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

(11) **EP 1 755 006 A1**

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**21.02.2007 Bulletin 2007/08**

(51) Int Cl.:
***G03G 15/00*** *(2006.01)*

(21) Application number: **06254313.7**

(22) Date of filing: **17.08.2006**

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

(30) Priority: **18.08.2005 JP 2005238045**
**14.09.2005 JP 2005267401**
**06.01.2006 JP 2006001511**
**12.05.2006 JP 2006133744**

(71) Applicant: **Ricoh Company, Ltd.**
**Tokyo 143-8555 (JP)**

(72) Inventor: **Hattori, Hitoshi**
**Ohta-ku, Tokyo 143-8555 (JP)**

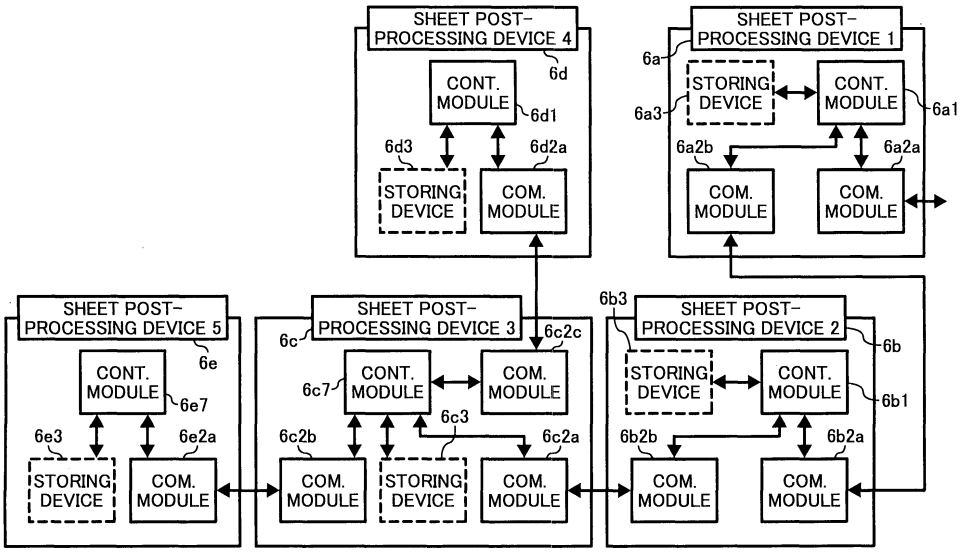
(74) Representative: **Lamb, Martin John Carstairs**
**Marks & Clerk**
**90 Long Acre**
**London WC2E 9RA (GB)**

## (54) Data transmission between sheet post-processing modules

(57) A sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e)includes a conveying member configured to convey a sheet-like recording medium, a processing unit configured to perform a given operation to the recording medium conveyed by the conveying member, a communication unit (6a2a, 6a2b, 6b2a, 6b2b, 6c2a, 6c2b, 6c2c, 6a2a, 6e2a)configured to communicate with an external device connected to the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) for the given operation performed by the processing unit, a control (6a1, 6b1, 6c1, 6d1, 6e1) unit configured to control, via the communication unit (6a2a, 6a2b, 6b2a, 6b2b, 6c2a, 6c2b, 6c2c, 6a2a, 6e2a), information passing between the sheet post-processing device and the external device at a desired timing. A storing unit (6a3, 6b3, 6c3, 6d3, 6e3) may be provided configured to store information of the recording medium transmitted from the external device. The control unit (6a1, 6b1, 6c1, 6d1, 6e1) may transmit the information at one of timing before a discharge of the recording medium and a timing after a discharge of the recording medium.

A sheet post-processing system and a image forming system (100, 200) including a plurality of the sheet post-processing devices (6, 6a, 6b, 6c, 6d, 6e)are provided.

FIG. 5




EP 1 755 006 A1

## Description

BACKGROUND

FIELD

**[0001]** The present patent application generally relates to a sheet post-processing device, a sheet post-processing system including a plurality of the sheet post-processing devices, and an image forming system including the sheet post-processing system having the plurality of the above-described sheet post-processing device.

DISCUSSION OF THE RELATED ART

**[0002]** One image forming system employs a known technique for controlling an image forming device connected with a plurality of sheet processing devices for stably performing a sheet processing operation.

**[0003]** Specifically, the image forming system includes a relay control unit is mounted between the image forming device and each sheet processing device so that the relay control unit can control operations of each sheet processing device. Such a relay control unit can determine the operation time for a corresponding sheet processing device that performs a specific function of various sheet processing operations, and, after a given period of the operation time has elapsed, transmit information of the sheet processing operation to each sheet processing device.

**[0004]** Further, another image forming system employs a known data communication method using a technique in which data transmission is controlled.

**[0005]** Specifically, when one peripheral device is connected with a single host system or with a plurality of host systems, the data communication method can cause the peripheral device to avoid the communication timeout with the host system. To avoid interruption of the communication with each host system when one peripheral device is connected to a plurality of host systems, a busy signal is output from the peripheral device to the host system while the peripheral device is in a condition it cannot receive data, and the host system that has received the busy signal temporarily stops data transmission after a given timeout period has elapsed.

**[0006]** With the above-described data communication method, the peripheral device is caused to specify a timeout prevention period that runs shorter than the timeout period, count the timeout prevention period starting from the initial state of the busy signal, and reset the output of the busy signal after the timeout prevention period has elapsed.

**[0007]** Further, one sheet post-processing system employs a known technique using a skewing part and connecting units that perform a multistage connection to simplify connecting mechanism and control software.

**[0008]** Specifically, the skewing part receives a paper sheet discharged from an image forming device in a skewed state and discharges the paper sheet to a first sheet post-processing device on the basis of one end portion thereof.

**[0009]** The connecting units are respectively provided in and controlled by a plurality of sheet post-processing devices so as to discharge the paper sheet from the skewing part or from an upstream device connected thereto to a downstream device also connected thereto.

**[0010]** To transmit information of a paper sheet, for example, a paper size, a request of sheet post-processing and so forth, to the corresponding downstream device in a system in which a plurality of sheet post-processing devices are connected, it is commonly known to mount a relay control unit so that the relay control unit determines respective appropriate operation times for the plurality of sheet post-processing devices, and transmits the information to the corresponding sheet post-processing device after a given period has elapsed. Thus, it is preferable that each sheet post-processing peripheral device receives information of the paper sheet before or after the paper sheet is received. Otherwise, it may be difficult to perform sheet post-processing operations in high-speed and stable manner.

**[0011]** However, the relay control unit may require space and costs, which can be a problem. Also, the operation times determined by the relay control unit generally have variations due to slippage in conveying paper sheets. When the degree of the variation is large, the information cannot be transmitted at a correct timing, which can cause errors.

**[0012]** Further, in a sheet post-post processing system in which a plurality of sheet post-processing devices are connected to each other, a sheet post-processing device disposed on a further downstream side may need a longer time to receive a paper sheet from an image forming device connected to a most upper sheet post-processing device.

**[0013]** If a driver of corresponding conveying rollers initiates the conveying rollers at the start of conveyance of the paper sheet, a period of rotation of the conveying rollers may become unnecessarily long. Especially when the sheet post-processing device is used for processing high-volume paper sheets in high speed, such unnecessary long period of rotation of the conveying rollers may cause a shorter life of the rollers.

**[0014]** Further, the above-described sheet post-processing system including a plurality of sheet post-processing devices is generally connected to an image forming device, forming an image forming system. Such system, however, has the same problems as described above.

## SUMMARY

**[0015]** The present invention has been made, taking the above-mentioned circumstances into consideration.

**[0016]** At least one embodiment of the present invention provides a sheet post-processing device that in-

cludes a conveying member configured to convey a sheet-like recording medium, a processing unit configured to perform a given operation to the recording medium conveyed by the conveying member, characterised in that a communication unit is provided, configured to communicate with an external device connected to the sheet post-processing device for the given operation performed by the processing unit, and a control unit is provided, configured to control, via the communication unit, information passing between the sheet post-processing device and the external device at a desired timing.

**[0017]** The external device, to which the sheet post-processing device of the present invention may be connected, may be upstream or downstream of the sheet post-processing device, the control unit controlling information received from the external device or transmitted to the external device, at a desired timing. The sheet post-processing device of the present invention may be connected to other sheet post-processing devices, both upstream and downstream in the sheet feeding direction.

**[0018]** At least one further embodiment of the present invention provides a sheet post-processing system that includes a plurality of the above-described sheet post-processing devices each connected to at least one different sheet post-processing device of the system.

**[0019]** At least one further embodiment of the present patent application provides an image forming system that includes an image forming device configured to form an image on a surface of a recording medium, and a plurality of the above-described sheet post-processing devices connected to at least one different sheet post-processing device thereof.

In the sheet post-processing system or image forming system of the invention, the external device to which each sheet post-processing devices is connected may be another sheet post-processing device of the system or a device external to the system.

Preferred and/or optional features are set out in claims 2-15 and 17.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0020]** The accompanying drawings are intended to depict example embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

**[0021]** A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Figure 1 is a schematic structure of an image forming system as at least one example embodiment of the present patent application;

Figure 2 is a schematic structure of another image forming system as at least one example embodiment of the present patent application;

Figure 3 is a schematic structure of a sheet post-processing device, included in the image forming systems of Figures 1 and 2, according to the at least one example embodiment of the present patent application;

Figure 4 is a schematic structure of a sheet post-processing system including a plurality of sheet post-processing devices according to the at least one example embodiment of the present patent application;

Figure 5 is a block diagram of the sheet post-processing system of Figure 4;

Figure 6 is a schematic diagram showing communication timings of paper sheet information during a paper sheet feeding operation according to an example of a first example embodiment of the present patent application;

Figure 7 is a schematic diagram showing communication timings of paper sheet information after Figure 6;

Figure 8 is a flowchart showing a paper sheet information receiving operation as another example according to the first example embodiment of the present patent application;

Figure 9 is a flowchart showing a paper sheet information sending operation as another example according to the first example embodiment of the present patent application;

Figure 10 is a schematic diagram showing a start timing of driving conveying rollers;

Figure 11 is a flowchart showing an operation of rotating conveying rollers of Figure 10;

Figure 12 is a flowchart showing a received signal storing operation according to an example of a second example embodiment of the present patent application;

Figure 13 is a flowchart showing a different received signal storing operation according to another example of the second example embodiment of the present patent application;

Figure 14 is a flowchart showing a different received signal storing operation according to another example of the second example embodiment of the present patent application;

Figure 15 is a flowchart showing an operation of transmitting a leading edge discharging signal according to a third example embodiment of the present patent application;

Figure 16 is a flowchart showing an operation of a task of processing a first paper sheet of a stack of paper sheets, according to an example of a fourth example embodiment of the present patent application;

Figures 17A and 17B are flowcharts showing respective tasks of processing second and third paper sheets of the stack of paper sheets of Figure 16, according to examples of the fourth example embod-

iment of the present patent application;

Figure 18 is a flowchart showing a task of processing the leading edge of a paper sheet, according to an example of a fifth example embodiment of the present patent application;

Figure 19 is a flowchart showing a task of processing the trailing edge of a paper sheet, according to another example of the fifth example embodiment of the present patent application;

Figure 20 is a schematic diagram showing transmission timings of signals transmitted in the flowcharts of Figures 18 and 19;

Figure 21 is a flowchart showing a task of processing a leading edge of a first paper sheet, according to an example of a sixth example embodiment of the present patent application;

Figure 22 is a flowchart showing a task of processing a trailing edge of a first paper sheet, according to another example of the sixth example embodiment of the present patent application;

Figures 23A and 23B are flowcharts showing tasks of processing leading and trailing edges of a second paper sheet, according to other examples of the sixth example embodiment of the present patent application;

Figure 24 is a schematic diagram showing transmission timings of signals transmitted in the flowcharts of Figures 21, 22, 23A and 23B; and

Figure 25 is a flowchart of an operation of transmitting signals in the third through sixth example embodiments.

## DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

**[0022]** It will be understood that if an element or layer is referred to as being "on", "against", "connected to" or "coupled to" another element or layer, then it can be directly on, against, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, if an element is referred to as being "directly on", "directly connected to" or "directly coupled to" another element or layer, then there are no intervening elements or layers present. Like numbers referred to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

**[0023]** Spatially relative terms, such as "beneath", "below", "lower", "above", "upper" and the like may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements describes as "below" or "beneath" other elements or features would hen be oriented "above" the other elements or features. Thus, term such as "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors herein interpreted accordingly.

**[0024]** Although the terms first, second, etc. may be used herein to described various elements, components, regions, layers and/or sections, it should be understood that these elements, components, regions, layer and/or sections should not be limited by these terms. These terms are used only to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

**[0025]** The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "includes" and/or "including", when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

**[0026]** In describing example embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner.

**[0027]** Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, example embodiments of the present patent application are described.

**[0028]** It is important to note that, in the exemplary embodiments hereinafter described, a sheet post-processing device corresponds to sheet post-processing devices 6a, 6b, 6c, 6d, and 6e. A conveying member corresponds to a pair of outlet rollers 11, a pair of discharging rollers 19, sheet stack conveying rollers 17a and 17b, and respective pairs of conveying rollers 34, 35, and 36. A processing unit corresponds to a punching unit 7, a jogger fence 16, a rear end fence 31, a folding plate 23, and a pair of folding rollers 24. A communication unit corresponds to communication modules 6a2a, 6a2b, 6b2a, 6b2b, 6c2a, 6c2b, 6c2c, 6d2a, and 6e2a. A control unit corresponds to control modules or units 6a1, 6b1, 6c1, 6d1, and 6e1. A storing unit corresponds to storing units 6a3, 6b3, 6c3, 6d3, and 6e3. An image forming device corresponds to an image forming device 1.

<First Example Embodiment>

**[0029]** Referring to Figures 1 and 2, respective schematic structures of image forming systems 100 and 200 that include a sheet post-processing device 6 according to an example embodiment of the present patent application are described.

**[0030]** The image forming system 100 of Figure 1 is shown in the form of a copier. The image forming system 100 includes an image forming device 1, a sheet feeding device 2 that feeds paper sheets to the image forming device 1, and a scanner 3, and a circulation type automatic document feeder 4, both of which read an image formed on an original document. A paper sheet on which an image is formed or printed by the image forming device 1 is fed to an inlet guide plate in a sheet post-processing device 6 via a relay unit 5.

**[0031]** A "paper sheet" is an example of a recording medium. The recording medium includes a recording paper, transfer sheet, OHP sheet, and so forth. In the example embodiments of the present patent application, a "paper sheet" represents these kinds of recording medium.

**[0032]** Figure 2 is a schematic view of the image forming system 200 in the form of a printer, which is mounted neither with such the scanner 3 nor with such the circulation type automatic document feeder 4. Aside from the scanner 3 and the circulation type automatic document feeder 4, the image forming system 200 has the same structural arrangement of the image forming system 100 as the above-described copier.

**[0033]** The sheet post-processing device 6 is mounted on a side of the image forming device 1, as described above. A paper sheet discharged from the image forming device 1 is guided into the sheet post-processing device 6 and then various kinds of post-processing operations are applied to the paper sheet in accordance with the function of the sheet post-processing device 6. In this case, the image forming device 1 can be selected from devices or apparatuses having the known image forming function, for example, an image forming device based on the electrophotographic process, a device including an inkjet type printing bead, or the like, and therefore detailed description thereof is omitted.

**[0034]** Referring to Figure 3, a schematic structure of the sheet post-processing device 6 according to the present example embodiment is described.

**[0035]** A sheet post-processing device that can achieve the example embodiments of the present patent application is not limited to the sheet post-processing device 6 having the structure shown in Figure 3. The present patent application can apply a sheet post-processing device that performs an operation of punching, center folding, Z-folding, binding, or other sheet post-processing operations.

**[0036]** As indicated by an arrow shown in Figure 3, in the sheet post-processing device 6, a paper sheet received from the image forming device 1 is conveyed or forwarded through an inlet sheet conveying path A in which a sheet post-processing mechanism for applying the post-processing operations to a single paper sheet is disposed. For example, a punching unit 7, which serves as a processing unit, in the sheet post-processing device 6 in Figure 3 serves as a perforation mechanism including a hopper 8.

**[0037]** The paper sheet is then sorted and transferred into one of an upper sheet conveying path B, an intermediate sheet conveying path C, and a lower sheet conveying path D by means of path selectors 28 and 29 and turning guides 37 and 38.

**[0038]** When the paper sheet has passed the path selector 28 and the turning guide 37 into the upper sheet conveying path B, the paper sheet is conveyed through a position mounted with an upper sheet discharging sensor 40, through a pair of outlet rollers 11, and is guided to a proof tray 22.

**[0039]** When the paper sheet has passed the path selector 28 and the turning guide 37 and has been guided by the path selector 29 and the turning guide 38 to the intermediate sheet conveying path C, the paper sheet is conveyed to a shift roller 13.

**[0040]** When the paper sheet has passed the path selector 28 and the turning guide 37 and has been guided by the path selector 29 and the turning guide 38 to the lower sheet conveying path D, the paper sheet is conveyed to a staple tray 14 where adjustment and staple binding operation are carried out.

**[0041]** Paper sheets transferred onto the staple tray 14 by respective pairs of conveying rollers 34, 35, and 36, each of which serving as a conveying member, are aligned in a direction perpendicular to the paper feed direction by a jogger fence 16 as a processing unit, and further the feed direction of the paper sheets is adjusted with reference to a rear end fence 31, which serves as a processing unit, by a knock roller 12.

**[0042]** Thereafter, a sheet stack conveying roller 17b, which serves as a conveying member and is supported by a sheet stack guide plate (not shown), approaches another sheet stack conveying roller 17a, which serves as a conveying member, by the rotation of the sheet stack guide plate, and thereby the sheet stack is clamped therebetween to maintain its attitude and the rear end fence 31 is shifted to the position indicated by the broken line in Figure 3. In the case of the end binding process, the staple process is carried out at a given position, and then fed upward by a discharge hook 15, so that the paper sheets are discharged into an outlet tray 21 by a pair of discharge rollers 19 serving as a conveying roller, and then accumulated therein.

**[0043]** A sheet discharge sensor 46 detects the condition of discharging the paper sheets to the outlet tray 21, and a sheet surface detection sensor 47 detects the amount of accumulated paper sheets on the outlet tray 21.

**[0044]** In the first example embodiment, when the top sheet of the accumulated paper sheets has reached to

a given height, the outlet tray 21 is moved to a downward direction by a fixed or given amount so that a further amount of paper sheets can be accumulated.

**[0045]** Further, a hook position detection sensor 45 detects the home position of the discharge hook 15. Based on the result of the above-described detection, a discharge belt 18 is controlled.

**[0046]** In the case of the saddle stitching process, the sheet stack is adjusted regarding the position, and fed downward, after the paper sheets are pinched by the pair of sheet stack conveying rollers 17a and 17b. At the end of the saddle stitching process, the paper sheets are fed to a folding position by sheet stack conveying rollers 30a and 30b, and the middle folding process is carried out, using a folding plate 23 and a pair of folding rollers 24, both serve as a processing unit. Thereafter, the paper sheets are fed to a center-folded sheet discharging tray 27 by a center-folded sheet discharging roller 26, and then stacked therein.

**[0047]** In the inlet sheet conveying path A, which is commonly disposed upstream with respect to the upper sheet conveying path B, the intermediate sheet conveying path C, and the lower sheet conveying path D, an inlet sensor 39 for detecting a paper sheet supplied from the image forming device 1 is disposed, and a pair of conveyor rollers 32 and the punching unit 7 are disposed downstream thereto, and further the path selector 28 and the turning guide 37 are disposed downstream thereto.

**[0048]** The path selector 28 is maintained in the state shown by a solid line in Figure 3 by a spring (not shown). When a solenoid (not shown) is turned on, the path selector 28 rotates counterclockwise, as indicated by an alternate long and short dashed lines shown in Figure 3, so that paper sheets are sorted into the lower sheet conveying path D. When the solenoid is turned off, the paper sheets are sorted into the upper sheet feeding path B.

**[0049]** The path selector 29 is maintained in the state shown by a solid line in Figure 3 by another spring (not shown). When another solenoid (not shown) is turned on, the path selector 29 rotates clockwise, as indicated by an alternate long and short dashed lines shown in Figure 3, so that the paper sheets are sorted into the intermediate sheet conveying path C. When the solenoid is turned off, the paper sheets are further fed to the lower sheet conveying path D, and fed by the pairs of conveying rollers 34 and 35.

**[0050]** The turning guides 37 and 38 have a roller shape so as to guide the paper sheets to smoothly turn at a sharp angle and serve to assist the sorting of the paper sheets by means of the path selectors 28 and 29. In this case, paper sheets in a direction changed by the path selectors 28 and 29 come into contact with the turning guides 37 and 38, and then are moved together therewith. Accordingly, the turning guides 37 and 38 serve to reduce the feeding resistance for the paper sheet at a branching section having a smaller radius of nature.

**[0051]** In the intermediate sheet conveying path C, the shift roller 13 is mounted, which roller is capable of moving the paper sheets by a specified distance in a direction perpendicular to the feeding direction. In the shift roller 13, the shift function results from the movement of the paper sheets in the direction perpendicular to the feeding direction by a driving unit (not shown).

**[0052]** The movement of the paper sheets transferred to the intermediate sheet conveying path C by a pair of conveying rollers 33 and the turning roller 38 by the shift roller 13 by such a specified distance in the direction perpendicular to the feeding direction causes to provide an appropriate amount of shift for the paper sheets both in the feeding direction and in the direction perpendicular thereto, so that the paper sheets are discharged by the pair of discharge rollers 19 serving as a conveying member, preset the shifted state, one end portion of which is supported rotatably with respect to the sheet discharge guide plate 20, and then stacked in the outlet tray 21. In this case, the timing in the above processes is determined on the basis of the paper detection information from a roller shift sensor 41, the sheet size information and others.

**[0053]** In the lower sheet conveying path D, a staple tray sheet discharge sensor 43 is mounted. The paper discharging sensor 43 makes it possible to detect whether or not a sheet of paper exists in the lower sheet conveying path D. In this case, a paper detecting signal may be used as a trigger signal for aligning the paper sheet when discharging the paper sheet into the staple tray 14.

**[0054]** The paper sheets transferred to the lower sheet conveying path D are sequentially fed by the pairs of conveyor rollers 34, 35 and 36, and aligned in the staple tray 14 after stacked.

**[0055]** The trailing end of the paper sheets discharged into the staple tray 14 is adjusted with reference to the rear end fence 31.

**[0056]** The rear end fence 31 is designed so as to rotate around the center axis of the sheet stack conveying roller 17a. In the case of stacking the paper sheets into a sheet stack, one end portion of the rear end fence 31 on the solenoid side is moved by a solenoid, and the other end portion of the rear end fence 31 is inserted into the feed line, thereby enabling the paper sheets to be stacked into a sheet stack.

**[0057]** The paper sheets stacked in the staple tray 14 are temporarily dropped or moved downward by means of the knock roller 12, and then the lower end thereof is aligned.

**[0058]** The knock roller 12 receives an oscillating motion with respect to the center at a supporting point 12a from a knock solenoid (not shown). Such an oscillating motion intermittently acts on the paper sheets supplied to the staple tray 14 to collide them with the rear end fence 31. In this case, the knock roller 12 rotates such that the paper sheet rotated counterclockwise by a timing belt moves towards the rear end fence 31.

**[0059]** The alignment of the paper sheets stacked in the staple tray 14 in the direction perpendicular to the feed direction is carried out by jogger fences 16.

**[0060]** The jogger fences 16 are driven via the timing belt by a rotation reversible jogger motor (not shown), and reciprocally move in the direction perpendicular to the paper feed direction. The pressing of the end surface of the sheet stack by the movement causes the paper sheets to be aligned in the direction perpendicular to the feed direction. This action is carried out either during the stacking process or after final sheets has been stacked in accordance with requirement.

**[0061]** A sheet detection sensor 44 mounted on the staple tray 14 is used as a so-called sheet detecting sensor for detecting whether or not a sheet of paper exists on the staple tray 14. The knock roller 12, the rear end fence 31, and the jogger fences 16 constitutes an alignment mechanism for aligning the sheet stack both in a direction parallel to the paper feed direction and in a direction perpendicular thereto.

**[0062]** The pairs of sheet stack conveying rollers 17a, 17b, 30a, and 30b cause a mechanism (not shown) to apply a press and release action. After the sheet stack passes between the pairs of conveying rollers 17a, 17b, 30a, and 30b in the release state, these rollers 17a, 17b, 30a, and 30b press the sheet stack and then convey them. The pairs of sheet stack conveying rollers 17a, 17b, 30a, and 30b are capable of becoming either in or out of contact with each other by a pressure release motor (not shown).

**[0063]** Furthermore, the pairs of sheet conveying rollers 17a, 17b, 30a, and 30b are rotated by a stepping motor (not shown), a pulley (not shown), and a timing belt (not shown). The feeding distance of the sheet stack can be adjusted by controlling the rotation rate of the stepping motor. Both of the pair of sheet stack conveying rollers 17a and 17b and the pair of sheet stacking conveying rollers 30a and 30b can be separately disposed in a pair wise manner, and the press contact distance therebetween can be freely adjusted.

**[0064]** As shown in Figure 3, the staple unit 9 includes a stitcher 9a (in this specification, the unit is referred to as a stitcher, although it is traditionally referred as a driver) for projecting a needle and a clincher 9b for bending the end portion of the needle driven into the sheet stack. In the present embodiment, the stitcher 9a and the clincher 9b are separately structured and the staple unit 9 is supported movably in the direction perpendicular to the sheet stack feed direction by a stapler moving guide 10. Moreover, the stitcher 9a and the clincher 9b include a mutual position determining mechanism and a movement driving mechanism (both not shown).

**[0065]** The staple position of the sheet stack in the feed direction is determined from the conveying of the sheet stack by the pair of sheet stack conveying rollers 17a and 17b. Thereby, the staple can be stopped at various positions for the sheet stack.

