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(54) PAPER MONEY FEEDER

(57) A banknote feeding apparatus 10 comprises a first kicker roller 16 configured to be in contact with a surface of one banknote of a plurality of banknotes stored in the banknote storage unit 101, and further configured to be continuously rotated; a second kicker roller 18 provided upstream relative to the first kicker roller 16 in a feed direction of the banknotes, and configured to be continuously rotated, in the same direction of rotation, at approximately the same peripheral velocity, as those of the first kicker roller 16; and a feed roller 12 adapted for feeding each banknote kicked by the first kicker roller 16. The first kicker roller 16 has a high friction unit 16a adapted for kicking each banknote and partly provided in the outer circumference of the first kicker roller 16. The second kicker roller 18 has a low friction unit 18a having a coefficient of friction lower than the coefficient of friction of the high friction unit 16a of the first kicker roller 16 and provided over the whole outer circumference of the second kicker roller 18. The outer-circumferential length of the first kicker roller 16 is set greater than a length in a feed direction of the banknote having the largest size of the banknotes to be fed out by the banknote feeding apparatus 10.

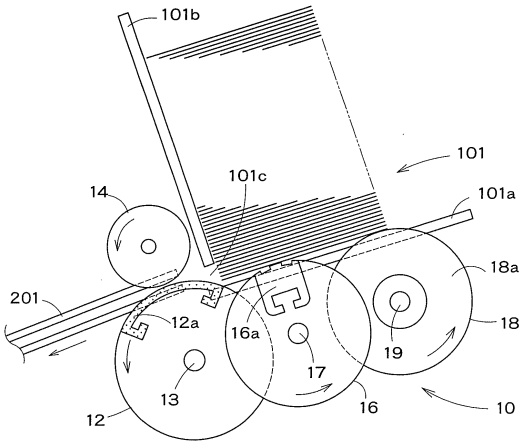

FIG. 3

EP 2 110 352 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a banknote feeding apparatus adapted for feeding a plurality of banknotes stored in a banknote storage unit, one by one, and particularly relates to the banknote feeding apparatus which can feed various kinds of banknotes respectively having different sizes, one by one, stably.

BACKGROUND OF THE INVENTION

[0002] Conventionally, a banknote handling machine, which can sort the banknotes deposited from a customer, for each kind thereof, and then store them therein, has been known. In such a banknote handling machine, the banknotes, when deposited in the machine, are first received in a hopper. Then, the banknotes received in the hopper are fed to the interior of the banknote handling machine, one by one, by the banknote feeding apparatus.

[0003] The conventional banknote feeding apparatus comprises a feed roller provided in the vicinity of the hopper and adapted for feeding the banknotes, one by one, successively, a gate roller (or reversal roller) provided to be opposed to the feed roller, thereby forming a gate part between the gate roller and the feed roller, and a kicker roller provided just below the hopper and adapted for kicking one banknote, present at the lowest layer of the banknotes stored in the hopper, toward the feed roller.

[0004] It is preferred that various kinds of banknotes of each country in the world, such as yen banknotes, dollar banknotes, euro banknotes and the like, can be selected as objects to be stored in the banknote handling machine. In this case, in the banknote feeding apparatus as described above, when such various kinds of banknotes of each country in the world are stored in the hopper, the size of each banknote should differ, for each kind thereof. Therefore, in some cases, there is a risk that the kicking operation for the banknotes due to the kicker roller may not be performed, one by one, stably. In addition, in the case in which relatively small-sized banknotes are stored in the hopper and only one kicker roller is provided for kicking such banknotes, each banknote kicked by the kicker roller may tend to be advanced obliquely relative to a normal feed direction thereof.

[0005] As another conventional banknote feeding apparatus, the apparatus disclosed in Japanese Utility Model Registration No. 2522467 has been known. Specifically, the banknote feeding apparatus disclosed in Japanese Utility Model Registration No. 2522467 is configured to feed each banknote in such a manner that the banknote is grasped between a pair of belts or between one belt and one roller. However, also in this banknote feeding apparatus, the size of each banknote should differ, for each kind thereof, when the various kinds of banknotes as described above are fed by the apparatus. This makes it difficult to feed the banknotes, one by one, stably.

DISCLOSURE OF THE INVENTION

[0006] The present invention was made in light of the above problems. Therefore, it is an object of the present invention to provide a new banknote feeding apparatus, which can feed various kinds of banknotes respectively having different sizes, one by one, stably.

[0007] The banknote feeding apparatus of the present invention is adapted for feeding a plurality of banknotes stored in a banknote storage unit, one by one, through a feed opening of the banknote storage unit, and comprises: a feed roller provided in the vicinity of the feed opening of the banknote storage unit and adapted for feeding out the banknotes, one by one, successively, through the feed opening toward the exterior of the banknote storage unit; a gate unit provided to be opposed to the feed roller, thereby forming a gate part between the gate unit and the feed roller; a first kicker roller configured to be in contact with a surface of one banknote of the plurality of banknotes stored in the banknote storage unit and adapted for kicking the one contacted banknote toward the gate part, the first kicker roller being further configured to be continuously rotated and having an outer-circumferential length set greater than a length in a feed direction of the banknote having the largest size of the banknotes to be fed out by the banknote feeding apparatus, and further having a high friction unit adapted for kicking each banknote and partly provided in the outer circumference of the first kicker roller; and a second kicker roller provided upstream relative to the first kicker roller in the feed direction of the banknotes, the second kicker roller being configured to be continuously rotated, at approximately the same peripheral velocity as that of the first kicker roller, and having a low friction unit having a coefficient of friction lower than the coefficient of friction of the high friction unit of the first kicker roller and provided over the whole outer circumference of the second kicker roller.

