



(11)

EP 1 788 532 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.05.2007 Bulletin 2007/21

(51) Int Cl.:
G07D 11/00 (2006.01)

(21) Application number: **06018472.8**

(22) Date of filing: **04.09.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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(30) Priority: **21.11.2005 JP 2005335703**

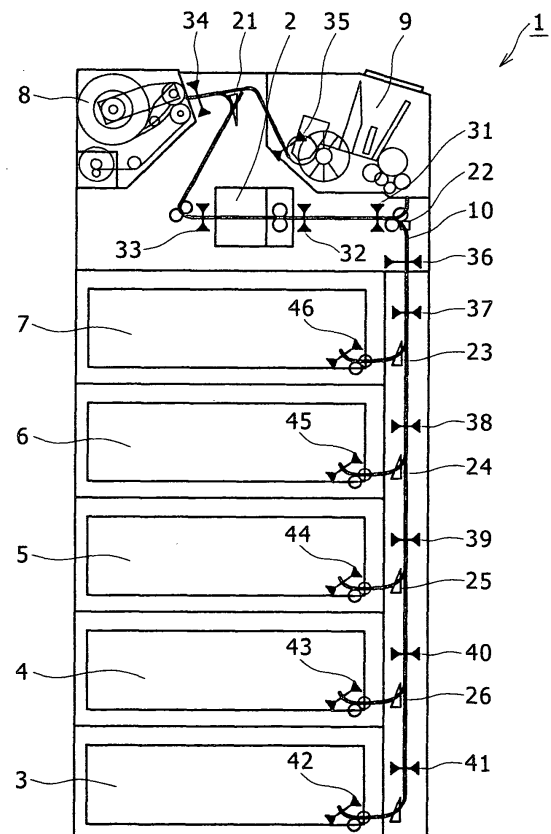
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(54) **Paper sheet handling machine**

(57) It is intended to make possible informing, at the time of maintenance for regular inspection or the like, personnel in charge of any part where a trouble is predictable to enable them to perform inspection or maintenance before the trouble occurs and thereby to reduce the duration the failure of the apparatus. A bill handling apparatus 1 is provided with a conveyance path 10 for conveying bills among a deposit/withdrawal unit 9, bill boxes 3-6, a rejected bill box 7 and a temporary stocking box 8, wherein sensors 31-46 for detecting passage of the bills are arranged on the conveyance path 10, and there are further provided a conveyance monitoring/control unit 213 for monitoring a conveyance status of the bills in each of sensor sections on the conveyance path on the basis of front end passage times and rear end passage times of the bills at the sensors and a display device for perceivably outputting a result of monitoring by the conveyance monitoring/control unit 213.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a paper sheet handling apparatus for handling paper sheets, such as cards, bills and itemized papers for instance.

[0002] Paper sheet handling apparatuses for handling paper sheets, such as automatic teller machines installed at financial institutions to handle bills, are already offered for public use. In such a paper sheet handling apparatus, a conveyance path for conveying paper sheets, an inlet/outlet for accepting and/or delivering paper sheets, and stocking units for stocking paper sheets are equipped with various driving devices. These driving devices may become unable to operate normally on account of the wear of parts or some contingency. Such inability of driving devices to operate normally would invite a troubled state of the paper sheet handling apparatus and make it unable to continue operation unless the trouble is eliminated.

[0003] In view of this, an automatic transaction system which can continue operation by identifying the occurring position and other aspects of the trouble after it has arisen and avoid that occurring position of the trouble is proposed (see Patent Reference 1). This automatic transaction system is claimed to enable failures of automatic transaction apparatuses to be reduced by avoiding trouble occurring positions.

[0004] However, this automatic transaction system still involves the problem that the automatic transaction apparatus fails when a trouble occurs in an unavoidable position.

[0005] Moreover, since this automatic transaction system restores the trouble occurring position after the trouble has arisen, it involves inconvenience where the maintenance base is far away as in an overseas location or the like. Thus, where the maintenance base is far away, it is desirable to perform regular maintenance to replace defective parts, worn-out parts and the like before any trouble occurs, and this automatic transaction system is nothing useful for such preventive maintenance.

[0006] [Patent Reference 1] Japanese Patent Application Laid-Open No. Hei 08-077417

SUMMARY OF THE INVENTION

[0007] An object of the present invention, attempted in view of the problems noted above, is to make it possible to inform, at the time of maintenance for regular inspection or the like, personnel in charge of any part where a trouble is predictable to enable them to perform inspection or maintenance before the trouble occurs and thereby to reduce the duration the failure of the apparatus.

[0008] The invention provides a paper sheet handling apparatus characterized in that plural sensors for detecting the passage of paper sheets are arranged, the apparatus is provided with a determining device which de-

termines the state of conveyance of the paper sheets in a sensor section until each sensor on a conveyance path on the basis of the time of passage of the paper sheets at the front end and the time of passage of the same at the rear end of the pertinent sensor, and an output device for outputting the result of determination by the determining device.

[0009] The invention makes it possible to inform, at the time of maintenance for regular inspection or the like, personnel in charge of any part where a trouble is predictable to enable them to perform inspection or maintenance before the trouble occurs and thereby to reduce the duration the failure of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a schematic configurational diagram of a bill handling apparatus;

Fig. 2 is a control block diagram of the bill handling apparatus;

Figs. 3A to 3C are diagrams illustrative of processing sensor change times;

Fig. 4 is a flowchart of figuring out the conveyance distance and the bill length variation rate when there is one destination of conveyance;

Fig. 5 is a flowchart of figuring out the conveyance distance and the bill length variation rate when there are two destinations of conveyance;

Fig. 6 is a diagram illustrative of standard conveyance information when counting deposited bills;

Fig. 7 is a diagram illustrative of standard conveyance information when accepting deposited bills;

Fig. 8 is a diagram illustrative of standard conveyance information when delivering bills (forward conveyance);

Fig. 9 is a diagram illustrative of standard conveyance information when storing rejected bills for delivery;

Fig. 10 is a diagram illustrative of error specifying component information;

Fig. 11 is a flowchart of outputting trouble prediction;

Fig. 12 shows an image of a maintenance screen (of a predicted error occurrence section); and

Fig. 13 shows an image of a maintenance screen (of detailed information on a predicted error occurrence section).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] A preferred embodiment of the present invention will be described below together with drawings.

[0012] First, a bill handling apparatus which, mounted on an automatic machine such as an automatic teller machine, performs control pertaining to the depositing and delivery of bills as paper sheets will be described.

[0013] Fig. 1 is a schematic drawing of a bill handling apparatus, which is an embodiment of the invention.

[0014] In Fig. 1, reference numeral 1 denotes a bill handling apparatus as a paper sheet handling apparatus; 2 denotes a discriminating unit for discriminating the denominations and trueness or falseness of bill; 3 through 6 denote bill boxes in which bills can be separated or stacked; 7 denotes a rejected bill box for keeping rejected bills; 8 denotes a temporary stocking box for rolling and temporarily stocking bills; 9 denotes a deposit/withdrawal unit as a port to accepting and delivering bill; 10 denotes a conveyance path for conveying bills to different units in the apparatus; 21 through 26 denote gates for switching over the conveying direction of bills; and 31 through 46 denote sensors for detecting the passage of bills.

[0015] The sensors 31 through 46 are sensors on the conveyance path, of which 35 and 36 also serve as stack inlet sensors and 31, as a separation outlet sensor. Further, 34 and 42 through 45 also serve as separation outlet sensors and stack inlet sensors.

[0016] Fig. 2 is a control unit block diagram of the bill handling apparatus 1.

[0017] In Fig. 2, reference numeral 201 denotes a superior apparatus mounted with the bill handling apparatus 1, such as an automatic teller machine.

[0018] A main control unit 202 is the main control unit of the bill handling apparatus 1.

[0019] A line control unit 203 transmits and receives information between the superior apparatus 201 and the main control unit 202.

[0020] A conveyance motor control unit 204 is connected to a conveyance motor, not shown, for driving the conveyance path 10, and controls the conveyance motor. Also, the conveyance motor control unit 204 counts the extent of the shift of the conveyance motor, registers it in a motor time area 205, and registers information on the speed change of the conveyance motor in a conveyance motor speed change information area 206.

[0021] Similarly, a separation motor control unit 207 is connected to a separation motor, not shown, provided in each of the bill cassettes 3 through 6 as accommodating units to control the separation motors, and registers speed change information on the separation motors in a separation motor speed change information area 208.

[0022] A stack motor control unit 209 is connected to a stack motor, not shown, provided in each of the bill boxes 3 through 6, and the rejected bill box 7, to control the stack motors, and registers speed change information on the stack motor in a stack motor speed change information area 210.

[0023] A sensor control unit controls the sensors 31 through 46 on the conveyance path 10, and registers the change time of each sensor in a sensor change time registration area 212.

[0024] A conveyance monitoring/control unit 213 as the determining device monitors conveyed bills by using the sensors 31 through 46 on the conveyance path 10 at the instruction of the main control unit 202, and regis-

ters in a conveyance status information area 214 bill length variation rates acquired on the basis of detection by the sensors 31 through 46 on the conveyance path 10.

[0025] A gate control unit 215 turns on or off gates 21 through 26 at the instruction of the main control unit 202. Also, the gate control unit 215 registers in a gate change information area 216 the turned-on time and the turned-off time of each of the gates 21 through 26 and, periodically checking the current gate status, registers the gate status in a gate status information area 217.

[0026] Standard conveyance information is registered in a standard conveyance information area 218. This standard conveyance information is information obtained by conveying bills in advance in the processing of money depositing and delivery or the like by using plural bill handling apparatuses similar to the bill handling apparatus 1, and calculating the statistically standard conveyance state according to the bill conveyance state of each bill handling apparatus 1 at the time.

[0027] Error specifying component information is registered in an error specifying component information area 119 at the time of shipment. This error specifying component information is information on components which require checkup for any error in each of plural error sections in which errors are predictable.