**[0066]** In Figure 3, a middle folding mechanism is positioned downstream in the sheet conveying direction for the staple unit 9 (downstream in the case of folding the paper sheet, and spatially the under side). The middle folding mechanism includes the pair of folding rollers 24, the folding plate 23, and a stopper 25. In the upstream portion of the staple unit 9, a sheet stack stapled at the center of the paper sheet in the feed direction is conveyed by the pair of sheet stack conveying rollers 17a and 17b until it comes into contact with the stopper 25, and then the reference position for folding the sheet stack is determined by temporarily releasing the nipping pressure of the sheet stack conveying roller 17b. Thereafter, the sheet stack is held by applying the nipping pressure between the pair of sheet stack conveying rollers 30a and 30b thereto, and then the stopper 25 is moved back and decoupled from the trailing end of the sheet stack, so that the sheet stack is conveyed by a given distance and set in the folding position on the basis of the sheet size signal supplied from the main body of the image forming device 1. The sheet stack, which is conveyed to the folding position (normally the center of the sheet stack in the sheet feeding direction) and stopped there, is inserted into a spacing between the pair of folding rollers 24 by the folding plate 23, so that the pair of folding rollers 24 causes the sheet stack to be folded at the center by pressing and rotating the sheet stack. In this case, if the sheet stack by a larger size, it is conveyed to a downstream position in the feed direction by a greater distance than at the position.of the stopper 25.

**[0067]** In this embodiment, the sheet conveying path on the downstream side curved at an area far away from the stopper 25 to guide the end of the sheet stack into the horizontal direction. Such a structural arrangement allows the sheet stack to be conveyed, even if it has a larger size, thereby making it possible to decrease the size of the paper sheet post-processing device 6 in the height direction.

**[0068]** As shown in Figure 3, the stopper 25, which serves as an alignment mechanism is designed such that the stopper 25 can be rotated around the center axis of the sheet stack conveying roller 30a, and that the end portion of the stopper 25 on the solenoid side is driven by the solenoid, and the end portion is away from the sheet conveying path.

**[0069]** The folded sheet stack is discharged into a center-folded sheet discharging tray 27 by a center-folded sheet discharging roller 26, and then stacked therein.

**[0070]** Sensors 48 and 49 in the center-folded section detect whether or not a sheet of paper exists therein.

**[0071]** Moreover, a sensor 51 in the center-folded sheet discharging tray 27 detects whether or not the sheet stack is placed on the center-folded sheet discharging tray 27. It is used to count the number of sheet stacks discharged from the empty state and to monitor the full state of the center-folded sheet discharging tray 27.

**[0072]** A fold end stopper position detecting sensor 50 detects the end position of the sheet stacks in the case when the stopper 25 is either activated or deactivated.

**[0073]** Figure 4 shows a schematic structure of a sheet post-processing system 300 in which a plurality of sheet

post-processing devices 6a, 6b, 6c, 6d, and 6e are connected, along with the accompanying image forming device 1.

**[0074]** In the present example embodiment, the image forming device 1 is connected with a document feeding device 4, a high-volume sheet feeding device 2, and a plurality of sheet post-processing devices or first through fifth sheet post-processing devices 6a, 6b, 6c, 6d, and 6e. The first sheet post-processing device 6a is connected with one upstream device, which is the image forming device 1, and one downstream device, which is the second sheet post-processing device 6b. The second sheet post-processing device 6b is also connected with one upstream device, which is the first sheet post-processing device 6a, and one downstream device, which is the third sheet post-processing device 6c. The third sheet post-processing device 6c is connected with one upstream device, which is the second sheet post-processing device 6b, and two downstream devices, which are the fourth and fifth sheet post-processing devices 6d and 6e. The fourth sheet post-processing device 6d is the most downstream device and is connected with one upstream device, which is the third sheet post-processing device 6c. The fifth sheet post-processing device 6d is the most downstream device and is connected with one upstream device, which is the third sheet post-processing device 6c.

**[0075]** Figure 5 shows a block diagram of the sheet post-processing system 300 in which various modules or units including respective communication modules for the first through fifth sheet post-processing devices 6a through 6e are described.

**[0076]** Each of the first through fifth sheet post-processing devices 6a through 6e includes one communication module or unit with respect to one device connected with itself. Specifically, the first sheet post-processing device 6a includes first and second communication modules 6a2a and 6a2b. The second sheet post-processing device 6b includes first and second communication modules 6b2a and 6b2b. The third sheet post-processing device 6c includes first, second, and third communication modules 6c2a, 6c2b, and 6c2c. The fourth sheet post-processing device 6d includes a first communication modules 6d2a. The fifth sheet post-processing device 6e includes a first communication module 6e2a.

**[0077]** The sheet post-processing devices 6a, 6b, 6c, 6d, and 6e also include control modules or units 6a1, 6b1, 6c1, 6d1, and 6e1, respectively, serving as a transmission unit for sending and receiving data at respectively given timings or intervals.

**[0078]** Further, the sheet post-processing devices 6a, 6b, 6c, 6d, and 6e include storing units 6a3, 6b3, 6c3, 6d3, and 6e3, respectively, for arbitrarily storing and reading respective received signals.

**[0079]** As a transmission method, it is general to employ a serial communication using, for example, a UART (Universal Asynchronous Receiver Transmitter).

**[0080]** A memory or a hard disk drive (HDD) is used as a storing unit according to the volume of data to be stored therein. In the example embodiment of the present patent application, a memory and a HDD are used. However, any other storing unit that can temporarily store target information may be applied to the present patent application.

**[0081]** Each of the control modules 6a1, 6b1, 6c1, 6d1, and 6e1 includes a central processing unit (CPU) (not shown), a read-only memory (ROM) (not shown), and a random access memory (RAM) (not shown). In the control performed in the respective control modules or units 6a1, 6b1, 6c1, 6d1, and 6e1, the CPU executes programs stored in the ROM by using the RAM as a working area, and thus the control of each of the sheet post-processing devices 6a, 6b, 6c, 6d, and 6e is carried out, based on the programs.

**[0082]** Referring to Figures 6 and 7, schematic diagrams showing communication timings of paper sheet information during a paper sheet feeding operation are described according to the first example embodiment of the present patent application.

**[0083]** In Figures 6 and 7, the reference number "P1", "P2", "P3", "P4", "P5", and "P6" represent respective paper sheets that are conveyed in the sheet post-processing devices 6a, 6b, and 6c.

**[0084]** When a paper sheet, for example a paper sheet P1, is fed from the image forming device 1 shown in Figures 1, 2, and 4 to the first sheet post-processing device 6a, the communication module 6a2a of the first sheet post-processing device 6a receives paper sheet information from the image forming device 1 and stores the paper sheet information in the first storing unit 6a3 thereof. The paper sheet information contains information necessary for processing the paper sheet fed from the image forming device 1, for example, the size, thickness, ID, a request of sheet post-processing operation to a specific sheet post-processing device, and so forth.

**[0085]** The first sheet post-processing device 6a receives a paper sheet, performs the sheet post-processing operation according to a request of sheet post-processing operation issued from the image forming device 1, and conveys or forwards the processed paper sheet to the second sheet post-processing device 6b, which is a downstream device of the first sheet post-processing device 6a. When no request of sheet post-processing operation to be performed in the first sheet post-processing device 6a has been issued, the first sheet post-processing device 6a performs no specific sheet post-processing operation and simply forwards the paper sheet to the second sheet post-processing device 6b.

**[0086]** When a paper sheet is to be discharged to the outside of the first sheet post-processing device 6a, for example, when the leading edge of a paper sheet comes at a specified position, such as the pair of outlet rollers 11 serving as a conveying member in the present example embodiment, the first sheet post-processing device

6a transmits the paper sheet information stored in the first storing unit 6a3, to the second sheet post-processing device 6b. Through the above-descried transmission, the second sheet post-processing device 6b can obtain the paper sheet information before receiving the paper sheet. Thereby, the second sheet post-processing device 6b can perform its sheet post-processing operation under the proper and stable condition. Further, even when the content of a request of the sheet post-processing operation is changed, the sheet post-processing operation can avoid unnecessary interruption. Thereby, a series of sheet post-processing operations can be performed in high and stable speed.

**[0087]** When the paper sheet processed in or passed through the first sheet post-processing device 6a is fed, the second sheet post-processing device 6b receives the paper sheet information from the first sheet post-processing device 6a and stores the paper sheet information in the second storing unit 6b3 thereof. When discharging or forwarding the paper sheet to the third sheet post-processing device 6c, the second sheet post-processing device 6b transmits the paper sheet information stored in the second storing unit 6b3, to the third sheet post-processing device 6c.

**[0088]** As shown in Figure 7, the sheet post-processing device 6c performs the operation similar to those performed by the first and second sheet post-processing devices 6a and 6b. That is, when the paper sheet processed in or passed through the second sheet post-processing device 6b is fed, the third sheet post-processing device 6c receives the paper sheet information from the second sheet post-processing device 6b and stores the information in the third storing unit 6c3 thereof. And, when the paper sheet is discharged to the outside of the third sheet post-processing device 6c or to one of the sheet post-processing devices 6d and 6e connected thereto as shown in Figures 4 and 5, the third sheet post-processing device 6c transmits the paper sheet information stored in the third storing unit 6c3, to the downstream sheet post-processing device.

**[0089]** The method of transmitting the paper sheet information is not limited to the above-described method but other various ways may be applied to the present patent application. In Figures 6 and 7 of the present example embodiment of the present patent application, for example, a paper sheet forwarding signal is transmitted to the downstream device after the paper sheet information has been sent. The downstream device can confirm the paper sheet information by receiving the paper sheet forwarding signal.

**[0090]** Referring to a flowchart of Figure 8, a procedure of a paper sheet information receiving operation is described. The paper sheet information receiving operation is performed such that a currently operating device or a local sheet post-processing device, which is connected to an upstream device and a downstream device, receives paper sheet information during the paper sheet feeding operation.

**[0091]** In the example embodiments of the present patent application, the "local sheet post-processing device" represents any one of the first, second, and third sheet post-processing devices 6a, 6b, and 6c while the fourth and fifth sheet post-processing devices 6d and 6e are the most downstream devices, as shown in Figures 4 and 5.

**[0092]** As previously described, the sheet post-processing operations are controlled by the CPU (not shown) of the control module or unit of each sheet post-processing device. In the present example embodiment, the CPU of the local first sheet post-processing device basically controls the operations of the following flowcharts.

**[0093]** At the start of the paper sheet information receiving operation of Figure 8, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the paper sheet information from an upstream device of the local sheet post-processing device in step S101.

**[0094]** When the local sheet post-processing device has received the paper sheet information from the upstream device, the determination result in step S101 is YES, and the process goes to step S102.

**[0095]** When the local sheet post-processing device has not yet received the paper sheet information from the upstream device, the determination result in step S101 is NO, and the process of step S101 repeats until the local sheet post-processing device receives the paper sheet information.

**[0096]** The CPU temporarily writes the paper sheet information, including the size, thickness, ID, the request of sheet post-processing operation, and so forth, in a storing unit of the local sheet post-processing device in step S102, and determines whether the local sheet post-processing device has received the paper sheet forwarding signal in step S103.

**[0097]** When the local sheet post-processing device has received the paper sheet forwarding signal from the upstream device, the determination result in step S103 is YES, and the process goes to step S104.

**[0098]** When the local sheet post-processing device has not yet received the paper sheet forwarding signal from the upstream device, the determination result in step S103 is NO, and the process of step S103 goes back to step S101.

**[0099]** In step S104, the CPU confirms the paper sheet information and stores the information in the storing unit.

**[0100]** Referring to a flowchart of Figure 9, a procedure of a paper sheet information sending operation is described. The paper sheet information sending operation is performed by the local sheet post-processing device to transmit paper sheet information during the paper sheet feeding operation.

**[0101]** At the start of the paper sheet information sending operation of Figure 9, the CPU of the local sheet post-processing device determines whether the leading edge of the paper sheet has come at a specified position of

the paper sheet.

**[0102]** When the leading edge of the paper sheet has come at the specified position, the determination result in step S201 is YES and the process goes to step S202.

**[0103]** When the leading edge of the paper sheet has not yet come at the specified position, the determination result in step S201 is NO and the process of step S201 repeats until the leading edge of the paper sheet comes at the specified portion.

**[0104]** The CPU transmits the paper sheet information that is stored in the storing unit of the local sheet post-processing device in step S202, and transmits the paper sheet forwarding signal to the downstream device in step S203.

**[0105]** As described above, each sheet post-processing device of the present example embodiment receives corresponding paper sheet information, stores the received information, and transmits the stored information when discharging the paper sheet to the downstream device. However, information other than the information necessary for each paper sheet, for example, information of destination, a speed of conveying the paper sheet, and so forth, is not necessarily transmitted during the sheet feeding operation. That is, in this case, the local sheet post-processing device can transmit information other than the information necessary for each paper sheet, to the downstream device instantly on receiving the information.

**[0106]** Referring to Figure 10, a schematic diagram is described to show a start timing of driving the pair of conveying rollers 32, which have been stopped, of the second sheet post-processing device 6b. The specific diagram of Figure 10 shows one example of the roller driving operation, which also can be applied to the operation performed between the first, second, third, fourth, and fifth sheet post-processing devices 6a, 6b, 6c, 6d, and 6e.

**[0107]** When the image forming device 1 starts the paper sheet feeding operation with respect to the first sheet post-processing device 6a, the pair of sheet conveying rollers 32 of the second sheet post-processing device 6b still remains stopped.

**[0108]** When the first sheet post-processing device 6a discharges a paper sheet to the second sheet post-processing device 6b, the paper sheet information followed by the paper sheet forwarding signal is transmitted.

**[0109]** The second sheet post-processing device 6b starts rotating the pair of conveying rollers 32 when receiving the paper sheet information followed by the paper sheet forwarding signal.

**[0110]** With the above-described operation, the pair of conveying rollers 32 can prevent the rotations thereof for an unnecessarily long time, which can extend the lives of the rollers and other parts. That is, by starting the rotation of the pair of conveying rollers 32 at the receipt of the paper sheet information by the communication module 6b2a of the second sheet post-processing device 6b, the rotation period of the pair of conveying rollers 32 may become shorter and the lives of the pair of conveying rollers 32 may become longer.

**[0111]** Referring to a flowchart of Figure 11, a procedure of an operation of rotating conveying rollers that have not been rotated is described.

**[0112]** In step S301 of the flowchart in Figure 11, the CPU of a local sheet post-processing device determines whether the pair of conveying rollers thereof remains stopped.

**[0113]** When the pair of conveying rollers is stopped, the determination result in step S301 is YES, and the process goes to step S302.

**[0114]** When the pair of conveying roller is rotated, the determination result in step S301 is NO, and the CPU completes the procedure.

**[0115]** In step S302, the CPU determines whether the local sheet post-processing device has received the paper sheet forwarding signal.

**[0116]** When the local sheet post-processing device has received the paper sheet forwarding signal, the determination result in step S302 is YES, and the process goes to step S303.

**[0117]** When the local sheet post-processing device has not yet received the paper sheet forwarding signal, the determination result in step S302 is NO, and the process of step S302 repeats until the local sheet post-processing device receives the paper sheet forwarding signal.

**[0118]** In step S303, the CPU initiates the rotation of the pair of conveying rollers, and completes the procedure.

<Second Example Embodiment>

**[0119]** Referring to a flowchart of Figure 12, a communication procedure of a received signal storing operation is described according to a second example embodiment of the present patent application. The received signal storing operation is performed by the local sheet post-processing device to transmit a signal from the upstream device during the paper sheet feeding operation.

**[0120]** At the start of the received signal storing operation of the flowchart of Figure 12, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received various information signals from the upstream device. The various information signals include the paper sheet information necessary for processing the paper sheet fed from the upstream device, for example, paper sheet information of the size, thickness, ID, a request of sheet post-processing operation to a specific sheet post-processing device, and so forth. The various information signals can include a single information signal even through the term is used in plural in the example embodiments of the present patent application.

**[0121]** When the local sheet post-processing device has received various information signals from the upstream device, the determination result in step S401 is

YES, the process goes to step S402.

**[0122]** When the local sheet post-processing device has not yet received various information signals from the upstream device, the determination result in step S401 is NO, the process of step S401 repeats until the local sheet post-processing device receives the various information signals.

**[0123]** In step S402, the CPU temporarily writes the received information signals in a storing unit of the local sheet post-processing device, and the process goes to step S403.

**[0124]** The local sheet post-processing device receives the paper sheet, conveys the paper sheet therein, performs the sheet post-processing operation according to the request of the sheet post-processing operation contained in the paper sheet information, and discharges or forwards the paper sheet to the downstream device. When no request of sheet post-processing operation corresponding to the local sheet post-processing device is received, the local sheet post-processing device simply transmits the paper sheet to the downstream device without performing any sheet post-processing operation therein.

**[0125]** In step S403, the CPU of the local sheet post-processing device determines whether the processed paper sheet has come at a specified position, for example, whether the leading edge of the paper sheet has been present at or in the vicinity of the pair of outlet rollers 11.

**[0126]** When the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the determination result in step S403 is YES and the process goes to step S404.

**[0127]** When the leading edge of the paper sheet is not present at or in the vicinity of the pair of outlet rollers 11, the determination result in step S403 is NO and the process of step S403 goes back to step S401.

**[0128]** The CPU transmits the information signals including the paper sheet information stored in the storing unit, to the downstream device in step S404, and determines whether the signal transmission has been completed in step S405.

**[0129]** When the signal transmission has been completed, the determination result in step S405 is YES and the CPU completes the process.

**[0130]** When the signal transmission has not yet been completed, the determination result in step S405 is NO, and the process goes back to step S401.

**[0131]** According to the above-described operation, the downstream device can receive the information signals including the paper sheet information of the corresponding paper sheet. Therefore, the downstream device can perform the sheet post-processing operation in a proper and stable manner. Further, even when the paper sheet information of the corresponding paper sheet has been changed, the sheet post-processing operation can be continuously performed without temporarily stopping the operation. Therefore, a high-speed sheet post-processing operation can be performed.

**[0132]** Similar to the operation described above, when the downstream device has received various information signals from the local sheet post-processing device, the downstream device temporarily writes the paper sheet information included in the received various information signals, into the storing unit of the downstream device. When the paper sheet has come at a specified position, for example, when the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the downstream device transmits the information signals stored therein to a further downstream device connected to the downstream device.

**[0133]** As previously described, in the second example embodiment of the present invention, each sheet post-processing device includes the corresponding storing unit for temporarily writing or storing a portion of or whole information signals received from the upstream device with respect to the local sheet post-processing device. When the whole sheet post-processing devices except the most downstream device receive information signals from the upstream device during the sheet feeding operation, the sheet post-processing devices except the most downstream device temporarily write the various information signals to the corresponding storing unit, and transmits the portion of or whole information signals stored therein, according to the position of the paper sheet in the local sheet post-processing device. Therefore, the downstream device can perform the sheet post-processing operation in an accurate and stable manner. Further, when the content of the paper sheet information of the corresponding paper sheet has been changed, the sheet post-processing operation can be continuously performed without temporarily stopping. Therefore, a high-speed sheet post-processing operation can be performed.

**[0134]** Referring to a flowchart of Figure 13, a different communication procedure of the received signal storing operation is described according to another example of the second example embodiment of the present patent application. The received signal storing operation is performed by the local sheet post-processing device to transmit information signals one by one by a fixed or given amount or length of byte thereof, from the upstream device during the paper sheet feeding operation.

**[0135]** At the start of the received signal storing operation of the flowchart of Figure 13, when the local sheet post-processing device receives various information signals from the upstream device, the local sheet post-processing device temporarily writes the received information signals in the storing unit thereof. At this time, the information signals are stored in an orderly sequence so as to easily recognize the receipt order of the received information signals.

**[0136]** In each storing unit of the sheet post-processing devices, a series of storage areas are provided to write information signals received from the upstream device. Each storage area is basically provided for a series of

various information signals of one paper sheet. In this case, the storing unit of the local sheet post-processing device provides a storage area A having addresses including a top address "a". The addresses of the storage area A are represented by a variable "A". The various information signals received by the local sheet post-processing device are temporarily written into the storage area A one by one in the orderly sequence starting from the top address "a". That is, the writing of the various information signals starts from the address having the smallest number.

**[0137]** When the paper sheet has come at a specified position, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the local sheet post-processing device transmits the various information signal including the paper sheet information stored therein to the downstream device. Also at this time, the received information signals are sequentially read out starting from the top address "a" and are transmitted in the orderly sequence thereof to the downstream device.

**[0138]** Specifically, according to the flowchart of Figure 13, the CPU of the local sheet post-processing device specifies the variable "A" representing the storage area A so as to assign the top address "a" thereto in step S501, and determines whether the local sheet post-processing device has received a fixed or given amount of various information signals transmitted from the upstream device.

**[0139]** When the local sheet post-processing device has received the fixed amount of various information signals, the determination result in step S502 is YES and the process proceeds to step S503.

**[0140]** When the local sheet post-processing device has not yet received various information signals, the determination result in step S502 is NO and the process of step S502 repeats until the local sheet post-processing device receives a fixed or given amount of information signals.

**[0141]** The CPU temporarily writes the received information signal in the top address "a" in step S503, and increments the variable "A" by one as a fixed or given amount of the information signals in step S504, and the process proceeds to step S505.

**[0142]** In step S505, the CPU determines whether the paper sheet has come at the specified position.

**[0143]** When the paper sheet has come at the specified position, the determination result in step S505 is YES and the process proceeds to step S506.

**[0144]** When the paper sheet has not yet come at the specified position, the determination result in step S505 is NO, and the process of step S505 goes back to step S502. The CPU repeats the steps S502 through S505 until no more sequential information signals of the corresponding paper sheet is transmitted.

**[0145]** After the determination result in step S505 becomes "YES", the CPU assigns the top address "a" to the variable "A" in step S506, reads out and transmits the received information signal from the top address "a" to the downstream device in step S507. The CPU then increments the variable "A" by one as the fixed amount of the information signals in step S508, and the process proceeds to step S509.

**[0146]** In step S509, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals with respect to the downstream device.

**[0147]** When the local sheet post-processing device has completed the transmission of the information signals, the determination result in step S509 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0148]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S509 is NO, and the process goes back to step S507 to repeat steps S507 through S509 until no more sequential information signal to be transmitted for the corresponding paper sheet remains in the storing area A of the storing unit of the local sheet post-processing device.

**[0149]** Similar to the operation performed by the local sheet post-processing device, when receiving various information signals from the local sheet post-processing device, the downstream device temporarily writes the paper sheet information included in the received information signals, into the storing unit thereof. When the paper sheet has come at the specified position, for example, when the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the downstream device transmits the information signals stored therein to the further downstream device. Also in this case, the CPU controls to transmit the information signals in the orderly sequence thereof.

**[0150]** When a plurality of information signals that are not properly managed are transmitted at one time, the sequence order of the signals may be changed. The above-described condition may cause, for example, the disorder of the requests.

**[0151]** In a case in which a signal A represents a signal to indicate the request of the sheet post-processing operation and a signal B represents a signal to fix the request, when the order of the signal A and the signal B is reversed, the fixing timing of the request may change.

**[0152]** Specifically, when the signal A comes before the signal B, which is the correct sequence order, the request of the sheet post-processing operation indicated by the signal A may be fixed when the signal B is received.

**[0153]** On the contrary, when the signal A has not been received before the signal B is received, which is the incorrect order, the request indicated by the signal A may not be fixed until the next signal B is received.

**[0154]** To avoid the above-described problem causing the transmission of signals in the incorrect order, the signals of the present example embodiment can be controlled to properly manage the addresses stored in the storage area, thereby the signals can be kept in the orderly

sequence.

**[0155]** Referring to a flowchart of Figure 14, a different communication procedure of a received signal storing operation is described according to another example of the second example embodiment of the present patent application. The received signal storing operation is performed by the local sheet post-processing device to transmit a signal from the downstream device during the paper sheet feeding operation.

**[0156]** In the communication procedure of Figure 14, the paper sheet forwarding signal is provided for informing a timing of forwarding a paper sheet.

**[0157]** When the paper sheet has come at the specified position, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the local sheet post-processing device transmits the paper sheet forwarding signal to the downstream device. By receiving the paper sheet forwarding signal, the downstream device can recognize a timing of a paper sheet to be fed.

**[0158]** Similar to the communication procedures shown in Figures 12 and 13, the paper sheet information including the size, thickness, ID, the request of the sheet post-processing operation, and so forth are temporarily written or stored in the storage area A in the storing unit of the local sheet post-processing device, and transmitted while keeping the orderly sequence with respect to the paper sheet forwarding signal. Respective transmission timings of signals other than the paper sheet forwarding signal are sequentially transmitted immediately before or after the paper sheet forwarding signal. Hereinafter, signals other than the paper sheet forwarding signal are referred to as "information signals" to distinguish from the paper sheet forwarding signal.

**[0159]** The communication procedure in the flowchart of Figure 14 is basically similar to the procedure shown in the flowchart of Figure 13, except that the communication procedure of Figure 14 uses the paper sheet forwarding signal.

**[0160]** Specifically, according to the flowchart of Figure 14, the CPU of the local sheet post-processing device specifies the variable "A" representing the storage area A so as to assign the top address "a" thereto in step S601, and the process proceeds to step S602.

**[0161]** In step S602, the CPU determines whether the local sheet post-processing device has received an information signal of various information signals transmitted from the upstream device.

**[0162]** When the local sheet post-processing device has received a fixed or given amount of various information signals, the determination result in step S602 is YES and the process proceeds to step S603.

**[0163]** When the local sheet post-processing device has not yet received various information signals, the determination result in step S602 is NO, and the process of step S602 repeats until the local sheet post-processing device receives information signals.

**[0164]** The CPU temporarily writes the received information signal in the top address "a" in step S603, and increments the variable "A" by one as the fixed amount of the information signals in step S604, and the process proceeds to step S605.

**[0165]** In step S605, the CPU determines whether the paper sheet forwarding signal has been received.

**[0166]** When the paper sheet forwarding signal has been received, the determination result in step S605 is YES, and the process goes to step S606.

**[0167]** When the paper sheet forwarding signal has not yet been received, the determination result in step S605 is NO, and the process goes back to step S602.

