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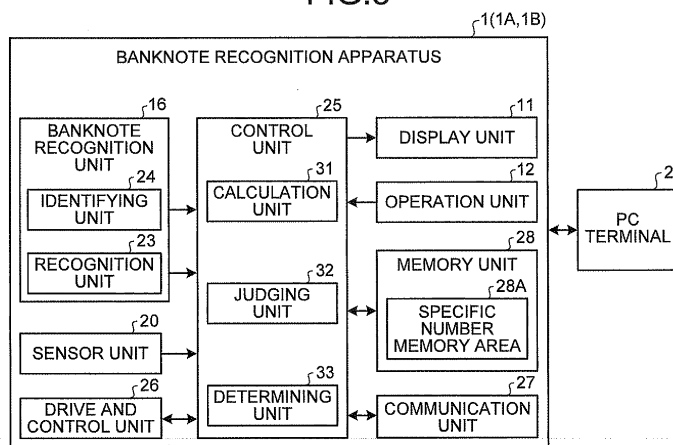
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PAPER MONEY PROCESSING DEVICE, PAPER MONEY PROCESSING SYSTEM, AND PAPER MONEY PROCESSING METHOD

(57) Disclosed is a paper money processing device provided with a transport unit (15) for transporting paper money fed from a hopper unit (13) to an accumulation unit (17) or a reject unit(18), a recognition unit (24) for recognizing a code/number of the paper money transported by the transport unit (15), and a control unit (25) which executes a calculation process using a sum check function on the basis of the code/number obtained from the code/number recognition result of the paper money

by the recognition unit (24), and, when the calculation result of the paper money is not a predetermined value, acknowledges that the code/number of the paper money is incorrect, and controls the transport unit (15) to transport the paper money to the reject unit (18). Thus, it can be confirmed as to whether or not the code/number is correct, and malfunction in various processes by using an unconfirmed incorrect code/number can be prevented.

FIG.3



Description

TECHNICAL FIELD

[0001] The present invention relates to a banknote handling apparatus, a banknote handling system, and a banknote handling method that have a function of identifying, for example, its serial number.

BACKGROUND ART

[0002] A banknote handling system for identifying serial numbers of deposited banknotes has been known in the art. The banknote handling system includes a banknote handling apparatus that sorts and stacks the deposited banknotes, and a server that is connected to this banknote handling apparatus. The banknote handling apparatus has a function of recognizing the denominations of the deposited banknotes and sorting and stacking the deposited banknotes based on the recognition result. The banknote handling apparatus also identifies serial numbers of the deposited banknotes and notifies the identified serial numbers to the server.

[0003] The server is connected to a serial number database in which, for example, serial numbers of counterfeit banknotes have been saved previously. Upon receiving the identified serial number of a deposited banknote from the banknote handling apparatus, the server compares the received serial number with the serial numbers of the counterfeit banknotes in the serial number database. Based on the comparison result the server judges whether the deposited banknote is a counterfeit banknote. Specifically, if the received serial number is present in the serial number database, the server judges that the deposited banknote is a counterfeit banknote. In contrast, if the received serial number is not present in the serial number database, the server judges that the deposited banknote is not a counterfeit banknote.

[0004] Thus, with the conventional banknote handling system, the banknote handling apparatus and the server operate together to determine, based on the serial number of the deposited banknote, whether the deposited banknote is a counterfeit banknote.

[Conventional Art Documents]

[Patent Documents]

[0005] [Patent Document 1] Japanese Patent Application Laid-open No. 2009-116798 (see Abstract and FIG. 5)

DISCLOSURE OF INVENTION

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0006] In the conventional banknote handling system, the serial number of the deposited banknote is identified,

and the identified serial number is treated as a correct serial number without checking whether the identified serial number is correct. Subsequently, various processes such as a serial number processing are executed by using this unchecked serial number. With the conventional banknote handling system, however, an undesirable event can occur when the identified serial number is incorrect; because, the processes such as the serial number processing need to be executed by using a correct serial number.

[0007] Euro banknotes used in Europe have a checksum function for their serial numbers. In reality, however, the conventional banknote handling systems are not making effective use of the checksum function for the serial numbers.

[0008] The present invention has been conceived in light of the above discussion. It is an object of the present invention to provide a banknote handling apparatus, a banknote handling system, and a banknote handling method, with which correctness of a serial number can be checked and with which an undesirable event that may occur in various processes due to use of an unchecked, incorrect serial number can be prevented.

[MEANS TO SOLVE THE PROBLEMS]

[0009] To achieve the above object, a banknote handling apparatus according to an aspect of the present invention includes a receiving unit that receives banknotes and feeds the banknotes one by one; a banknote stacking unit that stacks the banknotes; a rejected banknote stacking unit that stacks banknotes to be rejected; a transport unit that transports the banknotes fed by the receiving unit to the banknote stacking unit or the rejected banknote stacking unit; an identifying unit that identifies a serial number of each of the banknotes transported by the transport unit; and a control unit that executes a predetermined calculation process based on the serial number identified by the identifying unit and, when a calculation result of the calculation process does not match with a predetermined calculation result, determines that the serial number of the banknote is incorrect, and executes a predetermined process on the banknote.

[0010] In the banknote handling apparatus according to another aspect of the present invention, the control unit executes the predetermined calculation process based on a checksum function for the serial number of the banknote.

[0011] In the banknote handling apparatus according to still another aspect of the present invention, the predetermined calculation process corresponds to a calculation process including replacing an alphabetic character contained in the serial number of the banknote with a number that corresponds to an alphabetical order, and dividing the sum total of the number after replacement and numerical values of all the digits in the serial number by 9 to obtain a remainder, and the predetermined calculation result is 8.

[0012] In the banknote handling apparatus according to still another aspect of the present invention, the predetermined calculation process corresponds to a calculation process including replacing an alphabetic character contained in the serial number of the banknote with a number that corresponds to an alphabetical order, calculating a sum total of numerical values of all the digits including the number after replacement in the serial number of the banknote, and repeating the calculation of the sum total, which is the calculation result, of the numerical values of all the digits until the sum total becomes a single-digit number, and the predetermined calculation result is 8.

[0013] In the banknote handling apparatus according to still another aspect of the present invention, the predetermined calculation process corresponds to a calculation process including replacing an alphabetic character contained in the serial number of the banknote with a number that is a decimal number corresponding to an ASCII character code of the alphabetic character, and dividing the sum total of the number after replacement and numerical values of all the digits in the serial number by 9 to obtain a remainder, and the predetermined calculation result is 0.

[0014] In the banknote handling apparatus according to still another aspect of the present invention, the predetermined calculation process corresponds to a calculation process including replacing an alphabetic character contained in the serial number of the banknote with a number that is a decimal number corresponding to an ASCII character code of the alphabetic character, and dividing the sum total of numerical values of all the digits including the number after replacement in the serial number by 9 to obtain the remainder, and the predetermined calculation result is 0.

[0015] In the banknote handling apparatus according to still another aspect of the present invention, the control unit executes the predetermined calculation process by using a numerical value of a predetermined digit of the serial number.

[0016] In the banknote handling apparatus according to still another aspect of the present invention, the control unit, when the serial number of the banknote obtained as a identified result includes an unrecognizable digit, executes an inverse operation of the calculation process based on checksum function for the serial number, thereby calculating a numerical value of the unrecognizable digit in the serial number by using the numbers of the digits in the serial number that are successfully recognized and the predetermined calculation result.

[0017] In the banknote handling apparatus according to still another aspect of the present invention, the control unit, as the predetermined process, transports and stacks the banknote in the rejected banknote stacking unit.

[0018] In the banknote handling apparatus according to still another aspect of the present invention, the control unit, as the predetermined process, notifies occurrence

of an error.

[0019] In the banknote handling apparatus according to still another aspect of the present invention, the control unit, when notifying the occurrence of the error, displays an alert message regarding the serial number of the banknote.

[0020] In the banknote handling apparatus according to still another aspect of the present invention, the control unit, when notifying the occurrence of the error, displays an alert message indicating that the banknote is a suspect banknote.

[0021] The banknote handling apparatus according to still another aspect of the present invention further includes a recognition unit that recognizes denominations of the banknotes transported by the transport unit, and the control unit, when a denomination recognition result of the banknote obtained by the recognition unit is normal and the calculation result for the banknote obtained in the calculation process matches with the predetermined calculation result, determines that the serial number of the banknote is correct and executes a predetermined serial number processing on the serial number of the banknote.

[0022] In the banknote handling apparatus according to still another aspect of the present invention, the predetermined serial number processing executed by the control unit is at least one among a specific number checking process for comparing the serial number of the banknote with a specific serial number, a serial number printing process for printing the serial number of the banknote, a serial number data storing process for saving the serial number of the banknote as data, and a number difference checking process for comparing serial numbers printed on a plurality of different locations on the same banknote with each other.

[0023] A banknote handling system according to still another aspect of the present invention includes an acquiring unit that acquires a serial number of a banknote; a calculation unit that executes a predetermined calculation process based on the serial number of the banknote acquired by the acquiring unit and outputs a calculation result; a judging unit that judges whether the calculation result outputted by the calculation unit matches with a predetermined calculation result; and a determining unit that determines whether the serial number of the banknote is correct based on a judgment result obtained by the judging unit.

[0024] In the banknote handling system according to still another aspect of the present invention, the determining unit determines that the serial number of the banknote is incorrect when the judging unit judges that the calculation result does not match with the predetermined calculation result, and correct when the judging unit judges that the calculation result matches with the predetermined calculation result.

[0025] In the banknote handling system according to still another aspect of the present invention, the acquiring unit includes at least one of an identifying unit that iden-

tifies the serial number of the banknote and acquires the serial number based on the identified result, and an input unit that receives input of the serial number of the banknote.

[0026] A banknote handling method according to still another aspect of the present invention includes acquiring a serial number of a banknote; executing a predetermined calculation process based on the serial number of the banknote acquired at the acquiring and outputs a calculation result for the banknote; judging whether the calculation result outputted at the executing matches with a predetermined calculation result; and determining whether the serial number of the banknote is correct based on a judgment result obtained at the judging.

[0027] In the banknote handling method according to still another aspect of the present invention, the determining includes determining that the serial number of the banknote is incorrect when it is judged at the judging that the calculation result does not match with the predetermined calculation result, and correct when it is judged at the judging that the calculation result matches with the predetermined calculation result.

[ADVANTAGES OF THE INVENTION]

[0028] According to an aspect of the present invention, a banknote handling apparatus having the above structure executes a predetermined calculation process based on the identified serial number of the banknote, determines that the identified serial number of the banknote is incorrect when the calculation result for this banknote does not match with a predetermined result, and executes a predetermined process for the banknote. Thus, it is determined whether the identified serial number of the banknote is correct, and when the identified serial number of the banknote is incorrect, the predetermined process is executed for the banknote. Therefore, any unfavorable events that can be caused due to use of an unchecked, incorrect serial number can be prevented. In addition, unlike the conventional technique that requires cooperation with the server, the banknote handling apparatus according to the present invention can solely check whether the serial number is correct, and can instantly realize the predetermined process for the banknote based on the checking result.

[0029] According to another aspect of the present invention, in the banknote handling apparatus, the predetermined calculation process is executed by using the checksum function for the serial number of the banknote. Consequently, it can be determined whether the serial number of the banknote is correct based on the calculation result.

[0030] According to still another aspect of the present invention, in the banknote handling apparatus, an alphabetic character contained in the identified serial number of the banknote is replaced with a number that corresponds to an alphabetical order of the alphabetic character in the alphabetic series of A to Z. The sum total of

the number replaced from the alphabetic character and numerical values of all the digits in the identified serial number is divided by 9, and it is judged, when the remainder is 8, that the calculation result for the banknote matches with a predetermined result. Based on this judgment result, it can be determined whether the identified serial number of the banknote is correct.

[0031] According to still another aspect of the present invention, in the banknote handling apparatus, the alphabetic character contained in the identified serial number of the banknote is replaced with the number that corresponds to the alphabetical order of the alphabetic character in the alphabetic series of A to Z. The sum total of numerical values of all the digits in the identified serial number including the number replaced from the alphabetic character is calculated. The calculation of the sum total, which is the calculation result, of numerical values of all the digits is repeated until the sum total becomes a single-digit number. It is judged when the calculation result, the single digit number, is 8 that the calculation result for the banknote matches with a predetermined result. Based on this judgment result, it can be determined whether the identified serial number of the banknote is correct.

