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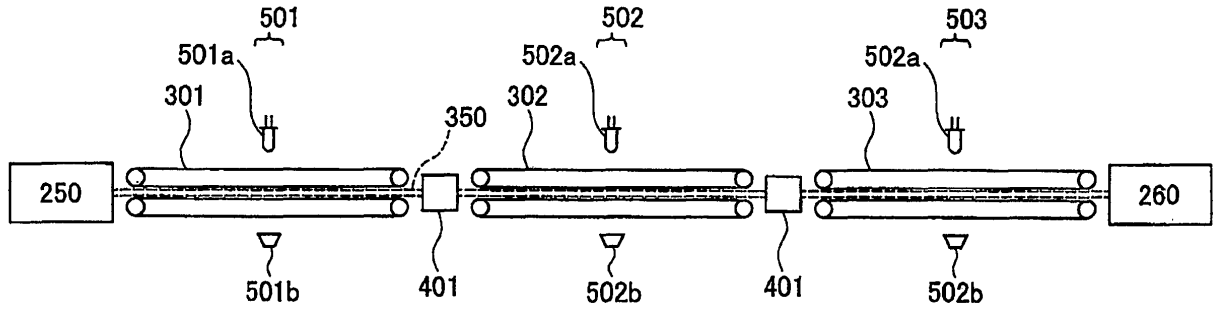
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(54) Paper sheet storage device and control method and control program for paper sheet storage device

(57) A paper sheet storage device comprises paper sheet transporting units (301-303) having a transport path for paper sheets and for transporting the paper sheets; a paper sheet feeder (250) for feeding a paper sheet onto the transport path; sensors (501 to 503), disposed on the transport path, for detecting passage of a paper sheet; a transport speed acquiring unit for acquiring the transport speed of a paper sheet based on detection by the sensors; and a controller (210) for controlling the paper sheet transport unit and the paper sheet feeder. In the event that the acquired transport speed of a paper sheet is slower than a prescribed speed, the controller causes the paper sheet feeder to halt the feeding of paper sheets, and operates in reverse a portion of the paper sheet transport unit that is situated closer to the paper sheet feeder than the slow moving paper sheet.

Fig.7



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a currency bill deposit/withdrawal device such as an automated teller machine or cash dispensing machine.

Description of the Related Art

[0002] Automated teller machines and cash dispensing machines handle bulk deposits and withdrawals of currency bills. If bills should overlap as they are conveyed through an automatic teller machine or cash dispensing machine, jamming may occur. One known means for preventing this is a chain correction mechanism which varies the speed of transport depending on the spacing between individual bills detected by a sensor. In this prior art, for paper currency bills which are being transported in succession, in the event that a following bill is transported at high speed such that it begins to overtake a leading bill, the following bill will be transported at slower speed; or in the event that a leading bill is slow and begins to be overtaken by a following bill, the leading bill will be transported at faster speed.

[0003] However, in the prior art discussed above, paper currency transport speed cannot be faster than the speed of the transport unit, and thus under normal circumstances it will not be possible for a following bill is transported at high speed sufficient to overtake a leading bill. On the other hand, it is possible for a following bill to overtake a leading one in the event that, for example, slipping has occurred between the leading bill and the transport unit. So in relation to speed adjustment in the same direction, there are instances in which the transport speed of the leading bill cannot be increased. Accordingly, in the prior art, it was difficult to prevent the occurrence of jamming caused when a slow leading bill is overlapped by a following bill.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to prevent or reduce jamming caused by overlapping paper currency bills.

[0005] The present invention in a first aspect provides a paper sheet storage device. The device comprises a paper sheet transport unit having a transport path for paper sheets; a paper sheet feeder for feeding the paper sheets to the transport path; a sensor, disposed on the transport path, for detecting passage of the paper sheets; a transport speed acquiring unit for acquiring the transport speed of the paper sheet based on detection by the sensor; and a controller for controlling the paper sheet transport unit and the paper sheet feeder. In the event that the acquired transport speed of a paper sheet is slower than a prescribed speed, the controller causes the paper sheet feeder to halt the feeding of paper sheets, and operates in reverse a portion of the paper sheet transport unit that is situated closer to the paper sheet feeder than the slow moving paper sheet. According to this configuration, in the case a transport speed of a leading paper sheet will become slow, a following paper sheet will run to reverse. So a gap between the leading paper sheet and the following paper sheet becomes wide, and it is possible to prevent or reduce jamming caused by overlapping paper sheets.

[0006] The device may include a plurality of sensors including first and second sensors that are disposed adjacently with each other; and the transport speed acquiring unit may acquire the speed of motion of a paper sheet based on a gap between first and second sensors, and a difference between a point in time that the paper sheet passes the first sensor and another point in time that the paper sheet passes the second sensor. According to this configuration, the transport speed of the paper sheets can be determined easily.

[0007] The device may include the aforementioned plurality of the sensors including first and second sensors that are disposed adjacently with each other, and may further comprise an arrival time predicting unit for predicting, from a point in time that the paper sheet passes the first sensor, arrival time of the paper sheet at the second sensor. In the event that the paper sheet fails to arrive at the second sensor within a predetermined time interval starting from the predicted arrival time, the controller causes the paper sheet feeder to halt the feed of paper sheets, and operates in reverse a portion of the paper sheet transport unit, that is situated closer to the paper sheet feeder than the first sensor. According to this configuration, delayed transport of paper sheets can be detected and jamming can be prevented before it occurs.

[0008] The present invention in a second aspect provides a method of controlling a paper sheet storage device. The method comprises the steps of feeding paper sheets from a paper sheet feeder; using a paper sheet transport unit to transport paper sheets; using a sensor to detect passage of a paper sheet; determining the transport speed of the paper sheet from the paper sheet passage time; and in the event that the transport speed of a paper sheet is slower than a prescribed transport speed, halting the feed of paper sheets from the paper sheet feeder, and then reverse-feeding the following paper sheets to return to the paper sheet feeder. According to this aspect, jamming caused by overlapping paper sheets can be prevented before it occurs.

[0009] The present invention in a third aspect provides a control program, stored on a computer readable medium, for a paper sheet storage device. The program accomplishes the functions of feeding paper sheets; transporting paper sheets; detecting passage of a paper sheet; determining the transport speed of the paper sheet from the passage time of the paper sheet; and in the

event that the determined transport speed of a paper sheet is slower than a prescribed transport speed, halting feed of paper sheets by the paper sheet feeder, and then reverse-feeding the following paper sheets by the paper sheet transport unit to return to the paper sheet in the paper sheet feeder. According to this aspect, jamming caused by overlapping paper sheets can be prevented before it occurs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Preferred embodiments of the present invention will now be described in conjunction with the accompanying drawings, in which:

FIG. 1 is an illustration depicting schematically the appearance of an ATM pertaining to Embodiment 1.
FIG. 2 is an illustration depicting schematically the block configuration of an ATM pertaining to Embodiment 1.
FIG. 3 is an illustration showing the control block of a paper currency handling unit 200.
FIG. 4 is an illustration depicting schematically the internal configuration of a paper currency handling unit 200.
FIG. 5 is a flowchart depicting operation of an ATM 10 when making a deposit.
FIG. 6 is a flowchart depicting operation of an ATM 10 when making a withdrawal.
FIG. 7 is an illustration showing in detail a path leading from a paper currency accepting/dispensing unit 250 to a paper currency discriminating unit 260.
FIG. 8 is a flowchart depicting transport control of paper currency.
FIG. 9 is a flowchart depicting transport control of paper currency in a Modification Example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] The configuration of an automated teller machine (hereinafter "ATM") pertaining to Embodiment 1 will be described with reference to FIGS. 1 and 2. FIG. 1 is an illustration depicting schematically the appearance of an ATM pertaining to Embodiment 1. FIG. 2 is an illustration depicting schematically the block configuration of the ATM pertaining to Embodiment 1. The ATM 10 includes a main controller 100, a card/statement processor 110, a touch panel 120, an administrator operation unit 130, a network interface 140, and a paper currency handling unit 200, which are interconnected through an internal bus 150.

[0012] The main controller 100 controls the card/statement processor 110, the touch panel 120, the administrator operation unit 130, the network interface 140, and the paper currency handling unit 200. The card/statement processor 110 includes a passbook printer 112 and a reader/writer 114. The passbook printer 112 performs printing of transaction records or printing of passbook entries. The reader/writer 114 performs reading of data from or writing of data to a card.

[0013] The touch panel 120 detects input from a customer. Here, "customer input" refers to an instruction to make a deposit or a withdrawal, for example. The detected input is transmitted from the touch panel 120 to the main controller 100. The touch panel 120 has both an input detection function and a display function; it both detects customer input and displays messages from the ATM 10 to the customer. The administrator operation unit 130 detects operations performed by an administrator employee of the financial institution. The network interface 140 connects the ATM 10 to a network 20. The ATM 10 is connected to a host computer (not shown) via the network 20.