[0028] Incidentally, in the standard conveyance information area 218 and error specifying component information area 119, it is possible to reregister new standard conveyance information or error specifying component information, whichever may apply, from the superior apparatus 201 via the line control unit 203 when a change in component or a change in control necessitates a change in standard conveyance information or error specifying component information after the shipment of the bill handling apparatus 1. Therefore, the line control unit 203, the standard conveyance information area 218 and the error specifying component information area 119 function as means of permitting registration.

[0029] Next, processing to determine the status of bill conveyance will be described with respect to money acceptance and money discharging by way of example.

[0030] Fig. 3A is a configurational diagram showing the configuration of the first sensor 31 and the conveyance path 10; Fig. 3B is a diagram illustrative of registration in the sensor change time registration area 212 wherein the change times of the sensors 31 through 46 on the conveyance path 10 are registered; and Fig. 3C is a flowchart of processing to register the change times of the sensors 31 through 46 on the conveyance path 10 in the sensor change time registration area 212.

[0031] Fig. 4 is a flowchart of figuring out the conveyance distance to the conveyance status information area 214 and the bill length variation rate when there is one destination of conveyance.

[0032] Fig. 5 is a flowchart of figuring out the conveyance distance to the conveyance status information area 214 and the bill length variation rate when the conveyance is divided between plural destinations.

[0033] When bills are set by a customer in the deposit/withdrawal unit 9 (see Fig. 1), the main control unit 202 (see Fig. 2) receives an instruction from the superior apparatus 201 via the line control unit 203, and performs deposited bill counting.

[0034] The main control unit 202 informs the conveyance motor control unit 204, the separation motor control unit 207, the stack motor control unit 209, the sensor control unit 211, the conveyance monitoring/control unit 213 and the gate control unit 215 of the start of operation. This causes the conveyance motor control unit 204 to instruct a conveyance motor, not shown, to be driven in the forward direction, causes the conveyance path 10 to turn in the forward direction, and motor times to be registered in the motor time area 205 from time to time.

[0035] On the other hand, the sensor control unit 211 initializes the processing pointer 312 and the storage pointer 311 of each sensor to their respective leading positions (step S313).

[0036] After that, the main control unit 202 instructs the separation motor control unit 207 to drive the separation motor, not shown, of the deposit/withdrawal unit 9 (see Fig. 1), and causes bills to be fed one by one from the deposit/withdrawal unit 9 to the conveyance path 10.

[0037] The fed bills are handed over to the conveyance path 10, pass the sensors 31 and 32, and conveyed to the discriminating unit 2. The discriminating unit 2 discriminates the bills as to their trueness or falseness, presence or absence of damage, and conveyance status.

[0038] The main control unit 202 decides the destinations of the bills, such as the deposit/withdrawal unit 9 for rejected bills and the temporary stocking box 8 for normal bills. According to the decided destinations, the main control unit 202 issues an on/off instruction for the gate 21 to the gate control unit 215 according to the sequence of bill conveyance.

[0039] If it is a normal bill, this normal bill is caused to pass the sensors 33 and 34, and temporarily stocked in the temporary stocking box 8.

[0040] If it is a rejected bill, this rejected bill is caused to pass the sensors 33 and 35, and sequentially stacked behind the partition plate of the deposit/withdrawal unit 9. In this process, the sensor control unit 211 watches the light-to-dark and dark-to-light changes of the sensors, and at the same time registers the time of each variation in the sensor change time registration area 212 on the basis of information from the motor time area 205.

[0041] For instance, if a light-to-dark change is detected by the sensor 31 (step S314), the reading of the motor time area 205 at the time of the light-to-dark change is registered (step S315) in the leading position area in the area pointed by the processing pointer 312 (Fig. 3B), and the processing pointer 312 is updated by +1 (step S316).

[0042] Next, if a dark-to-light change is detected by the sensor 31 (step S317), the reading of the motor time area 205 at the time of the dark-to-light change is registered (step S318) in the trailing position area of the area pointed by the storage pointer 311 (Fig. 3B), and the storage

pointer 311 is updated by +1 (step S319).

[0043] The processing at these steps S314 through S319 is carried on in response to the passage of each bill until the conveyance of all the bills is completed (step S320).

[0044] The controls at these steps S314 through S320 are similarly performed on the sensors 32 through 46 on the conveyance path 10 at the times of deposited money acceptance and of delivering money. Thus, the change time of each of the sensors 32 through 46 is registered in the sensor change time registration area 212 of each on the basis of information in the motor time area 205.

[0045] After all the bills are conveyed to the temporary stocking box 8 and the deposit/withdrawal unit 9, the main control unit 202 instructs the conveyance motor control unit 204 to stop the conveyance motor, and at the same time instructs the conveyance monitoring/control unit 213 to create conveyance status information. The conveyance monitoring/control unit 213, instructed to create conveyance status information, creates conveyance status information from the sensor change time registration area 212 and registers it in the conveyance status information area 214.

[0046] Next, the method of creating conveyance status information will be described with reference to the flowcharts of Fig. 4 and Fig. 5.

[0047] First, a case in which bills are not divided by a gate but are conveyed to only one destination as in the sensor section from the sensor 31 to the sensor 32 will be described with reference to the flowchart of Fig. 4. In this case, the conveyance monitoring/control unit 213 uses information from the leading information of the sensor change time registration area 212 of each of the sensor 31 and the sensor 32 to the information pointed by the processing pointer 312 and the storage pointer 311, and figures out the conveyance distance and the bill length variation rate as conveyance status information.

[0048] First, to make comparison from the first bill onward, $N = 1$ being supposed (step S403), the conveyance distance from the sensor 31 to the sensor 32 (the distance of conveying the bill the sensor section from the sensor 31 to the sensor 32) is figured out (step S404) from the sensor 31's front end time of the N -th bill (the time at which the leading edge of the N -th bill passed the sensor 31) and the sensor 32's front end time of the N -th bill.

[0049] The conveyance monitoring/control unit 213 determines whether or not the figured-out conveyance distance is greater than the maximum conveyance distance from the sensor 31 to the sensor 32 already registered in the conveyance status information area 214 (step S405) and, if it is greater, sets the conveyance distance of the N -th bill in the maximum conveyance distance area (step S406).

[0050] Also, the conveyance monitoring/control unit 213 adds the figured-out conveyance distance of the N -th bill to the total conveyance distance area for the sensor 31 to the sensor 32 at the time of this conveyance (step S407).

[0051] Next, the conveyance monitoring/control unit 213 figures out the bill length at the sensor 31 from the sensor 31's front end time of the N-th bill and the sensor 31's rear end time of the N-th bill (the time at which the trailing edge of the N-th bill passed the sensor 31) (step S408). Similarly, it also figures out the bill length at the sensor 32 (step S409).

[0052] The conveyance monitoring/control unit 213 figures out the bill length variation rate, which is the rate of variation of the bill length in the sensor section from the sensor 31 to the sensor 32, from the figured-out bill lengths at the sensor 31 and the sensor 32 (step S410). This bill length variation rate is calculated by dividing the bill length at the sensor 32, which is the later step, by the bill length at the sensor 31, which is the earlier step.

[0053] And the conveyance monitoring/control unit 213 determines whether or not the figured-out bill length variation rate is greater than the maximum bill length variation rate from the sensor 31 to the sensor 32 already registered in the conveyance status information area 214 (step S411) and, if it is greater, sets the bill length variation rate in the maximum bill length variation rate area (step S412).

[0054] Also, the conveyance monitoring/control unit 213 adds the figured-out bill length variation rate of the N-th bill to the total bill length variation rate area for the sensor 31 and the sensor 32 (step S413). This addition is accomplished by updating by +1 the N-th bill information from the front end time until the rear end time pointed by the respective processing pointer 312 and storage pointer 311 of the sensor 31 and the sensor 32 (step S414).

[0055] When the processing has been completed for all the bills conveyed from the sensor 31 to the sensor 32 (the processing pointer 312 and the storage pointer 311 have been reached) (step S415), the value of the total conveyance distance area for the current conveyance from the sensor 31 to the sensor 32 is divided by $(N - 1)$ to calculate the average conveyance distance from the sensor 31 to the sensor 32 and, only when it is greater than the average conveyance distance from the sensor 31 to the sensor 32 already registered in the conveyance status information area 214, it is registered in the average conveyance distance area of the conveyance status information area 214 (step S416). Similarly, the average bill length variation rate for the sensor 31 to the sensor 32 is calculated and set (step S417).

[0056] In the same way, the conveyance distance and the bill length variation rate is also figured out for the sensor 32 to the sensor 33, which is another conveyance section.

[0057] From the sensor 32 to the sensor 33 where bills are not divided by a gate, the conveyance distance and the bill length variation rate can be figured out in this way.

[0058] Next, a case in which bills are divided by a gate between the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 and conveyed to destinations will be described with reference to the flowchart of Fig. 5. In this

case, the conveyance distance and the bill length variation rate are calculated by using the leading information of the sensor change time registration area 212 of each of the sensor 33, the sensor 34 and the sensor 35 to the information pointed by the processing pointer 312 and the storage pointer 311.

[0059] First, to compare from the first of each, the conveyance monitoring/control unit 213 supposes $N = 1$, $M = 1$ and $L = 1$ (step S501), and determines whether or not the destination of the N-th bill is the temporary stocking box 8 (step S502).

[0060] Incidentally, N represents the total number of bills to be conveyed, and M and L represent the numbers of bills passing the respectively corresponding sensors. In this embodiment, M represents the number of bills passing the sensor 34 and L represents that of bills passing the sensor 35.

[0061] If the destination is the temporary stocking box 8, the conveyance distance from the sensor 33 to the sensor 34 is calculated from the front end time of the N-th bill at the sensor 33 and the front end time of the M-th bill at the sensor 34 (step S503).

[0062] The conveyance monitoring/control unit 213 determines whether or not the figured-out conveyance distance of the M-th bill is greater than the maximum conveyance distance from the sensor 33 to the sensor 34 already registered in the maximum conveyance distance area 214 (step S504) and, if it is greater, sets the conveyance distance of the M-th bill in the maximum conveyance distance area (step S505).

[0063] Also, the conveyance monitoring/control unit 213 adds the figured-out conveyance distance of the M-th bill to the total conveyance distance area for the sensor 33 to the sensor 34 at the time of this conveyance (step S506).