[0032] According to still another aspect of the present invention, in the banknote handling apparatus, the alphabetic character contained in the identified serial number of the banknote is replaced with the number that is a decimal number corresponding to an ASCII character code of the alphabetic character, the sum total of the number replaced from the alphabetic character and numerical values of all the digits in the identified serial number is divided by 9, and it is judged, when the calculation result is 0, that the calculation result for the banknote matches with a predetermined result. Based on this judgment result, it can be determined whether the identified serial number of the banknote is correct.

[0033] According to still another aspect of the present invention, in the banknote handling apparatus, the alphabetic character contained in the identified serial number of the banknote is replaced with the number that is a decimal number corresponding to an ASCII character code of the alphabetic character, the sum total of numerical values of all the digits including the number replaced from the alphabetic character in the identified serial number is divided by 9, and it is determined, when the remainder is 0, that the calculation result for the banknote matches with a predetermined result. Based on this judgment result, it can be determined whether the identified serial number of the banknote is correct.

[0034] According to still another aspect of the present invention, in the banknote handling apparatus, the predetermined calculation process is executed by using a numerical value of a predetermined digit of the identified serial number of the banknote. Based on this calculation result, it can be determined whether the identified serial number of the banknote is correct.

[0035] According to still another aspect of the present

invention, in the banknote handling apparatus, when the identified serial number of the banknote includes an unrecognizable digit, an inverse operation of the predetermined calculation process that uses the checksum function for the serial number is executed. A numerical value of the unrecognizable digit in the identified serial number is calculated based on the numerical values of the digits that are successfully identified and the value to be obtained as the calculation result of the predetermined calculation process. Consequently, even when the identified serial number of the banknote includes an unrecognizable digit, the numerical value of the unrecognizable digit can be identified by effectively using the checksum function for the serial number.

[0036] According to still another aspect of the present invention, in the banknote handling apparatus, the banknote is transported to and stacked in the rejected banknote stacking unit, as the predetermined process. Consequently, when the identified serial number of the banknote is incorrect, the banknote can be instantly transported to and stacked in the rejected banknote stacking unit.

[0037] According to still another aspect of the present invention, in the banknote handling apparatus, when the identified serial number of the banknote is incorrect, occurrence of an error is notified. Consequently, the operator can recognize that the identified serial number is incorrect based on the error notification.

[0038] According to still another aspect of the present invention, in the banknote handling apparatus, when the identified serial number of the banknote is incorrect, an alert message for the identified serial number of the banknote is displayed. Consequently, the operator can instantly recognize the details of the identified serial number based on the displayed alert message.

[0039] According to still another aspect of the present invention, in the banknote handling apparatus, when the identified serial number of the banknote is incorrect, an alert message indicating that the banknote is a suspect banknote is displayed. Consequently, the operator can instantly recognize that the banknote is a suspect banknote, based on the displayed alert message.

[0040] According to still another aspect of the present invention, in the banknote handling apparatus, when a denomination recognition result of the banknote obtained by the recognition unit is normal and also the calculation result for the banknote obtained in the calculation process matches with the predetermined calculation result, it is determined that the identified serial number of the banknote is correct, and predetermined serial number processing is executed on the identified serial number of the banknote. Therefore, only when the denomination recognition result of the banknote is normal and the identified serial number is correct, the predetermined serial number processing is executed on the identified serial number of the banknote. Consequently, any unfavorable events that can be caused in the predetermined serial number processing due to use of an unchecked, incorrect

serial number can be prevented.

[0041] According to still another aspect of the present invention, in the banknote handling apparatus, at least one among a specific number checking process, a serial number printing process, a serial number data storing process, and a number difference checking process is executed as the predetermined serial number processing. Consequently, only when the denomination recognition result of the banknote is normal and the identified serial number is correct, the specific number checking process, the serial number printing process, the serial number data storing process, or the number difference checking process can be realized as the predetermined serial number processing.

[0042] According to still another aspect of the present invention, in a banknote handling system, a predetermined calculation process is executed based on the serial number of a banknote acquired by an acquiring unit, it is judged whether the calculation result for the banknote matches with a predetermined calculation result, and it is determined based on this judgment result that the acquired serial number of the banknote is correct. Because it is determined whether the acquired serial number of the banknote is correct, any unfavorable events that can be caused in various processes due to use of an unchecked serial number can be prevented.

[0043] According to still another aspect of the present invention, in the banknote handling system, it is determined that the acquired serial number of the banknote is incorrect when the calculation result for the banknote does not match with the predetermined calculation result, and that the acquired serial number of the banknote is correct when the calculation result matches with the predetermined calculation result. In this manner, it can be determined whether the acquired serial number of the banknote is correct.

[0044] According to still another aspect of the present invention, in the banknote handling system, it can be determined whether the identified serial number or the inputted serial number is correct.

[0045] According to still another aspect of the present invention, with a banknote handling method, a predetermined calculation process is executed based on an acquired serial number of a banknote, it is judged whether the calculation result for the banknote matches with a predetermined calculation result, and it is determined based on this judgment result whether the acquired serial number of the banknote is correct. Because it is determined whether the acquired serial number of the banknote is correct, any unfavorable events that can be caused in various processes due to use of an unchecked serial number can be prevented.

[0046] According to still another aspect of the present invention, with the banknote handling method, it is determined that the acquired serial number of the banknote is incorrect when the calculation result for the banknote does not match with the predetermined calculation result, and that the acquired serial number of the banknote is

correct when the calculation result for the banknote matches with the predetermined calculation result. Consequently, it can be determined whether the acquired serial number of the banknote is correct.

BRIEF DESCRIPTION OF DRAWINGS

[0047]

FIG. 1 is a perspective view of an outer appearance of a banknote recognition apparatus according to a first embodiment.

FIG. 2 is a diagram for explaining an internal structure of the banknote recognition apparatus according to the first embodiment.

FIG. 3 is a block diagram of an internal structure of the banknote recognition apparatus according to the first embodiment.

FIG. 4 is a flowchart of the procedure of banknote processing according to the first embodiment.

FIG. 5 is another flowchart of the procedure of the banknote processing according to the first embodiment.

FIG. 6 is a diagram for explaining an example of an input selection screen.

FIG. 7 is a diagram for explaining an example of a serial number correction input screen.

FIG. 8 is a diagram for explaining an example of a serial number input screen (alert screen).

FIG. 9 is a diagram for explaining an example of an input selection screen.

FIG. 10 is a diagram for explaining an example of the serial number input screen (12-digit input screen).

FIG. 11 is a flowchart of an operation of a control unit in a serial number checksum process.

FIG. 12 is a perspective view of a banknote recognition apparatus according to a second embodiment.

FIG. 13 is a diagram for explaining an internal structure of a banknote recognition apparatus according to the second embodiment.

FIG. 14 is a diagram for explaining an internal structure of a banknote recognition apparatus according to a third embodiment.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0048] Exemplary embodiments of a banknote handling apparatus, a banknote handling system, and a banknote handling method are explained in detail below with reference to the accompanying drawings.

[0049] An overview of the present embodiments will be presented first. In the embodiments, a predetermined calculation process is executed based on an acquired serial number of a banknote, it is judged whether the calculation result matches with a predetermined result, and it is determined whether the serial number of the

banknote is correct based on the judgment result. As a result, it can be judged whether the serial number of the banknote is correct, and therefore any unfavorable events that may occur due to use of an unchecked serial number can be prevented.

[First Embodiment]

[0050] FIG. 1 is a perspective view of an outer appearance of a banknote recognition apparatus according to a first embodiment, and FIG. 2 is a diagram of an internal structure of the banknote recognition apparatus according to the first embodiment. A banknote recognition apparatus 1 shown in FIGS. 1 and 2 includes a display unit 11 having a screen on which various kinds of information is displayed, an operation unit 12 with which various commands are inputted on the display screen, a hopper unit 13 in which banknotes of a transaction that are to be received into the apparatus are placed, and a feeding unit 14 that feeds the banknotes, one by one, placed in the hopper unit 13 into the apparatus. The banknote recognition apparatus 1 further includes a transport unit 15, such as a transport belt, that transports the banknotes fed out by the feeding unit 14, and a banknote recognition unit 16 that recognizes denominations, authenticity, orientations, and the like of the banknotes transported by the transport unit 15.

[0051] Furthermore, the banknote recognition apparatus 1 includes a stacking unit 17 that sequentially stacks the banknotes based on the recognition result obtained by the banknote recognition unit 16 recognizing the kinds of the banknotes, and a reject unit 18 that rejects banknotes that are unrecognizable or banknotes that are not included in target banknotes as per the setting.

[0052] A diverter 19 is arranged at each branching point on a transport path inside the banknote recognition apparatus 1. The diverter 19 separates the banknotes transported through the transport path to the stacking unit 17 or the reject unit 18. When a tracking sensor 20A detects the leading end of a banknote, the diverter 19 is driven by a not-shown solenoid such that the banknotes are sorted.

[0053] The stacking unit 17 includes a stacking wheel 21 for stacking the banknotes one by one at a predetermined position in a banknote stacking space and a shutter 22 that opens and closes a banknote slot in the banknote stacking space. The banknotes stacked in the banknote stacking space can be taken out when the shutter 22 is open.

[0054] The banknote recognition unit 16 includes a line sensor unit that optically detects the face-side and back-side of the banknote on the transport path and recognizes the banknote based on the detection result. The line sensor unit includes a recognition unit 23 that recognizes kinds such as denominations of the banknotes, and an identifying unit 24 that identifies the serial numbers printed on the banknotes. The banknote recognition apparatus 1 further includes a control unit 25 that controls the

entire banknote recognition apparatus 1.

[0055] FIG. 3 is a block diagram of an internal structure of the banknote recognition apparatus 1 according to the first embodiment. The banknote recognition apparatus 1 shown in FIG. 3 includes the display unit 11, the operation unit 12, the banknote recognition unit 16 having the recognition unit 23 and the identifying unit 24, a sensor unit 20 having the tracking sensor 20A or the like, the control unit 25, a drive control unit 26, a communication unit 27, and a memory unit 28. The drive control unit 26 drives and controls the feeding unit 14, the transport unit 15, the stacking unit 17, the reject unit 18, the diverter 19, the stacking wheel 21, the shutter 22, and the like. The communication unit 27 corresponds to a communication interface that is connected to an external PC terminal 2 via a communication network to communicate. Various kinds of information is stored in the memory unit 28. The memory unit 28 includes, for example, a specific number memory area 28A in which specific numbers that indicate the serial numbers of registered counterfeit banknotes are registered.

[0056] The control unit 25 includes a calculation unit 31, a judging unit 32, and a determining unit 33. The calculation unit 31 uses, for example, the checksum function that has been adopted for the serial numbers of euro banknotes, and executes a predetermined calculation process based on the serial numbers of the banknotes. The predetermined calculation process corresponds to, for example, a calculation process in which an alphabetic character included in a 12-digit serial number is replaced with a number that corresponds to an alphabetical order of the alphabetic character in the alphabetic series of A to Z, and then the sum total of the number replaced from the alphabetic character and numerical values of all the digits in the serial number is divided by 9 to obtain a remainder. For example, when the 12-digit serial number is "Z10708476264", because "Z" is the 26th alphabetic character in the alphabetic series of A to Z, the calculation unit 31 replaces "Z" with "26". Then, the calculation unit 31 calculates the sum total of the number "26" replaced from "Z" and numerical values of all the remaining digits of "10708476264", that is "26+1+0+7+0+8+4+7+6+2+6+4=71". The calculation unit 31 divides the sum total "71" by "9" to obtain the remainder.

[0057] Thereafter, the judging unit 32 judges whether the calculation result outputted by the calculation unit 31, which is the remainder, matches with a set value. The set value is a value that is always obtained when the predetermined calculation process for the checksum function is executed by using the correct serial number. In the calculation process according to the present embodiment, the set value is "8".

[0058] When the calculation result outputted by the calculation unit 31 matches with the set value, the determining unit 33 determines that the serial number of the banknote is correct. For example, when the calculation result is "8", the determining unit 33 determines that the serial number of the banknote is correct. In contrast, when the

calculation result outputted by the calculation unit 31 does not match with the set value, the determining unit 33 determines that the serial number of the banknote is incorrect. For example, when the calculation result is not "8", the determining unit 33 determines that the serial number of the banknote is incorrect.