**[0168]** In step S606, the CPU determines whether the paper sheet has come at the specified position.

**[0169]** When the paper sheet has come at the specified position, the determination result in step S606 is YES, and the process proceeds to step S607.

**[0170]** When the paper sheet has not yet come at the specified position, the determination result in step S606 is NO, and the process of step S606 repeats until the paper sheet comes at the specified position.

**[0171]** After the determination result in step S606 becomes "YES", the CPU assigns the top address "a" to the variable "A" in step S607, reads out and transmits the received information signal by the fixed amount of information signals, from the top address "a" to the downstream device in step S608. The CPU then increments the variables "A" by one in step S609, and the process proceeds to step S610.

**[0172]** In step S610, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals to the downstream device.

**[0173]** When the local sheet post-processing device has completed the transmission of the information signals, the determination result in step S610 is YES, and the process goes to step S611.

**[0174]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S610 is NO, and the process goes back to step S608 to repeat steps S608 through S610 until no more sequential information signal to be transmitted for the corresponding paper sheet remains in the storing area A of the storing unit.

**[0175]** The CPU then transmits the paper sheet forwarding signal in step S611, and terminates the sheet post-processing operation in the local sheet post-processing device.

**[0176]** Similar to the operation performed by the local sheet post-processing device, when receiving various information signals from the local sheet post-processing device, the downstream device temporarily writes the paper sheet information included in the received information signals, into the storing unit thereof. When the paper sheet has come at the specified position, for example, when the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the down-

stream device transmits the information signals stored therein to the further downstream device. Also in this case, the CPU controls to transmit the information signals in the orderly sequence thereof.

**[0177]** When the whole receiving interval times of a plurality of signals are stored to perform a delayed transmission according to the interval times, the controls of the operations performed by the CPU may become complicated and the size of the storage capacity for the operations may increase. However, by transmitting signals in a sequential manner as described above, the controls may be simplified and the size of the storage capacity may be reduced, but the interval times of the information signals in sending and those in receiving may become different. Even when the interval times of the information signals are changed, it is necessary to determine which signal corresponds to which paper sheet or which paper sheet and thereafter.

**[0178]** On the contrary, as shown in the operations in the second example embodiment, if the transmission of the paper sheet forwarding signal and the other information signals are kept in an orderly sequence thereof, it may be easy to connect the signals with the corresponding information signals, which can easily solve the above-described problem.

**[0179]** For example, the local sheet post-processing device may receive the information signals including the paper sheet information, then receive the paper sheet forwarding signal, and confirm the contents of the information signals. When the paper sheet forwarding signal and the information signals are transmitted in the orderly sequence, the local sheet post-processing device can easily apply the paper sheet information included in the information signals to the paper sheet corresponding to the paper sheet forwarding signal. At this time, the information signals may sequentially be transmitted immediately before or after the paper sheet forwarding signal has been transmitted, without changing the sequence order of the paper sheet forwarding signal and the information signals. Therefore, the sheet post-processing operation can be performed without making the operation control to be complex and the size of the storage capacity to be increased.

**[0180]** When a plurality of stacks of paper sheets are conveyed in the local sheet post-processing device for the operations shown in Figures 12 through 14, the CPU may perform parallel processing. Since the CPU of the local sheet post-processing device may take the operation procedures for the plurality of paper sheet stacks same as the operation procedure taken for a single paper sheet as described above, the description of the detailed procedures is omitted.

<Third Example Embodiment>

**[0181]** Referring to a flowchart of Figure 15, a communication procedure of an operation of transmitting a leading edge discharging signal is described according to a third example embodiment of the present patent application.

**[0182]** The communication procedure of the operation according to the third example embodiment is similar to the communication procedure of the second example embodiment. Except that the communication procedure performed in the third example embodiment issues the leading edge discharging signal as the paper sheet forwarding signal. Specifically, in the communication procedure according to the third example embodiment of the present patent application, the leading edge discharging signal is transmitted from the communication unit of the upstream device to the communication unit of the local sheet post-processing device. The communication unit of the local sheet post-processing device receives the leading edge discharging signal before or after the leading edge of a paper sheet is discharged. The above-described transmission of the leading edge discharging signal can make the local sheet post-processing device recognize the timing of the leading edge of a paper sheet to be conveyed or fed. The other parts, structures, and functions are same as those used in the first and second example embodiments. Therefore, the same reference numbers as those used in the first and second example embodiment are given, and the description of these parts, structures, and functions are omitted in the third example embodiment.

**[0183]** In the flowchart of Figure 15, the operation of transmitting the leading edge discharging signal may be performed by the local sheet post-processing device to receive and transmit the leading edge discharging signal for informing the timing of conveying or feeding the leading edge of each paper sheet during the paper sheet feeding operation.

**[0184]** When the leading edge of a paper sheet has come at a discharging position through which the paper sheet is discharged, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the upstream device transmits the leading edge discharging signal to the local sheet post-processing device.

**[0185]** In step S701, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the leading edge discharging signal. By receiving the leading edge discharging signal, the local sheet post-processing device can recognize the timing of conveyance of the paper sheet.

**[0186]** When the local sheet post-processing device has received the leading edge discharging signal, the determination result in step S701 is YES and the process proceeds to step S702.

**[0187]** When the local sheet post-processing device has not yet received the leading edge discharging signal, the determination result in step S701 is NO, and the process of step S701 repeats until the local sheet post-processing device receives the leading edge discharging signal.

**[0188]** After the determination result in step S701 becomes "YES" by receiving the leading edge discharging signal, the local sheet post-processing device can confirm various information requests or signals, determine which request or signal corresponds to which paper sheet or which paper sheet and thereafter, and perform a paper sheet receiving operation, for example, of rotating a sheet conveying motor, of moving the jogger fences 16 to a standby position according to its size, etc. in step S702.

**[0189]** After step S702 is completed, the CPU of the local sheet post-processing device determines, in step S703, whether the leading edge of the paper sheet has come at a discharging position, for example, whether the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11.

**[0190]** When the leading edge of the paper sheet is present at the discharging position, the determination in step S703 is YES, and the process proceeds to step S704.

**[0191]** When the leading edge of the paper sheet is not at the discharging position, the determination in step S703 is NO, and the process of step S703 repeats until the leading edge of the paper sheet comes at the discharging position.

**[0192]** In step S704, the CPU of the local sheet post-processing device transmits the leading edge discharging signal to the downstream device, and completes the procedure.

**[0193]** In a case in which a single paper sheet is fed to the local sheet post-processing device, the local sheet post-processing device performs the operation as shown in the flowchart of Figure 15. That is, when the leading edge of the paper sheet has come at the discharging position, or when the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the CPU of the upstream device transmits the leading edge discharging signal to the local sheet post-processing device. By receiving the leading edge discharging signal, the local sheet post-processing device can recognize the timing of conveyance of the paper sheet.

**[0194]** In a case in which a plurality of paper sheets are fed to the local sheet post-processing device, the local sheet post-processing device temporarily writes the information signals including the paper sheet information, and transmits the information signals without changing the sequence order of the information signals with respect to the leading edge discharging signal. The information signals are transmitted to the downstream device at the timing immediately after the transmission of the leading edge discharging signal.

**[0195]** Specifically, when the plurality of paper sheets are continuously fed, the information signals received between the transmission of the leading edge discharging signal of a first paper sheet or a paper sheet 1 and the transmission of the leading edge discharging signal of a second paper sheet or a paper sheet 2 are collectively written or stored in one group unit as Group 1, and the information signals received between the transmission of the leading edge discharging signal of the paper sheet 2 and the transmission of the leading edge discharging signal of a paper sheet 3 are collectively stored in one group unit as Group 2. Similarly, the information signals are stored respectively as Group 3, Group 4, and so on.

**[0196]** When the leading edge of the paper sheet 1 comes at the discharging position, the local sheet post-processing device transmits the leading edge discharging signal to the downstream device. Immediately after the transmission of the leading edge discharging signal, the local sheet post-processing device transmits the information signals corresponding to Group 1. When the leading edge of the paper sheet 2 comes at the discharging position, the local sheet post-processing device transmits the leading edge discharging signal to the downstream device, and immediately transmits the information signals corresponding to Group 2. Similarly, the operation repeats for Group 3, Group 4, and so on.

**[0197]** The local sheet post-processing device temporarily writes the information signals including the paper sheet information, and transmits the leading edge discharging signal and the information signals without changing the sequence order thereof. The information signals are transmitted at the timing immediately after the transmission of the leading edge discharging signal.

**[0198]** The communication procedure that is taken when the plurality of paper sheets are fed is basically same as the communication procedure in the flowchart of Figure 15. The whole signals are transmitted without changing the sequence order.

**[0199]** When the information signals and the leading edge discharging signal are transmitted from the local sheet post-processing device, the downstream device performs its operation in a same manner as the local sheet post-processing device. That is, the downstream device temporarily writes the information signals, and transmits the leading edge discharging signal and the information signals to the further downstream device.

**[0200]** In the second example embodiment of the present patent application, each of the sheet post-processing devices 6a, 6b, 6c, 6d, and 6e needs to recognize the timing of conveyance of a paper sheet. If the recognition of the timing fails, it may be difficult to assuredly determine which signal corresponds to which paper sheet or which paper sheet and thereafter. Further, if the timing of conveyance of a paper sheet cannot properly be recognized, the paper sheet receiving operation cannot be performed at an appropriate timing. The paper sheet receiving operation may include operations of rotating a sheet conveying motor, of moving the jogger fences 16 to a standby position according to its size, etc.

**[0201]** According to the present example embodiment, the leading edge discharging signal may be transmitted as the paper sheet forwarding signal to the communication device of the downstream device at the timing before or after the leading edge of the paper sheet is discharged, and the downstream device can recognize the conveyance of the leading edge of the paper sheet by receiving

the leading edge discharging signal. Thereby, the uncertainty of the determination and the inappropriateness of the timing can be reduced or prevented.

<Fourth Example Embodiment>

**[0202]** Referring to a flowchart of Figure 16, a communication procedure of an operation of a task of processing the paper sheet 1 is described according to a fourth example embodiment of the present patent application.

**[0203]** The communication procedure of the operation according to the fourth example embodiment of the present patent application is similar to the communication procedure of the third example embodiment. Except that the communication procedure performed by the fourth example embodiment writes or stores a portion or whole set of the information signals as a group unit. Further, in the fourth example embodiment, information signals can be transmitted by a flexible amount or length of byte thereof, from the upstream device to the downstream device during the paper sheet feeding operation.

**[0204]** Specifically, in the communication procedure according to the fourth example embodiment of the present invention, a portion or whole set of the information signals received between the transmission of the leading edge discharging signal of a paper sheet 1 and the transmission of the leading edge discharging signal of a paper sheet 2 are collectively written or stored in one group unit as Group 1, a portion or whole set of the information signals received between the transmission of the leading edge discharging signal of the paper sheet 2 and the transmission of the leading edge discharging signal of a paper sheet 3 are collectively written or stored in one group unit as Group 2. Similarly, the information signals are written or stored as Group 3, Group 4, and so on.

**[0205]** When the leading edge of the paper sheet 1 comes at the discharging position, the upstream device transmits the leading edge discharging signal to the downstream device. Immediately after the transmission of the leading edge discharging signal, the upstream device transmits the portion of whole set of the information signals corresponding to Group 1. When the leading edge of the paper sheet 2 comes at the discharging position, the upstream device transmits the leading edge discharging signal to the downstream device, and immediately transmits the portion or whole set of the information signals corresponding to Group 2. Similarly, the operation repeats for Group 3, Group 4, and so on. At this time, the received signals including the leading edge discharging signal and the corresponding information signals are transmitted without changing the sequence order thereof.

**[0206]** The other parts, structures, and functions are same as those used in the first and second example embodiments. Therefore, the same reference numbers as those used in the first and second example embodiments are given, and the description of these parts, structures, and functions are omitted.

**[0207]** In the flowchart of Figure 16, the task of processing the paper sheet 1, which is a first paper sheet of a stack of paper sheets, is described according to the fourth example embodiment of the present patent application.

**[0208]** In step S801, the CPU of the local sheet post-processing device, for example, determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 1 from the upstream device.

**[0209]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 1, the determination result in step S801 is YES, and the process proceeds to step S802.

**[0210]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 1, the determination result in step S801 is NO, and the process of step S801 repeats until the local sheet post-processing device receives the leading edge discharging signal.

**[0211]** The CPU starts the task of the paper sheet 2, which is a second paper sheet of the stack of paper sheets, in step S802, specifies the variable "A" representing the storage area A so as to assign the top address "a" thereto in step S803, and the process proceeds to step S804.

**[0212]** In step S804, the CPU determines whether the leading edge of the paper sheet 1 has come at the discharging position, for example, whether the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11.

**[0213]** When the leading edge of the paper sheet 1 is present at the discharging position, the determination result in step S804 is YES, and the process proceeds to step S810.

**[0214]** When the leading edge of the paper sheet 1 is not present at the discharging position, the determination result in step S804 is NO, and the process proceeds to step S805.

**[0215]** In step S805, the CPU determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 from the upstream device.

**[0216]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2, the determination result in step S805 is YES, and the process proceeds to step S809.

**[0217]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 2, the determination result in step S805 is NO, and determines whether the local sheet post-processing device has received a flexible amount of the information signals from the upstream device in step S806. The "information signals" in step S806 represents the various information signals that are received between the transmission of the leading edge discharging signal of the paper sheet 1 and the transmission of the leading

edge discharging signal of the paper sheet 2.

**[0218]** When the local sheet post-processing device has received a flexible amount of the information signals, the determination result of step S806 is YES, and the process proceeds to step S807.

**[0219]** When the local sheet post-processing device has not yet received information signals, the determination result of step S806 is NO, and the process goes back to step S804. The CPU repeats the steps S804 through S806 until the leading edge of the paper sheet 1 comes at the discharging position or the local sheet post-processing device receives the leading edge discharging signal or a flexible amount of the information signals.

**[0220]** After the determination result in step S806 becomes "YES", the CPU temporarily writes the received information signals by the number of addresses "N" corresponding to the flexible amount of the information signals in Group 1, starting from the top address "a" in the storing area A, in step S807. The CPU then increments the variable "A" by the number of addresses "N" according to the flexible amount of the information signals in step S808, and the process goes back to step S804. The CPU repeats steps S804 through S808 until no more sequential information signals for Group 1 is transmitted.

**[0221]** After the determination result in step S805 becomes "YES", the CPU determines whether the leading edge of the paper sheet 2 has come at the discharging position in step S809.

**[0222]** When the leading edge of the paper sheet 2 has come at the discharging position, the determination result in step S809 is YES, and the process proceeds to step S810.

**[0223]** When the leading edge of the paper sheet 2 has not yet come at the discharging position, the determination result in step S809 is NO, and the process of step S809 repeats until the leading edge of the paper sheet 2 comes at the discharging position.

**[0224]** After the arrival of the leading edge of the paper sheet 2 at the discharging position is confirmed in step S809, the CPU transmits the leading edge discharging signal to the downstream device in step S810, and determines whether the received information signals still remain in the storing unit of the local sheet post-processing device in step S811.

**[0225]** When the received information signals still remain in the storing unit, the determination result in step S811 is YES, and the process proceeds to step S812.

**[0226]** When the received information signals have completely transmitted and no information signals remain in there, the determination result in step S811 is NO, and the CPU terminates the process.

**[0227]** After the determination result in step S811 becomes "YES", the CPU assigns the top address "a" to the variable "A" in step S812, and reads out and transmits the received information signals in Group 1, starting from the top address "a" to the downstream device in step S813. The CPU then increments the variable "A" by one in step S814, and the process proceeds to step S815.

**[0228]** In step S815, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals of Group 1 with respect to the downstream device.

**[0229]** When the local sheet post-processing device has completed the transmission of the information signals of Group 1, the determination result in step S815 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0230]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S815 is NO, and the process goes back to step S813 so as to repeat steps S813 through S815 until no more sequential information signal to be transmitted for the corresponding paper sheet remains in the storing area A of the storing unit of the local sheet post-processing device.

**[0231]** Referring to flowcharts of Figures 17A and 17B, respective communication procedures of tasks of paper sheets 2 and 3, which are second and third paper sheets of the stack of paper sheets, respectively, are described according to the fourth example embodiment of the present patent application.

**[0232]** The communication procedures of the flowcharts shown in Figures 17A and 17B are basically similar to the communication procedure of the flowchart shown in Figure 16. Except, the CPU starts the task of the paper sheet 3 in step S902 of the flowchart of Figure 17A, and starts the task of a paper sheet 4 in step S902 of the flowchart of Figure 17B. Further, a storing area B including the top address "b" and a variable "B" is applied in the communication procedure shown in Figure 17A, and a storing area C including the top address "c" and a variable "C" is applied in the communication procedure shown in Figure 17B.

**[0233]** Here, the communication procedures of the respective tasks of the paper sheets 2 and 3 are described. Since the communication procedures of the respective tasks of the paper sheet 2 and 3 are basically similar to each other, the description of the communication procedure of the task of the paper sheet 3 is additionally generated to the description of the communication procedure of the task of the paper sheet 2.

**[0234]** In step S901, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 (the paper sheet 3 in Figure 17B) from the upstream device.

**[0235]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 (or the paper sheet 3), the determination result in step S901 is YES, and the process proceeds to step S902.

**[0236]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 2 (or the paper sheet 3), the determination result in step S901 is NO, and the process of step S901 repeats until the local sheet post-processing device

receives the leading edge discharging signal of the paper sheet 2 (or the paper sheet 3).

**[0237]** The CPU starts the task of the paper sheet 3 in step S902 (the task of the paper sheet 4 in Figure 17B). The CPU then specifies the variable "B" (the variable "C" in Figure 17B) representing the storage area B (the storing area C in Figure 17B) so as to assign the top address "b" (the top address "c" in Figure 17B) thereto in step S903, and the process proceeds to step S904.

**[0238]** In step S904, the CPU determines whether the leading edge of the paper sheet 2 (the leading edge of the paper sheet 3 in Figure 17B) has come at the discharging position, for example, whether the leading edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11.

**[0239]** When the leading edge of the paper sheet 2 (or the paper sheet 3) is present at the discharging position, the determination result in step S904 is YES, and the process proceeds to step S910.

**[0240]** When the leading edge of the paper sheet 2 (or the paper sheet 3) is not at the discharging position, the determination result in step S904 is NO, and the process proceeds to step S905.

**[0241]** In step S905, the CPU determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 3 (or the paper sheet 4) from the upstream device.

**[0242]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 3 (or the paper sheet 4), the determination result in step S905 is YES, and the process proceeds to step S909.

**[0243]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 3 (or the paper sheet 4), the determination result in step S905 is NO, and determines whether the local sheet post-processing device has received a flexible amount of the information signals from the upstream device. The "information signals" in step S906 represents the various information signals that are received between the transmission of the leading edge discharging signal of the paper sheet 2 and the transmission of the leading edge discharging signal of the paper sheet 3. In step S906 in Figure 17B, the information signals represents the various information signals that are received between the transmission of the leading edge discharging signal of the paper sheet 3 and the transmission of the leading edge discharging signal of the paper sheet 4.

**[0244]** When the local sheet post-processing device has received a flexible amount of the information signals, the determination result of step S906 is YES, and the process proceeds to step S907.

**[0245]** When the local sheet post-processing device has not yet received the information signals, the determination result of step S906 is NO, and the process goes back to step S904. The CPU repeats steps S904 through S906 until the local sheet post-processing device receives the leading edge discharging signal or a flexible amount of the information signals.

**[0246]** After the determination result in step S906 becomes "YES", the CPU temporarily writes the received information signals by the number of addresses "N" corresponding to the flexible amount of the information signals in Group 2 (Group 3 in Figure 17B), starting from the top address "b" (or the top address "c") in the storing area B (or the storing area C) in step S907. The CPU then increments the variable "B" (the variable "C" in Figure 17B) by the number of addresses "N" according to the flexible amount of the information signals in step S908, and the process goes back to step S904. The CPU repeats steps S804 through S808 until no more sequential information signals for Group 2 (or Group 3) is transmitted.

**[0247]** After the determination result in step S905 becomes "YES", the CPU determines whether the leading edge of the paper sheet 3 (or the leading edge of the paper sheet 4 in Figure 17B) has come at the discharging position in step S909.

**[0248]** When the leading edge of the paper sheet 3 (or the paper sheet 4) has come at the discharging position, the determination result in step S909 is YES, and the process proceeds to step S910.

**[0249]** When the leading edge of the paper sheet 3 (or the paper sheet 4) has not yet come at the discharging position, the determination result in step S909 is NO, and the process of step S909 repeats until the leading edge of the paper sheet 3 (or the paper sheet 4) comes at the discharging position.

**[0250]** After the arrival of the leading edge of the paper sheet 3 (the leading edge of the paper sheet 4 in Figure 17B) at the discharging position is confirmed in step S909, the CPU transmits the leading edge discharging signal to the downstream device in step S910, and determines whether the received information signals still remain in the storing unit of the local sheet post-processing device in step S911.

**[0251]** When the received information signals still remain in the storing unit, the determination result in step S911 is YES, and the process proceeds to step S912.

**[0252]** When the received information signals have completely transmitted and no information signals remain in there, the determination result in step S911 is NO, and the CPU terminates the process.

**[0253]** After the determination result in step S911 becomes "YES", the CPU assigns the top address "b" to the variable "B" (or the top address "c" to the variable "C" in Figure 17B) in step S912, and reads out and transmits the received information signals in Group 2 (or Group 3), starting from the top address "b" (or the top address "c") to the downstream device in step S913. The CPU then increments the variable "B" (or the variable "C") by one in step S914, and the process proceeds to step S915.

**[0254]** In step S915, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals of Group 2 (or

Group 2) with respect to the downstream device.

**[0255]** When the local sheet post-processing device has completed the transmission of the information signals of Group 2 (or Group 3), the determination result in step S915 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0256]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S915 is NO, and the process goes back to step S913 so as to repeat steps S913 through S915 until no more sequential information signal to be transmitted for the corresponding paper sheet remains in the storing area B (or the storing area C) of the storing unit of the local sheet post-processing device.

**[0257]** In a case in which the information signals are transmitted immediately before the leading edge discharging signal in the third example embodiment, the timing of transmission of the leading edge discharging signal may delay according to the number or amount of the information signals. Especially when a serial communication, for example the UART, is selected for transmission, the delay of the timing of transmitting the last leading edge discharging signal may greatly depend on the number or amount of the information signals.

**[0258]** When the upstream device has a delay of the timing of transmitting the last leading edge discharging signal as described above, the downstream device controlled to start driving its conveying motor depending upon the receipt of the leading edge discharging signal may cause a delay to start the conveying motors, which can cause deterioration in performance of conveying paper sheets.

**[0259]** Transmission of the information signals immediately before the leading edge discharging signal may cause a sheet post-processing device to make the interval between the receipt of the information signals and the transmission thereof to be the longest interval. That is, the sheet post-processing device may cause a delay in transferring the signal to the downstream sheet post-processing device, which cannot make it to prepare the paper sheet receiving operation depending on the requirements of the signal.

**[0260]** In contrast, the sheet post-processing devices in the present example embodiment can:

1) Prevent the delay of transmitting the leading edge discharging signal depending on the number or amount of the information signals;
2) Prevent the delay of starting the conveying motor when the downstream device is controlled to drive the conveying motor in response to the receipt of the leading edge discharging signal and to secure an appropriate level of the performance in the paper sheet feeding operation; and
3) Prepare the paper sheet receiving operation in a proper manner without causing the delay in transferring the signal to the downstream device.

<Fifth Example Embodiment>

**[0261]** Referring to flowcharts of Figures 18 and 19, communication procedures of respective tasks of processing the leading and trailing edges of a paper sheet are described according to a fifth example embodiment of the present patent application.

**[0262]** The communication procedures of the tasks according to the fifth example embodiment are similar to the communication procedure of the second example embodiment. Except that the communication procedure performed in the fifth example embodiment issues, in addition to the leading edge discharging signal, the trailing edge discharging signal also as the paper sheet forwarding signal. Specifically, in the communication procedures in the flowcharts of Figures 18 and 19 according to the fifth example embodiment of the present patent application, the leading edge discharging signal is transmitted from the communication unit of the upstream device to the communication unit of the local sheet post-processing device before or after the leading edge of a paper sheet is discharged, and the trailing edge discharging signal is transmitted from the communication unit of the upstream device to the communication unit of the local sheet post-processing device before or after the trailing edge of a paper sheet is discharged. The above-described transmissions of the leading edge discharging signal and the trailing edge discharging signal can make the local sheet post-processing device recognize the respective timings of the leading and trailing edges of a paper sheet to be conveyed or fed, respectively. The other parts, structures, and functions are same as those used in the first and second example embodiments. Therefore, the same reference numbers as those used in the first and second example embodiment are given, and the description of these parts, structures, and functions are omitted in the fifth example embodiment.

**[0263]** As previously described, in the fifth example embodiment, two kinds of the paper sheet forwarding signal are provided. That is, the leading edge discharging signal is used to inform the timing of conveying the leading edge of a paper sheet, and the trailing edge discharging signal is used to inform the timing of conveying the trailing edge of the paper sheet.

**[0264]** The flowchart of Figure 18 shows the task of processing the leading edge of a paper sheet, and the flowchart of Figure 19 shows the task of processing the trailing edge of a paper sheet.

**[0265]** When the leading edge of a paper sheet has come at a discharging position through which the paper sheet is discharged, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the upstream device transmits the leading edge discharging signal to the local sheet post-processing device. By receiving the leading edge discharging signal, the local sheet post-processing device

can recognize the timing of the leading edge of the paper sheet to be discharged.

**[0266]** According to the receipt of the leading edge discharging signal, the local sheet post-processing device can confirm various information requests or signals, determine which request or signal corresponds to which paper sheet or which paper sheet and thereafter, and perform a paper sheet receiving operation, for example, of rotating a sheet conveying motor, of moving the jogger fences 16 to a standby position according to its size, etc.

