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

(11) EP 2 251 288 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.11.2010 Bulletin 2010/46

(51) Int Cl.:
B65H 7/20 *(2006.01)*

(21) Application number: **10250911.4**

(22) Date of filing: **12.05.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

(30) Priority: **13.05.2009 JP 2009116037**

(71) Applicant: **Hitachi-Omron Terminal Solutions, Corp.**
Shinagawa-ku
Tokyo
141-8576 (JP)

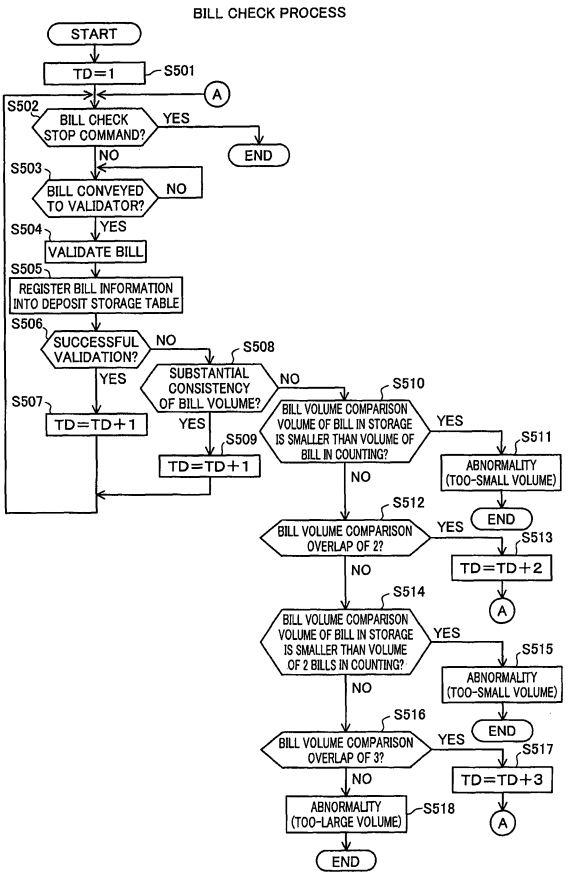
(72) Inventors:
- **Tanaka, Shuji**
  Tokyo 100-8220 (JP)
- **Uozumi, Atsuko**
  Tokyo 100-8220 (JP)
- **Kato, Riichi**
  Tokyo 100-8220 (JP)

(74) Representative: **Calderbank, Thomas Roger et al**
Mewburn Ellis LLP
33 Gutter Lane
London
EC2V 8AS (GB)

(54) Paper sheet handling apparatus

(57) The paper sheet handling apparatus includes: a validator configured to validate each of paper sheets; a conveyor assembly arranged to convey the paper sheets in the paper sheet handling apparatus; a controller configured to control components of the paper sheet handling apparatus; and a storage unit arranged to store information on the paper sheets, wherein the controller controls the validator to determine a volume of each of the paper sheets passing through the validator in a first conveyance and store volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance into the storage unit, wherein the first conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator first time, and the controller controls the validator to determine a volume of a certain paper sheet passing through the validator in a second conveyance and comparing volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator second time.

Fig.13



EP 2 251 288 A2

Description

[0001] The present invention relates to a paper sheet handling apparatus.

[0002] A paper sheet handling apparatus mounted on a cash machine, such as an automated teller machine (ATM) counts the number of bills received via a cash slot (deposit counting process), stores the received bills in a temporary cabinet to determine the number of the received bills, counts the number of bills stored in the temporary cabinet (deposit storage process), and stores the bills into cash cartridges.

[0003] In the cash machine, the consistency of the number of bills in the deposit counting process with the number of bills in the deposit storage process is verified for the strict cash management. When any bill has failed identification of its denomination in the deposit storage process, however, there is a difficulty in accurately verifying the consistency of the number of bills. This disadvantage is not characteristic of the deposit storage process but is commonly found in general paper sheet counting process in various paper sheet handing apparatuses.

[0004] There would thus be a demand for enhancing the reliability of paper sheet counting process.

[0005] In order to solve at least part of the disadvantage discussed above, the present invention is accomplished by any of various aspects and applications discussed below.

[0006] According to one aspect, a paper sheet handling apparatus is provided. The paper sheet handling apparatus comprises: a validator configured to validate each of paper sheets; a conveyor assembly arranged to convey the paper sheets in the paper sheet handling apparatus; a controller configured to control components of the paper sheet handling apparatus; and a storage unit arranged to store information on the paper sheets, wherein the controller controls the validator to determine a volume of each of the paper sheets passing through the validator in a first conveyance and store volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance into the storage unit, wherein the first conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator first time, and the controller controls the validator to determine a volume of a certain paper sheet passing through the validator in a second conveyance and comparing volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator second time.

[0007] According to this configuration, the paper sheet handling apparatus according to the first aspect of the invention compares the volume data of a certain paper sheet in the second conveyance with the volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify the consistency of the number of paper sheets conveyed in the first conveyance with the number of paper sheets conveyed in the second conveyance. This arrangement effectively enhances the reliability of the paper sheet counting process.

[0008] According to another aspect, the paper sheet handling apparatus wherein a paper sheet to be conveyed after the corresponding paper sheet in the second conveyance is specified as a next paper sheet, when the volume data of the certain paper sheet in the second conveyance is greater than the volume data of the corresponding paper sheet in the first conveyance with consideration of a potential error, the controller comparing the volume data of the certain paper sheet in the second conveyance with a sum of the volume data of the corresponding paper sheet in the first conveyance and volume data of the next paper sheet in the first conveyance, when the volume data of the certain paper sheet in the second conveyance is within a predetermined range, the controller determining an overlap of two paper sheets in the second conveyance.

[0009] According to this configuration, when the volume data of the certain paper sheet in the second conveyance is greater than the volume data of the corresponding paper sheet in the first conveyance with consideration of a potential error, the paper sheet handling apparatus of this application compares the volume data of the certain paper sheet in the second conveyance with the sum of the volume data of the corresponding paper sheet in the first conveyance and volume data of the next paper sheet in the first conveyance. When the volume data of the certain paper sheet in the second conveyance is within the predetermined range, the paper sheet handling apparatus determines an overlap of two paper sheets in the second conveyance. The paper sheet handling apparatus of this application is allowed to accurately count the number of paper sheets even in the event of an overlap of two paper sheets in the second conveyance. This arrangement further enhances the reliability of the paper sheet counting process.

[0010] According to another aspect, a paper sheet handling method, comprises the steps of: (a) conveying paper sheets; (b) validating each of the paper sheets; and (c) storing information on the paper sheets, wherein the step (b) in a first conveyance determines a volume of each of the paper sheets in the first conveyance and the step (c) stores volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance, wherein the first conveyance represents that the step (b) is performed first time during the step (a), and the step (b) in a second conveyance determines a volume of a certain paper sheet in the second conveyance and compares volume data of the certain paper

sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the step (b) is performed second time during the step (a).

[0011] According to another aspect, a computer program product for a paper sheet handling apparatus, comprising a computer readable storage medium having computer readable program embodied in the medium, the computer readable program comprises: a first program code for causing a computer to convey paper sheets; a second program code for causing the computer to validate each of the paper sheets; and a third program code for causing the computer to store information on the paper sheets, wherein the second program code in a first conveyance determines a volume of each of the paper sheets in the first conveyance and the third program code stores volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance, wherein the first conveyance represents that the second program code is performed first time during activation of the first program code, and the second program code in a second conveyance determines a volume of a certain paper sheet in the second conveyance and compares volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the second program code is performed second time during activation of the first program code.

[0012] The technique of the invention is not restricted to the paper sheet handling apparatus described above but may be actualized by diversity of other applications, for example, an automated teller machine with the paper sheet handling apparatus mounted thereon, a system utilizing the paper sheet handling apparatus, a paper sheet handling method, as well as computer programs configured to attain the functionalities of the paper sheet handling apparatus and the functional steps of the paper sheet handling method and recording media with such computer programs recorded therein.

In the drawings

Fig. 1 is a diagrammatic representation of the appearance of an automated teller machine with a paper sheet handling apparatus incorporated therein in one embodiment according to the invention;
Fig. 2 is a block diagram showing the internal structure of the ATM;
Fig. 3 is a diagrammatic representation of the general structure of the cash handling mechanism;
Fig. 4 is a block diagram showing the internal structure of the cash handling mechanism;
Fig. 5 is a diagrammatic representation of the structure of thickness detection sensors provided on the bill validator;
Figs. 6A through 6D are diagrammatic representations of a first example of bill volume calculation;
Figs. 7A through 7D are diagrammatic representations of a second example of bill volume calculation;
Figs. 8A through 8D are diagrammatic representations of a third example of bill volume calculation;
Figs. 9A through 9D are diagrammatic representations of a fourth example of bill volume calculation;
Figs. 10A through 10D are diagrammatic representations of a fifth example of bill volume calculation;
Fig. 11 is a diagrammatic representation of one example of a deposit count table;
Fig. 12 is a diagrammatic representation of one example of a deposit storage table;
Fig. 13 is a flowchart showing the details of a bill check process performed in the deposit storage process (step S403 in Fig. 19);
Fig. 14 is a diagrammatic representation of volume comparison performed in the bill check process;
Figs. 15A and 15B are diagrammatic representations of examples of the deposit storage table with registry of bill information;
Fig. 16 is a flowchart showing a deposit process in the ATM;
Fig. 17 is a flowchart showing the details of the deposit counting process;
Fig. 18 is a flowchart showing the details of the bill validation process of step S203 in the deposit counting process; and
Fig. 19 is a flowchart showing the details of the deposit storage process.

[0013] Some modes of carrying out the invention are described below in the following sequence with reference to the accompanied drawings.

A. Embodiment

(A-1) Structure of Automated Teller Machine

[0014] Fig. 1 is a diagrammatic representation of the appearance of an automated teller machine 1 with a paper sheet handling apparatus incorporated therein in one embodiment according to the invention. The automated teller machine 1 (hereafter abbreviated as 'ATM') has a card slot 101, a touch panel 201, and a cash slot 301 provided in a front face

thereof. The card slot 101 is structured as an insertion-ejection opening to receive any of various cards, such as a credit card or a cash card, inserted therein and eject the inserted card therefrom. The touch panel 201 is provided as part of a user operation unit to display an operation guide window for a user and to receive the user's input operation or instruction. The cash slot 301 is structured as an insertion-discharge opening to receive paper sheets (for example, 'bills' in the description below) inserted by the user and provide bills to the user. The ATM 1 has a vault casing 3 and a cash handling mechanism 300 placed inside an overall housing 2 structured to cover over the whole system of the ATM 1. The vault casing 3 is made of, for example, an iron plate of several tens millimeters in thickness and is structured to have the higher toughness and strength than the overall housing 2 and to have the high resistance against illegal accesses, for example, an attack for destroying the wall structure. The cash handling mechanism 300 will be described later in detail.

[0015] Fig. 2 is a block diagram showing the internal structure of the ATM 1. The ATM 1 has a card/receipt processing mechanism 100, a customer operation unit 200, the cash handling mechanism 300, an interface module 400, an operator operation unit 500, a main controller 600, an external storage unit 700, and a power supply unit 800.

[0016] The card/receipt processing mechanism 100 includes the card slot 101 and is provided to process the user's card inserted through the card slot 101 and to print a relevant transaction receipt. The customer operation unit 200 includes the touch panel 201 and is provided to receive and accept a user's operation or instruction and to transmit the user's operation or instruction to the main controller 600. The cash handling mechanism 300 includes the cash slot 301 and is provided to count the bills received or the bills to be dispensed and to actually receive and dispense the bills. The interface module 400 is provided to establish communication with a host computer (not shown). The operator operation unit 500 is provided to receive and accept an operator's (for example, a bank clerk's) operation or instruction and to transmit the operator's operation or instruction to the main controller 600. The external storage unit 700 is provided as a data recording device, such as a hard disk, a flash memory, or an optical disk. The main controller 600 is connected with the respective components 100 through 700 via a bus to control the operations of the respective components 100 through 700. The power supply unit 800 is provided to supply power to the respective components of the ATM 1.

[0017] Fig. 3 is a diagrammatic representation of the general structure of the cash handling mechanism 300. The cash handling mechanism 300 includes a cash opening 320, a bill validator 330, a temporary cabinet 340, a left-bill collection cabinet 360, a reject cartridge 370, five recycle cartridges 380, and a conveyor assembly 350 provided for interconnection of the respective components. The reject cartridge 370 and the five recycle cartridges 380 are placed in the vault casing 3. The conveyor assembly 350 includes a conveyor path 350a located outside (topside in the drawing) of the vault casing 3 and a conveyor path 350b located inside (underside in the drawing) of the vault casing 3. In the description hereafter, the conveyor path 350a and the conveyor path 350b are respectively referred to as 'upstream conveyor path' and 'downstream conveyor path'.

[0018] The cash opening 320 is provided to store the bills immediately after insertion into the cash slot 301 and the bills to be dispensed via the cash slot 301. The temporary cabinet 340 is provided to temporarily store the bills received by the cash opening 320 and the bills to be dispensed from the cash opening 320 before completion of the user's specified transaction. The bill validator 330 is provided to validate the bills as described later in detail and is equivalent to the validator in the claims of the invention. The left-bill collection cabinet 360 is provided to collect the bills left behind in the cash slot 301 by the user at the time of a cash deposit transaction or a cash withdrawal transaction. The recycle cartridges 380 are provided as storage cabinets to store the bills suitable for cash withdrawal. The structure of this embodiment has the five recycle cartridges 380. This number is, however, not restrictive in any sense, and any number (at least one) of recycle cartridges 380 may be used according to the requirements. The reject cartridge 370 is provided as a storage cabinet to store the bills unsuitable for cash withdrawal. The bills unsuitable for cash withdrawal include, for example, heavily damaged or stained legitimate bills and counterfeit bills. The conveyor assembly 350 is provided to convey the bills between the respective cabinets and cartridges. The conveyed bills move in the directions of the arrows, and the conveyor paths are switched over according to the requirements.

