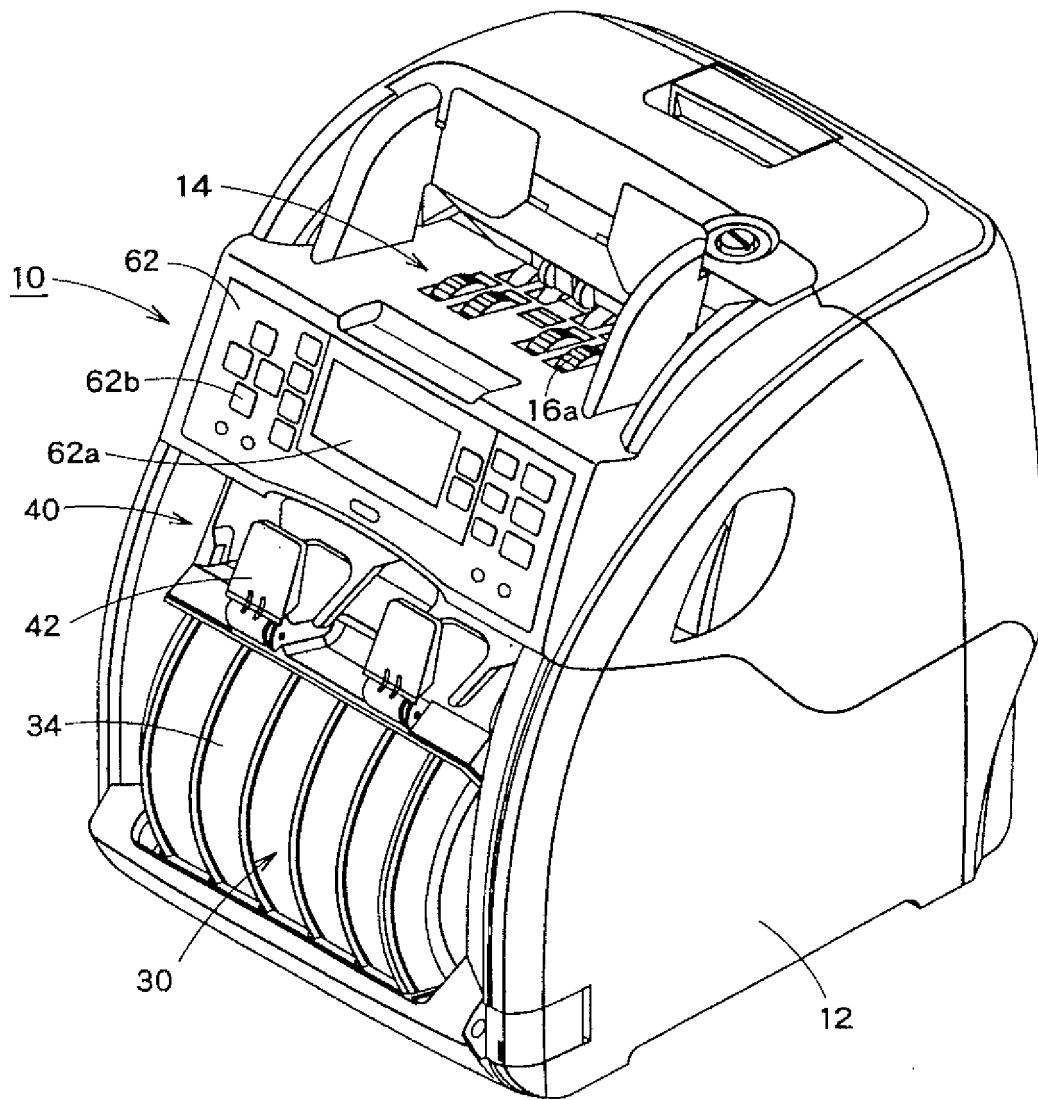


FIG. 1

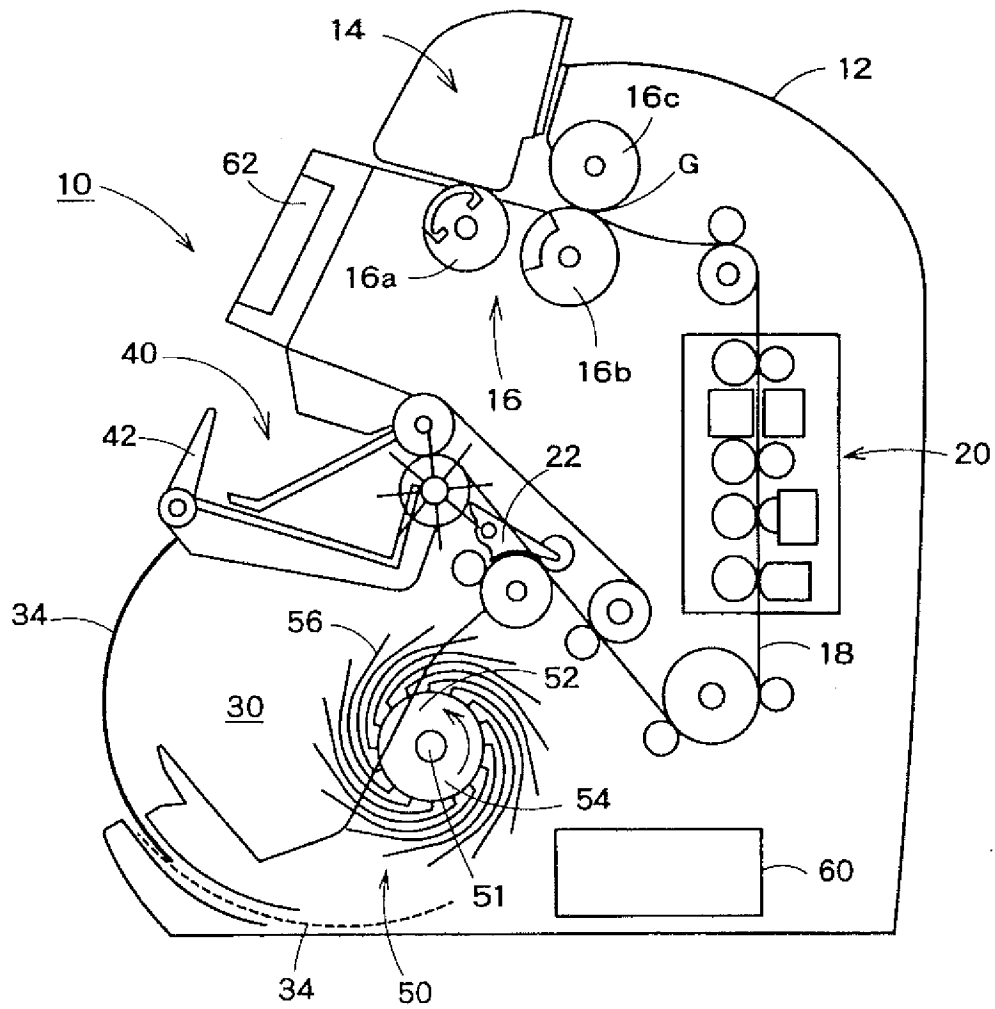


FIG. 2

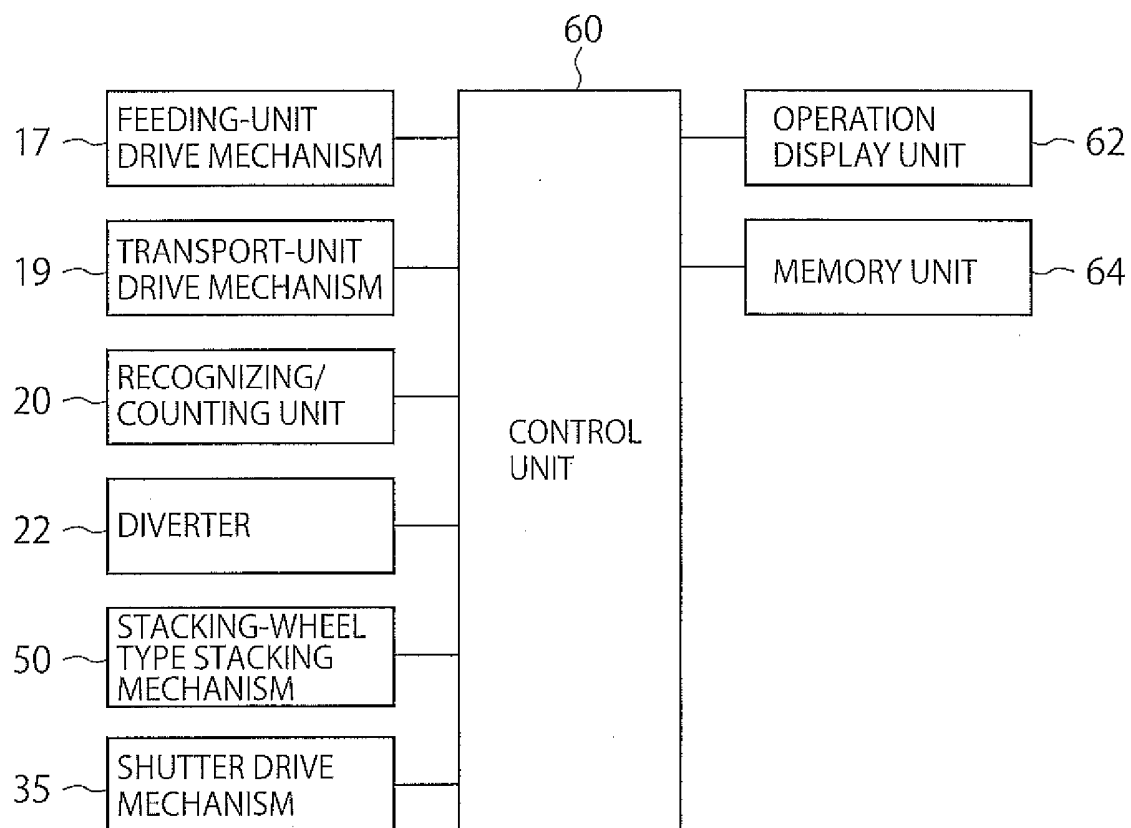


FIG. 3

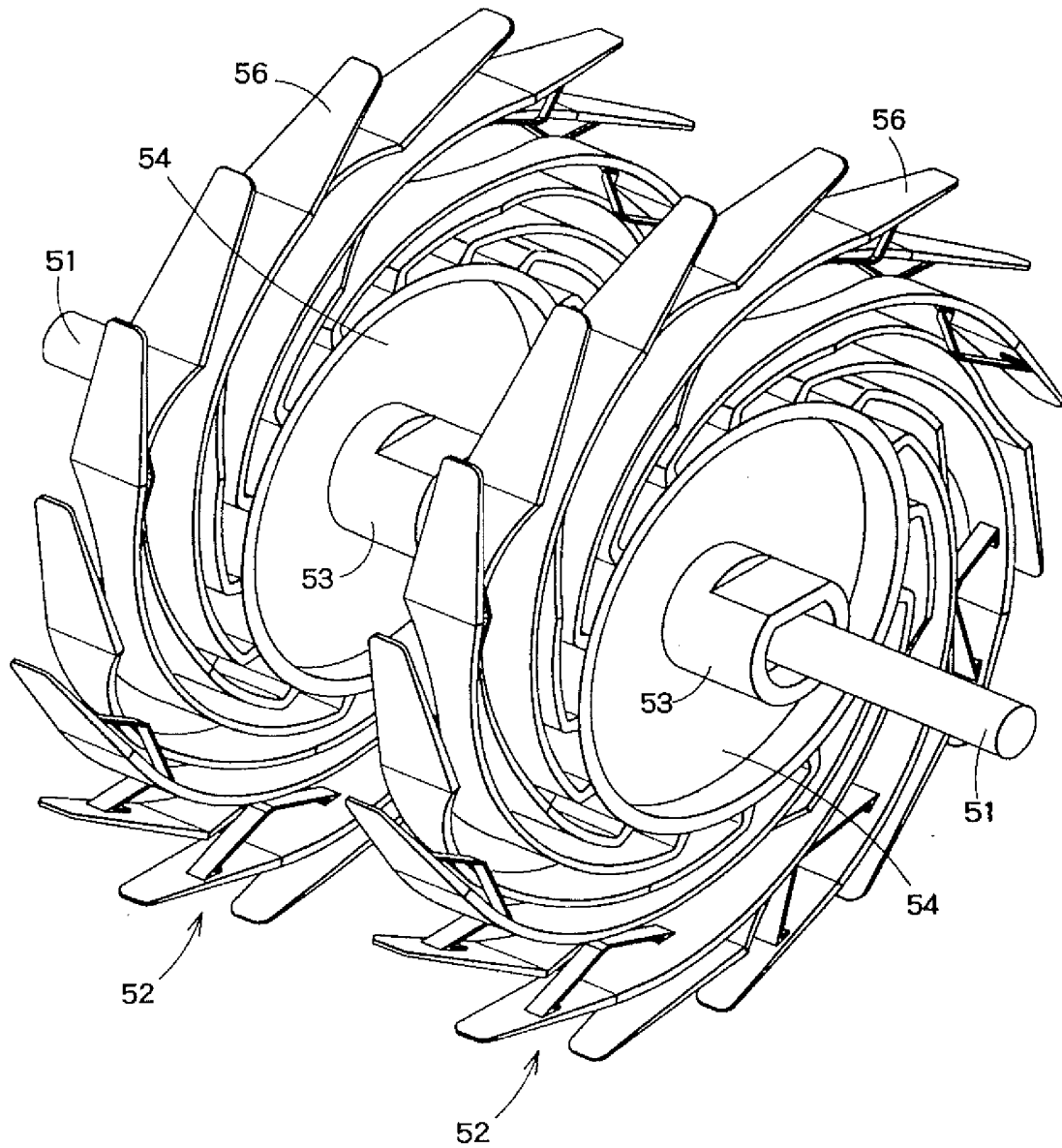


FIG. 4

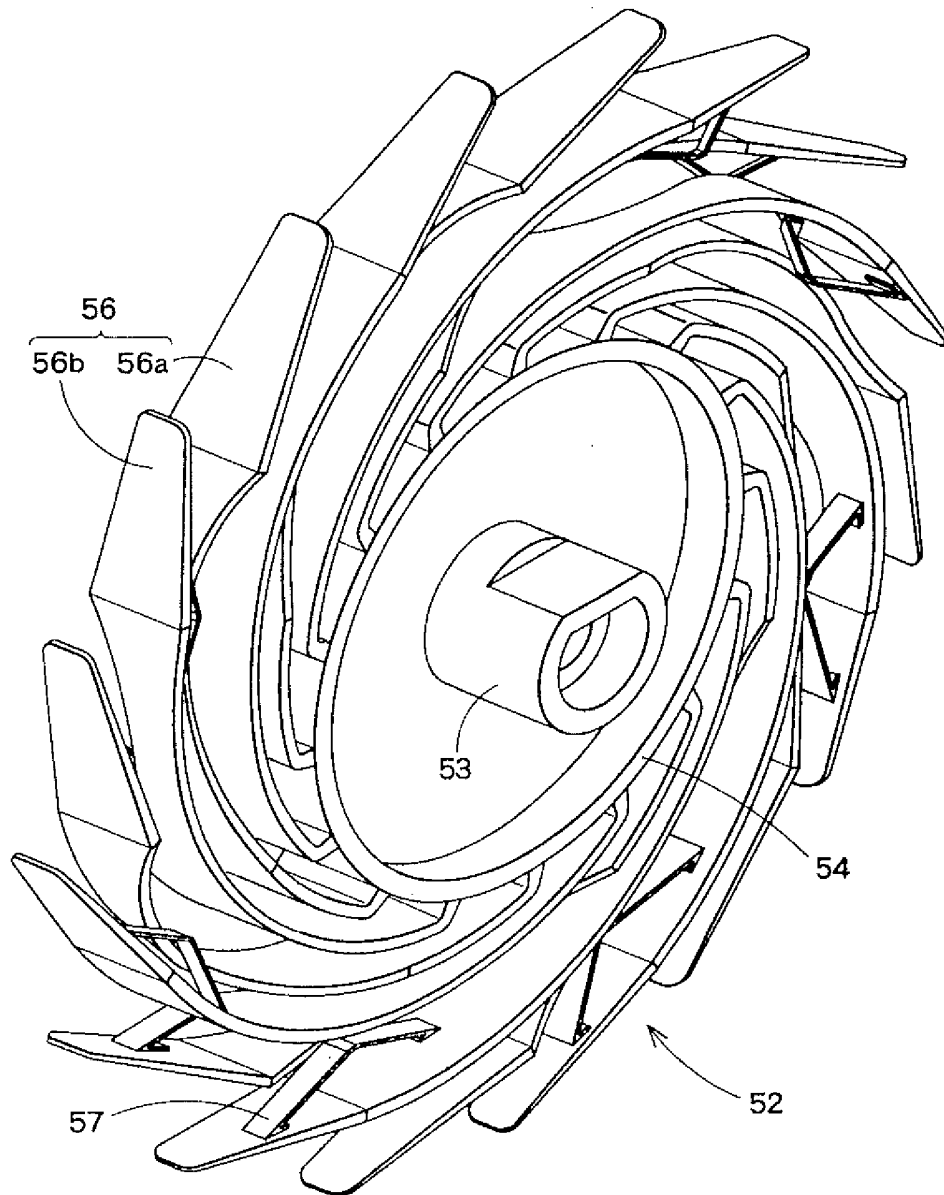


FIG. 5