**[0267]** When the trailing edge of the paper sheet has come at a discharging position through which the paper sheet is discharged, for example, when the trailing edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the upstream device transmits the trailing edge discharging signal to the local sheet post-processing device. By receiving the trailing edge discharging signal, the local sheet post-processing device can recognize the timing of the trailing edge of the paper sheet to be discharged. For example, even when the length of a paper sheet is not informed, the local sheet post-processing device can determine whether a paper jam has occurred if the trailing edge discharging signal is received.

**[0268]** Similar to the operation performed by the local sheet post-processing device, when the leading edge of a paper sheet has come at the discharging position through which the paper sheet is discharged, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the downstream device transmits the leading edge discharging signal to the further downstream device. And, when the trailing edge of the paper sheet has come at the discharging position, for example, when the trailing edge of the paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the downstream device transmits the trailing edge discharging signal to the further downstream device.

**[0269]** In step S1001 of the flowchart of Figure 18, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the leading edge discharging signal from the upstream device.

**[0270]** When the local sheet post-processing device has received the leading edge discharging signal, the determination result in step S1001 is YES, and the process proceeds to step S1002.

**[0271]** When the local sheet post-processing device has not yet received the leading edge discharging signal, the determination result in step S1001 is NO, and the process repeats until the local sheet post-processing device receives the leading edge discharging signal.

**[0272]** The CPU starts the task of processing the trailing edge of the paper sheet in step S1002, starts the paper sheet receiving operation in step S1003, and determines whether the leading edge of the paper sheet has come at the discharging position in step S1004.

**[0273]** When the leading edge of the paper sheet is present at the discharging position, the determination result in step S1004 is YES, and the process proceeds to step S1005.

**[0274]** When the leading edge of the paper sheet is not present at the discharging position, the determination result in step S1004 is NO, and the process of step S1004 repeats until the leading edge of the paper sheet comes at the discharging position.

**[0275]** After the determination result in step S1004 becomes "YES", the CPU transmits the leading edge discharging signal to the downstream device in step S1005, and terminates the process.

**[0276]** In step S1101 of the flowchart of Figure 19, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the trailing edge discharging signal from the upstream device.

**[0277]** When the local sheet post-processing device has received the trailing edge discharging signal, the determination result in step S1101 is YES, and the process proceeds to step S1102.

**[0278]** When the local sheet post-processing device has not yet received the trailing edge discharging signal, the determination result in step S1101 is NO, and the process of step S1101 repeats until the local sheet post-processing device receives the trailing edge discharging signal.

**[0279]** The CPU starts the trailing edge receiving operation in step S1102, and determines whether the trailing edge of the paper sheet has come at the discharging position in step S1103.

**[0280]** When the trailing edge of the paper sheet is present at the discharging position, the determination result in step S1103 is YES, and the process proceeds to step S1104.

**[0281]** When the trailing edge of the paper sheet is not present at the discharging position, the determination result in step S1103 is NO, and the process of step S1103 repeats until the trailing edge of the paper sheet comes at the discharging position.

**[0282]** After the determination result in step S1103 becomes "YES", the CPU of the local sheet post-processing device transmits the trailing edge discharging signal to the downstream device, and completes the process.

**[0283]** The transmission timings of the commands or signals used for the above-described flowcharts of Figures 18 and 19 are shown in a schematic diagram of Figure 20.

**[0284]** As shown in the diagram of Figure 20, the leading edge discharging signals that are indicated as "S1" and "S3" and the trailing edge discharging signal that is indicated as "S2" remain in a standby mode while these signals S1, S2, and S3 are transmitted from a device 1 representing an upstream device to a device 2 representing a local sheet post-processing device, and from the device 2 to a device 3 representing a downstream device.

**[0285]** In the operations of the second example embodiment in the flowchart of Figure 14, each of the sheet

post-processing devices 6a, 6b, 6c, 6d, and 6e needs to recognize the timing of conveyance of a paper sheet.

**[0286]** If the recognition of the timing fails, it may be difficult to assuredly determine which request or signal corresponds to which paper sheet or which paper sheet and thereafter. Further, if the timing of conveyance of a paper sheet cannot properly be recognized, the downstream device cannot perform the paper sheet receiving operation at an appropriate timing, as previously described.

**[0287]** Further, when the length of the paper sheet is not informed, the downstream device needs to recognize the timing of receiving the trailing edge of the paper sheet so as to detect a defect, for example a paper jam. When the timing cannot specifically be recognized, the downstream device may fail to determine the detection of the paper jam and so forth.

**[0288]** The communication procedure performed in the fifth example embodiment, therefore, uses both the leading edge discharging signal and the trailing edge discharging signal as the paper sheet forwarding signal that are transmitted before or after the leading and trailing edges of a paper sheet are discharged, respectively. With the above-described transmissions of the leading edge discharging signal and the trailing edge discharging signal, the downstream device can recognize the conveyance or passage of the leading and trailing edges of a paper sheet, respectively.

**[0289]** With the above-described operation, the present example embodiment can:

1) Correctly determine which request or signal corresponds to which paper sheet or which paper sheet and thereafter;
2) Clearly recognize the timing of conveyance of a paper sheet so that the downstream device can perform the paper sheet receiving operation, for example, of rotating the sheet conveying motor, of moving the jogger fences 16 to the standby position according to its size, etc. at respective appropriate timings; and
3) Correctly recognize the timing of conveyance of the trailing edge of a paper sheet so that the downstream device can easily determine whether a paper jam has occurred, which can avoid the occurrence of paper jam.

<Sixth Example Embodiment>

**[0290]** Referring to flowcharts of Figures 21, 22, 23A, and 23B, communication procedures of tasks of processing the leading and trailing edges of paper sheets 1 and 2 are described according to examples of a sixth example embodiment of the present patent application.

**[0291]** The communication procedures of the tasks according to the sixth example embodiment of the present patent application are similar to the communication procedures of the fifth example embodiment. Except that each of the communication procedures performed by the sixth example embodiment stores a portion or whole set of the information signals as a group.

**[0292]** Specifically, in the communication procedures according to the sixth example embodiment of the present invention, a portion or whole set of the information signals received between the transmission of the leading edge discharging signal of a paper sheet 1 and the transmission of the trailing edge discharging signal of the paper sheet 1 are collectively written or stored in one group unit as Group 1-1 as shown in Figure 21, a portion or whole set of the information signals received between the transmission of the trailing edge discharging signal of the paper sheet 1 and the transmission of the leading edge discharging signal of a paper sheet 2 are collectively written or stored in one group unit as Group 1-2 as shown in Figure 22. Similarly, the information signals are written or stored as Group 2-1 in Figure 23A, Group 2-2 in Figure 23B, and so on.

**[0293]** When the leading edge of the paper sheet 1 comes at the discharging position, the upstream device transmits the leading edge discharging signal to the downstream device. Immediately after the transmission of the leading edge discharging signal, the upstream device transmits the portion of whole set of the information signals corresponding to Group 1-1. When the trailing edge of the paper sheet 1 comes at the discharging position, the upstream device transmits the trailing edge discharging signal to the downstream device, and immediately transmits the portion or whole set of the information signals corresponding to Group 1-2. Similarly, the operation repeats for Group 2-1, Group 2-2, and so on. At this time, the received signals including the leading edge discharging signals, the trailing edge discharging signals, and the corresponding information signals are transmitted without changing the sequence order thereof.

**[0294]** The other parts, structures, and functions are same as those used in the first, second and fifth example embodiments. Therefore, the same reference numbers as those used in the first, second and fifth example embodiments are given, and the description of these parts, structures, and functions are omitted.

**[0295]** In the flowcharts of Figures 21, 22, 23A, and 23B, respective communication procedures to send and receive signals during the paper sheet feeding operations are described as the examples of the sixth example embodiment of the present patent application.

**[0296]** As previously described in the fifth example embodiment, when the leading edge of a paper sheet has come at a discharging position through which the paper sheet is discharged, for example, when the leading edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the upstream device transmits the leading edge discharging signal to the local sheet post-processing device. By receiving the leading edge discharging signal, the local sheet post-processing device can recognize the timing of conveyance of the leading

edge of the paper sheet.

**[0297]** Further, when the trailing edge of a paper sheet has come at a discharging position through which the paper sheet is discharged, for example, when the trailing edge of a paper sheet is present at or in the vicinity of the pair of outlet rollers 11, the upstream device transmits the trailing edge discharging signal to the local sheet post-processing device. By receiving the trailing edge discharging signal, the local sheet post-processing device can recognize the timing of conveyance of the trailing edge of the paper sheet.

**[0298]** In the sixth example embodiment, the local sheet post-processing device temporarily writes or stores the information signals including information of the size, thickness, and ID of the paper sheets, the request of the sheet post-processing operation, and so forth, and transmits the information signals without changing the sequence order thereof with respect to the leading edge discharging signal and the trailing edge discharging signal. The information signals are transmitted at the timing immediately after the transmission of the leading edge discharging signal or immediately after the transmission of the trailing edge discharging signal, depending on the discharging signal to which the information signals correspond.

**[0299]** As previously described, when the plurality of paper sheets are continuously fed, the respective information signals received between the transmissions of two adjacent discharging signals are collectively written or stored into the corresponding groups.

**[0300]** The upstream device transmits the leading edge discharging signal to the downstream device when the leading edge of the paper sheet 1 comes at the discharging position, then immediately transmits the information signals corresponding to Group 1-1.

**[0301]** The upstream device transmits the trailing edge discharging signal to the downstream device when the trailing edge of the paper sheet 1 comes at the discharging position, then immediately transmits the information signals corresponding to Group 1-2.

**[0302]** Similarly, when the leading edge of the paper sheet 2 comes at the discharging position, the upstream device transmits the leading edge discharging signal to the downstream device, then immediately transmits the information signals corresponding to Group 2-1. Further, when the trailing edge of the paper sheet 2 comes at the discharging position, the upstream device transmits the trailing edge discharging signal to the downstream device, then immediately transmits the information signals corresponding to Group 2-2. Similarly, the operation repeats for Group 3-1, Group 3-2, and so on.

**[0303]** Each sheet post-processing device temporarily stores the information signals, and transmits the leading edge discharging signal, the trailing edge discharging signal, and the information signals without changing the sequence order thereof. The information signals are transmitted at the timing immediately after the transmission of the leading edge discharging signal or immediately after the transmission of the trailing edge discharging signal.

**[0304]** The communication procedure that is taken when the plurality of paper sheets are fed is basically same as the communication procedure as described above. The signals are transmitted without changing the sequence order thereof.

**[0305]** When the leading edge discharging signal, the trailing edge discharging signal, and the information signals are transmitted from the local sheet post-processing device, the downstream device performs in a same manner as the local sheet post-processing device. That is, the downstream device temporarily writes the information signals, and transmits the leading edge discharging signal, the trailing edge discharging signal, and the information signals to the further downstream device.

**[0306]** In the flowchart of Figure 21, the communication procedure of the task of processing the leading edge of the paper sheet 1 is described according to the sixth example embodiment of the present patent application.

**[0307]** In step S1201, the CPU of the local sheet post-processing device, for example, determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 1 from the upstream device.

**[0308]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 1, the determination result in step S1201 is YES, and the process proceeds to step S1202.

**[0309]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 1, the determination result in step S1201 is NO, and the process of step S1201 repeats until the local sheet post-processing device receives the leading edge discharging signal of the paper sheet 1.

**[0310]** The CPU starts the task of processing the trailing edge of the paper sheet 1 in step S1202, specifies the variable "A" representing the storage area A so as to assign the top address "a" thereto in step S1203, and the process proceeds to step S1204.

**[0311]** In step S1204, the CPU determines whether the leading edge of the paper sheet 1 has come at the discharging position.

**[0312]** When the leading edge of the paper sheet 1 is present at the discharging position, the determination result in step S1204 is YES, and the process proceeds to step S1210.

**[0313]** When the leading edge of the paper sheet 1 is not present at the discharging position, the determination result in step S1204 is NO, and the process proceeds to step S1205.

**[0314]** In step S1205, the CPU determines whether the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 1 from the upstream device.

**[0315]** When the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 1, the determination result in step S1205 is

YES, and the process proceeds to step S1209.

**[0316]** When the local sheet post-processing device has not yet received the trailing edge discharging signal of the paper sheet 1, the determination result in step S1205 is NO, and determines whether the local sheet post-processing device has received a flexible amount of the information signals from the upstream device in step S1206. The "information signals" in step S1206 represents the various information signals that are received between the transmission of the leading edge discharging signal of the paper sheet 1 and the transmission of the trailing edge discharging signal of the paper sheet 1. In this case, each information signal may be transmitted not in a given or fixed amount but in a flexible amount thereof. That is, the length of byte of the address (referred to as "N") to be used may be longer than the length used for writing and storing the fixed amount of the information signals.

**[0317]** When the local sheet post-processing device has received a flexible amount of the information signals, the determination result of step S1206 is YES, and the process proceeds to step S1207.

**[0318]** When the local sheet post-processing device has not yet received information signals, the determination result of step S1206 is NO, and the process goes back to step S1204. The CPU repeats steps S1204 through S1206 until the leading edge of the paper sheet 1 comes at the discharging position or the local sheet post-processing device receives the trailing edge discharging signal or a flexible amount of the information signals.

**[0319]** After the determination result in step S1206 has become "YES", the CPU temporarily writes the received information signal by the number of addresses "N" corresponding to the flexible amount of information signals in Group 1-1, starting from the top address "a" in the storing area A, in step S1207. The CPU then increments the variable "A" by the number of addresses "N" according to the flexible amount of the information signals in step S1208, and the process goes back to step S1204. The CPU repeats steps S1204 through S1208 until no more sequential information signals for Group 1-1 is transmitted.

**[0320]** After the determination result in step S1205 becomes "YES", the CPU determines whether the leading edge of the paper sheet 1 has come at the discharging position in step S1209.

**[0321]** When the leading edge of the paper sheet 1 has come at the discharging position, the determination result in step S1209 is YES, and the process proceeds to step S1210.

**[0322]** When the leading edge of the paper sheet 1 has not yet come at the discharging position, the determination result in step S1209 is NO, and the process of step S1209 repeats until the leading edge of the paper sheet 1 comes at the discharging position.

**[0323]** After the arrival of the leading edge of the paper sheet 1 at the discharging position is confirmed in step S1209, the CPU transmits the leading edge discharging signal to the downstream device in step S1210, and determines whether the received information signals still remain in the storing unit of the local sheet post-processing device in step S1211.

**[0324]** When the received information signals still remain in the storing unit, the determination result in step S1211 is YES, and the process proceeds to step S1212.

**[0325]** When the received information signals have completely transmitted and no information signals remain in there, the determination result in step S1211 is NO, and the CPU terminates the process.

**[0326]** After the determination result in step S1211 becomes "YES", the CPU assigns the top address "a" to the variable "A" in step S1212, reads out and transmits the received information signals in Group 1-1, starting from the top address "a" to the downstream device in step S1213. The CPU then increments the variable "A" by one in step S1214, and the process proceeds to step S1215.

**[0327]** In step S1215, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals of Group 1-1 with respect to the downstream device.

**[0328]** When the local sheet post-processing device has completed the transmission of the information signals of Group 1-1, the determination result in step S1215 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0329]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S1215 is NO, and the process goes back to step S1213 so as to repeat steps S1213 through S1215 until no more sequential information signal of Group 1-1 to be transmitted for the corresponding paper sheet remains in the storing area A of the storing unit of the local sheet post-processing device.

**[0330]** In the flowchart shown in Figure 22, the communication procedure of the task of processing the trailing edge of the paper sheet 1 is described as another example of the sixth example embodiment of the present patent application.

**[0331]** In step S1301, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 1 from the upstream device.

**[0332]** When the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 1, the determination result in step S1301 is YES, and the process proceeds to step S1302.

**[0333]** When the local sheet post-processing device has not yet received the trailing edge discharging signal of the paper sheet 1, the determination result in step S1301 is NO, and the process of step S1301 repeats until the local sheet post-processing device receives the trailing edge discharging signal of the paper sheet 1.

**[0334]** The CPU starts the task of processing the leading edge of the paper sheet 2 in step S1302, specifies the variable "A'" representing the storage area A' so as to assign the top address "a'" thereto in step S1303, and the process proceeds to step S1304.

**[0335]** In step S1304, the CPU determines whether the trailing edge of the paper sheet 1 has come at the discharging position.

**[0336]** When the trailing edge of the paper sheet 1 is present at the discharging position, the determination result in step S1304 is YES, and the process proceeds to step S1310.

**[0337]** When the trailing edge of the paper sheet 1 is not present at the discharging position, the determination result in step S1304 is NO, and the process proceeds to step S1305.

**[0338]** In step S1305, the CPU determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 from the upstream device.

**[0339]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2, the determination result in step S1305 is YES, and the process proceeds to step S1309.

**[0340]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 2, the determination result in step S1305 is NO, and determines whether the local sheet post-processing device has received a flexible amount of the information signals from the upstream device. The "information signals" in step S1306 represents the various information signals that are received between the transmission of the trailing edge discharging signal of the paper sheet 1 and the transmission of the leading edge discharging signal of the paper sheet 2. In this case, each information signal may be transmitted not in a fixed amount but in a flexible amount thereof. That is, the length of byte of the address (referred to as "N") to be used may be longer than the length used for writing and storing the fixed amount of the information signals.

**[0341]** When the local sheet post-processing device has received a flexible amount of the information signals, the determination result of step S1306 is YES, and the process proceeds to step S1307.

**[0342]** When the local sheet post-processing device has not yet received information signals, the determination result of step S1306 is NO, and the process goes back to step S1304. The CPU repeats steps S1304 through S1306 until the trailing edge of the paper sheet 1 comes at the discharging position or the local sheet post-processing device receives the leading edge discharging signal of the paper sheet 2 or a flexible amount of the information signals.

**[0343]** After the determination result in step S1306 becomes "YES", the CPU temporarily writes the received information signal by the number of addresses "N" corresponding to the flexible amount of information signals in Group 1-2, starting from the top address "a'" in the storing area A', in step S1307. The CPU then increments the variable "A'" by the number of addresses "N" according to the flexible amount of the information signals in step S1308, and the process goes back to step S1304. The CPU repeats steps S1304 through S1308 until no more sequential information signals for Group 1-2 is transmitted.

**[0344]** After the determination result in step S1305 becomes "YES", the CPU determines whether the trailing edge of the paper sheet 1 has come at the discharging position in step S1309.

**[0345]** When the trailing edge of the paper sheet 1 is present at the discharging position, the determination result in step S1309 is YES, and the process proceeds to step S1310.

**[0346]** When the trailing edge of the paper sheet 1 is not yet at the discharging position, the determination result in step S1309 is NO, and the process of step S1309 repeats until the trailing edge of the paper sheet 1 comes at the discharging position.

**[0347]** After the arrival of the trailing edge of the paper sheet 1 at the discharging position is confirmed in step S1309, the CPU transmits the trailing edge discharging signal to the downstream device in step S1310, and determines whether the received information signals still remain in the storing unit of the local sheet post-processing device in step S1311.

**[0348]** When the received information signals still remain in the storing unit, the determination result in step S1311 is YES, and the process proceeds to step S1312.

**[0349]** When the received information signals have completely transmitted and no information signals remain in there, the determination result in step S1311 is NO, and the CPU terminates the process.

**[0350]** After the determination result in step S1311 becomes "YES", the CPU assigns the top address "a'" to the variable "A'" in step S1312, reads out and transmits the received information signals in Group 1-2, starting from the top address "a'" to the downstream device in step S1313. The CPU then increments the variable "A'" by one in step S1314, and the process proceeds to step S1315.

**[0351]** In step S1315, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals of Group 1-2 with respect to the downstream device.

**[0352]** When the local sheet post-processing device has completed the transmission of the information signals of Group 1-2, the determination result in step S1315 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0353]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S1315 is NO, and the process goes back to step S1313 so as to repeat steps S1313 through S1315 until no more sequential information signal of Group 1-2 to be transmitted for the corresponding paper sheet remains in the

storing area A' of the storing unit of the local sheet post-processing device.

**[0354]** In the flowcharts of Figures 23A and 23B, the respective procedures of the tasks of processing the leading and trailing edges of the paper sheet 2 are described according to other examples of the sixth example embodiment of the present patent application.

**[0355]** The communication procedures of the flowcharts shown in Figures 23A and 23B are basically similar to the procedures of the flowcharts shown in Figures 21 and 22, respectively. Except, the CPU starts the task of the trailing edge of the paper sheet 2 in step S1402 of the flowchart of Figure 23A, and starts the task of the leading edge of the paper sheet 3 in step S1402 of the flowchart of Figure 23B. Further, a storing area B including the top address "b" and a variable "B" is applied in the communication procedures shown in the flowchart of Figure 23A, and a storing area B' including the top address "b'" and a variable "B'" is applied in the communication procedures shown in the flowchart of Figure 23B.

**[0356]** Here, the communication procedures of the respective tasks of the leading and trailing edges of the paper sheet 2 are described. Since the communication procedures of the respective tasks of the leading and trailing edges of the paper sheet 2 are basically similar to each other, the description of the communication procedure of the task of the trailing edge of the paper sheet 2 is additionally generated to the description of the communication procedure of the task of the leading edge of the paper sheet 2.

**[0357]** In step S1401, the CPU of the local sheet post-processing device determines whether the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 (the trailing edge of the paper sheet 2 in Figure 23B) from the upstream device.

**[0358]** When the local sheet post-processing device has received the leading edge discharging signal of the paper sheet 2 (or the trailing edge discharging signal of the paper sheet 2), the determination result in step S1401 is YES, and the process proceeds to step S1402.

**[0359]** When the local sheet post-processing device has not yet received the leading edge discharging signal of the paper sheet 2 (or the trailing edge discharging signal of the paper sheet 2), the determination result in step S1401 is NO, and the process of step S1401 repeats until the local sheet post-processing device receives the leading edge discharging signal (or the trailing edge discharging signal).

**[0360]** The CPU starts the task of the trailing edge of the paper sheet 2 in step S1402 (the task of the leading edge of the paper sheet 3 in Figure 23B). The CPU then specifies the variable "B" (the variable "B'" in Figure 23B) representing the storage area B (the storing area B' in Figure 23B) so as to assign the top address "b" (the top address "b'" in Figure 23B) thereto in step S1403, and the process proceeds to step S1404.

**[0361]** In step S1404, the CPU determines whether the leading edge of the paper sheet 2 (the trailing edge of the paper sheet 2 in Figure 23B) has come at the discharging position.

**[0362]** When the leading edge of the paper sheet 2 (or the trailing edge of the paper sheet 2) is present at the discharging position, the determination result in step S1404 is YES, and the process proceeds to step S1410.

**[0363]** When the leading edge of the paper sheet 2 (or the trailing edge of the paper sheet 2) is not present at the discharging position, the determination result in step S1404 is NO, and the process proceeds to step S1405.

**[0364]** In step S1405, the CPU determines whether the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 2 (or the leading edge discharging signal of the paper sheet 3 in Figure 23B) from the upstream device.

**[0365]** When the local sheet post-processing device has received the trailing edge discharging signal of the paper sheet 2 (or the leading edge discharging signal of the paper sheet 3), the determination result in step S1405 is YES, and the process proceeds to step S1409.

**[0366]** When the local sheet post-processing device has not yet received the trailing edge discharging signal of the paper sheet 2 (or the leading edge discharging signal of the paper sheet 3), the determination result in step S1405 is NO, and determines whether the local sheet post-processing device has received a flexible amount of the information signals from the upstream device. The "information signals" in step S1406 represents the various information signals that are received between the transmission of the leading edge discharging signal of the paper sheet 2 and the transmission of the trailing edge discharging signal of the paper sheet 2. In step S1406 of Figure 23B, the "information signals" represents the various information signals that are received between the transmission of the trailing edge discharging signal of the paper sheet 2 and the transmission of the leading edge discharging signal of the paper sheet 3.

**[0367]** When the local sheet post-processing device has received a flexible amount of the information signals, the determination result of step S1406 is YES, and the process proceeds to step S1407.

**[0368]** When the local sheet post-processing device has not yet received the information signals, the determination result of step S1406 is NO, and the process goes back to step S1404. The CPU repeats steps S1404 through S1406 until the local sheet post-processing device receives the trailing edge discharging signal or a flexible amount of the information signals.

**[0369]** After the determination result in step S1206 becomes "YES", the CPU temporarily writes the received information signals by the number of addresses "N" corresponding to the flexible amount of the information signals in Group 2-1 (Group 2-2 in Figure 23B), starting from the top address "b" (or the top address "b'" in Figure 23B) in the storing area B (or the storing area B') in step S1407. The CPU then increments the variable "B" (the variable "B'" in Figure 23B) by the number of addresses "N" ac-

cording to the flexible amount of the information signals in step S1408, and the process goes back to step S1404. The CPU repeats steps S1404 through S1408 until no more sequential information signals for Group 2-1 (or Group 2-2) is transmitted.

**[0370]** After the determination result in step S1405 becomes "YES", the CPU determines whether the leading edge of the paper sheet 2 (or the trailing edge of the paper sheet 2 in Figure 23B) has come at the discharging position in step S1409.

**[0371]** When the leading edge (or the trailing edge) of the paper sheet 2 has come at the discharging position, the determination result in step S1409 is YES, and the process proceeds to step S1410.

**[0372]** When the leading edge (or the trailing edge) of the paper sheet 2 has not yet come at the discharging position, the determination result in step S1409 is NO, and the process of step S1409 repeats until the leading edge (or the trailing edge) of the paper sheet 2 comes at the discharging position.

**[0373]** After the arrival of the leading edge (or the trailing edge) of the paper sheet 2 at the discharging position is confirmed in step S1409, the CPU transmits the leading edge discharging signal (or the trailing edge discharging signal in Figure 23B) to the downstream device in step S1410, and determines whether the received information signals still remain in the storing unit of the local sheet post-processing device in step S1411.

**[0374]** When the received information signals still remain in the storing unit, the determination result in step S1411 is YES, and the process proceeds to step S1412.

**[0375]** When the received information signals have completely transmitted and no information signals remain in there, the determination result in step S1411 is NO, and the CPU terminates the process.