[0019] A deposit counting process represents a cash counting operation performed in response to the user's insertion of bills. The deposit counting process individually separates the bills inserted into the cash slot 301 (Fig. 1) and activates the conveyor assembly 350 to convey the individually separated bills into the bill validator 330. The bill validator 330 identifies the denomination of each bill, checks for the authenticity of each bill, and calculates the volume of each bill. Bills determined as acceptable are conveyed to the temporary cabinet 340 by means of the conveyor assembly 350. Bills determined as unacceptable are, on the other hand, conveyed to the cash opening 320 to be returned to the user. The bills determined as unacceptable include, for example, bills unidentifiable as true banknotes and bills detected to have abnormal levels of inclination or abnormal intervals from adjacent bills. In this embodiment, the conveyance of the bills inserted into the cash slot 301 from the cash opening 320 through the bill validator 330 to the temporary cabinet 340 is defined as 'first conveyance'.

[0020] A deposit storage process represents another cash counting operation performed in response to the user's entry representing the user's confirmation of the result of the deposit counting process. The deposit storage process individually separates the bills stored in the temporary cabinet 340 and activates the conveyor assembly 350 to convey

the individually separated bills into the bill validator 330. The bill validator 330 performs the identification of the bill denomination and the calculation of the bill volume in the same manner as the deposit counting process and determines whether each bill is suitable or unsuitable for cash withdrawal or recirculation. Bills determined as suitable for cash withdrawal are conveyed to the recycle cartridges 380 set corresponding to the respective denominations by means of the conveyor assembly 350. Bills determined as unsuitable for cash withdrawal are conveyed to the reject cartridge 370 by means of the conveyor assembly 350. The bills determined as unsuitable include, for example, heavily damaged or stained bills. In this embodiment, the conveyance of the bills stored in the temporary cabinet 340 from the temporary cabinet 340 through the bill validator 330 to either the reject cartridge 370 or one of the recycle cartridges 380 is defined as 'second conveyance'.

[0021] Fig. 4 is a block diagram showing the internal structure of the cash handling mechanism 300. The cash handling mechanism 300 has a cash handling controller 310 and a storage unit 315, in addition to the components 320 through 380 described above with reference to Fig. 3. The cash handling controller 310 is equivalent to the controller in the claims of the invention and controls the respective components 320 through 380 described above with reference to Fig. 3. The cash handling controller 310 is connected with the main controller 600 via the bus. The storage unit 315 is used to store information on the bills identified and determined by the bill validator 330 as described below in detail.

[0022] Fig. 5 is a diagrammatic representation of the structure of thickness detection sensors provided on the bill validator 330. The bill validator 330 has three thickness detection sensors 20R, 20C, and 20L arranged in a direction perpendicular to a bill conveyance direction. The thickness detection sensor 20R includes a magnetic sensor 23, an upper roller 21, a lower roller 22, an upper shaft 25, and a lower shaft 26.

[0023] The upper roller 21 has a metal pipe 21a and a rubber member 21b. The metal pipe 21a is a hollow cylindrical metal member. The upper roller 21 is structure to have the elastic rubber member 21b placed between the metal pipe 21a and the upper shaft 25. The lower roller 22 is a cylindrical metal member and is fastened to the lower shaft 26. The upper shaft 25 and the lower shaft 26 are set in a freely rotatable manner. At least one of the upper shaft 25 and the lower shaft 26 is rotated by a motor (not shown). The upper roller 21 is arranged to press against the lower roller 22 by application of an adequate pressure. The magnetic sensor 23 outputs a voltage corresponding to a distance from the surface of the metal pipe 21a of the upper roller 21. A sensor designed to have an increase in output voltage with a decrease in distance from the metal pipe 21a is used for the magnetic sensor 23 in the embodiment.

[0024] In the thickness detection sensor 20R of this structure, as a bill is conveyed between the upper roller 21 and the lower roller 22, the upper roller 21 is displaced in a vertical direction by the thickness of the bill. The magnetic sensor 23 is capable of measuring the thickness of a bill, based on the voltage output corresponding to the distance from the surface of the metal pipe 21a of the upper roller 21. The other thickness detection sensors 20C and 20L have substantially the same structure as that of the thickness detection sensor 20R described above. The thickness detection sensor 20C measures the thickness of a center area of a bill, while the thickness detection sensors 20R and 20L measure the thicknesses of both ends of the bill. These sensors 20R, 20C, and 20L are allowed to independently measure the thickness of each bill.

(A-2) Bill Volume Calculation

[0025] Figs. 6A through 6D are diagrammatic representations of a first example of bill volume calculation. Fig. 6A shows a bill conveyance pattern in the first example. In the first example, a bill BL is conveyed in a normal state without any inclination, overlap, or fold. A built-in controller (not shown) of the bill validator 330 first activates an imaging device 10 to take an image of the bill BL and processes the image to determine the area of the bill BL. As shown in Fig. 6A, it is preferable to determine three divisional areas SR, SC, and SL corresponding to the three thickness detection sensors 20R, 20C, and 20L. Such divisional area determination desirably increases the accuracy of volume calculation of the bill BL. The controller scans the image pattern of the bill BL to identify the denomination of the bill BL and check for the authenticity of the bill BL.

[0026] Figs. 6B, 6C, and 6D show waveforms of the respective output voltages of the thickness detection sensors 20R, 20C, and 20L. The bill BL is conveyed in the normal state in the first example. The output voltages of the three thickness detection sensors 20R, 20C, and 20L accordingly have substantially identical detection start timings TR1, TC1, and TL1 and substantially identical detection end timings TR2, TC2, and TL2. The three thickness detection sensors 20R, 20C, and 20L also give substantially identical output voltage values VR, VC, and VL. The controller determines the thicknesses at three different positions of the bill BL, based on these three output voltage values. A concrete procedure determines a thickness d1 of the divisional area SR of the bill BL based on the output voltage value shown in Fig. 6B, determines a thickness d2 of the divisional area SC of the bill BL based on the output voltage value shown in Fig. 6C, and determines a thickness d3 of the divisional area SL of the bill BL based on the output voltage value shown in Fig. 6D. The thicknesses d1, d2, and d3 may be determined by referring to a table that has been set and stored in advance in the controller to represent a correlation of the output voltage value to the thickness.

[0027] The controller of the bill validator 330 calculates a volume E of the bill BL from the determined divisional areas

SR, SC, and SL and the determined thicknesses d1, d2, and d3 according to an equation of:

$$\text{Volume E} = (SR \times d1) + (SR \times d2) + (SL \times d3)$$

[0028] Figs. 7A through 7D are diagrammatic representations of a second example of bill volume calculation. Fig. 7A shows a bill conveyance pattern in the second example. In the second example, two bills BL1 and BL2 are conveyed in a partly overlap manner in its conveying direction CC. The controller of the bill validator 330 processes an image taken with the imaging device 10 to determine divisional areas SR, SC, and SL in the same manner as the first example discussed above.

[0029] In the second example, the output voltages of the three thickness detection sensors 20 have substantially identical detection start timings and substantially identical detection end timings. The bills BL1 and BL2 are partly overlapped, so that overlap portions of the two bills BL1 and BL2 have higher output voltage values (Figs. 7B through 7D). Since the output voltage values of the respective thickness detection sensors 20 are not constant but are varied, the controller calculates average output voltage values before determining the thicknesses of the bill BL. The average output voltage value is calculated, for example, according to an equation of:

$$\text{Average Output Voltage Value} = \text{Area Defined by Output Waveform (Hatched Area)} / \text{Length between TR1 and TR2}$$

[0030] The controller determines the thicknesses d1, d2, and d3 at the three different positions of the bill BL based on the calculated average output voltage values. The controller then calculates the volume E of the bill BL from the divisional areas SR, SC, and SL and the thicknesses d1, d2, and d3 according to the equation given above in the first example.

[0031] Figs. 8A through 8D are diagrammatic representations of a third example of bill volume calculation. Fig. 8A shows a bill conveyance pattern in the third example. In the third example, a bill BL is conveyed in a state with dog ears at four corners. The controller similarly determines the three divisional areas SR, SC, and SL of the bill BL and the thicknesses d1, d2, and d3 at the three different positions of the bill BL and calculates the volume E. In this third example, the thickness d2 is determined according to the method of the first example, whereas the thicknesses d1 and d3 are determined according to the method of the second example.

[0032] Figs. 9A through 9D are diagrammatic representations of a fourth example of bill volume calculation. Fig. 9A shows a bill conveyance pattern in the fourth example. In the fourth example, a bill BL is conveyed in a state with folds on both edges. The controller similarly determines the three divisional areas SR, SC, and SL of the bill BL and the thicknesses d1, d2, and d3 at the three different positions of the bill BL and calculates the volume E. In this fourth example, the thickness d2 is determined according to the method of the first example, whereas the thicknesses d1 and d3 are determined according to the method of the second example.

[0033] Figs. 10A through 10D are diagrammatic representations of a fifth example of bill volume calculation. Fig. 10A shows a bill conveyance pattern in the fifth example. In the fifth example, a bill BL is conveyed in a state of inclination relative to its conveying direction CC. The controller of the bill validator 330 processes an image taken with the imaging device 10 to determine divisional areas SR, SC, and SL in the same manner as the first example discussed above.

[0034] In the fifth example, the bill BL is conveyed in an inclined orientation. The output voltages of the three thickness detection sensors 20 accordingly have different detection start timings and different detection end timings. The bill BL has no dog ear or fold, so that the output voltage values of the respective thickness detection sensors 20 are substantially constant (Figs. 10B through 10D). In the fifth example, an interval L' between the detection start timing TR1 and the detection end timing TR2 of the output voltage is wider than a corresponding interval L in a straight orientation of the first example. The wider interval is ascribed to the inclined orientation of the bill BL. The relation of the interval L' relative to the interval L is expressed as:

$$L' = L/\cos\theta$$

[0035] The controller determines the thicknesses d1, d2, and d3 at the three different positions of the bill BL in the

same manner as the first example. The controller then calculates the volume E of the bill BL from the divisional areas SR, SC, and SL and the thicknesses d1, d2, and d3 according to the equation given above in the first example.

[0036] Fig. 11 is a diagrammatic representation of one example of a deposit count table 901. The deposit count table 901 is designed to store information on the bills obtained by the deposit counting process and is set in the storage unit 315. The deposit count table 901 includes a bill number TA, denomination data TM, circulation data TR, and volume data TV. The bill number TA is an arbitrarily settable identification number allocated to identify each bill or banknote. In this embodiment, natural numbers are used in the bill number TA field. The number in the bill number TA field is counted up by one every time a set of data is stored. This method preferably correlates information on respective bills to a bill conveying order of the respective bills. The denomination data TM represents the denominations of bills. In this embodiment, specified numbers are used in the denomination data TM field: '0', '1', '2', and '3' respectively denote 'Unidentifiable', '1000-Yen bill', '5000-Yen bill', and '10000-Yen bill'. Information representing either the suitability or the unsuitability of each bill for cash withdrawal or recirculation is stored in the circulation data TR field. The volume of each bill calculated by the method of bill volume calculation described above with reference to Figs. 6 through 10 is stored in the volume data TV field.

[0037] Fig. 12 is a diagrammatic representation of one example of a deposit storage table 902. The deposit storage table 902 is designed to store information on the bills obtained by the deposit storage process and is set in the storage unit 315. The deposit storage table 902 includes a bill number DA, denomination data DM, circulation data DR, and volume data DV. The meanings of the respective fields in the deposit storage table 902 of Fig. 12 are identical with those in the deposit count table 901 of Fig. 11.

(A-3) Bill Check Process

[0038] Fig. 13 is a flowchart showing the details of a bill check process performed in the deposit storage process (step S403 in Fig. 19). The bill check process is mainly controlled by the cash handling controller 310. The cash handling controller 310 first initializes an internal counter TD for storing the bill conveying order (step S501) and determines whether a bill check stop command is received from the main controller 600 (step S502). In the case of reception of the bill check stop command (step S502: Yes), the cash handling controller 310 immediately terminates the bill check process. In the case of non-reception of the bill check stop command (step S502: No), on the other hand, the cash handling controller 310 checks whether any bill has been conveyed to the bill validator 330 (step S503). When any bill has been conveyed to the bill validator 330 (step S503: Yes), the cash handling controller 310 controls the bill validator 330 to validate the conveyed bill (step S504). In the description hereafter, a bill NB represents a currently processed bill. The bill validator 330 identifies the denomination of the bill NB, checks for the authenticity of the bill NB, and calculates the volume of the bill NB. The volume of the bill is calculated by the method of bill volume calculation described above with reference to Figs. 6 through 10.

[0039] The cash handling controller 310 subsequently registers information on the bill NB obtained by the bill validation into the deposit storage table 902 (Fig. 12) (step S505). The count on the internal counter TD is registered into the bill number DA field. The specified number representing the denomination of the bill NB is registered into the denomination data DM field. The information representing the suitability or the unsuitability of the bill NB for cash withdrawal or recirculation is registered into the circulation data DR field. The information on the volume of the bill NB is registered into the volume data DV field. In this manner, the cash handling controller 310 controls the bill validator 330 to calculate the volume of each bill passing through the bill validator 330 in the second conveyance and store the bill volume data in correlation to the bill conveying order in the second conveyance into the deposit storage table 902 set in the storage unit 315.