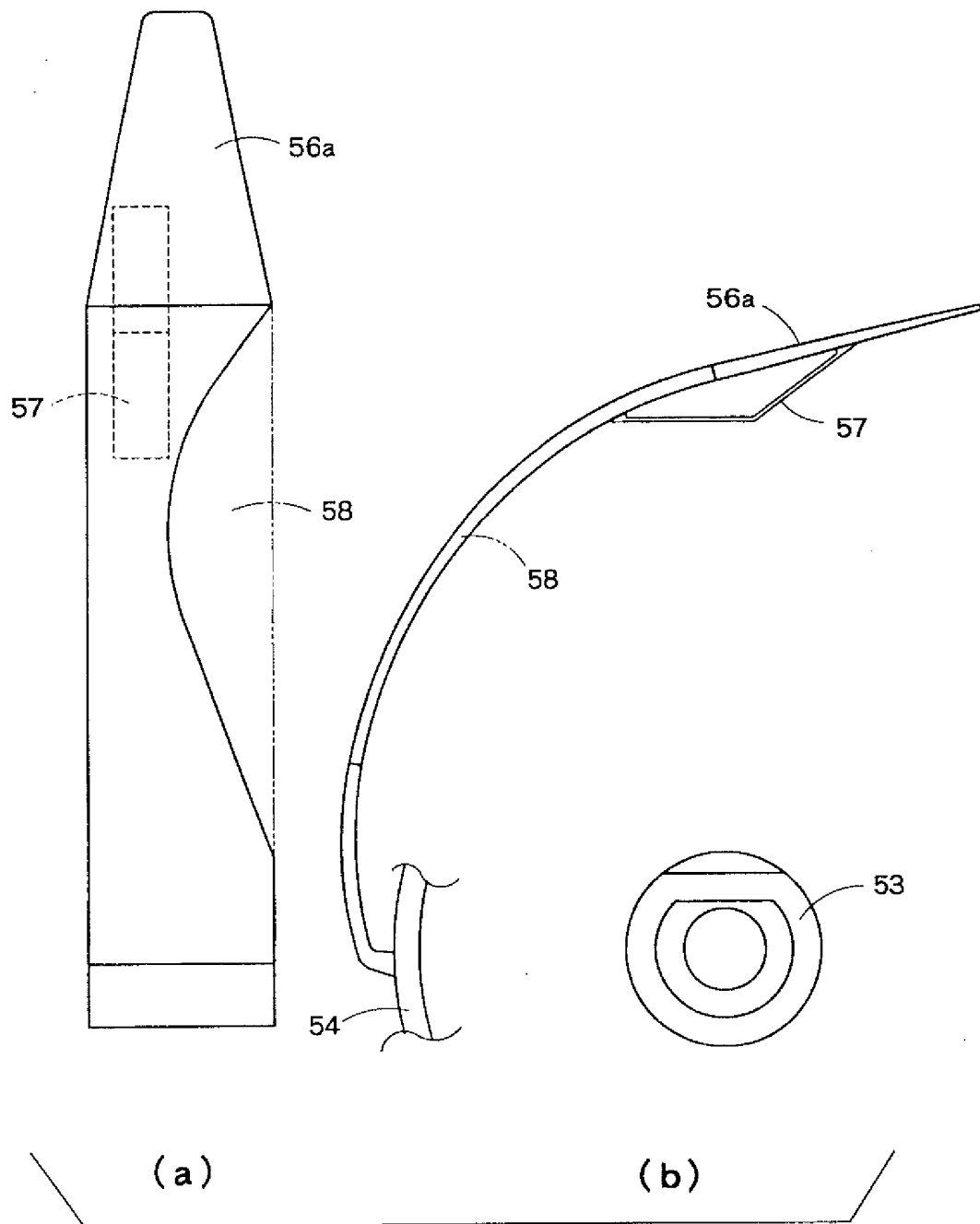


FIG. 6

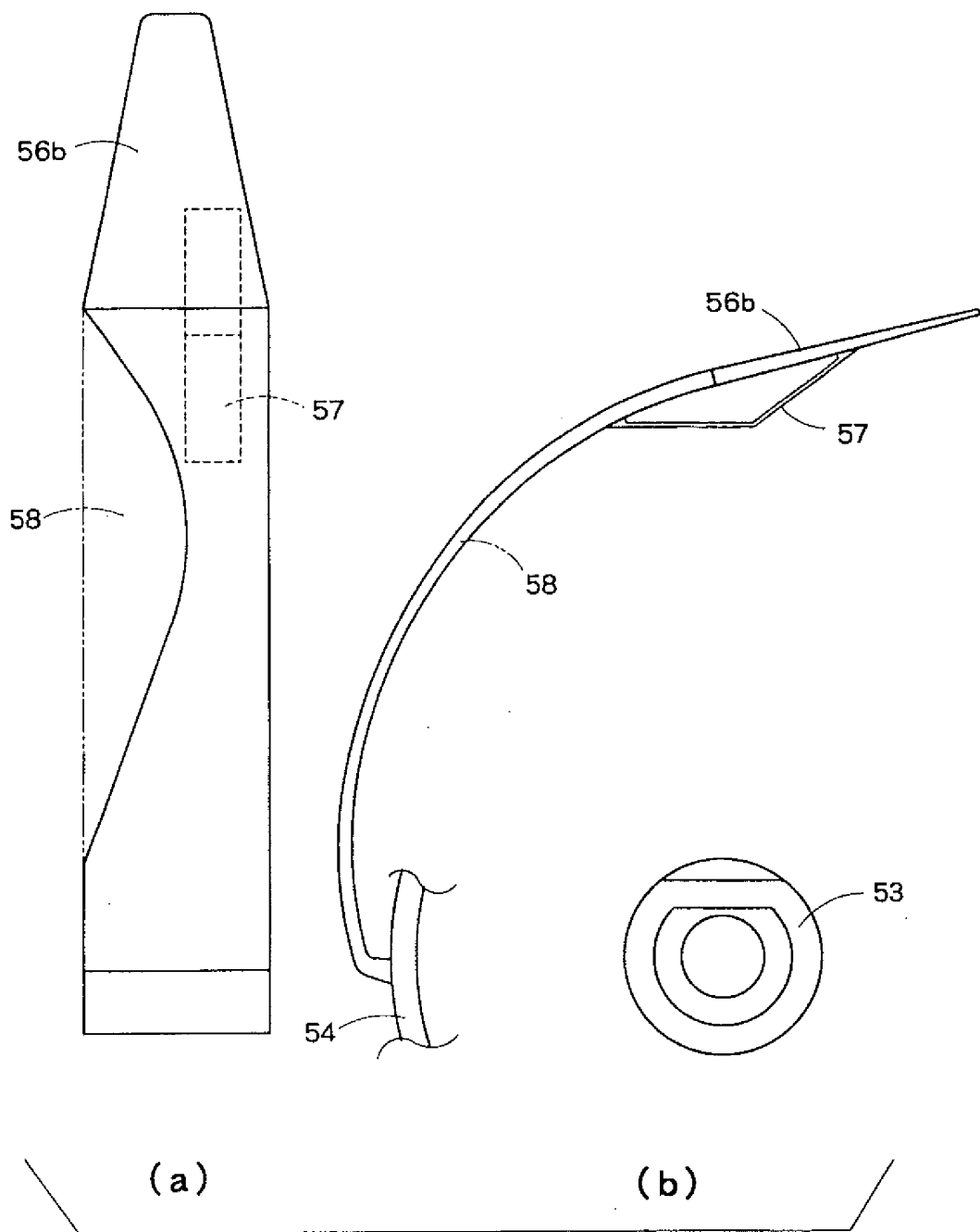


FIG. 7

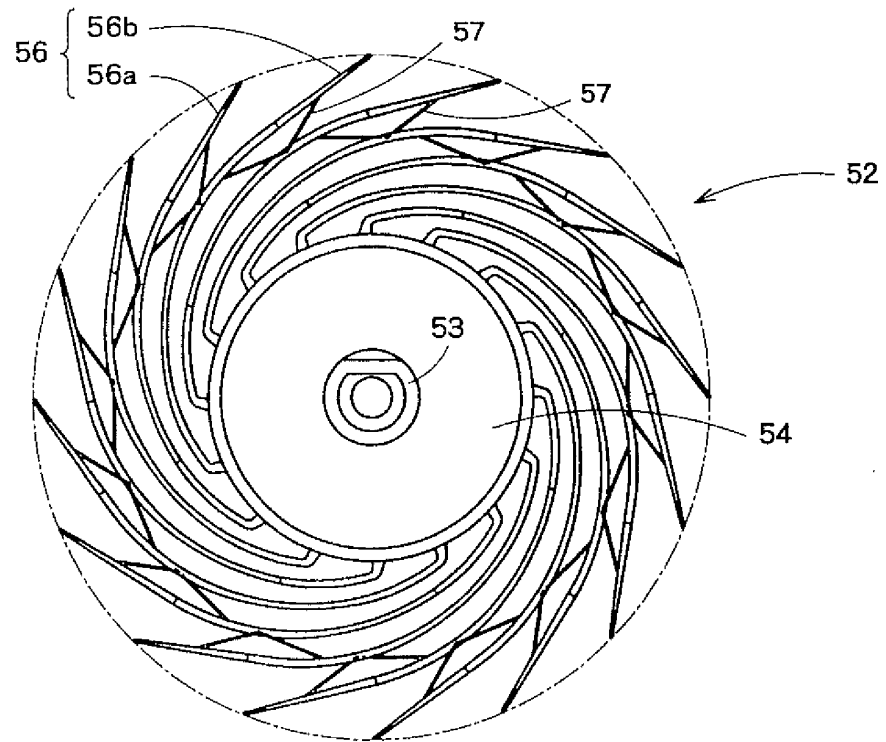


FIG. 8

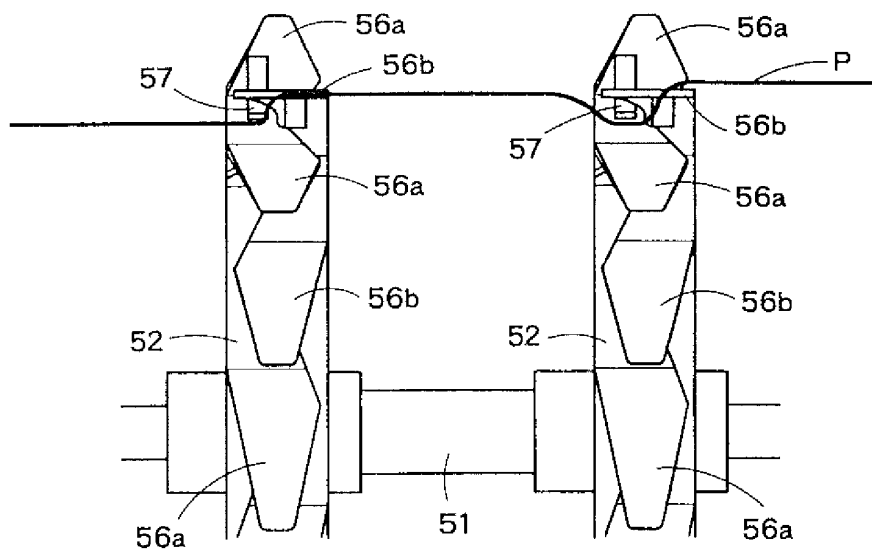


FIG. 9

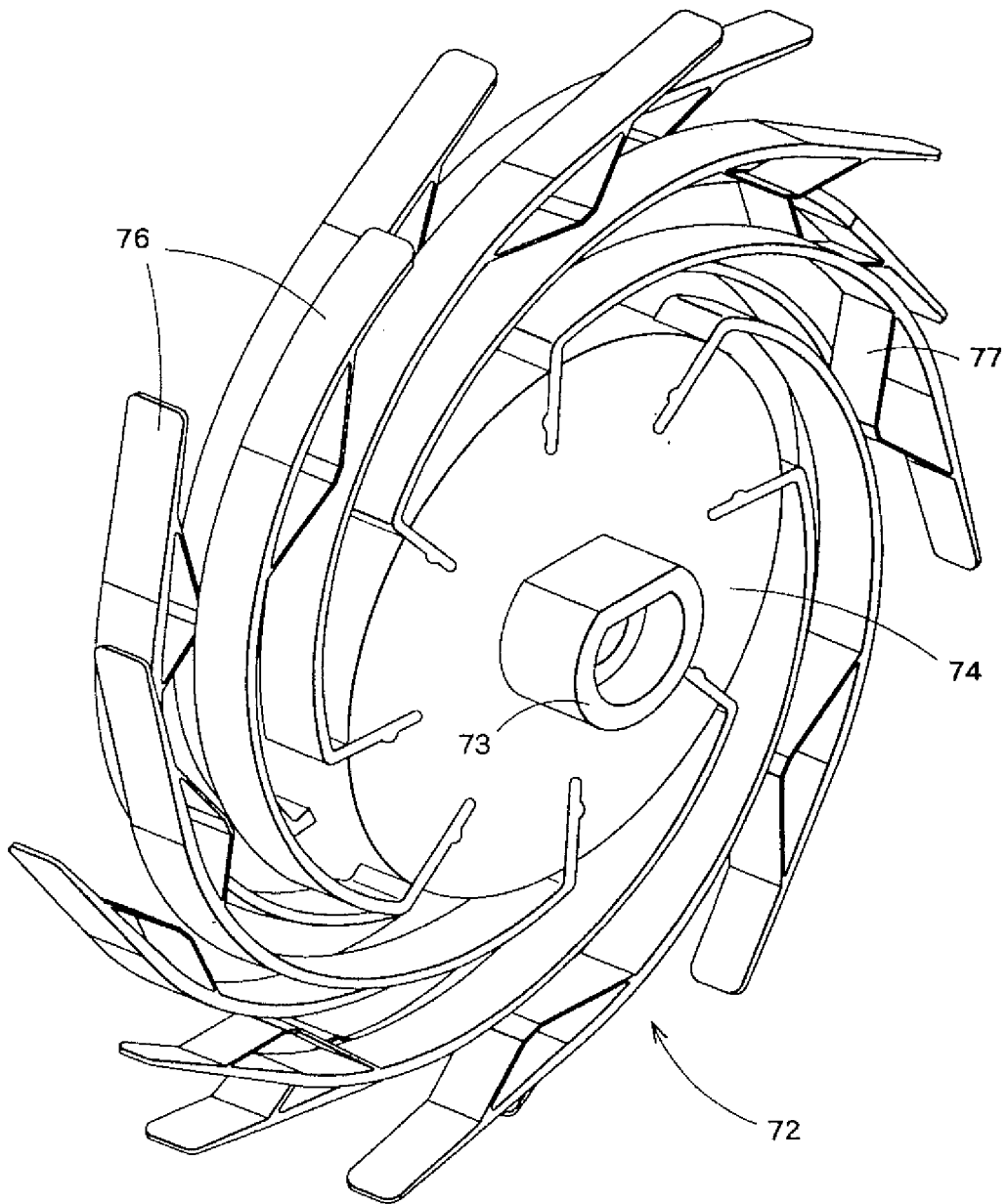


FIG. 10

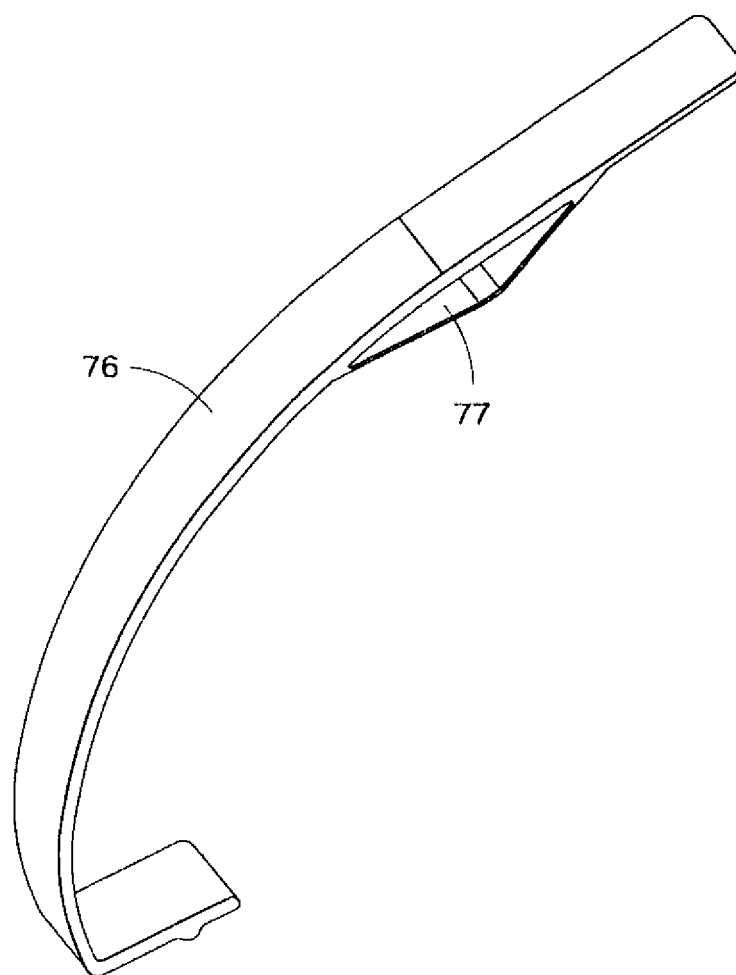