[0059] When the determining unit 33 determines that the serial number of the banknote is incorrect, the control unit 25 executes a predetermined process for the banknote. The predetermined process corresponds to, for example, an error display process in which an alert message is displayed onto the display unit 11 or a reject transport process in which the banknote is transported to and stacked in the reject unit 18. When the determining unit 33 determines that the serial number is incorrect number, the control unit 25 controls the drive control unit 26 so that the banknote can be transported to the reject unit 18 as a checksum checking failure banknote. Also, when the determining unit 33 determines that the serial number is incorrect number, an alert message for this banknote can be displayed onto the display unit 11 by the control unit 25.

[0060] When the determining unit 33 determines that the serial number of the banknote is correct, the control unit 25 executes the serial number processing for this banknote. The serial number processing includes a specific number checking process, a serial number printing process, a serial number data storing process, a number difference checking process, and the like.

[0061] In the specific number checking process, when the determining unit 33 determines that the serial number is correct, the serial number of this banknote is compared with specific numbers that correspond to the serial numbers of the counterfeit banknotes registered in the specific number memory area 28 to determine whether the serial number of the banknote matches with any of the specific numbers. When the control unit 25 executes the specific number checking process and finds that the serial number of the banknote matches with a specific number, the banknote is transported to the reject unit 18 as a specific-number banknote. When the serial number of the banknote does not match with any of the specific numbers, the control unit 25 transports the banknote to the stacking unit 17.

[0062] In the serial number printing process, when the determining unit 33 determines that the serial number is correct, the serial number of this banknote is printed and outputted. When the determining unit 33 determines that the serial number is correct, the control unit 25 outputs the serial number of the banknote by printing through a not-shown printer.

[0063] In the serial number data storing process, when the determining unit 33 determines that the serial number is correct, the serial number of the banknote is stored into the memory unit 28. When the determining unit 33 determines that the serial number of the banknote is correct, the control unit 25 stores the serial number of the banknote into the memory unit 28.

[0064] In the number difference checking process, when the determining unit 33 determines that the serial number is correct, two serial numbers printed on the banknote are compared to determine whether these serial numbers match with each other. If in the number difference checking process it is determined that the two serial numbers do not match with each other, the control unit 25 transports this banknote to the reject unit 18 as a different-number banknote. In contrast, if in the number difference checking process it is determined that the serial numbers match with each other, the control unit 25 transports the banknote to the stacking unit 17.

[0065] The control unit 25 can be configured to automatically register the serial number identified by the identifying unit 24 in the specific number memory area 28A as a specific number in the registration mode. The registration mode can be set by performing a setting operation with the operation unit 12. In the registration mode, the control unit 25 can also be configured to accept a manually input serial number via the operation unit 12 and register it in the specific number memory area 28A as a specific number. The control unit 25 can also be configured to register the manually inputted serial number as a specific number in the specific number memory area 28A, by performing a predetermined operation with the operation unit 12, even if the operation mode is not the registration mode.

[0066] Furthermore, the control unit 25 can be configured to acquire a specific number from an SD memory card inserted into a not-shown memory card slot and register the acquired specific number in the specific number memory area 28A. The control unit 25 can also be configured to register the specific number registered in the specific number memory area 28A in the SD memory card.

[0067] Still further, the control unit 25 can be configured to establish connection with the PC terminal 2 via the communication unit 27 to communicate, obtain specific numbers from the PC terminal 2, and register the obtained specific numbers in the specific number memory area 28A. The control unit 25 can also be configured to transmit the specific numbers registered in the specific number memory area 28A to the PC terminal 2.

[0068] Next, the operation of the banknote recognition apparatus 1 according to the first embodiment is explained. FIGS. 4 and 5 are flowcharts of the procedure of banknote processing according to the first embodiment. As shown in FIG. 4, the operator inserts banknotes into the hopper unit 13 of the banknote recognition apparatus 1 (Step S11). The control unit 25 of the banknote recognition apparatus 1 feeds the banknotes inserted into the hopper unit 13 into the apparatus one by one, controls the recognition unit 23 to recognize the denomination of each banknote, and judges whether the denomination of the banknote has been recognized based on the recognition result obtained by the recognition unit 23 (Step S12).

[0069] When the denomination of the banknote has

been recognized (Yes at Step S12), the control unit 25 judges, based on the recognition result obtained by the recognition unit 23, whether the banknote has been recognized as a genuine banknote (Step S13). When the banknote has been recognized as a genuine banknote (Yes at Step S13), the control unit 25 controls the identifying unit 24 to identify the serial number of the banknote, and judges whether the serial number has been identified (Step S14).

[0070] When the serial number has been identified (Yes at Step S14), the control unit 25 executes the serial number checksum process by using the checksum function to determine whether the identified serial number is correct (Step S15). After executing the serial number checksum process, the control unit 25 judges whether the identified serial number has been determined as a correct number (Step S16). When the serial number has been determined as a correct number (Yes at Step S16), the control unit 25 executes normal serial number processing for this banknote (Step S17), transports the banknote to the stacking unit 17 (Step S17A), displays the processing result such as the recognition result and the count result on the display unit 11 (Step S17B), and terminates the processing operation. The normal serial number processing includes the specific number checking process, the serial number printing process, the serial number data storing process, the number difference checking process, and the like.

[0071] When the denomination of the banknote cannot be recognized (No at Step S12), the control unit 25 controls the drive control unit 26 to transport the banknote to the reject unit 18 as a transport error banknote or a denomination error banknote (Step S18). When denomination of a banknote could not be recognized, a transport error such as skewed transport of the banknote on the transport path can be considered as one of the causes in addition to an error of the denomination recognition process. The control unit 25 displays on the display unit 11 an operation screen such that manual input of the denomination, the number of banknotes, or the like can be selected (Step S19), and judges whether the manual input is selected on the operation screen (Step S20).

[0072] When the manual input is selected (Yes at Step S20), the control unit 25 judges whether the denomination and number of banknotes have been manually inputted (Step S21). When the denomination and number of banknotes have been manually inputted (Yes at Step S21), the control unit 25 displays the serial number input screen so that the serial number of each of the banknotes can be inputted on the display unit 11 (Step S22). The serial number input screen corresponds to a screen that prompts for input of all the digits of the serial number (12 digits) as shown in FIG. 10.

[0073] The control unit 25 determines whether manual input process of the serial number is completed on the serial number input screen (Step S23). When manual input process of the serial number is completed (Yes at Step S23), the control unit 25 executes the serial number

checksum process of FIG. 11, which will be described later (Step S24). After executing the serial number checksum process, the control unit 25 judges whether the manually inputted serial number is determined as a correct number (Step S25). When the manually inputted serial number is determined as a correct number (Yes at Step S25), the control unit 25 proceeds to Step S17, at which the normal serial number processing for the banknote is to be executed.

[0074] When the manually inputted serial number is not determined as a correct number, or in other words, when it is determined as an incorrect number (No at Step S25), the control unit 25 displays on the display unit 11 an alert screen indicating that the banknote is a suspect banknote that is likely to be a counterfeit banknote (Step S26). The alert screen is shown in FIG. 8. By checking the alert screen, the operator collects the banknote transported to the reject unit 18 as a counterfeit banknote (Step S27).

[0075] When the manual input is not selected (No at Step S20), the control unit 25 proceeds to Step S11, at which the operator manually re-inserts the banknote transported to and stacked in the reject unit 18 into the hopper unit 13. When the input of the denomination and number of banknotes and the like is not completed (No at Step S21), the control unit 25 continues the monitoring operation of Step S21 until the input of the denomination and number of banknotes and the like is completed. When the manual input is not completed (No at Step S23), the control unit 25 continues the monitoring operation of Step S23 until the manual input is completed.

[0076] When the banknote cannot be recognized as a genuine banknote (No at Step S13), the control unit 25 controls the drive control unit 26 to transport the banknote to the reject unit 18 (Step S28). The control unit 25 displays an SUSP message indicating that the banknote is a suspect banknote on the display unit 11 (Step S29). Based on the SUSP message, the operator performs visual checking for the banknote transported to the reject unit 18 to check the authenticity of the banknote and determines whether the banknote is a genuine banknote (Step S30). When the operator determines the banknote as a genuine banknote (Yes at Step S30), the control unit 25 proceeds to M1 in FIG. 4, at which the operator can manually re-insert into the hopper unit 13 the banknote transported to and stacked in the reject unit 18.

[0077] When the operator does not determine the banknote as a genuine banknote (No at Step S30), the banknote is judged as a counterfeit banknote. The operator therefore manually collects the banknote transported to and stacked in the reject unit 18 as a counterfeit banknote (Step S31).

[0078] When the serial number of the banknote cannot be identified (No at Step S14), the control unit 25 controls the drive control unit 26 so that the banknote can be transported as an unidentifiable serial number banknote to the reject unit 18 (Step S32). Furthermore, the control unit 25 displays onto the display unit 11 the input selection

screen such that the manual input of the serial number can be selected (Step S33), and judges whether the manual input has been selected on this input selection screen (Step S34). The input selection screen corresponds to the screen shown in FIG. 6. When the manual input is selected (Yes at Step S34), the control unit 25 displays the serial number correction input screen on the display unit 11 (Step S35), and proceeds to Step S23. On the serial number correction input screen, the digits of the serial number identified by the identifying unit 24 are displayed, and also any digit that could not be recognized is displayed as a blank, as shown in FIG. 7. When the manual input is not selected (No at Step S34), the control unit 25 proceeds to M2 in FIG. 4, at which the banknote transported to and stacked in the reject unit 18 can be manually re-inserted into the hopper unit 13.

[0079] When the identified serial number is not determined as a correct number (No at Step S16), or in other words, when the identified serial number is determined as an incorrect number, the control unit 25 proceeds to M3 in FIG. 5.

[0080] When the identified serial number is determined as an incorrect number at M3 in FIG. 5, the control unit 25 controls the drive control unit 26 so that the banknote can be transported to the reject unit 18 as a checksum checking failure banknote (Step S41). The control unit 25 displays the input selection screen onto the display unit 11 so that manual input of the serial number can be selected (Step S42). The input selection screen corresponds to the screen as shown in FIG. 9. The operator visually checks the serial number of the banknote transported to and stacked in the reject unit 18, and judges whether the recognition result of the serial number of the banknote is correct (Step S43). When the operator judges that the recognition result of the serial number of the banknote transported to and stacked in the reject unit 18 is correct, or in other words, that the serial number of the banknote matches with the serial number recognition result (Yes at Step S43), it is judged that there is no error in the serial number recognition result. The operator manually collects the banknote as a counterfeit banknote (Step S44).

[0081] When the operator judges, by visual checking, that the recognition result of the serial number of the banknote is incorrect, or in other words, that the serial number is not accurately identified (No at Step S43), the control unit 25 judges that there is an error in the serial number recognition result, and determines whether the manual input for serial number correction is selected on the input selection screen (Step S45). When the manual input for serial number correction is selected on the input selection screen (Yes at Step S45), the control unit 25 displays a serial number correction screen on the display unit 11 (Step S46), and determines whether the correction of the serial number is completed (Step S47).

[0082] When the correction of the serial number is completed (Yes at Step S47), the control unit 25 proceeds to M4 in FIG. 4, at which the serial number checksum

process of Step S24 can be executed to judge whether the manually inputted serial number is correct. When the correction of the serial number is not yet completed (No at Step S47), the control unit 25 proceeds to Step S47 to continue the monitoring operation until the correction of the serial number is completed. When the manual input for serial number correction is not selected on the input selection screen (No at Step S45), the control unit 25 proceeds to M5 in FIG. 4, at which the operator manually re-inserts the banknote transported to and stacked in the reject unit 18 into the hopper unit 13.

[0083] In the banknote processing of FIG. 4, when the serial number of the banknote is identified, it is determined with the checksum function whether the identified serial number is correct, and when it is determined that the serial number is correct, the serial number processing is executed for this banknote.

[0084] In the banknote processing, when it is determined with the checksum function that the identified serial number is incorrect, this banknote is transported to and stacked in the reject unit 18.

[0085] Furthermore, in the banknote processing, when the serial number of the banknote is manually inputted, it is determined with the checksum function whether the manually inputted serial number is correct, and when it is determined that the serial number is correct, the serial number processing is executed for this banknote.