[0040] In the case of successful validation of the bill NB by the bill validator 330, that is, the cases other than, for example, the case of failed detection of the bill NB as a banknote by the imaging device 10 and the case of detection of abnormal inclination of the bill NB (step S506: Yes), the cash handling controller 310 increments the count on the internal counter TD by one (step S507) and returns the processing flow to step S502.

[0041] In the case of failed validation of the bill NB by the bill validator 330 (step S506: No), on the other hand, the cash handling controller 310 determines the substantial consistency or the inconsistency of the bill volume (step S508) according to the following procedure:

Step 1-1) The procedure searches the deposit count table 901 (Fig. 11) for a volume SA1 of the bill NB in the first conveyance. Specifically the procedure extracts a record with a specific value in the bill number TA field equal to the count on the internal counter TD from the deposit count table 901 and refers to the value registered in the volume data TV field of the extracted record. The registration of the bill information into the deposit count table 901 will be described later.

Step 1-2) The procedure compares a volume SD of the bill NB calculated at step S504 with the volume SA1. It is

preferable to make the comparison by taking into account potential errors in calculation of the bill volume by the cash handling controller 310. For example, the 'substantial consistency' of the bill volume may be determined on condition that the volume SD satisfies a relation of:

$$SA1-\alpha 1 \leq SD \leq SA1+\alpha 1$$

Here $\alpha 1$ denotes an error and may be 10% of SA1. Upon determination of the 'substantial consistency' of the bill volume (step S508: Yes), the cash handling controller 310 increments the count on the internal counter TD by one (step S509) and returns the processing flow to step S502.

[0042] Upon determination of the inconsistency of the bill volume (step S508: No), on the other hand, the cash handling controller 310 determines whether the volume SD is smaller than the volume SA1 (step S510). When the volume SD is smaller than the volume SA1 (step S510: Yes), there is a possibility that part of the bill NB is broken to remain in the conveyor assembly 350. The cash handling controller 310 accordingly detects abnormality as the too-small volume (step S511) and terminates the bill check process.

[0043] When the volume SD is not smaller than the volume SA1 (step S510: No), the cash handling controller 310 determines whether the bill NB has an overlap of two bills (step S512) according to the following procedure:

Step 2-1) The procedure searches the deposit count table 901 for the volume SA1 of the bill NB and a volume SA2 of a next bill NB2 to be conveyed after the bill NB in the first conveyance. Specifically the procedure extracts the record with the specific value in the bill number TA field equal to the count on the internal counter TD and a record with another specific value in the bill number TA field equal to addition of'1' to the count on the internal counter TD from the deposit count table 901 and refers to the values registered in the volume data TV field of the two extracted records.

Step 2-2) The procedure compares the volume SD of the bill NB calculated at step S504 with a sum of the volume SA1 and the volume SA2. For example, the 'overlap of two bills' may be determined on condition that the volume SD satisfies a relation of:

$$SA1+SA2-\alpha 2 \leq SD \leq SA1+SA2+\alpha 2$$

Here $\alpha 2$ denotes an error and is preferably set to be a little greater than $\alpha 1$. Upon determination of the 'overlap of two bills' (step S512: Yes), the cash handling controller 310 increments the count on the internal counter TD by two (step S513) and returns the processing flow to step S502.

[0044] Upon no determination of the 'overlap of two bills' (step S512: No), the cash handling controller 310 determines whether the volume SD is smaller than the sum of the volume SA1 and the volume SA2 (step S514). When the volume SD is smaller than the sum of the volume SA1 and the volume SA2 (step S514: Yes), there is a possibility that part of the bill NB is broken to remain in the conveyor assembly 350. The cash handling controller 310 accordingly detects abnormality as the too-small volume (step S515) and terminates the bill check process.

[0045] When the volume SD is not smaller than the sum of the volume SA1 and the volume SA2 (step S514: No), the cash handling controller 310 determines whether the bill NB has an overlap of three bills (step S516) according to the following procedure:

Step 3-1) The procedure searches the deposit count table 901 for the volume SA1 of the bill NB, the volume SA2 of the next bill NB2 to be conveyed after the bill NB, and a volume SA3 of a subsequent bill NB3 to be conveyed after the bill NB2 in the first conveyance.

Step 3-2) The procedure compares the volume SD of the bill NB calculated at step S504 with a sum of the volumes SA1 through SA3. For example, the 'overlap of three bills' may be determined on condition that the volume SD satisfies a relation of:

$$SA1+SA2+SA3-\alpha 3 \leq SD \leq SA1+SA2+SA3+\alpha 3$$

Here $\alpha 3$ denotes an error and is preferably set to be a little greater than $\alpha 2$. Upon determination of the 'overlap of three bills' (step S516: Yes), the cash handling controller 310 increments the count on the internal counter TD by three (step S517) and returns the processing flow to step S502. Upon no determination of the 'overlap of three bills' (step S516: No), the cash handling controller 310 detects abnormality as the too-large volume (step S518) and terminates the bill check process.

[0046] Fig. 14 is a diagrammatic representation of volume comparison performed in the bill check process. When the volume SD of the bill NB is within any of hatched areas, the bill NB is identified as a normal banknote.

[0047] Figs. 15A and 15B are diagrammatic representations of examples of the deposit storage table 902 with registry of bill information. Fig. 15A shows the registration in the deposit storage table 902 in the case of conveyance of two overlapped bills. A record PL1 is registered when the 'overlap of two bills' is determined at step S512 in the flowchart of Fig. 13. The number '0' representing 'unidentifiable' is registered in the denomination data DM field of the record PL1 with determination of the 'overlap of two bills'. A subsequent record PL2 for information of a next bill has the number '3' in the denomination data DM field. Fig. 15B shows the registration in the deposit storage table 902 in the case of conveyance of three overlapped bills. The deposit storage table 902 has the similar registry as that in the case of conveyance of two overlapped bills.

[0048] The cash handling controller 310 checks the information in the deposit storage table 902 (Fig. 12) registered in the second conveyance against the information in the deposit count table 901 (Fig. 11) registered in the first conveyance to verify the consistency of the number of bills (step S410 in Fig. 19). When a maximum value in the bill number TA field of the deposit count table 901 is identical with a maximum value in the bill number DA filed of the deposit count table 902, the consistency of the number of bills may be determined. The consistency of the number of bills with regard to each denomination may be verified, based on the denomination data TM of the deposit count table 901 and the denomination data DM of the deposit storage table 902. In the case of determination of any overlap of multiple bills, the consistency of the number of bills may be verified, based on the denomination data TM and the volume data TV of the deposit count table 901 and the denomination data DM and the volume data DV of the deposit storage table 902.

(A-4) Deposit Process

[0049] Fig. 16 is a flowchart showing a deposit process in the ATM 1. The deposit process is mainly controlled by the main controller 600. The main controller 600 first gives a guidance display including, for example, a receivable limit on the touch panel 201 (step S101) and opens a shutter of the cash slot 301 (step S102) and waits for the user's insertion of bills (step S103). In response to detection of the user's insertion of bills (step S103: Yes), the main controller 600 closes the shutter of the cash slot 301 (step S104) and performs the deposit counting process (step S105) as described later in detail.

[0050] In the case of interruption of the deposit counting process (step S106: Yes), the main controller 600 gives a guidance display requesting the user to pull out the bills from the cash slot 301 and reinsert the bills into the cash slot 301 on the touch panel 201 (step S121). The deposit counting process is interrupted, for example, in response to detection of malfunction or failure of the cash handling mechanism 300 or in response to detection of a jam of the inserted bills. The main controller 600 opens the shutter of the cash slot 301 (step S122) and waits for the user's pullout of bills (step S123). In response to detection of the user's pullout of bills (step S123: Yes), the main controller 600 closes the shutter of the cash slot 301 (step S124). When the user's reinsertion of bills is accepted (step S125: Yes), the main controller 600 returns the processing flow to step S101. When the user's reinsertion of bills is not accepted (step S125: No), the main controller 600 returns the processing flow to step S107.

[0051] On completion of the deposit counting process without interruption (step S106: No), the main controller 600 gives a guidance display including the number of bills counted by the deposit counting process on the touch panel 201 (step S107). When the user's acknowledgement is obtained (step S108: Yes), the main controller 600 establishes communication with the host computer (step S109) and performs the deposit storage process (step S110) as described later in detail.

[0052] When the user's acknowledgement is not obtained (step S108: No) with non-selection of cancellation (step S111: No), the main controller 600 returns the processing flow to step S107. When the user's acknowledgement is not obtained (step S108: No) with selection of cancellation (step S111: Yes), on the other hand, the main controller 600 conveys the bills stored in the temporary cabinet 340 to the cash opening 320 to return the bills to the user (step S112). The main controller 600 opens the shutter of the cash slot 301 (step S113) and waits for the user's pullout of bills (step S114). In response to detection of the user's pullout of bills (step S114: Yes), the main controller 600 closes the shutter of the cash slot 301 (step S115). When the user's reinsertion of bills is accepted (step S116: Yes), the main controller 600 returns the processing flow to step S101. When the user's reinsertion of bills is not accepted (step S116: No), the main controller 600 terminates the deposit process.

(A-5) Deposit Counting Process

[0053] Fig. 17 is a flowchart showing the details of the deposit counting process. The deposit counting process is mainly controlled by the cash handling controller 310. The cash handling controller 310 first actuates the upstream conveyor path 350a to prepare for conveyance of bills (step S201). The cash handling controller 310 subsequently starts a slot bill separation process (step S202), a bill validation process (step S203), and a gate process (step S204). The slot bill separation process of step S202 individually separates the bills received by the cash opening 320 and feeds the individually separated bills to the conveyor assembly 350. The bill validation process of step S203 will be described later in detail. The gate process of step S204 switches over the conveyor paths of the conveyor assembly 350 to dividedly convey the bills to the appropriate places in the cash handling mechanism 300.

[0054] When all the bills received by the cash opening 320 have not yet been fed to the conveyor assembly 350 (step S205: No) and when the reject cartridge 370 is not full (step S206: No), the cash handling controller 310 continues the processing. When all the bills received by the cash opening 320 have not yet been conveyed to the conveyor assembly 350 (step S205: No) and when the reject cartridge 370 is full (step S206: Yes), the cash handling controller 310 stops the slot bill separation process (step S207) and waits for recovery of bills from the reject cartridge 370. After the recovery of bills from the reject cartridge 370, the cash handling controller 310 performs the processing of and after step S208.

[0055] When all the bills received by the cash opening 320 have been fed to the conveyor assembly 350 (step S205: Yes) and when all the bills have passed through the bill validator 330 (step S208: Yes), the cash handling controller 310 stops the bill validation process (step S209) and the gate process (step S210). The cash handling controller 310 subsequently deactuates the upstream conveyor path350a (step S211) and terminates the deposit counting process.

[0056] Fig. 18 is a flowchart showing the details of the bill validation process of step S203 in the deposit counting process. The bill validation process is mainly controlled by the cash handling controller 310. The cash handling controller 310 first initializes an internal counter TA for storing the bill conveying order (step S301) and determines whether a bill validation stop command is received from the main controller 600 (step S302). In the case of reception of the bill validation stop command (step S302: Yes), the cash handling controller 310 immediately terminates the bill validation process. In the case of non-reception of the bill validation stop command (step S302: No), on the other hand, the cash handling controller 310 checks whether any bill has been conveyed to the bill validator 330 (step S303). When any bill has been conveyed to the bill validator 330 (step S303: Yes), the cash handling controller 310 controls the bill validator 330 to validate the conveyed bill (step S304). As mentioned previously, the bill validator 330 identifies the denomination of the bill, checks for the authenticity of the bill, and calculates the volume of the bill. The volume of the bill is calculated by the method of bill volume calculation described above with reference to Figs. 6 through 10.

[0057] In the case of successful validation by the bill validator 330, that is, when it is determined that the bill is acceptable (step S305: Yes), the cash handling controller 310 registers information on the bill obtained by the bill validation into the deposit count table 901 (Fig. 11) (step S306). The count on the internal counter TA is registered into the bill number TA field. The registry of the data into the other fields of the deposit count table 901 is similar to the registry of the data into the corresponding fields of the deposit storage table 902 described previously with reference to Fig. 13. The cash handling controller 310 subsequently increments the count on the internal counter TA by one (step S307). In the case of failed validation by the bill validator 330 for example, the case of failed detection of the bill as a banknote by the imaging device 10 or the case of detection of abnormal inclination of the bill (step S305: No), on the other hand, the cash handling controller 310 returns the processing flow to step S302 to validate a next bill. The bills with failed validation are returned to the user.

[0058] The deposit counting process returns the bills with failed validation by the bill validator 330 to the user. The deposit count table 901 accordingly has the bill information with high reliability. In the case of successful validation of a bill, the count on the internal counter TA is incremented by one. The count on the internal counter TA is registered in the bill number TA field of the deposit count table 901. Namely the bill numbers TA represent the bill conveying order of the bills with successful validation. In this manner, the cash handling controller 310 controls the bill validator 330 to calculate the volume of each bill passing through the bill validator 330 in the first conveyance and store the bill volume data in correlation to the bill conveying order in the first conveyance into the deposit count table 901 set in the storage unit 315.

(A-6) Deposit Storage Process

[0059] Fig. 19 is a flowchart showing the details of the deposit storage process. The deposit storage process is mainly controlled by the cash handling controller 310. The cash handling controller 310 first actuates the upstream conveyor path 350a and the downstream conveyor path 350b to prepare for conveyance of bills (step S401). The cash handling controller 310 subsequently starts a cabinet bill separation process (step S402), a bill validation process and a bill check process (step S403), and a gate process (step S404). The cabinet bill separation process of step S402 individually separates the bills stored in the temporary cabinet 340 and feeds the individually separated bills to the conveyor assembly

350. The bill check process of step S403 is identical with the bill check process discussed previously with reference to Fig. 13. The gate process of step S404 is identical with the gate process of step S204 described previously with reference to Fig. 17.