[0008] According to this banknote feeding apparatus, the second kicker roller adapted for additionally kicking each banknote toward the feed roller is provided, in addition to the first kicker roller adapted for directly kicking the banknote toward the feed roller, and the length of the outer circumference of the first kicker roller is set greater than the length in the feed direction of the banknote having the largest size of the banknotes to be fed out by the banknote feeding apparatus. Moreover, the first kicker roller and second kicker roller are respectively configured to be continuously rotated at approximately the same peripheral velocity. Therefore, even in the case in which various kinds of banknotes respectively having different sizes are stored in the banknote storage unit, the kicking operation for such banknotes toward the feed roller can be securely performed. More specifically, even in the case in which the position of each banknote stored in the banknote storage unit is considerably shifted away from

the feed roller, such a shifted banknote can be fed toward the feed roller by the second kicker roller continuously rotated at approximately the same peripheral velocity as that of the first kicker roller. Therefore, a failure or error can be prevented, upon the kicking operation for each banknote toward the feed roller by using such kicker rollers. Additionally, even when each banknote is not in contact with the high friction unit of the first kicker roller, the low friction part provided over the whole outer circumference of the continuously rotated second kicker roller can always push the banknote toward the feed roller. Thus, such a banknote pushed toward the feed roller will be securely kicked by the high friction unit of the first kicker roller.

[0009] In the banknote feeding apparatus of the present invention, it is preferred that the diameter of the first kicker roller is approximately the same as the diameter of the second kicker roller, wherein the first kicker roller and second kicker roller are arranged, respectively, in positions such that the first kicker roller can be partly and alternately overlapped with the second kicker roller, when seen in an axial direction of the first kicker roller, without any interference between the first kicker roller and the second kicker roller in the axial direction of the first kicker roller. With such configuration, a distance between the first kicker roller and the second kicker roller can be reduced, thus each banknote can be brought into contact with both of the first and second kicker rollers, in a flattened condition, even in the case in which relatively small-sized banknotes are stored in the banknote storage unit. Accordingly, the second kicker roller can be utilized for supporting the kicking operation for the banknotes.

[0010] In the banknote feeding apparatus of the present invention, it is preferred that the first kicker roller is provided in a plural number along a common shaft, wherein the positions, in which the plurality of first kicker rollers are arranged, are set, respectively, such that, when assuming that the banknote having the smallest size of the banknotes to be fed out by the banknote feeding apparatus is divided into a pair of left and right regions, with respect to an imaginary central line defined along the feed direction of the banknotes, such a pair of left and right regions of the banknote having the smallest size and stored in any given position of the banknote storage unit can be kicked out by the first kicker rollers, respectively. With this configuration, the pair of left and right regions of the banknote having any given size can be kicked out by the first kicker rollers, respectively corresponding to the regions. Thus, the kicking operation for the banknotes due to such first kicker rollers can securely prevent each banknote from being advanced in an unduly oblique state, relative to a normal feed direction thereof (i.e., a direction vertical to the axial direction of the feed roller). Therefore, the feeding speed of the banknotes can also be highly elevated.

[0011] In the banknote feeding apparatus of the present invention, it is preferred that three first kicker rollers are provided, wherein one of the three first kicker rollers is located corresponding to a central position of the banknote storage unit in a direction along the shaft of the first kicker rollers, and wherein the other two of the three first kicker rollers are respectively located in positions that are symmetrical about the first kicker roller located corresponding to the central position of the banknote storage unit. With such configuration, since one of the three kicker rollers is located corresponding to the central position of the banknote storage unit, the pair of left and right regions of each banknote can be securely kicked by the central first kicker roller and either one of the left and right first kicker rollers, respectively, even in the case in which the banknote is located in any given position of the banknote storage unit. Accordingly, this feeding operation for the banknotes due to such first kicker rollers can prevent, more securely, each banknote from being advanced in an unduly oblique state relative to the normal feed direction thereof.

[0012] In the banknote feeding apparatus of the present invention, it is preferred that two second kicker rollers are arranged along a common shaft, while each second kicker roller is located between each adjacent pair of the first kicker rollers, wherein the first kicker rollers and second kicker rollers are arranged, respectively, in positions such that each first kicker roller can be partly and alternately overlapped with each second kicker roller, when seen in the axial direction of the first kicker roller. In this case, each second kicker roller can support the kicking operation for the banknotes, even in the case in which each banknote is located in any given position of the banknote storage unit. Therefore, even in the case in which various kinds of banknotes respectively having different sizes are stored in the banknote storage unit, the kicking operation for the banknotes toward the feed roller can be performed more securely.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a perspective view showing an outline of a banknote handling machine comprising a banknote feeding apparatus of the present invention.

Fig. 2 is a schematic diagram showing general internal construction of the banknote handling machine shown in Fig. 1.

Fig. 3 is a side view showing construction of the banknote feeding apparatus according to the present invention.

Fig. 4 is a top view when the banknote feeding apparatus shown in Fig. 3 is seen from above.

Fig. 5 is an illustration showing a state, in which a pair of left and right regions of one banknote present at the lowest layer of the banknotes stored in a hopper, are respectively kicked by first kicker rollers respectively corresponding to the regions.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Hereinafter, one embodiment of the present invention will be described, with reference to the drawings. It should be construed that this embodiment is not intended to limit the scope of the present invention, but is merely intended to describe and show one preferred example thereof.

[0015] First, referring to Figs. 1 and 2, general construction of a banknote handling machine provided with a banknote feeding apparatus of the present invention will be discussed.

[0016] Fig. 1 is a perspective view showing an outline of the banknote handling machine 100 related to one exemplary embodiment of the present invention. As shown in Fig. 1, the banknote handling machine 100 comprises a hopper 101, two reject units 102, an operation unit 103, a first general display unit 104, a second general display unit 105, four stacking units 106 and four individual display units 107.

[0017] The hopper 101 is configured such that a plurality of banknotes can be placed thereon, in a stacked condition, by an operator. The banknotes once stored in the hopper 101 will be fed to the interior of the banknote handling machine 100 by the banknote feeding apparatus 10 as will be described later. Each reject unit 102 can serve to discharge the banknote, when this banknote fed from the hopper 101 is a rejected banknote (e.g., a counterfeit banknote or the like). For instance, a lower one of the two reject units 102 may be used for discharging each counterfeit banknote or the like, while the upper reject unit 102 may be used for storing therein each banknote excluded from ones to be sorted although it has been recognized by a recognition unit 220 as will be described below.