[0014] The paper currency handling unit 200 performs discrimination of paper currency bills which have been deposited to the ATM 10, and transmits the discrimination results to the main controller 100 as well as sorting the paper currency bills and placing them in an internal repository. Upon receiving an instruction from the main controller 100, the paper currency handling unit 200 will retrieve and dispense paper currency bills from the internal repository. The paper currency handling unit 200 has both a paper currency accepting/dispensing unit 250 for accepting and dispensing paper currency, and a coin accepting/dispensing unit 252 for accepting and dispensing coins.

[0015] The paper currency handling unit 200 will be described making reference to FIGS. 3 and 4. FIG. 3 is an illustration showing the control block of the paper currency handling unit 200. FIG. 4 is an illustration depicting schematically the internal configuration of the paper currency handling unit 200.

[0016] The control block of the paper currency handling unit 200 includes a CPU 210 and a memory 220 which are interconnected by an internal bus 240. The paper currency handling unit 200 is provided internally with a paper currency discriminating unit 260, a paper currency escrow repository 270, a counterfeit bill repository 272, a walk-away recovery repository 274, a paper currency recovery repository 276, recycling repositories 278a to 278e, paper currency transport devices 301 to 322, and switching gates 401 to 410.

[0017] The paper currency discriminating unit 260 scans the currency bills and acquires currency data for the purpose of discerning the genuineness and denomination of the currency bills. In the present embodiment, determination of genuineness and denomination of currency bills is carried out through execution by the CPU 210, discussed later, of a paper currency discrimination program 224, discussed later, and processing of the currency data acquired by the paper currency discriminating unit 260. The paper currency escrow repository 270 provides temporary storage of genuine currency bills. The counterfeit bill repository 272 stores any counterfeit bills. The walk-away recovery repository 274 will store any cur-

rency bills that a customer has forgotten to retrieve when cash is dispensed or returned. The paper currency recovery repository 276 stores currency bills which are genuine but damaged to the point of being unsuitable for recirculation. The recycling repositories 278a through 278e store currency bills which are genuine and suitable for recirculation. In the present embodiment, five recycling repositories 278a through 278e are provided in association with different denominations. It would be acceptable to provide two or more of recycling repositories 278a through 278e for a single denomination. Where recycling repositories 278a through 278e are not distinguished in this way, they will be denoted as recycling repositories 278. For security purposes the paper currency recovery repository 276 and the recycling repositories 278 are located within a safe 280.

[0018] The paper currency transport devices 301 to 322 are transport devices for transporting currency bills. In the present embodiment, the paper currency transport devices 301 to 322 use belts or rollers for example to transport the currency bills. The switching gates 401 to 410 are gates for switching the transport direction of currency bills. The switching gates 401 to 410 have transport devices in three or four directions, and will shunt a paper currency bill transported from one of these directions into any of the remaining two or three directions.

[0019] The placement of the paper currency transport devices 301 to 322 and the switching gates 401 to 410 will be described with reference to FIG. 4. The paper currency transport device 301, the switching gate 401, the paper currency transport device 302, the switching gate 402, and the paper currency transport device 303 are situated between the paper currency accepting/dispensing unit 250 and the paper currency discriminating unit 260. The paper currency transport device 304, the switching gate 403, and the paper currency transport device 305 are situated between the paper currency discriminating unit 260 and the paper currency escrow repository 270. The paper currency transport device 306, the switching gate 404, and the paper currency transport device 307 are situated between the switching gate 403 and the paper currency accepting/dispensing unit 250. The paper currency transport device 311 is situated between the switching gate 402 and the switching gate 404. The paper currency transport device 308, the switching gate 405, and the paper currency transport device 309 are situated between the switching gate 403 and the counterfeit bill repository 272. The paper currency transport device 310 is situated between the switching gate 405 and the walk-away recovery repository 274.

[0020] The paper currency transport device 312, the switching gate 406, the paper currency transport device 313, the switching gate 407, the paper currency transport device 314, the switching gate 408, the paper currency transport device 315, the switching gate 409, the paper currency transport device 316, the switching gate 410, and the paper currency transport device 317 are situated between the switching gate 401 and the paper currency recovery repository 276. The paper currency transport devices 318 through 322 are situated respectively between the switching gates 406 through 410 and the recycling repositories 278a-e.

[0021] The CPU 210 controls the operation of the paper currency accepting/dispensing unit 250, the paper currency discriminating unit 260, the paper currency escrow repository 270, the counterfeit bill repository 272, the walk-away recovery repository 274, the paper currency recovery repository 276, the recycling repositories 278, the paper currency transport devices 301 to 322, and the switching gates 401 to 410. The memory 220 has stored in memory therein a paper currency feed control program 222, the paper currency discrimination program 224, a transport speed acquisition program 226, a paper currency arrival time prediction program 228, a paper currency transport control program 230, and a switching gate control program 232.

[0022] In the event that, for example, slowed transport speed of a currency bill has been detected, the paper currency feed control program 222 will perform control of feed of the currency bills by halting the feed of currency bills from the paper currency accepting/dispensing unit 250, the paper currency escrow repository 270, the recycling repositories 278, and so on. The paper currency discrimination program 224 uses the currency bill data acquired from currency bills by the paper currency discriminating unit 260 to determine the genuineness and denomination of the currency bills. The transport speed acquisition program 226 uses the point in time that a currency bill arrived at a sensor (discussed later), which has been recorded in the memory 220, and the distance between sensors, which is stored in memory 220, to determine the transport speed of the currency bill. The paper currency arrival time prediction program 228 uses the time of arrival at a given sensor to predict the time of arrival at the next sensor. In general, when calculating the transport speed of a currency bill it will be necessary for the bill to pass sensors at two locations. However, if a currency bill fails to reach the next sensor within a prescribed time interval from the time at which it passed the first sensor, it can be detected that the currency bill transport speed has been slowed, even if the actual transport speed of the bill is not known. The paper currency transport control program 230 controls operations of the paper currency transport device 301 through 322. For example, if slow transport speed is detected, it will control a prescribed paper currency transport device so as to reverse its direction of rotation. The switching gate control program 232 controls the direction of shunting of transported paper currency in the switching gates 401 through 410.

[0023] The operation of the ATM 10 will be described below with reference to FIGS. 5 and 6. FIG. 5 is a flowchart depicting operation of an ATM 10 when making a deposit. FIG. 6 is a flowchart depicting operation of an ATM 10 when making a withdrawal. Here, typical operations during an ATM 10 deposit and withdrawal will be described; the paper currency transport control which is

a particular feature of the present embodiment will be discussed later.

Deposit Operation

[0024] When an instruction to initiate a deposit is made on the touch panel 120 by the user, the main controller 100 will open the door of the paper currency accepting/dispensing unit 250 and wait for currency bills to be placed in the paper currency accepting/dispensing unit 250 (Step S100). Upon receiving an instruction from the main controller 100, the CPU 210 will switch the switching gates 401, 402 so that the currency bills are transported from the paper currency accepting/dispensing unit 250 to the paper currency discriminating unit 260, and will then drive the paper currency transport devices 301 to 303 to feed the currency bills to the paper currency discriminating unit 260, acquire paper currency data from the paper currency discriminating unit 260, and determine the genuineness and denomination of the currency bills (Step S110). In the event that a currency bill is found to be genuine, the CPU 210 will record the denomination in the memory 220, switch the switching gate 403 so that the bill is transported to the paper currency escrow repository 270, and drive the paper currency transport devices 304, 305 to transport the bill to the paper currency escrow repository 270. In the event that a currency bill is found to be counterfeit, the CPU 210 will switch the switching gates 403, 405 so that the bill is transported to the counterfeit bill repository 272, and drive the paper currency transport devices 304, 308, and 309 to transport the bill to counterfeit bill repository 272 (Step S120).

[0025] The main controller 100 will then display on the touch panel 120 the total amount of the denominations of the deposited paper currency (Step S130), and will wait for an instruction from the user. In the event that user input of an instruction to proceed with the deposit is detected (Step S140: Yes), the main controller 100 will instruct the paper currency handling unit 200 to transport the currency bills to the paper currency recovery repository 276 and the recycling repositories 278 (Step S150). Specifically, upon receiving an instruction from the main controller 100, the CPU 210 will switch the switching gate 403 so that the currency bills are transported to the paper currency discriminating unit 260, and drive the paper currency transport devices 305, 304 to transport the bills to the paper currency discriminating unit 260. The CPU 210 will then acquire the currency bill data from the paper currency discriminating unit 260 and re-check the paper currency denominations. On the basis of the paper currency denominations the CPU 210 will determine whether to transport the bills to the paper currency recovery repository 276 or the recycling repositories 278a-e, and perform the appropriate switching of the switching gates 402, 401, and 406 through 410. The CPU 210 will then drive the paper currency transport devices 303, 302, and 312 through 322 to transport the bills to their determined transport destinations.