[0086] In the banknote processing, when the serial number of the banknote is manually inputted, it is determined with the checksum function whether the manually inputted serial number is correct, and when it is determined that the serial number is incorrect, this banknote is determined as a collection target because it is a counterfeit banknote.

[0087] The serial number checksum process executed at Steps S15 and S24 in FIG. 4 is explained below. FIG. 11 is a flowchart of the operation of the serial number checksum process performed inside the control unit 25. In the serial number checksum process of FIG. 11, it is determined with the checksum function whether the identified serial number of the banknote or the manually inputted serial number is correct.

[0088] In FIG. 11, the calculation unit 31 of the control unit 25 executes the calculation process by using the checksum function based on the identified serial number of the banknote or the manually inputted serial number (Step S51). The judging unit 32 of the control unit 25 judges whether the calculation result outputted by the calculation unit 31 is the set value "8" (Step S52). When the calculation result outputted by the calculation unit 31 is the set value "8" (Yes at Step S52), the determining unit 33 of the control unit 25 determines that the serial number of the banknote is correct (Step S53). Then, this processing operation is terminated.

[0089] When the calculation result outputted by the calculation unit 31 is not the set value "8" (No at Step S52), the determining unit 33 determines that the serial number of the banknote is not correct, or in other words, that the

serial number includes an error (Step S54). Then, this operation is terminated.

[0090] In the serial number checksum process of FIG. 11, the calculation process is executed by using the checksum function based on the identified serial number or the manually inputted serial number. When the calculation result matches with the set value, it is determined that the serial number of the banknote is correct.

[0091] Furthermore, in the serial number checksum process, the calculation process is executed by using the checksum function based on the identified serial number or the manually inputted serial number. When the calculation result does not match with the set value, it is determined that the serial number of the banknote is incorrect.

[0092] In the first embodiment, the calculation process is executed by using the checksum function based on the identified serial number of the banknote. When the calculation result for this banknote does not match with the set value, it is determined that the serial number of the banknote is incorrect, and this banknote is transported to and stacked in the reject unit 18. In this manner, it is determined whether the identified serial number is correct, and when the serial number is incorrect, this banknote is transported to and stacked in the reject unit 18. Consequently, the serial number processing using incorrect serial numbers can be reliably prevented.

[0093] In the first embodiment, when the calculation result for the banknote matches with the set value, it is determined that the identified serial number of the banknote is correct. After this banknote is transported to and stacked in the stacking unit 17, the serial number processing is executed for the banknote. Consequently, the serial number processing using correct serial numbers can be realized.

[0094] In the first embodiment, unlike with the conventional technique that requires cooperation with the server (PC terminal 2), the banknote recognition apparatus 1 can solely determine whether the identified serial number is correct, and can immediately transport the banknote to the reject unit 18 and stack it therein when the serial number of the banknote is incorrect.

[0095] In the first embodiment, it is determined whether the identified serial number is correct, and when the serial number of the banknote is incorrect, an alert message for the banknote is displayed on the display unit 11. Consequently, the operator can visually notice the alert message and recognize that the identified serial number is incorrect.

[0096] In the first embodiment, an alphabetic character contained in the serial number of the banknote is replaced with a number that corresponds to the alphabetical order of this alphabetic character in the alphabetic series of A to Z. After replacement, the sum total of the number replaced from the alphabetic character and numerical values of all the digits in the serial number is divided by 9, and it is determined that the serial number of the banknote is correct when the remainder is 8. Consequently,

it can be determined, based on the result of the checksum calculation process, whether the serial number of the banknote is correct.

[0097] In the first embodiment, when the denomination recognition result of the banknote is normal and also when it is determined that the identified serial number is correct, the serial number processing such as the specific number checking process, the serial number printing process, the serial number data storing process, and the number difference checking process is executed. Consequently, the serial number processing using correct serial numbers can be realized.

[0098] In the first embodiment, because the banknote recognition apparatus 1 includes the specific number memory area 28A in which specific numbers are registered, the specific number checking process can be realized solely by the banknote recognition apparatus 1, without requiring cooperation with the PC terminal 2. In addition to the specific number checking process, the serial number processing such as the serial number printing process, the serial number data storing process, and the number difference checking process can also be realized solely by the banknote recognition apparatus 1.

[0099] In the first embodiment, it is determined whether the identified serial number or the manually inputted serial number is correct by using the checksum function of the serial number, and various processes are executed in accordance with verification result of the serial number of the banknote. Consequently, unfavorable events can be prevented in the various processes using an unchecked serial number.

[0100] The banknote recognition apparatus 1 according to the first embodiment includes a single stacking unit 17; however, two stacking units 17 can be arranged. Such an arrangement is explained below as a second embodiment.

[Second Embodiment]

[0101] FIG. 12 is a perspective view of an outer appearance of a banknote recognition apparatus according to the second embodiment, and FIG. 13 is a diagram of an internal structure of the banknote recognition apparatus according to the second embodiment. The same numerals are given to the same structural components as those of the banknote recognition apparatus 1 according to the first embodiment, and the overlapping portion of the structure and operation is omitted from the explanation.

[0102] A banknote recognition apparatus 1A shown in FIGS. 12 and 13 includes the display unit 11, the operation unit 12, the hopper unit 13, the feeding unit 14, the transport unit 15, the banknote recognition unit 16, the reject unit 18, the diverters 19, the sensor unit 20 having the tracking sensors 20A, and the stacking wheels 21. In addition, the banknote recognition apparatus 1A includes a control unit 25A, and also the drive control unit 26, the communication unit 27, and the memory unit 28

that are not shown in the figure. A major difference between the banknote recognition apparatus 1A shown in FIG. 12 and the banknote recognition apparatus 1 according to the first embodiment is that the former includes two stacking units, a first stacking unit 17A and a second stacking unit 17B, in place of the stacking unit 17 of the latter.

[0103] The sensor unit 20 further includes a tracking sensor 20B that detects presence/absence of a banknote in the hopper unit 13, and tracking sensors 20C that detect presence/absence of a banknote in the first stacking unit 17A and the second stacking unit 17B. The sensor unit 20 also includes full detection sensors 20D that detect whether the first stacking unit 17A and the second stacking unit 17B are filled with the banknotes, and a tracking sensor 20E that detects presence/absence of a banknote in the reject unit 18.

[0104] The control unit 25A controls the drive control unit 26 so that, when the banknote is found to be a normal fit banknote based on the recognition result obtained by the banknote recognition unit 16, the fit banknote is transported to and stacked in the first stacking unit 17A, and that, when the banknote is found to be a normal unfit banknote, the unfit banknote is transported to and stacked in the second stacking unit 17B. When the banknote is found to be an abnormal banknote such as a counterfeit banknote, a specific-number banknote, a different-number banknote, a checksum checking failure banknote, a transport error banknote, a denomination error banknote, or an unidentifiable serial number banknote by the banknote recognition unit 16, the control unit 25A controls the drive control unit 26 so that the banknote is transported to and stacked in the reject unit 18.

[0105] In the second embodiment, the calculation process is executed by using the checksum function based on the identified serial number of the banknote, and when the calculation result for this banknote does not match with the set value, it is determined that the serial number of the banknote is incorrect. Then, this banknote is transported to and stacked in the reject unit 18. In this manner, it is determined whether the identified serial number is correct, and when the serial number is incorrect, this banknote is transported to and stacked in the reject unit 18. Consequently, the serial number processing using any incorrect serial number can be reliably prevented.

[0106] When the calculation result for the banknote matches with the set value, it is determined that the identified serial number of the banknote is correct. After fit banknotes are transported to and stacked in the first stacking unit 17A, and unfit banknotes are transported to and stacked in the second stacking unit 17B, the serial number processing is executed for the banknotes. Consequently, the serial number processing using correct serial numbers can be realized for both the fit banknotes and the unfit banknotes.

[0107] In the second embodiment, unlike with the con-

ventional technique that requires cooperation with the server (PC terminal 2), it can be determined whether the identified serial number is correct, and when the serial number of the banknote is incorrect, this banknote can be instantly transported to and stacked in the reject unit 18.

[0108] In the second embodiment, the normal unfit banknotes are transported to and stacked in the second stacking unit 17B. However, the arrangement can be set such that, transport error banknotes, denomination error banknotes, and unidentifiable serial number banknotes are transported to and stacked in the reject unit 18, while counterfeit banknotes, specific-number banknotes, different-number banknotes, and checksum checking failure banknotes are transported to and stacked in the second stacking unit 17B. The kinds of banknotes that are stacked in the first stacking unit 17A, the second stacking unit 17B, and the reject unit 18 can be suitably changed as desired.

[0109] In the banknote recognition apparatus 1A according to the second embodiment, two stacking units 17 and one reject unit 18 are arranged; however, eight stacking units 17 and two reject units 18 can be arranged. Such an arrangement is explained below as a third embodiment.

[Third Embodiment]

[0110] FIG. 14 is a diagram of an internal structure of a banknote recognition apparatus according to the third embodiment. The same structural components as those of the banknote recognition apparatus 1A according to the second embodiment are given the same numerals, and the overlapping portion of the structure and operation is omitted from the explanation. A banknote recognition apparatus 1B shown in FIG. 14 includes the display unit 11 (not shown), the operation unit 12 (not shown), the hopper unit 13, the feeding unit 14, the transport unit 15, the banknote recognition unit 16, the diverters 19, the sensor unit 20 having the tracking sensors 20A, and the stacking wheels 21. The banknote recognition apparatus 1B further includes a control unit 25B, and also the drive control unit 26, the communication unit 27, and the memory unit 28 that are not shown in the figure.

[0111] A major difference between the banknote recognition apparatus 1B and the banknote recognition apparatus 1A according to the second embodiment is that the former includes eight stacking units 17, the first stacking unit 17A to an eighth stacking unit 17H in place of the two stacking units 17 of the latter, and two reject units, a first reject unit 18A and a second reject unit 18B, in place of the reject unit 18 of the latter. In the banknote recognition apparatus 1B, it is possible to set the kinds of banknotes to be stacked in the first stacking unit 17A to the eighth stacking unit 17H and the first reject unit 18A and the second reject unit 18B by performing a setting operation with the operation unit 12. For example, setting is performed so that 10-euro fit banknotes are stacked in

the first stacking unit 17A, 20-euro fit banknotes in the second stacking unit 17B, 50-euro fit banknotes in the third stacking unit 17C, and 100-euro fit banknotes in the fourth stacking unit 17D. Furthermore, setting is performed so that 10-euro unfit banknotes are stacked in the fifth stacking unit 17E, 20-euro unfit banknotes in the sixth stacking unit 17F, 50-euro unfit banknotes in the seventh stacking unit 17G, and 100-euro unfit banknotes in the eighth stacking unit 17H. Still further, setting is performed so that counterfeit banknotes, checksum checking failure banknotes, specific-number banknotes, and different-number banknotes are stacked in the first reject unit 18A. Moreover, setting is performed so that transport error banknotes, denomination error banknotes, and unidentifiable serial number banknotes are stacked in the second reject unit 18B.

[0112] When it is found based on the recognition result obtained by the banknote recognition unit 16 that the transported banknote is abnormal, i.e., a counterfeit banknote, a specific-number banknote, a different-number banknote, or a checksum checking failure banknote, the control unit 25B controls the drive control unit 26 so that this transported banknote is transported to and stacked in the first reject unit 18A.

[0113] When it is found based on the recognition result obtained by the banknote recognition unit 16 that the transported banknote is abnormal, i.e., a transport error banknote, a denomination error banknote, and an unidentifiable serial number banknote, the control unit 25B controls the drive control unit 26 so that this transported banknote is transported to and stacked in the second reject unit 18B.

[0114] In the third embodiment, the checksum calculation process is executed based on the identified serial number of the banknote, and when the calculation result for this banknote does not match with the set value, it is determined that the serial number of the banknote is incorrect. The banknote is transported to and stacked in the first reject unit 18A. In this manner, it is determined whether the identified serial number is correct, and when the serial number is incorrect, the banknote is transported to and stacked in the first reject unit 18A. Consequently, the serial number processing using any incorrect serial number can be reliably prevented.

[0115] Moreover, it is determined that the identified serial number of the banknote is correct when the calculation result for the banknote matches with the set value. This banknote is transported to and stacked in corresponding one of the first stacking unit 17A to the eighth stacking unit 17H based on the designated denomination. Consequently, the serial number processing of the banknotes by using correct serial numbers can be realized.