[0018] The operation unit 103 includes input keys for inputting instructions of the operator therein. The first general display unit 104 and second general display unit 105 are respectively provided for displaying predetermined data (e.g., graphic data or the like). Each stacking unit 106 is configured to stack therein the banknotes fed from the hopper 101 due to the banknote feeding apparatus 10, for each attribute (e.g., denomination or the like) of the banknotes. Each individual display unit 107 is provided corresponding to each stacking unit 106, and is configured to display the number of banknotes stacked in the corresponding stacking unit 106. While the two reject units 102, four stacking units 106 and four individual display units 107 are respectively depicted in Fig. 1, each number of these components can be altered without any limitation.

[0019] Fig. 2 is a schematic diagram showing general internal construction of the banknote handling machine 100 shown in Fig. 1, and is intended in particular to illustrate a transport system and a sensor system thereof.

[0020] As shown in Fig. 2, a transport path 201 configured for transporting each banknote to each stacking unit 106 from the hopper 101 is provided in the banknote handling machine 100. Usually, the transport path 201 is composed of several belt transport mechanisms combined with one another. Various sensors 202 to 214 are provided along the transport path 201. The sensor 202 provided on the side of an outlet of the hopper 101 and the sensor 203 provided on the side of an inlet of the recognition unit 220 as will be described later can serve to detect whether or not each banknote is securely taken in the transport path 201, respectively. The recognition unit 220 provided along the transport path 201 is composed of various detection units, and serves to detect fitness, authentication, denomination, orientation, face/back and the like of each banknote taken therein from the hopper 101. More specifically, the recognition unit 220 includes a sensor 204 composed of, for example, a transparent sensor, wherein the sensor 204 is adapted for detecting the denomination, authentication and the like of each banknote, by the light transmission.

[0021] On the downstream side relative to the recognition unit 220 in the transport path 201, two diverters 231 are provided in series. Each diverter 231 is configured to feed each banknote that cannot be recognized by the recognition unit 220 or banknote that is excluded from ones to be sorted although it has been recognized by the recognition unit 220, to each corresponding reject unit 102. The sensors 205, 206 can serve to detect that each banknote is fed from each diverter 231 to each corresponding reject unit 102, respectively. Meanwhile, each banknote selected as one to be sorted is detected, about its transported condition, by the sensor 207, and then further transported through the transport path 201. On the downstream side relative to the diverters 231 in the transport path 201, three diverters 232 to 234 are further provided in series. Each diverter 232 to 234 can serve to feed each banknote, which has been fed from the diverter 231 toward each corresponding one of the four stacking units 106 according to, for example, the denomination or the like of the banknote. In this way, each banknote that has been recognized, about the denomination or the like thereof, by the recognition unit 220 is stored in a suitable one of the four stacking unit 106. The sensors 208 to 214 can serve to detect whether or not the sorting operation for the banknotes from the transport path 201 to each stacking unit 106 is appropriately performed, respectively. Further, the storage condition of the banknotes in each stacking unit 106 is detected by each corresponding residue detection sensor 221 to 224.

[0022] Next, construction of the banknote feeding apparatus 10 provided in the banknote handling machine 100 shown in Figs. 1 and 2 will be detailed, with reference to Figs. 3 and 4. The banknote feeding apparatus 10 is configured to feed the banknotes stored in the hopper 101, one by one, to the transport path 201 in the banknote handling machine 100. Fig. 3 is a side view showing the construction of the banknote feeding apparatus 10, and Fig. 4 is a top view when the banknote feeding apparatus shown in Fig. 3 is seen from above. In particular, Fig. 4

is intended to illustrate each positional relationship between feed rollers 12, first kicker rollers 16 and second kicker rollers 18.

[0023] First, referring to Fig. 3, the hopper 101 configured for storing therein the banknotes to be fed by the banknote feeding apparatus 10 will be described. The hopper 101 is composed of a bottom plate 101a and a side plate 101b, and is configured to store therein the banknotes, while the banknotes are stacked on the bottom plate 101a. As shown in Fig. 3, a feed opening 101c is provided to a bottom portion of the hopper 101, such that the banknotes stored in the hopper 101 can be fed to the outside from the feed opening 101c. The bottom plate 101a is slightly inclined downward, relative to a horizontal plane, as one goes toward the feed opening 101c. In accordance with this inclination, the side plate 101b extends obliquely upward.

[0024] As shown in Figs. 3 and 4, the banknote feeding apparatus 10 comprises the first kicker rollers 16, each provided to be in contact with a surface of one banknote present at the lowest layer of the plurality of banknotes stored in the stacked condition in the hopper 101, the second kicker rollers 18, each located upstream relative to the first kicker rollers 16 in a feed direction of the banknotes (i.e., a direction depicted by arrows in Figs. 3, 4), and the feed rollers 12, each located downstream relative to the first kicker rollers 16 in the feed direction of the banknotes and adapted for feeding each banknote kicked by the first kicker rollers 16. In addition, gate rollers (or reversal rollers) 14 are provided to be opposed to the corresponding feed rollers 12, thereby forming a gate part between each gate roller 14 and each feed roller 12. With such configuration, the banknotes kicked out by the first kicker rollers 16 can be fed to the transport path 201, one by one, through the feed opening 101c and gate parts.

[0025] The feed rollers 12 include a pair of left and right rollers, as shown in Figs. 3 and 4, each having a rubber 12a partly provided to an outer circumference thereof. Namely, each banknote kicked by the first kicker rollers 16 through the feed opening 101c will be fed out by the rubbers 12a at the gate parts. One common shaft 13 is provided for the pair of left and right feed rollers 12. This shaft 13 is configured to be continuously rotated by a stepping motor 15.

[0026] The gate rollers 14 include a pair of left and right rollers, each provided to be opposed to each corresponding feed roller 12, as shown in Fig. 3. A rubber is provided to an outer circumference of each gate roller 14. As described above, the gate part is formed between each gate roller 14 and each corresponding feed roller 12. This gate part is formed into a gap corresponding to the thickness of one banknote. Thus, the banknotes kicked out by the first kicker rollers 16 can be fed through gate parts, while being restricted one by one. More specifically, each gate roller 14, as shown in Fig. 3, is usually provided to be rotated, intermittently, in a direction reverse to the feed direction of the banknotes. With such intermittent reverse rotation of each gate roller 14, the whole outer-circumferential face of the gate roller 14 can be utilized, evenly, for forming the gate part. Therefore, uneven wear of the gate roller 14 can be successfully prevented. In this case, when only one banknote is fed to the gate part between each gate roller 14 and each corresponding feed roller 12, this banknote can be fed to the transport path 201 by the feed roller 12. However, when two or more banknotes are fed to the gate part while being overlapped one on another, gate rollers 14 can serve to prevent the second and later banknotes from being fed through the gate part together with the first banknote (in an overlapped condition).