[0026] In the event that user input of an instruction to cancel the deposit is detected (Step S140: No), the main controller 100 will instruct the paper currency handling unit 200 to transport the paper currency to the paper currency accepting/dispensing unit 250 (Step S160) and return the bills to the user. Specifically, upon receiving an instruction from the main controller 100, the CPU 210 will switch the switching gates 403, 404 so that the currency bills are transported to the paper currency accepting/dispensing unit 250, and then drive the paper currency transport devices 305 through 307 to transport the bills to the paper currency accepting/dispensing unit 250.

Withdrawal Operation

[0027] When a withdrawal instruction is made on the touch panel 120 by the user (Step S200), the main controller 100 will detect this, and instruct the paper currency handling unit 200 to transport paper currency to the paper currency accepting/dispensing unit 250.

[0028] Upon receiving an instruction from the main controller 100, the CPU 210 will determine from which of the recycling repositories 278a-e to withdraw currency bills, and will switch the switching gates 406 through 410, 401, and 402 so that the bills are transported from the prescribed recycling repositories 278a-e to the paper currency discriminating portion unit. The CPU 210 will then drive the paper currency transport devices 318 to 322, 312 to 316, 302, and 303 to convey the bills to the paper currency discriminating unit 260, where their denominations will be determined (Step S210). In the event that the currency bill denominations were correct (Step S220: Yes), the CPU 210 will switch the switching gates 403, 404 so that the bills are transported to the paper currency accepting/dispensing unit 250, drive the paper currency transport devices 304, 306, 307, and transport the bills to the paper currency accepting/dispensing unit 250 (Step S230). Once all of the bills for withdrawal have been transported to the paper currency accepting/dispensing unit250, the CPU 210 will dispense the bills to the user. In the event that a currency bill denomination is not correct (Step S220: No), the CPU 210 will switch the switching gate 403 so that the bill is transported to the paper currency escrow repository 270, and drive the paper currency transport devices 304, 305 to transport the bill to the paper currency escrow repository 270. Once the cash dispensing operation to the user has been completed, the main controller 100 will now transport bills that were transported to the paper currency escrow repository 270 to the paper currency recovery repository 276 and the recycling repositories 278 (the recycling repositories 278a-e) (Step S240). This operation is identical to the operation of transporting bills from the paper currency escrow repository 270 to the paper currency recovery repository 276 and the recycling repositories 278 during a deposit, and will not be described.

[0029] The sensors will now be described, taking the example of the path from the paper currency accepting/

dispensing unit 250 to the paper currency discriminating unit 260. FIG. 7 is an illustration showing in detail the path leading from the paper currency accepting/dispensing unit 250 to the paper currency discriminating unit 260. In the present embodiment, a paper currency transport path 350 is formed by the paper currency transport devices 301 to 303 between the paper currency accepting/dispensing unit 250 and the paper currency discriminating unit 260; and sensors 501 to 503 are positioned along the paper currency transport path 350. The sensors 501 to 503 are respectively composed of light-emitting elements 501a to 503a, and photoreceptor elements 501b to 503b. In the present embodiment, the sensors 501 to 503 are transmission type sensors in which the light-emitting elements 501a to 503a and the photoreceptor elements 501b to 503b are disposed to either side of the paper currency transport path 350; however, it would also be acceptable to use reflection type sensors in which the light-emitting elements 501a to 503a and the photoreceptor elements 501b to 503b are disposed to the same side of the paper currency transport path 350. Since the signals from the photoreceptor elements will change as currency bills block the light between the light-emitting elements and the photoreceptor elements, the CPU 210 will detect passage of bills by reading the values of the signals from the photoreceptor elements. In the present embodiment, three sensors have been provided between the paper currency accepting/dispensing unit 250 to the paper currency discriminating unit 260, but the number of sensors is not limited to three, and may be a different number.

[0030] Control of paper currency transport during deposit operations will now be described in more detail, taking the example of the path from the paper currency accepting/dispensing unit 250 to the paper currency discriminating unit 260. FIG. 8 is a flowchart depicting transport control of paper currency. When currency bills are deposited, they will be fed one at a time to the paper currency transport path 350 from the paper currency accepting/dispensing unit 250. The bills will then be transported by the paper currency transport device 301, and as they pass the location of the sensor 501 the value of the signal from the sensor 501 will change, whereby the CPU 210 will detect arrival of the bills at the sensor 501 (Step S300). The CPU 210 will record the time t1 of arrival of a bill at the sensor 501 in the memory 220 (Step S305). The bill will then be transported forward by the paper currency transport devices 301, 302. When a bill reaches the location of the sensor 502, the signal from the sensor 502 will change, whereby the CPU 210 will detect arrival of bills at the sensor 502 (Step S310). The CPU 210 will record the time t2 of arrival of the bill at the sensor 502 in the memory 220 (Step S315).

[0031] Since the distance between the sensor 501 and the sensor 502 has been pre-stored in the memory 220, the CPU 210 will be able to calculate the currency bill transport speed from the distance between the sensor 501 and the sensor 502, and the difference between the time t1 of arrival of a bill at the sensor 501 and the time t2 of arrival of the bill at the sensor 502 (Step S320). In the event that the calculated transport speed is smaller than a prescribed value (Step S325: Yes), the CPU 210 will halt feed of the bill from the paper currency accepting/dispensing unit 250 and rotate the paper currency transport device 301 backward in order to reverse the subsequently dispensed bill (hereinafter termed the "following bill"; in association therewith, the corresponding bill transported at slow speed at this time is termed the "leading bill.") back into the paper currency accepting/dispensing unit 250 (Step S330).

[0032] The currency bill will then be transported forward by the paper currency transport devices 302, 303. When a bill reaches the location of the sensor 503, the signal from the sensor 503 will change, and thus the CPU 210 can detect that the bill has reached the sensor 503 (Step S335). The CPU 210 will record the time t3 of arrival of the bill at the sensor 503 in the memory 220 (Step S340).

[0033] Since the distance between the sensor 502 and the sensor 503 has been pre-stored in the memory 220, the CPU 210 will be able to calculate the currency bill transport speed from the distance between the sensor 502 and the sensor 503, and the difference between the time t2 of arrival of the bill at the sensor 502 and the time t3 of arrival of the bill at the sensor 503 (Step S345). In the event that the calculated transport speed is smaller than a prescribed value (Step S350: Yes), the CPU 210 will halt feed of the bill from the paper currency accepting/dispensing unit 250 and rotate the paper currency transport devices 301, 302 in backward in order to reverse the following bill back into the paper currency accepting/dispensing unit 250 (Step S330).

[0034] In the preceding description, only control on the path leading up to the paper currency discriminating unit 260 was described; however, control on the path between the paper currency discriminating unit 260 and the paper currency escrow repository 270 would be carried out analogously. The CPU 210 will calculate the transport speed of currency bills from the distance between two adjacent sensors and the difference in arrival times, and in the event it detects a bill moving at transport speed slower than a prescribed transport speed, it will rotate in reverse the paper currency transport devices situated between the bill traveling at slow speed and the paper currency accepting/dispensing unit 250.

[0035] Through this control, following bills will be returned to and stored in the paper currency accepting/dispensing unit 250, while transport of the leading bill will continue uninterrupted. In the event that the leading bill is stored at its storage destination, for example, in the paper currency escrow repository 270, the CPU 210 will again dispense bills from the paper currency accepting/dispensing unit 250, rotating the paper currency transport devices in the normal direction. The reason is that since the leading is in storage, there is no risk of overlap. It is not necessary that all of the following bills be returned to

the paper currency accepting/dispensing unit 250 at this time. Subsequent operation will proceed analogously to the operation described above. In the event that the leading bill fails to be stored in the paper currency escrow repository 270 within a prescribed time period, the CPU 210 will for example issue an alert to financial institution service personnel to request repair of the ATM 10. If jamming occurs due to overlapping bills, depending on the condition of the jam, recovery may be difficult; according to the present embodiment, however, leading bills will be conveyed forward while following bills will be conveyed backward, thus avoiding jams caused by overlap. Accordingly, it will be easier for service personnel to repair the ATM 10.

[0036] Verification of transport speed will be carried out for all paper currency bills which are fed from the paper currency accepting/dispensing unit 250. For example, if the CPU 210 has detected that the third bill (leading bill) which was fed is being transported at slow speed, it will perform control such that the paper currency transport device reached by the fourth bill (following bill), as well as the paper currency transport device lying towards the paper currency accepting/dispensing unit 250 side of this device, now rotate in reverse.