[0116] In the third embodiment, unlike with the conventional technique that requires the cooperation with the server (PC terminal 2), it is determined whether the identified serial number is correct, and when the serial number of the banknote is incorrect, this banknote is instantly

transported to and stacked in the first reject unit 18A.

[0117] When the transported banknote is, for example, a counterfeit banknote, a specific-number banknote, a different-number banknote, or a checksum checking failure banknote, this transported banknote is transported to and stacked in the first reject unit 18A. Therefore, the operator can readily collect the counterfeit banknote, the specific-number banknote, the different-number banknote, or the checksum checking failure banknote from among the transported banknotes.

[0118] Furthermore, when the transported banknote is, for example, a transport error banknote, a denomination error banknote, or an unidentifiable serial number banknote, this transported banknote is transported to and stacked in the second reject unit 18B. Therefore, the operator can readily collect the transport error banknote, the denomination error banknote, or the unidentifiable serial number banknote from among the transported banknotes.

[0119] Still further, when the transported banknote is a normal fit banknote or a normal unfit banknote, the transported banknote is transported to and stacked in corresponding one of the first stacking unit 17A to the eighth stacking unit 17H based on the designated denomination. Therefore, the operator can readily collect the normal fit banknote or normal unfit banknote of any designated denomination from among the transported banknotes.

[0120] In addition, when kinds of to-be-stacked banknotes are set to the first stacking unit 17A to the eighth stacking unit 17H and the first reject unit 18A and the second reject unit 18B, counterfeit banknotes can be set to the first reject unit 18A, while transport error banknotes, denomination error banknotes, and unidentifiable serial number banknotes can be set to the second reject unit 18B. Furthermore, checksum checking failure banknotes can be set to the first stacking unit 17A, specific-number banknotes can be set to the second stacking unit 17B, different-number banknotes can be set to the third stacking unit 17C, and different denominations of normal banknotes can be set to the fourth stacking unit 17D to the eighth stacking unit 17H.

[0121] With the above setting, when the transported banknote is a counterfeit banknote, the control unit 25B controls the drive control unit 26 so that the transported banknote is transported to and stacked in the first reject unit 18A. When the transported banknote is a transport error banknote, a denomination error banknote, or an unidentifiable serial number banknote, the control unit 25B controls the drive control unit 26 so that the transported banknote is transported to and stacked in the second reject unit 18B. When the transported banknote is a checksum checking failure banknote, the control unit 25B controls the drive control unit 26 so that the transported banknote is transported to and stacked in the first stacking unit 17A. When the transported banknote is a specific-number banknote, the control unit 25B controls the drive control unit 26 so that the transported banknote is

transported to and stacked in the second stacking unit 17B. When the transported banknote is a different-number banknote, the control unit 25B controls the drive control unit 26 so that the transported banknote is transported to and stacked in the third stacking unit 17C.

[0122] When the transported banknote is a counterfeit banknote, the banknote recognition apparatus 1B transports this transported banknote to the first reject unit 18A and stack it therein. When the transported banknote is a transport error banknote, a denomination error banknote, or an unidentifiable serial number banknote, the banknote recognition apparatus 1B transports this transported banknote to the second reject unit 18B and stack it therein. When the transported banknote is a checksum checking failure banknote, the banknote recognition apparatus 1B transports this transported banknote to the first stacking unit 17A and stack it therein. When the transported banknote is a specific-number banknote, the banknote recognition apparatus 1B transports this transported banknote to the second stacking unit 17B and stacks it therein. When the transported banknote is a different-number banknote, the banknote recognition apparatus 1B transports this transported banknote to the third stacking unit 17C and stacks it therein. When the transported banknote is a normal banknote, the banknote recognition apparatus 1B transports this transported banknote to corresponding one of the fourth stacking unit 17D to the eighth stacking unit 17H based on the designated denomination and stacks it therein.

[0123] In the first to third embodiments, as the checksum calculation process for serial numbers, the calculation process is executed in which an alphabetic character contained in a serial number is replaced with a number that corresponds to the alphabetical order of the alphabetic character in the alphabetic series of A to Z, and the sum total of the number after replacement and numerical values of all the digits in the serial number is divided by "9" to obtain the remainder. When the remainder is the set value "8", it is determined that the serial number is correct. However, the following calculation process can be used instead of the checksum calculation process explained above.

[0124] The calculation unit 31 can execute a calculation process by replacing any alphabetic character contained in the serial number of the banknote with the number that corresponds to the alphabetical order of the alphabetic character in the alphabetic series of A to Z, calculating the sum total of numerical values of all the digits in the serial number including this number replaced from the alphabetic character, and repeating the calculation of the sum total of numerical values of all the digits until the sum total, which is the calculation result, becomes a single-digit number. For example, when a 12-digit serial number is "Z10708476264", "Z" is replaced with "26" because "Z" is the "26th" alphabetic character in the alphabetic series of A to Z. The sum total of numerical values of all the digits in the serial number "2610708476264" including this number after replace-

ment, which is $2+6+1+0+7+0+8+4+7+6+2+6+4=53$, is calculated. Obtaining the sum total "53", the calculation unit 31 calculates $5+3=8$ and obtains the calculation result "8". The determining unit 33 determines that the serial number is correct when this calculation result is the set value "8".

[0125] In an alternative method, the calculation unit 31 replaces an alphabetic character contained in the serial number of the banknote with the number that is a decimal value corresponding to an ASCII character code and dividing the sum total of the number replaced from the alphabetic character and numerical values of all the digits in the serial number by "9" to obtain the remainder. For example, when the 12-digit serial number is "Z10708976264", the alphabetic character "Z", whose ASCII character code in decimal system is "90", is replaced with "90". The sum total of the number after replacement "90" and numerical values of all the digits in the remaining number "10708475264" is calculated, which is $90+1+0+7+0+8+4+7+6+2+6+4=135$. The sum total is divided by "9" to obtain the remainder. The determining unit 33 determines that the serial number is correct when the calculation result is a previously set value "0".

[0126] In an alternative method, the calculation unit 31 executes the calculation process by replacing an alphabetic character in the serial number of the banknote with the number that is a decimal value corresponding to an ASCII character code and dividing the sum total of numerical values of all the digits including the number replaced from the alphabetic character in the serial number by "9" to obtain the remainder. For example, when the 12-digit serial number is "Z10708476264", the alphabetic character "Z", whose ASCII character code in decimal system is "90", is replaced with "90". The sum total of numerical values of all the digits including the number after replacement, "90", in the serial number, "9010708476264", is calculated, which is $9+0+1+0+7+0+8+4+7+6+2+6+4=54$. The calculation unit 31 then calculates the sum total of numerical values of the digits of the sum total "54", i.e., $5+4=9$ and obtains the calculation result "9". Then, the calculation unit 31 divides the calculation result "9" by "9" to obtain the remainder. The determining unit 33 determines that the serial number is correct, when the calculation result is the set value "0".

[0127] In the first to third embodiments, when the identified serial number includes an unrecognizable digit, the unrecognizable digit can be manually inputted. However, for example, if there is one digit that is unrecognizable, an inverse operation of the above calculation process by using the sum check function can be performed to automatically obtain a numerical value of the unrecognizable digit. For example, assume that the 12-digit serial number is "Z10708*76264" where the seventh digit is unrecognizable and therefore replaced with "*". Then, "Z" is replaced with the number "26" that corresponds to the alphabetical order. Subsequently, the sum total of the

number after replacement, "26", and numerical values of all the digits in "10708*76264" except for the unrecognizable digit is calculated, which is $26+1+0+7+0+8+7+6+2+6+4=67$. The sum total is divided by "9" and the remainder "4" is obtained. The remainder "4" is subtracted from the set value "8", and the calculation result "4" is obtained as the number of the seventh digit that has been unrecognizable.

[0128] In other words, when the identified serial number of the banknote includes an unrecognizable digit, an inverse operation of the predetermined calculation process is executed by using the checksum function for the serial number, and the numerical value of the unrecognizable digit in the serial number can be calculated based on the recognized digits of the serial number and the set value of the calculation process. Consequently, even when an unrecognizable digit is included in the identified serial number of the banknote, the numerical value of the unrecognizable digit can be identified by effectively using the checksum function for the serial number.

[0129] In the above embodiments, the banknote recognition apparatus 1 (1A, 1B) can solely perform the calculation process by using the checksum function based on the serial number, a judgment process of judging whether the calculation result matches with a set value, and a determination process of determining based on the judgment result whether the serial number is correct. However, similar effects can be attained by assigning any of the calculation process, the judgment process, and the determination process to the PC terminal 2 connected to the banknote recognition apparatus 1 (1A, 1B).

[0130] In the above embodiments, euro banknotes that adopt the checksum function for their serial numbers are used as an example, but the banknotes are not limited to the euro banknotes. The present embodiments are applicable to any banknotes that use the checksum function.

[0131] In the above embodiments, the checksum function is used to determine whether the serial number is correct. However, a check digit function can be used for the serial number to judge whether a specific digit of the serial number matches with the check digit, and it can be determined whether the serial number is correct based on the judgment result.

[0132] The embodiments of the present invention have been explained so far; however, the embodiments should not be interpreted to limit the scope of the technical ideas of the present invention, and various modifications can be embodied without departing from the claimed technical ideas. In addition, the advantages are not limited to the ones described above.

[0133] All or part of the processes explained as being automatically executed in the present embodiments can be manually executed. Conversely, all or part of the processes explained as being manually executed in the present embodiments can be automatically executed. In addition, the processing procedure, the controlling procedure, specific names, and information including vari-

ous kinds of data and parameters that have been explained in the present embodiments also can be suitably modified unless otherwise specified.

[0134] The structural components of the apparatus are shown in the drawings to describe concepts of their functions, and therefore do not always have to be physically configured as shown. The specific mode of the apparatus should not be limited to the one shown in the drawings.

[0135] The various processing functions realized by the apparatus can be entirely or partially executed on a CPU (central processing unit) (or a microcomputer such as an MPU (microprocessing unit) and an MCU (microcontroller unit)), on a computer program analyzed and executed by the CPU (or the microcomputer such as the MPU and the MCU), or on hard wired logic.

INDUSTRIAL APPLICABILITY

[0136] The banknote handling apparatus having the above structures according to the present invention executes a predetermined calculation process for the serial number of the banknote, determines whether the serial number of the banknote is correct based on the calculation result, and executes a predetermined process for the banknote only when its serial number is incorrect. Because any unfavorable events that can be caused in the various processes due to use of an unchecked, incorrect serial number can be prevented, the present invention is useful in the banknote recognition apparatus that executes various processes using the serial numbers.

EXPLANATIONS OF LETTERS OR NUMERALS

[0137]

1:	Banknote recognition apparatus
1A:	Banknote recognition apparatus
1B:	Banknote recognition apparatus
11:	Display unit
12:	Operation unit
13:	Hopper unit
15:	Transport unit
17:	Stacking unit
17A to 17H:	First to eighth stacking units
18:	Reject unit
18A:	First reject unit
18B:	Second reject unit
23:	Recognition unit
24:	Identifying unit
25:	Control unit
25A:	Control unit
25B:	Control unit
31:	Calculation unit
32:	Judging unit

(continued)

33: Determining unit

Claims

1. A banknote handling apparatus comprising:

a receiving unit that receives banknotes and feeds the banknotes one by one;
a banknote stacking unit that stacks the banknotes;
a rejected banknote stacking unit that stacks banknotes to be rejected;
a transport unit that transports the banknotes fed by the receiving unit to the banknote stacking unit or the rejected banknote stacking unit;
an identifying unit that identifies a serial number of each of the banknotes transported by the transport unit; and
a control unit that executes a predetermined calculation process based on the serial number identified by the identifying unit and, when a calculation result of the calculation process does not match with a predetermined calculation result, determines that the serial number of the banknote is incorrect, and executes a predetermined process on the banknote.

2. The banknote handling apparatus according to Claim 1, wherein the control unit executes the predetermined calculation process based on a checksum function for the serial number of the banknote.

3. The banknote handling apparatus according to Claim 2, wherein the predetermined calculation process corresponds to a calculation process including

replacing an alphabetic character contained in the serial number of the banknote with a number that corresponds to an alphabetical order, and dividing the sum total of the number replaced at the replacing and numerical values of all the digits in the serial number by 9 to obtain a remainder, and

the predetermined calculation result is 8.