[0027] Each first kicker roller 16 is provided to be in contact with the surface of one banknote present at the lowest layer of the plurality of banknotes stored in the stacked condition in the hopper 101 as shown in Fig. 3, and is configured to be continuously rotated in a direction depicted by an allow in Fig. 3. More specifically, a shaft 17 is commonly provided to the first kicker rollers 16, such that the shaft 17 of the first kicker rollers 16 can be rotated together with the shaft 13 of the feed rollers 12, due to an interlock mechanism (not shown). Thus, when the shaft 13 of the feed rollers 12 is rotated by the stepping motor 15, the shaft 17 of the first kicker rollers 16 can be continuously rotated together with the shaft 13. Additionally, as shown in Fig. 3, each first kicker roller 16 has a high friction unit 16a partly provided in an outer circumference thereof for kicking each banknote. Therefore, once each first kicker roller 16 is rotated and the high friction unit 16a thereof is in contact with the banknote of the lowest layer in the hopper 101, this banknote will be kicked out toward the feed rollers 12.

[0028] As shown in Fig. 4, three first kicker rollers 16 are provided to the single shaft 17. One of the three first kicker rollers 16 is located corresponding to a central position of the hopper 101 in a direction along the shaft 17 (or lateral direction in Fig. 4). The other two first kicker rollers 16 are respectively located in positions that are laterally symmetrical about the first kicker roller 16 located corresponding to the central position of the hopper 101.

[0029] Fig. 5 shows a positional relationship between one banknote 20 having the smallest size (e.g., one five-euro banknote) and present at the lowest layer in the hopper 101, the first kicker rollers 16 and the second kicker rollers 18. Now, as shown in Fig. 5, assume that the banknote 20 having the smallest size of the banknotes to be fed by the banknote feeding apparatus 10 is divided into a pair of left and right regions 21, 22, with respect to an imaginary central line 20a defined along the feed direction (i.e., the direction depicted by an arrow in Fig. 5) of the banknotes. In this case, the three first kicker rollers 16 are positioned, respectively, such that the pair of left and right regions 21, 22 of the banknote 20 stored in any given position of the hopper 101 can be securely in contact with the first kicker rollers 16, respectively.

[0030] Therefore, even in the case in which the banknotes having any given size are stored in the hopper 101, the pair of left and right regions 21, 22 of each banknote will be kicked by the corresponding kicker rollers 16, respectively. This can successfully prevent each banknote 20 kicked by the kicker rollers 16 from being advanced in an unduly oblique state, relative to a normal feed direction thereof (i.e., the direction depicted by an arrow in Fig. 5). Accordingly, the feeding speed of each banknote can be highly elevated up to, for example, 850 sheets of banknotes per minute. Additionally, as described above, one of the three first kicker rollers 16 is located, corresponding to the central position of the hopper 101. Therefore, even in the case in which each banknote is located in any given position of the hopper 101, the pair of left and right regions 21, 22 of the banknote can be securely kicked by the central first kicker roller 16 and either one of the other left and right first kicker rollers 16, respectively, as shown in Fig. 5. Thus, the feeding operation due to such first kicker rollers 16 can securely prevent each banknote kicked by these rollers 16 from being advanced in an unduly oblique state, relative to the normal feed direction of the banknote.

[0031] The second kicker rollers 18 are located upstream relative to the first kicker rollers 16 in the feed direction, respectively, as shown in Fig. 3. Each second kicker roller 18 is configured to be continuously rotated in a direction depicted by an arrow in Fig. 3. More specifically, a single shaft 19 is provided commonly to the second kicker rollers 18, such that the shaft 19 of the second kicker rollers 18 can be rotated together with the shaft 13 of the feed rollers 12, due to an interlock mechanism (not shown). Thus, when the shaft 13 of the feed rollers 12 is rotated by the stepping motor 15, the shaft 19 of the second kicker rollers 18 can be continuously rotated together with the shaft 13. Additionally, as shown in Fig. 3, each second kicker roller 18 has a low friction unit 18a provided over the whole outer circumference thereof. The coefficient of friction of the low friction unit 18a is lower than the coefficient of friction of the high friction unit 16a of each first kicker roller 16. Therefore, when a banknote is in contact with each second kicker roller 18, such a banknote can be always kicked toward the feed rollers 12 due to the low friction unit 18a. In addition, the peripheral velocity of each second kicker roller 18 is approximately the same as the peripheral velocity of each first kicker roller 16.

[0032] The diameter of each second kicker roller 18 is approximately the same as that of each first kicker roller 16, and is, for example, about 40mm. In this case, the outer-circumferential lengths of each first kicker roller 16 and second kicker roller 18 are respectively set longer than the length in the feed direction of the banknote having the largest size (e.g., the 500-euro banknote) of the banknotes to be fed out by the banknote feeding apparatus 10. Now, the reason for setting the diameters of each kicker roller 16 and 18 at about 40mm will be described. As discussed herein, various kinds of banknotes respectively having different sizes are assumed as the banknotes stored in the hopper 101 of the banknote handling machine 100. For instance, as the banknote having the largest size, the 500-euro banknote having a lateral length of 160mm and a feed direction length of 82mm can be mentioned. In this case, for continuously feeding such 500-euro banknotes by using the banknote feeding apparatus 10 while securely performing recognition about each banknote by the recognition unit 220 after the banknote is fed out, it is preferred that a space of at least 40mm is ensured, between one first 500-euro banknote and a following 500-euro banknote, respectively placed on the transport path 201. Namely, because the length in the feed direction of each 500-euro banknote is 82mm, it is preferred that a distance of about 122mm is ensured between a distal end of one 500-euro banknote and the distal end of the following 500-euro banknote. Therefore, it is preferred that the outer-circumferential length of each first kicker roller 16 operated for kicking each banknote toward the feed rollers 12 is also set at about 122mm. For this reason, the diameter of each first kicker roller 16 is set at about 40mm.