[0037] In the preceding discussion, transport of bills from the paper currency accepting/dispensing unit 250 to the paper currency escrow repository 270 during deposit was described taking the example of the path from the paper currency accepting/dispensing unit 250 to the paper currency discriminating unit 260; however, the process would be similar in the case of transport of bills from the paper currency escrow repository 270 to the a paper currency recovery repository 276 or to the recycling repositories 278 for the purpose of storage, or of transport of bills from the paper currency escrow repository 270 to the paper currency accepting/dispensing unit 250 for the purpose of returning cash. Since description of these identical processes would be redundant they will not be described here. The process of transporting bills from the recycling repositories 278 to the paper currency accepting/dispensing unit 250 during withdrawal is also analogous to the above. Specifically, if the CPU 210 detects slow transport speed from a sensor signal, it will halt the feed of the bills, and perform control to rotate in reverse the paper currency transport device which is situated towards the feed side from the bill which was detected to be transported at slow speed.

[0038] According to the embodiment above, if the CPU 210 detects a bill transported at slow speed, it will perform control to rotate in reverse the paper currency transport device which is situated towards the feed side from the detected bill, thereby preventing the leading bill and the following bill from overlapping and causing jamming.

Modification Example

[0039] The Modification Example will be described below with reference to FIG. 9. FIG. 9 is a flowchart depicting transport control of paper currency in a Modification Example. The configuration of the Modification Example is the same as the configuration of the embodiment, so the configuration will not be discussed.

[0040] Currency bills are fed one at time from the paper currency accepting/dispensing unit 250 to the paper currency transport path 350. The bills will then be transported by the paper currency transport device 301. As a bill passes the location of the sensor 501, the value of the signal from the sensor 501 will change, whereby the CPU 210 will detect the arrival of the bill at the sensor 501 (Step S400). The CPU 210 will record the time t1 of arrival of the bill at the sensor 501 in the memory 220 (Step S405).

[0041] The CPU 210 will then predict the time at which the bill will reach the sensor 502 (Step S410) and record this value to the memory 220 (Step S415). The distance between the sensor 501 and the sensor 502 is a known value, and since the transport speed by the paper currency transport devices 301, 302 is also known, if the time t1 of arrival of a bill at the sensor 501 is known it will be a simple matter to predict the time of arrival t2a at the sensor 502.

[0042] The CPU 210 will then wait for the bill to reach the sensor 502 (Step S420). If before the bill reaches the sensor 502 (Step S420: No) the elapsed time has passed t2a (Step S425: Yes), the CPU 210 will detect that delayed transport of the bill has occurred (Step S430). The CPU 210 will then halt the feed of bills from the paper currency accepting/dispensing unit 250 and reverse the following bills back into the paper currency accepting/dispensing unit 250 (Step S435). Specifically, the CPU 210 will rotate the paper currency transport device 301 in reverse.

[0043] If the CPU 210 detects that the bill has reached the sensor 502 (Step S420: Yes), it will record the time t2 of arrival of the bill at the sensor 502 in the memory 220 (Step S440). The CPU 201 will then predict the time at which the bill will reach the sensor 503 (Step S445), and record this value to the memory 220 (Step S450). The distance between the sensor 502 and the sensor 503 is a known value, and since the transport speed by the paper currency transport devices 302, 303 is also known, if the time t2 of arrival of a bill at the sensor 502 is known it will be a simple matter to predict the time of arrival t3a at the sensor 503.

[0044] The CPU 210 will then wait for the bill to reach the sensor 503 (Step S455). If before the bill reaches the sensor 503 (Step S455: No) the elapsed time has passed t3a (Step S460: Yes), the CPU 210 will detect that delayed transport of the bill has occurred (Step S430). The CPU 210 will then halt the feed of bills from the paper currency accepting/dispensing unit 250 and reverse the following bills back into the paper currency accepting/dispensing unit 250 (Step S435). Specifically, the CPU 210 will rotate the paper currency transport devices 301, 302 in reverse.

[0045] If the CPU 210 detects that the bill has reached

the sensor 503 (Step S455: Yes), it will record the time t3 of arrival of the bill at the sensor 503 in the memory 220 (Step S465). The time t3 will be used to predict the time t4a of arrival of the bill at the next sensor. The subsequent process is a repeat of the above and will not be described.

[0046] According to the Modification Example, the CPU 210 can detect delayed transport of currency bills even before a bill reaches the next sensor. Accordingly, it will be possible to prevent jamming caused by overlapping paper currency bills in the event that, for example, the transport speed of a bill slows markedly for some reason during transport, or where it ceases to move at all.

[0047] In the preceding embodiment, if transport delay of a leading bill is detected, the CPU 210 will carry out control in such a way as to reverse the rotation of the paper currency transport devices so that the following bill will be conveyed in the reverse direction. However, it would also be possible, for example, to slow down the rotation speed of the paper currency transport devices so that the transport speed of the following bill becomes slower than the transport speed of the leading bill.

[0048] In the preceding description, there was no particular discussion of the spacing between currency bills as they are fed, but the CPU 210 may wait until a fed bill has reached the initial sensor 501 before feeding the next bill. This can prevent jamming caused by overlap of bills before reaching the initial sensor 501. The CPU 210 may also feed and control the transport of bills in such a way that two or more bills will never be present between neighboring sensors. This can prevent jamming caused by overlapping bills.

[0049] In the embodiment, sensors are positioned midway along the paper currency transport devices, but the sensors could instead be positioned between two neighboring paper currency transport devices. Since currency bill transport speed can be changed in before or after sensors, jamming caused by overlapping bills can be prevented.

[0050] With regard to sensors, the embodiment and the Modification Example described three sensors positioned between the paper currency accepting/dispensing unit 250 and the paper currency discriminating unit 260; however, it would be possible for example to position multiple sensors on other paper currency transport paths, such as that between the paper currency discriminating unit 260 to the paper currency escrow repository 270, that between the paper currency escrow repository 270 and the paper currency accepting/dispensing unit 250, or that between the paper currency escrow repository 270 and the paper currency recovery repository 276 or the recycling repositories 278.

[0051] In the embodiment, a leading bill transported at slow speed will continue be transported forward, but it would be possible for the leading bill to be returned to the feed source as well. When returning bills to the feed source, return may take place at a slower transport speed than normal.

[0052] While the invention has been shown herein based on certain preferred embodiments, the embodiments of the invention set forth herein are intended to facilitate understanding of the invention and should not be construed as limiting of the invention in any way. The intention is to cover all modifications and improvements falling within the spirit and scope of the invention as defined by the appended claims.

Claims

1. A paper sheet storage device comprising:

a paper sheet transport unit having a transport path for paper sheets;
a paper sheet feeder for feeding paper sheets onto the transport path;
a sensor, disposed on the transport path, for detecting passage of a paper sheet;
a transport speed acquiring unit for acquiring the transport speed of the paper sheet based on detection by the sensor; and
a controller for controlling the paper sheet transport unit and the paper sheet feeder,

wherein in the event that the acquired transport speed of a paper sheet is slower than a prescribed speed, the controller causes the paper sheet feeder to halt the feeding of paper sheets, and operates in reverse a portion of the paper sheet transport unit that is situated closer to the paper sheet feeder than the slow moving paper sheet.

2. The paper sheet storage device according to claim 1, wherein

the device includes a plurality of the sensors including first and second sensors that are disposed adjacently with each other; and
the transport speed acquiring unit acquires the speed of motion of a paper sheet based on a gap between first and second sensors, and a difference between a point in time that the paper sheet passes the first sensor and another point in time that the paper sheet passes the second sensor.

3. The paper sheet storage device according to claim 1,

the device including the plurality of the sensors including first and second sensors that are disposed adjacently with each other and further comprising:

an arrival time predicting unit for predicting, from a point in time that the paper sheet passes the first sensor, arrival time of the

paper sheet at the second sensor;

wherein in the event that the paper sheet fails to arrive at the second sensor within a predetermined time interval starting from the predicted arrival time, the controller causes the paper sheet feeder to halt the feed of paper sheets, and operates in reverse a portion of the paper sheet transport unit, that is situated closer to the paper sheet feeder than the first sensor.

4. A method of controlling a paper sheet accepting device comprising the steps of:

feeding paper sheets from a paper sheet feeder;
using a paper sheet transport unit to transport paper sheets;
using a sensor to detect passage of a paper sheet;
determining the transport speed of the paper sheet from the paper sheet passage time; and
in the event that the transport speed of a paper sheet is slower than a prescribed transport speed, halting the feed of paper sheets from the paper sheet feeder, and then reverse-feeding the following paper sheets to return to the paper sheet feeder.

5. A computer program, stored on a computer readable medium, for controlling a paper sheet accepting device wherein the program accomplishes the functions of:

feeding paper sheets;
transporting paper sheets;
detecting passage of a paper sheet;
determining the transport speed of the paper sheet from the passage time of the paper sheet; and
in the event that the determined transport speed of a paper sheet is slower than a prescribed transport speed, halting the feed of paper sheets by the paper sheet feeder, and then reverse-feeding the following paper sheets by the paper sheet transport unit to return to the paper sheet feeder.