4. The banknote handling apparatus according to Claim 2, wherein the predetermined calculation process corresponds to a calculation process including

replacing an alphabetic character contained in the serial number of the banknote with a number that corresponds to an alphabetical order, and

calculating a sum total of numerical values of all the digits, including the number replaced at the replacing, in the serial number of the banknote, and

repeating the calculating of the sum total, which is the calculation result, of the numerical values of all the digits until the sum total becomes a single-digit number, and

the predetermined calculation result is 8.

5. The banknote handling apparatus according to Claim 2, wherein the predetermined calculation process corresponds to a calculation process including

replacing an alphabetic character contained in the serial number of the banknote with a number that is a decimal number corresponding to an ASCII character code of the alphabetic character, and

dividing the sum total of the number replaced at the replacing and numerical values of all the digits in the serial number by 9 to obtain a remainder, and

the predetermined calculation result is 0.

6. The banknote handling apparatus according to Claim 2, wherein the predetermined calculation process corresponds to a calculation process including

replacing an alphabetic character contained in the serial number of the banknote with a number that is a decimal number corresponding to an ASCII character code of the alphabetic character, and

dividing the sum total of numerical values of all the digits, including the number replaced at the replacing, in the serial number by 9 to obtain the remainder, and

the predetermined calculation result is 0.

7. The banknote handling apparatus according to Claim 1, wherein the control unit executes the predetermined calculation process by using a numerical value of a predetermined digit of the serial number.

8. The banknote handling apparatus according to any one of Claims 2 to 6, wherein the control unit, when the serial number of the banknote obtained as a identified result includes an unrecognizable digit, executes an inverse operation of the calculation process based on the checksum function for the serial number, thereby calculating a numerical value of the unrecognizable digit in the serial number by using

the numbers of the digits in the serial number that are successfully recognized and the predetermined calculation result.

9. The banknote handling apparatus according to any one of Claims 1 to 8, wherein the control unit, as the predetermined process, transports and stacks the banknote in the rejected banknote stacking unit.

10. The banknote handling apparatus according to any one of Claims 1 to 9, wherein the control unit, as the predetermined process, notifies occurrence of an error.

11. The banknote handling apparatus according to Claim 10, wherein the control unit, when notifying the occurrence of the error, displays an alert message regarding the serial number of the banknote.

12. The banknote handling apparatus according to Claim 10, wherein the control unit, when notifying the occurrence of the error, displays an alert message indicating that the banknote is a suspect banknote.

13. The banknote handling apparatus according to any one of Claims 1 to 12, further including a recognition unit that recognizes denominations of the banknotes transported by the transport unit, wherein the control unit, when a denomination recognition result of the banknote obtained by the recognition unit is normal and the calculation result for the banknote obtained in the calculation process matches with the predetermined calculation result, determines that the serial number of the banknote is correct and executes a predetermined serial number processing on the serial number of the banknote.

14. The banknote handling apparatus according to Claim 13, wherein the predetermined serial number processing executed by the control unit is at least one among a specific number checking process for comparing the serial number of the banknote with a specific serial number, a serial number printing process for printing the serial number of the banknote, a serial number data storing process for saving the serial number of the banknote as data, and a number difference checking process for comparing serial numbers printed on a plurality of different locations on the same banknote with each other.

15. A banknote handling system comprising:

an acquiring unit that acquires a serial number of a banknote;
a calculation unit that executes a predetermined

calculation process based on the serial number of the banknote acquired by the acquiring unit and outputs a calculation result;
 a judging unit that judges whether the calculation result outputted by the calculation unit matches with a predetermined calculation result; and
 a determining unit that determines whether the serial number of the banknote is correct based on a judgment result obtained by the judging unit.

16. The banknote handling system according to Claim 15, wherein the determining unit determines that the serial number of the banknote is incorrect when the judging unit judges that the calculation result does not match with the predetermined calculation result, and correct when the judging unit judges that the calculation result matches with the predetermined calculation result.
17. The banknote handling system according to Claim 15 or 16, wherein the acquiring unit includes at least one of
 an identifying unit that identifies the serial number of the banknote and acquires the serial number based on the identified result, and
 an input unit that receives input of the serial number of the banknote.
18. A banknote handling method comprising:
 acquiring a serial number of a banknote;
 executing a predetermined calculation process based on the serial number of the banknote acquired at the acquiring and outputs a calculation result for the banknote;
 judging whether the calculation result outputted at the executing matches with a predetermined calculation result; and
 determining whether the serial number of the banknote is correct based on a judgment result obtained at the judging.
19. The banknote handling method according to Claim 18, wherein the determining includes determining that the serial number of the banknote is incorrect when it is judged at the judging that the calculation result does not match with the predetermined calculation result, and correct when it is judged at the judging that the calculation result matches with the predetermined calculation result.