[0033] As shown in Fig. 4, two second kicker rollers 18 are provided to the single shaft 19. In the direction along the shaft 19 (or in the lateral direction in Fig. 4), the coordinates of the position of each first kicker roller 16 is different from the coordinates of the position of each second kicker roller 18. Specifically, each second kicker roller 18 is located between each adjacent pair of the first kicker rollers 16. When seen in the direction along the shaft 19 (e.g., when seen in the left direction in Fig. 4), the positional relationship between the shaft 17 of the first kicker rollers 16 and the shaft 19 of the second kicker rollers 18 is defined, such that each first kicker roller 16 can be partly and alternately overlapped with each second kicker roller 18 (see Fig. 3). Now, the reason that each first kicker roller 16, when seen in the direction along the shaft 17 thereof, is partly and alternately overlapped with each second kicker roller 18 will be discussed. As described above, the diameters of each first kicker roller 16 and second kicker roller 18 are set at approximately 40mm. Therefore, if each first kicker roller 16, when seen in the direction along the shaft 17 thereof, is not alternately overlapped with each second kicker roller 18 (or if each first kicker roller 16 is spaced away, when seen in the direction along the shaft 17 thereof, from each second kicker roller 18), the banknote having a considerably small size cannot be in contact with both of the first kicker rollers 16 and the second kicker rollers 18, in some cases, in a flattened and non-curved condition. In other words, such a small-sized banknote stored in the hopper 101 will be in contact with both of the first kicker rollers 16 and the second kicker rollers 18, in an undesirably curved and downwardly projected form, thus being likely to cause some failure or error upon the feeding operation due to the first kicker rollers 16. However, in this embodiment, since the first kicker rollers 16 and second kicker rollers 18 are respectively located such that each first

kicker roller 16, when seen in the direction along the shaft 17 thereof, is partly and alternately overlapped with each second kicker roller 18, the distance between each first kicker roller 16 and each second kicker roller 18 is reduced. Therefore, even in the case of feeding such a small-sized banknote as described above, the banknote can be in contact with both of the first kicker rollers 16 and the second kicker rollers 18, in a suitably flattened and non-curved condition.

[0034] Next, the operation and effect of the banknote feeding apparatus 10 as described above will be discussed, with reference to Figs. 3 through 5.

[0035] As shown in Fig. 3, when the banknotes having various sizes are stored in the hopper 101, in the stacked condition, the banknote present at the lowest layer will be in contact with the first kicker rollers 16 and second kicker rollers 18. At this time, the first kicker rollers 16 and second kicker rollers 18 are continuously rotated, respectively, in the direction depicted by the arrows, at substantially the same peripheral velocity. Therefore, each time the first kicker rollers 16 make one rotation, respectively, one banknote is kicked toward the feed rollers 12, due to the high friction units 16a of the respective first kicker rollers 16. Meanwhile, the second kicker rollers 18 support this kicking operation for the banknote, by using the low friction units 18a thereof, respectively. For instance, even when the position of each banknote stored in the hopper 101 is considerably shifted away from the feed rollers 12 and hence such a banknote is not in contact with the first kicker rollers 16, the second kicker rollers 18 can kick the banknote toward the feed rollers 12, thereby to return the banknote to its original position.

[0036] Thereafter, each banknote fed to the feed rollers 12 by the first kicker rollers 16 and second kicker rollers 18 will be further fed to the transport path 201, due to the rubber 12a of each feed roller 12, at the gate parts formed between the feed rollers 12 and the gate rollers 14. In this way, the banknotes stored in the hopper 101 in the stacked condition can be transported, one by one, to the interior of the banknote handling machine 100.

[0037] As described above, according to the banknote feeding apparatus 10 of this embodiment, the first rollers 16, each having the high friction unit 16a partly provided in the outer circumference thereof for kicking each banknote, and the second kicker rollers 18, each located upstream relative to the first rollers 16 in the feed direction of the banknote, are provided. Additionally, each second kicker roller 18 has the low friction unit 18a provided over the whole outer circumference thereof, wherein the coefficient of friction of the low friction unit 18a is smaller than the coefficient of friction of the high friction unit 16a of each first kicker roller 16. These kicker rollers 16, 18 are respectively configured to be rotated at approximately the same peripheral velocity. Furthermore, the length of the outer circumference of each first kicker roller 16 is set greater than the feed-direction length of the banknote having the largest size of the banknotes to be fed by the banknote feeding apparatus 10. In this manner, the second kicker rollers 18 that can support the kicking operation for the banknotes are provided, in addition to the first kicker rollers 16 respectively provided for directly kicking the banknotes toward the feed rollers 12, while these kicker rollers 16, 18 are configured to be rotated at approximately the same peripheral velocity. Therefore, even when various kinds of banknotes respectively having different sizes are stored in the hopper 101, the kicking operation for the banknotes toward the feed rollers 12 can be securely performed. More specifically, even when the position of each banknote stored in the hopper 101 is considerably shifted away from the feed rollers 12, such a shifted banknote can be fed toward the feed rollers 12, due to the second kicker rollers 18, each rotated continuously at the peripheral velocity approximately the same as that of each first kicker roller 16. Therefore, the failure or error can be successfully prevented, upon the kicking operation for each banknote toward the feed rollers 12 by using such kicker rollers 16, 18. Additionally, even when each banknote is not in contact with the high friction unit 16a of each first kicker roller 16, the low friction part 18a provided over the whole outer circumference of each continuously rotated second kicker roller 18 can always push such a banknote toward the kicker rollers 12. Thus, this banknote pushed toward the feed rollers 12 can be securely kicked by the high friction unit 16a of each first kicker roller 16.

[0038] In addition, the diameter of each first kicker roller 16 is substantially the same as the diameter of each second kicker roller 18, while the coordinates of the position of each first kicker roller 16 is different from the coordinates of the position of each second kicker roller 18, in the direction along the shaft 17 of the first kicker rollers 16. Furthermore, when seen in the direction along the shaft 17, the first kicker rollers 16 and second kicker rollers 18 are respectively arranged, such that each first kicker roller 16 can be partly and alternately overlapped with each second kicker roller 18. This can reduce the distance between the first kicker rollers 16 and the second kicker rollers 18. As such, even when the banknotes having a relatively small size are stored in the hopper 101, each banknote can be securely brought into contact with both of the first kicker rollers 16 and the second kicker rollers 18, while being well flattened. Therefore, the second kicker rollers 18 can be utilized for supporting the kicking operation for the banknotes.

