(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 732 044 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
13.12.2006 Bulletin 2006/50

(21) Application number: **04821726.9**

(22) Date of filing: **20.10.2004**

(51) Int Cl.:
G07D 9/00 *(2006.01)*

(86) International application number:
PCT/JP2004/015530

(87) International publication number:
WO 2005/088564 (22.09.2005 Gazette 2005/38)

(84) Designated Contracting States:
DE ES

(30) Priority: **15.03.2004 JP 2004073609**

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(54) SHEET HANDLER

(57) An inserted bundle of paper currency is carried while being clamped by moving the clamp toward a carrying belt. The clamp is moved by transmitting a power to two arms. The power transmitted to one arm is further transmitted to the other arm through a link. The link is provided with a plurality of slits and a plurality of sensors for detecting the slits are provided. A decision is made whether the height of a pressed bundle of paper currency is acceptable or not by utilizing a variation in positional relation between the slit and the sensor incident to movement of the clamp.

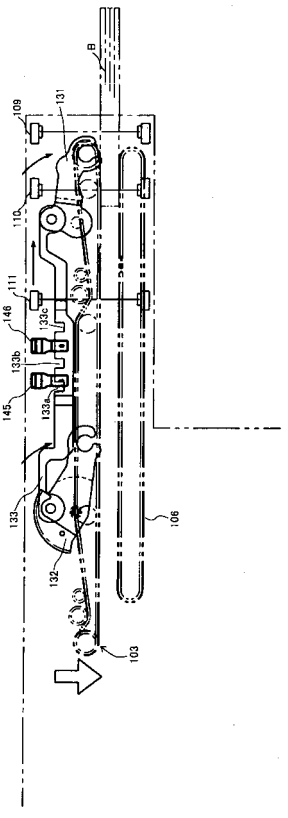

FIG. 4

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Description

Technical Field

[0001] The present invention relates to a paper sheet handling device that can handle paper sheets inserted from outside.

Background Art

[0002] In recent years, automatic machines such as cash dispensers (CDs), automated-teller machines (ATMs), and the like have been installed not only in financial facilities, but also in stores such as convenience stores and the like. A paper sheet handling device is included in automatic machines such as the above for handling bank notes as paper sheets in order to operate in accordance with instructions given by the main body of the automatic machine.

[0003] The greater the number of bank notes that a customer must insert into the machine one by one, the more troublesome it becomes for the customer. Thus, the automatic machine can accept bank notes in the form of a bundle consisting of stacked bank notes to be entered. The above bank-note bundle consists of one or more bank notes being stacked because only one bank note may be entered.

[0004] Not every customer inserts the bank-note bundle properly. For example, some customers might insert a bundle consisting of bank notes in a number greater than the capacity specific to the automatic machine or the paper sheet handling device. Thus, some conventional paper sheet handling devices that extract bank notes from the bundle inserted by the customer one by one to convey them employ a configuration in which the height of the inserted bundle is detected, and the bundle is returned to the customer when the detected height is larger than a limit value, as disclosed in Japanese Patent Application Publication No. 1-177188.

[0005] The paper sheet handling device disclosed in the above Japanese Patent Application Publication No. 1-177188 detects the height of the bank-note bundle accurately by using the weight of each bank note stacked horizontally or obliquely. However, because each bank note only has a light weight, it can have a high elasticity relative to its weight. Thus, even when the bank notes are stacked, the entire height of the bundle will vary depending on the elasticity of each bank note. Because of this variation, it is not always possible to accurately detect the height of the bank-note bundle.

[0006] Some paper sheet handling devices accept the inserted bank-note bundle as it is. This type of conventional paper sheet handling device accepts a bank-note bundle when an insertion of the bank-note bundle is detected. However, not every customer inserts the bank-note bundle properly. Accordingly, troubles such as jams and the like due to improper insertion by the customer have occurred frequently. In view of the above, it is thought to be important to accurately determine in an early stage whether or not a bundle of bank-notes has been inserted from outside.

Patent Document 1:
Japanese Patent Application Publication No. 1-177188

Patent Document 2:
Japanese Patent Application Publication No. 64-82293

Disclosure of Invention

[0007] It is an object of the present invention to provide a paper sheet handling device that can accurately determine whether or not a bank-note bundle inserted from outside is proper at an early stage.

[0008] A Paper sheet handling device according to the first through fourth aspects of the present invention can handle paper sheets inserted from outside, and respectively comprises the units below.

[0009] Apaper sheet handling device according to the first aspect of the present invention comprises a bundle conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from outside while applying pressure to the paper sheet bundle, and a height detection unit detecting the height of the paper sheet bundle in the direction in which the paper sheets in the paper sheet bundle to be conveyed by the conveyance unit are stacked, and a conveyance control unit determining whether or not the height of the paper sheet bundle detected by the height detection unit satisfies a condition for acceptance, and for causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when it is determined that the height does not satisfy the condition.

[0010] A paper sheet handling device according to the second aspect of the present invention comprises a pressure application unit applying pressure to a paper sheet bundle including one or more stacked paper sheets inserted from outside, a height detection unit detecting the height of the paper sheet bundle to which pressure is applied by the pressure application unit, and a conveyance control unit determining whether or not the height of the paper sheet bundle detected by the height detection unit satisfies a condition for acceptance, and for stopping acceptance of the paper sheet bundle when it is determined that the height does not satisfy the condition.

[0011] It is desirable that in the first and second aspects, the conveyance control unit determines, when a plurality of paper sheet bundles that should be handled together are inserted separately from outside, whether or not the condition is satisfied based on the height detected by the height detection unit for each of the paper sheet bundles.

[0012] Apaper sheet handling device according to the third aspect of the present invention comprises a bundle

conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from outside, a size detection unit detecting one or more sizes in a direction orthogonal to the direction in which the paper sheets in the paper sheet bundle to be conveyed by the bundle conveyance unit are stacked, and a conveyance control unit causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when the size of the paper sheet bundle detected by the size detection unit is not within an acceptable range.

[0013] A paper sheet handling device according to the fourth aspect of the present invention comprises a bundle conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from outside, an amount of obliqueness detection unit detecting the amount of obliqueness of the paper sheet bundle to be conveyed by the bundle conveyance unit, and conveyance control unit causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when the amount of obliqueness detected by the amount of obliqueness detection unit is not within an acceptable range.

[0014] In the present invention, the height of the paper sheet bundle inserted from outside is detected while pressure is applied to the bundle, it is determined whether or not the detected height satisfies the condition for accepting the bundle, and when it is determined that the detected height does not satisfy the condition, the paper sheet bundle is discharged to the outside.

[0015] It is possible to accurately determine the actual height of a paper sheet bundle whose height has become larger due to elasticity of the paper sheets by detecting the height of the bundle while applying pressure to the bundle. Usually, pressure is applied in both of the case of conveying the inserted paper sheet bundle as it is and the case of extracting and conveying the paper sheets one by one. Because of this, it is possible to prevent a paper sheet bundle that is actually proper from being recognized as improper.

[0016] In an automatic machine such as an ATM or the like for example, customers can conduct an additional deposit after their first transaction. In the additional deposit, bank notes as the paper sheets are inserted separately in plural times. It is desirable that even when the paper sheets have been inserted separately in plural times, the return of the paper sheets is conducted all at once. Therefore, when the paper sheets that should be handled together are inserted from outside separately in plural times, it is determined whether or not the condition is satisfied based on the height of each paper sheet bundle such that it is possible to properly determine whether or not the total height of all the inserted paper sheet bundles is proper.

[0017] In the present invention, at least one size of the paper sheet bundle is detected in the direction orthogonal to the direction in which the paper sheets of the paper sheet bundle to be conveyed are stacked, and when the detected size of the paper sheet bundle is not within an acceptable range, the paper sheet bundle is discharged to the outside. Accordingly, it is possible to accept only paper sheet bundles of the proper size.

[0018] In the present invention, the amount of obliqueness of the paper sheet bundle to be conveyed after being inserted is detected, and when the detected amount of obliqueness is not within an acceptable range, the paper sheet bundle is discharged. Accordingly, it is possible to accept only paper sheet bundles that can be conveyed in a suitable state.

[0019] The above determination of the paper sheet bundle is performed when the bundle is inserted or immediately after starting the conveyance of the bundle after the insertion. Thereby, any determination of whether or not the paper sheet bundle inserted from outside is proper can be performed accurately in an early stage.

Brief Description of Drawings

[0020]

Fig. 1 is a sectional view of a paper sheet handling device according to an embodiment of the present invention;

Fig. 2 shows a configuration of a conveying system of a paper sheet conveying device (pre-acceptor) that accepts a bank-note bundle inserted from outside;

Fig. 3A is a top view showing a configuration of a clamp and the driving system thereof;

Fig. 3B is a side view showing the configuration of the clamp and the driving system thereof;

Fig. 3C is a front view showing the configuration of the clamp and the driving system thereof;

Fig. 4 shows a state in which pressure is applied by the clamp to the inserted bank-note bundle;

Fig. 5 shows an arrangement of sensors provided in the vicinity of an opening;

Fig. 6 shows the circuit configuration of the paper sheet handling device according to an embodiment of the present invention;

Fig. 7A shows a method of detecting the height of the inserted bank-note bundle by using the sensors (upper end position);

Fig. 7B shows the method of detecting the height of the inserted bank-note bundle by using the sensors (first position at which bundle can be accepted);

Fig. 7C shows the method of detecting the height of the inserted bank-note bundle by using the sensors (second position at which bundle can be accepted);

Fig. 7D shows the method of detecting the height of the inserted bank-note bundle by using the sensors (lower end position);

Fig. 8A shows a bank-note bundle that satisfies the condition that the bank-note bundle should satisfy in order to be accepted;

Fig. 8B shows a bank-note bundle that does not satisfy the condition that the bank-note bundle should

satisfy in order to be accepted;

Fig. 9 shows a method of measuring the amount of obliqueness of the bank-note bundle;

Fig. 10 is a flowchart of processes executed when bank notes are deposited;

Fig. 11 is a flowchart of processes executed when bank notes are accepted;

Fig. 12 shows another example of detecting an improper bank-note bundle;

Fig. 13A shows a state before insertion of the bank-note bundle in the above example; and

Fig. 13B shows a state after the insertion of the bank-note bundle in the above example.

Best Modes for Carrying Out the Invention

[0021] Hereinafter, embodiments of the present invention will be explained in detail by referring to the drawings.

[0022] Fig. 1 is a sectional view of a paper sheet handling device according to an embodiment of the present invention.

[0023] The paper sheet handling device 1 is configured based on the assumption that the paper sheet handling device 1 is used for an automatic machine such as, for example, an automated-teller machine (ATM), for handling bank notes as paper sheets. As shown in Fig. 1, the paper sheet handling device 1 comprises a pre-acceptor 100 for accepting a bank-note bundle B inserted by a customer consisting of one or more stacked bank notes, a lower unit 200 for storing the bank notes, and an upper unit 300 for conveying the bank notes between the lower unit 200 and the pre-acceptor 100. The pre-acceptor 100 is referred to as "acceptor" or as "PAC" hereinafter.

[0024] Operations in the above configuration will be explained. The paper sheet handling device 1 is a device for conducting processes for the deposit and withdrawal of bank notes. Thus, the operations are explained respectively for both deposit and withdrawal. An ATM is assumed as the automatic machine that includes the paper sheet handling device 1; in other words, it is assumed that the paper sheet handling device 1 operates in accordance with instructions from the main body of the ATM.

[0025] An opening 101 provided in the acceptor 100 is for receiving the bundle "B" of bank notes entered by the customer and for discharging the bundle "B" of bank notes to the outside for a customer who wants to withdraw the bank notes. When included in an ATM, a shutter (not shown) for opening and closing is provided on the external side of the opening 101. Hereinafter, the side of the opening 101 with respect to the acceptor 100 is referred to as the front side, and the other side is referred to as the back side, based on the view point of the customer. Also, the side of the upper unit 300 with respect to the lower unit 200 is referred to as upward, and the other side is referred to as downward.

[0026] First, operations when bank notes are deposited are explained in detail. A deposit is conducted, for example, by a customer operating an operation unit (not shown) of the ATM in order to request to be allowed to deposit bank notes. When the request is made by the customer, the main body of the ATM causes the paper sheet handling device 1 to open the shutter and to shift to a state in which the bank-note bundle B can be inserted (entered) into the opening 101, and instructs the paper sheet handling device 1 to accept the inserted paper sheets B.

[0027] In the vicinity of the opening 101, a sensor is provided for detecting the inserted bank-note bundle B. When receiving the instruction from the main body of the ATM, the paper sheet handling device 1 waits for the sensor to detect the bank-note bundle B, and conveys the bundle. Being conveyed by the paper sheet handling device 1, the bank-note bundle B reaches a separator (SEP) unit 310 of the upper unit 300 via a conveying path 102.

[0028] The paper sheet handling device 1, after having accepted the bank-note bundle B, notifies the main body of the ATM of this fact. The main body of the ATM causes the paper sheet handling device 1 to close the shutter based on the notification.

[0029] In the lower part of the separator unit 310, an extraction mechanism 311 is provided for extracting bank notes from the bank-note bundle B one by one. The extraction mechanism 311 is of a known type, for example. Specifically, the extraction mechanism 311 employs a configuration that includes a pick roller for transmitting motive power in an extraction direction to the lowermost bank note, a feed roller for conveying the bank note extracted by the pick roller, and a separator that contacts the feed roller to prevent the bank notes from being conveyed in a stacked state.

[0030] The bank-note bundle B reaches a stage 312 in the state shown in Fig. 2 by being conveyed to the separator 310 by the acceptor 100. The stage 312, and a pusher 313 above the stage 312 can move upward and downward. Thereby, the bank-note bundle B is conveyed to the position at which the extraction mechanism 311 can extract the bank note by moving the stage 313 downward. The positions of the stage 312 and the pusher 313 shown in Fig. 2 are respectively the upper ends of their movable range, and these positions are accordingly referred to as upper ends or as upper end positions.

[0031] As is well known, extraction of the bank note requires that the bank note and the pick roller contact each other with suitable pressure. The pusher 313 is used for applying this pressure in order to cause the bank note and the pick roller to contact each other. The pusher 313 is moved downward after moving the stage 312 downward to its lower end, and thereby the required pressure is applied.

[0032] The above pick roller can move upward and downward by being supported by an elastic member (not shown). This is for determining from the position of the pick roller whether or not pressure suitable for extracting

the bank note is being applied. For this purpose, a sensor is provided for detecting when the pick roller is moved downward due to the pressure applied to it. The pusher 313 is moved downward in to apply suitable pressure by monitoring the detection result of the sensor. Because of this, driving systems for moving the stage 312 and the pusher 313 are provided separately. As power sources of the movement, stepping motors are used for both of the driving systems.