FIG.1

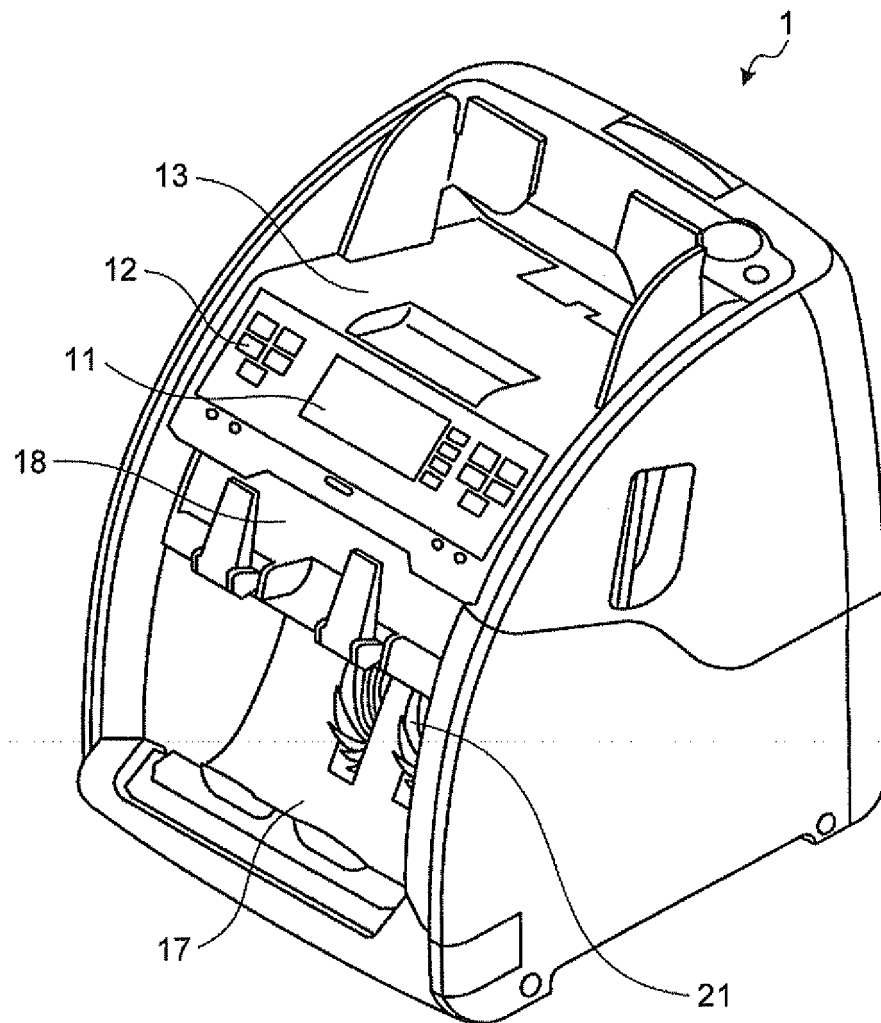


FIG.2

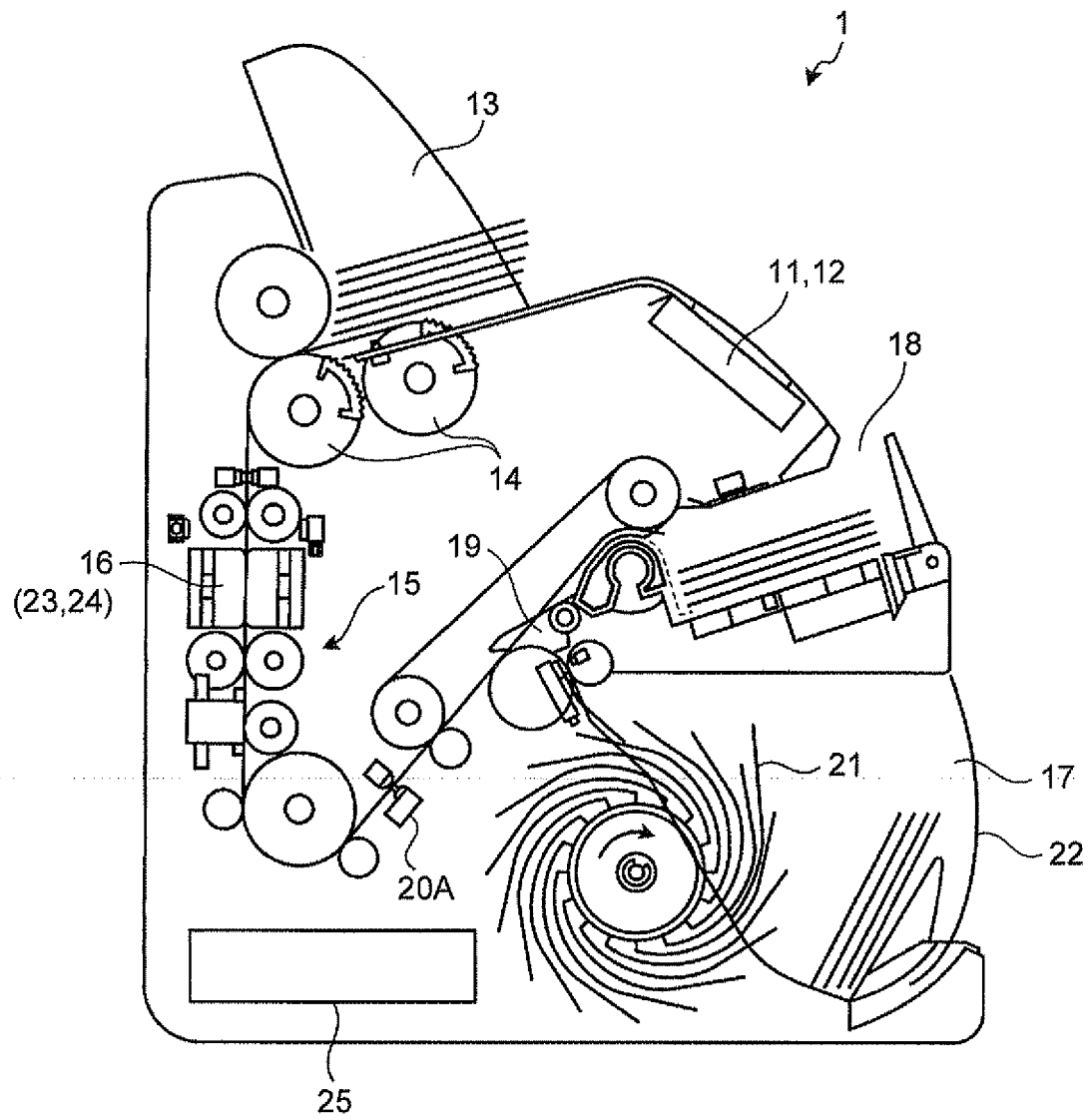


FIG.3

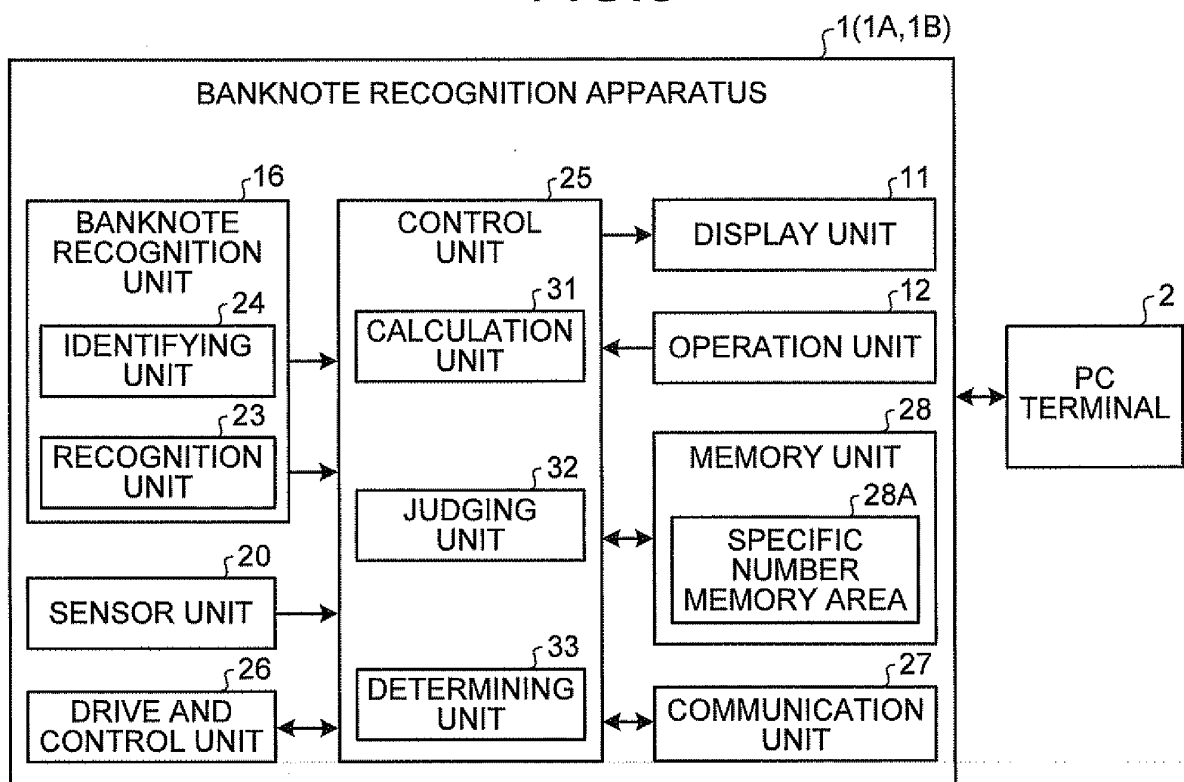


FIG. 4

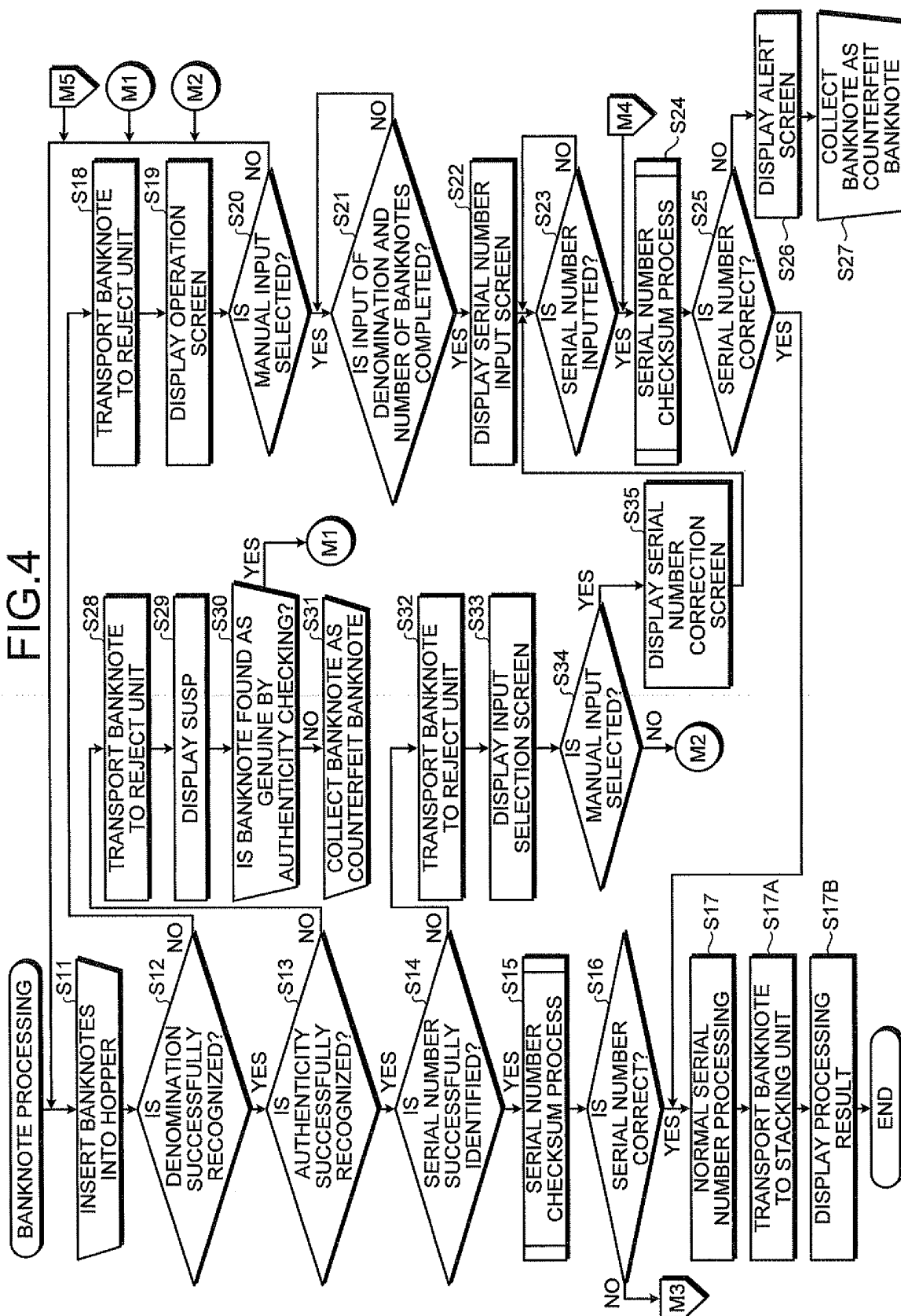


FIG.5

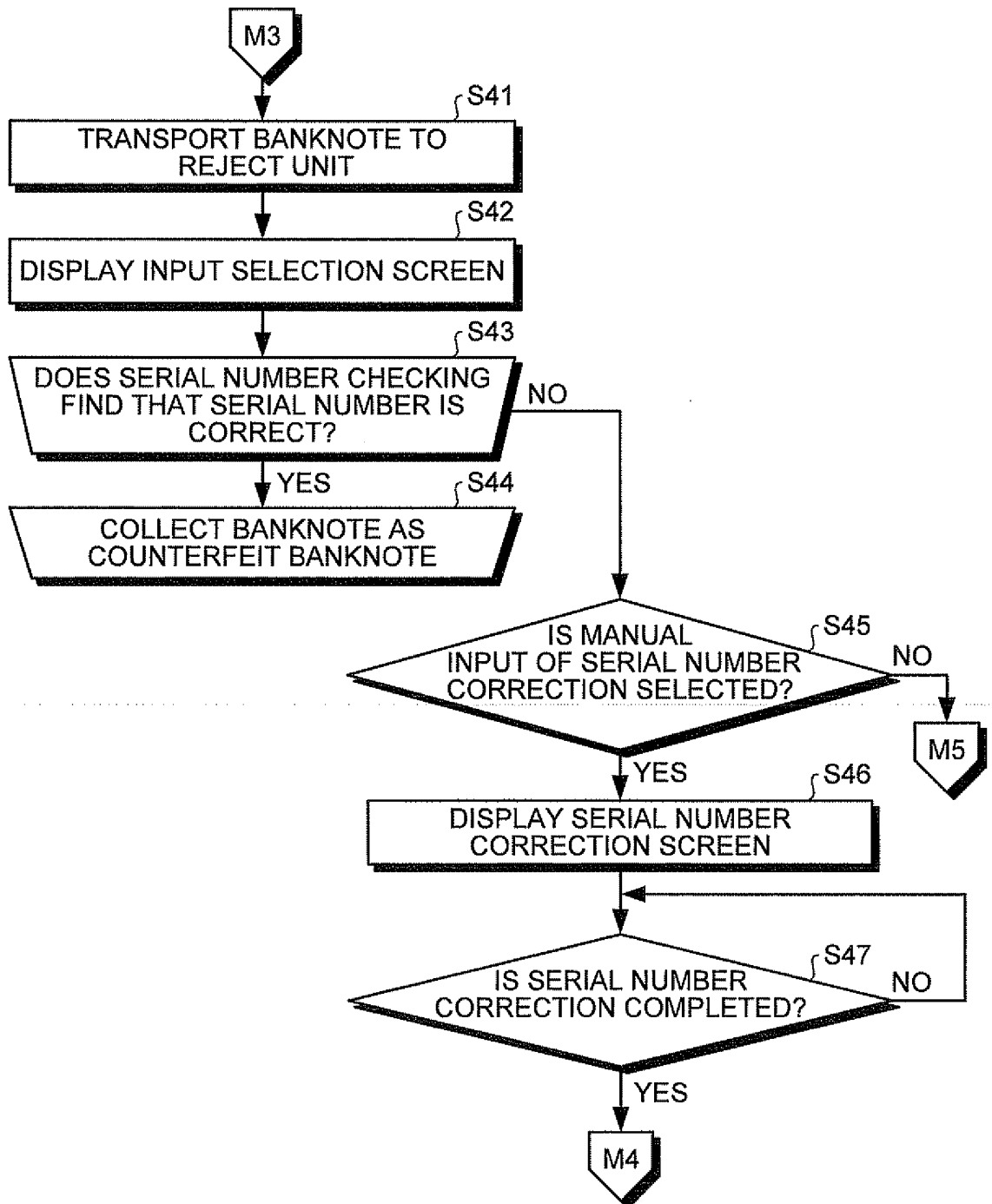


FIG.6

SERIAL NUMBER READ FAILED.

MANUAL ENTRY? YES / NO

FIG.7

ENTER 12-DIGITS SERIAL NUMBER!

Z107084_6264

FIG.8

INCORRECT SERIAL NUMBER!
SUSPECT BANKNOTE!