Fig.1

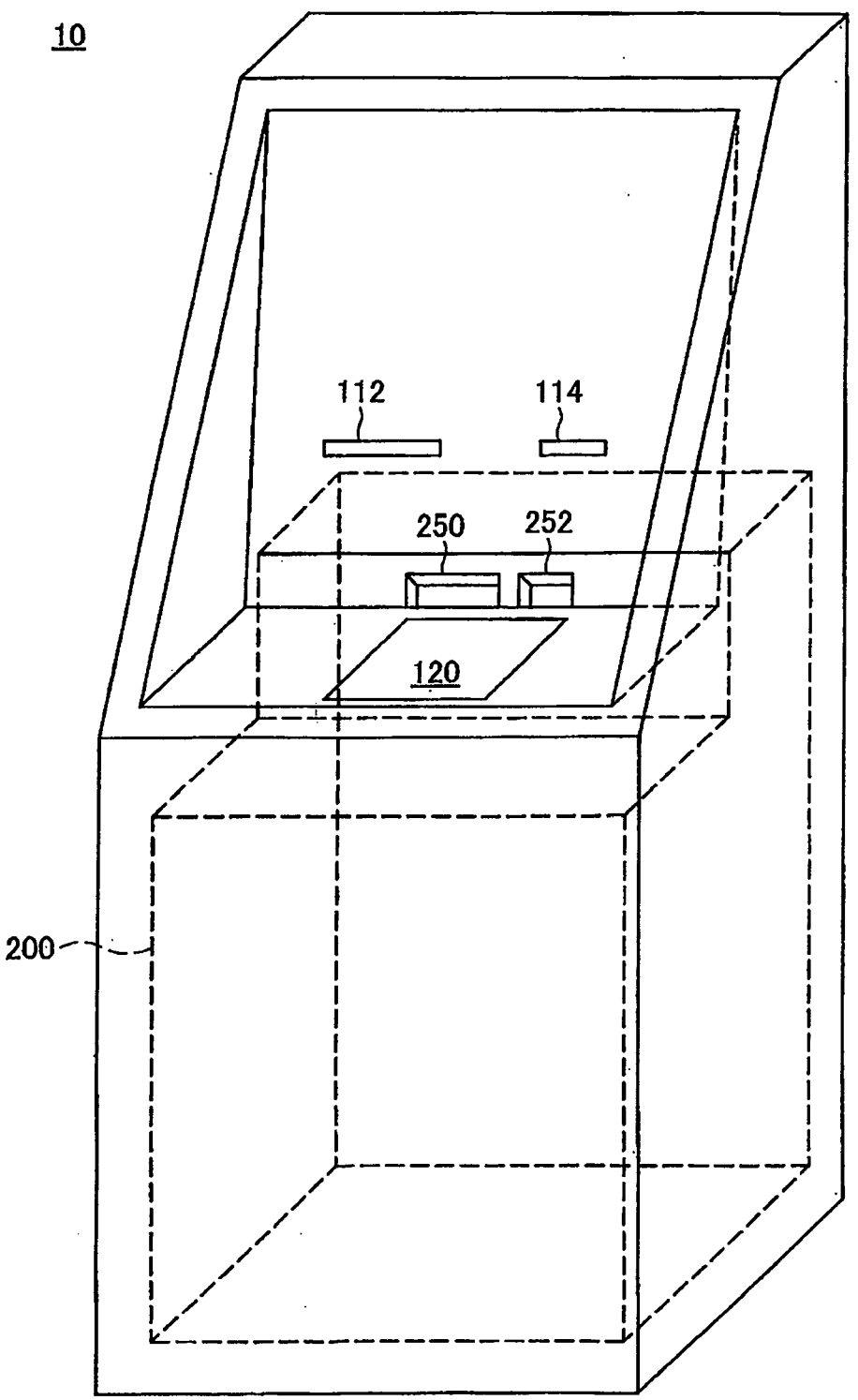


Fig.2

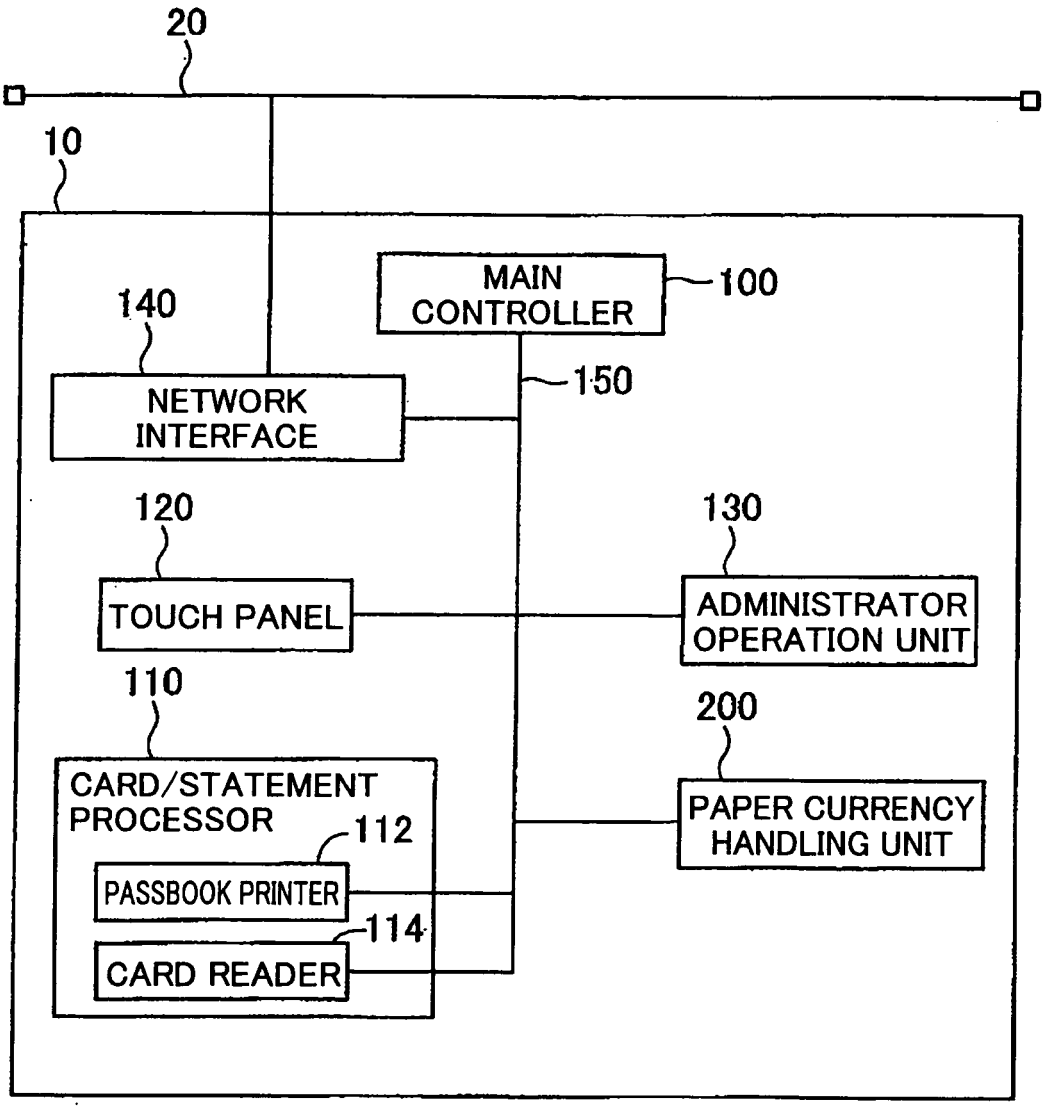

20
10
MAIN CONTROLLER
100
140
150
NETWORK INTERFACE
120
130
TOUCH PANEL
ADMINISTRATOR OPERATION UNIT
110
200
CARD/STATEMENT PROCESSOR
112
PAPER CURRENCY HANDLING UNIT
PASSBOOK PRINTER
114
CARD READER