Claims

1. A banknote feeding apparatus adapted for feeding a plurality of banknotes stored in a banknote storage unit, one by one, through a feed opening of the banknote storage unit, the banknote feeding apparatus comprising:

   a feed roller provided in the vicinity of the feed

opening of the banknote storage unit and adapted for feeding out the banknotes, one by one, successively, through the feed opening toward the exterior of the banknote storage unit;
a gate unit provided to be opposed to the feed roller, thereby forming a gate part between the gate unit and the feed roller;
a first kicker roller configured to be in contact with a surface of one banknote of the plurality of banknotes stored in the banknote storage unit and adapted for kicking the one contacted banknote toward the gate part, the first kicker roller being further configured to be continuously rotated and having an outer-circumferential length set greater than a length in a feed direction of the banknote having the largest size of the banknotes to be fed out by the banknote feeding apparatus, and further having a high friction unit adapted for kicking each banknote and partly provided in the outer circumference of the first kicker roller; and
a second kicker roller provided upstream relative to the first kicker roller in the feed direction of the banknotes, the second kicker roller being configured to be continuously rotated, at approximately the same peripheral velocity as that of the first kicker roller, and having a low friction unit having a coefficient of friction lower than the coefficient of friction of the high friction unit of the first kicker roller and provided over the whole outer circumference of the second kicker roller.

2. The banknote feeding apparatus according to claim 1,
wherein the diameter of the first kicker roller is approximately the same as the diameter of the second kicker roller, and
wherein the first kicker roller and second kicker roller are arranged, respectively, in positions such that the first kicker roller can be partly and alternately overlapped with the second kicker roller, when seen in an axial direction of the first kicker roller, without any interference between the first kicker roller and the second kicker roller in the axial direction of the first kicker roller.

3. The banknote feeding apparatus according to claim 1,
wherein the first kicker roller is provided in a plural number along a common shaft, and
wherein the positions, in which the plurality of first kicker rollers are arranged, are set, respectively, such that, when assuming that the banknote having the smallest size of the banknotes to be fed out by the banknote feeding apparatus is divided into a pair of left and right regions, with respect to an imaginary central line defined along the feed direction of the banknotes, such a pair of left and right regions of the banknote having the smallest size and stored in any given position of the banknote storage unit can be kicked out by the first kicker rollers, respectively.

4. The banknote feeding apparatus according to claim 3,
wherein three first kicker rollers are provided,
wherein one of the three first kicker rollers is located corresponding to a central position of the banknote storage unit in a direction along the shaft of the first kicker rollers, and
wherein the other two of the three first kicker rollers are respectively located in positions that are symmetrical about the first kicker roller located corresponding to the central position of the banknote storage unit.

5. The banknote feeding apparatus according to claim 4,
wherein two second kicker rollers are arranged along a common shaft, while each second kicker roller is located between each adjacent pair of the first kicker rollers, and
wherein the first kicker rollers and second kicker rollers are arranged, respectively, in positions such that each first kicker roller can be partly and alternately overlapped with each second kicker roller, when seen in the axial direction of the first kicker roller.