[0064] Next, the conveyance monitoring/control unit 213 figures out the bill length at the sensor 33 from the sensor 33's front end time of the N-th bill and the sensor 33's rear end time of the N-th bill (step S507). Similarly, it also figures out the M-th bill length at the sensor 34 (step S508).

[0065] The conveyance monitoring/control unit 213 figures out the M-th bill length variation rate from the figured-out bill lengths of the N-th bill at the sensor 33 and of the M-th bill at the sensor 34 (step S509); determines whether or not it is greater than the maximum bill length variation rate from the sensor 33 to the sensor 34 already registered in the conveyance status information area 214 (step S510) and, if it is greater, sets the M-th bill length variation rate in the maximum bill length variation rate area (step S511).

[0066] Also, the conveyance monitoring/control unit 213 adds the figured-out bill length variation rate of the M-th bill to the total bill length variation rate area for the sensor 33 and the sensor 34 (step S512). This addition is accomplished, where the destination is the temporary stocking box 8, by updating by +1 the M-th bill information (step S513) from the front end time until the rear end time

pointed by the processing pointer 312 and the storage pointer 311 of the sensor 34 and updating by +1 the N-th bill information (step S524).

[0067] If at step S502 above the destination is not the temporary stocking box 8 side but the deposit/withdrawal unit 9 side, the conveyance monitoring/control unit 213 figures out the conveyance distance from the sensor 33 to the sensor 35 from the front end time of the N-th bill at the sensor 33 and the front end time of the L-th bill at the sensor 35 (step S514).

[0068] The conveyance monitoring/control unit 213 determines whether or not the figured-out conveyance distance of the L-th bill is greater than the maximum conveyance distance from the sensor 33 to the sensor 35 already registered in the conveyance status information area 214 (step S515) and, if it is greater, sets the conveyance distance of the L-th bill in the maximum conveyance distance area (step S516). Also, the conveyance monitoring/control unit 213 adds the figured-out conveyance distance of the L-th bill to the total conveyance distance area for the sensor 33 to the sensor 35 at the time of this conveyance (step S517).

[0069] Next, the conveyance monitoring/control unit 213 figures out the bill length at the sensor 33 from the sensor 33's front end time of the N-th bill and the sensor 33's rear end time of the N-th bill (step S518). Similarly, it also figures out the L-th bill length at the sensor 35 (step S519).

[0070] The conveyance monitoring/control unit 213 figures out the L-th bill length variation rate from the figured-out bill lengths of the N-th bill at the sensor 33 and of the L-th bill at the sensor 35 (step S520); determines whether or not it is greater than the maximum bill length variation rate from the sensor 33 to the sensor 35 already registered in the conveyance status information area 214 (step S521) and, if it is greater, sets the L-th bill length variation rate in the maximum bill length variation rate area (step S522).

[0071] Also, the conveyance monitoring/control unit 213 adds the figured-out bill length variation rate of the L-th bill to the total bill length variation rate area for the sensor 33 through the sensor 35 (step S522). This addition is accomplished, where the destination is the deposit/withdrawal unit 9 side, by updating by +1 the L-th bill information (step S523) from the front end time until the rear end time pointed by the processing pointer 312 and the storage pointer 311 of the sensor 35 and updating by +1 the N-th bill information (step S524).

[0072] When the processing has been completed for all the bills conveyed to the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 (the processing pointer 312 and the storage pointer 311 have been reached) (step S526), the conveyance monitoring/control unit 213 divides by (N - 1) the value of the total conveyance distance area for the current conveyance from the sensor 31 to the sensor 32 to calculate the average distance of conveyance from the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 this time; compares it with

the average distance of conveyance from the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 already registered in the conveyance status information area 214; and, only when it is greater, registers it in the average conveyance distance area of the conveyance status information area 214 (step S527). Similarly, the average bill length variation rate for the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 is calculated and set (step S527).

[0073] After the creation of conveyance status information is completed, the main control unit 202 informs the superior apparatus 201 via the line control unit 203 of the completion of deposited money counting.

[0074] After that, when instructed by the superior apparatus 201 via the line control unit 203 to accept the deposited money, the main control unit 202 instructs the conveyance motor control unit 204 to drive the conveyance motor, not shown, in the reverse direction to feed out one by one the bills temporarily stocked in the temporary stocking box 8, and to stack them in the bill boxes 3, 4, 5 or 6 and the rejected bill box 7 in accordance with result given by the discriminating unit 2.

[0075] In this process, for the sensor sections of the sensor 34 to the sensor 33, the sensor 33 to the sensor 32, the sensor 32 to the sensor 31, the sensor 31 to the sensor 36, the sensor 36 to the sensor 37 and the sensor 41 to the sensor 42, the conveyance distance and the bill length variation rate are calculated on the basis of the change time of each sensor as in the sensor section of the sensor 31 to the sensor 32 shown in Fig. 4.

[0076] Also, for the sensor sections of the sensor 37 to the sensor 38, the sensor 37 to the sensor 46, the sensor 38 to the sensor 39, the sensor 38 to the sensor 45, the sensor 39 to the sensor 40, the sensor 39 to the sensor 44, the sensor 40 to the sensor 41 and the sensor 40 to the sensor 43, the conveyance distance and the bill length variation rate are calculated on the basis of the change time of each sensor as for the sensor sections of the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 shown in Fig. 5.

[0077] After completing the creation of conveyance status information in this way, the main control unit 202 informs the superior apparatus 201 via the line control unit 203 of the completion of deposited money acceptance.

[0078] Money delivering operation is performed by the main control unit 202 having received a money delivery instruction from the superior apparatus 201 via the line control unit 203. Instructed to deliver money, the main control unit 202 informs the conveyance motor control unit 204, the separation motor control unit 207, the stack motor control unit 209, the sensor control unit 211, the conveyance monitoring/control unit 213 and the gate control unit 215 of the start of operation.

[0079] This causes the conveyance motor control unit 204 to drive the conveyance motor, not shown, in the forward direction, the conveyance path 10 to turn in the forward direction and the motor time to be registered in

the motor time area 205 from time to time. Also, the sensor control unit 211 initializes the processing pointer 312 and the storage pointer 311 of each sensor to their respective leading positions.

[0080] After that, the main control unit 202 instructs the separation motor control unit 207 to drive the separation motor, not shown, of the bill box 3, 4, 5 or 6 in which the pertinent denomination of money stored, and to feed out bills one by one out of the bill box in which the denomination of money is stored. The description here refers to feeding out of the bill box 3 by way of example.

[0081] The fed-out bills are handed over to the conveyance path 10 and, past the sensors 41, 40, 39, 38, 37, 36, 31 and 32, are conveyed to the discriminating unit 2. The discriminating unit 2 discriminates the bills as to their trueness or falseness, presence or absence of damage, denomination and conveyance status.

[0082] The main control unit 202 decides the destination of bills, such as the temporary stocking box 8 for rejected bills and the deposit/withdrawal unit 9 for normal bills. According to the decided destinations, the main control unit 202 issues an on/off instruction for the gate 21 to the gate control unit 215 according to the sequence of bill conveyance. If it is a normal bill, this normal bill is caused to pass the sensors 33 and 35, and sequentially stacked in the deposit/withdrawal unit 9. If it is a rejected bill, this rejected bill is caused to pass the sensors sensor 33 and 34, and temporarily stocked in the temporary stocking box 8.

[0083] The main control unit 202, after stacking all the bills fed out of the bill box 3 in the deposit/withdrawal unit 9 or the temporary stocking box 8 according to the discrimination by the discriminating unit 2, causes the conveyance motor control unit 204 to stop driving the conveyance motor.

[0084] And on the basis of the change time of each sensor, the conveyance distance and the bill length variation rate are calculated for the sensor sections of the sensor 41 to the sensor 40, the sensor 40 to the sensor 39, the sensor 39 to the sensor 38, the sensor 38 to the sensor 37, the sensor 37 to the sensor 36, the sensor 36 to the sensor 31, the sensor 31 to the sensor 32 and the sensor 32 to the sensor 33 in the same way as for the sensor section of the sensor 31 to the sensor 32 shown in Fig. 4, and the conveyance distance and the bill length variation rate are calculated for the sensor sections of the sensor 33 to the sensor 34 and the sensor 33 to the sensor 45 in the same way as for the deposited money counting in the sensor sections of the sensor 33 to the sensor 34 and the sensor 33 to the sensor 35 shown in Fig. 5.

[0085] After completing the creation of conveyance status information in this way, the main control unit 202 carries out storing of rejected bills for delivery temporarily stocked in the temporary stocking box to store them into the rejected bill box 7. In this storing rejected bills for delivery, the main control unit 202 informs the conveyance motor control unit 204, the separation motor control

unit 207, the stack motor control unit 209, the sensor control unit 211, the conveyance monitoring/control unit 213 and the gate control unit 215 of the start of operation.

[0086] This causes the conveyance motor control unit 204 to instruct driving of the conveyance motor, not shown, in the reverse direction, turning of the conveyance path 10 in the reverse direction and registration of motor times in the motor time area 205 from time to time. Also, the sensor control unit 211 initializes the processing pointer 312 and the storage pointer 311 of each sensor to their respective leading positions.

[0087] Further, the conveyance motor control unit 204, after driving the conveyance motor, not shown, in the reverse direction, feeds out one by one the bills temporarily stocked in the temporary stocking box 8, and conveys them in the sequence of the sensors 34, 33, 32, 31, 36, 37 and 46 to store them into the rejected bill box 7.

[0088] After storing all the bills in the temporary stocking box 8 into the rejected bill box 7, the conveyance motor control unit 204 stops driving the conveyance motor. On the basis of the change time of each sensor, the conveyance monitoring/control unit 213 calculates the conveyance distance and the bill length variation rate for the sensor sections of the sensor 34 to the sensor 33, the sensor 33 to the sensor 32, the sensor 32 to the sensor 31, the sensor 31 to the sensor 36, the sensor 36 to the sensor 37 and the sensor 37 to the sensor 46 in the same way as for the sensor section of the sensor 31 to the sensor 32 shown in Fig. 4.