**[0376]** After the determination result in step S1411 becomes "YES", the CPU assigns the top address "b" to the variable "B" (or the top address "b'" to the variable "B'" in Figure 23B) in step S1412, reads out and transmits the received information signals in Group 2-1 (or Group 2-2), starting from the top address "b" (or the top address "b'") to the downstream device in step S1413. The CPU then increments the variable "B" (or the variable "B'") by one in step S1414, and the process proceeds to step S1415.

**[0377]** In step S1415, the CPU determines whether the local sheet post-processing device has completed the transmission of the information signals of Group 2-1 (or Group 2-2) with respect to the downstream device.

**[0378]** When the local sheet post-processing device has completed the transmission of the information signals of Group 2-1 (or Group 2-2), the determination result in step S1415 is YES, and the CPU terminates the sheet post-processing operation in the local sheet post-processing device.

**[0379]** When the local sheet post-processing device still has the information signals to be transmitted to the downstream device, the determination result in step S1415 is NO, and the process goes back to step S1413 so as to repeat steps S1413 through S1415 until no more sequential information signal to be transmitted for the corresponding paper sheet remains in the storing area B (or the storing area B') of the storing unit of the local sheet post-processing device.

**[0380]** The transmission timings of the commands or signals used for the above-described flowcharts of Figures 21, 22, 23A are shown in a schematic diagram of Figure 24.

**[0381]** As shown in the diagram of Figure 24, the leading edge discharging signals that are indicated as "S1" and "S3" and the trailing edge discharging signal that is indicated as "S2" remain in a standby mode while these signals S1, S2, and S3 are transmitted from a device 1 representing an upstream device to a device 2 representing a local sheet post-processing device, and from the device 2 to a device 3 representing a downstream device. During the respective intervals of the signals S1, S2, and S3 in the standby mode, the respective groups of the information signals are transmitted from the upstream device to the downstream device. As previously described, each group of the information signals is transmitted immediately after the corresponding one of the signals S1, S2, and S3. Therefore, the leading edge discharging signal S1 and the information signals corresponding to the leading edge discharging signal S1 are transmitted as a set of signals as shown in Figure 24, and so are the trailing edge discharging signal S2 and the corresponding information signals, and the leading edge discharging signal S3 and the corresponding information signals.

**[0382]** As previously described in the flowchart of Figure 14 according to the second example embodiment, each of the sheet post-processing devices 6a, 6b, 6c, 6d, and 6e needs to recognize the timing of conveyance of a paper sheet.

**[0383]** If the recognition of the timing fails, it may be difficult to assuredly determine which request or signal corresponds to which paper sheet or which paper sheet and thereafter. Further, if the timing of conveyance of a paper sheet cannot properly be recognized, the downstream device cannot perform the paper sheet receiving operation at an appropriate timing, as previously described.

**[0384]** Further, when the length of the paper sheet is not informed, the downstream device needs to recognize the timing of receiving the trailing edge of the paper sheet so as to detect a defect, for example a paper jam. When the timing cannot specifically be recognized, the downstream device may fail to determine the detection of the paper jam and so forth.

**[0385]** Therefore, the communication procedure performed in the sixth example embodiment stores the portion or whole set of the information signals as a group.

**[0386]** Accordingly, as previously described, when the leading edge of the paper sheet 1 comes at the discharging position, an upstream device transmits the leading

edge discharging signal to a downstream device. Immediately after the transmission of the leading edge discharging signal, the upstream device transmits the portion of whole set of the information signals corresponding to Group 1-1. When the trailing edge of the paper sheet 1 comes at the discharging position, the upstream device transmits the trailing edge discharging signal to the downstream device, and immediately transmits the portion or whole set of the information signals corresponding to Group 1-2. Similarly, the operation repeats for Group 2-1, Group 2-2, and so on. At this time, the received signals including the leading edge discharging signals, the trailing edge discharging signals, and the information signals are transmitted without changing the sequence order thereof. By keeping the orderly sequence of the signals, the downstream device can properly recognize the leading and trailing edges of a series of paper sheets. For example, the signals are transmitted in the order of the leading edge of the paper sheet 1, the trailing edge of the paper sheet 1, the leading edge of the paper sheet 2, the trailing edge of the paper sheet 2, and so on, which can cause the downstream device to perform the operations smoothly. With the above-described operation, the present patent application can enhance the effects that can be obtained through the performance in the fifth example embodiment.

**[0387]** Referring to a flowchart of Figure 25, a communication procedure of an operation of transmitting signals is described. The local sheet post-processing device performs the operations of the communication procedure to process the information signals in the third through sixth example embodiments.

**[0388]** In a case in which the local sheet post-processing device receives the information signals from the upstream device after the local sheet post-processing device has already transmitted the preceding paper sheet forwarding signal corresponding to the information signals, to the downstream device, the local sheet post-processing device instantly transmits the information signals corresponding to the preceding paper sheet forwarding signal, to the downstream device. The "preceding paper sheet forwarding signal" can be applied to the leading edge discharging signal or the trailing edge discharging signal.

**[0389]** Specifically, the CPU of the local sheet post-processing device determines whether the whole paper sheet forwarding signal(s) transmitted to the local sheet post-processing device have already been transmitted to the downstream device or have not been received from the upstream device in step S1501.

**[0390]** When the paper sheet forwarding signal(s) in the local sheet post-processing device have already been transmitted or have not been received, the determination result in step S1501 is YES, and the process proceeds to step S1502.

**[0391]** When the paper sheet forwarding signal(s) remain in the local sheet post-processing device, the determination result in step S1501 is NO, and the process of step S1501 repeats until the local sheet post-processing device empties the paper sheet forwarding signals therefrom.

**[0392]** In step S1502, the CPU determines the local sheet post-processing device has received the information signals.

**[0393]** When the local sheet post-processing device has received the information signals, the determination result in step S1502 is YES, and the process proceeds to step S1503.

**[0394]** When the local sheet post-processing device has not yet received the information signals, the determination result in step S1502 is NO, and the process of step S1502 goes back to step S1501.

**[0395]** After the determination result of step S1502 has become "YES", the local sheet post-processing device instantly transmits the received signals to the downstream device in step S1503, and terminates the process.

**[0396]** By performing the above-described communication procedure shown in the flowchart of Figure 25, the signals can be aligned in the orderly sequence and the information signals can be transmitted in the fastest way.

**[0397]** With the operations and tasks as described above according to the first through sixth example embodiments, it is possible to establish a sheet post-processing system that includes a plurality of sheet post-processing device, each of which receives various signals including paper sheet information by at least one communication module or unit before or after the paper sheet is fed, stores the received signals in the storing unit, and transmits the stored signals before or after the paper sheet is discharged. Further, each of the plurality of sheet post-processing devices of the sheet post-processing system keeps the conveying rollers unrotated until the paper sheet forwarding signal is received. Further, the sheet post-processing system can be connected with an image forming device. With the above-described structures, the sheet post-processing system can perform the sheet feeding operation in a high speed and stable manner and at low cost.

**[0398]** Further, with the operations as described above according to the present example embodiment, it is also possible to establish an image forming system that includes the sheet post-processing system and the image forming device connected together with the sheet post-processing system. With the above-described structure, the image forming system can perform the sheet feeding operation in a high speed and stable manner and at low cost.

**[0399]** The above-described example embodiments are illustrative, and numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different example embodiments herein may be combined with each other and/or substituted for each other within the scope of this disclosure and appended claims. It is therefore to be understood that within the scope of the appended claims, the disclosure of this patent specification may be

practiced otherwise than as specifically described herein.

**[0400]** This patent application is based on Japanese patent applications, No. 2005-238045, filed in the Japan Patent Office on August 18, 2005, No. 2005-267401, filed in the Japan Patent Office on September 14, 2005, No. 2006-001511, filed in the Japan Patent Office on January 6, 2006, and No. 2006-133744, filed in the Japan Patent Office on May 12, 2006, the entire contents of which are incorporated by reference herein.

## Claims

**1.** A sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e), comprising:

a conveying member configured to convey a sheet-like recording medium;
a processing unit configured to perform a given operation to the recording medium conveyed by the conveying member;
**characterised in that**
a communication unit (6a2a, 6a2b, 6b2a, 6b2b, 6c2a, 6c2b, 6c2c, 6d2a, 6e2a) is provided, configured to communicate with an external device connected to the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) for the given operation performed by the processing unit; and
a control unit (6a1, 6b1, 6c1, 6d1, 6e1) is provided, configured to control, via the communication unit, information passing between the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e)and the external device at a desired timing.

**2.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 1, further comprising:

a storing unit (6a3, 6b3, 6c3, 6d3, 6e3) configured to store information relating to the recording medium transmitted from the external device,
wherein the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is configured to receive the information at one of a timing before a discharge of a leading edge of the recording medium and a timing after a discharge of a leading edge of the recording medium from the external device.

**3.** The sheet post-processing device (6,6a,6b,6c,6d, 6e) according to claim 1, further comprising:

a storing unit (6a3,6b3,6c3,6d3,6e3) configured to store information relating to the recording medium transmitted from the external device

wherein the control unit (6a1,6b1,6c1,6d1,6e1) is configured to transmit the information at one of a timing before a discharge of leading edge of the recording medium and a timing after a discharge of a leading edge of the recording medium by the conveying member to a different external device.

**4.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 1,2, or 3, wherein:

the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) is configured to receive a forwarding signal to inform a timing of conveyance of the recording medium, and
the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is configured to initiate a rotation of the conveying member when the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) receives the forwarding signal and the information transmitted from the external device.

**5.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 2 or 3, wherein:

the storing unit (6a3, 6b3, 6c3, 6d3, 6e3) includes a first storing unit configured to store at least one signal of a set of signals corresponding to the information relating to the recording medium, and when the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) receives the at least one signal of the set of signals during a sheet feeding operation, the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is configured to cause the storing unit (6a3, 6b3, 6c3, 6d3, 6e3) to store the at least one signal of the set of signals therein and transmit the at least one signal of the set of signals to a different external device disposed downstream thereof, when the recording medium comes at a specified position.

**6.** The sheet post-processing device according to claim 5, wherein:

the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is for causing the storing unit (6a3, 6b3, 6c3, 6d3, 6e3) to write a plurality of signals therein in an orderly sequence when the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) receives the plurality of signals and transmitting at least one of the plurality of signals while keeping the orderly sequence when the recording medium comes at the specified position during the sheet feeding operation.

**7.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 5, wherein:

the sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) is configured to receive a forwarding signal to inform a timing of conveyance of the recording medium, and the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is for transmitting a plurality of

signals sequentially at one of a timing immediately before a transmission of the forwarding signal and a timing immediately after a transmission of the forwarding signal when the recording medium comes at the specified position during the sheet feeding operation, the control unit (6a1, 6b1, 6c1, 6d1, 6e1) being configured to keep an orderly sequence of the forwarding signal and the plurality of signals according to receipts thereof.

**8.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 6, wherein:

the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is configured to transmit the forwarding signal including a first discharging signal, at one of a timing before a discharge of a leading edge of the recording medium and a timing after a discharge of a leading edge of the recording medium, to inform a timing of conveyance of the leading edge of the recording medium to a different external device.

**9.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 7, wherein:

the storing unit (6a3, 6b3, 6c3, 6d3, 6e3) includes a second storing unit configured to store at least one of the plurality of signals received between the first discharging signal and a second discharging signal following the first discharging signal, the second storing unit being for storing the at least one of the plurality of signals as one group unit, and the control unit (6a1, 6b1, 6c1, 6d1, 6e1) includes a transmission unit configured to transmit the first discharging signal at one of a timing before a discharge of a leading edge of the recording medium and a timing after a discharge of a leading edge of the recording medium, and transmit the at least one of the plurality of signals as one group unit immediately after a transmission of the first discharging signal.

**10.** The sheet post-processing device (6, 6a, 6b, 6c, 6d; 6e) according to claim 9, wherein:

the transmission unit is configured to transmit the first discharging signal and the plurality of signals while keeping an orderly sequence thereof.

**11.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 7, wherein:

the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is for transmitting the forwarding signal including a first discharging signal, at one of a timing before a discharge of a leading edge of the recording medium and a timing after a discharge of a leading edge of the recording medium, to inform a timing of conveyance of the leading edge of the recording medium to a different external device, and

the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is for transmitting the forwarding signal including a second discharging signal, at one of a timing before a discharge of a trailing edge of the recording medium and a timing after a discharge of a trailing edge of the recording medium, to inform a timing of conveyance of the trailing edge of the recording medium to a different external device.

**12.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 6, wherein:

the storing unit (6a3, 6b3, 6c3, 6d3, 6e3) include a second storing unit configured to store at least one of a plurality of first signals received between the first discharging signal of a first recording medium and the second discharging signal of the first recording medium following the first discharging signal thereof as a first group unit, and also store at least one of a plurality of second signals received between the second discharging signal of the first recording medium and a third discharging signal of a second recording medium following the second discharging signal of the first recording medium as a second group unit.

**13.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 12, wherein:

the control unit (6a1, 6b1, 6c1, 6d1, 6e1) includes a transmission unit configured to transmit the first discharging signal of the first recording medium at one of a timing before a discharge of a leading edge of the first recording medium and a timing after a discharge of a leading edge of the first recording medium, transmit the at least one of the plurality of first signals as the first group unit immediately after a transmission of the first discharging signal of the first recording medium, transmit the second discharging signal of the first recording medium at one of a timing before a discharge of a trailing edge of the first recording medium and a timing after a discharge of a trailing edge of the first recording medium, and transmit the at least one of the plurality of second signals as the second group unit immediately after a transmission of the second discharging signal of the first recording medium.

**14.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 13, wherein:

the transmission unit is configured to transmit the first discharging signal, the second discharging signal and the plurality of signals while keeping an orderly sequence thereof.

**15.** The sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) according to claim 7, wherein:

when the plurality of signals are received after a transmission of the forwarding signal corresponding to the plurality of signals to a downstream external device disposed downstream of the sheet post-processing device, the control unit (6a1, 6b1, 6c1, 6d1, 6e1) is configured to transmit the plurality of signals instantly to the downstream external device.

**16.** A sheet post-processing system (6), comprising:

a connecting member; and
a plurality of sheet post-processing devices (6, 6a, 6b, 6c, 6d, 6e) each connected by the connecting member to at least one different sheet, wherein each of the sheet-processing devices (6, 6a, 6b, 6c, 6d, 6e) is according to any preceding claim

**17.** The sheet post-processing system of 16, wherein a storing unit (6a3, 6b3, 6c3, 6d3, 6e3) is provided configured to store information relating to the recording medium transmitted from the external device,
wherein the plurality of sheet post-processing devices (6a, 6b, 6c) other than a most downstream sheet post-processing device are configured to store at least one signal of a set of signals to the storing unit at a receipt of the at least one signal of the set of signals during a sheet feeding operation and to transmit the at least one signal of the set of signals when the recording medium comes at a specified position.

**18.** An image forming system (100, 200), comprising:

an image forming device (1) configured to form an image on a surface of a recording medium; and
a plurality of sheet post-processing devices (6, 6a, 6b, 6c, 6d, 6e) connected by a connecting member to at least one different sheet post-processing device(6a, 6b, 6c, 6d, 6e) of the image forming system, wherein each sheet post-processing device (6, 6a, 6b, 6c, 6d, 6e) is according to any of claims 1 to 15,

wherein a most upstream sheet post-processing device (6a) of the plurality of sheet post-processing devices is connected to the image forming device (1).

FIG. 1

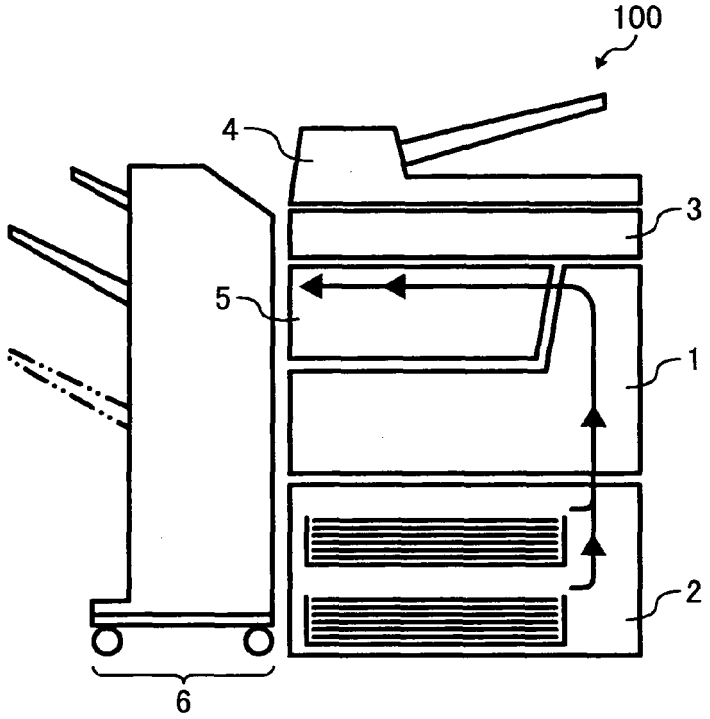



FIG. 2

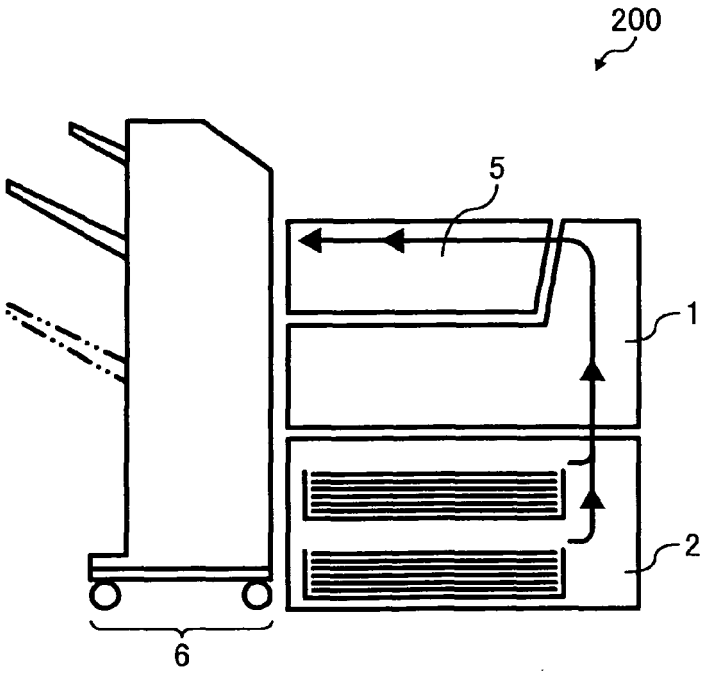


FIG. 3

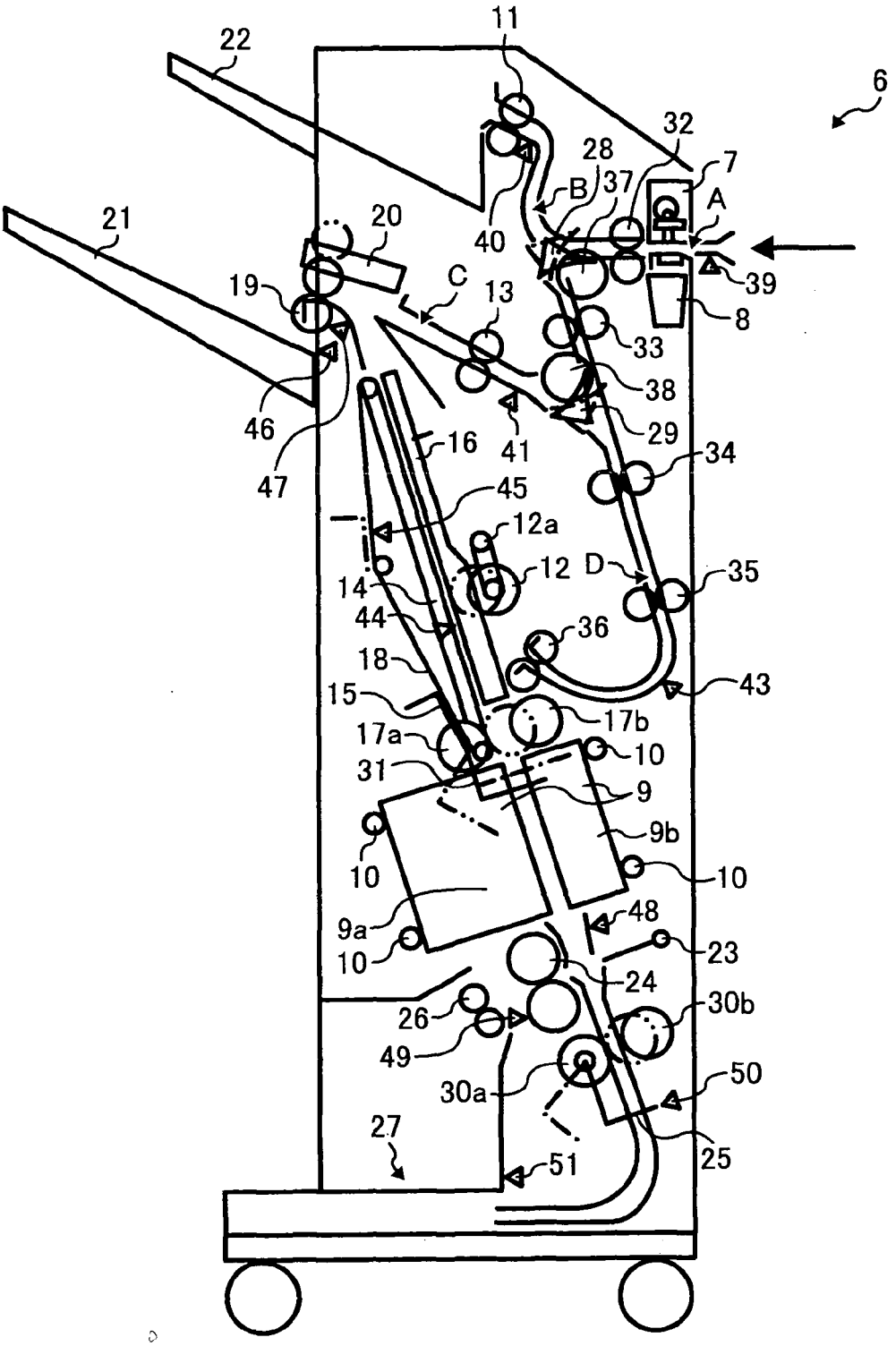

11
22
6
32
28
7
B
37
A
21
20
40
39
19
C
13
8
33
38
46
29
16
41
34
47
45
12a
12
D
35
14
44
36
18
43
15
17b
17a
10
31
9
9b
10
10
9a
48
10
23
24
26
30b
49
50
30a
27
25
51

FIG. 4

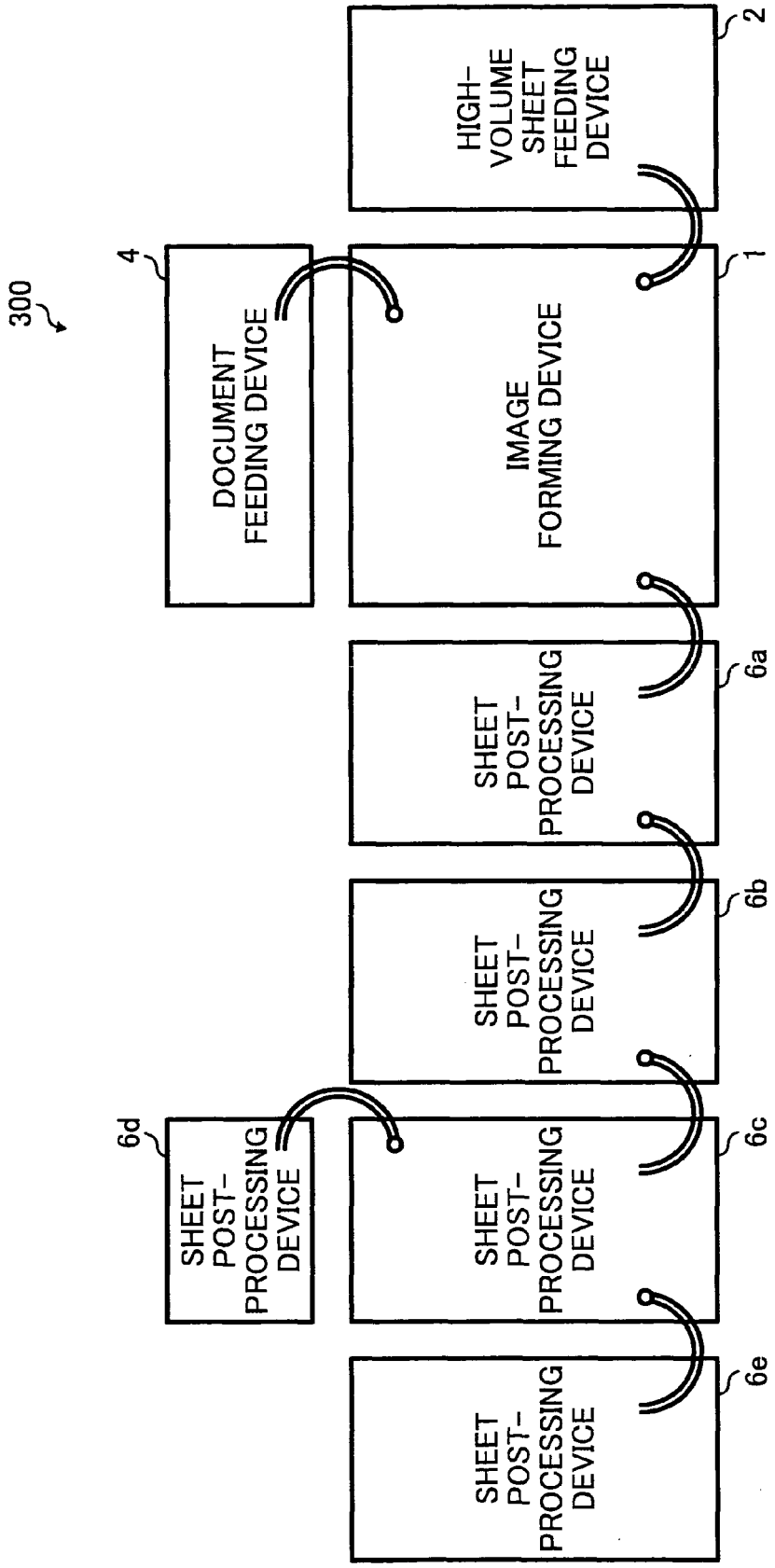

300
4
DOCUMENT FEEDING DEVICE
HIGH-VOLUME SHEET FEEDING DEVICE
2
IMAGE FORMING DEVICE
1
SHEET POST-PROCESSING DEVICE
6a
SHEET POST-PROCESSING DEVICE
6b
6d
SHEET POST-PROCESSING DEVICE
SHEET POST-PROCESSING DEVICE
6c
SHEET POST-PROCESSING DEVICE
6e