[0060] When all the bills stored in the temporary cabinet 340 have not yet been fed to the conveyor assembly 350 (step S405: No) or when all the bills have not yet passed through the bill validator 330 (step S406: No), the cash handling controller 310 continues the processing. When all the bills stored in the temporary cabinet 340 have been fed to the conveyor assembly 350 (step S405: Yes) and when all the bills have passed through the bill validator 330 (step S406: Yes), the cash handling controller 310 stops the bill validation process (step S407) and the gate process (step S408). The cash handling controller 310 subsequently deactuates the upstream conveyor path 350a and the downstream conveyor path350b (step S409) and verifies the consistency of the number of bills in the deposit counting process with the number of bills in the deposit storage process (step S410). The verification of the consistency of the number of bills has been described previously.

[0061] In the embodiment described above, the cash handling controller 310 controls the bill validator 330 to calculate the volume of each bill in the first conveyance and the volume of each bill in the second conveyance and store the bill volume data in correlation to the bill conveying order in the first conveyance into the deposit count table 901 and the bill volume data in correlation to the bill conveying order in the second conveyance into the deposit storage table 902. The procedure of the embodiment verifies the consistency of the number of bills, based on the volume data of bills and the bill conveying order. Specifically the volume data of a bill in the second conveyance is compared with the volume data of a corresponding bill, which is expected to be the same bill based on the bill conveying order, in the first conveyance, in order to verify the consistency of the number of bills. Such verification desirably enhances the reliability of the bill counting process. When the volume data of a bill in the second conveyance is greater than the volume data of the corresponding bill in the first conveyance with consideration of a potential error, the procedure of the embodiment compares the volume data of the bill in the second conveyance with a sum of the volume data of the corresponding bill in the first conveyance and the volume data of a next bill in the first conveyance to detect an overlap of two bills. This arrangement allows for bill counting even in the event of an overlap of two bills in the second conveyance, thus further enhancing the reliability of the bill counting process.

B. Modifications

[0062] The embodiment and its applications discussed above are to be considered in all aspects as illustrative and not restrictive. There may be many modifications, changes, and alterations without departing from the scope or spirit of the main characteristics of the present invention. Some examples of possible modification are given below.

B1. Modification 1

[0063] The above embodiment describes the automated teller machine handling the bills or banknotes. The technique of the invention is, however, not restricted to the bills or banknotes but is applicable to other paper sheet handling apparatuses handling various paper sheets, such as stock certificates and investment securities. The procedure of the above embodiment performs the deposit counting process in the first conveyance and the deposit storage process in the second conveyance. This is, however, not restrictive but is only illustrative. The method of bill counting described in the embodiment may be adopted in a withdrawal counting process and in a detailed check counting process.

B2. Modification 2

[0064] The procedure of the above embodiment divides a bill into three divisional areas and determines thicknesses at three different positions of the bill with three thickness detection sensors to calculate the volume of the bill. This is, however, not restrictive but is only illustrative. In general, the procedure may divide a bill into 'n' divisional areas and determine thicknesses at 'n' different positions of the bill with 'n' thickness detection sensors to calculate the volume of the bill, where n denotes an integral number of not less than 1. This method enables the volume of the bill to be calculated with high accuracy.

B3. Modification 3

[0065] The procedure of the above embodiment is on the assumption that the feeding order of bills from the cash opening in the first conveyance is identical with the feeding order of bills from the temporary cabinet in the second conveyance (the first bill in the first conveyance is the first bill in the second conveyance). The feeding order of bills from the cash opening in the first conveyance may be reverse to the feeding order of bills from the temporary cabinet in the second conveyance. The technique of the invention is also applicable to such modification. In this case, when there are

'n' bills, the first bill in the first conveyance is the n-th bill in the second conveyance. The bill check process of Fig. 13 may be modified to initialize the internal counter TD to TD= n at step S501 and decrement the internal counter TD at steps S507, S509, S513, and S517.

B4. Modification 4

[0066] The bill check process of the above embodiment is allowed to detect an overlap of three bills at the maximum. This is, however, not restrictive but is only illustrative. For example, the bill check process may be modified to detect an overlap of four or more bills. The processing with regard to the overlap of three bills may be adopted for this purpose.

B5. Modification 5

[0067] The structures of the deposit count table and the deposit storage table described in the above embodiment are not restrictive but are only illustrative. For example, the deposit count table and the deposit storage table may be structured to have fields for storing bill area data and bill thickness data, in place of or in addition to the volume data TV (DV). The deposit count table and the deposit storage table may be structured to have various fields other than those shown in Figs. 11 and 12.

B6. Modification 6

[0068] The above embodiment describes the structures and the functions of the respective components of the ATM and the cash handling mechanism. These structures and functions are not restrictive but are only illustrative and may be modified and changed in various ways without departing from the scope of the invention. For example, some members of the components may be structured in different shapes or in different dimensions. Additional functions, such as audio guidance function and a status display function, may be provided according to the requirements.

Claims

1. A paper sheet handling apparatus, comprising:

a validator configured to validate each of paper sheets;
a conveyor assembly arranged to convey the paper sheets in the paper sheet handling apparatus;
a controller configured to control components of the paper sheet handling apparatus; and
a storage unit arranged to store information on the paper sheets,
wherein the controller controls the validator to determine a volume of each of the paper sheets passing through the validator in a first conveyance and store volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance into the storage unit, wherein the first conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator first time, and
the controller controls the validator to determine a volume of a certain paper sheet passing through the validator in a second conveyance and comparing volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the paper sheets conveyed by the conveyor assembly pass through the validator second time.

2. The paper sheet handling apparatus according to claim 1, wherein a paper sheet to be conveyed after the corresponding paper sheet in the second conveyance is specified as a next paper sheet,
when the volume data of the certain paper sheet in the second conveyance is greater than the volume data of the corresponding paper sheet in the first conveyance with consideration of a potential error, the controller comparing the volume data of the certain paper sheet in the second conveyance with a sum of the volume data of the corresponding paper sheet in the first conveyance and volume data of the next paper sheet in the first conveyance,
when the volume data of the certain paper sheet in the second conveyance is within a predetermined range, the controller determining an overlap of two paper sheets in the second conveyance.

3. A paper sheet handling method, comprising the steps of:

(a) conveying paper sheets;
(b) validating each of the paper sheets; and
(c) storing information on the paper sheets,
wherein the step (b) in a first conveyance determines a volume of each of the paper sheets in the first conveyance and the step (c) stores volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance, wherein the first conveyance represents that the step (b) is performed first time during the step (a), and
the step (b) in a second conveyance determines a volume of a certain paper sheet in the second conveyance and compares volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the step (b) is performed second time during the step (a).

4. A computer program product for a paper sheet handling apparatus, comprising a computer readable storage medium having computer readable program embodied in the medium, the computer readable program comprising:

a first program code for causing a computer to convey paper sheets;
a second program code for causing the computer to validate each of the paper sheets; and
a third program code for causing the computer to store information on the paper sheets,
wherein the second program code in a first conveyance determines a volume of each of the paper sheets in the first conveyance and the third program code stores volume data of the paper sheet in correlation to a paper sheet conveying order in the first conveyance, wherein the first conveyance represents that the second program code is performed first time during activation of the first program code, and
the second program code in a second conveyance determines a volume of a certain paper sheet in the second conveyance and compares volume data of the certain paper sheet in the second conveyance with volume data of a corresponding paper sheet in the first conveyance, which is expected to be identical with the certain paper sheet based on the paper sheet conveying order, so as to verify consistency of number of paper sheets conveyed in the first conveyance with number of paper sheets conveyed in the second conveyance, wherein the second conveyance represents that the second program code is performed second time during activation of the first program code.

Fig.1

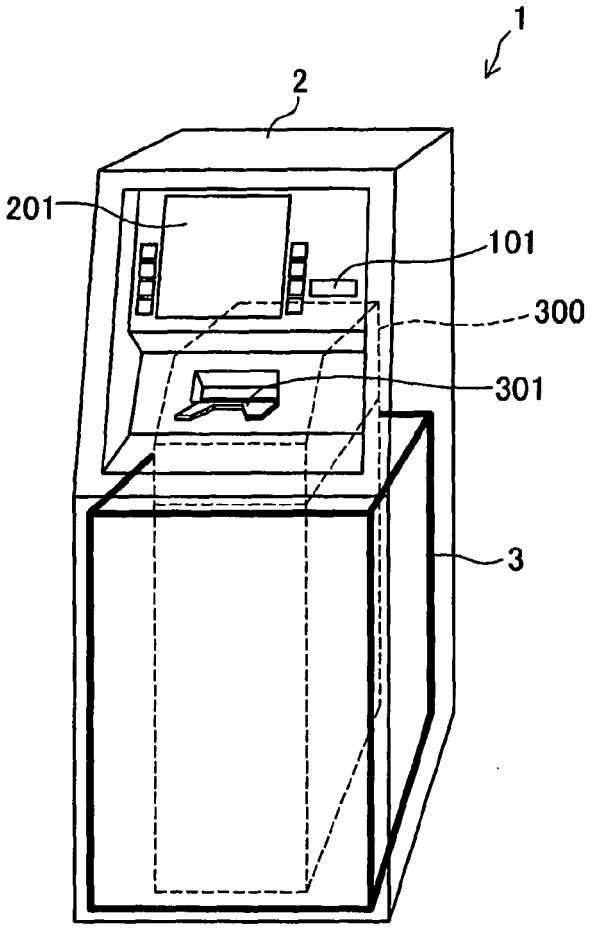
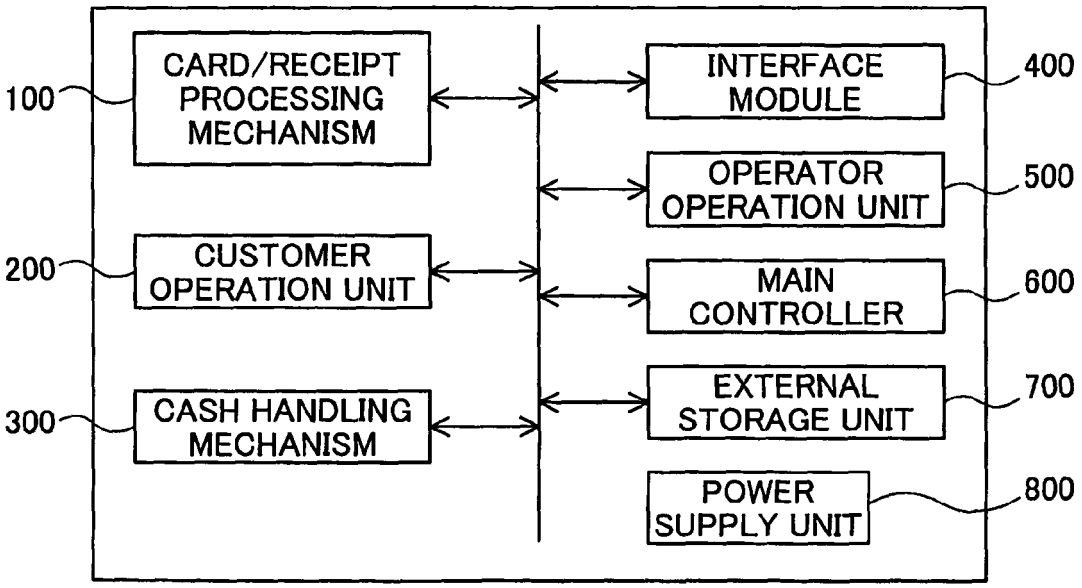

1
2
201
101
300
301
3

Fig.2


100
CARD/RECEIPT PROCESSING MECHANISM
200
CUSTOMER OPERATION UNIT
300
CASH HANDLING MECHANISM
INTERFACE MODULE
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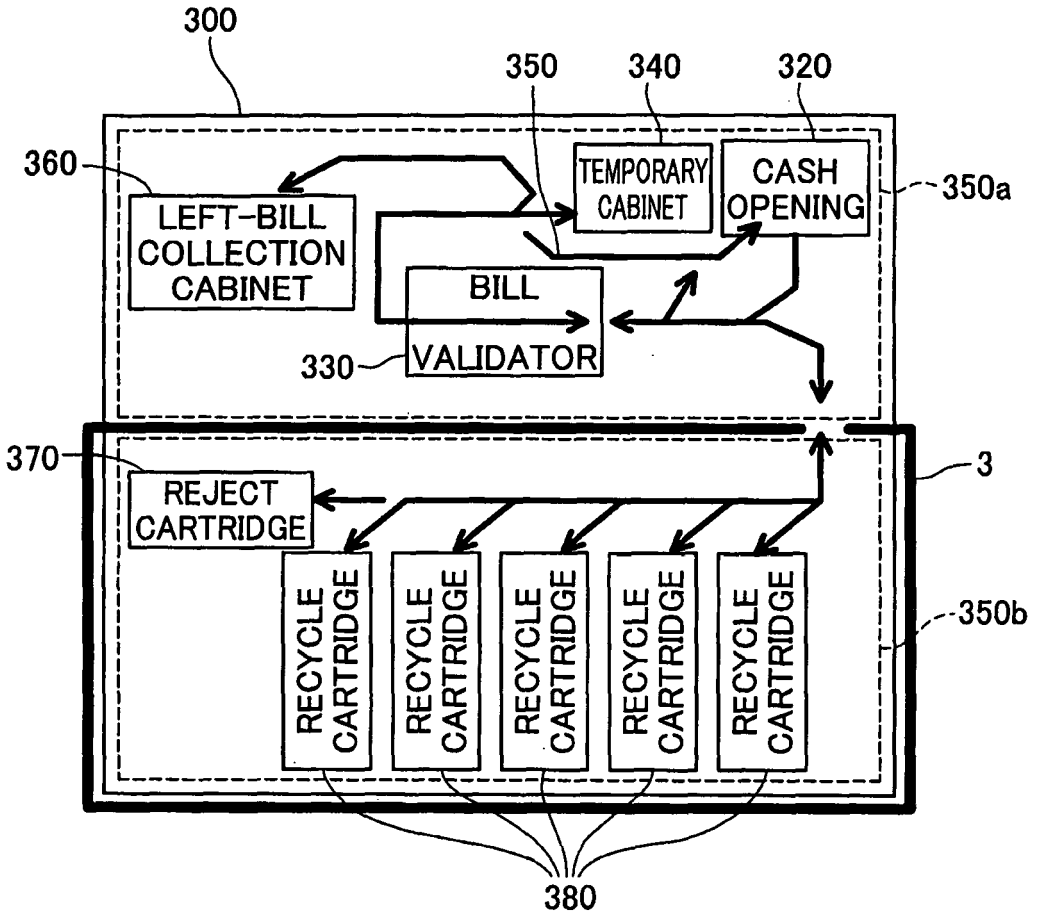
OPERATOR OPERATION UNIT
500
MAIN CONTROLLER
600
EXTERNAL STORAGE UNIT
700
POWER SUPPLY UNIT
800