FIG.9

INCORRECT SERIAL NUMBER!
MANUAL ENTRY? YES / NO

FIG.10

ENTER 12-DIGITS SERIAL NUMBER! _____

FIG.11

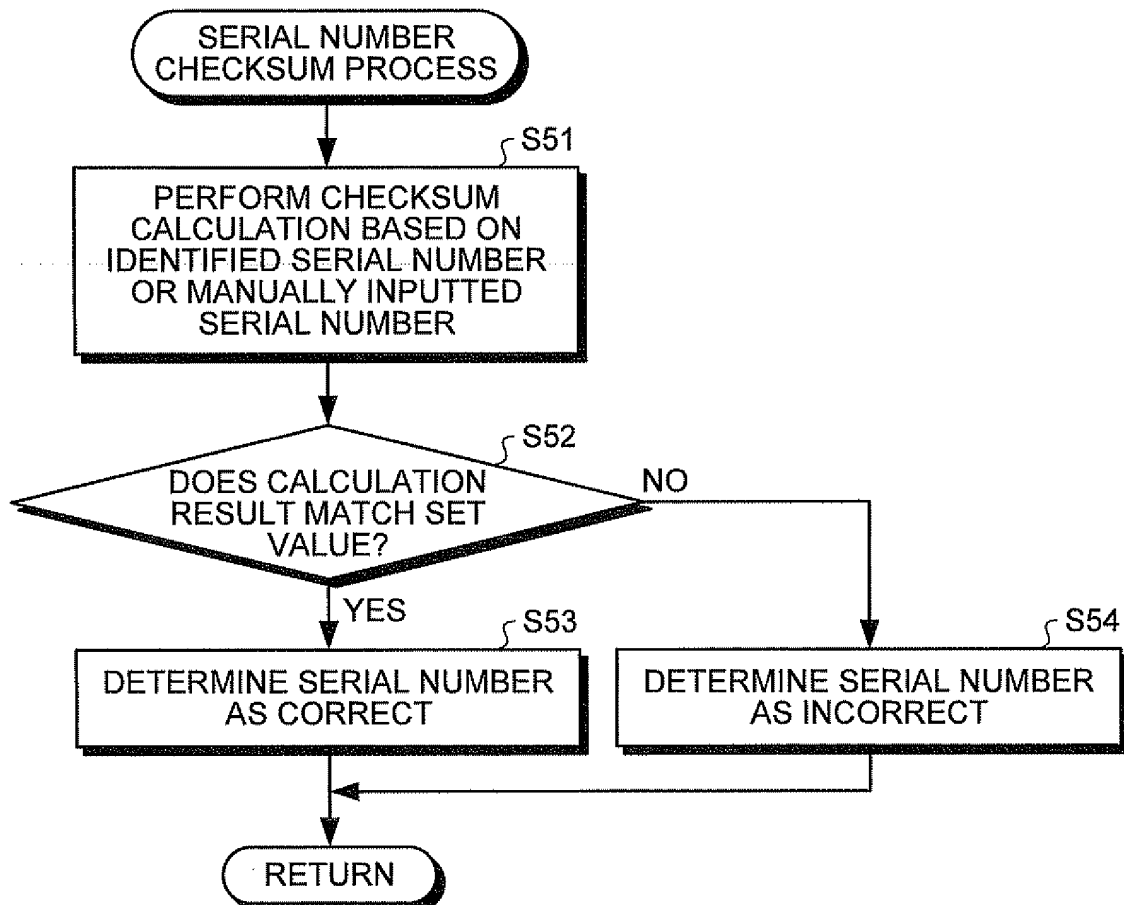


FIG.12

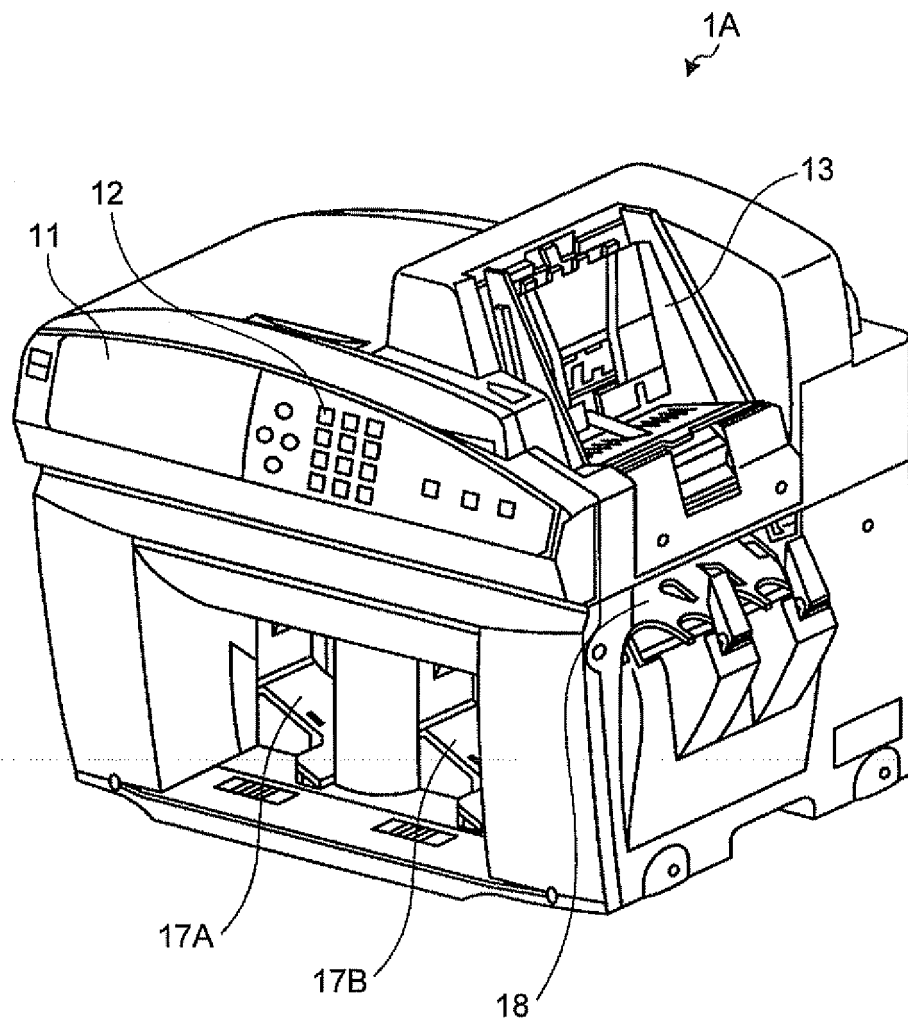
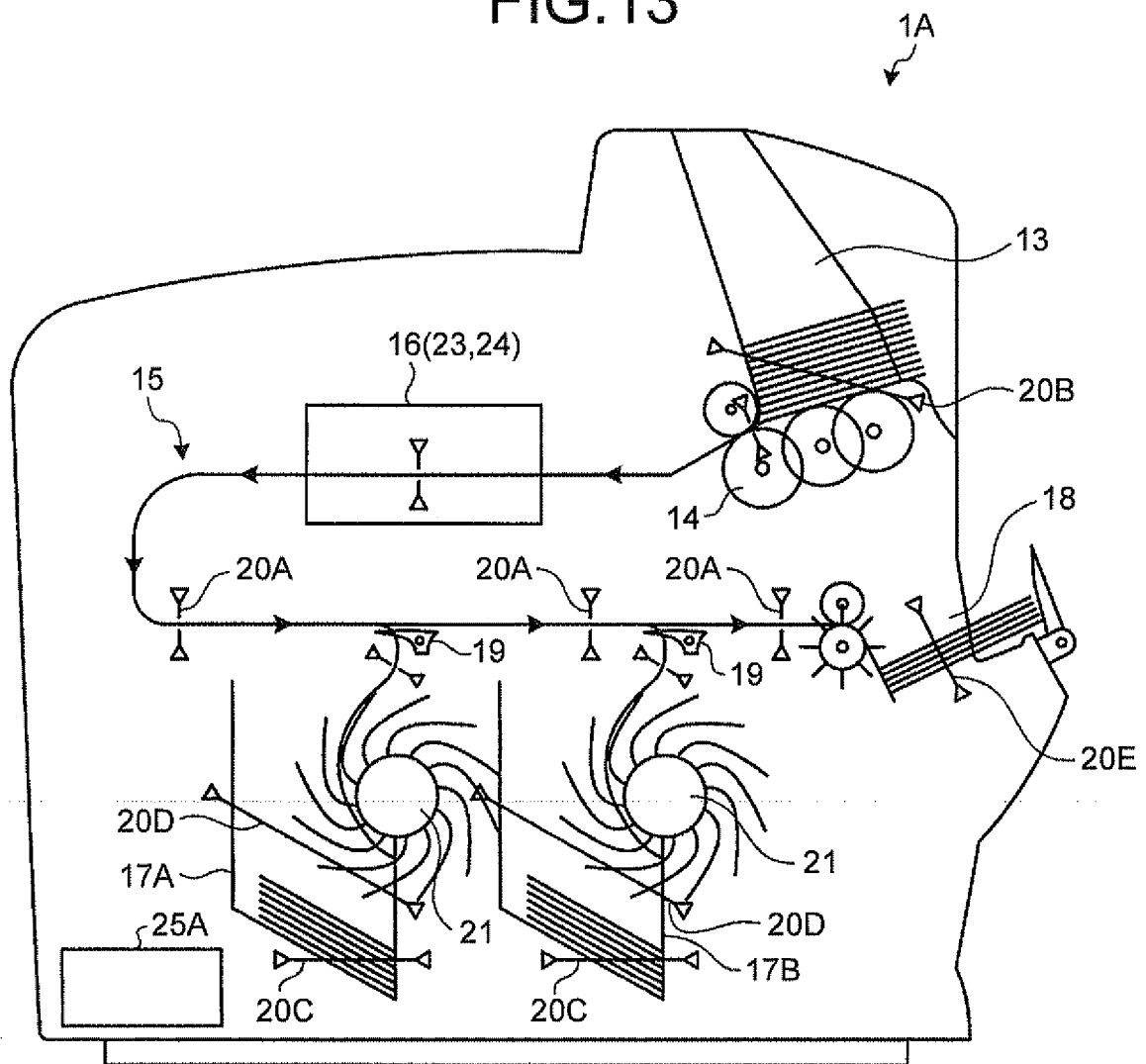
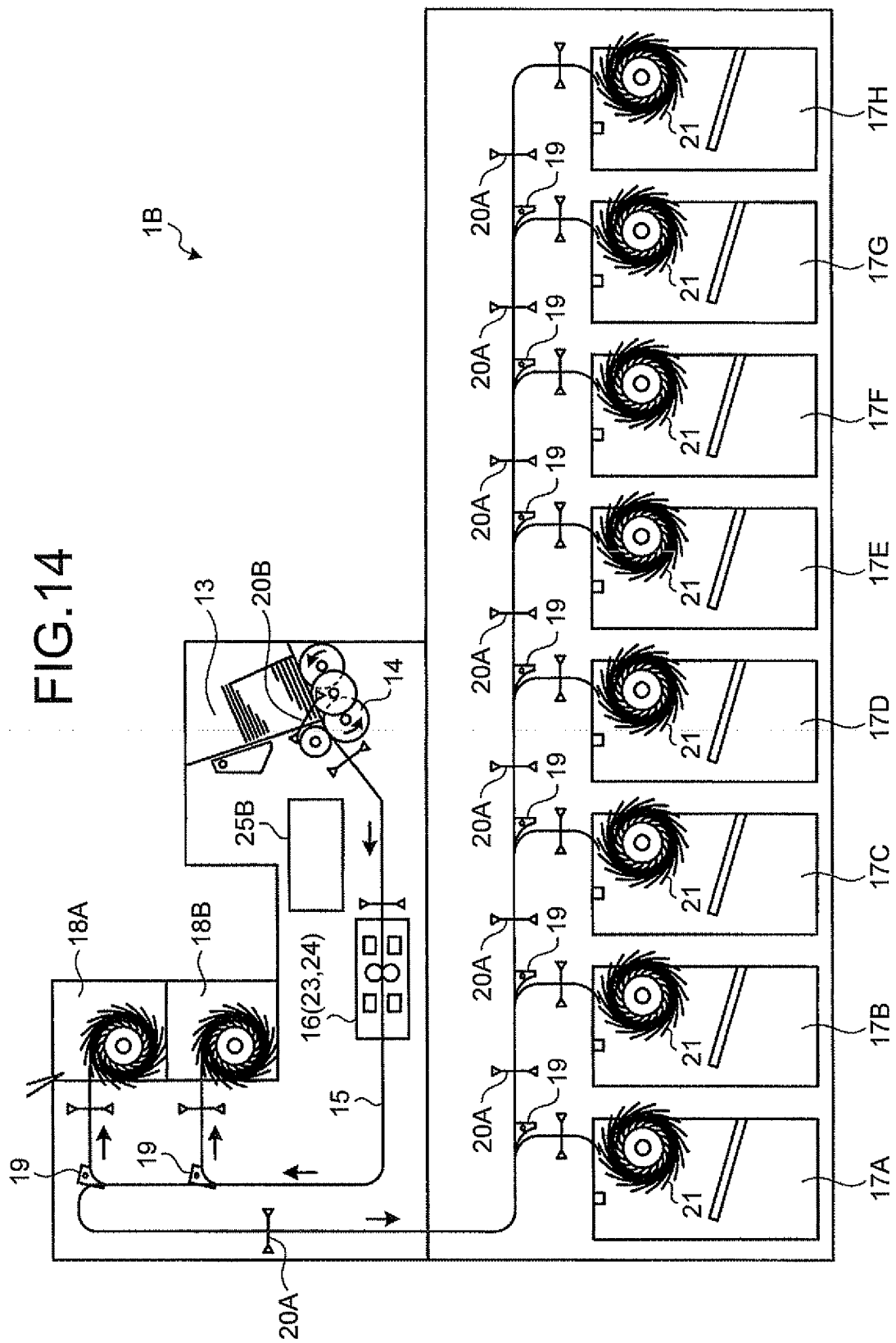


FIG.13





INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/061072

A. CLASSIFICATION OF SUBJECT MATTER

G07D7/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G07D7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-116798 A (Fuji Xerox Co., Ltd.), 28 May 2009 (28.05.2009), entire text; all drawings (Family: none)	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

02 August, 2010 (02.08.10)

Date of mailing of the international search report

10 August, 2010 (10.08.10)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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Form PCT/ISA/210 (second sheet) (July 2009)

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Patent documents cited in the description

- JP 2009116798 A [0005]