[0089] In this way, both in receiving and delivering money, the maximum and average conveyance distances and bill length variation rates can be figured out. It is also possible to secure total information since the shipment and the information and information area for the last three months (this month, the month before and the month still before), calculate and register the conveyance distances and bill length variation rates on that basis, and keep track of changes in the status of the apparatus according to such information.

[0090] At the time of shipment, it is possible to receive and deliver money with plural similar bill handling apparatuses 1, calculate for each sensor section the maximum conveyance distance, the maximum bill length variation rate, the average conveyance distance and the average bill length variation rate, decide the permissible limits of each, and register them from the superior apparatus 201 into the standard conveyance information area 218 via the line control unit 203.

[0091] Similarly, it is possible to decide information on predictable trouble and remedies for each sensor section of predicted error occurrence, and register them from the superior apparatus 201 into the error specifying component information area 219 via the line control unit 203.

[0092] Incidentally, it is preferable to calculate the maximum, minimum and average Mahalanobis distances and the standard deviation on the basis of information on the shift or skew of bills, bill spacing, conveyance distance or length variation rate, figure out unit spaces by

the MT method on the basis of the calculated Mahalanobis distances, and register these unit spaces in the standard conveyance information area 218.

[0093] Next will be described the standard conveyance information used for predicting error occurrence and the error specifying component information which is component information regarding components whose errors are predictable.

[0094] Fig. 6, Fig. 7, Fig. 8 and Fig. 9 show examples of the standard conveyance information area 218 registered in advance at the time of shipment.

[0095] For counting deposited bills, as shown in Fig. 6, the permissible maximum and the permissible average of the conveyance distance and the permissible maximum and the permissible average of the bill length variation rate are stored in the standard conveyance information area 218 for each pertinent sensor section.

[0096] For accepting deposited bills, as shown in Fig. 7, the permissible maximum and the permissible average of the conveyance distance and the permissible maximum and the permissible average of the bill length variation rate are stored in the standard conveyance information area 218 for each pertinent sensor section.

[0097] For delivering bills, as shown in Fig. 8, the permissible maximum and the permissible average of the conveyance distance and the permissible maximum and the permissible average of the bill length variation rate are stored in the standard conveyance information area 218 for each pertinent sensor section.

[0098] For storing rejected bills for delivery, as shown in Fig. 9, the permissible maximum and the permissible average of the conveyance distance and the permissible maximum and the permissible average of the bill length variation rate are stored in the standard conveyance information area 218 for each pertinent sensor section.

[0099] Fig. 10 is a diagram illustrative of the error specifying component information 219 registered in advance at the time of shipment.

[0100] In the error specifying component information 219, there are stored information on predictable trouble and remedies. For each sensor section of predicted error occurrence, plural items of component information are stored, and a remedy is stored for each individual one of these items of component information.

[0101] Next, the operation to output trouble prediction will be described.

[0102] Fig. 11 is a flowchart showing the operation to output trouble prediction.

[0103] Fig. 12 and Fig. 13 are prior error predictive screens, each being one maintenance screen displayed on a display unit by the manipulation of personnel in charge.

[0104] At the time of regular inspection by personnel in charge or on a similar occasion, when an input device such as a key switch is manipulated for inputting and the bill handling apparatus 1 is switched over to the inspection mode (step S601), the main control unit 202 as the control device compares the standard conveyance infor-

mation area 218 and the conveyance status information area 214 to perform trouble prediction (step S602). In this trouble prediction, if any value in the conveyance status information area 214 is found variant to a certain extent or more from the corresponding value in the standard conveyance information area 218, the main control unit 202 determines that conveyance section (the sensor section) as a conveyance section in which trouble is predictable.

[0105] Incidentally, it is preferable to determine the presence or absence of any variance to a certain extent or more by calculating Mahalanobis distances regarding the conveyance distance and the bill length variation rate and seeing whether or not these Mahalanobis distances are within the aforementioned unit space.

[0106] In trouble prediction, if any value in the conveyance status information area 214 is found variant to a certain extent or more from the corresponding value in the standard conveyance information area 218 (step S603), the main control unit 202 displays on a display device as an output device, not shown, a maintenance screen 701 containing information on the predicted error occurrence section as predictable trouble information as shown in Fig. 12 (step S604). In this maintenance screen 701, there are provided an action display section 702, a "Next predicted error occurrence section displayed" button 703, a "Detailed information on this section displayed" button 704, a "Maintenance screen ended" button 705 and a trouble part display diagram 706.

[0107] The action display section 702 lights and displays the component whose trouble is predictable (such as a specific component of the conveyance path 10, the discriminating unit 2 or a specific one among the sensors 31 through 46) in a different color from other components (a conspicuous color, such as red for instance). In this way, personnel in charge are made aware of any component in which the occurrence of an abnormality which may invite trouble, such as the wear of a roller, invasion of a foreign matter or a hitch on the belt, is more likely, in other words any component whose trouble is predictable.

[0108] When a person in charge presses the "Detailed information on this section displayed" button 704 of the predicted error occurrence section display screen (step S605), the main control unit 202 causes the display device to display a detailed information display screen as shown in Fig. 13, and causes the maximum and the average in that predicted error occurrence section to be displayed (step S606). This can urge the person in charge to check the conveyance status in the predicted error occurrence section.

[0109] The information on the predicted error occurrence section and detailed information on the predicted error occurrence section are made printable by a printing device. It is also made possible to review the standard conveyance information area 218 by collecting information on each apparatus and statistically surveying the conveyance statuses in predicted error occurrence sec-

tions. If the findings of the survey reveal the need to review the standard conveyance information area 218, it is made possible to prevent maintenance by personnel in charge regarding variations within a certain range in any specified conveyance section until the superior apparatus 201 alters the standard conveyance information area 218 via the line control unit 203 (prevention of unnecessary maintenance work due to a bill factor or fluctuations in the environment or the like).

[0110] If variations are found at step S603 described above to be within a certain range in all the conveyance section, "Normal" is displayed on the screen (step S607) to inform the personnel in charge.

[0111] The operations described above make it possible to monitor the status of conveyance by each sensor and record any variation in the conveyance status. While this variation in the conveyance status may be due to one of various causes such as the wear of a roller or abnormality of a gate, a variation in the conveyance status due to a delay in bill conveyance or a skew can be identified by measuring the conveyance distance of bills and comparing it with the conveyance distance on a normal occasion. From this variation in the conveyance status, any conveyance section in which trouble is predictable can be identified, and personnel in charge can be warned in advance for regular inspection of this conveyance section or like actions. The personnel in charge can take an action, such as replacing an expendable item, on the basis of information on predictable error occurrence displayed at the time regular inspection, remove the potential trouble in advance of its actualization and reduce the failure of the apparatus due to trouble occurrence.

[0112] In particular, by figuring out the bill length on the basis of the front end passage time and the rear end passage time of each bill regarding each of the sensors 31 through 46, a bill longer than the normal length can be determined to be skewed, for instance, and personnel in charge can be made aware of the presence of abnormality which might invite trouble in the future in any of the sensor sections until the pertinent sensor.

[0113] Further the conveyance distance of a bill in a sensor section, which is the interval between adjacent sensors, is figured out according to the points of time at which the bill passed the adjacent sensors in sequence (the front end passage times in this embodiment) and it is determined whether or not this conveyance distance is appropriate, therefore personnel in charge can be made aware of the presence of abnormality which might invite trouble in the future in this sensor section.

[0114] Also, to display predictable error occurrence information, personnel in charge can check this predictable error occurrence information and remove the cause for potential trouble before it is actualized.

[0115] Where calculation of Mahalanobis distances is done, trouble can be predicted more accurately.

[0116] Further, as each sensor section and components whose trouble is predictable in that sensor section

are matched in their storage in the error specifying component information 219 and their registration are permitted to make possible updating, appropriate adaptation to version upgrading or software replacement in the bill handling apparatus 1 can be accomplished.

[0117] Since predictable error occurrence information is displayed only when personnel in charge performs regular inspection or the like, there is no possibility for predictable error occurrence information to be displayed when a common customer is to use the apparatus, and accordingly any common customer can execute his or her transactions with the automatic transaction apparatus 1 with no worry.

[0118] Also, by excluding bill information at the time of jamming due to a specific bill or the like from registration in paper conveyance information, more accurate prediction of abnormality occurrence is made possible. Further by applying such information to units responsible for the gate state, separation, stacking state and so forth, the prediction of trouble occurrence can be expanded. Personnel in charge can be thereby urged to perform inspection and preventive maintenance, and reduce the failure of the apparatus due to trouble occurrence.

[0119] Not only prediction of trouble but also stopping and error notification in time of actual trouble occurrence can be accomplished with no problem. Thus, if monitoring by the sensors 31 through 46 fails to detect any variation for a certain period of time, the main control unit 202 will determine that trouble has occurred on account of jamming or some other cause, delivers an order to stop feeding out to the separation motor control unit 207, and delivers an order to stop conveyance to the conveyance motor control unit 204. And it transmits error information to the superior apparatus 201 via the line control unit 203.

[0120] Since the certain period of time allowed for determination of trouble occurrence is set longer than the period matching the permissible maximum of the conveyance distance or the period matching the permissible maximum of the bill length variation rate, the detection of predictable trouble occurrence and the detection of actual trouble occurrence can take place without disturbing each other.

[0121] To add, the present invention is not limited to the configuration of the above-described embodiment but can be embodied in many other forms.