FIG. 11

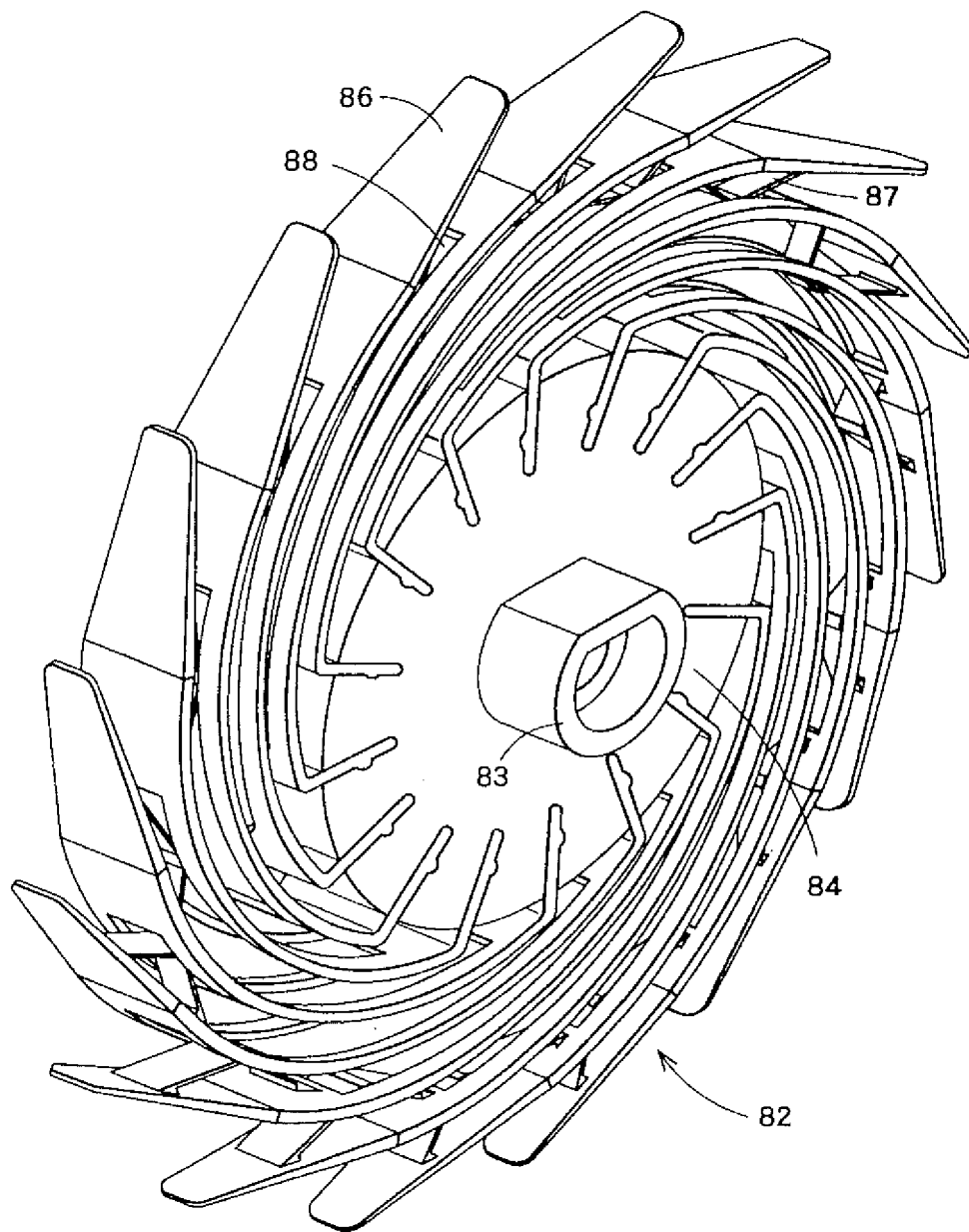


FIG. 12

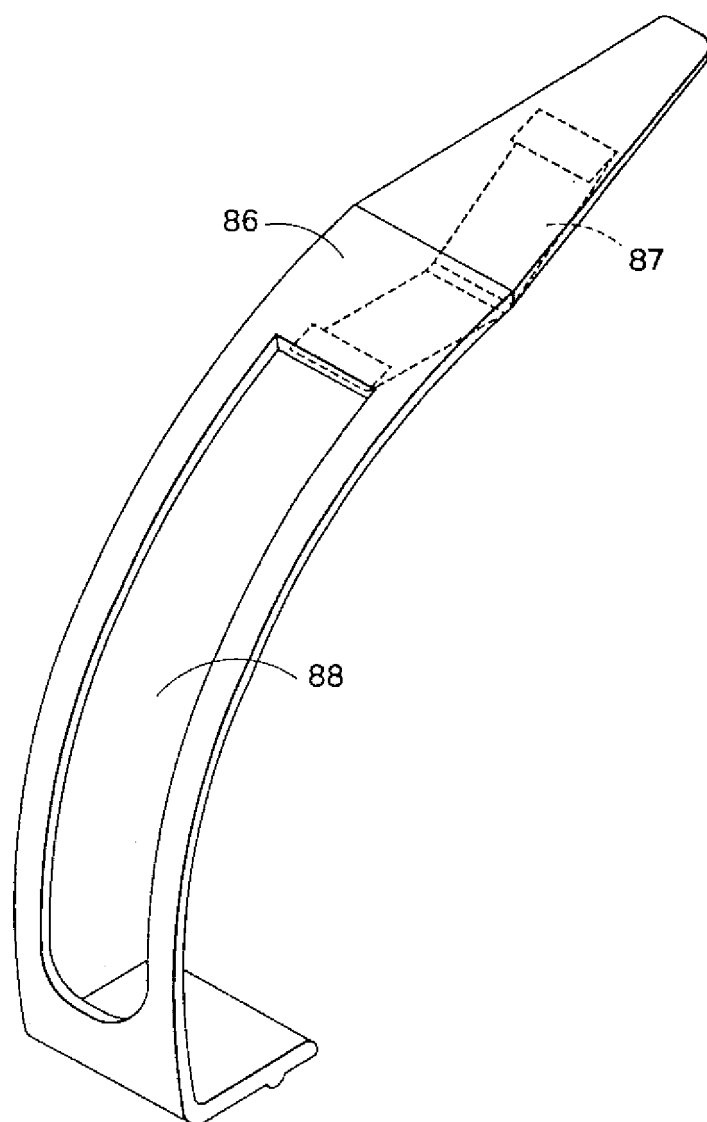


FIG. 13

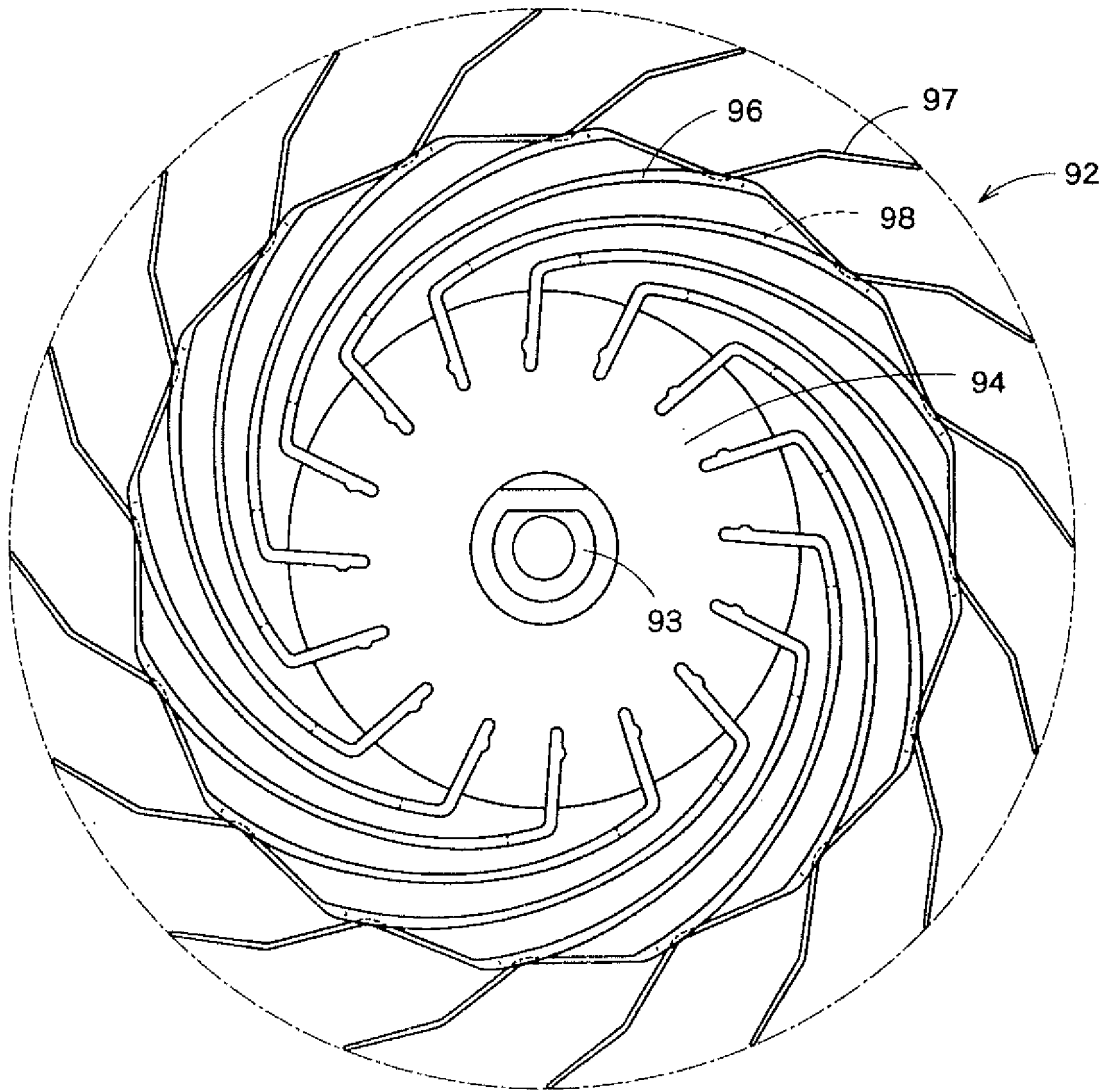


FIG. 14

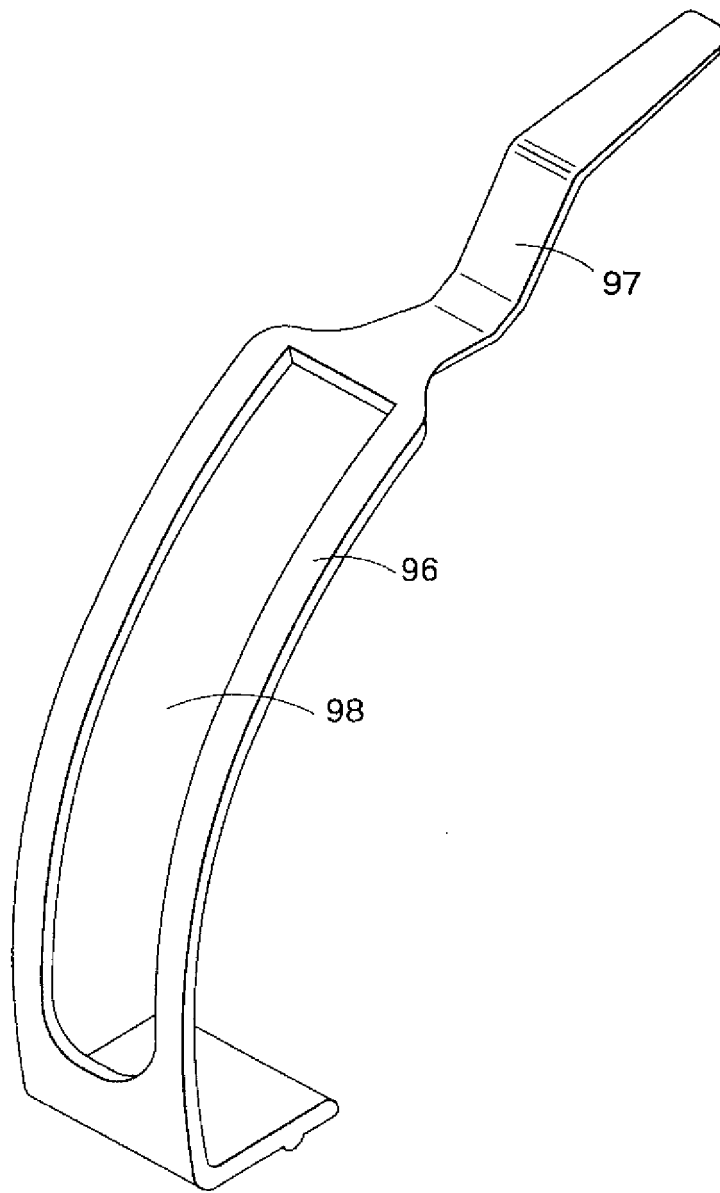


FIG. 15

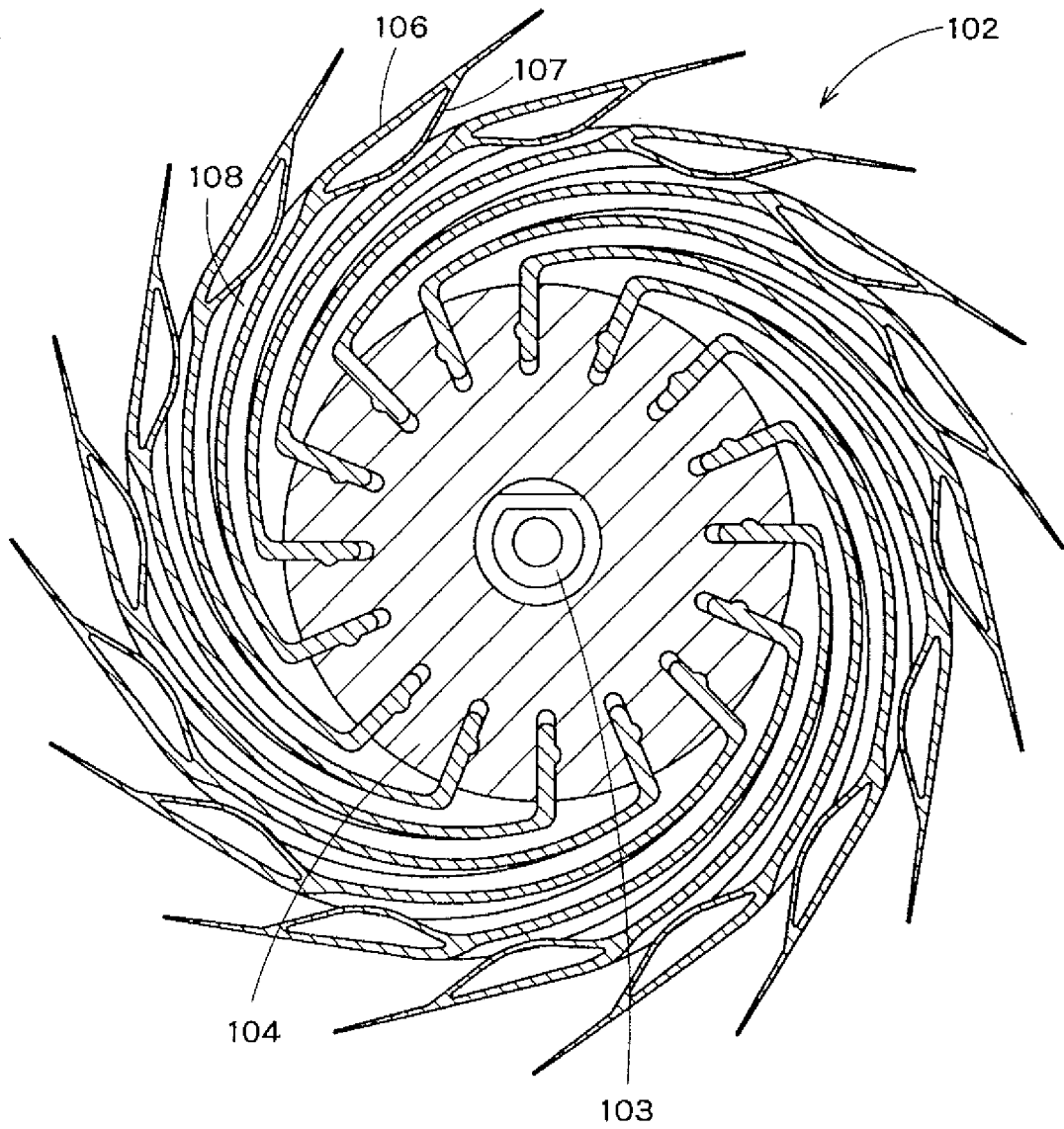


FIG. 16