[0033] Each bank note extracted by the extraction mechanism 311 from the separator unit 310 one by one is conveyed to a discrimination unit 320 via a conveying path 301, and is discriminated. With this discrimination, determination as to whether or not the bank note is a normal note and determination of the denominations of the notes are conducted. A bank note that is determined to be a counterfeit note, a note that cannot be discriminated, or a damaged note is determined to be an abnormal note. After the discrimination, the bank note is conveyed via a conveying path 302.

[0034] The upper unit 300 includes three reject boxes 351 to 353. A temporary holding unit 330 is provided for temporarily storing the bank notes entered by the customer. A conveying path 303 is formed for storing the bank notes in the temporary holding unit 330, and a conveying path 304 is formed for storing the bank notes in one of the reject boxes 351 to 353.

[0035] On the conveying path 302, switching pawls 302a and 302b are arranged for switching the conveyance destinations of the bank notes. It is possible to switch the conveying path that subsequently conveys the bank note being conveyed to conveying path 303 by switching pawl 302a and to conveying path 304 by switching pawl 302b. The bank note after the discrimination is sent from conveying path 302 to conveying path 303 by switching pawl 302a, and is stored in the temporary holding unit 330.

[0036] In the temporary holding unit 330, two stages 331 and 332 that are movable upward and downward are provided. Stage 331 is used for storing bank notes which were determined to be abnormal notes, and stage 332 is used for storing bank notes which were determined to be normal notes. Herein, for convenience, the storing unit realized by stage 331 is referred to as a reservoir unit, and the storing unit realized by stage 332 is referred to as an escrow unit. Stage 331 is also referred to as an RSV stage, and Stage 332 is also referred to as ESC stage.

[0037] The stages 331 and 332 are attached to a belt 335 stretched between two pulleys 333 and 334 provided with an interval between them in a vertical direction. The two pulleys 333 and 334 and the belt 335 are prepared separately for the stages such that the stages 331 and 332 can be moved independently.

[0038] On the conveying path 303, a switching pawl is arranged such that the conveyance destination of the bank note can be selected between the reservoir unit and the escrow unit . Thereby, the bank note conveyed on the conveying path 303 is stored in the reservoir unit or in the escrow unit. On the conveying path 304, two switching pawls are arranged for storing the bank note in one of the reject boxes 351 to 353.

[0039] The discrimination of bank notes and the storage of the bank notes in the temporary holding unit 330 in accordance with the discrimination results are conducted on all the bank notes which have been extracted one by one from the separator unit 310. Accordingly, after the extraction of the bank notes from the separator unit 310 is completed, the extracted bank notes are stored in the reservoir unit or in the escrow unit of the temporary holding unit 330. The completion of the extraction is confirmed by a sensor detecting that there are no bank notes in the separator unit 310 or by detecting that no bank notes are being extracted to the conveying path 301 even when the extraction is being conducted.

[0040] When storage in the temporary holding unit 330 of the bank notes entered in the form of the bank-note bundle B is completed, the paper sheet handling device 1 notifies the main body of the ATM of this fact. The paper sheet handling device 1 also notifies the main ody of the ATM of the money amount calculated by counting the number of bank notes that were determined by the discrimination unit 320 to be normal notes for each denomination. Based on the above information, the main body of the ATM inquires of the customer whether he/she wants to conduct transactions, or to deposit bank notes additionally, etc. Subsequent operations are conducted based on the answer to this inquiry.

[0041] When a customer makes a request to deposit additional bank notes, the main body of the ATM causes the paper sheet handling device 1 to open the shutter again, and instructs the paper sheet handling device 1 to accept the paper sheets B that are inserted. The bank notes constituting the bundle B inserted by the customer are stored in the reservoir unit or the escrowunit of the temporary holding unit 330 as described above.

[0042] When the customer requests cancellation of the transaction, the main body of the ATM instructs the paper sheet handling device 1 to return the bank notes that were accepted. The bank notes are usually stored in the reservoir unit and/or the escrow unit of the temporary holding unit 330. The paper sheet handling device 1 returns the bank notes as below depending on the places that store the bank notes.

[0043] Above the temporary holding unit 330, a conveying path 305 is provided for conveying the bank-note bundle B. The conveying path 305 can convey the bank-note bundle B stored in the temporary holding unit 330 to the acceptor 100. The conveyance of the bank-note bundle B on the conveying path 305 is conducted by using a carrier 341. This carrier 341 is for conveying the bank-note bundle B by pushing the bundle from its back side. By conveying the bundle as above, the respective bank notes stacked as the bank-note bundle B are supported by the carrier 341. Thereby, the bank-note bundle B is conveyed properly and accurately such that bank

notes will be prevented from projecting in a direction orthogonal to the direction of stacking of the bank notes while being conveyed.

[0044] On the conveying path 305, many gears are provided for transmitting motive power to the carrier 341. The carrier 341 moves along a guide (not shown) provided on the conveying path 305 by the above motive power transmitted by the gears. Because of this, different gears transmit the motive power to the carrier 341 depending on the positions of the carrier 341 on the conveying path 305. The guide is also provided on the stages 331, 332, and 312.

[0045] When bank notes are stored only in the reservoir unit, the RSV stage 331 is moved to a position (release position) on the conveying path 305 after the carrier 341 is moved to a position (escrow retraction position) on the back side of the stage 331 at the release position. The bank-note bundle B on the stage 331 is conveyed to the opening 101 by the acceptor 100 after the carrier 341 is moved to the position (release position) before the acceptor 100. When the carrier 341 is moved to the release position, for example, the main body of the ATM is notified of this fact and the shutter is consequently opened. The position of the carrier 341 before the stage 331 is moved, and the timing of the notification of the main body of the ATM are basically the same in other cases.

[0046] When bank notes are stored only in the escrow unit, the RSV stage 331 is moved to the position (upper end position) on the conveying path 305, and the ESC stage 332 is moved to a position (release position) on the conveying path 305. The bank-note bundle B on the stage 332 is moved to the opening 101 by the acceptor 100 after moving the carrier 341 to the position (release position) before the acceptor 100.

[0047] When the bank notes are stored in both the reservoir unit and the escrow unit, the RSV stage 331 is moved to the position (release position) on the conveying path 305 after the stage 312 and the pusher 313 are moved to the upper end positions respectively. The bank-note bundle B on the RSV stage 331 is conveyed onto the stage 312 by moving the carrier 341 to the separator unit 310. Next, the stage 312 is moved downward, and the pusher 313 is moved to a mergence preparation position, which is the upper end position of the stage 312. After the pusher 313 is moved to the mergence preparation position, a fork 342 (shown in Fig. 1) is caused to project to the pusher 313 (project forward). After the projection, the pusher 313 is moved to the upper end position.

[0048] Because bank notes have elasticity, a folded bank note tends to remain in the folded state. Thereby, when bank notes are simply stacked, the height of the stacked bank notes varies depending on elasticity of each bank note. The more the bundle includes folded bank notes, the higher the height of the bundle becomes. Thus, the fork 342 is provided to prevent the bank-note bundle B on the stage 312 from projecting to the conveying path 305.

[0049] The fork 342 projects along the conveying path 305 at the height of the mergence preparation position, and is configured such that it can retract from the projecting state. To enable the projection, the pusher 313 includes a recess. In the above configuration, the fork 342 projects outward while the bank-note bundle B on the stage 312 is pressed by the pusher 313 such that the fork 342 presses the bank-note bundle B in order to prevent the bank-note bundle B from projecting to the conveying path 305 after moving the pusher 313 upward.

[0050] The carrier 341 is returned to the escrow retraction position after conveying the bank-note bundle B on the RSV stage 331 to the separator unit 310. Thereafter, the stages 331 and 332 are sequentially moved to the upper end positions. The upper end position of the ESC stage 332 corresponds to the release position of the RSV stage 331. Thus, the carrier 341 is moved in order to convey the bank-note bundle B on the ESC stage 332 to the separator unit 310.

[0051] By being conveyed to the separator unit 310, the bank-note bundle B is conveyed onto the fork 342. After the bank-note bundle B is conveyed, the fork 342 is caused to retract. Thereby, the bank-note bundle B, having been stored in the reservoir unit, and the bank-note bundle B, having been stored in the escrow unit, are stacked in the corresponding order, and are combined into one. The bank-note bundle B, which has been combined into one, is conveyed to the release position of the acceptor 100 by the carrier 341 by moving the stage 312 to the upper end position, and is further conveyed to the opening 101 by the acceptor 100. Thereby, the bundle B is returned to the customer.

[0052] As above, in the embodiment of the present invention, the bank notes that have been stored respectively in the reservoir unit and in the escrow unit are returned in a state in which they have been combined into one. This to prevent the customer from leaving the returned bank notes, a situation that may more easily arise if the retuned bank notes are stored in two separate units. Bank notes that a customer has forgotten to take are stored in the reject box 353, for example.

[0053] When the customer requests to conduct a transaction (deposit bank notes), the main body of the ATM instructs the paper sheet handling device 1 to store the bank notes that have been accepted. The bank notes are stored in the reservoir unit and/or the escrow unit of the temporary holding unit 330. The paper sheet handling device 1 stores the bank notes depending on the place that store the bank notes.

[0054] Abnormal notes i.e., the bank notes that were not determined to be normal notes, are stored in the reservoir unit. Accordingly, when the bank notes are stored only in the reservoir unit, they are returned. The above returning operations are basically the same as the operations of returning the bank notes that are stored only in the reservoir unit in response to a cancellation request by the customer.

[0055] When the bank notes are stored only in the escrow unit, the RSV stage 331 is retracted and moved to the upper end position on the conveying path 305, and the ESC stage 332 is moved to the release position on the conveying path 305 in order to convey the bank-note bundle B on the stage 332 to the separator unit 310. The bank notes are extracted from the conveyed bank-note bundle B to the separator unit 310 one by one, and each bank note is conveyed to the lower unit 200 via the conveying path 301, the discrimination unit 320, and the conveying path 302.

[0056] The lower unit 200 includes detachable bank note cassettes 210 for respective denominations of the stored bank notes. On each cassette 210, an extraction mechanism 211 is provided for storing the bank notes and for extracting the stored bank notes. The bank notes conveyed to the lower unit 200 are conveyed on a conveying path 201, guided to suitable bank note cassettes by the switching pawls on the conveying path 201, and are stored by the extraction mechanism 211. In this method, the bank notes inserted by the customer are stored in the cassettes 210 separately depending on the denominations.

[0057] When bank notes are being stored in both the reservoir unit and the escrow unit, the bank notes stored in the reservoir unit are returned to the customer as described above, and only the bank notes that are stored in the escrow unit are conveyed to the separator unit 310. The conveyed bank notes are extracted to the separator unit 310 one by one, and the bank notes that are determined to be normal notes are conveyed to the lower unit 200 via the conveying path 301, the discrimination unit 320, and the conveying path 302, and are stored in the cassettes 210 separately depending on the denominations. The bank notes that are determined to be abnormal notes are stored in the reject box 351 or 352 via the conveying path 301, the discrimination unit 320, the conveying path 302, and the conveying path 304. Alternatively, the abnormal notes are again discriminated by being conveyed to the separator unit 310 after being stored once in the reservoir unit, for example.

[0058] As above, in the present embodiment, the paper sheet bundle B inserted by the customer is conveyed to the separator unit 310 without changing its state. Thereafter, bank notes are extracted from the bank-note bundle B, and the bank notes that have been extracted and discriminated are stored in the temporary holding unit 330 and conveyed and returned in the state of the bank-note bundle B, or are moved to the separator unit 310. Therefore, it is possible to make the distance over which the bank notes are conveyed one by one shorter than the distance when the stored bank notes are extracted and conveyed one by one after the discrimination. Thereby, the likelihood of troubles such as a jam or the like occurring during the conveyance can be reduced in order to improve reliability.

[0059] Next, operations when the customer withdraws bank notes are explained. A withdrawal is conducted, for example, by a customer operating an operation unit of the ATM in order to request to be allowed to withdraw bank notes of the specified amount. When the customer makes a request for withdrawal, the main body of the ATM instructs the paper sheet handling device 1 to discharge bank notes of the specified amount. When the customer specifies the desired bank notes, the paper sheet handling device 1 is notified of the specified bank notes.

[0060] The paper sheet handling device 1, receiving the above instruction from the main body of the ATM, determines the number of bank notes that should be withdrawn by the customer for each denomination, for example, and causes the extraction mechanisms 211 to extract the bank notes one by one from the suitable bank note cassettes 210. Each bank note extracted is conveyed to the discrimination unit 320 via the conveying path 201 and a conveying path 306 of the upper unit 300, and is discriminated. After the discrimination, bank notes that are determined to be normal notes are conveyed to the escrow unit, and bank notes that are determined to be abnormal note are conveyed to the reject box 351 or 352.

[0061] The conveyance of the bank notes to the escrow unit is continued until the correct number and amount of bank notes to be withdrawn as requested by the customer are stored. After storage of the banknotes in the amount to be withdrawn is completed, the bank notes are conveyed to the opening 101 by the acceptor 100 after moving the carrier 341 to the release position before the acceptor 100 in a similar manner to the way in which bank notes stored only in the escrow unit were returned.

[0062] As above, the bank notes to be withdrawn by the customer are also conveyed to the opening 101 of the acceptor 100 as a bank-note bundle B. Therefore, the paper sheet handling device 1 can be installed even when only a small space can be used around the opening 101.

[0063] Next, the configuration of the acceptor 100 will be explained in detail by referring to Figs. 2 to 5.

[0064] Fig. 2 shows the configuration of the conveying system of the acceptor 100. As shown in Fig. 2, the acceptor 100 comprises a clamp 103 provided above the conveying path 102, a tray 104 provided under the conveying path 102, a hook 105 attached to the tray 104, a conveyer belt 106 for conveying the bank-note bundle B along the conveying path 102, an encoder 107 for confirming the conveyance distance of the bank-note bundle B by the conveyerbelt 106, sensors 109 to 112 provided at different positions on the conveyer belt 106, and stoppers 113 and 114, which are provided at different positions on the conveying path 102, and which can project to the conveying path 102 and can retract. The hook 105 and the stoppers 113 and 114 are provided in plural numbers and are arranged in the direction orthogonal to the direction of the conveyance of the bank-note bundle B.