Fig.3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340
320
360
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CASH OPENING
350a
LEFT-BILL COLLECTION CABINET
BILL
330
VALIDATOR
370
3
REJECT CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
350b
380

Fig.4

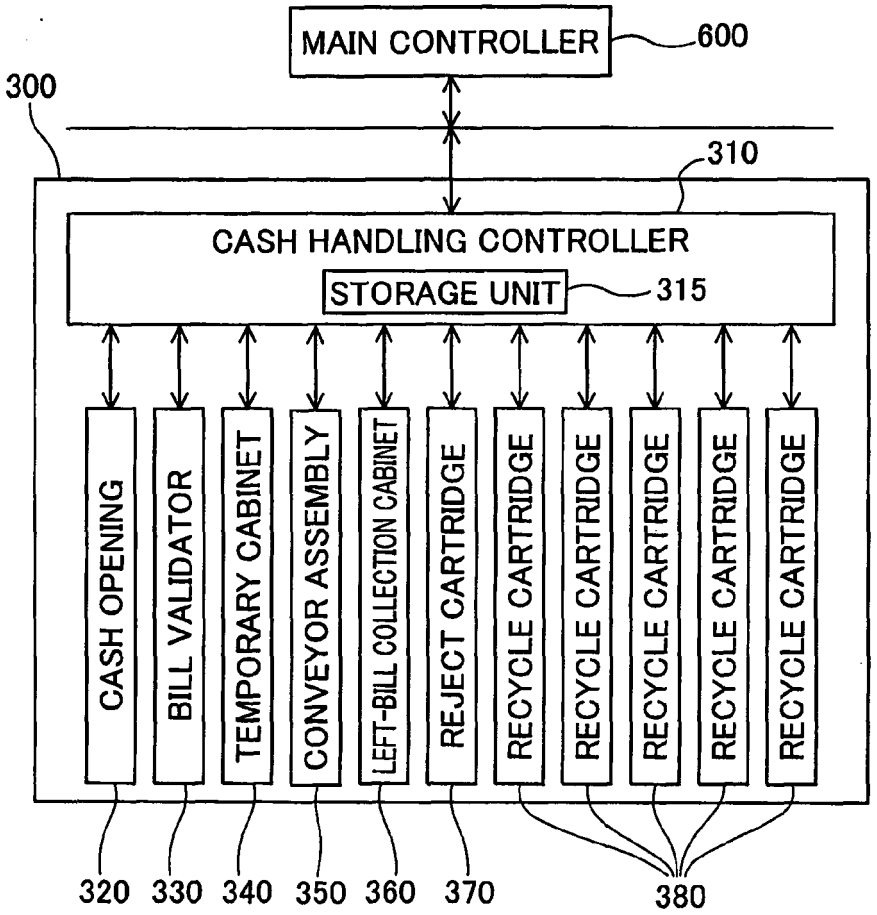
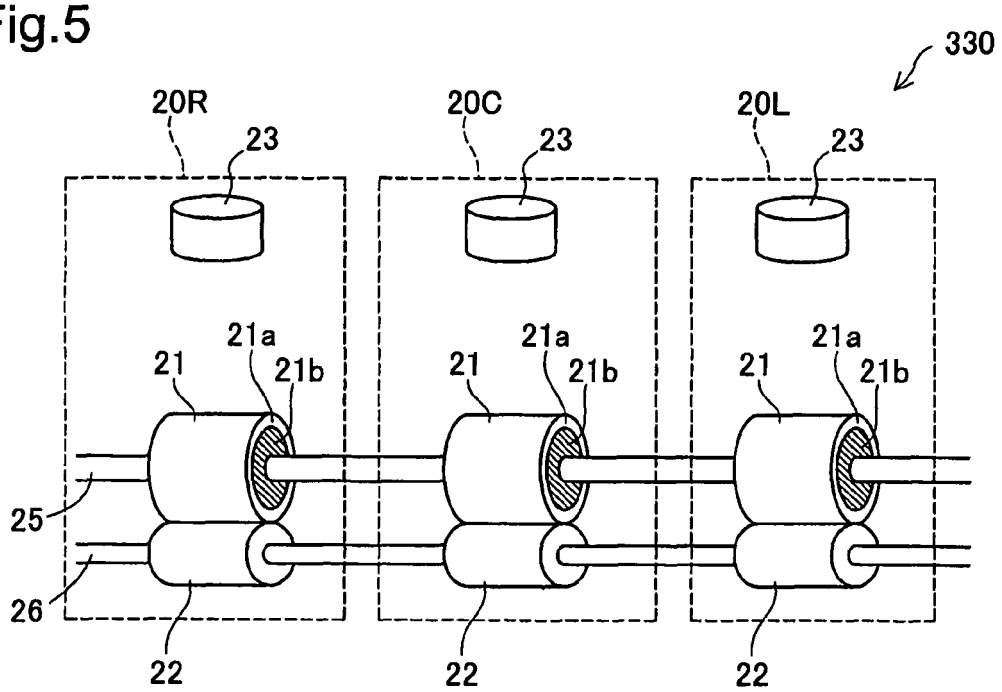

MAIN CONTROLLER
600
300
310
CASH HANDLING CONTROLLER
STORAGE UNIT
315
CASH OPENING
BILL VALIDATOR
TEMPORARY CABINET
CONVEYOR ASSEMBLY
LEFT-BILL COLLECTION CABINET
REJECT CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
RECYCLE CARTRIDGE
320
330
340
350
360
370
380

Fig.5


330
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23
23
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21b
21a
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21a
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21b
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26
22
22
22