FIG. 5

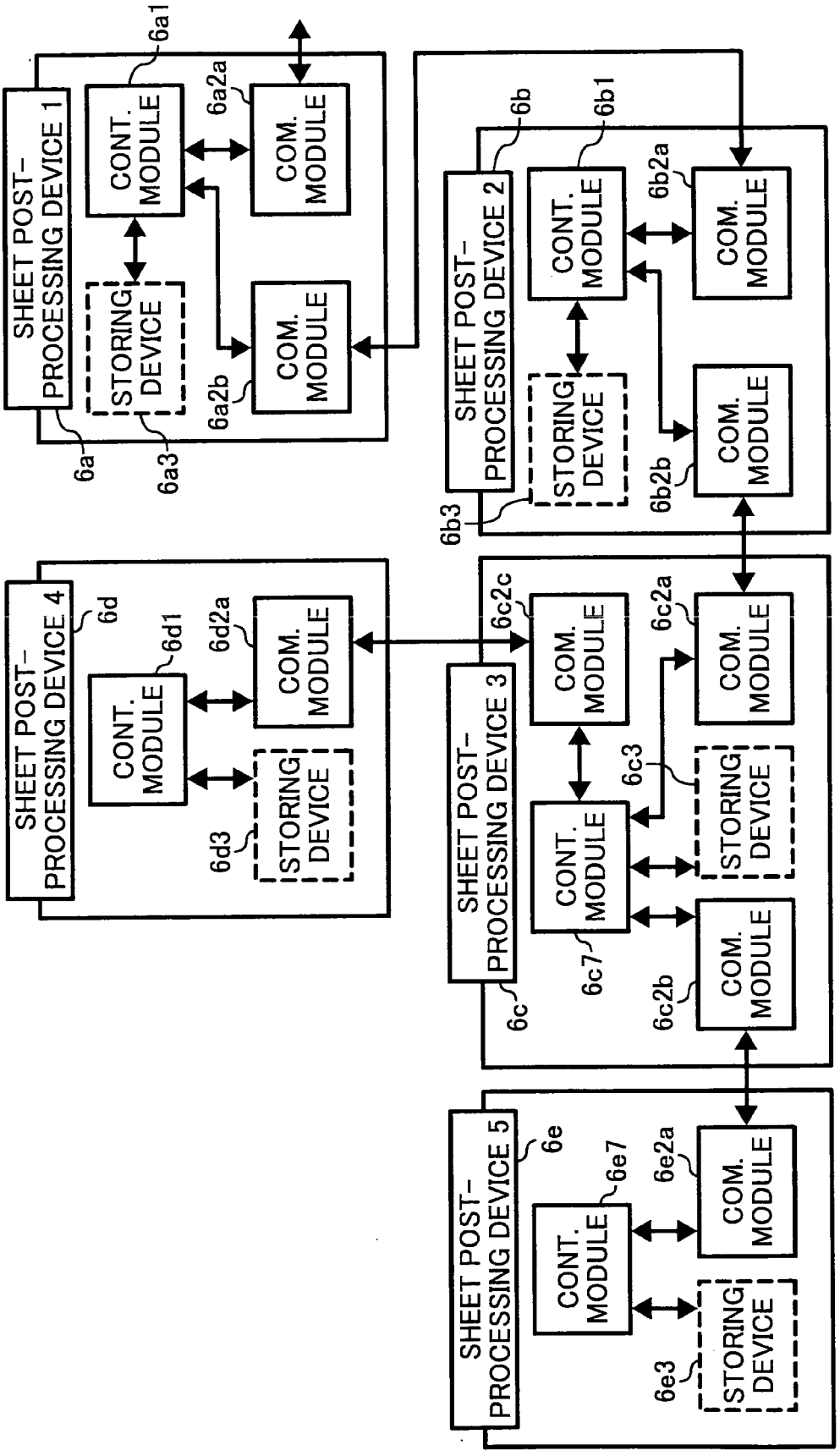

SHEET POST-PROCESSING DEVICE 1
CONT. MODULE
COM. MODULE
STORING DEVICE
COM. MODULE
6a1
6a2a
6a2b
6a
6a3
SHEET POST-PROCESSING DEVICE 2
CONT. MODULE
COM. MODULE
STORING DEVICE
COM. MODULE
6b
6b1
6b2a
6b2b
6b3
SHEET POST-PROCESSING DEVICE 4
CONT. MODULE
COM. MODULE
STORING DEVICE
6d
6d1
6d2a
6d3
SHEET POST-PROCESSING DEVICE 3
COM. MODULE
COM. MODULE
CONT. MODULE
STORING DEVICE
COM. MODULE
6c2c
6c2a
6c3
6c7
6c2b
6c
SHEET POST-PROCESSING DEVICE 5
CONT. MODULE
COM. MODULE
STORING DEVICE
6e
6e7
6e2a
6e3

FIG. 6

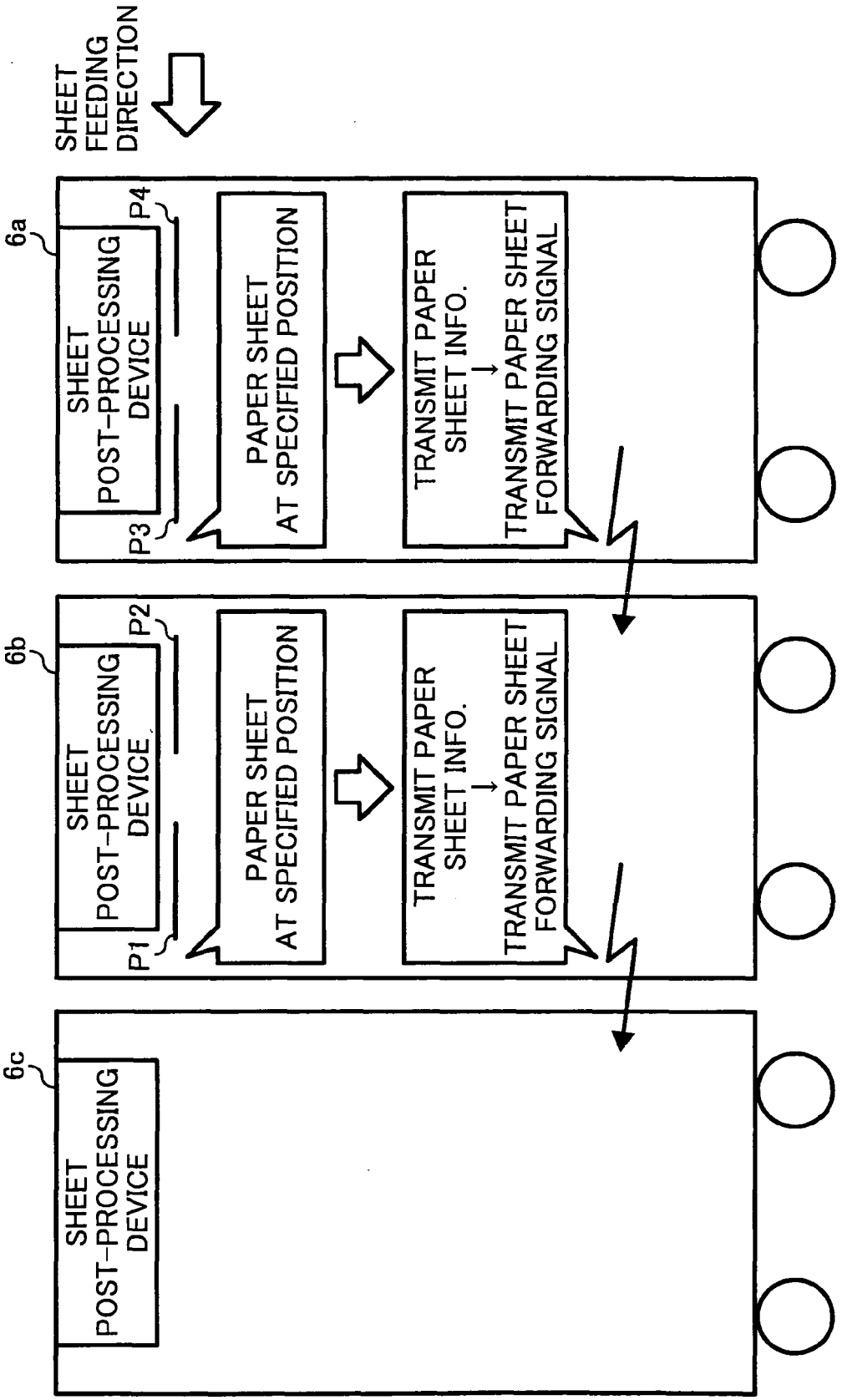
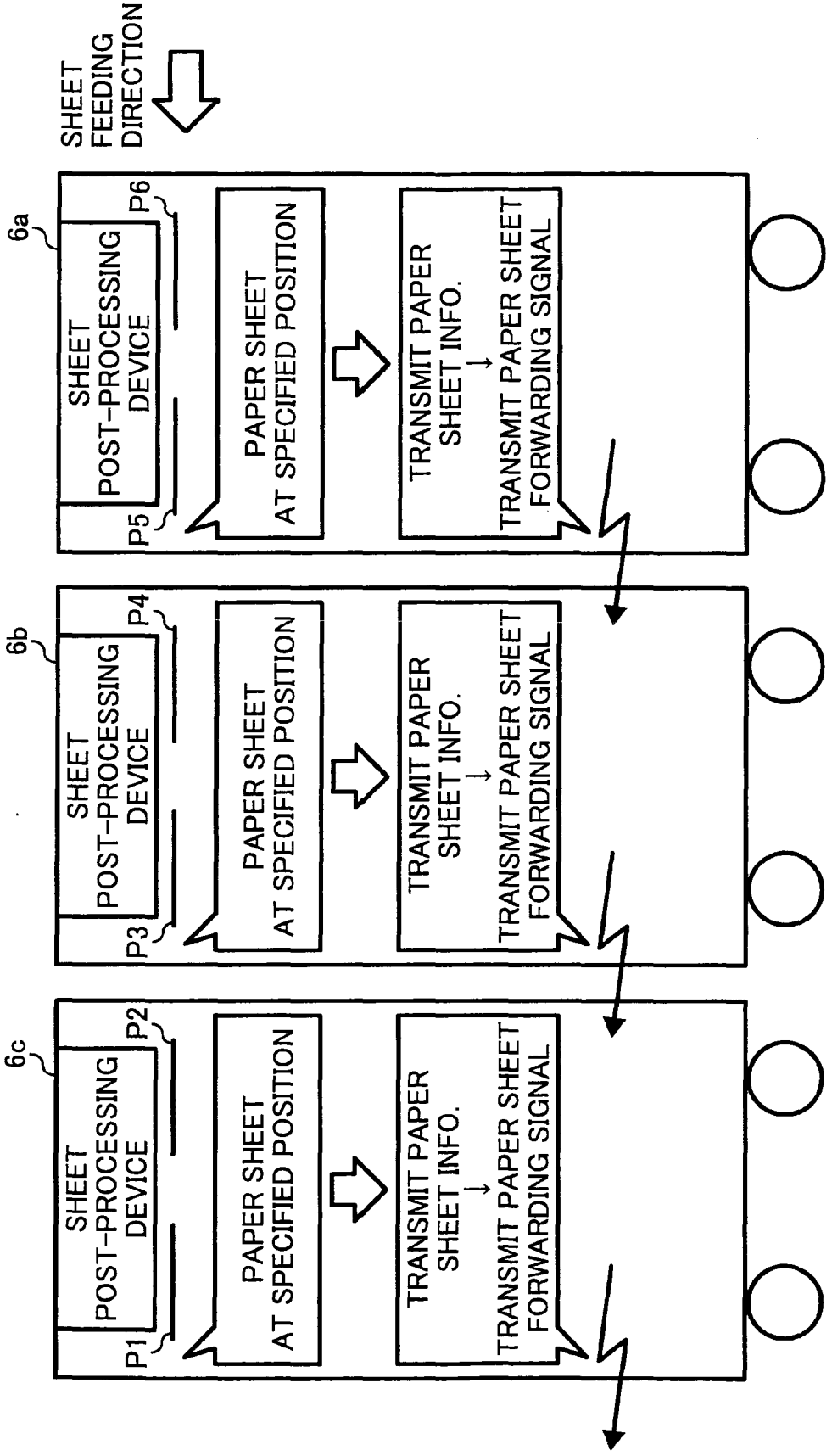

SHEET FEEDING DIRECTION
6a
SHEET POST-PROCESSING DEVICE
P4
P3
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL
6b
SHEET POST-PROCESSING DEVICE
P2
P1
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL
6c
SHEET POST-PROCESSING DEVICE

FIG. 7


SHEET FEEDING DIRECTION
6a
SHEET POST-PROCESSING DEVICE
P5
P6
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL
6b
SHEET POST-PROCESSING DEVICE
P3
P4
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL
6c
SHEET POST-PROCESSING DEVICE
P1
P2
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL

# FIG. 8

PAPER SHEET INFO. RECEIVING OPERATION

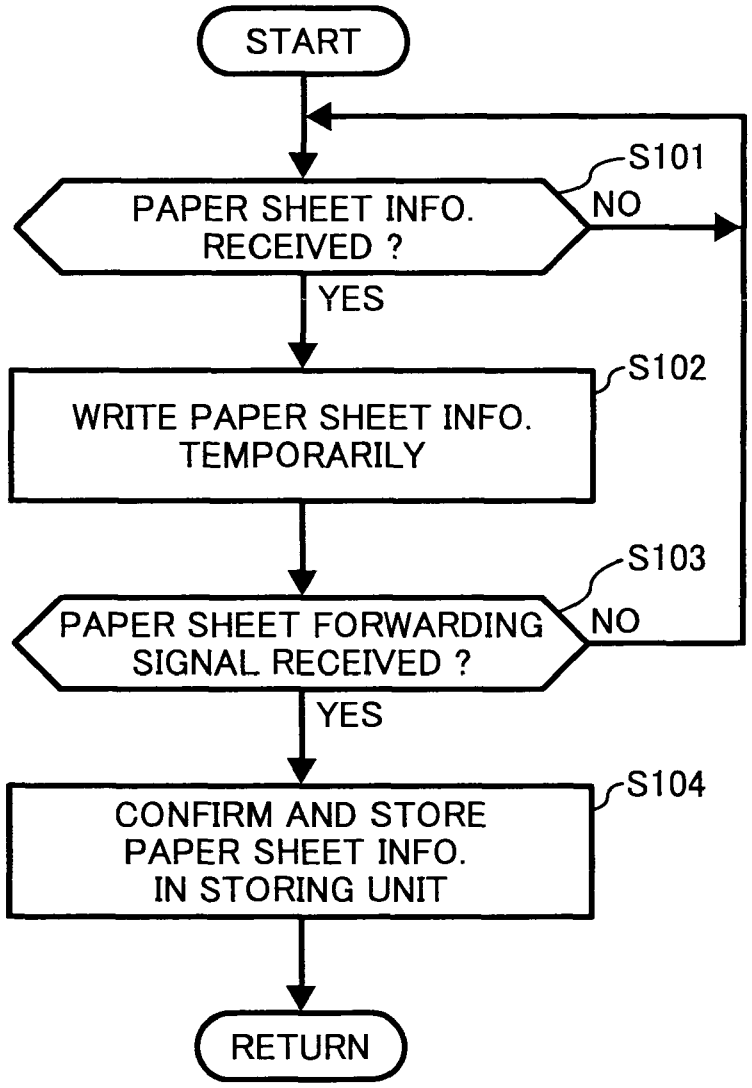


FIG. 9

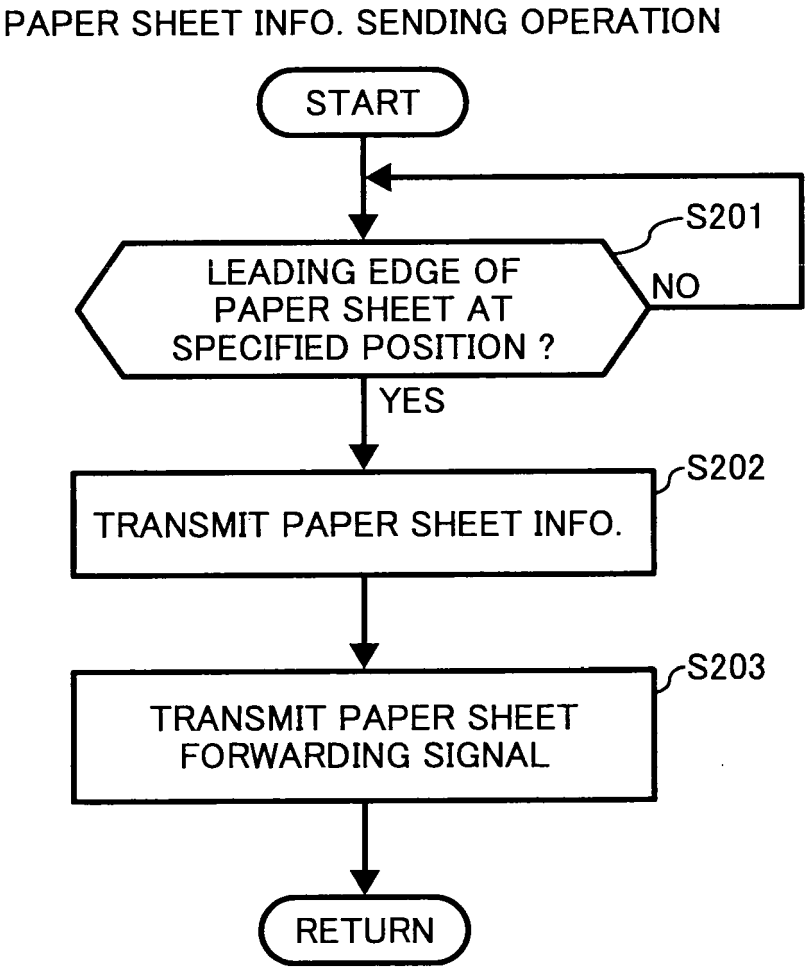

PAPER SHEET INFO. SENDING OPERATION
START
S201
LEADING EDGE OF PAPER SHEET AT SPECIFIED POSITION ?
NO
YES
S202
TRANSMIT PAPER SHEET INFO.
S203
TRANSMIT PAPER SHEET FORWARDING SIGNAL
RETURN

FIG. 10

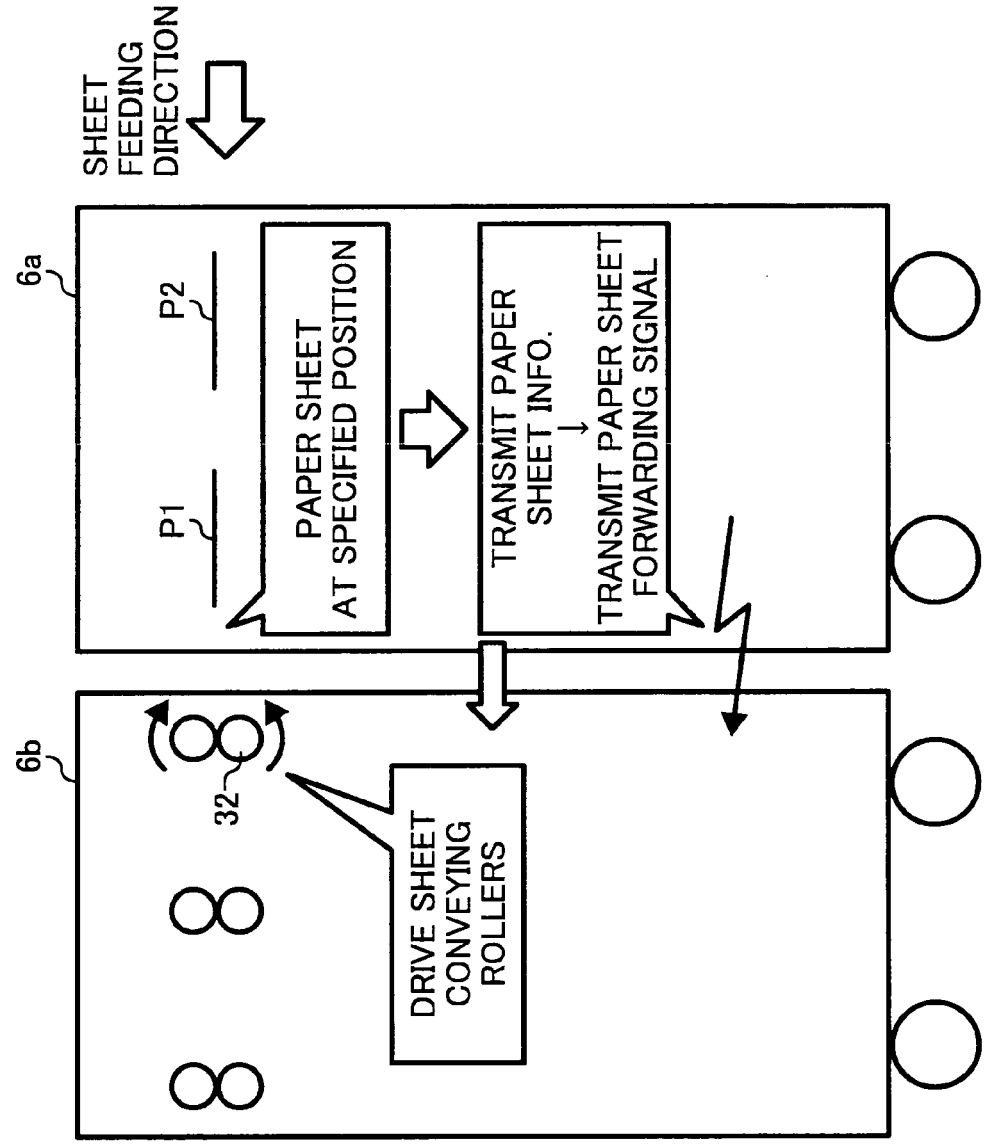

SHEET FEEDING DIRECTION
6a
P2
P1
PAPER SHEET AT SPECIFIED POSITION
TRANSMIT PAPER SHEET INFO.
TRANSMIT PAPER SHEET FORWARDING SIGNAL
6b
32
DRIVE SHEET CONVEYING ROLLERS