[0065] The above encoder 107 comprises a disk 107a rotating in conjunction with the rotation of a motor that

transmits motive power to the conveyer belt 106, and a sensor 107b for detecting a slit provided on the circumference of the disk 107a. The sensor 107b is an optical sensor comprising a light emitting element and a photo detector. The light beam emitted from the light emitting element is shielded intermittently by the rotation of the disk 107a. Thereby, pulse signal is output from the photo detector, and by counting the pulse signal, the actual conveyance distance is determined.

[0066] The above tray 104 is a plate-shaped member for supporting the bank-note bundle B inserted via the opening 101. The hook 105 attached to the tray 104 can project to the conveying path 102 and retract. The hook 105 is used for guiding the length over which the bank-note bundle B should be inserted, as shown in Fig. 2.

[0067] The movement of the tray 104 along the conveying path 102 is conducted by a stretched belt that overlaps the conveyer belt 106 when viewed from the viewpoint of Fig. 2. The encoder 107 as shown in Fig. 2 is independently prepared in order to determine the movement distance. In order to avoid confusion, the stopper 113 arranged on the front side is referred to as an A stopper, and the stopper 114 arranged on the back side is referred to as a D stopper.

[0068] Figs. 3A to 3C show the configuration of the above clamp 103 and its driving system.

[0069] As shown in Fig. 3A, the clamp 103 has a configuration in which four conveyer belts 123 for conveying the bank-note bundle B are supported in a tensioned state by a plurality of shafts, including shafts 121 and 122. A plurality of guides 124 for insertion of the bank-note bundle B are attached to the shaft 121 which is nearest to the front side. The motive power for moving the conveyer belts 123 is transmitted via one shaft e.g., shaft 121. The motive power is transmitted also to the conveyer belt 106 arranged below.

[0070] The clamp 103 can move in the direction orthogonal to the direction along the conveying path 102 in order to clamp the inserted bank-note bundle B together with the tray 104. The driving system realizes the movement by arms 131 attached to both ends of the shaft 121, and by arms 132 attached to both ends of the shaft 122. The motive power is transmitted to arms 132, and the motive power is further transmitted to arms 131 via links 133.

[0071] As shown in Fig. 3B, the arms 131 and 132 can swing on shafts 131a and 132a, respectively. At the ends of the arms, recesses 131b and 132b are respectively formed such that the shafts 121 and 122 are rotatably attached to the recesses 131b and 132b. Teeth are formed on another end 132c which is arc-shaped, and the teeth are engaged in the teeth of gears 135.

[0072] As shown in Fig. 3C, the gears 135 are attached to the ends of the shafts 134. To the other ends of the shafts 134, pulleys 136 are attached. Between these pulleys 136 and pulleys 139 attached to the ends of shaft 138, drive belts 137 are stretched.

[0073] A motor 140 is the power source for the driving system for moving the clamp 103. The motor is, for example, a stepping motor. The motive power of the motor 140 is transmitted to the shaft 138 via gears 141 to 143 and a clutch 144, as shown in Fig. 3B. The motive power transmitted to the shaft 138 is transmitted to the arms 132 via the pulleys 139, the drive belts 137, the pulleys 136, the shafts 134 and the gears 135. As a result of the transmission of the motive power, the clamp 103 can change its state from the state (upper end position) shown in Fig. 2 to the state shown in Fig. 4, and conversely, from the state shown in Fig. 4 to the state shown in Fig. 2.

[0074] By causing the clamp 103 to change its state from the state shown in Fig. 2 to the state shown in Fig. 4, downward pressure is applied to the bank-note bundle B and it is clamped between the clamp 103 and the tray 104. It is not necessary to apply a greater pressure than is needed to the bank-note bundle B. It is not possible to predict the height of the bank-note bundle B when a sufficient pressure is applied to the bundle B because the height of the bank-note bundle B varies. Accordingly, in the present embodiment, a one-way clutch that slips when confronted with resistance larger than a prescribed value is employed as a clutch 144. Thereby, it can be ensured that suitable pressure is applied to the bank-note bundle B.

[0075] As shown in Fig. 4, three slits 133a to 133c are provided in the link 133, and two sensors 145 and 146 for detecting these slits 133a to 133c are provided. The sensors 145 and 146 are both optical sensors for recognizing the slits 133a to 133c by detecting whether or not the light beam emitted from the light emitting element is shielded.

[0076] The slits 133a to 133c and the sensors 145 and 146 are arranged such that the position of the clamp 103 and whether or not the bank-note bundle B has a height that allows acceptance canbe determined. When the clamp 103 is at the upper endposition shown in Fig. 2, the light passes through each of the sensors 145 and 146, that is, the light from the light emitting element can enter the photo detector as shown in Fig. 7A. When the bank-note bundle B has a height that allows acceptance, the sensor 145 cuts off the light, that is, prevents the light from the light emitting element frombeing entering to the photo detector. At this time, the other sensor 146 can either cut off or pass the light. When there is no bank-note bundle B or the bank-note bundle B has a small height, the sensor 145 passes the light, and the sensor 146 cuts off the light as shown in Fig. 7D. When the state is as shown in Fig. 7D, the clamp 103 is at the lower end position.

[0077] Fig. 5 shows an arrangement of sensors provided in the vicinity of the opening 101. All of the sensors 109 to 111 in the vicinity of the opening 101 and the sensor 112 provided on the back side thereof are optical sensors.

[0078] As shown in Fig. 5, the bank-note bundle B is inserted between width adjusting guides 151 such that

the longitudinal direction of the bundle is orthogonal to the insertion direction. In order to determine whether or not the longitudinal length of the bank-note bundle B inserted into the opening 101 is of normal notes, sensors 109a to 109d are arranged in line. These sensors 109a to 109d and a sensor 110 are used to determine whether or not the bank-note bundle B is a target that should be accepted. The condition that the bank-note bundle B should satisfy to be accepted is that each of the sensors 110, 109b and 109c detect the bank-note bundle B, and in addition that one of the sensors 109a and 109d detects it. A bundle B that does not satisfy the above condition as shown in Fig. 8 is rejected. Arrows in Fig. 8A and Fig. 8B represent the insertion direction of bank notes.

[0079] The bank-note bundle B may be inserted obliquely to the opening 101. The obliqueness of the bundle B is detected by the sensors 109b and 109c. The detection of obliqueness is performed only on bank-note bundles B that satisfy the condition of acceptance.

[0080] As shown in Fig. 9, when the bank-note bundle B inserted in the insertion direction represented by the arrow is oblique, the timing at which the sensors 109b and 109c stop detecting may be different during the conveyance of the bundle B. When it is assumed that the above time difference is ΔT and the conveyance speed is V, the gap amount X between the sensors 109b and 109c shown in Fig. 9 is expressed by the equation below.

$$X = V \cdot \Delta T$$

[0081] Accordingly, when it is assumed that the interval between the sensors 109b and 109c is Y, the amount of obliqueness in angle $\theta(°)$ is expressed by the equation below.

$$\theta = \tan^{-1}(X/Y)$$

[0082] Only when the amount of obliqueness θ is within an acceptable range will the bank-note bundle B continue to be accepted.

[0083] As described above, the longitudinal length of the bank-note bundle B is checked by the sensors 109a and 109b. The lateral length thereof is checked by confirming whether or not the distance over which the bank-note bundle B is conveyed between the position at which the bundle B started shielding the light beam and the position at which the bundle B stopped that shielding is within an acceptable range. The height of the bundle B is measured by detecting the rotation amount of the motor 140 required for retuning the clamp 103 to the upper end position after applying pressure to it. A Stepping motor is used as the motor 140, thus the number of pulses (number of steps) given to the motor for driving it is counted as the rotation amount.

[0084] At the upper end position, the sensors 145 and 146 are pass the light as shown in FIG. 7A. Accordingly, by monitoring the signals output from the sensors 145 and 146, it is possible to count the number of pulses applied to the motor 140 during the movement from the position of applying pressure to the bank-note bundle B to the upper end position. Thereby, the height of the bank-note bundle B can be calculated by subtracting the height corresponding to the number of steps from the height between the clamp 103 at the upper end position and the tray 104.

[0085] Usually, a bank note has an elasticity that is great relatively to its weight. This means that a deformation due to the elasticity of the bank note can not be prevented by the weight. Thus, when bank notes are simply stacked, the height of the entire stacked bank notes varies depending on the elasticity in the bank notes. Usually, the elasticity of the bake note cannot be removed permanently. Accordingly, even if the bank-note bundle B whose height has become greater due to elasticity is pressed, the height of the bank-note bundle B becomes greater when the pressing is stopped. Because of this, the height of the bank-note bundle B is obtained in the state of being pressed. The height thus obtained is accurate because the elasticity in each bank note is removed, and the height increases for each bank note.

[0086] As described above, in the present invention, the size of the bank-note bundle B (longitudinal length and lateral length) is accurately checked, and the amount of obliqueness θ and the height of the bundle B are accurately measured while the bank-note bundle B is in the acceptor 100. Accordingly, it is possible to determine an improper bank-note bundle B accurately in order to return it to the customer in an early step. Thereby, reliability is improved, and higher use efficiency is realized. The operations for realizing the above effects will be explained later.

[0087] Fig. 6 shows the circuit configuration of the paper sheet handling device 1.

[0088] The above acceptor 100 comprises a sensor group 161, a motor group 162, and a solenoid group 163. The sensor group 161 comprises the above sensors 109 to 112, 145, and 146, the sensor 107b of the encoder 107, and the like. The motor group 162 comprises the motor 140 as a power source for moving the clamp 103, the conveyer belt 123 stretched over the clamp 103, a driving motor for driving the conveyer belt 106 stretched below it, and a motor for moving the tray 104. All of these motors are stepping motors. The projection and retraction of the hook 105, the A stopper 113, and the D stopper 114 are conducted by solenoids. The solenoid group 163 consists of these solenoids.

[0089] The lower unit 200 operates on the basis of control by a printed circuit board (PCB) 260. To the printed circuit board 260, motor groups 217 and 272, a sensor group 273, and a solenoid group 274 are connected.

[0090] The motor group 271 comprises a plurality of stepping motors, for example. The respective stepping

motors are used as power sources for moving the stages in the corresponding cassettes 210. The motor group 272 comprises a plurality of DC motors, for example. The respective DC motors are used as power sources of the extraction mechanisms 211 in the corresponding cassettes 210.

[0091] The sensor group 273 comprises sensors provided on the conveying path 201 for detecting the paper notes, sensors for detecting the cassettes 210 (for example a switch), sensors for detecting the position of the stages of the cassettes 210, sensors for detecting the paper sheets stored in the cassettes 210, and the like. The solenoid group 274 comprises solenoids for switching the states of each switching pawl prepared on the conveying path 201, solenoids for transmitting motive power to the extraction mechanisms 211 in the respective cassettes 210, and the like.

[0092] On the printed circuit board 260, a CPU 261 for controlling the entirety of the paper sheet handling device 1, ROM 262 storing programs executed by the CPU 261 and various control data, RAM 263 to be used by the CPU 261, a sensor driving unit 264 for driving the sensors constituting the sensor group 273, a solenoid driving unit 265 for separately driving solenoids constituting the solenoid group 274, a motor driving unit 266 for driving the stepping motors constituting the motor group 271, a motor driving unit 267 for driving the DC motors constituting the motor group 272, a communication interface (I/F) 268 for conducting communications with, for example, the upper unit 300, and a communication interface (I/F) 269 for conducting communications with superior devices such as the main body of the ATM, for example, are provided.

[0093] The upper unit 300 operates on the basis of control by a printed circuit board (PCB) 360. To the printed circuit board 360, motor groups 371 and 162, DC motor 372, sensor groups 373 and 161, solenoid groups 374 and 163, and a discrimination unit 320 are connected. Thereby, the acceptor 100 is controlled by the upper unit 300.

[0094] The motor group 371 comprises a plurality of stepping motors, for example. The carrier 341, the respective stages 312, 331, and 332, and the pusher 313 are respectively moved by the stepping motors as the power sources. The DC motor 372 is a power source for extracting bank notes from the separator unit 310 and conveying them.

[0095] The sensor group 373 comprises a plurality of sensors provided on the conveying paths 301 to 305 for detecting the bank notes or the carrier 341, a plurality of sensors provided in the separator unit 310, a plurality of sensors provided in the temporary holding unit 330, and the like. The solenoid group 374 comprises solenoids for switching the states of each of the switching pawls 302a and 302b respectively prepared on the conveying path 301, and solenoids for switching the states of each of the switching pawls prepared on the other conveying paths 303 and 304 respectively, and the like.

[0096] On the printed circuit board 360, a CPU 361 for controlling the entirety of the upper unit 300, ROM 362 storing programs executed by the CPU 361 and various control data, RAM 363 to be used by the CPU 361, a sensor driving unit 364 for driving the sensors constituting the sensor groups 373 and 161, a motor driving unit 365 for driving the stepping motors constituting the motor groups 371 and 162, a motor driving circuit 366 for driving the DC motor 372, a solenoid driving unit 367 for separately driving solenoids constituting the solenoid groups 374 and 163, a communication interface (I/F) 368 for transmitting/receiving signals to/from the discrimination unit 320, and a communication interface (I/F) 369 for conducting communications with the lower unit 200, are provided.

[0097] The operations in the above configuration are explained.

[0098] The CPUs 261 and 361 respectively on the printed circuit boards 260 and 360 conduct control by executing the programs respectively stored in the ROMs 262 and 362. The CPU 261 receives instructions from the main body of the ATM via the communication I/F 269, and conducts the control of the lower unit 200 in accordance with the instructions, and gives instructions to the upper unit 300. The instruction is transmitted to the CPU 361 of the upper unit 300 via the communication I/Fs 268 and 369.

[0099] The CPU 261 receives, from a sensor driving unit 264, the detection result obtained by causing the sensor driving unit 264 to drive the sensor group 273 as needed, and receives the contents of the communication from the upper unit 300 or the main body of the ATM from the I/F 268 or 269 as needed. These detection results and the contents of communications are analyzed, and instructions corresponding to the situations are given to the solenoid driving unit 265 and the motor driving units 266 and 267. Thereby, the lower unit 200 operates under control of the CPU 261. Also, the information to be notified is transmitted via the communication I/F 268 or 269 as needed.

[0100] The CPU 361 of the upper unit 300 controls the upper unit 300 and the acceptor 100 based on the instruction from the lower unit 200. The control is conducted by giving instructions corresponding to the situations respectively to the solenoid driving unit 367, the motor driving unit 365, the motor driving circuit 366, and the discrimination unit 320 after receiving and analyzing the various detection results obtained by causing the sensor driving unit 364 to drive the sensor groups 373 and 161 as needed. Thereby, the upper unit 300 and the acceptor 100 operate under control of the CPU 361. The instruction is given to the discrimination unit 320 via the I/F 368, and the information to be notified to the lower unit 200 is transmitted as needed via the communication I/F 369. When the bank-note bundle B inserted by the customer is accepted, the money amount thereof is transmitted to the lower unit 200, and when the bank notes are stored, the denominations of the notes which have been determined to be normal notes or the like are transmitted to the lower

unit 200 as information.