Fig.6A

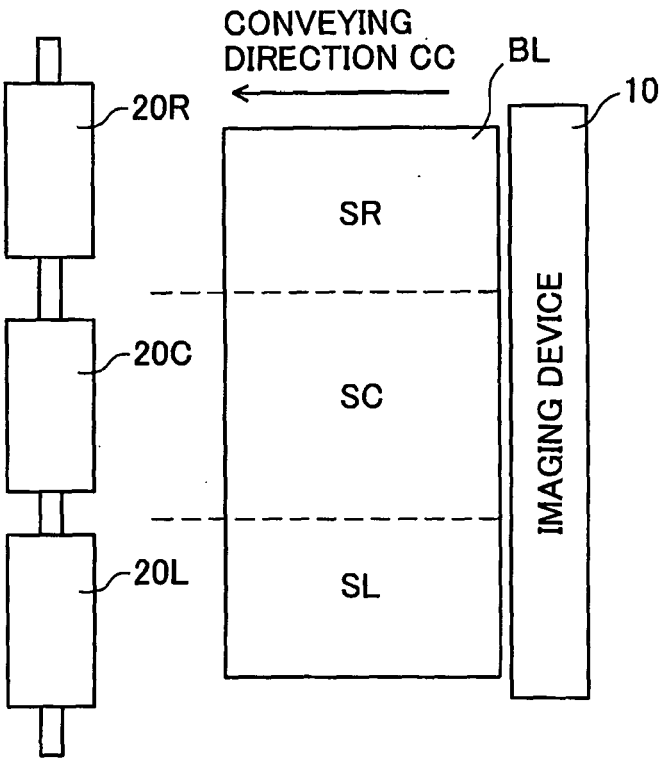


Fig.6B

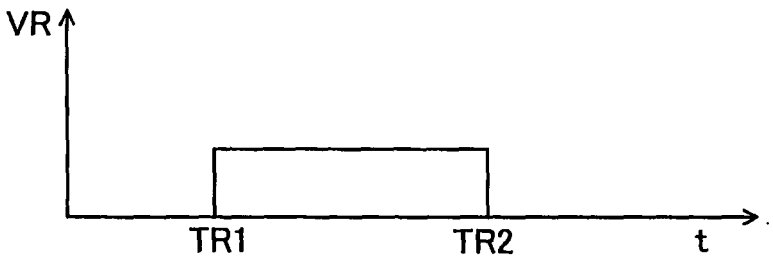


Fig.6C

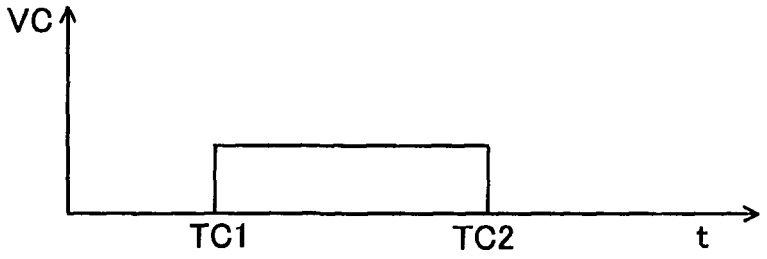


Fig.6D

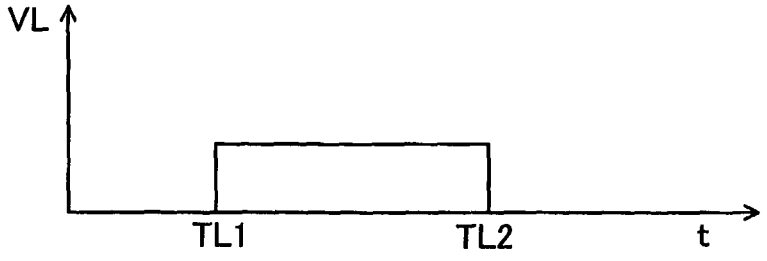


Fig.7A

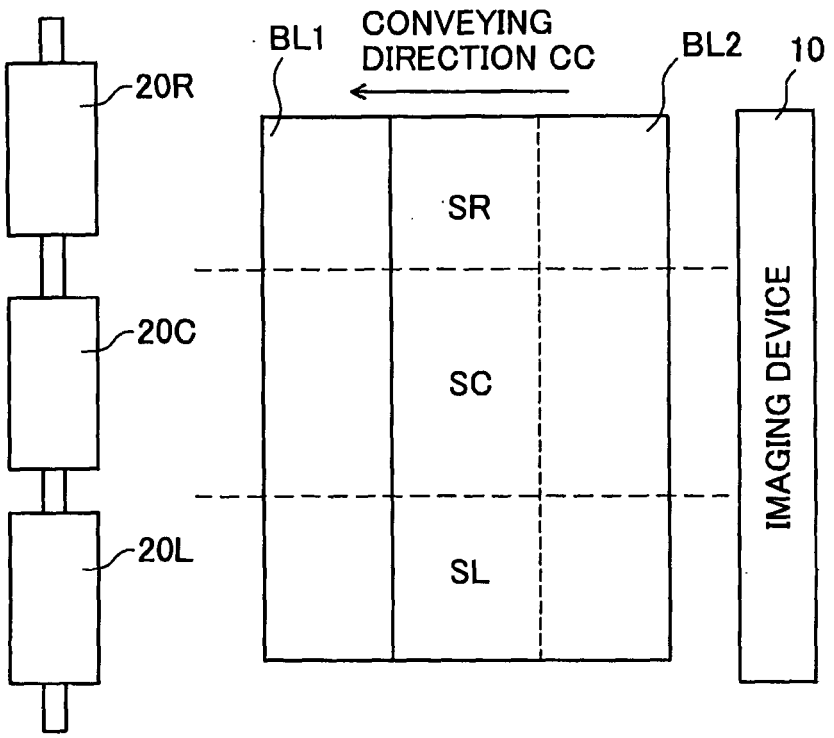


Fig.7B

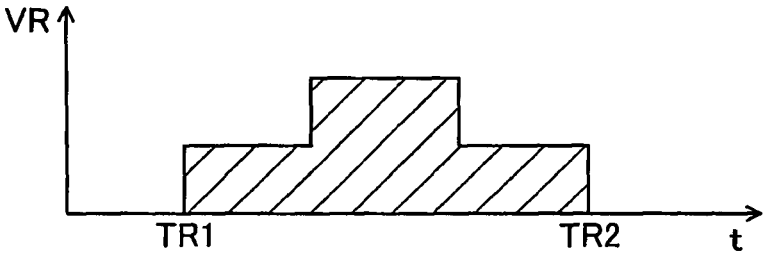


Fig.7C

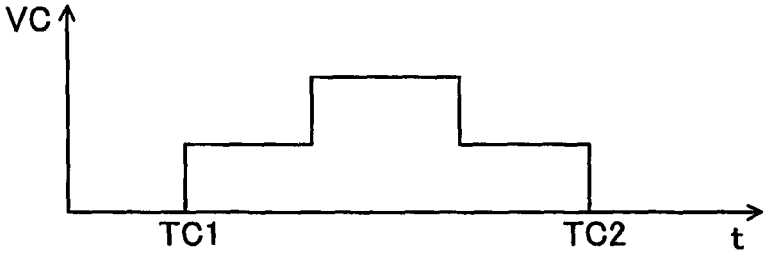


Fig.7D

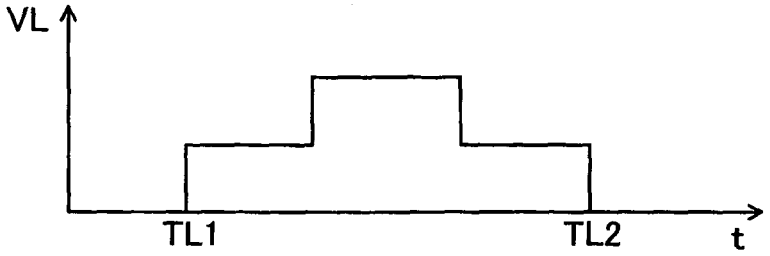


Fig.8A

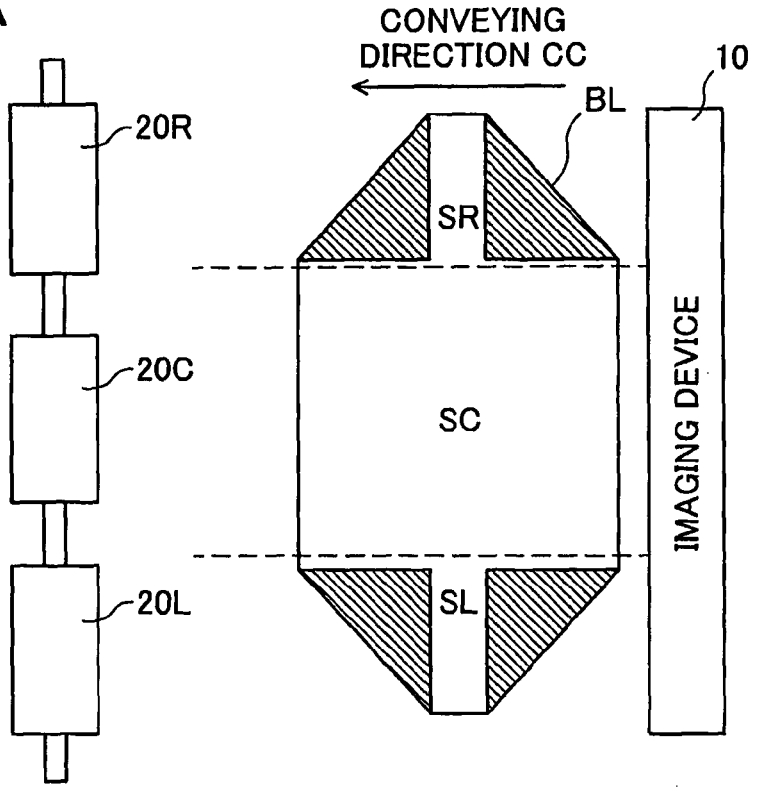


Fig.8B

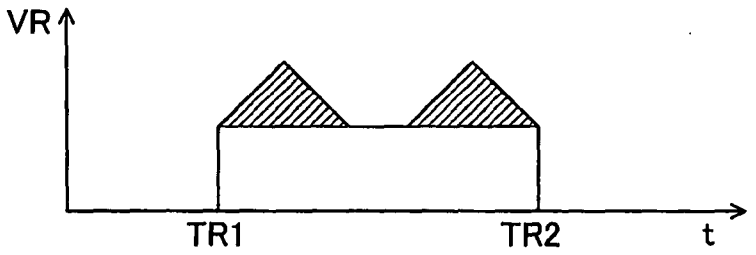


Fig.8C

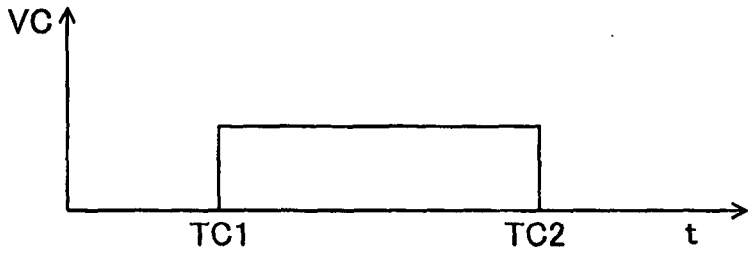


Fig.8D

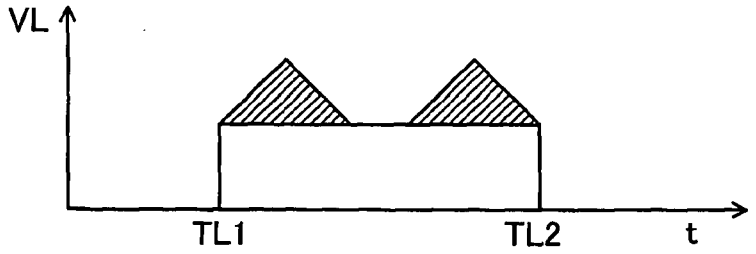


Fig.9A

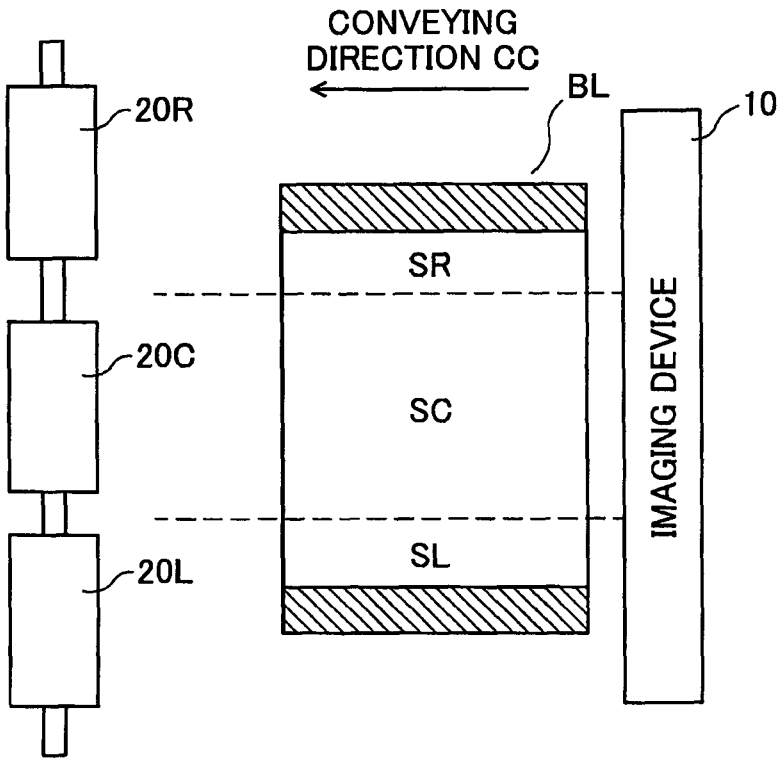


Fig.9B

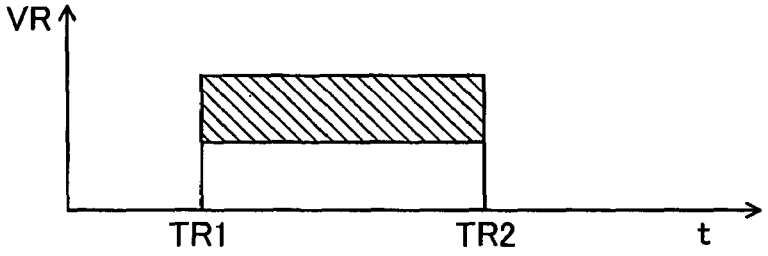


Fig.9C

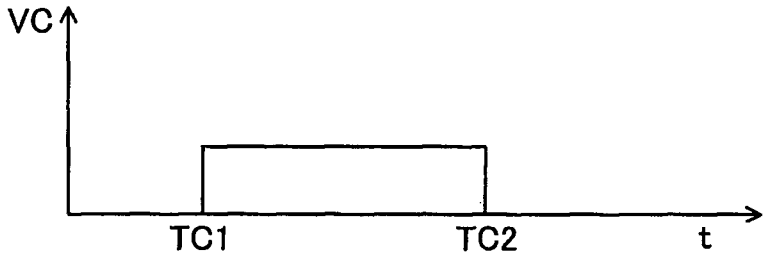


Fig.9D

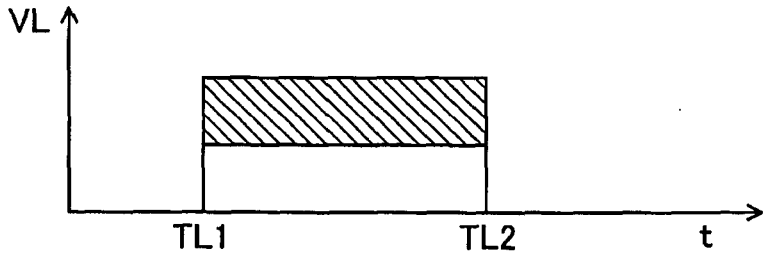


Fig.10A

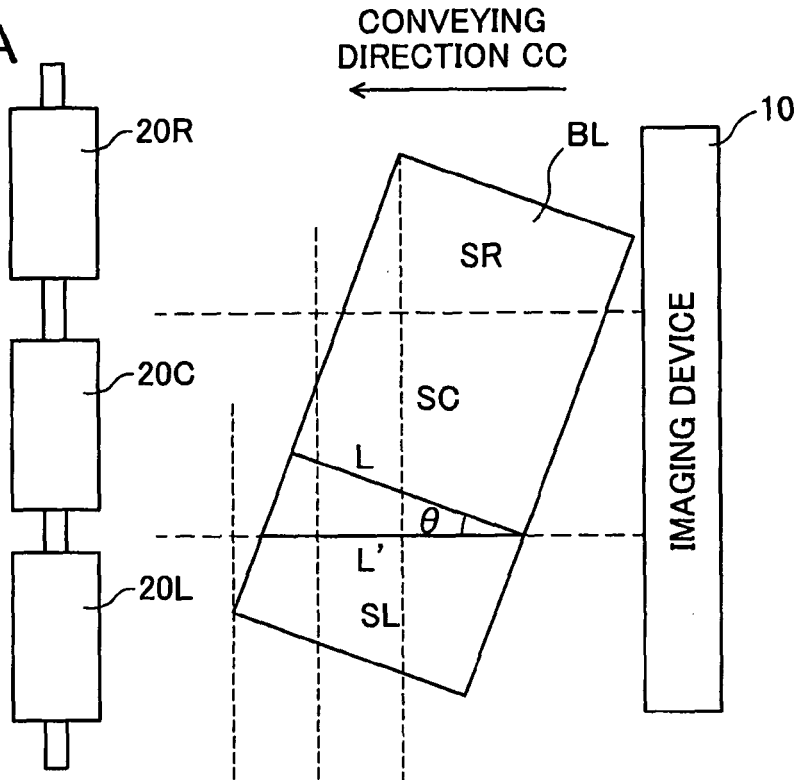


Fig.10B

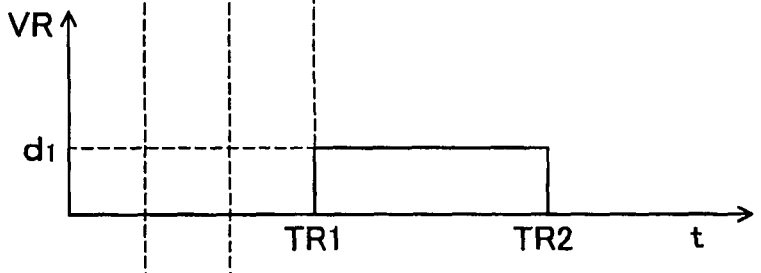


Fig.10C

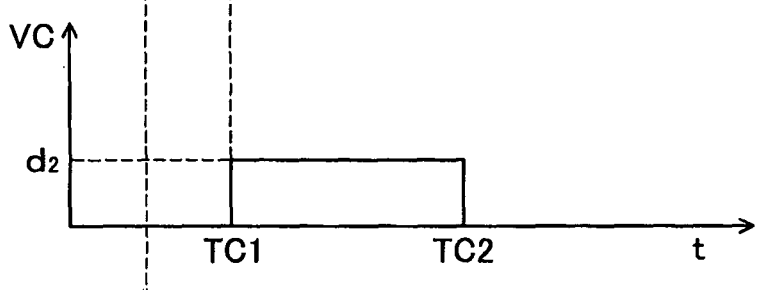


Fig.10D

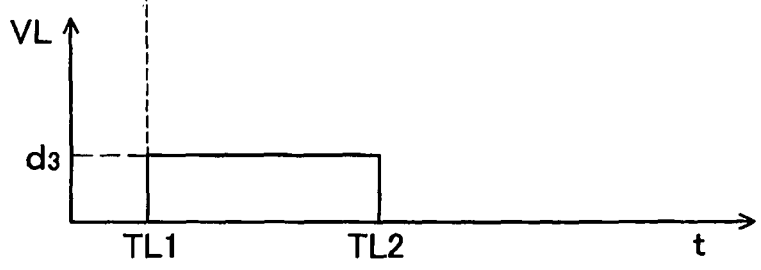


Fig.11

<DEPOSIT COUNT TABLE> 901

BILL NUMBER : TA	DENOMINATION DATA: TM	CIRCULATION DATA: TR	VOLUME DATA: TV
1	1	ALLOWED	SA1
2	2	PROHIBITED	SA2
3	2	ALLOWED	SA3
4	3	ALLOWED	SA4
5	1	ALLOWED	SA5

Fig.12

<DEPOSIT STORAGE TABLE> 902

BILL NUMBER : DA	DENOMINATION DATA: DM	CIRCULATION DATA: DR	VOLUME DATA: DV
1	1	ALLOWED	SD1
2	2	PROHIBITED	SD2
3	2	ALLOWED	SD3
4	3	ALLOWED	SD4
5	1	ALLOWED	SD5