FIG. 11

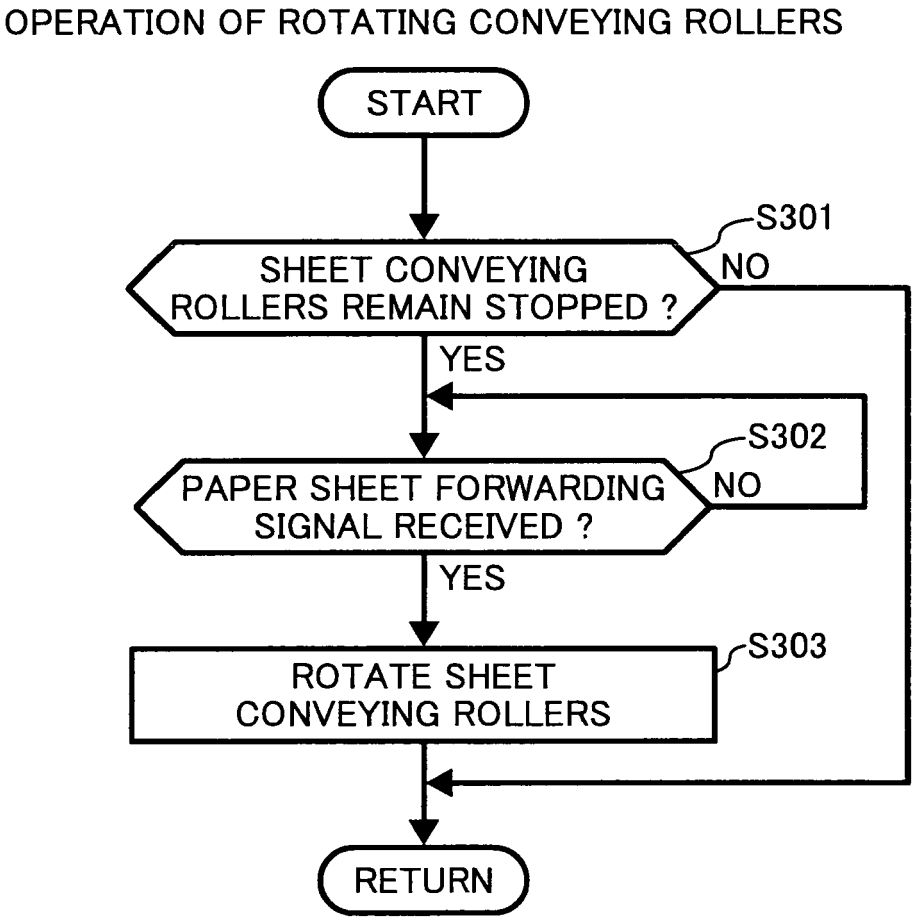
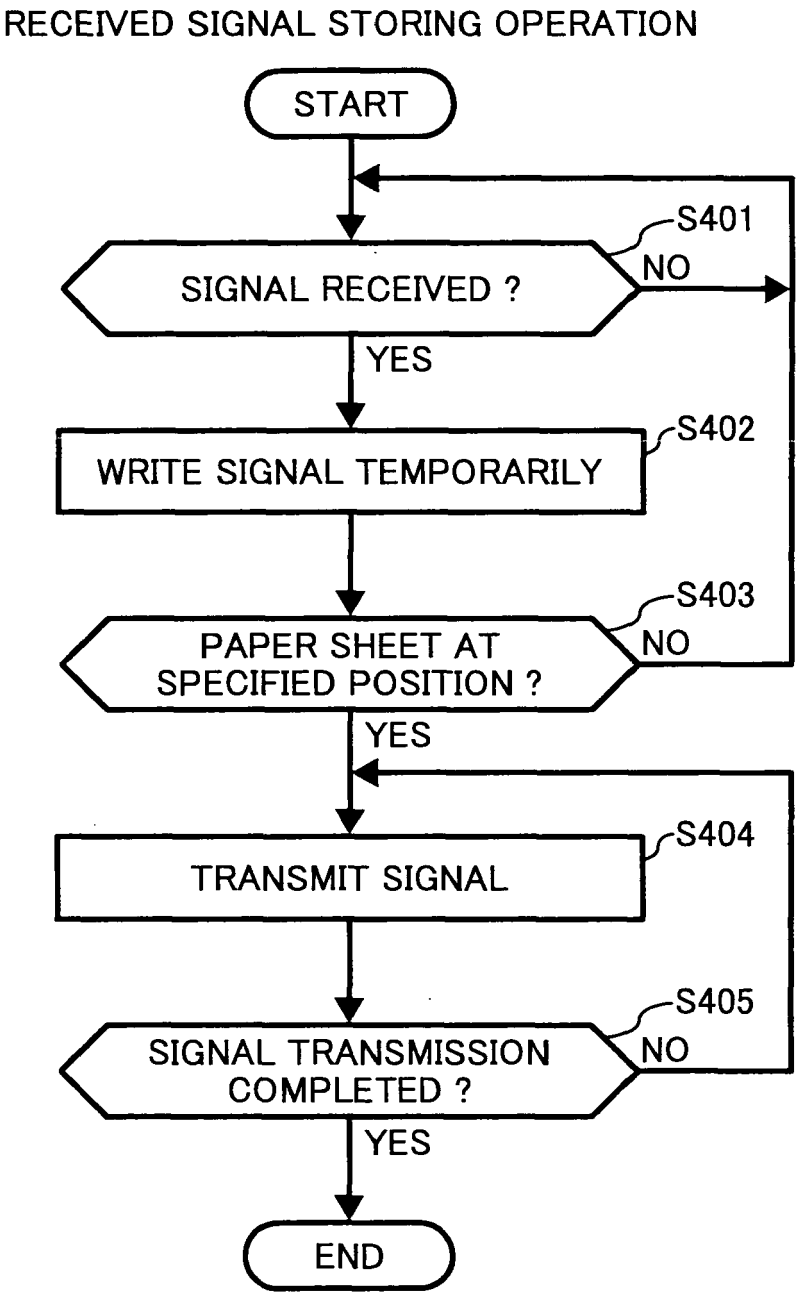
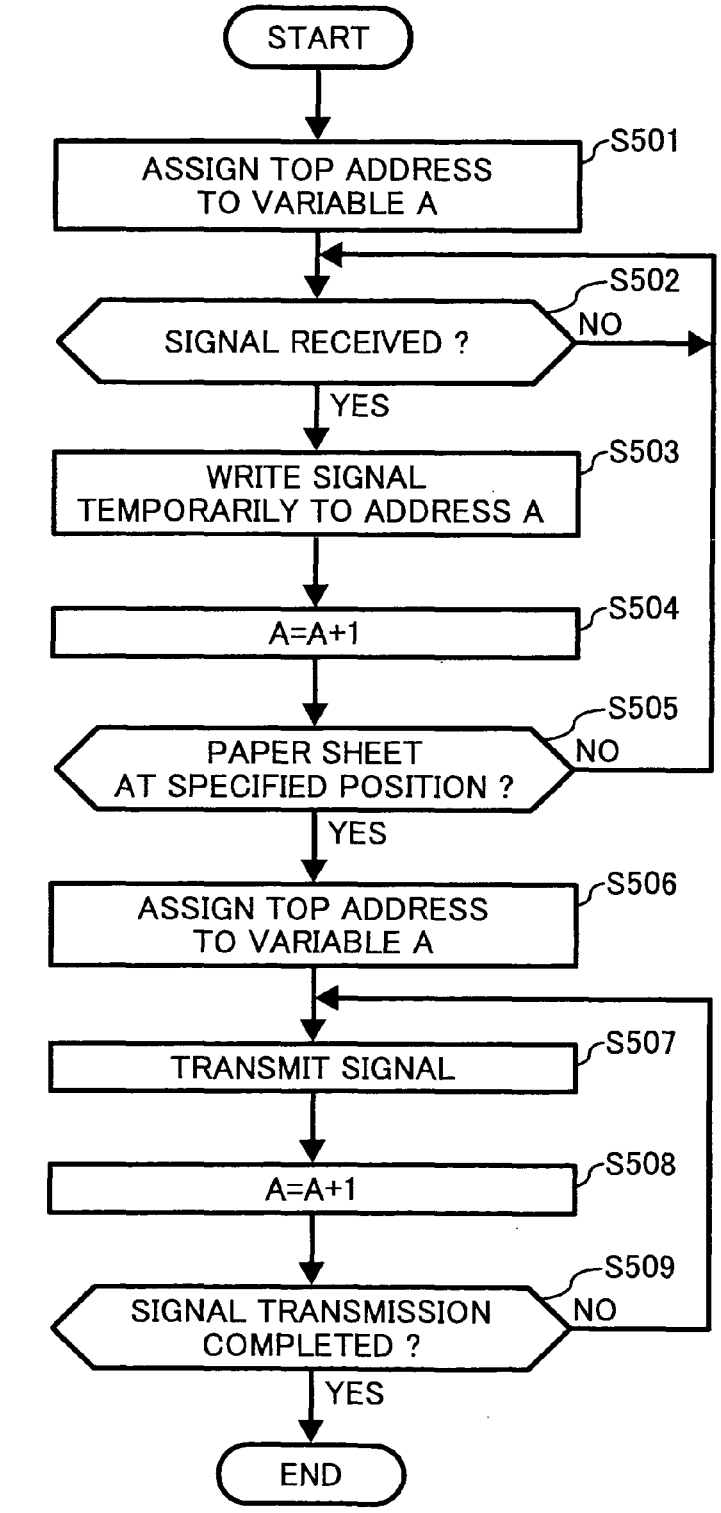

OPERATION OF ROTATING CONVEYING ROLLERS
START
S301
SHEET CONVEYING ROLLERS REMAIN STOPPED ?
NO
YES
S302
PAPER SHEET FORWARDING SIGNAL RECEIVED ?
NO
YES
S303
ROTATE SHEET CONVEYING ROLLERS
RETURN

FIG. 12


RECEIVED SIGNAL STORING OPERATION
START
S401
SIGNAL RECEIVED ?
NO
YES
S402
WRITE SIGNAL TEMPORARILY
S403
PAPER SHEET AT SPECIFIED POSITION ?
NO
YES
S404
TRANSMIT SIGNAL
S405
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

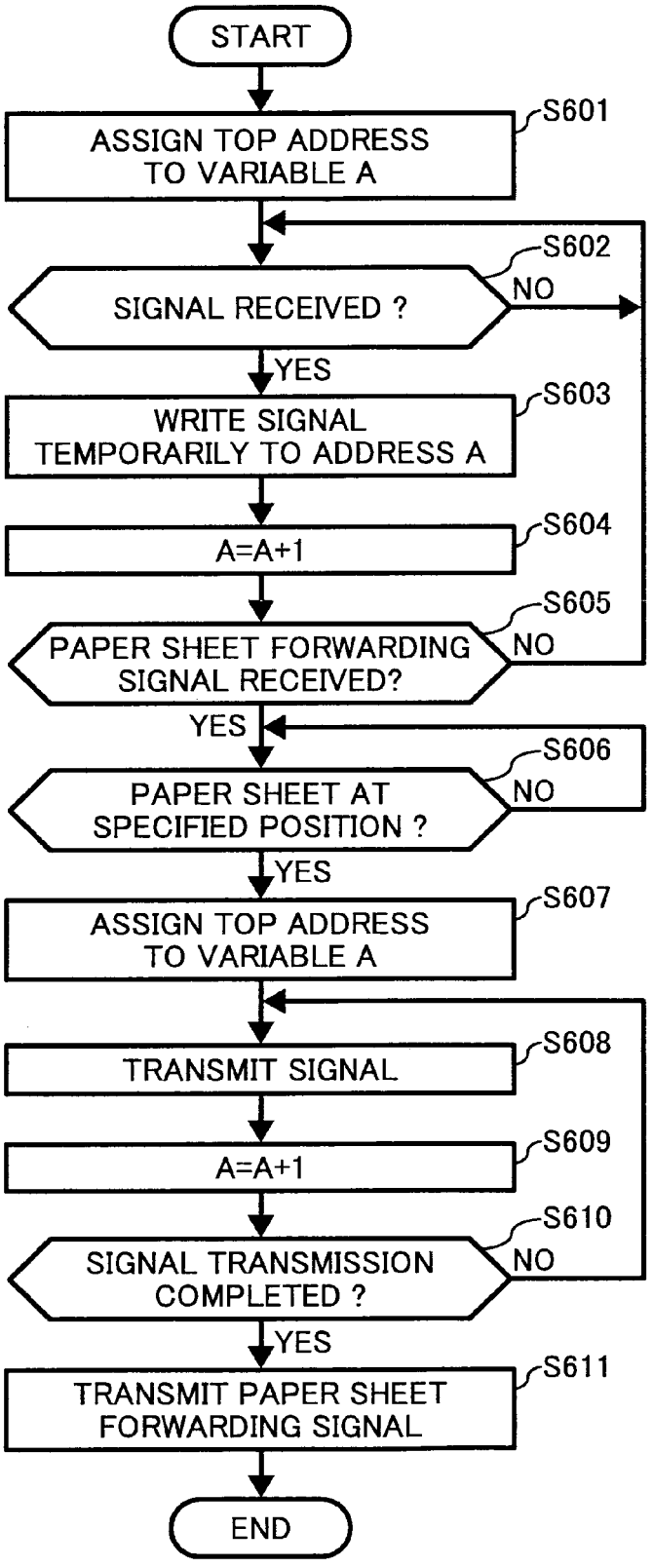
# FIG. 13

RECEIVED SIGNAL STORING OPERATION



# FIG. 14

RECEIVED SIGNAL STORING OPERATION



# FIG. 15

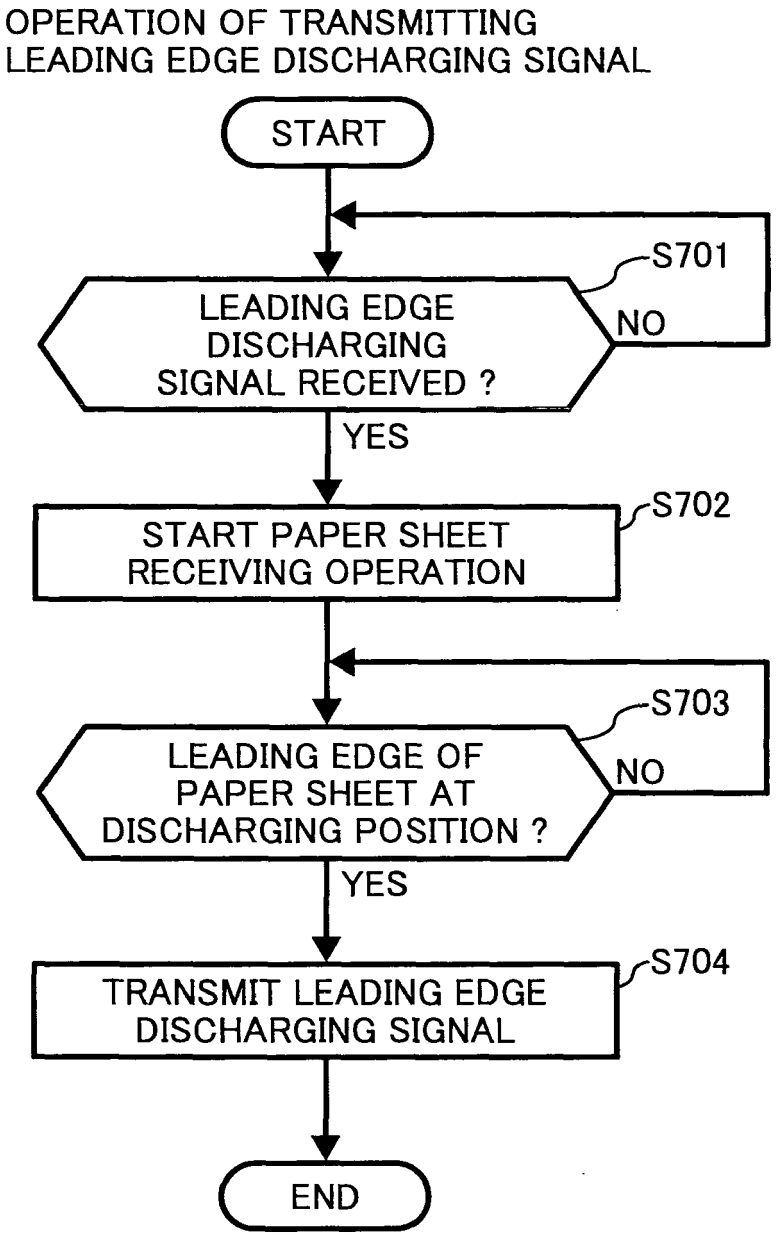

OPERATION OF TRANSMITTING
LEADING EDGE DISCHARGING SIGNAL
START
S701
LEADING EDGE
DISCHARGING
SIGNAL RECEIVED ?
NO
YES
S702
START PAPER SHEET
RECEIVING OPERATION
S703
LEADING EDGE OF
PAPER SHEET AT
DISCHARGING POSITION ?
NO
YES
S704
TRANSMIT LEADING EDGE
DISCHARGING SIGNAL
END

FIG. 16

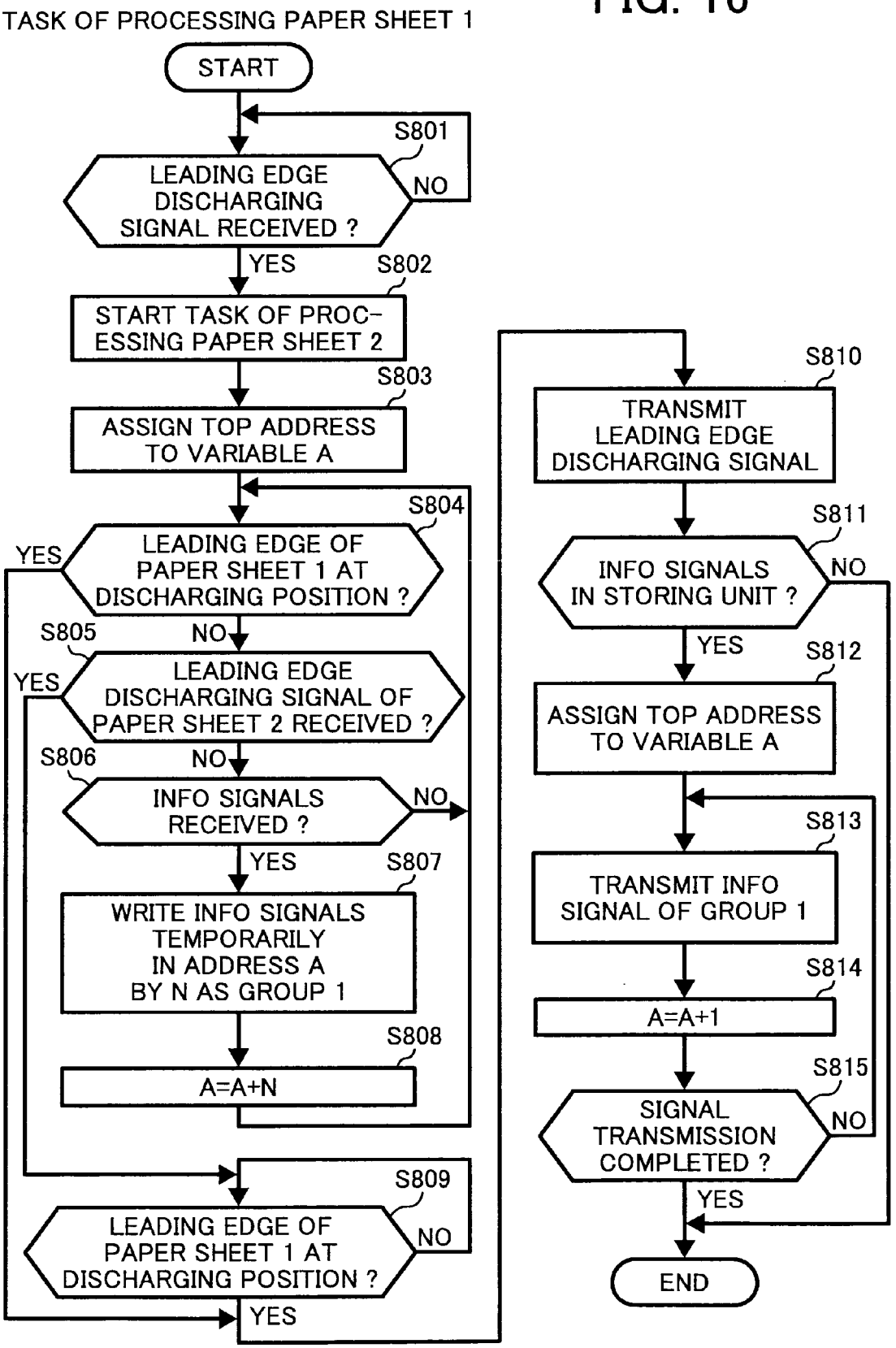

TASK OF PROCESSING PAPER SHEET 1
START
S801
LEADING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S802
START TASK OF PROCESSING PAPER SHEET 2
S803
ASSIGN TOP ADDRESS TO VARIABLE A
S804
LEADING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
YES
NO
S805
LEADING EDGE DISCHARGING SIGNAL OF PAPER SHEET 2 RECEIVED ?
YES
NO
S806
INFO SIGNALS RECEIVED ?
NO
YES
S807
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS A BY N AS GROUP 1
S808
A=A+N
S809
LEADING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
NO
YES
S810
TRANSMIT LEADING EDGE DISCHARGING SIGNAL
S811
INFO SIGNALS IN STORING UNIT ?
NO
YES
S812
ASSIGN TOP ADDRESS TO VARIABLE A
S813
TRANSMIT INFO SIGNAL OF GROUP 1
S814
A=A+1
S815
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 17A

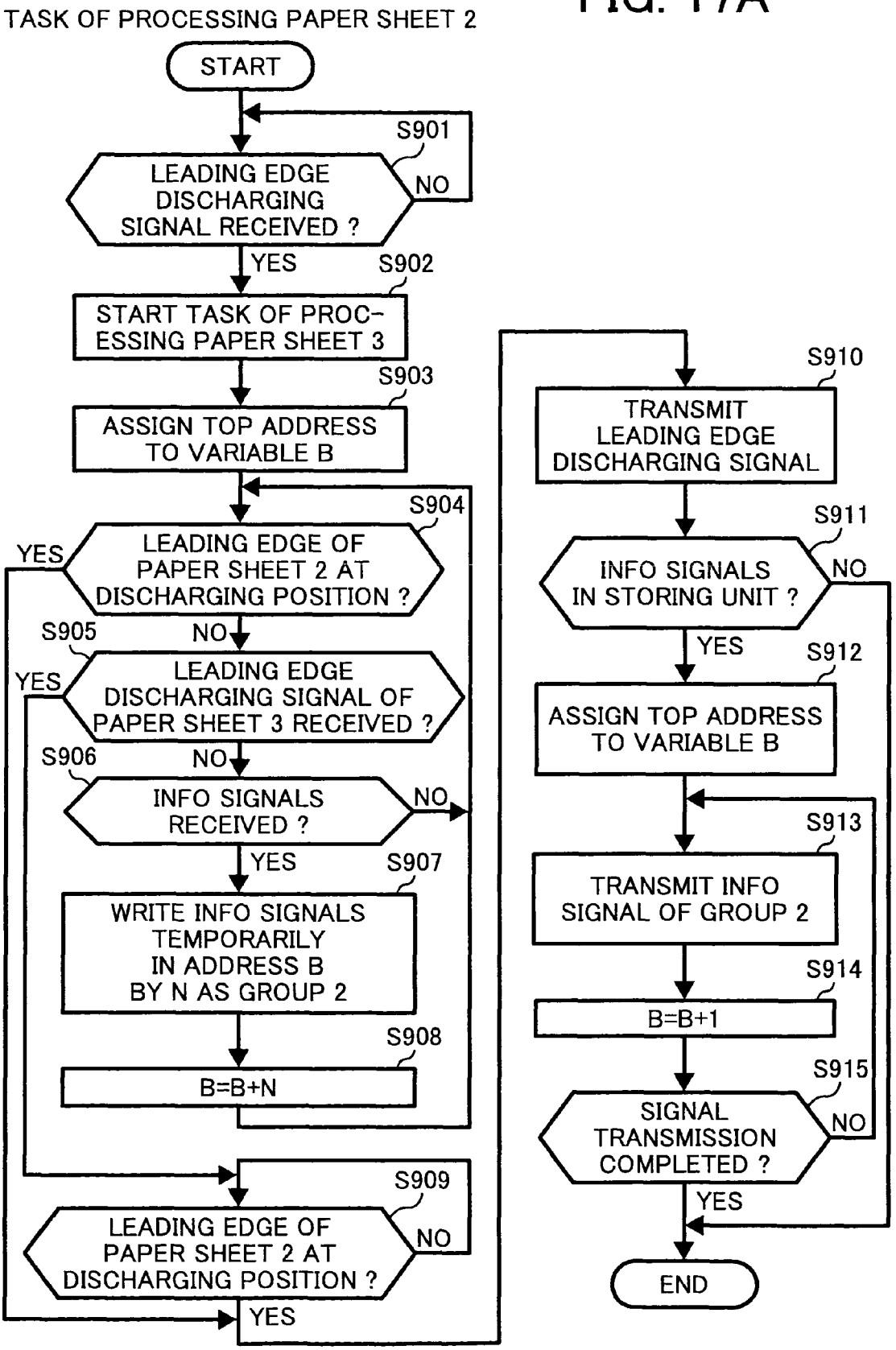
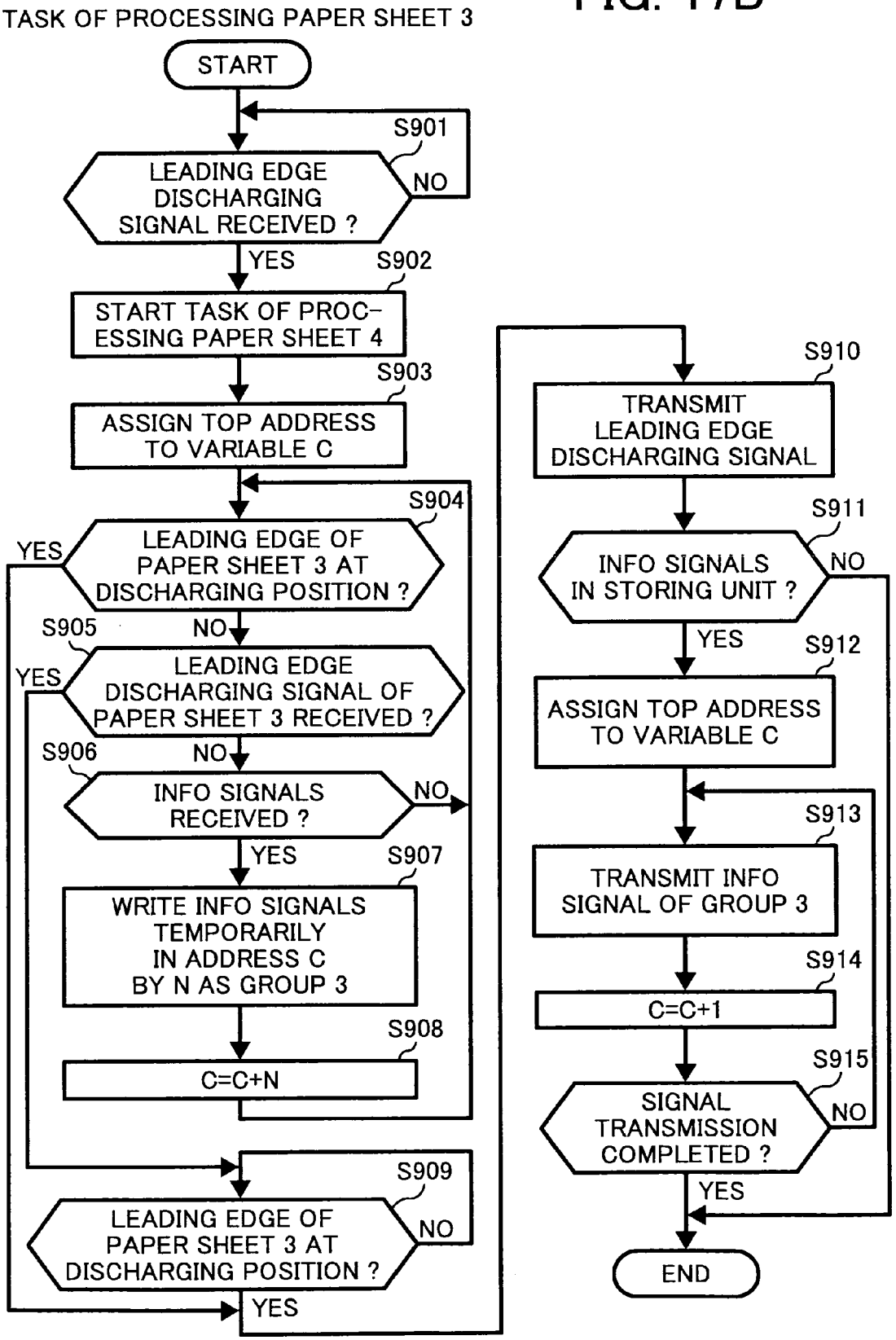
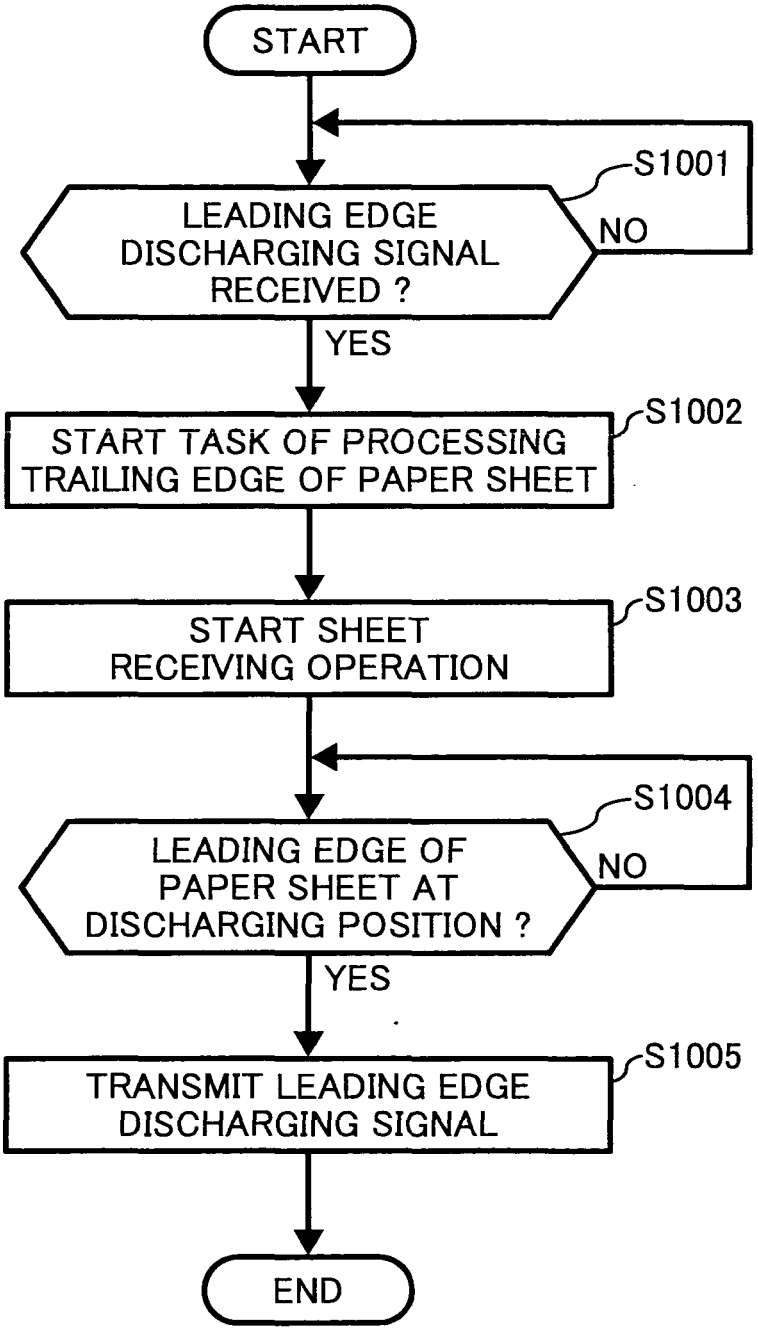