Claims

1. A paper sheet handling apparatus provided with a conveyance path (10) for conveying paper sheets between an inlet/outlet (9) and stocking units (3 to 8), comprising:

a plurality of sensors (31 to 46) for detecting passage of paper sheets;
a determining device for determining, on the basis of front end passage time and rear end pas-

- sage time of the paper sheets in each sensor, a conveyance status of the paper sheets in a sensor section up to that sensor on the conveyance path (10); and
 an output device for outputting a result of determination by the determining device. 5
2. The apparatus of claim 1, wherein the determining device is further adapted to determine the conveyance status of the paper sheets in a sensor section of mutually adjacent sensors on the conveyance path (10) on the basis of the passage times of papers sequentially detected by mutually adjacent sensors, out of the plurality of sensors (31 to 46), on the conveyance path. 10 15
3. The apparatus of claim 1 or 2, wherein the determining device is adapted to figure out a distance on the basis of the front end passage time, the rear end passage time, the passage time or more than one of these factors, and to determine the conveyance status in the pertinent sensor section to be not normal when the distance is not within a preset reference range, and
 the output device is adapted to output, as the result of determination, trouble predictive information predicting occurrence of trouble regarding the sensor section whose conveyance status has been determined to be not normal. 20 25 30
4. The apparatus of claim 1 or 2, wherein the determining device is adapted to figure out a distance or a distance variation rate on the basis of the front end passage time, the rear end passage time, the passage time or more than one of these factors, to figure out a Mahalanobis distance on the basis of the distance or distance variation rate, and to determine the conveyance status in the pertinent sensor section to be not normal when the Mahalanobis distance is not within a unit space preset by the MT method, and
 the output device is adapted to output as the result of determination trouble predictive information predicting occurrence of trouble regarding the sensor section whose conveyance status has been determined to be not normal. 35 40 45
5. The apparatus of claim 1 or 2, wherein the output device is adapted to output, as the result of determination, component information regarding any component which is predicted to prove defective in the conveyance status of any sensor section, and the apparatus further comprises a registration permitting device (203, 218, 219) for permitting registration of the component information matched with the sensor section. 50 55
6. The apparatus of claim 3 or 4, wherein
- the output device is adapted to output, as the result of determination, component information regarding any component which is predicted to prove defective in the conveyance status of any sensor section, and the apparatus further comprises a registration permitting device (203, 218, 219) for permitting registration of the component information matched with the sensor section.
7. The apparatus of any preceding claim, wherein the output device comprises:
- a display device for displaying images;
 an input device for permitting shifted inputting to a maintenance screen by a personnel in charge; and
 a control device that, at the time of shift to the maintenance screen, causes the result of determination to be outputted to the display device.