[0101] Hereinbelow, the operations of the paper sheet handling device 1 will be explained by referring to the flowcharts in Figs. 10 and 11. The operations are realized by the configuration in which the CPU 261 of the lower unit 200 controls the lower unit 200 and the CPU 361 of the upper unit 300 controls the upper unit 300 and the acceptor 100 under control of the CPU 261.

[0102] The above check of the size of the bank-note bundle B (check of longitudinal length and of lateral length), and the measurements of the amount of obliqueness 8 and the height of the bundle B are conducted when the bank-note bundle B is inserted into the opening 101 of the acceptor 100. Therefore, only operations when the bank-note bundle B is inserted are explained.

[0103] Fig. 10 is a flowchart of processes that occur when bank notes are deposited. The processes are executed so that a deposit of the bank notes in the amount specified by the customer can be realized on the basis of the instruction given by the main body of the ATM. First, the processes when bank notes are deposited are explained by referring to Fig. 10.

[0104] The respective parts of the lower unit 200 operate under control of CPU 261, and the respective parts of the upper unit 300 and the acceptor 100 operate under control of CPU 371. Therefore, the following explanation is given by considering the CPUs which control the operations of the above units.

[0105] First, in step 101, it is confirmed whether or not the tray 104 is at the delivery position shown in Fig. 2, and when the tray 104 is not at the delivery position, the tray 104 is moved to the delivery position. In the next step 102, it is determined whether or not a bank note that satisfies the condition of acceptance (Fig. 8A) is detected at the opening 101. When the bank-note bundle B inserted into to the opening 101 by the customer satisfies the condition of acceptance, the determination result is Yes, and the process proceeds to step 104. When the bundle B does not satisfy the condition of acceptance, the determination result is No, and the process proceeds to step 103. To satisfy the condition of acceptance means that the longitudinal length of the bank-note bundle B is within the acceptable range.

[0106] The processes of the above steps 101 and 102 are realized by controlling, via the CPU 361, the upper unit 300, which is instructed by the CPU 261 of the lower unit 200 to accept the bank-note bundle B. This is also applied to steps 103 to 118, which will be described later. The shutter provided in the vicinity of the opening 101 is opened after the process of step 101 is executed for example. The hook 105 is usually in the state of projecting.

[0107] In step 103, it is determined whether or not a prescribed time period has elapsed since the bank-note bundle B started to be detected. If the prescribed time period has elapsed, the determination result is Yes, and the series of processes is terminated. If the prescribed time period has not elapsed, the determination result is No, and the process returns to the above step 102. Then, the process waits for the bank-note bundle B to be inserted until the prescribed time period elapses.

[0108] Although it is not shown, CPU 361 notifies CPU 261 that the bank-note bundle B has not been inserted in the phase prior to step 103 in which the determination result is Yes, and CPU 261 further notifies the main body of the ATM of this fact. Based on the notification at this time, the determination result becomes Yes in step 103 after the main body of the ATM causes the shutter to close.[0]

[0109] In step 104, the carrier 341 is moved to the delivering position, which is the position at which the bank-note bundle B is conveyed to the separator 310, and the pusher 313 and the stage 312 are respectively moved to the upper end positions. In the next step 105, as shown in Fig. 4, pressure is applied by driving the motor 140 such that the sensors 145 and 146 detect the height of the bank-note bundle B (Fig. 7A to Fig. 7D). The driving of the motor 140, which is a stepping motor, is conducted by CPU 361 by specifying the rotation direction and the number of pulses given (step number) to the motor driving unit 365. This is applied to other stepping motors.

[0110] In step 105a to be executed next, it is determined whether or not the detected height is within the acceptable range. When the detected height permits acceptance, the sensor 145 shifts its state from a light passing state to a light cutting off state while the clamp 103 is moved downward to apply pressure as shown in FIGS. 7A through 7D. Therefore, when the sensor 145 does not shift as above, it is determined that the height of the bank-note bundle B is not within the acceptable range, i.e., the determination result is no, and the process proceeds to step 108. When the sensor 145 has shifted, the determination result is Yes, and the process proceeds to step 106.

[0111] In step 106, after causing the hook 105 to retract, motive power is transmitted respectively to the conveyance belts 106 and 123 and the tray 104, and the bank-note bundle B is conveyed such that the lateral length of the bank-note bundle B is checked. The conveyance is conducted over the maximum length within the acceptable range after the sensor 111 detects the bank-note bundle B. In the conveyance, the amount of obliqueness θ is also calculated by measuring the time gap between the time at which the sensor 109b stops detecting the bundle B and the time at which the sensor 109c stops detecting the bank-note bundle B for checking the obliqueness (Fig. 9). The retraction of the hook 105 is conducted by the CPU 361 by instructing the solenoid driving unit 367 to drive the solenoid for the retraction. This is applied also to other solenoids. The measurement of the time gap may be conducted by using an included timer, for example. The actual conveyance distance is confirmed by monitoring the signals output from a sensor 107b of the encoder 107. The length check of the longitudinal length of the bank-note bundle B is conducted in step 102 as described above.

[0112] In step 107 subsequent to step 106, it is deter-

minedwhether or not the bank-note bundle B is normal, i.e., whether or not both the lateral length and the amount of obliqueness θ of the bank-note bundle B are within their respective acceptable ranges. When both of them are within their acceptable ranges, the determination result is Yes, and the process proceeds to step 110. When the bank-note bundle B is abnormal, i.e., when either the lateral length or the amount of obliqueness θ or both are not within the acceptable range, the determination result is No, and the process proceeds to step 108.

[0113] In step 108, after moving the tray 104 to the delivery position while pressure is being applied by the clamp 103, the application of pressure is stopped. Thereafter, the process proceeds to step 109 and waits for the bank-note bundle B to be drawn out. When all of the sensors 109a to 109d get in a state in which they do not detect the bank-note bundle B, it is recognized that the bank-note bundle B has been drawn out, and CPU 361 notifies CPU 261 of this recognition, and CPU 261 further notifies the main body of the ATM of this recognition, and thereafter, the series of processes is terminated.

[0114] Although it is not shown, when the bank-note bundle B is continuously detected for a prescribed time period, it is recognized that the customer left the bank-note bundle B in the ATM, and the bundle B is stored in the reject box 353. Thereby, that the ATM is prevented from getting into a state in which it cannot be used due to a customer leaving bank notes in the ATM.

[0115] In step 110, which is executed when the determination result is Yes in step 107, acceptance processes are executed for conveying the bank-note bundle B to the separator unit 310. By executing the acceptance process, the bank-note bundle B is conveyed onto the stage 312. Thereafter, step 110a is executed.

[0116] The above acceptance process is explained in detail by referring to the flowchart in Fig. 11. When the execution of the acceptance process starts, the end portion on the front side of the bank-note bundle B is on the back side with respect to the position at which the sensor 111 detects bank notes (Fig. 2) .

[0117] The above acceptance process is explained in detail, by referring to the flowchart in Fig. 11. When the execution of the acceptance process starts, the end portion on the front side of the bank-note bundle B is on the back side with respect to the position at which the sensor 111 detects bank notes (Fig. 2) .

[0118] First, in step 201, the A stopper 113 is caused to project. In the next step 202, the clamp 103 is caused to retract by moving it to the upper end position shown in Fig. 2. Then, as described above, by monitoring the signals output from the sensors 145 and 146, the number of pulses given to the motor 140 is counted. Thereafter, the process proceeds to step 203, and a retraction amount is obtained from the counted step number. Then, by subtracting the obtained retraction amount from the height between the clamp 103 and the tray 104 at the upper end positions, the height of the inserted bank-note bundle B is calculated. Thereafter, step 204 is executed.

[0119] In step 204, it is determined whether or not the bank-note bundle B was inserted as an additional deposit. If the bank-note bundle B was inserted by a customer who made an additional deposit request, the determination result is Yes. Then the process proceeds to step 205, and the total value of the height of the bank-note bundle B inserted by the customer during the current transaction is calculated. The calculation is performed by summing the heights calculated for the respective bank-note bundles B by executing the process of step 203. Thereafter, step 206 is executed. If the bank-note bundle B was not inserted by a customer who made an additional deposit request, the determination result is No, and step 207 is executed. Step 207 is executed in order to confirm whether the height allows acceptance of the bank-note bundle B based on the signals output from sensors 145 and 146 when the bank-note bundle B is pressed by the clamp 103 in step 106 of Fig. 10.

[0120] In step 206, it is determined whether or not the calculated total value is within an acceptable range. When the total value exceeds a prescribed upper limit, the determination result is No, and the series of the processes are terminated. When the total value does not exceed the prescribed upper limit, the determination result is Yes, and step 207 is executed.

[0121] In order to prevent the customer from leaving the bank notes, it is desirable that all the bank notes are returned all at once. However, there is a height limitation for conveying the bank notes all at once because in some portions the bank notes are conveyed in the form of a bundle. In the case of additional deposits, it is necessary for the bank-note bundle B inserted by the customer to be taken into consideration such that the total height of the bank-note bundle B after the additional deposit does not exceed the upper limit in height for returning the bank notes after the additional deposit. Therefore, the entire height of the bank-note bundle B is obtained and when the obtained height exceeds the upper limit, the bank-note bundle B newly inserted by the customer is not accepted. Thereby, it is possible to prevent the occurrence of troubles such as jams or the like. The upper limit can also be determined based on other factors such as the amount of money that can be transacted all at once, or the like.

[0122] It is not always possible to extract all the bank notes in the separator unit 310. When not all the bank notes are extracted, bank notes that were not extracted remain in the separator unit 310. The remaining bank notes are returned to the customer regardless of the customer's request. When the customer requests to make an additional deposit, the bank notes in the reservoir unit are returned together if the bank notes are in the reservoir unit.

[0123] By the return mechanism above, the number of bank notes in the upper unit 300 decreases and the total height of the bank notes becomes different from the height calculated in step 203 or the total value calculated in step 205. However, in the present embodiment, it is

assumed that both the number of remaining bank notes and the number of bank notes stored in the reservoir unit are small, and any change in height or total value of such bank notes is ignored.

[0124] In step 207, the tray 104 is moved backward as viewed from the delivery position i.e., the conveyance direction of the bank-note bundle B. After this movement, the process proceeds to step 208, and the hook 105 is caused to project. The hook 105 automatically recovers to the projecting state when the drive of the solenoid for retraction is terminated. The projection of the A stopper 113 is conducted by driving the solenoid that causes the projection on the basis of the instruction from CPU 361 to the solenoid driving unit 367.

[0125] In step 209 subsequent to step 208, after the retraction of the A stopper 113, the hook 105 moves the projecting tray 104 to the release position. The release position is the backmost position within the range over which the tray 104 can move. The movement to the release position is conducted by monitoring output signals of the sensor 112.

[0126] In step 210 subsequent to step 209, pressure by the clamp 103 is applied by driving the motor 140. After the application of this pressure, the bank-note bundle B is conveyed over a prescribed distance by transmitting motive power to the conveyer belts 106 and 123 (S211), and after the conveyance, the D stopper 114 is caused to project (S212). Thereby, after the conveyance of the bank-note bundle B to stage 312 of the separator unit 310, the series of the processes are terminated.

[0127] Step 110a and the subsequent steps in Fig. 10 are again explained.

[0128] In step 110a, it is determined whether the bank-note bundle B has been completely accepted into the separator unit 310. As described above, when the total value of the height of the bank-note bundle B does not exceed the upper limit, the determination result is Yes in step 206 of Fig. 11. Accordingly, if the determination result is Yes, the process proceeds to step 111. When the total value of the height of the bank-note bundle B exceeds the upper limit, the determination result is No, and the process proceeds to Step 122.

[0129] In step 122, pressure is applied to the bank-note bundle B by the clamp 103. In the subsequent step 123, motive power is transmitted respectively to the conveyer belts 106 and 123, and to the tray 104, thereby, the tray 104 is moved to the delivery position (Fig. 2) such that the bank-note bundle B newly inserted by the customer is returned. After the return, the process proceeds to step 119.

[0130] In step 111, after moving the stage 312 to the lower end, the pusher 313 is moved downward to the position at which a suitable pressure can be applied to the bank-note bundle B (pressure application position). In the subsequent step 112, the carrier 341 is moved to the escrow retraction position. Thereafter, the respective stages 331 and 332 of the temporary holding unit 330 are moved to store the bank notes extracted from the separator unit 310 (S113), and the DC motor 372 is caused to rotate (S114) . The application of pressure by the pusher 313 is conducted by monitoring the output of the sensor for detecting the pick roller when a suitable pressure is applied to the bank-note bundle B, and by moving the pick roller downward over a prescribed distance.

[0131] After starting the rotation of the motor 372, bank notes are sequentially extracted one by one from the separator unit 310 and are conveyed to the temporary holding unit 330 until the extraction of the bank notes from the separator unit 310 is completed (S115 and S116). Thereby, the bank notes inserted by the customer are stored in the reservoir unit or the escrow unit.

[0132] The extraction of bank notes is conducted by transmitting motive power to the extraction mechanism 311, and the place that stores the bank notes is determined by discriminating the extracted bank notes in the discrimination unit 320. The bank notes that are determined to be normal notes are counted for each denomination. In order to apply suitable pressure even during the extraction of the bank notes, the pusher 313 is intermittently lowered.

[0133] When the extraction of the bank notes conveyed to the separator unit 310 is completed, i.e., when all the bank notes that can be extracted are extracted and stored in the temporary holding unit, the determination result is Yes in step 116 and the process proceeds to step 117. Then, the DC motor 372 is stopped. In step 118, the pusher 313 and the stage 312 are respectively moved to the upper end positions (Fig. 2), the CPU 261 of the lower unit 200 is notified that the extraction is completed and is also notifiedof the amount (deposited amount) of the bank-note bundle B inserted by the customer. The CPU 261 then notifies the main body of the ATM of this information. The reported deposit amount correspond to the transaction contents.

[0134] With the above notification, the main body of the ATM inquires of the customer whether he/she wants to conduct further transactions (deposit) or to deposit bank notes additionally, etc. Then, instructions based on the answer to the inquiry are given to the lower unit 200.