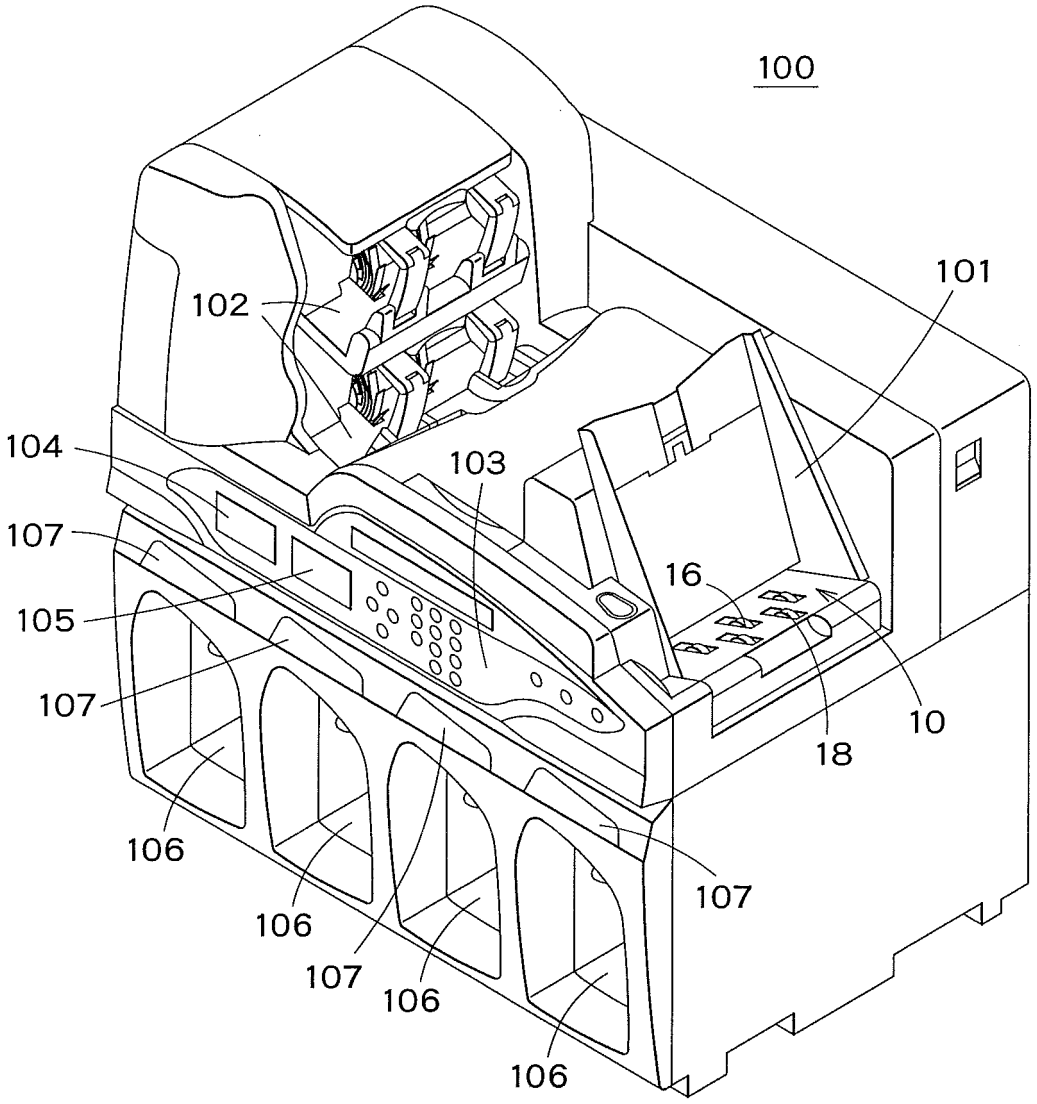

FIG. 1

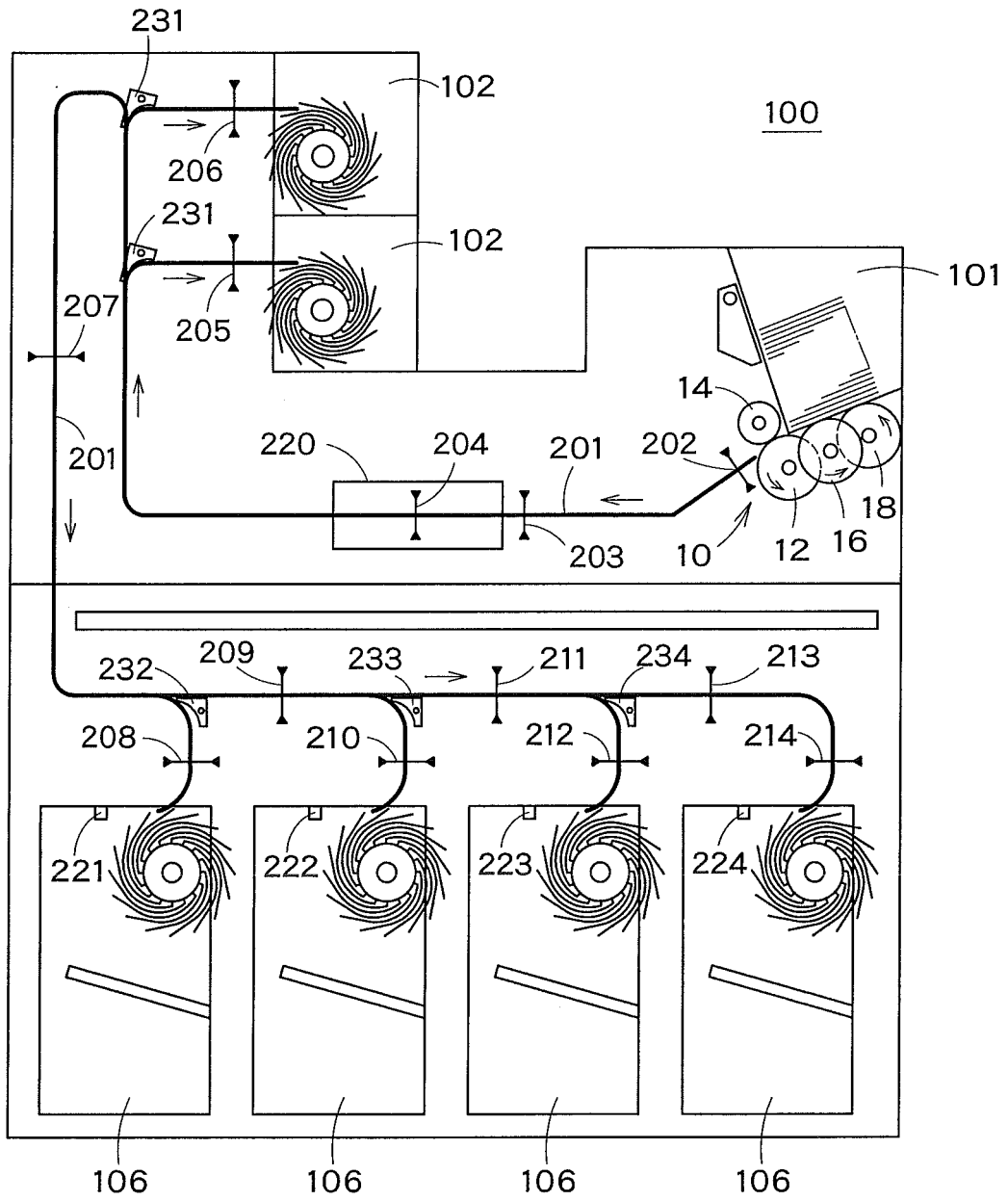
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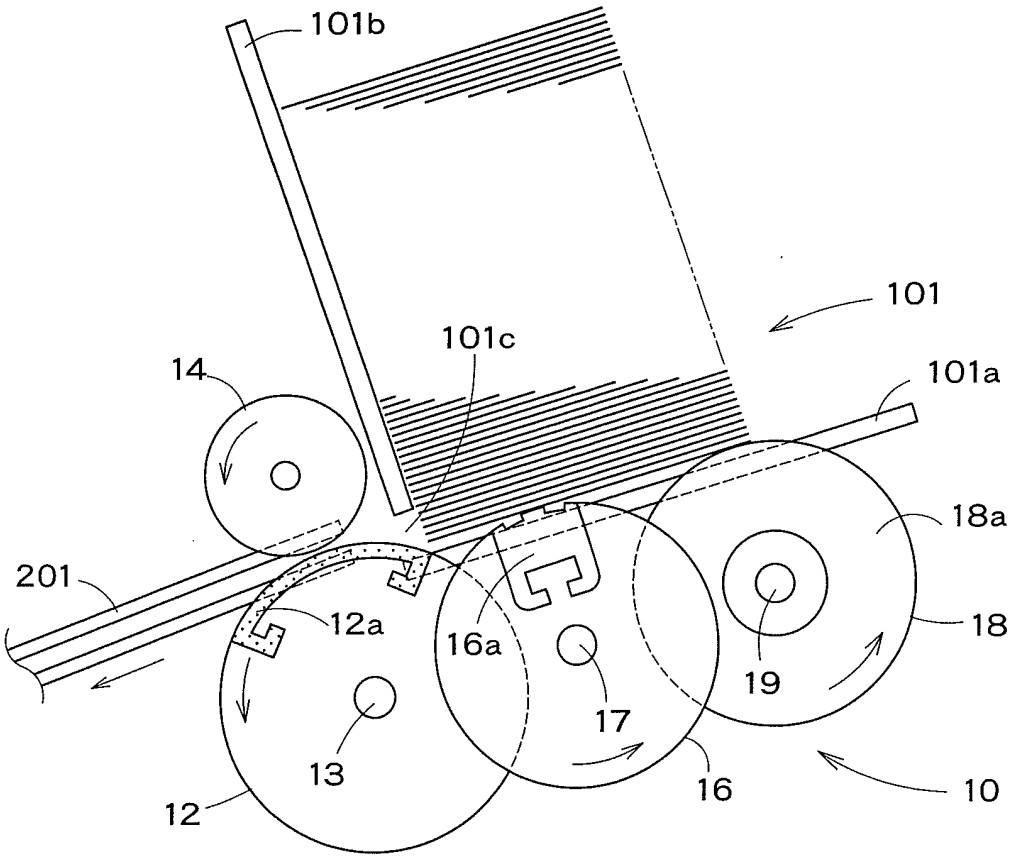
FIG. 2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101c
14
101a
18a
201
12a
16a
18
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17
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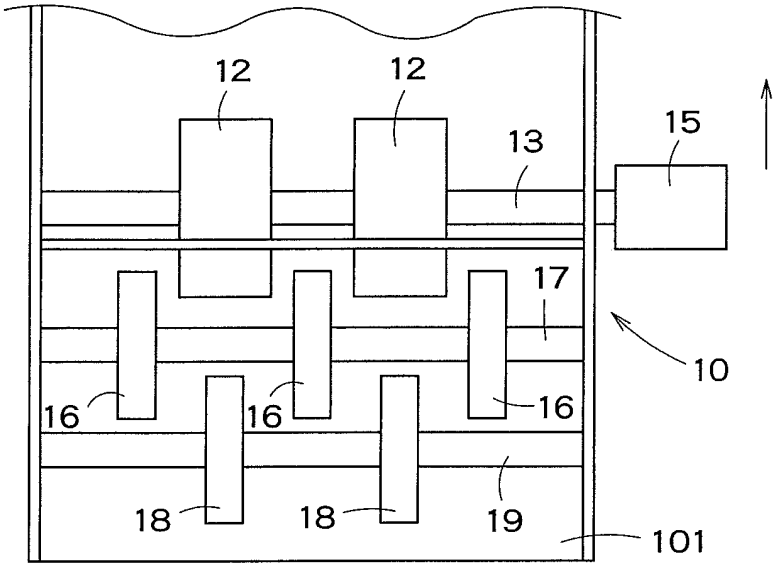
16
12
10