Fig.13

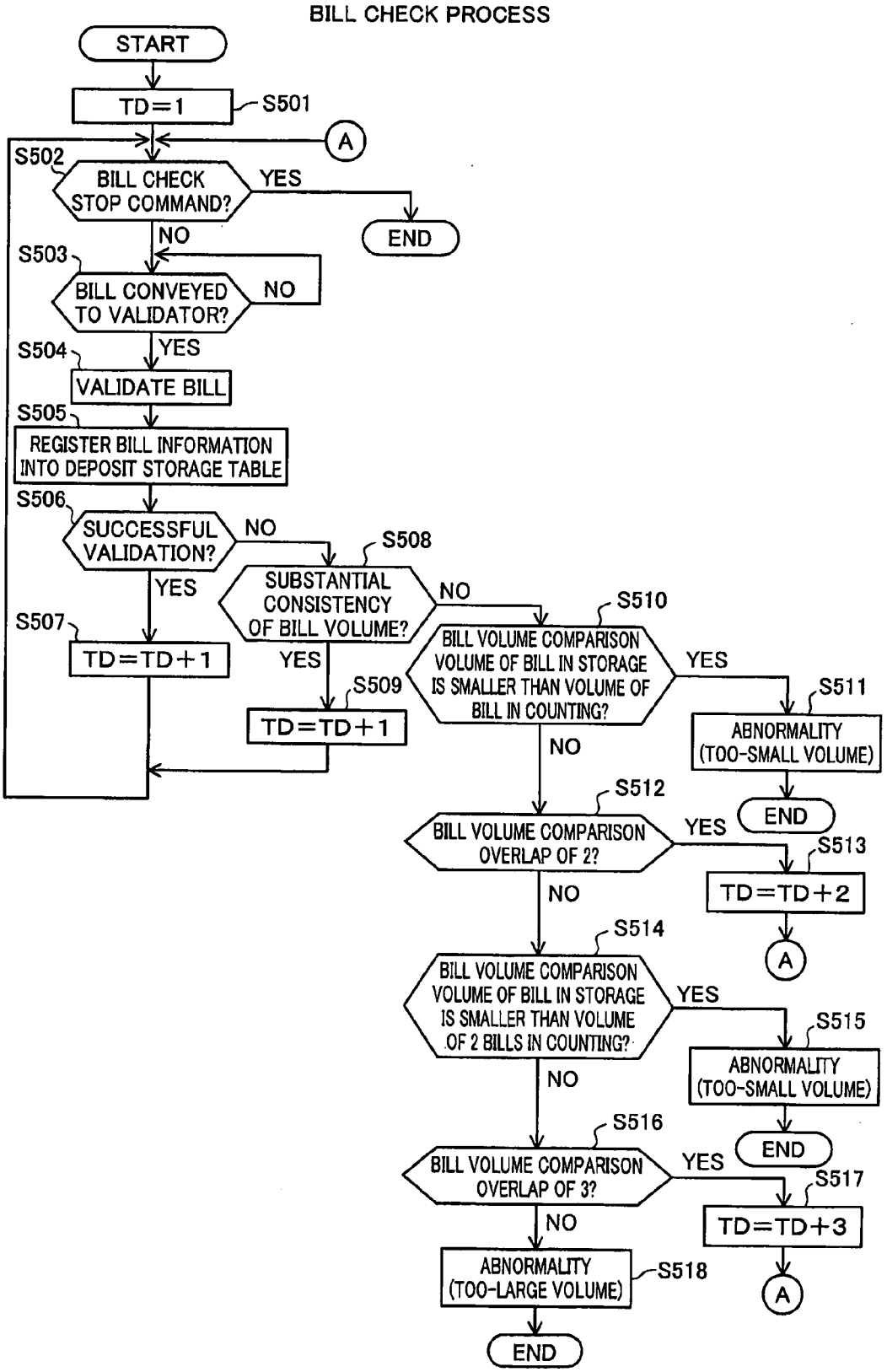

BILL CHECK PROCESS
START
TD=1
S501
A
S502
BILL CHECK STOP COMMAND?
YES
END
NO
S503
BILL CONVEYED TO VALIDATOR?
NO
YES
S504
VALIDATE BILL
S505
REGISTER BILL INFORMATION INTO DEPOSIT STORAGE TABLE
S506
SUCCESSFUL VALIDATION?
NO
S508
SUBSTANTIAL CONSISTENCY OF BILL VOLUME?
NO
S510
BILL VOLUME COMPARISON VOLUME OF BILL IN STORAGE IS SMALLER THAN VOLUME OF BILL IN COUNTING?
YES
S511
ABNORMALITY (TOO-SMALL VOLUME)
END
YES
S507
TD=TD+1
YES
S509
TD=TD+1
NO
S512
BILL VOLUME COMPARISON OVERLAP OF 2?
YES
S513
TD=TD+2
A
NO
S514
BILL VOLUME COMPARISON VOLUME OF BILL IN STORAGE IS SMALLER THAN VOLUME OF 2 BILLS IN COUNTING?
YES
S515
ABNORMALITY (TOO-SMALL VOLUME)
END
NO
S516
BILL VOLUME COMPARISON OVERLAP OF 3?
YES
S517
TD=TD+3
A
NO
ABNORMALITY (TOO-LARGE VOLUME)
S518
END

Fig.14

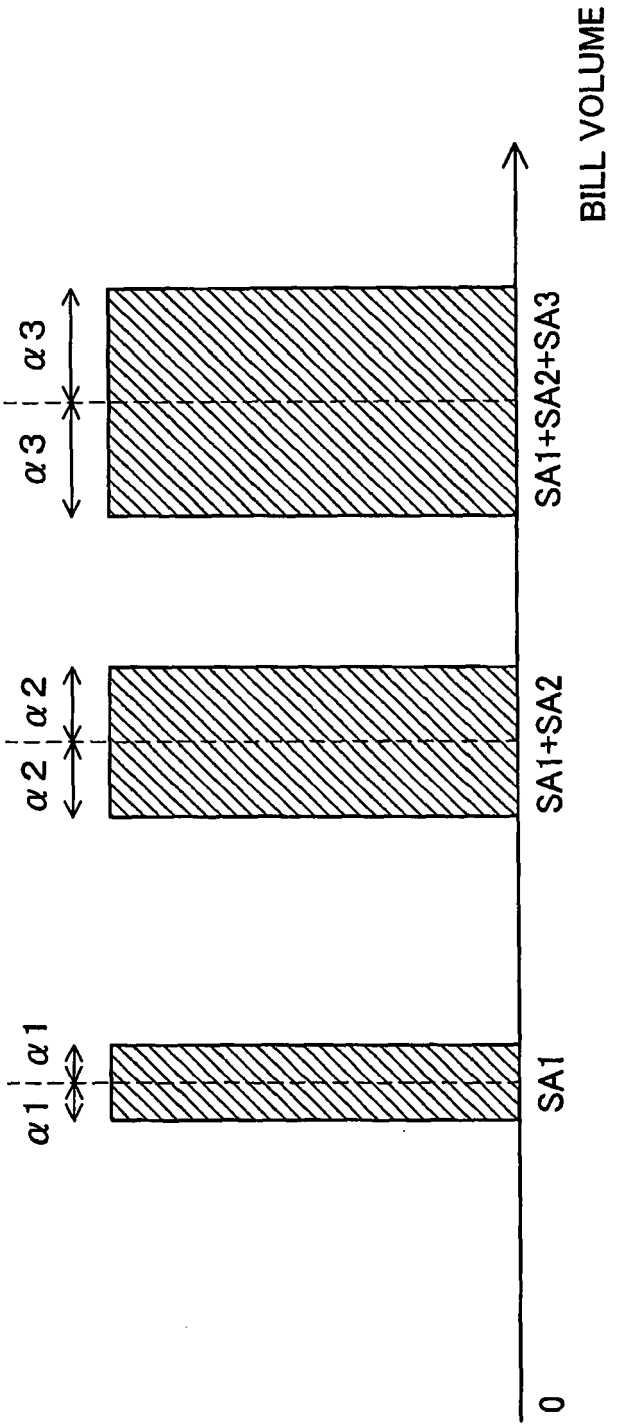


Fig.15A

IN THE CASE OF CONVEYANCE OF TWO OVERLAPPED BILLS

<DEPOSIT STORAGE TABLE>

902

	BILL NUMBER : DA	DENOMINATION DATA: DM	CIRCULATION DATA: DR	VOLUME DATA: DV
PL1	1	0	PROHIBITED	SD1
PL2	3	2	ALLOWED	SD3
	4	3	ALLOWED	SD4
	5	1	ALLOWED	SD5

Fig.15B

IN THE CASE OF CONVEYANCE OF THREE OVERLAPPED BILLS

<DEPOSIT STORAGE TABLE>

902

	BILL NUMBER : DA	DENOMINATION DATA: DM	CIRCULATION DATA: DR	VOLUME DATA: DV
PL3	1	0	PROHIBITED	SD1
PL4	4	3	ALLOWED	SD4
	5	1	ALLOWED	SD5

Fig.16

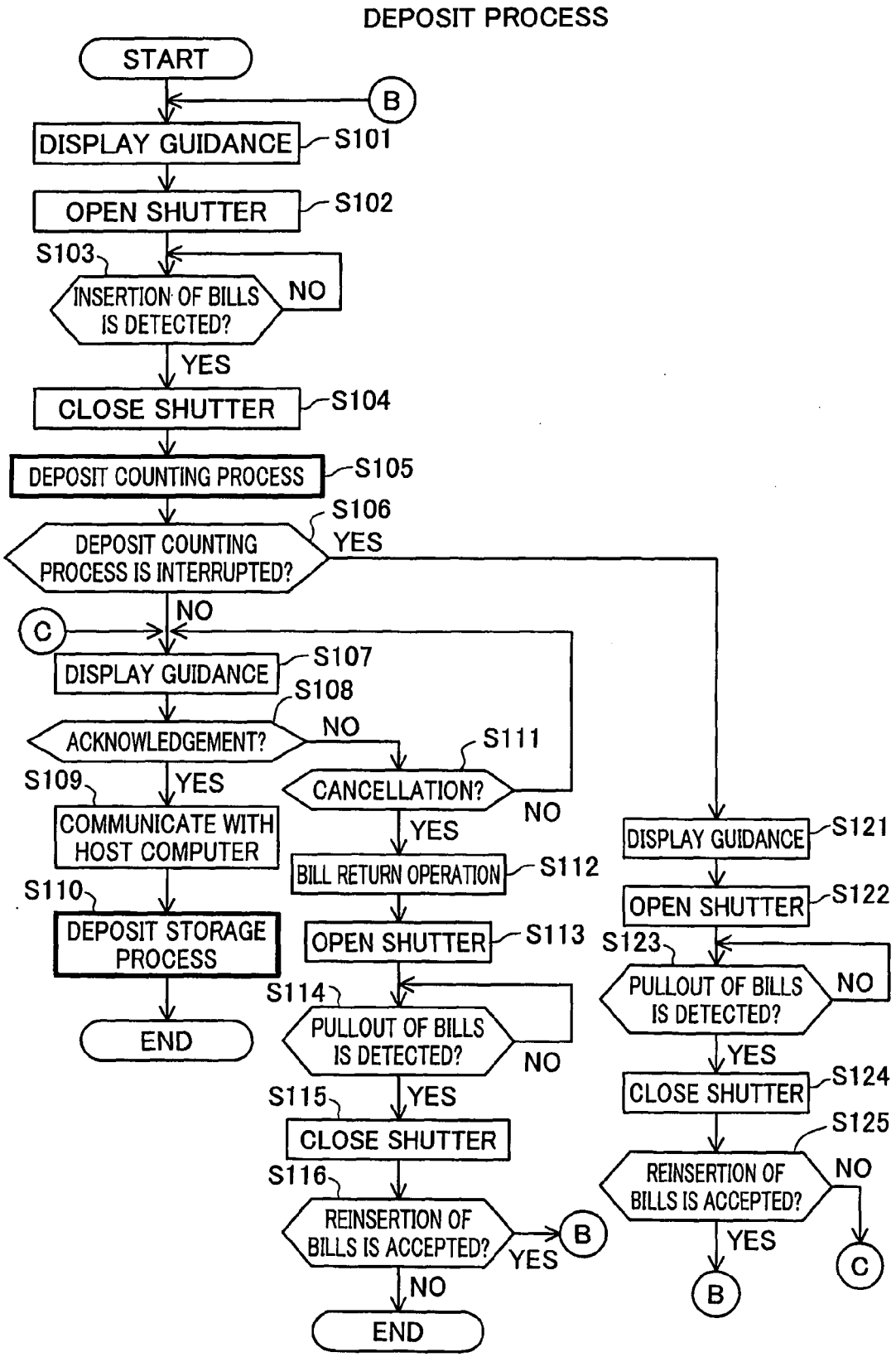

DEPOSIT PROCESS
START
B
DISPLAY GUIDANCE
S101
OPEN SHUTTER
S102
S103
INSERTION OF BILLS IS DETECTED?
NO
YES
CLOSE SHUTTER
S104
DEPOSIT COUNTING PROCESS
S105
S106
DEPOSIT COUNTING PROCESS IS INTERRUPTED?
YES
NO
C
DISPLAY GUIDANCE
S107
S108
ACKNOWLEDGEMENT?
NO
S111
CANCELLATION?
NO
S109
YES
COMMUNICATE WITH HOST COMPUTER
YES
BILL RETURN OPERATION
S112
S110
DEPOSIT STORAGE PROCESS
OPEN SHUTTER
S113
END
S114
PULLOUT OF BILLS IS DETECTED?
NO
S115
YES
CLOSE SHUTTER
S116
REINSERTION OF BILLS IS ACCEPTED?
B
YES
NO
END
DISPLAY GUIDANCE
S121
OPEN SHUTTER
S122
S123
PULLOUT OF BILLS IS DETECTED?
NO
YES
CLOSE SHUTTER
S124
S125
REINSERTION OF BILLS IS ACCEPTED?
NO
YES
C
B