[0135] In step 119 subsequent to step 118, CPU 261 waits for the instruction from the main body of the ATM and determines the contents thereof. When the main body of the ATM instructs the CPU 261 the additional deposit based on the customer's request to make an additional deposit, the fact is recognized, the process returns to the above step 101, and the ATM waits for a new bank-note bundle B to be inserted. When the main body of the ATM instructs the CPU 261 the return of bank notes due to a customer's cancellation request, the fact is recognized and the process proceeds to step 120. When the main body of the ATM instructs the CPU 261 the storage of the accepted bank notes, the fact is recognized, and the process proceeds to step 121.

[0136] In step 120, a return process is performed in which the accepted bank notes are returned. In step 121,

executed when the instruction for the storage of the accepted bank notes is given by the main body of the ATM based on the transaction request, a storage process is executed in which the accepted bank notes are stored in the cassettes 210. After executing one of the above processes, the series of the processes are terminated.

[0137] In the present invention, as shown in Fig. 5, the position in the longitudinal direction of the bank-note bundle B inserted into the opening 101 is controlled by the guides 151 . However, there is a possibility that a bank-note bundle B whose longitudinal size is not suitable will be inserted even when such guides 151 are provided. In other words, a customer may forcibly insert into the opening 101 a bank-note bundle B in which the bank notes are not aligned such that the bundle is received between the guides 151. Such insertion of a bank-note bundle B will cause problems.

[0138] The occurrence of a problem such as the above can be prevented by moving the guides 171 from the position of controlling the insertion of the bank-note bundle B, and by further arranging sensors 109e and 109f in new positions, as shown in Fig. 12. The respective guides 171 can be moved inward in the two directions, the direction which extends those intervals, and the direction which narrows the interval, along with rails 172. The motive power is transmitted from a belt 175 stretched between pulleys 173 and 174 in order to realize the movement. As a power source, an electric motor may be employed, for example.

[0139] The positions at which the respective sensors 109e and 109f can detect the bank-note bundle B are the positions at which the guides 151 are arranged before the bank-note bundle B is inserted, as shown in Fig. 13A. Therefore, when the respective guides 171 are moved as shown in Fig. 13B after detection of the insertion of the bank-note bundle B (Fig. 8A) which satisfying the condition of acceptance, one of the bank notes that constitute the bundle B may not be arranged in the longitudinal direction as the bank notes projected at least one of the side of the longitudinal direction by its elasticity and may therefore not be able to be received between the guides. Thereby, it is possible to prevent acceptance of a bundle B in which bank notes are not arranged in the longitudinal direction by employing one of the sensors 109e and 109f to detect the bundle B and to cancel acceptance of bank-note bundle B if one of the sensors 109e and 109f detects the bundle B. Accordingly, it is possible to prevent acceptance of an improper bank-note bundle B.

Claims

1. A paper sheet handling device that can handle paper sheets inserted from outside, comprising:

   a bundle conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from the outside while applying pressure to the paper sheet bundle;
   a height detection unit detecting the height of the paper sheet bundle in the direction in which the paper sheets in the paper sheet bundle to be conveyed by the conveyance unit are stacked; and
   a conveyance control unit determining whether or not the height of the paper sheet bundle detected by the height detection unit satisfies a condition for acceptance, and for causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when it is determined that the height does not satisfy the condition.

2. A paper sheet handling device that can handle paper sheets inserted from outside, comprising:

   a pressure application unit applying pressure to a paper sheet bundle including one or more stacked paper sheets inserted from the outside;
   a height detection unit detecting the height of the paper sheet bundle to which pressure is applied by the pressure application unit; and
   a conveyance control unit determining whether or not the height of the paper sheet bundle detected by the height detection unit satisfies a condition for acceptance, and for stopping acceptance of the paper sheet bundle when it is determined that the height does not satisfy the condition.

3. A paper sheet handling device according to claim 1 or 2, wherein:

   the conveyance control unit determines, when a plurality of paper sheet bundles that should be handled together are inserted separately from the outside, whether or not the condition is satisfied based on the height detected by the height detection unit for each of the paper sheet bundles.

4. A paper sheet handling device according to claim 1 or 3, further comprising:

   a size detection unit detecting one or more sizes in a direction orthogonal to the height direction of the paper sheet bundle inserted from the outside, wherein:
   the conveyance control unit causes the bundle conveyance unit to discharge the paper sheet bundle to the outside when the size of the paper sheet bundle detected by the size detection unit is not within an acceptable range.

5. A paper sheet handling device that can handle paper sheets inserted from outside, comprising:

a bundle conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from the outside;
a size detection unit detecting one or more sizes in a direction orthogonal to the direction in which the paper sheets in the paper sheet bundle to be conveyed by the bundle conveyance unit are stacked; and
a conveyance control unit causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when the size of the paper sheet bundle detected by the size detection unit is not within an acceptable range.

6. A paper sheet handling device according to claim 4 or 5, further comprising:

a guide moving unit moving a guide for setting a position in the orthogonal direction of the paper sheet bundle inserted from the outside, wherein:
the size detection unit can detect the size in the orthogonal direction of the paper sheet bundle after the guide moving unit distances the guide from the paper sheet bundle by moving the guide.

7. A paper sheet handling device according to claim 1, 2, 3, 4, or 5, further comprising:

an amount of obliqueness detection unit detecting the amount of obliqueness of the paper sheet bundle to be conveyed by the bundle conveyance unit, wherein:
the conveyance control unit causes the bundle conveyance unit to discharge the paper sheet bundle to the outside when the amount of obliqueness detected by the amount of obliqueness detection unit is not within an acceptable range.

8. A paper sheet handling device that can handle paper sheets inserted from outside, comprising:

a bundle conveyance unit for conveying a paper sheet bundle including one or more stacked paper sheets inserted from the outside;
an amount of obliqueness detection unit detecting the amount of obliqueness of the paper sheet bundle to be conveyed by the bundle conveyance unit; and
a conveyance control unit causing the bundle conveyance unit to discharge the paper sheet bundle to the outside when the amount of obliqueness detected by the amount of obliqueness detection unit is not within an acceptable range.

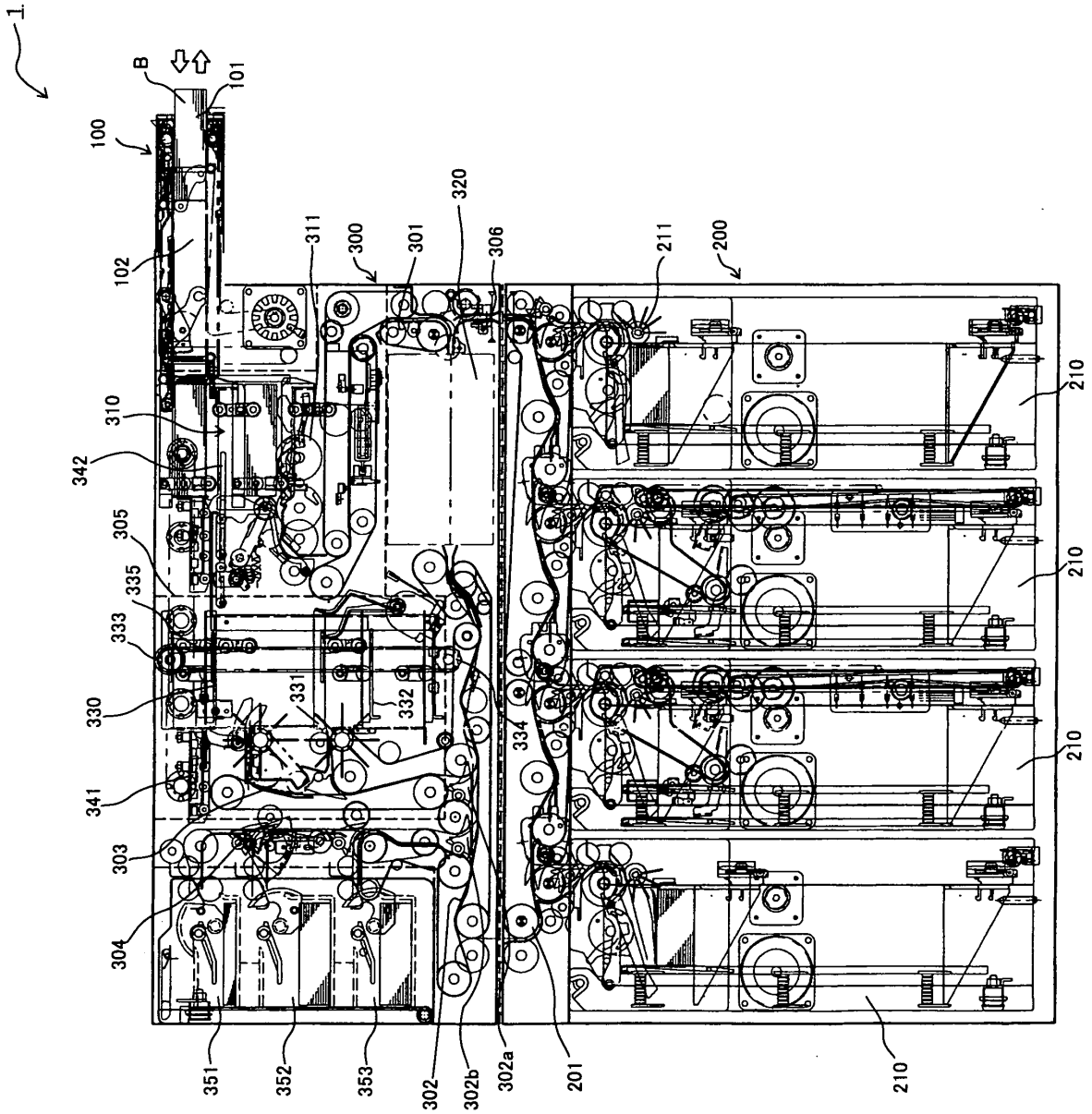
1
B
101
100
102
311
300
301
320
306
211
200
210
310
342
305
335
333
330
331
332
334
341
303
304
351
352
353
302
302b
302a
201

FIG. 1

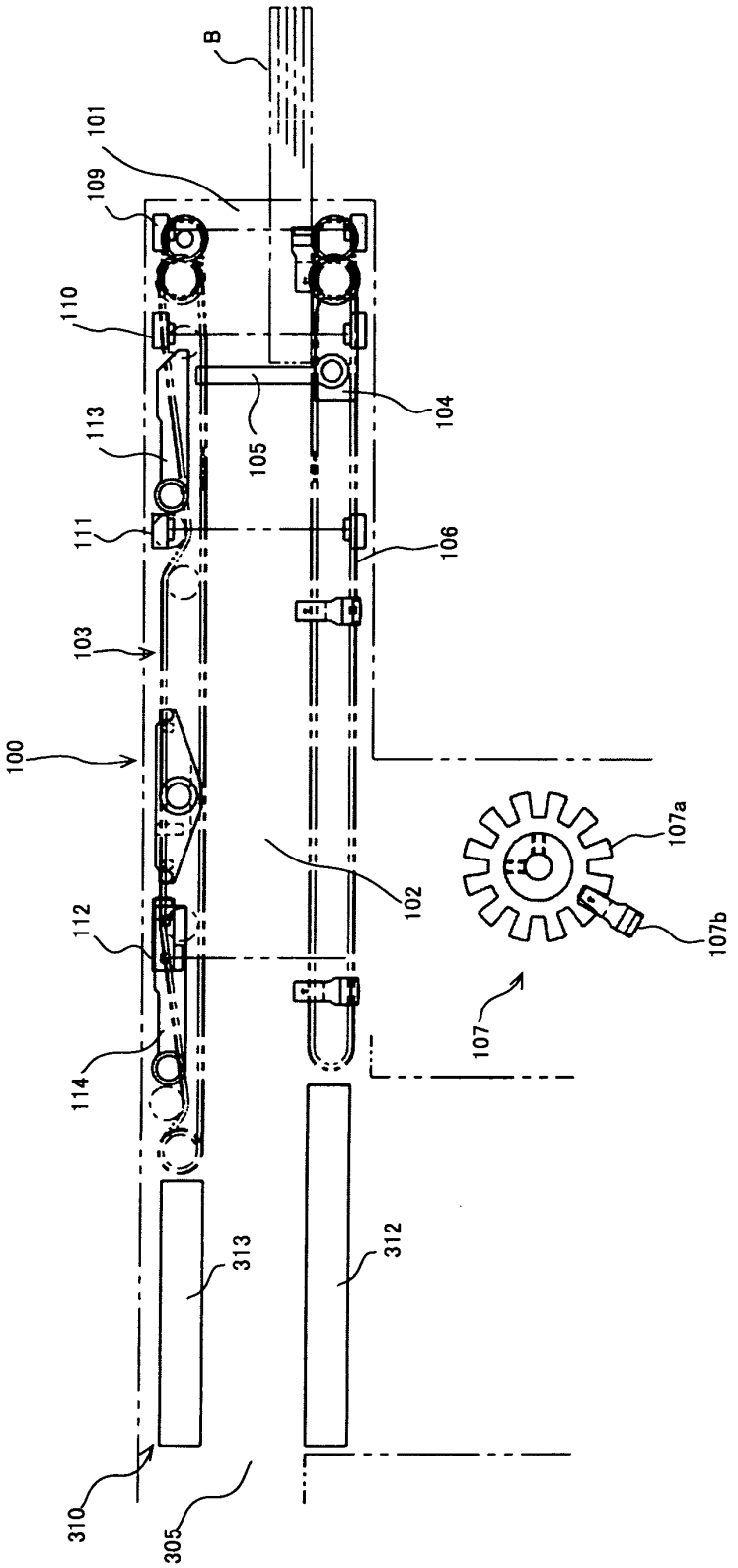
B
101
109
110
113
111
103
100
112
114
313
310
305
105
104
106
102
107a
107b
107
312