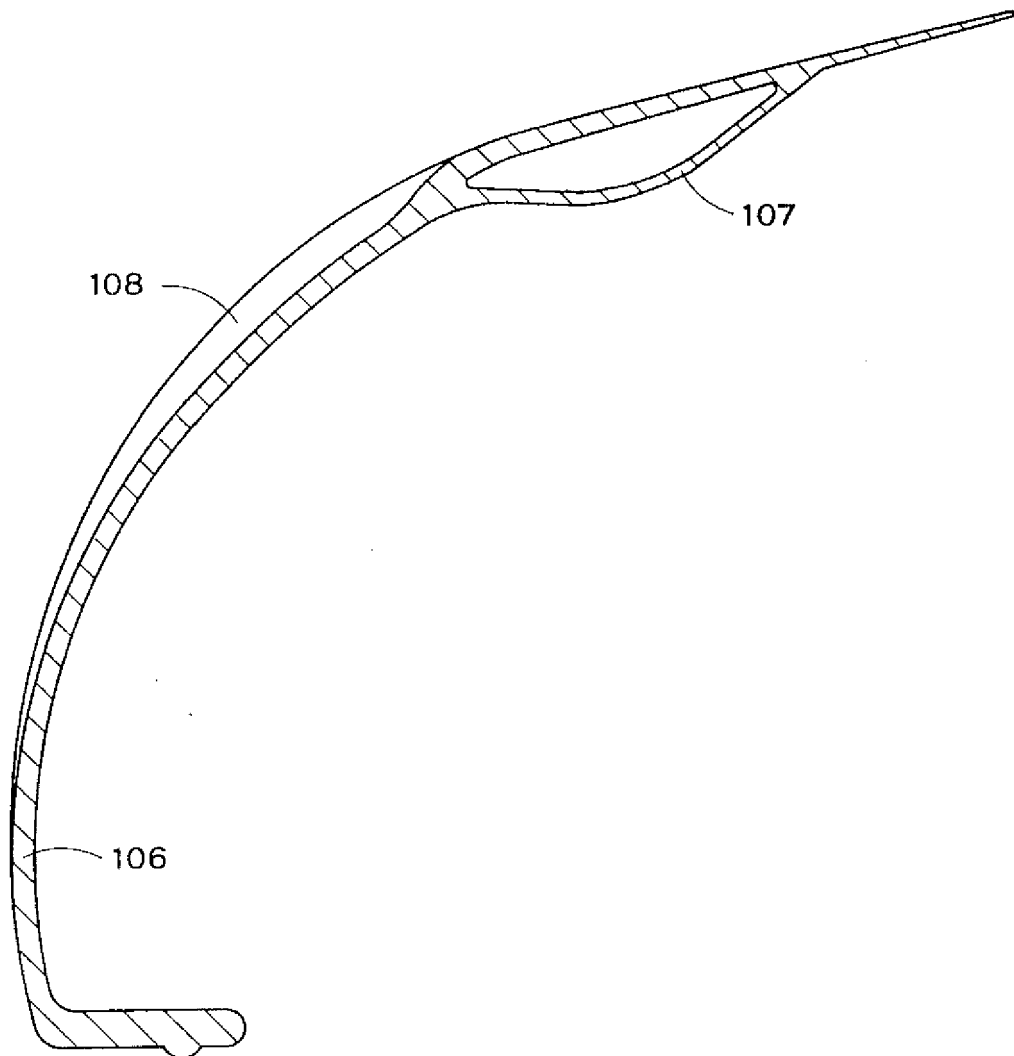


FIG. 17

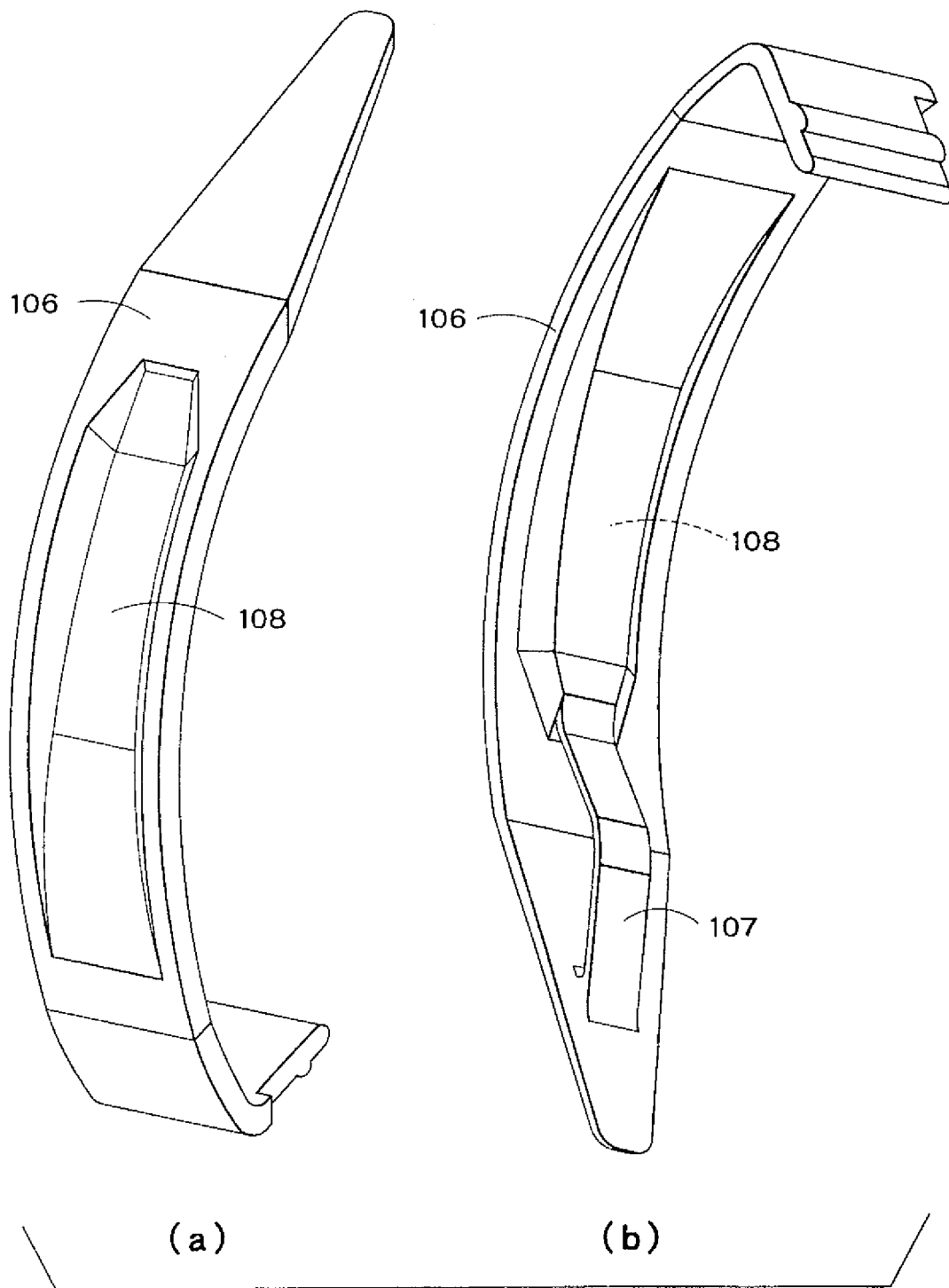


FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/065794

A. CLASSIFICATION OF SUBJECT MATTER

B65H29/40 (2006.01) i

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)

B65H29/40

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 38740/1986 (Laid-open No. 150451/1987) (Fujitsu Ltd.), 24 September 1987 (24.09.1987), specification, page 7, line 11 to page 10, line 2; fig. 2 to 4 (Family: none)	1-14

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

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
25 July, 2011 (25.07.11)Date of mailing of the international search report
02 August, 2011 (02.08.11)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/065794

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 170884/1983 (Laid-open No. 78350/1985) (Toshiba Corp.), 31 May 1985 (31.05.1985), specification, page 5, line 15 to page 7, line 8; fig. 3 to 4 (Family: none)	1-14
A	JP 2007-55751 A (Toshiba Corp.), 08 March 2007 (08.03.2007), paragraphs [0059] to [0063]; fig. 9 (Family: none)	1-14
A	WO 2001/40092 A1 (CGK COMPUTER GESELLSCHAFT KONSTANZ MBH), 07 June 2001 (07.06.2001), page 7, line 14 to page 10, line 33; fig. 1 to 2 (Family: none)	1-14

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2574769 B [0005]
- JP 52100792 U [0005]