Fig.17

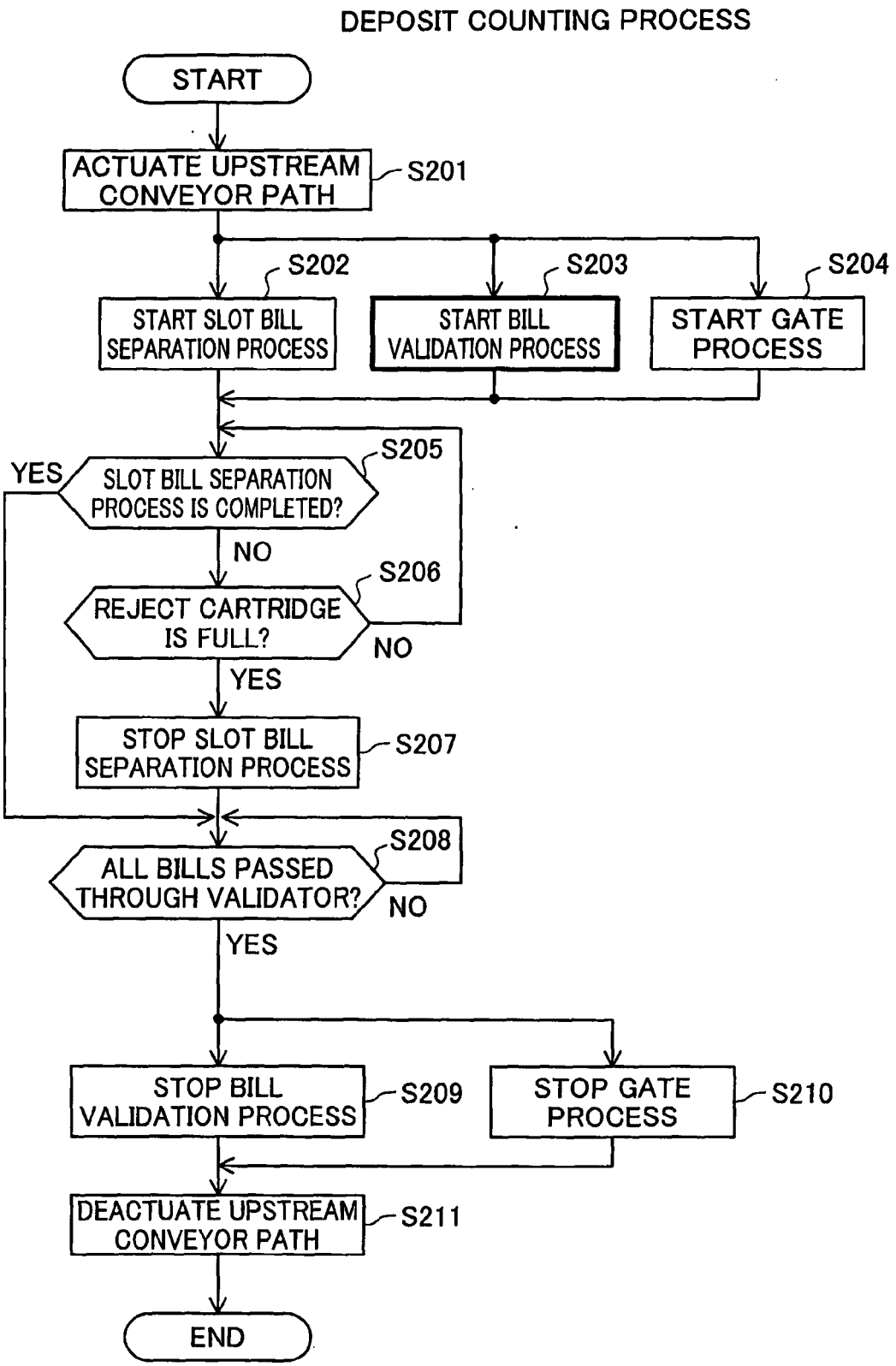

DEPOSIT COUNTING PROCESS
START
ACTUATE UPSTREAM CONVEYOR PATH
S201
S202
S203
S204
START SLOT BILL SEPARATION PROCESS
START BILL VALIDATION PROCESS
START GATE PROCESS
S205
YES
SLOT BILL SEPARATION PROCESS IS COMPLETED?
NO
S206
REJECT CARTRIDGE IS FULL?
NO
YES
STOP SLOT BILL SEPARATION PROCESS
S207
S208
ALL BILLS PASSED THROUGH VALIDATOR?
NO
YES
STOP BILL VALIDATION PROCESS
S209
STOP GATE PROCESS
S210
DEACTUATE UPSTREAM CONVEYOR PATH
S211
END

Fig.18

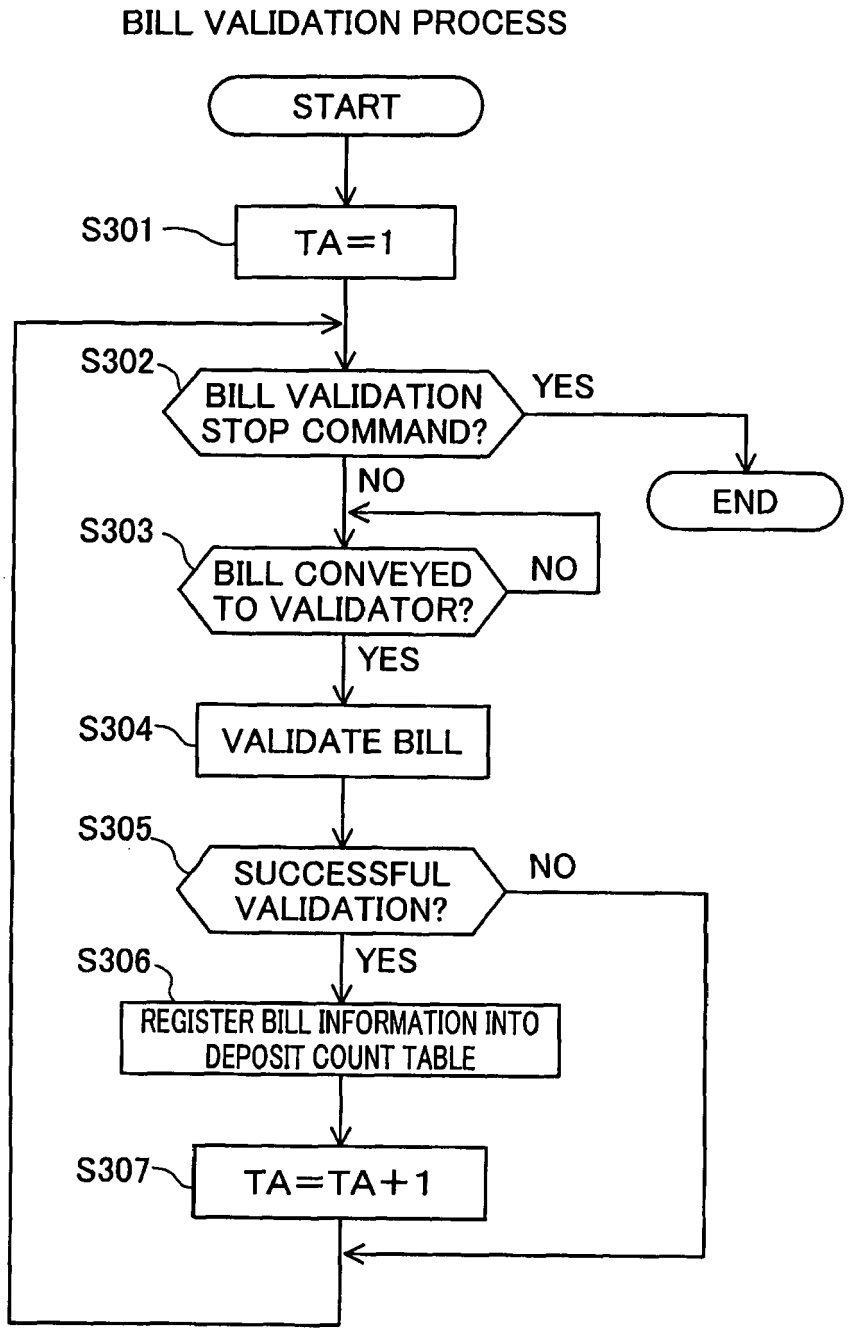
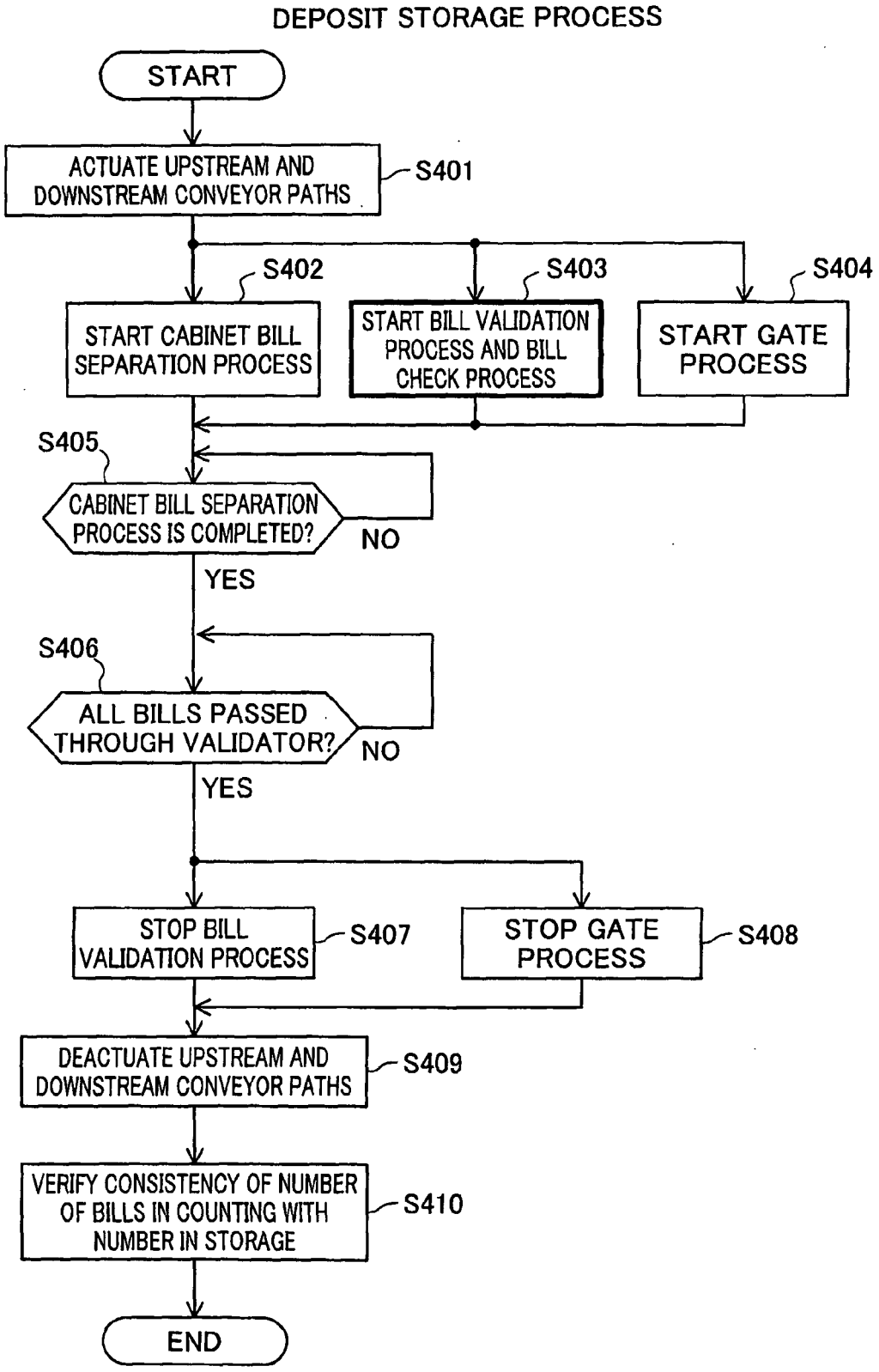

BILL VALIDATION PROCESS
START
S301
TA=1
S302
BILL VALIDATION STOP COMMAND?
YES
END
NO
S303
BILL CONVEYED TO VALIDATOR?
NO
YES
S304
VALIDATE BILL
S305
SUCCESSFUL VALIDATION?
NO
S306
YES
REGISTER BILL INFORMATION INTO DEPOSIT COUNT TABLE
S307
TA=TA+1

Fig.19


DEPOSIT STORAGE PROCESS
START
ACTUATE UPSTREAM AND DOWNSTREAM CONVEYOR PATHS
S401
S402
S403
S404
START CABINET BILL SEPARATION PROCESS
START BILL VALIDATION PROCESS AND BILL CHECK PROCESS
START GATE PROCESS
S405
CABINET BILL SEPARATION PROCESS IS COMPLETED?
NO
YES
S406
ALL BILLS PASSED THROUGH VALIDATOR?
NO
YES
STOP BILL VALIDATION PROCESS
S407
STOP GATE PROCESS
S408
DEACTUATE UPSTREAM AND DOWNSTREAM CONVEYOR PATHS
S409
VERIFY CONSISTENCY OF NUMBER OF BILLS IN COUNTING WITH NUMBER IN STORAGE
S410
END