FIG. 2

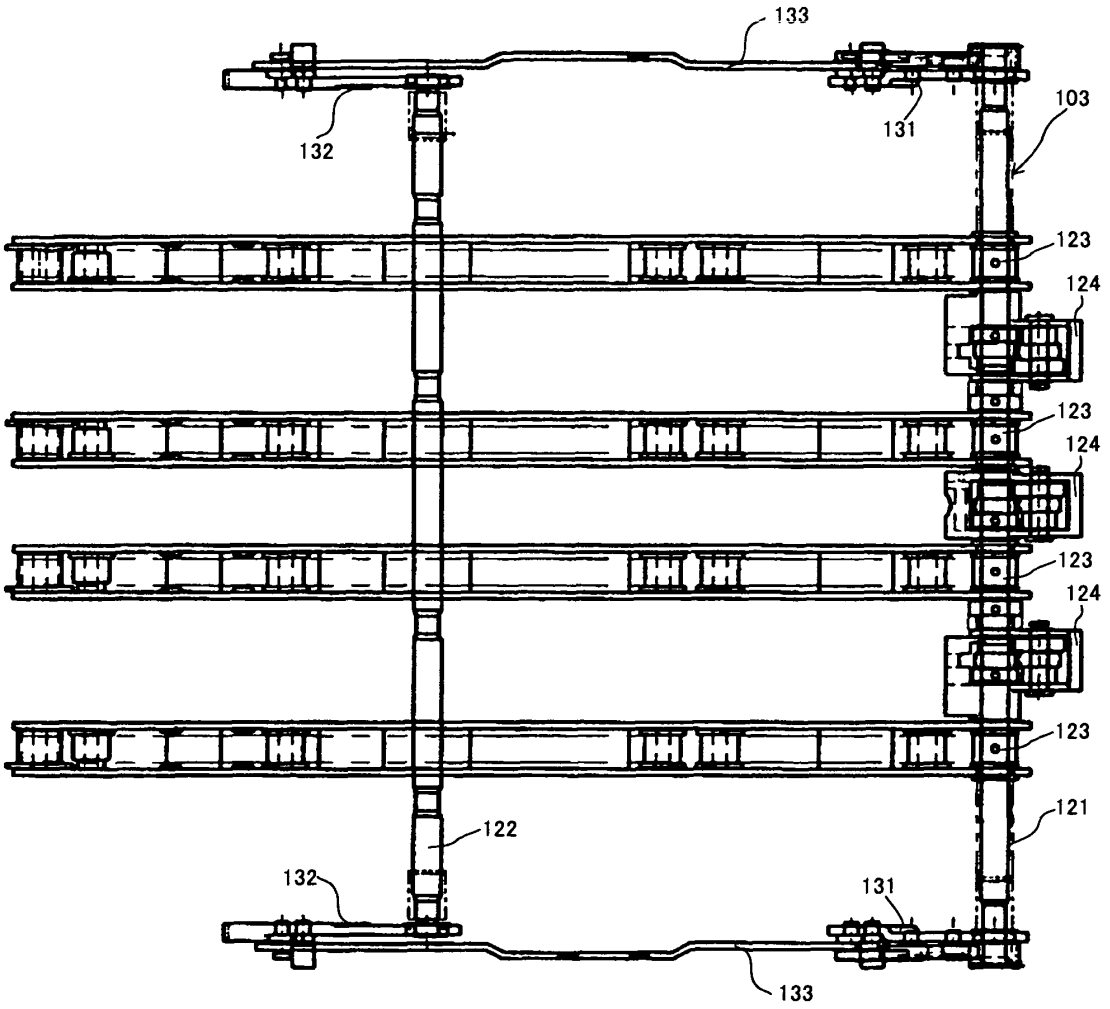

FIG. 3A

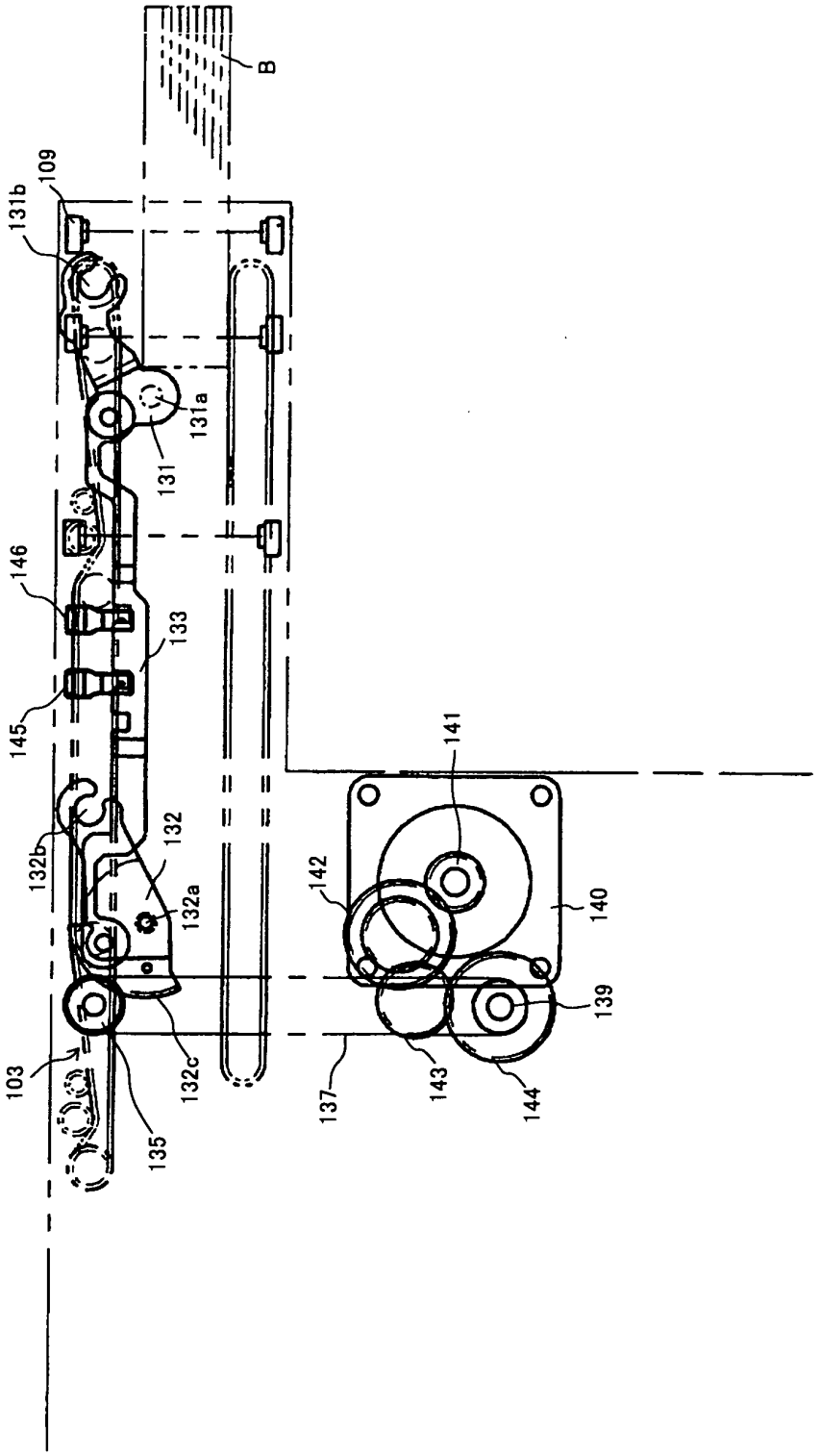
B
109
131b
131a
131
146
133
145
132
132b
132a
132c
103
135
141
142
140
139
137
143
144

FIG. 3B

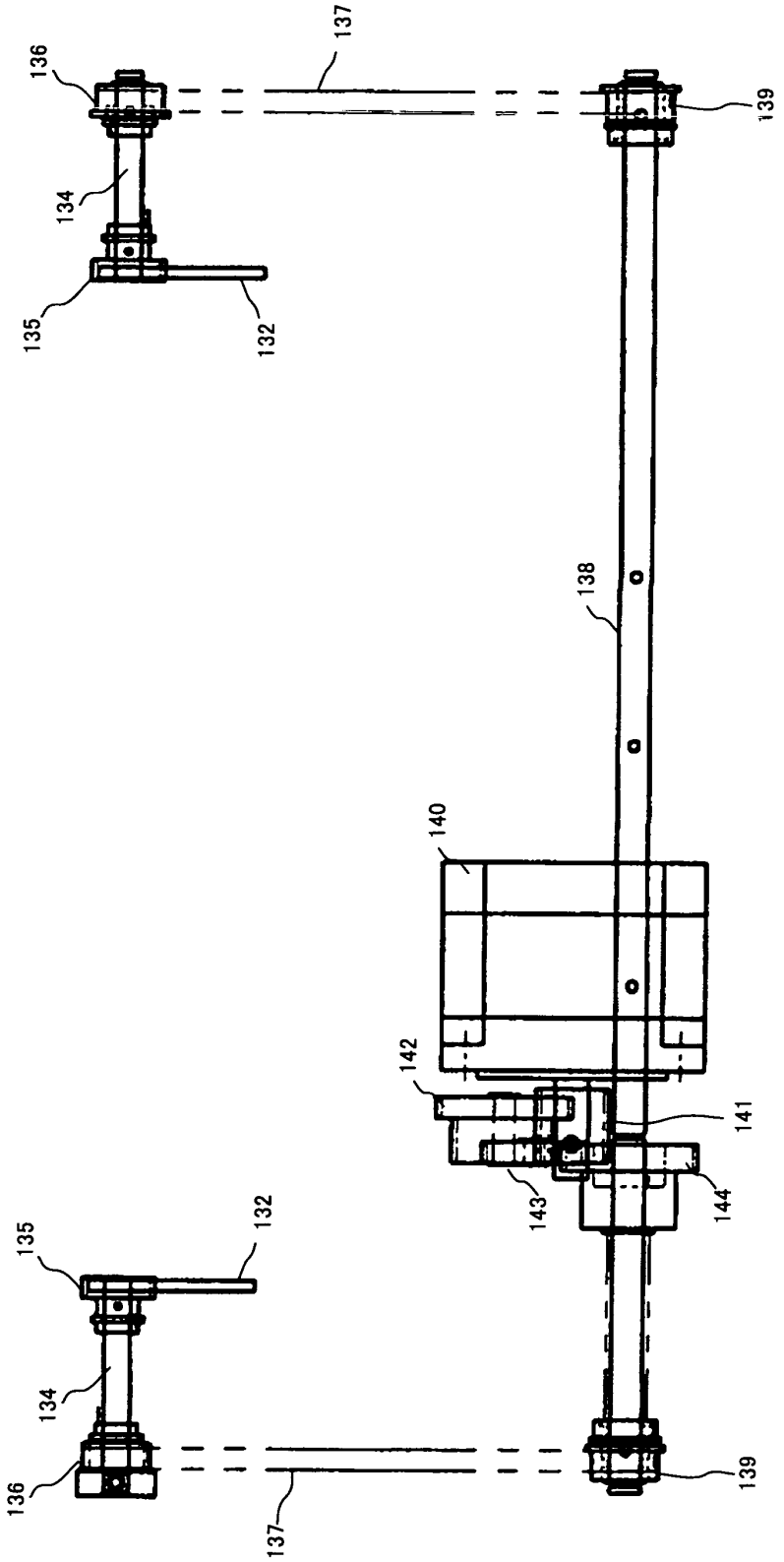
136
137
139
134
135
132
138
140
142
141
143
144
135
132
134
136
139
137