Fig.3

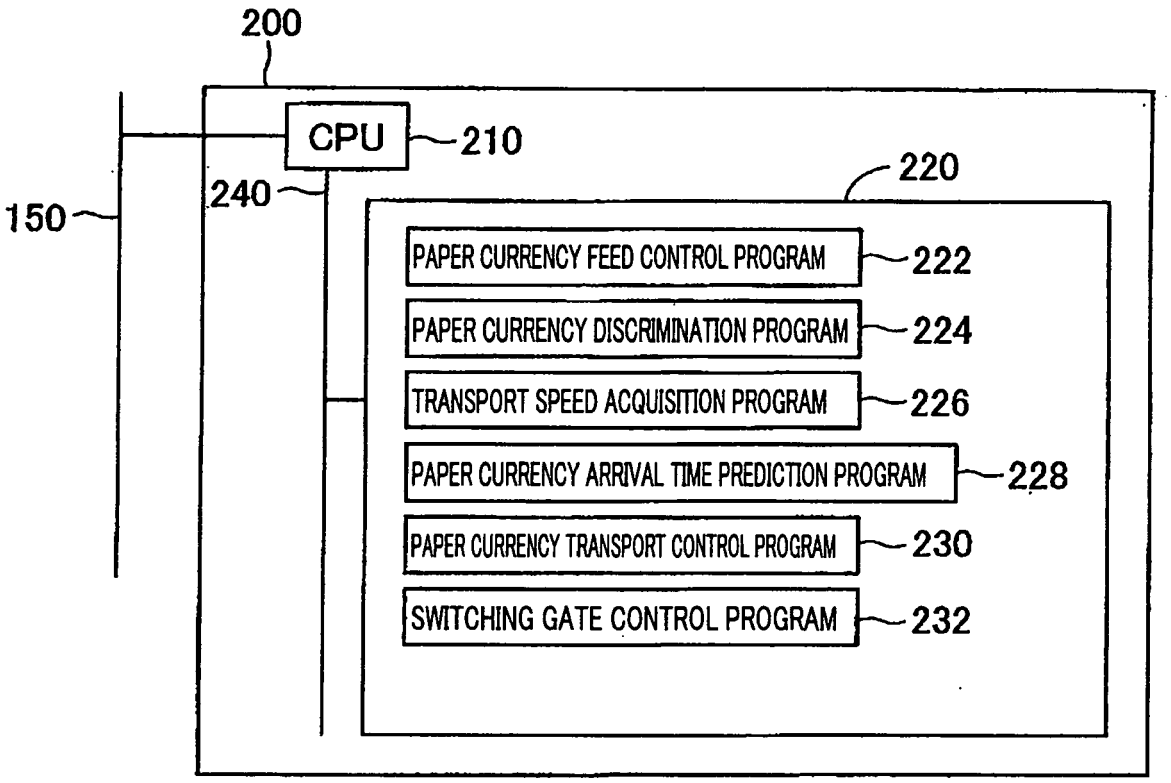

200
CPU
210
240
150
220
PAPER CURRENCY FEED CONTROL PROGRAM
222
PAPER CURRENCY DISCRIMINATION PROGRAM
224
TRANSPORT SPEED ACQUISITION PROGRAM
226
PAPER CURRENCY ARRIVAL TIME PREDICTION PROGRAM
228
PAPER CURRENCY TRANSPORT CONTROL PROGRAM
230
SWITCHING GATE CONTROL PROGRAM
232

Fig.4

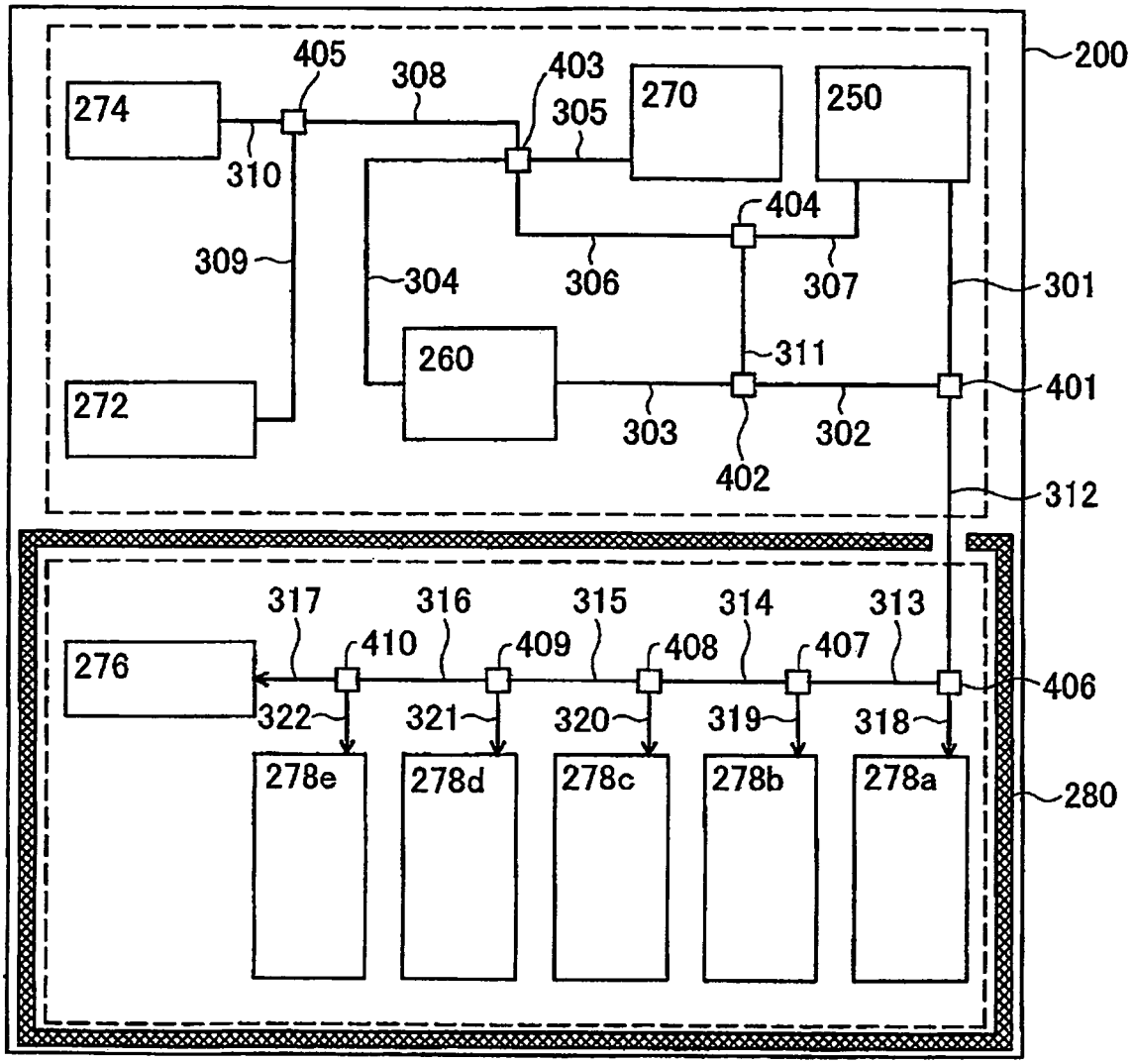

200
405
308
403
274
305
270
250
310
404
309
304
306
307
301
260
311
272
401
303
302
402
312
317
316
315
314
313
276
410
409
408
407
406
322
321
320
319
318
278e
278d
278c
278b
278a
280