FIG. 1

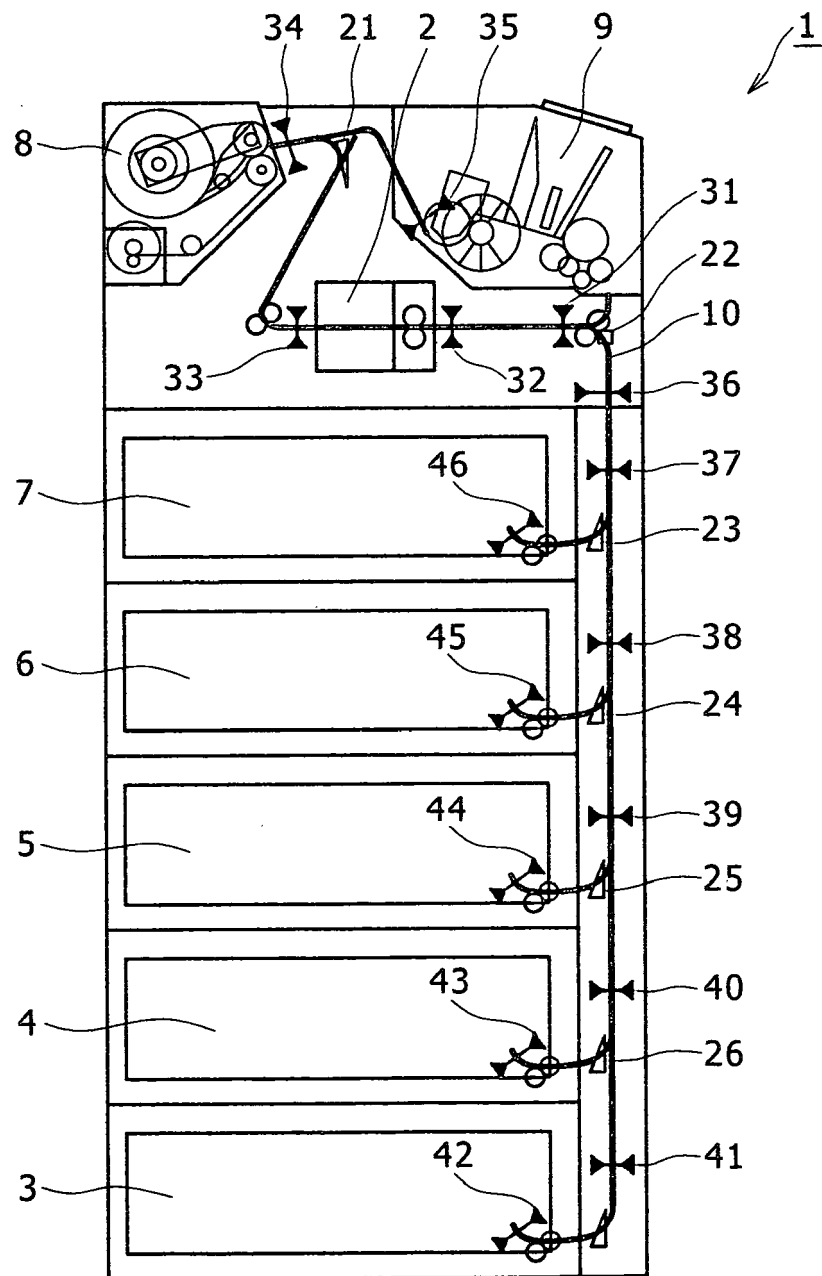


FIG. 2

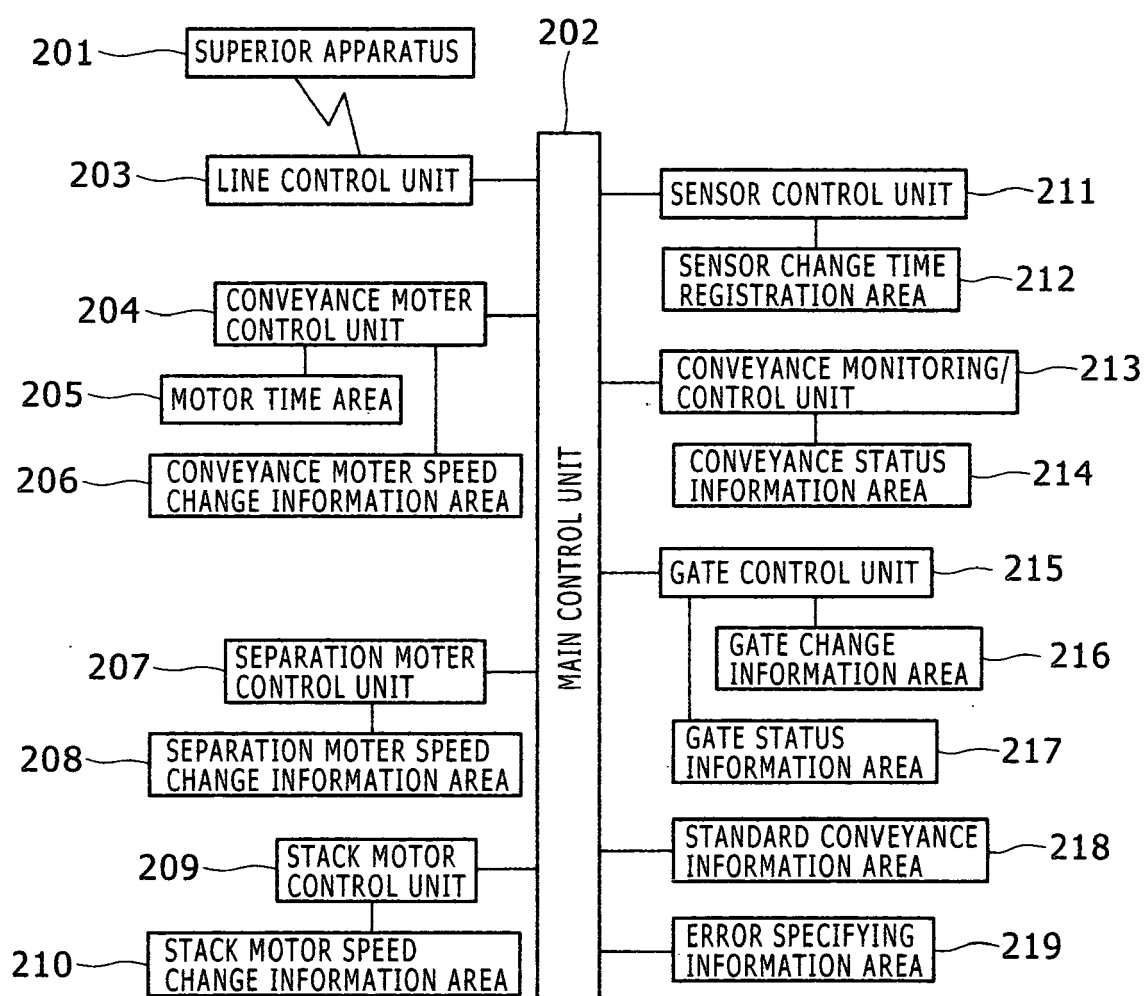


FIG. 3 A

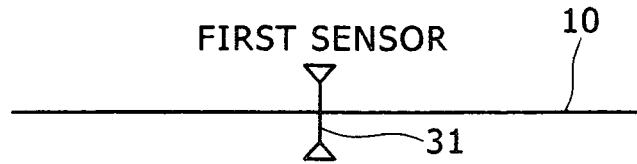


FIG. 3 B

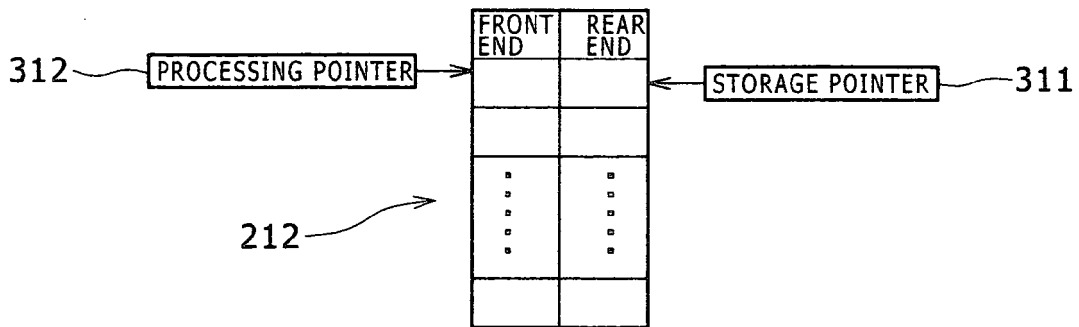


FIG. 3 C

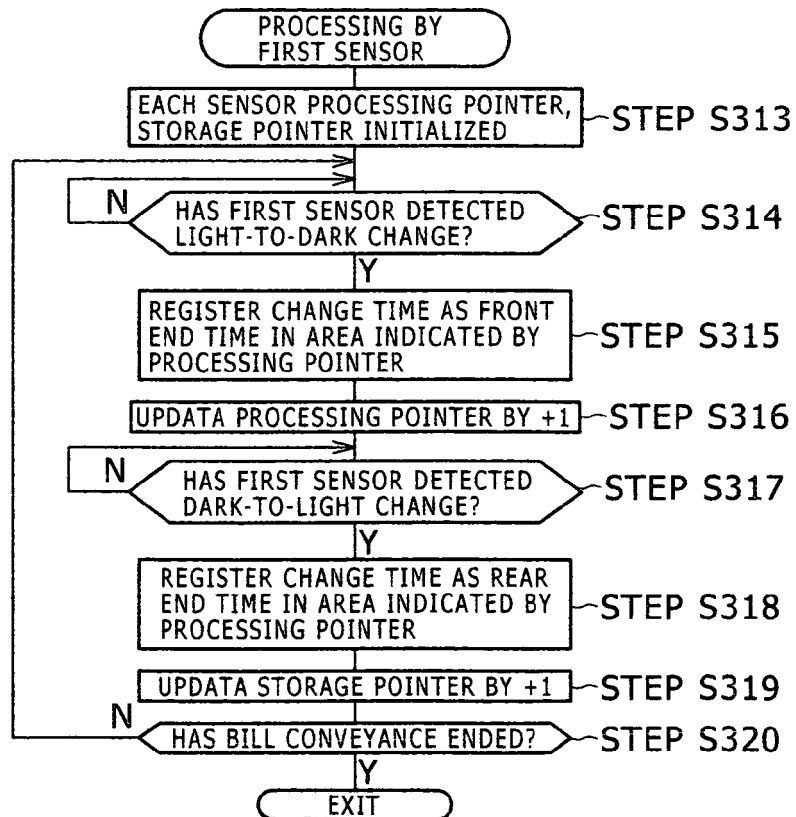


FIG. 4

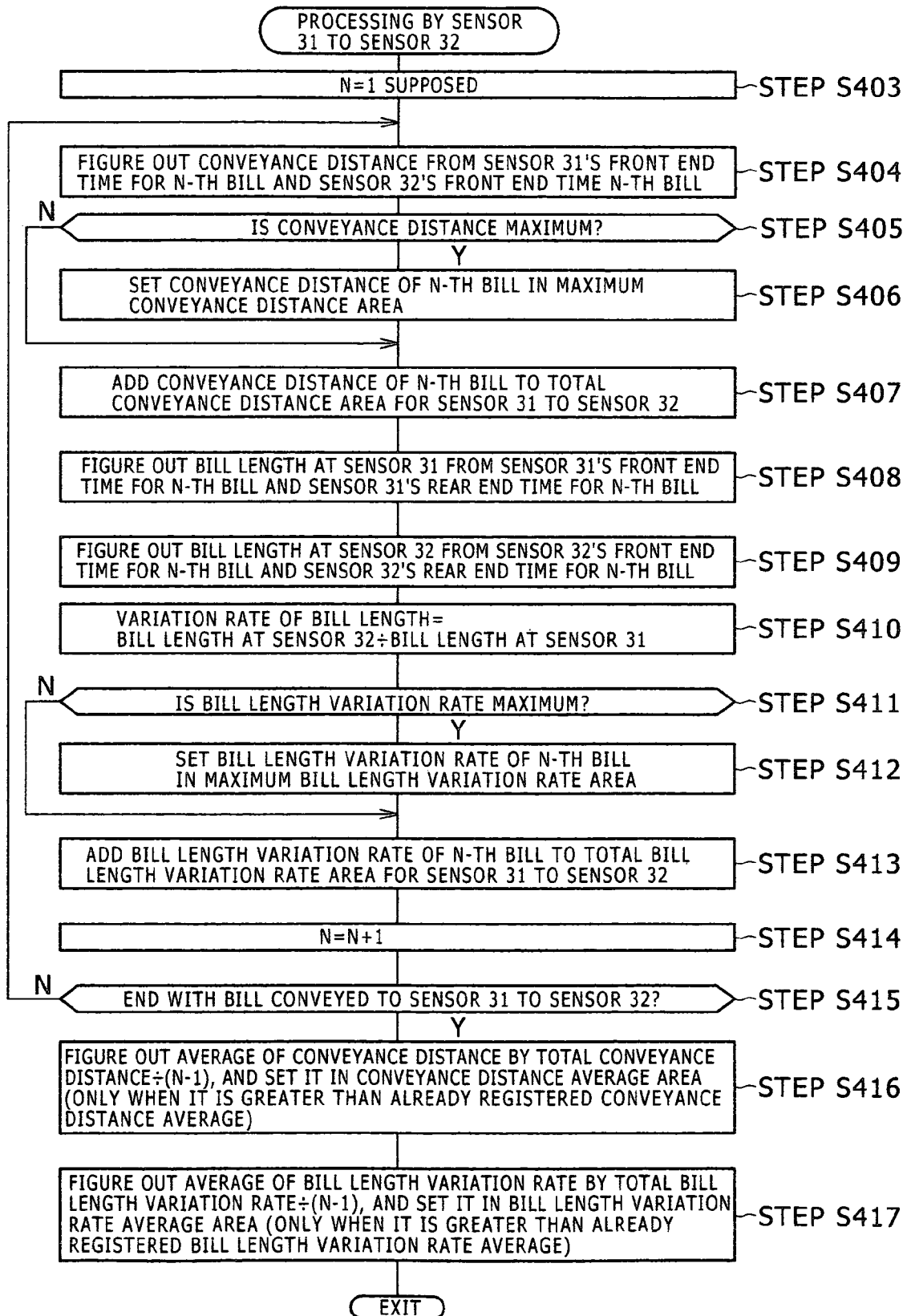


FIG. 5A

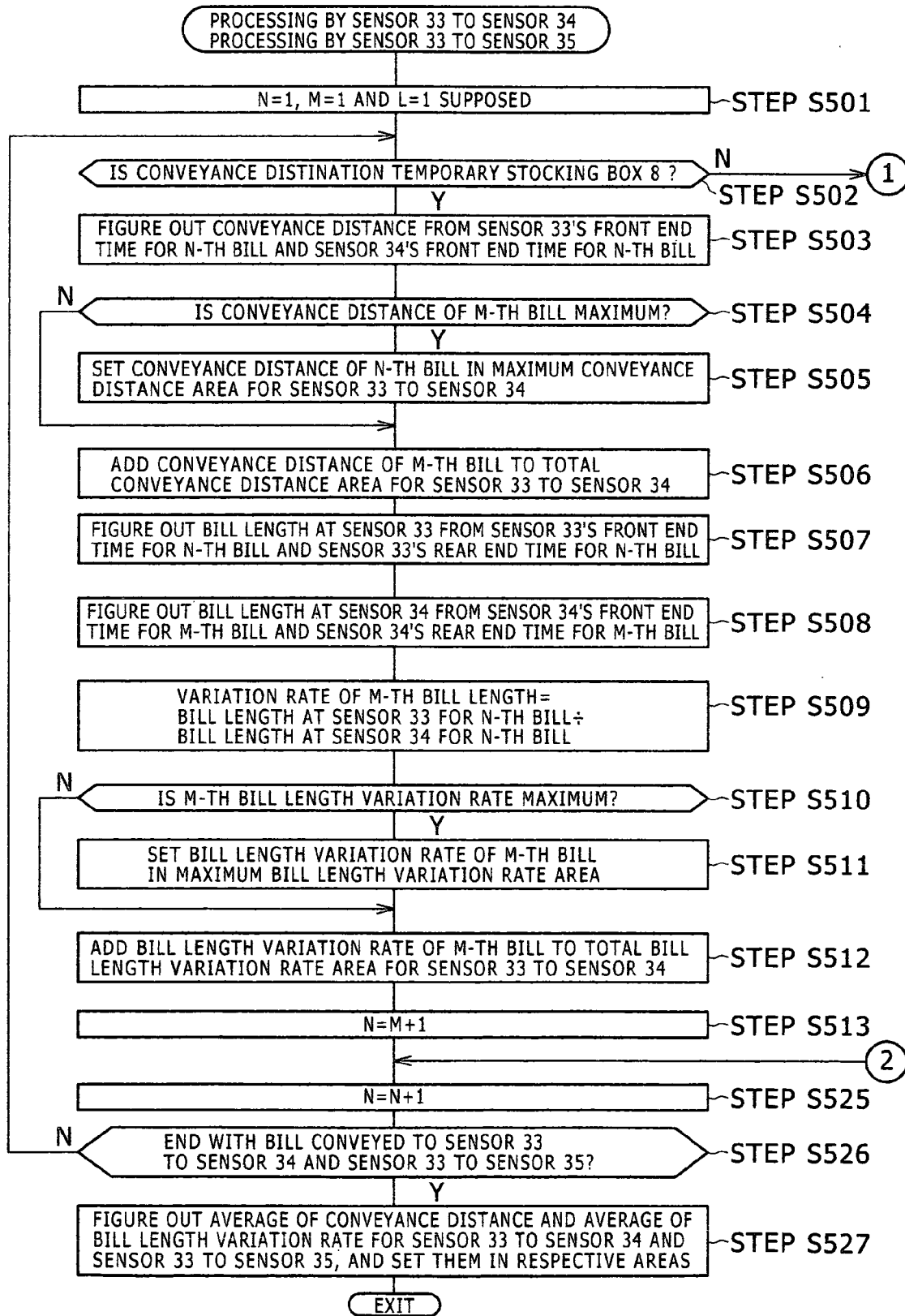


FIG. 5B

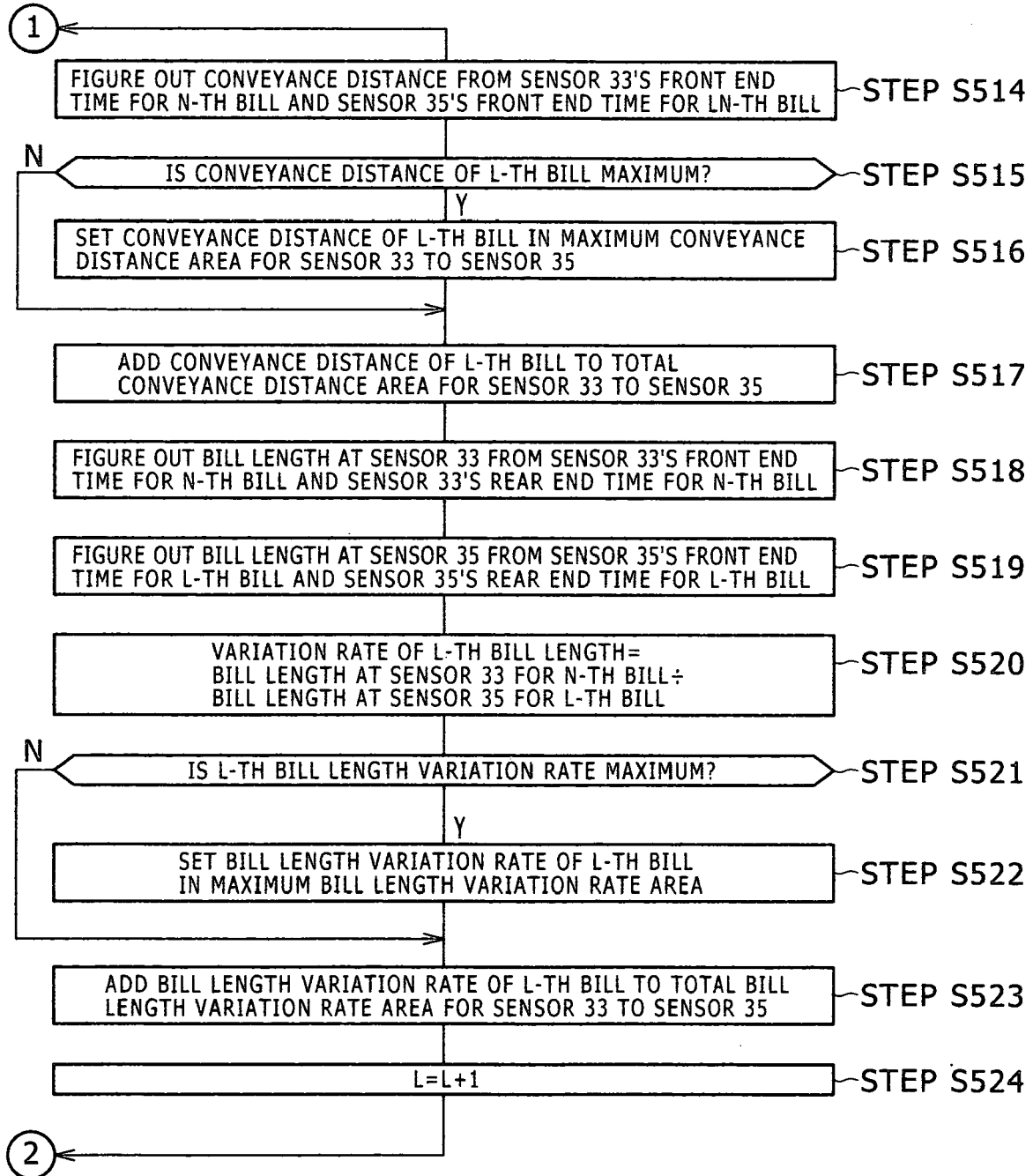


FIG. 6

[WHEN COUNTING DEPOSITED BILLS]

SENSOR SECTION	CONVEYANCE DISTANCE		BILL LENGTH VARIATION RATE	
	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE
SENSOR 31 ~ SENSOR 32	80	60	5	1
SENSOR 32 ~ SENSOR 33	300	210	20	8
SENSOR 33 ~ SENSOR 35	400	320	15	5
SENSOR 33 ~ SENSOR 34	450	380	15	5

FIG. 7

[WHEN ACCEPTING DEPOSITED BILLS]

SENSOR SECTION	CONVEYANCE DISTANCE		BILL LENGTH VARIATION RATE	
	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE
SENSOR 34~SENSOR 33	450	380	15	5
SENSOR 33~SENSOR 32	300	210	20	8
SENSOR 32~SENSOR 31	80	60	5	1
SENSOR 31~SENSOR 36	120	80	15	5
SENSOR 36~SENSOR 37	80	60	5	1
SENSOR 37~SENSOR 38	220	160	5	1
SENSOR 37~SENSOR 46	120	80	15	5
SENSOR 38~SENSOR 39	220	160	5	1
SENSOR 38~SENSOR 45	120	80	15	5
SENSOR 39~SENSOR 40	220	160	5	1
SENSOR 39~SENSOR 44	120	80	15	5
SENSOR 40~SENSOR 41	220	160	5	1
SENSOR 40~SENSOR 43	120	80	15	5
SENSOR 41~SENSOR 42	120	80	15	5

FIG. 8

[WHEN DELIVERING BILLS (FORWARD CONVEYANCE)]

SENSOR SECTION	CONVEYANCE DISTANCE		BILL LENGTH VARIATION RATE	
	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE
SENSOR 42~SENSOR 41	120	80	15	5
SENSOR 41~SENSOR 40	220	160	5	1
SENSOR 43~SENSOR 40	120	80	15	5
SENSOR 40~SENSOR 39	220	160	5	1
SENSOR 44~SENSOR 39	120	80	15	5
SENSOR 39~SENSOR 38	220	160	5	1
SENSOR 45~SENSOR 38	120	80	15	5
SENSOR 38~SENSOR 37	220	160	5	1
SENSOR 37~SENSOR 36	80	60	5	1
SENSOR 36~SENSOR 31	120	80	15	5
SENSOR 31~SENSOR 32	80	60	5	1
SENSOR 32~SENSOR 33	300	210	20	8
SENSOR 33~SENSOR 34	450	380	15	5
SENSOR 33~SENSOR 35	400	320	15	5

FIG. 9

[WHEN STORING REJECTED BILLS DELIVERY]

SENSOR SECTION	CONVEYANCE DISTANCE		BILL LENGTH VARIATION RATE	
	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE	PERMISSIBLE MAXIMUM	PERMISSIBLE AVERAGE
SENSOR 34~SENSOR 33	450	380	15	5
SENSOR 33~SENSOR 32	300	210	20	8
SENSOR 32~SENSOR 31	80	60	5	1
SENSOR 31~SENSOR 36	120	80	15	5
SENSOR 36~SENSOR 37	80	60	5	1
SENSOR 37~SENSOR 46	220	160	15	5

FIG. 10

ERROR OCCURRENCE PREDICTED SECTION	INFORMATION ON PREDICTED DEFECTIVE PARTS (INFORMATION PARTS NEEDING REVIEW)	REMEDY
SENSOR 30~ SENSOR 31	CONVEYANCE PATH 1	CHECK CONVEYANCE PATH OF LIT PART
	SENSOR 30	CHECK LIT SENSOR
	SENSOR 31	CHECK LIT SENSOR
SENSOR 31~ SENSOR 32	CONVEYANCE PATH 1	CHECK CONVEYANCE PATH OF LIT PART
	DISCRIMINATING PATH 2	CHECK STATE WITHIN DISCRIMINATING UNIT
	SENSOR 31	CHECK LIT SENSOR
	SENSOR 32	CHECK LIT SENSOR
SENSOR 32~ SENSOR 33	CONVEYANCE PATH 1	CHECK CONVEYANCE PATH OF LIT PART
	ROLLER	CHECK DEGREE OF WEAR AND ABRASION OF LIT ROLLER
	GATE 21	CHECK LIT GATE
	SENSOR 32	CHECK LIT SENSOR
	SENSOR 33	CHECK LIT SENSOR
⋮	⋮	⋮