FIG. 3C

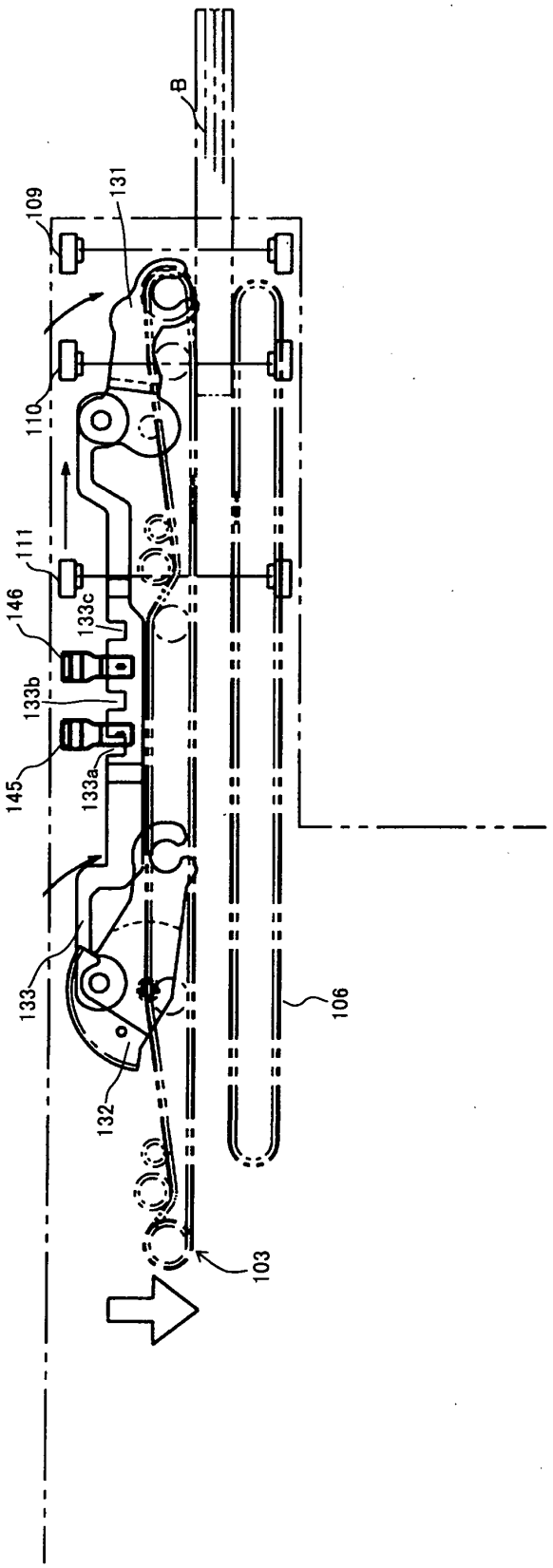

FIG. 4

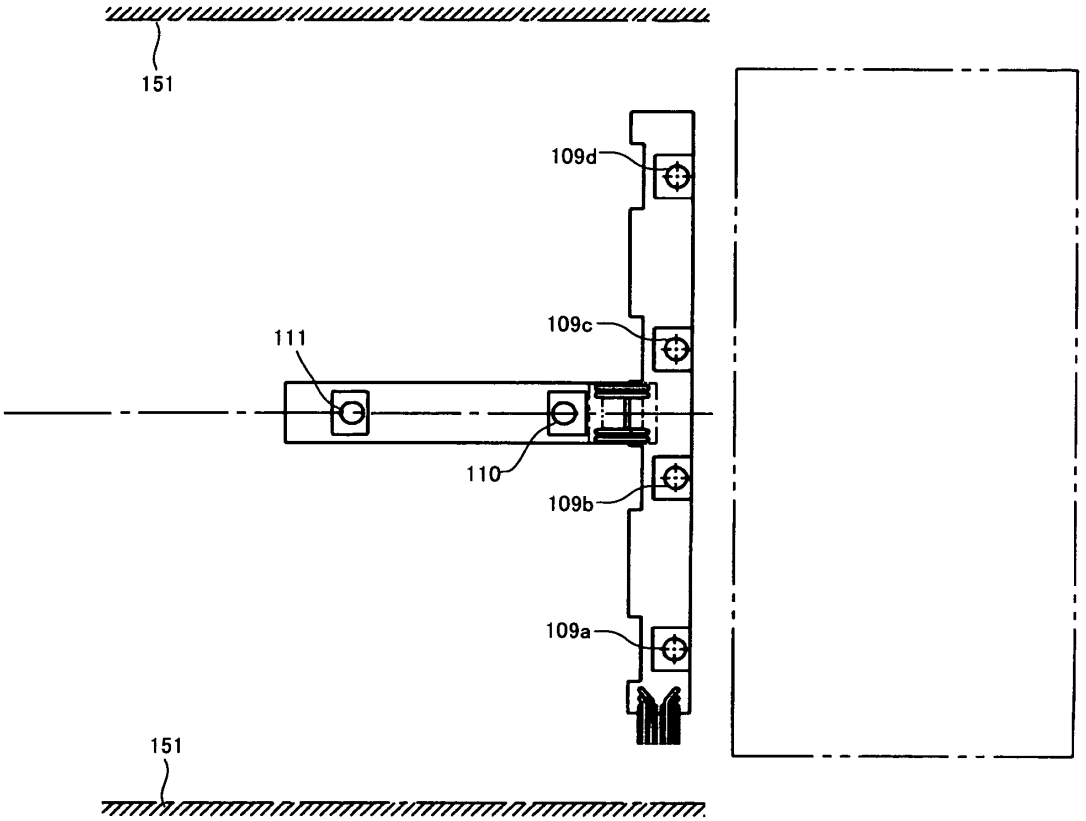

FIG. 5

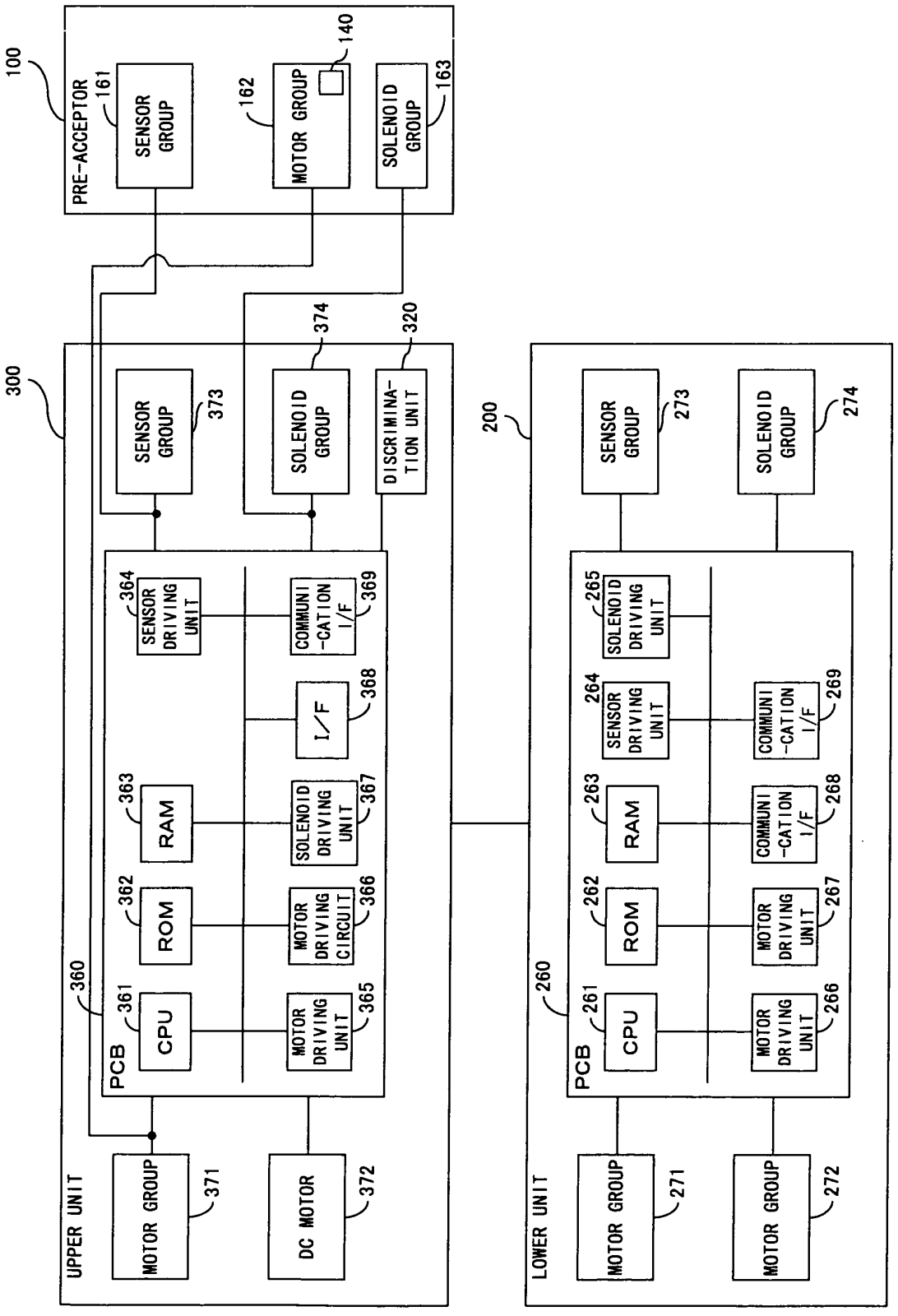
100
PRE-ACCEPTOR
161
SENSOR GROUP
162
MOTOR GROUP
140
163
SOLENOID GROUP
300
UPPER UNIT
373
SENSOR GROUP
374
SOLENOID GROUP
320
DISCRIMINA-TION UNIT
360
PCB
361
CPU
362
ROM
363
RAM
364
SENSOR DRIVING UNIT
365
MOTOR DRIVING UNIT
366
MOTOR DRIVING CIRCUIT
367
SOLENOID DRIVING UNIT
368
I/F
369
COMMUNI-CATION I/F
371
MOTOR GROUP
372
DC MOTOR
200
LOWER UNIT
273
SENSOR GROUP
274
SOLENOID GROUP
260
PCB
261
CPU
262
ROM
263
RAM
264
SENSOR DRIVING UNIT
265
SOLENOID DRIVING UNIT
266
MOTOR DRIVING UNIT
267
MOTOR DRIVING UNIT
268
COMMUNI-CATION I/F
269
COMMUNI-CATION I/F
271
MOTOR GROUP
272
MOTOR GROUP