Fig.5

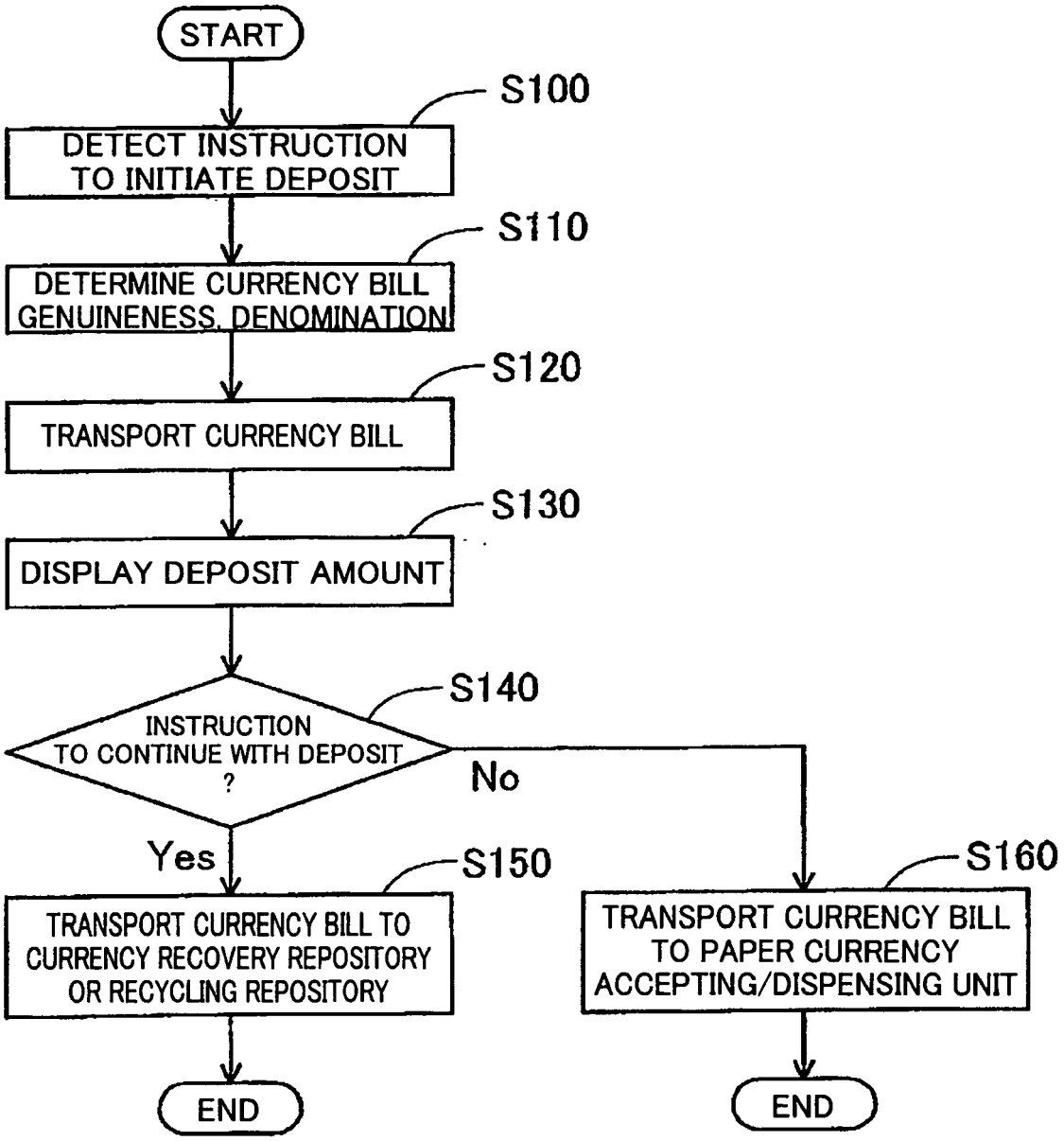

START
S100
DETECT INSTRUCTION TO INITIATE DEPOSIT
S110
DETERMINE CURRENCY BILL GENUINENESS, DENOMINATION
S120
TRANSPORT CURRENCY BILL
S130
DISPLAY DEPOSIT AMOUNT
S140
INSTRUCTION TO CONTINUE WITH DEPOSIT ?
No
Yes
S150
TRANSPORT CURRENCY BILL TO CURRENCY RECOVERY REPOSITORY OR RECYCLING REPOSITORY
END
S160
TRANSPORT CURRENCY BILL TO PAPER CURRENCY ACCEPTING/DISPENSING UNIT
END

Fig.6

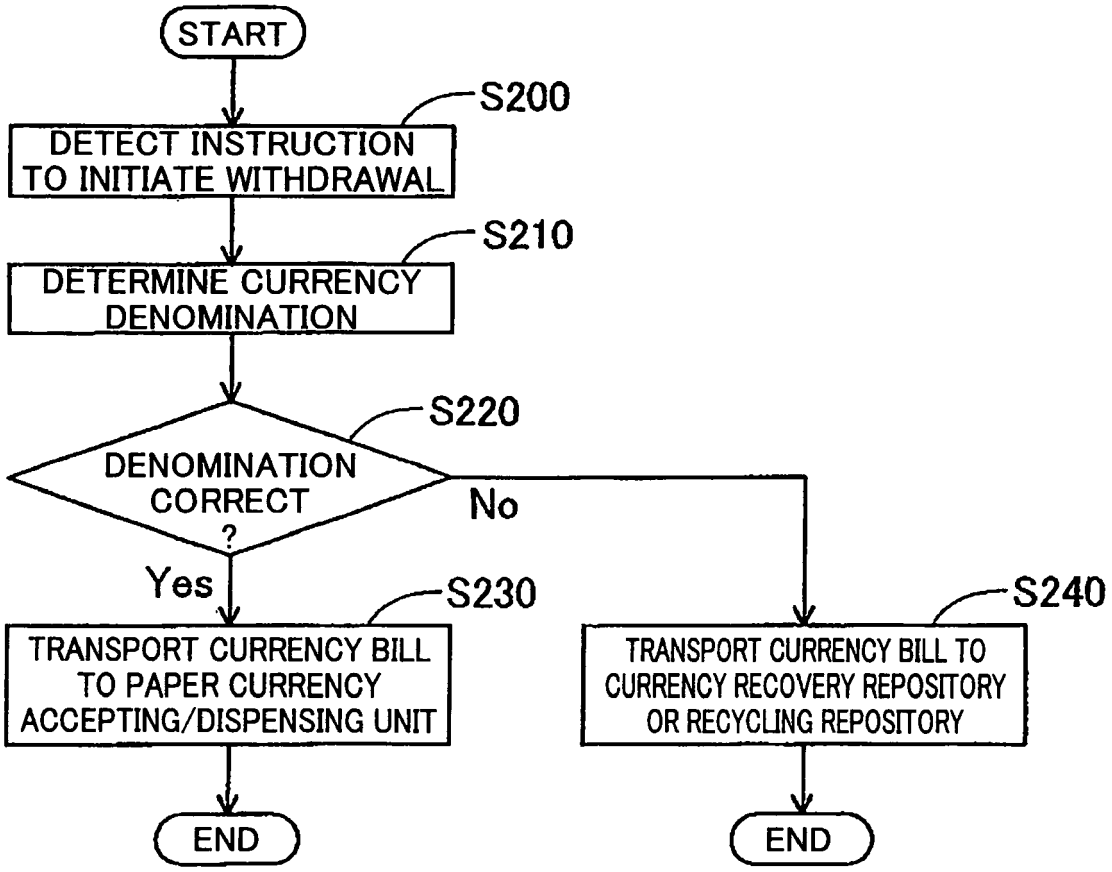

START
S200
DETECT INSTRUCTION TO INITIATE WITHDRAWAL
S210
DETERMINE CURRENCY DENOMINATION
S220
DENOMINATION CORRECT ?
No
Yes
S230
TRANSPORT CURRENCY BILL TO PAPER CURRENCY ACCEPTING/DISPENSING UNIT
S240
TRANSPORT CURRENCY BILL TO CURRENCY RECOVERY REPOSITORY OR RECYCLING REPOSITORY
END
END