FIG. 3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17
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18
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101

FIG. 4

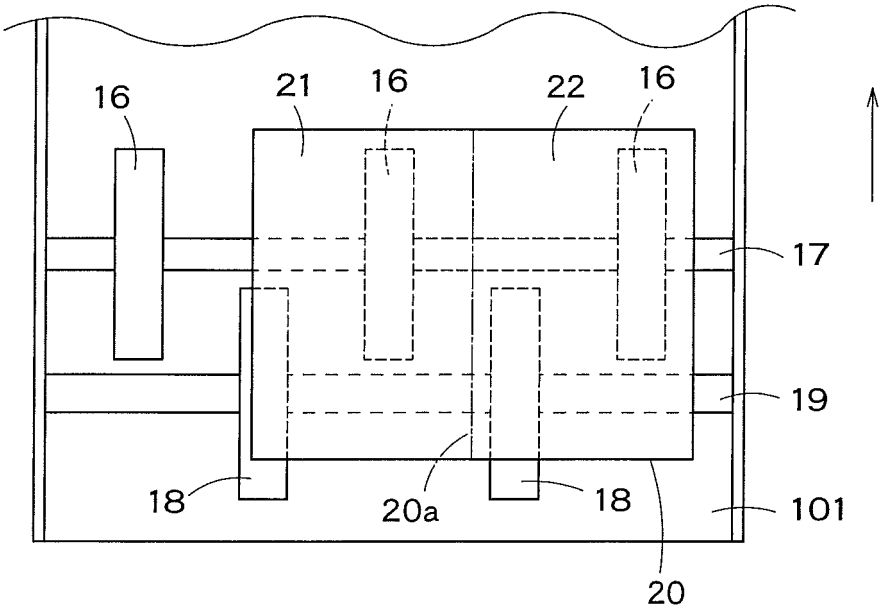

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/052186

A. CLASSIFICATION OF SUBJECT MATTER
B65H3/06(2006.01)i, *G07D9/00*(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)
B65H3/06, G07D9/00

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 71757/1986(Laid-open No. 183642/1987) (Omron Tateisi Electronics Co.), 21 November, 1987 (21.11.87), Full text; Figs. 1 to 4 (Family: none)	1,2 3-5
Y A	JP 10-218397 A (Glory Ltd.), 18 August, 1998 (18.08.98), Par. No. [0020]; Fig. 2 (Family: none)	1,2 3-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March, 2007 (23.03.07)	10 April, 2007 (10.04.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/052186

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 7-179233 A (Omron Corp.), 18 July, 1995 (18.07.95), Par. No. [0026]; Figs. 1 to 9 (Family: none)	1,2 3-5
A	JP 55-34194 Y1 (Ricoh Co., Ltd.), 13 August, 1980 (13.08.80), Full text; Figs. 1 to 7 (Family: none)	3-5
A	JP 2005-528302 A (Giesecke & Devrient GmbH), 22 September, 2005 (22.09.05), Full text; Figs. 1 to 4 & WO 2003/101870 A1 & US 2006/103066 A1	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2522467 B **[0005] [0005]**