FIG. 6

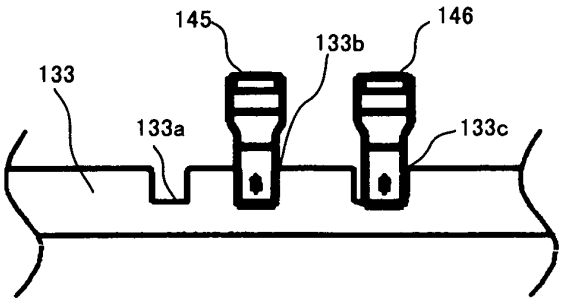

FIG. 7A

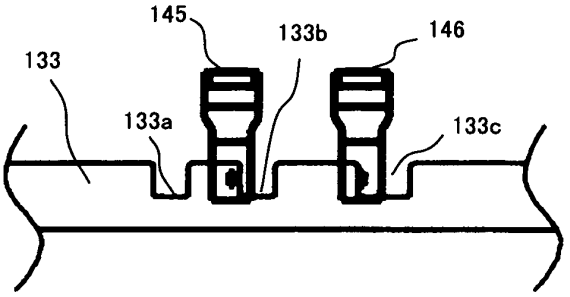

FIG. 7B

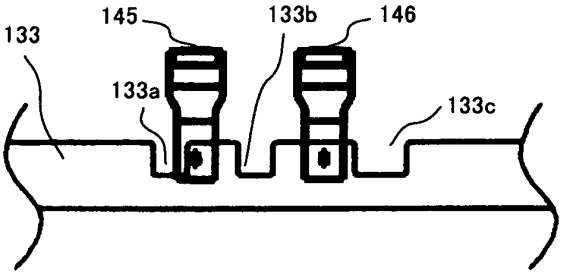

FIG. 7C

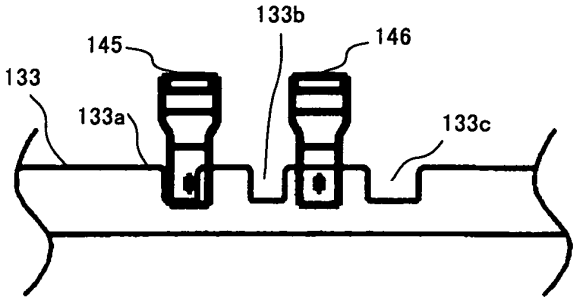

FIG. 7D

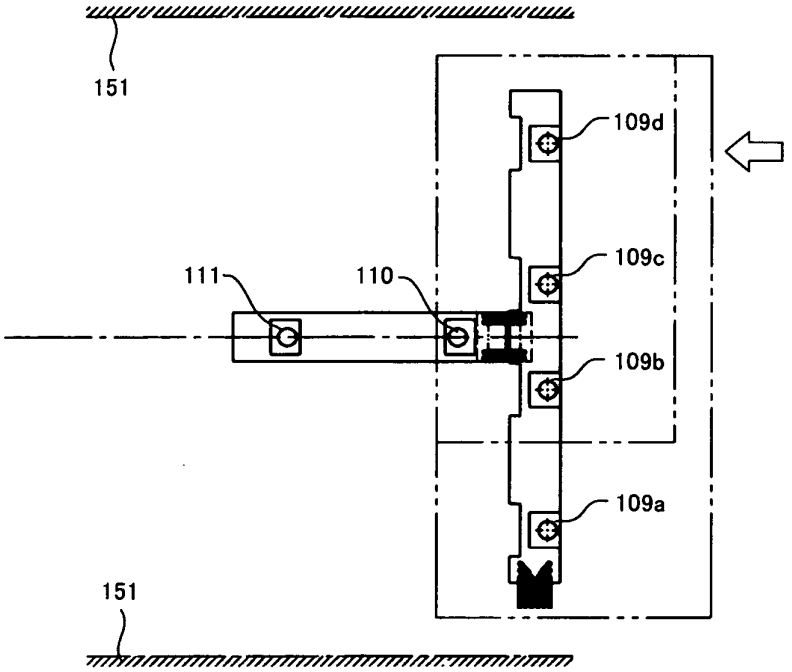
151
109d
109c
111
110
109b
109a
151

FIG. 8A

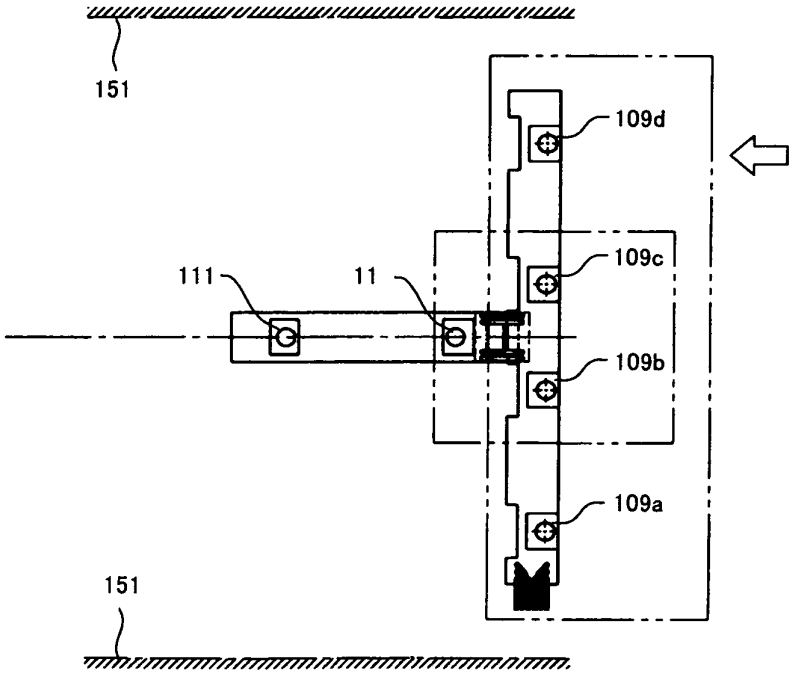
151
109d
109c
111
11
109b
109a
151

FIG. 8B

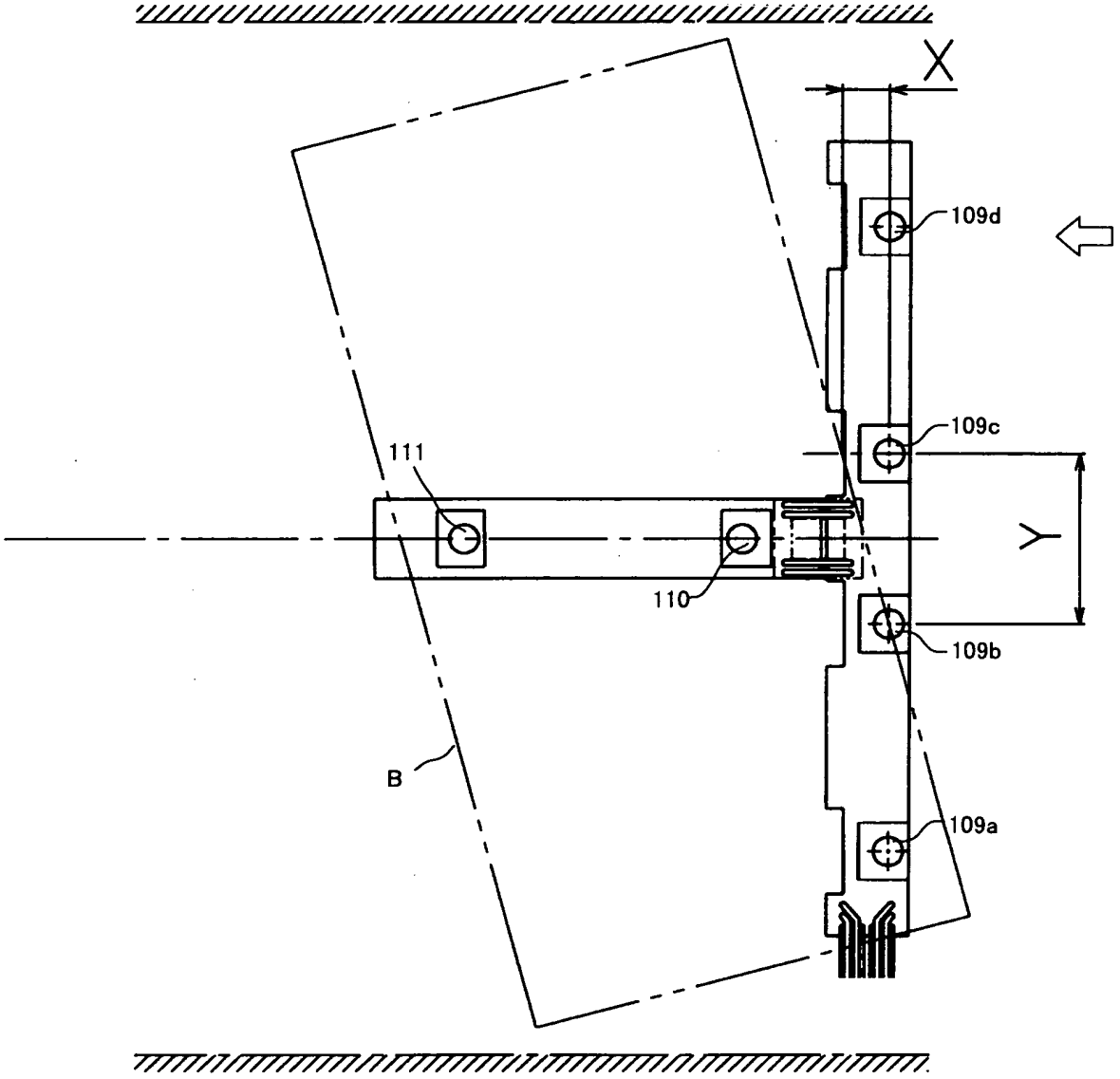

FIG. 9

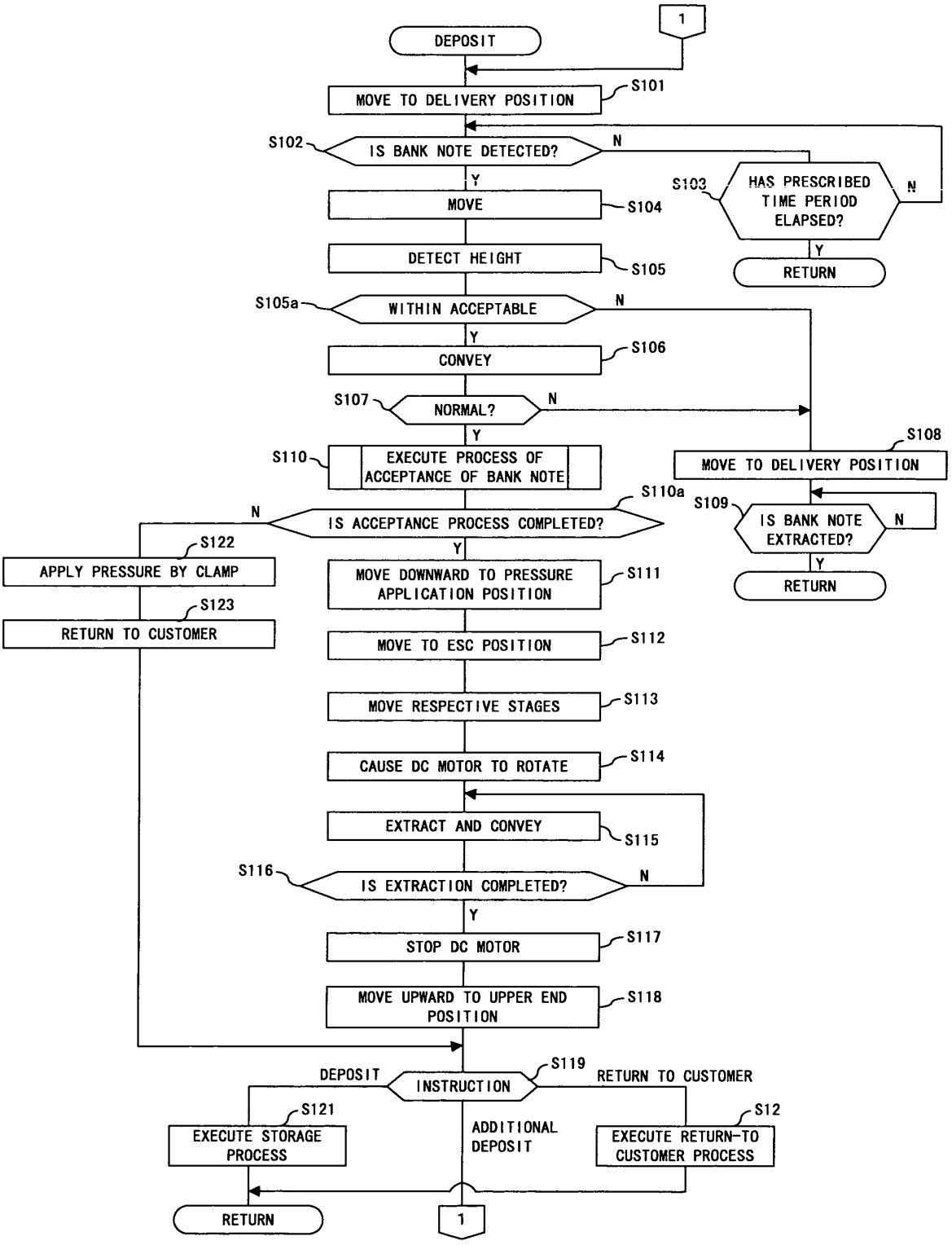
1
DEPOSIT
MOVE TO DELIVERY POSITION
S101
S102
IS BANK NOTE DETECTED?
N
Y
S103
HAS PRESCRIBED TIME PERIOD ELAPSED?
N
Y
RETURN
MOVE
S104
DETECT HEIGHT
S105
S105a
WITHIN ACCEPTABLE
N
Y
CONVEY
S106
S107
NORMAL?
N
Y
S108
MOVE TO DELIVERY POSITION
S110
EXECUTE PROCESS OF ACCEPTANCE OF BANK NOTE
S110a
IS ACCEPTANCE PROCESS COMPLETED?
N
Y
S109
IS BANK NOTE EXTRACTED?
N
Y
RETURN
S122
APPLY PRESSURE BY CLAMP
S123
RETURN TO CUSTOMER
MOVE DOWNWARD TO PRESSURE APPLICATION POSITION
S111
MOVE TO ESC POSITION
S112
MOVE RESPECTIVE STAGES
S113
CAUSE DC MOTOR TO ROTATE
S114
EXTRACT AND CONVEY
S115
S116
IS EXTRACTION COMPLETED?
N
Y
STOP DC MOTOR
S117
MOVE UPWARD TO UPPER END POSITION
S118
DEPOSIT
INSTRUCTION
S119
RETURN TO CUSTOMER
S121
EXECUTE STORAGE PROCESS
ADDITIONAL DEPOSIT
S12
EXECUTE RETURN-TO CUSTOMER PROCESS
RETURN
1

FIG. 10

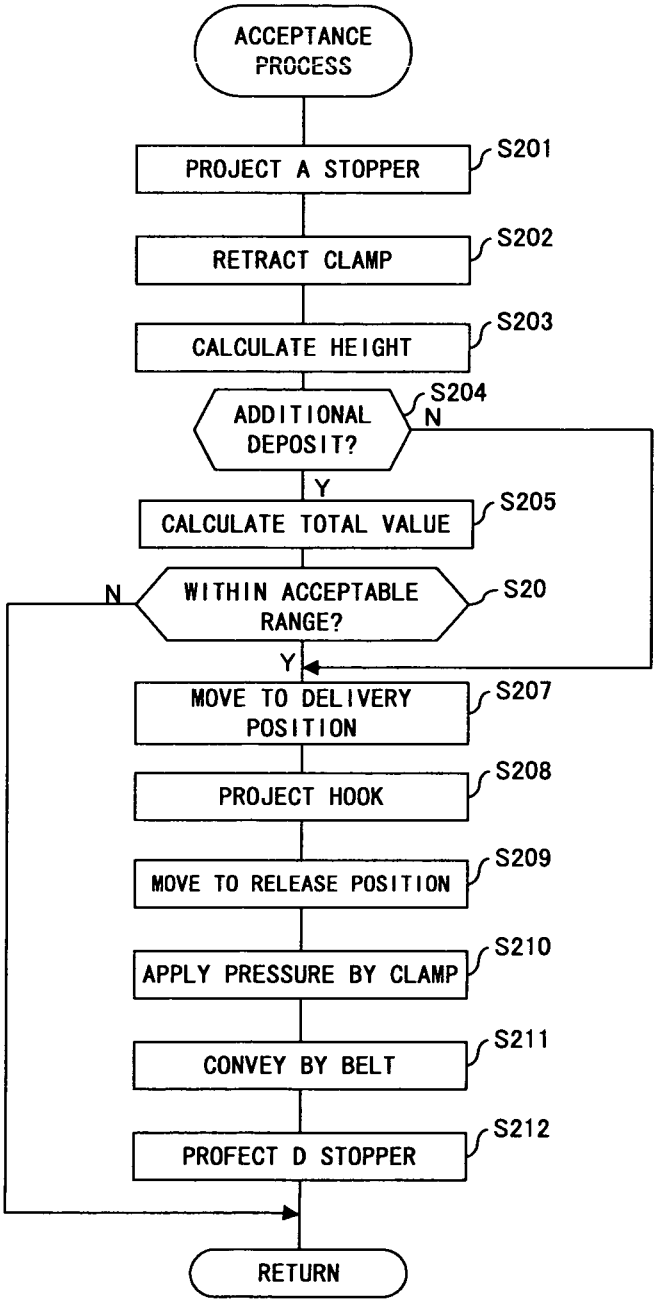
ACCEPTANCE PROCESS
PROJECT A STOPPER
S201
RETRACT CLAMP
S202
CALCULATE HEIGHT
S203
ADDITIONAL DEPOSIT?
S204
N
Y
CALCULATE TOTAL VALUE
S205
WITHIN ACCEPTABLE RANGE?
S20
N
Y
MOVE TO DELIVERY POSITION
S207
PROJECT HOOK
S208
MOVE TO RELEASE POSITION
S209
APPLY PRESSURE BY CLAMP
S210
CONVEY BY BELT
S211
PROFECT D STOPPER
S212
RETURN

FIG. 11

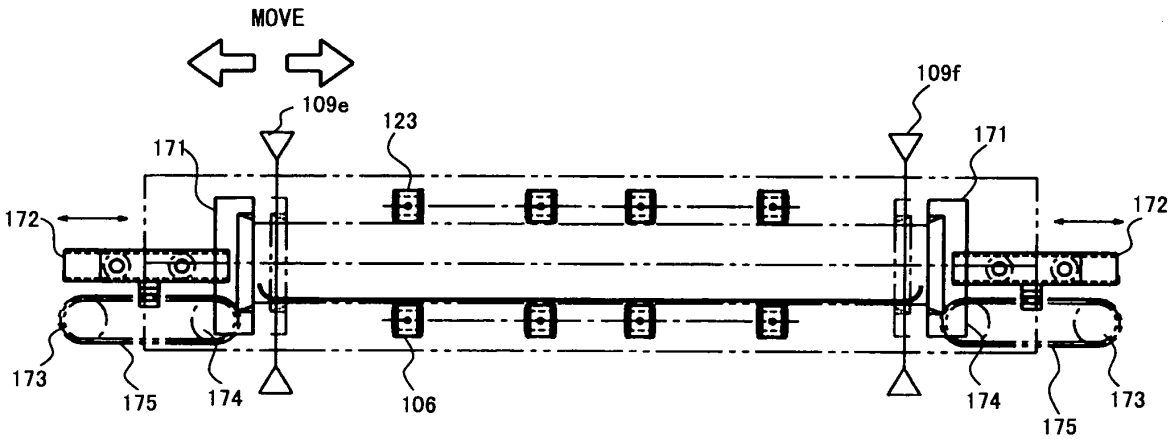

FIG. 12

FIG. 13A

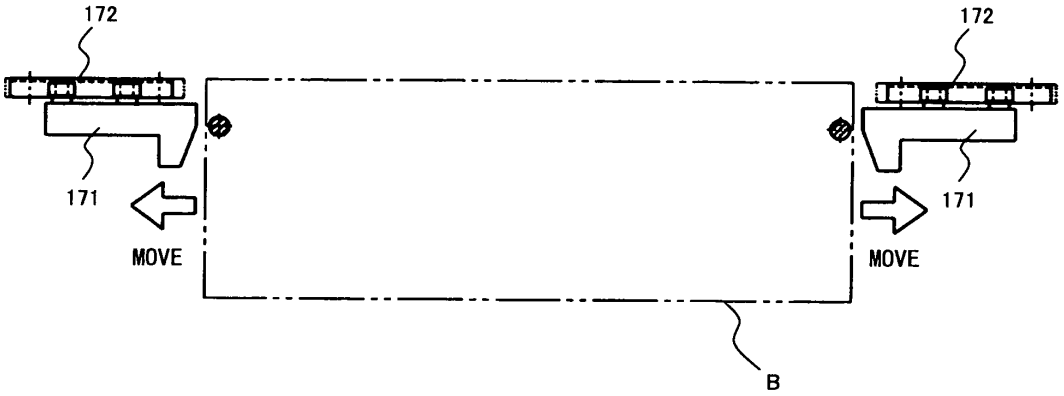

FIG. 13B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015530

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] G07D9/00

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)
Int.Cl[7] 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 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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.
X Y	JP 2-112091 A (Hitachi, Ltd., Hitachi Techno Engineering Co., Ltd.), 24 April, 1990 (24.04.90), Page 2, lower right column, line 15 to page 4, lower right column, line 17; Figs. 1 to 10 (Family: none)	2 1,3-8
Y	JP 2002-197505 A (Toshiba Corp.), 12 July, 2002 (12.07.02), Par. Nos. [0012] to [0019]; Figs. 1 to 8 (Family: none)	1,3-8
Y	JP 7-294205 A (Kabushiki Kaisha Kawashima Orimono), 10 November, 1995 (10.11.95), Par. Nos. [0013] to [0017]; Fig. 1 (Family: none)	6

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 January, 2005 (06.01.05)	25 January, 2005 (25.01.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015530

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 63-271592 A (Hitachi, Ltd.), 09 November, 1988 (09.11.88), Page 2, upper right column, line 14 to page 4, lower right column, line 4; Figs. 1 to 6 (Family: none)	7,8

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 1177188 A **[0004] [0005] [0006]**
- JP 6482293 B **[0006]**