Fig.7

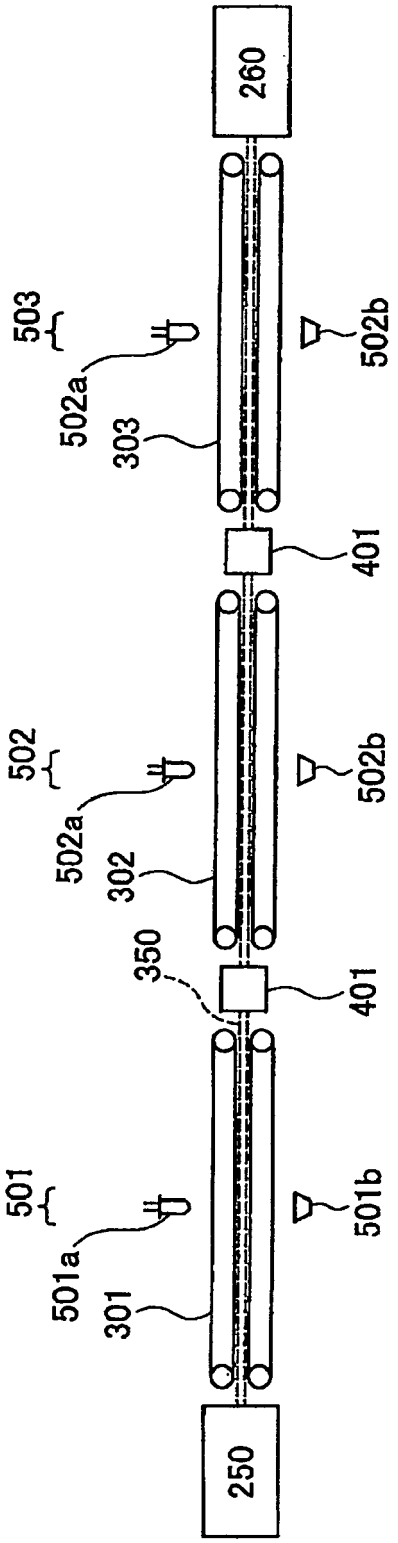

260
503
502a
303
502b
401
502
502a
302
502b
350
401
501
501a
301
501b
250

Fig.8

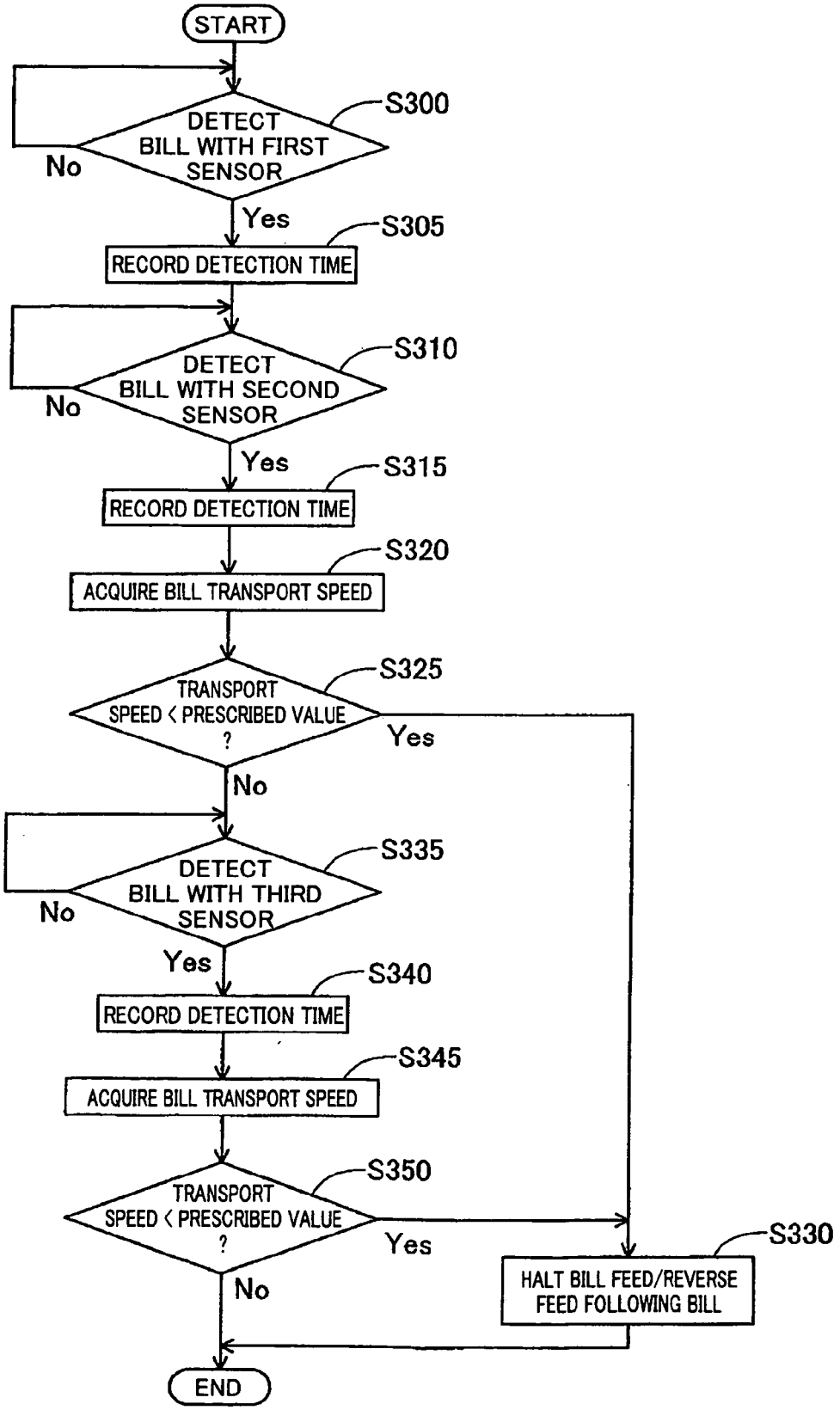
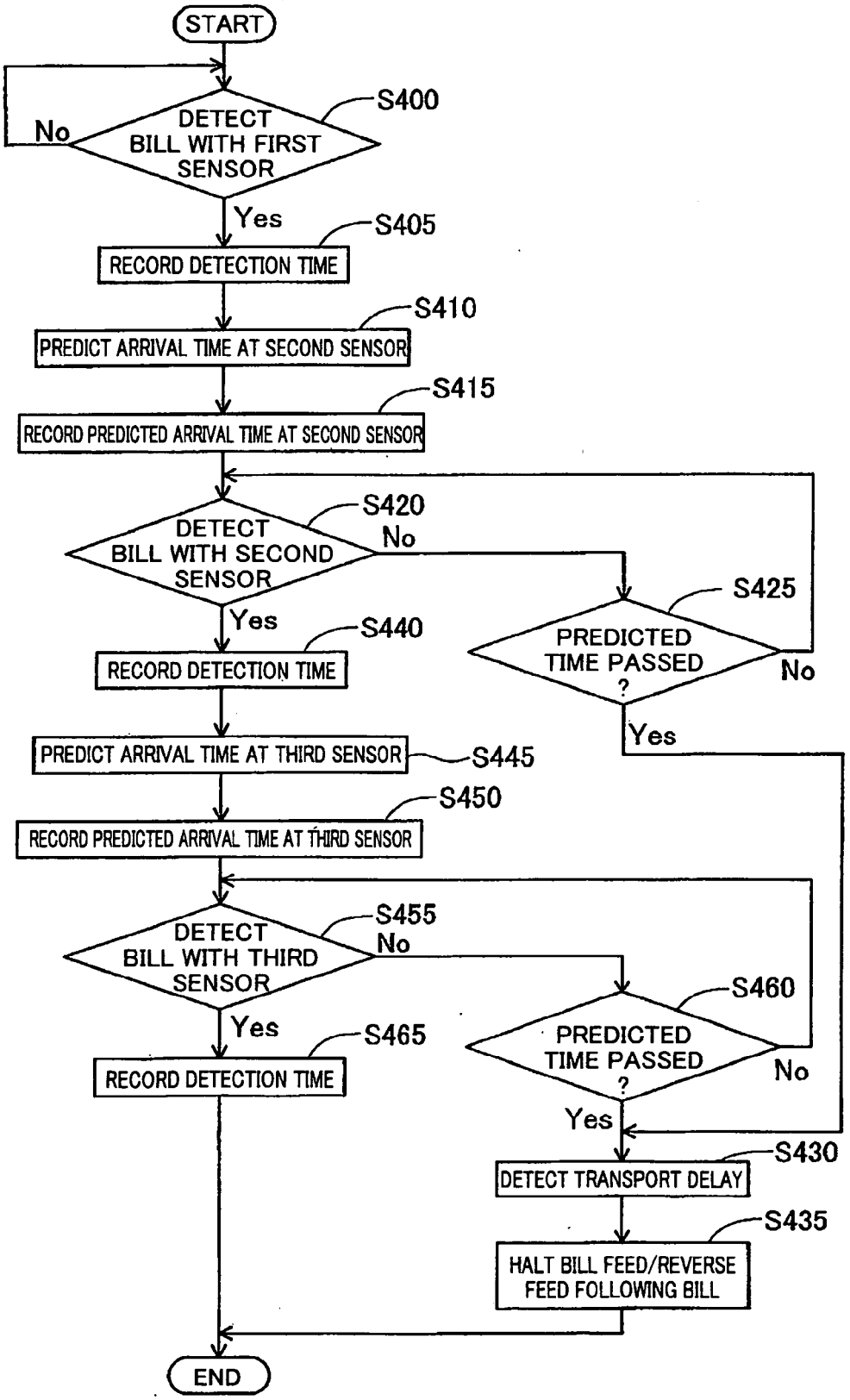

START
DETECT BILL WITH FIRST SENSOR
S300
No
Yes
RECORD DETECTION TIME
S305
DETECT BILL WITH SECOND SENSOR
S310
No
Yes
RECORD DETECTION TIME
S315
ACQUIRE BILL TRANSPORT SPEED
S320
TRANSPORT SPEED < PRESCRIBED VALUE ?
S325
Yes
No
DETECT BILL WITH THIRD SENSOR
S335
No
Yes
RECORD DETECTION TIME
S340
ACQUIRE BILL TRANSPORT SPEED
S345
TRANSPORT SPEED < PRESCRIBED VALUE ?
S350
Yes
No
HALT BILL FEED/REVERSE FEED FOLLOWING BILL
S330
END

Fig.9


START
S400
DETECT BILL WITH FIRST SENSOR
No
Yes
S405
RECORD DETECTION TIME
S410
PREDICT ARRIVAL TIME AT SECOND SENSOR
S415
RECORD PREDICTED ARRIVAL TIME AT SECOND SENSOR
S420
DETECT BILL WITH SECOND SENSOR
No
Yes
S425
PREDICTED TIME PASSED ?
No
Yes
S440
RECORD DETECTION TIME
PREDICT ARRIVAL TIME AT THIRD SENSOR
S445
S450
RECORD PREDICTED ARRIVAL TIME AT THIRD SENSOR
S455
DETECT BILL WITH THIRD SENSOR
No
Yes
S460
PREDICTED TIME PASSED ?
No
Yes
S465
RECORD DETECTION TIME
S430
DETECT TRANSPORT DELAY
S435
HALT BILL FEED/REVERSE FEED FOLLOWING BILL
END