FIG. 11

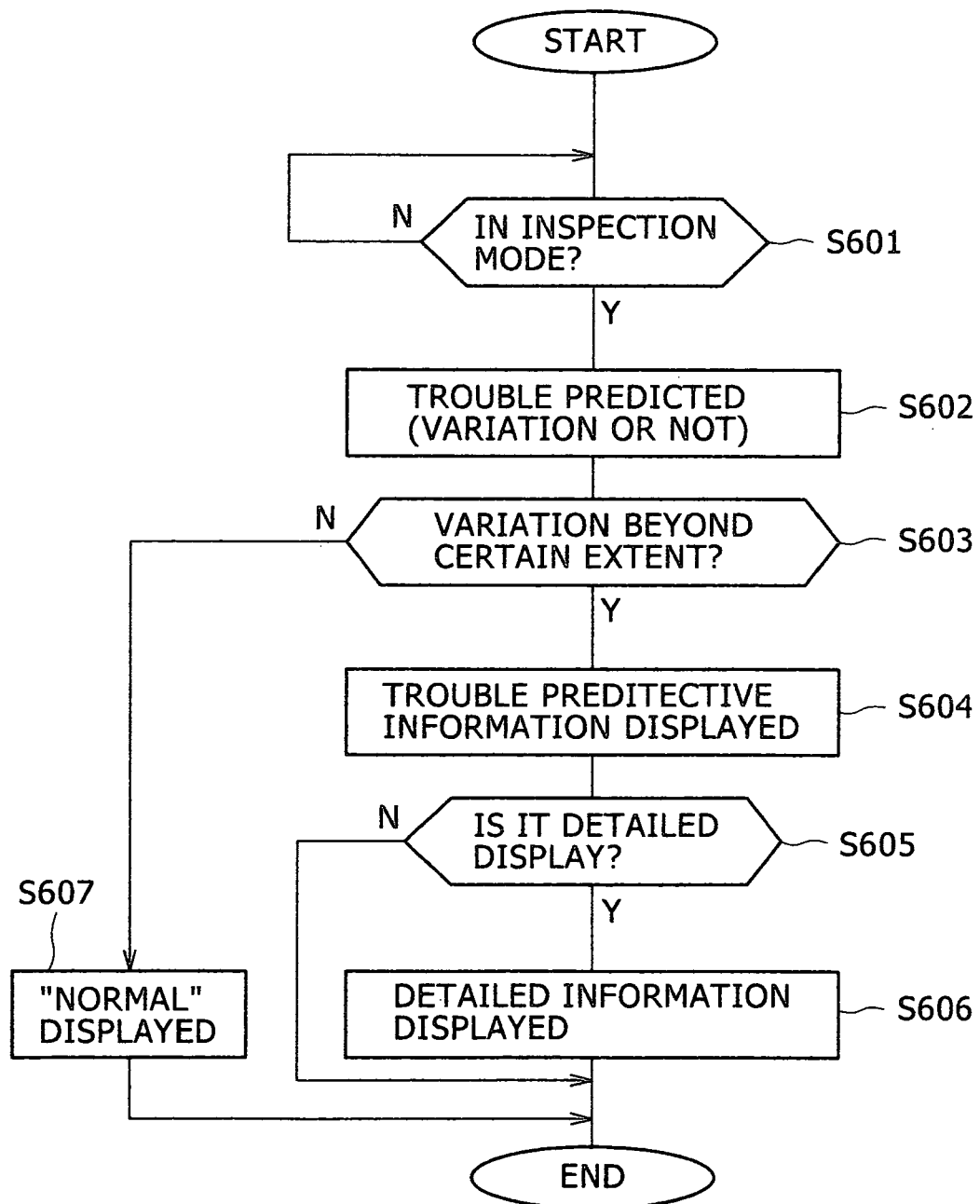


FIG. 12

701

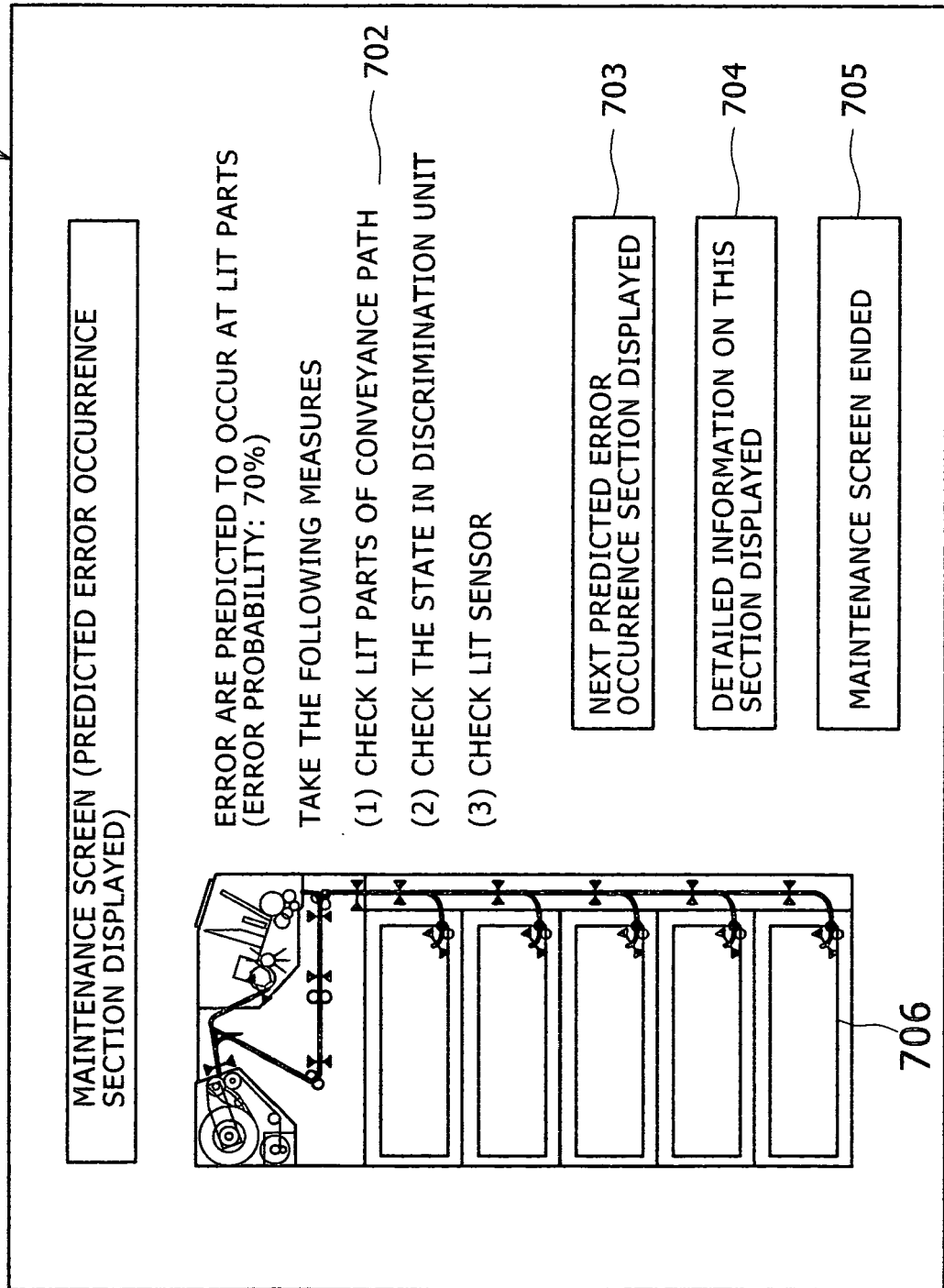
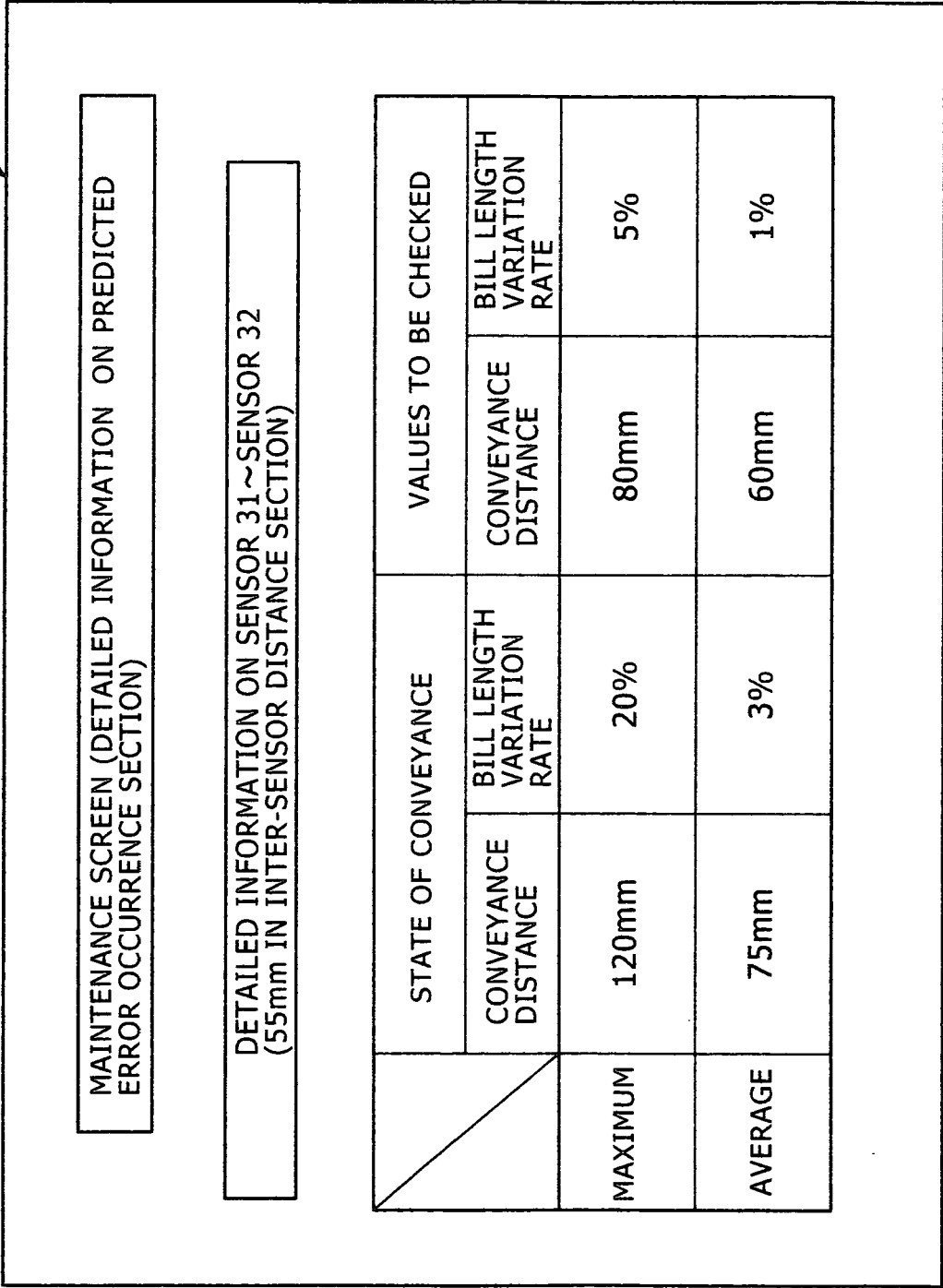


FIG. 13

701



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 8077417 A [0006]