TASK OF PROCESSING PAPER SHEET 2
START
S901
LEADING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S902
START TASK OF PROCESSING PAPER SHEET 3
S903
ASSIGN TOP ADDRESS TO VARIABLE B
S904
YES
LEADING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
S905
NO
YES
LEADING EDGE DISCHARGING SIGNAL OF PAPER SHEET 3 RECEIVED ?
S906
NO
INFO SIGNALS RECEIVED ?
NO
YES
S907
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS B BY N AS GROUP 2
S908
B=B+N
S909
LEADING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
NO
YES
S910
TRANSMIT LEADING EDGE DISCHARGING SIGNAL
S911
INFO SIGNALS IN STORING UNIT ?
NO
YES
S912
ASSIGN TOP ADDRESS TO VARIABLE B
S913
TRANSMIT INFO SIGNAL OF GROUP 2
S914
B=B+1
S915
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 17B


TASK OF PROCESSING PAPER SHEET 3
START
S901
LEADING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S902
START TASK OF PROCESSING PAPER SHEET 4
S903
ASSIGN TOP ADDRESS TO VARIABLE C
S904
LEADING EDGE OF PAPER SHEET 3 AT DISCHARGING POSITION ?
YES
NO
S905
LEADING EDGE DISCHARGING SIGNAL OF PAPER SHEET 3 RECEIVED ?
YES
NO
S906
INFO SIGNALS RECEIVED ?
NO
YES
S907
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS C BY N AS GROUP 3
S908
C=C+N
S909
LEADING EDGE OF PAPER SHEET 3 AT DISCHARGING POSITION ?
NO
YES
S910
TRANSMIT LEADING EDGE DISCHARGING SIGNAL
S911
INFO SIGNALS IN STORING UNIT ?
NO
YES
S912
ASSIGN TOP ADDRESS TO VARIABLE C
S913
TRANSMIT INFO SIGNAL OF GROUP 3
S914
C=C+1
S915
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

# FIG. 18

TASK OF PROCESSING LEADING EDGE OF PAPER SHEET



# FIG. 19

TASK OF PROCESSING TRAILING EDGE OF PAPER SHEET

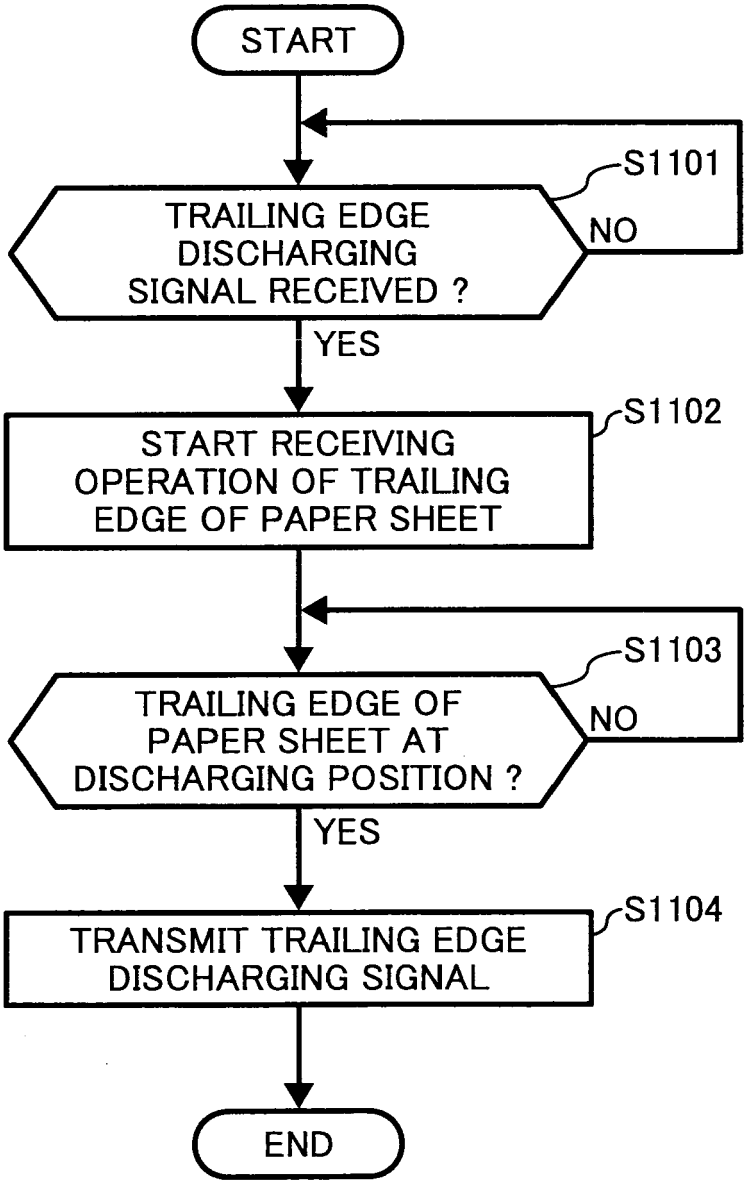


FIG. 20

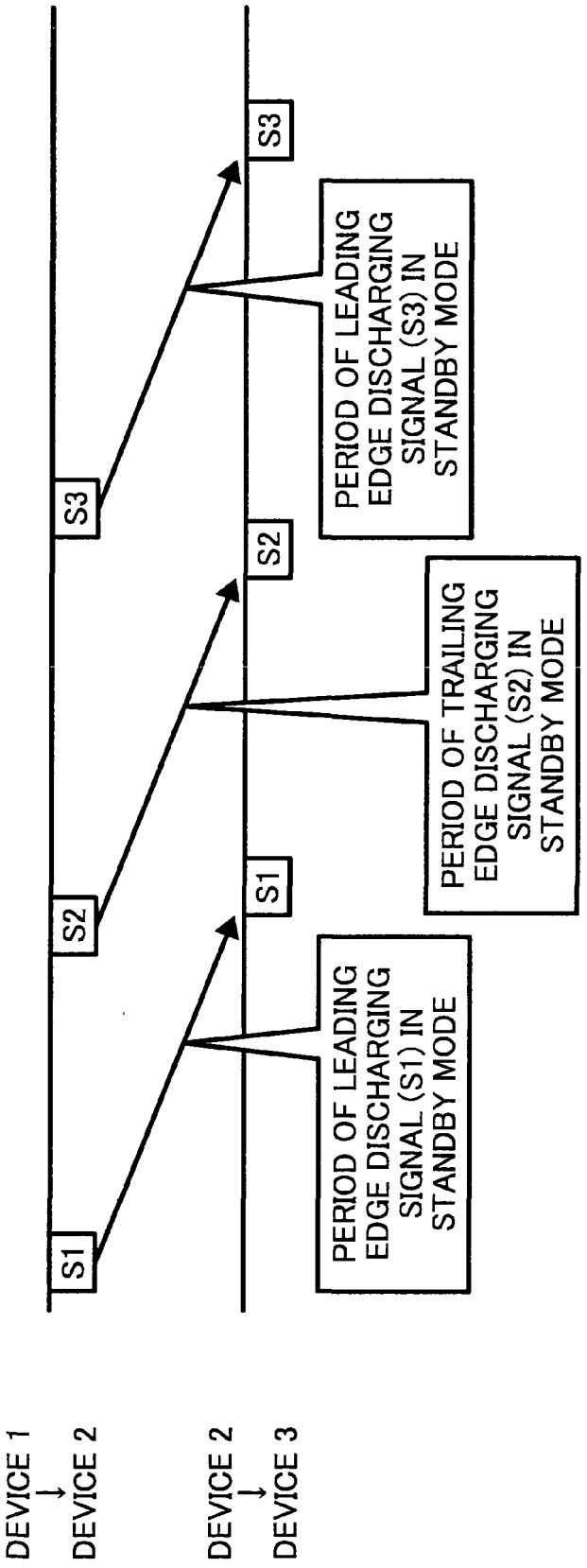

DEVICE 1
DEVICE 2
DEVICE 2
DEVICE 3
S1
S2
S3
S1
S2
S3
PERIOD OF LEADING EDGE DISCHARGING SIGNAL (S1) IN STANDBY MODE
PERIOD OF TRAILING EDGE DISCHARGING SIGNAL (S2) IN STANDBY MODE
PERIOD OF LEADING EDGE DISCHARGING SIGNAL (S3) IN STANDBY MODE

FIG. 21

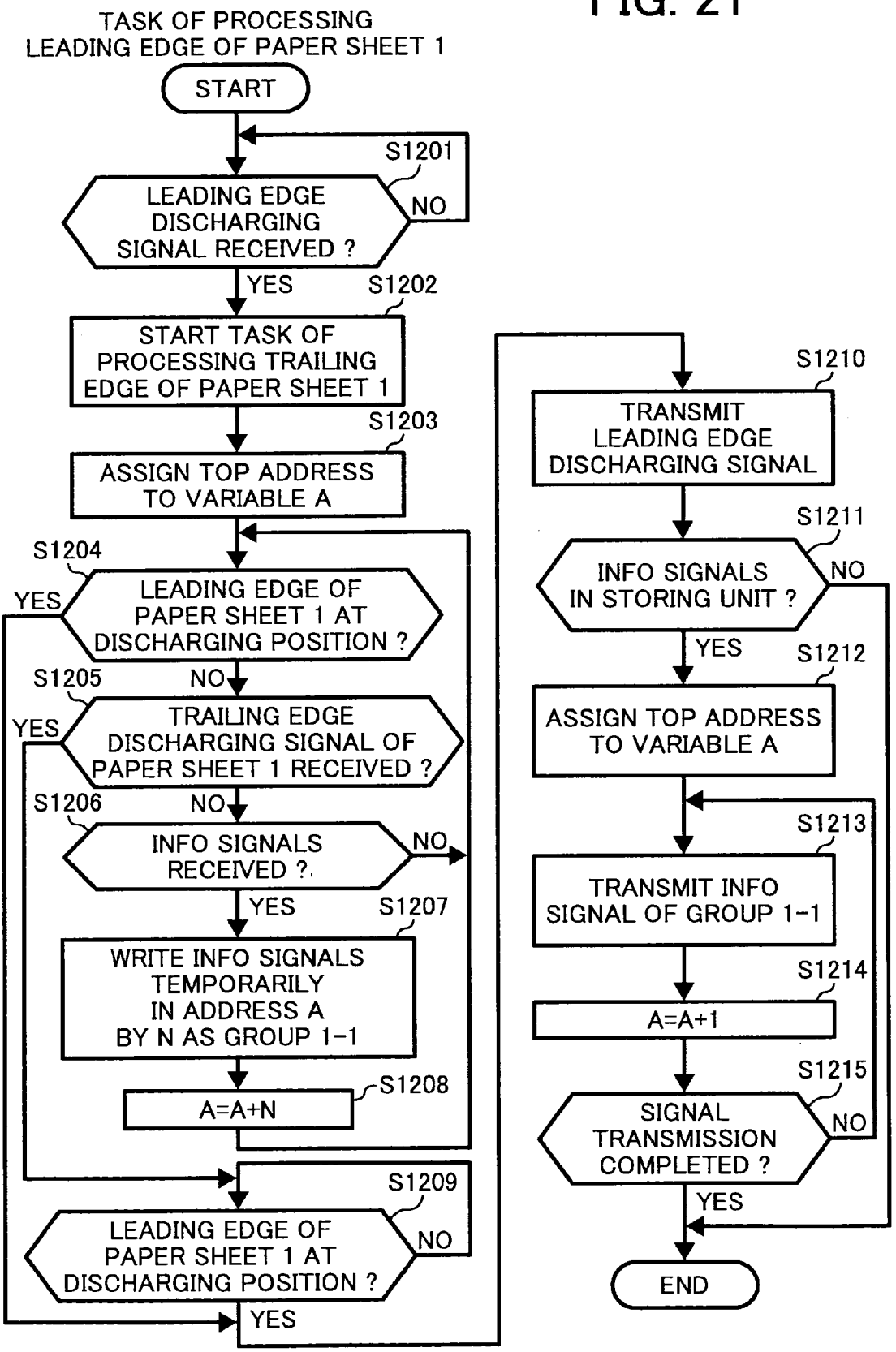

TASK OF PROCESSING LEADING EDGE OF PAPER SHEET 1
START
S1201
LEADING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S1202
START TASK OF PROCESSING TRAILING EDGE OF PAPER SHEET 1
S1203
ASSIGN TOP ADDRESS TO VARIABLE A
S1204
YES
LEADING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
S1205
NO
YES
TRAILING EDGE DISCHARGING SIGNAL OF PAPER SHEET 1 RECEIVED ?
S1206
NO
INFO SIGNALS RECEIVED ?
NO
YES
S1207
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS A BY N AS GROUP 1-1
S1208
A=A+N
S1209
LEADING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
NO
YES
S1210
TRANSMIT LEADING EDGE DISCHARGING SIGNAL
S1211
INFO SIGNALS IN STORING UNIT ?
NO
YES
S1212
ASSIGN TOP ADDRESS TO VARIABLE A
S1213
TRANSMIT INFO SIGNAL OF GROUP 1-1
S1214
A=A+1
S1215
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 22

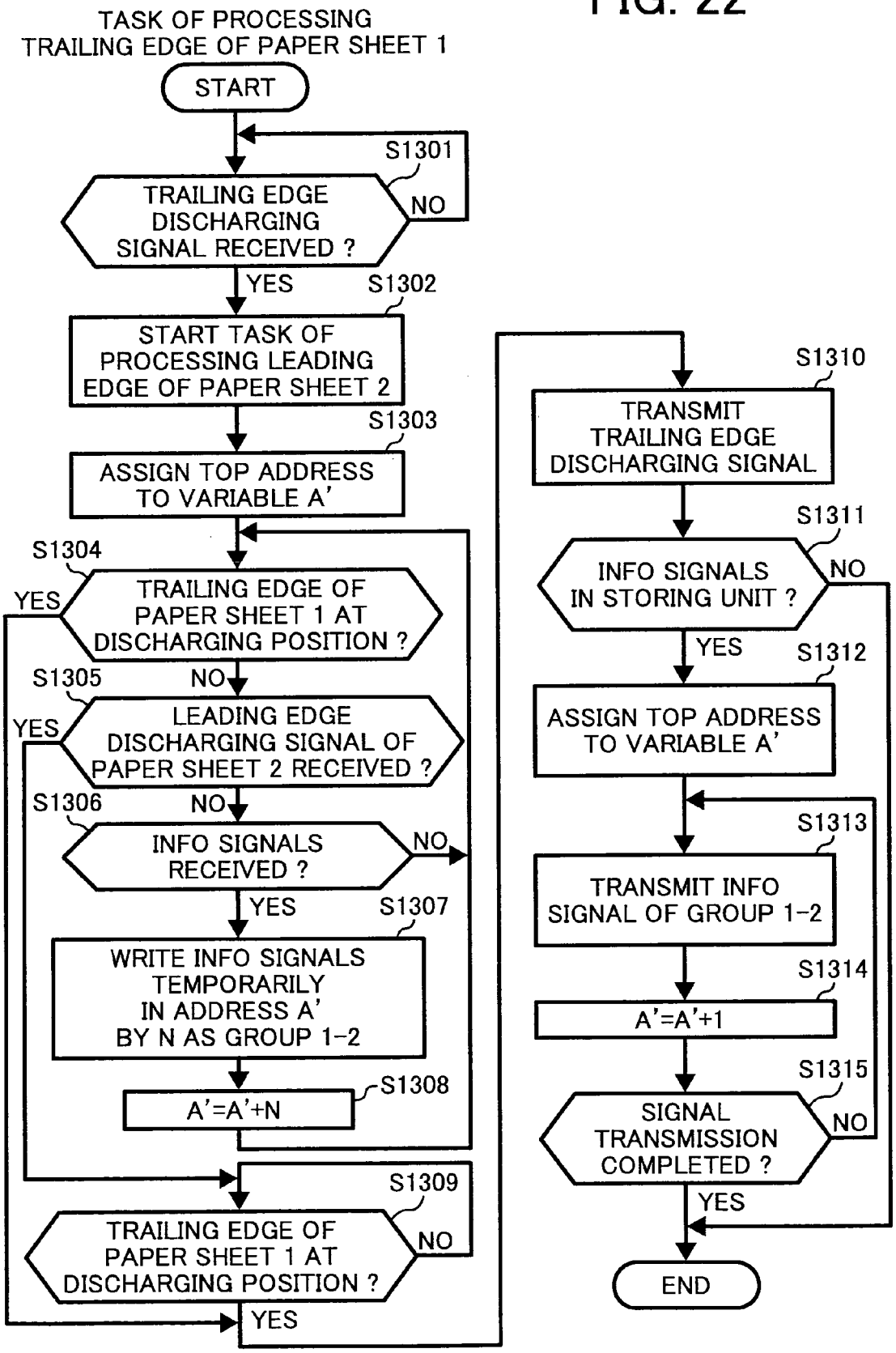

TASK OF PROCESSING TRAILING EDGE OF PAPER SHEET 1
START
S1301
TRAILING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S1302
START TASK OF PROCESSING LEADING EDGE OF PAPER SHEET 2
S1303
ASSIGN TOP ADDRESS TO VARIABLE A'
S1304
YES
TRAILING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
S1305
NO
YES
LEADING EDGE DISCHARGING SIGNAL OF PAPER SHEET 2 RECEIVED ?
S1306
NO
INFO SIGNALS RECEIVED ?
NO
YES
S1307
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS A' BY N AS GROUP 1-2
S1308
A'=A'+N
S1309
TRAILING EDGE OF PAPER SHEET 1 AT DISCHARGING POSITION ?
NO
YES
S1310
TRANSMIT TRAILING EDGE DISCHARGING SIGNAL
S1311
INFO SIGNALS IN STORING UNIT ?
NO
YES
S1312
ASSIGN TOP ADDRESS TO VARIABLE A'
S1313
TRANSMIT INFO SIGNAL OF GROUP 1-2
S1314
A'=A'+1
S1315
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 23A

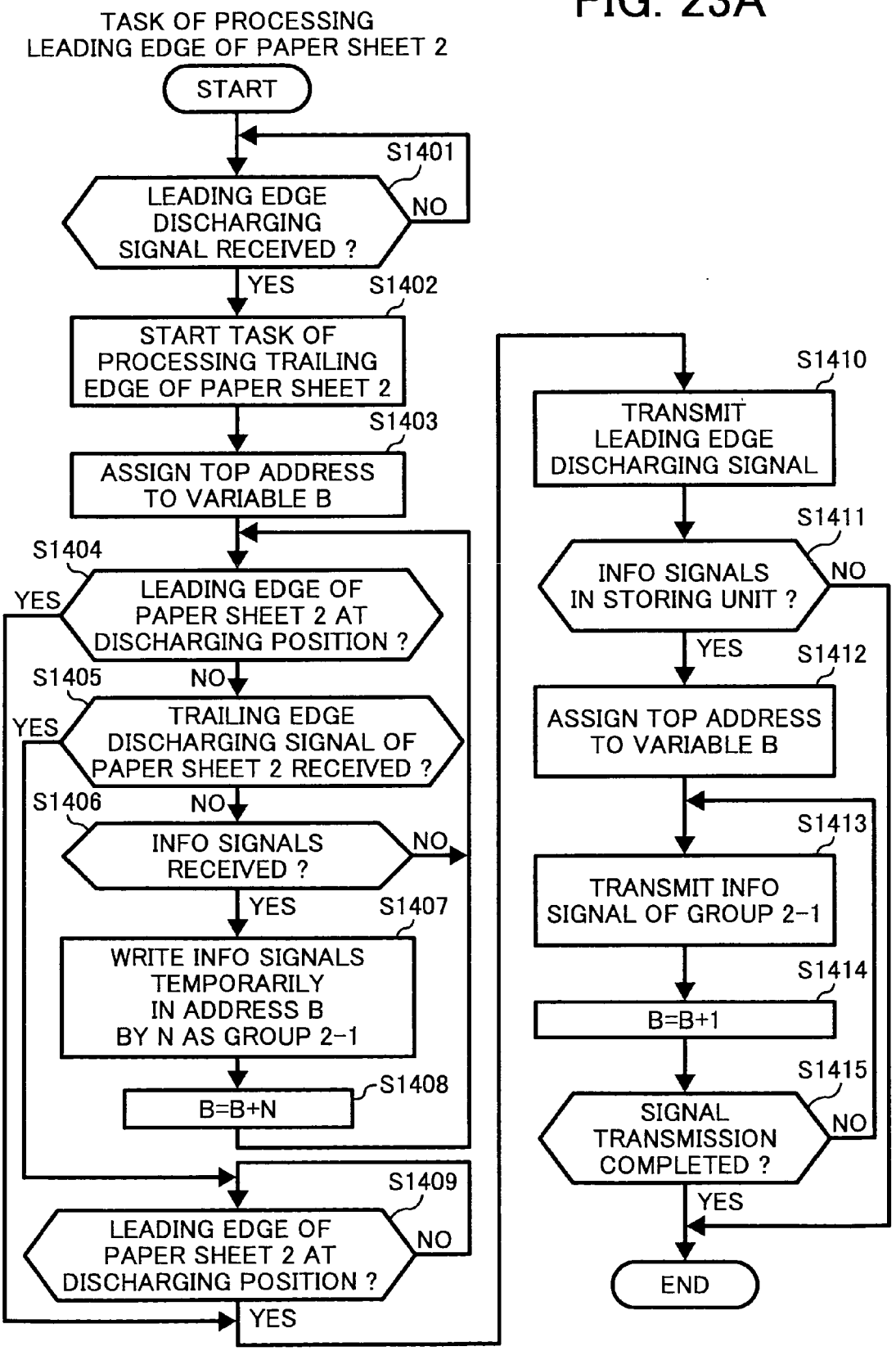

TASK OF PROCESSING LEADING EDGE OF PAPER SHEET 2
START
S1401
LEADING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S1402
START TASK OF PROCESSING TRAILING EDGE OF PAPER SHEET 2
S1403
ASSIGN TOP ADDRESS TO VARIABLE B
S1404
YES
LEADING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
S1405
NO
YES
TRAILING EDGE DISCHARGING SIGNAL OF PAPER SHEET 2 RECEIVED ?
S1406
NO
INFO SIGNALS RECEIVED ?
NO
YES
S1407
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS B BY N AS GROUP 2-1
S1408
B=B+N
S1409
LEADING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
NO
YES
S1410
TRANSMIT LEADING EDGE DISCHARGING SIGNAL
S1411
INFO SIGNALS IN STORING UNIT ?
NO
YES
S1412
ASSIGN TOP ADDRESS TO VARIABLE B
S1413
TRANSMIT INFO SIGNAL OF GROUP 2-1
S1414
B=B+1
S1415
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 23B

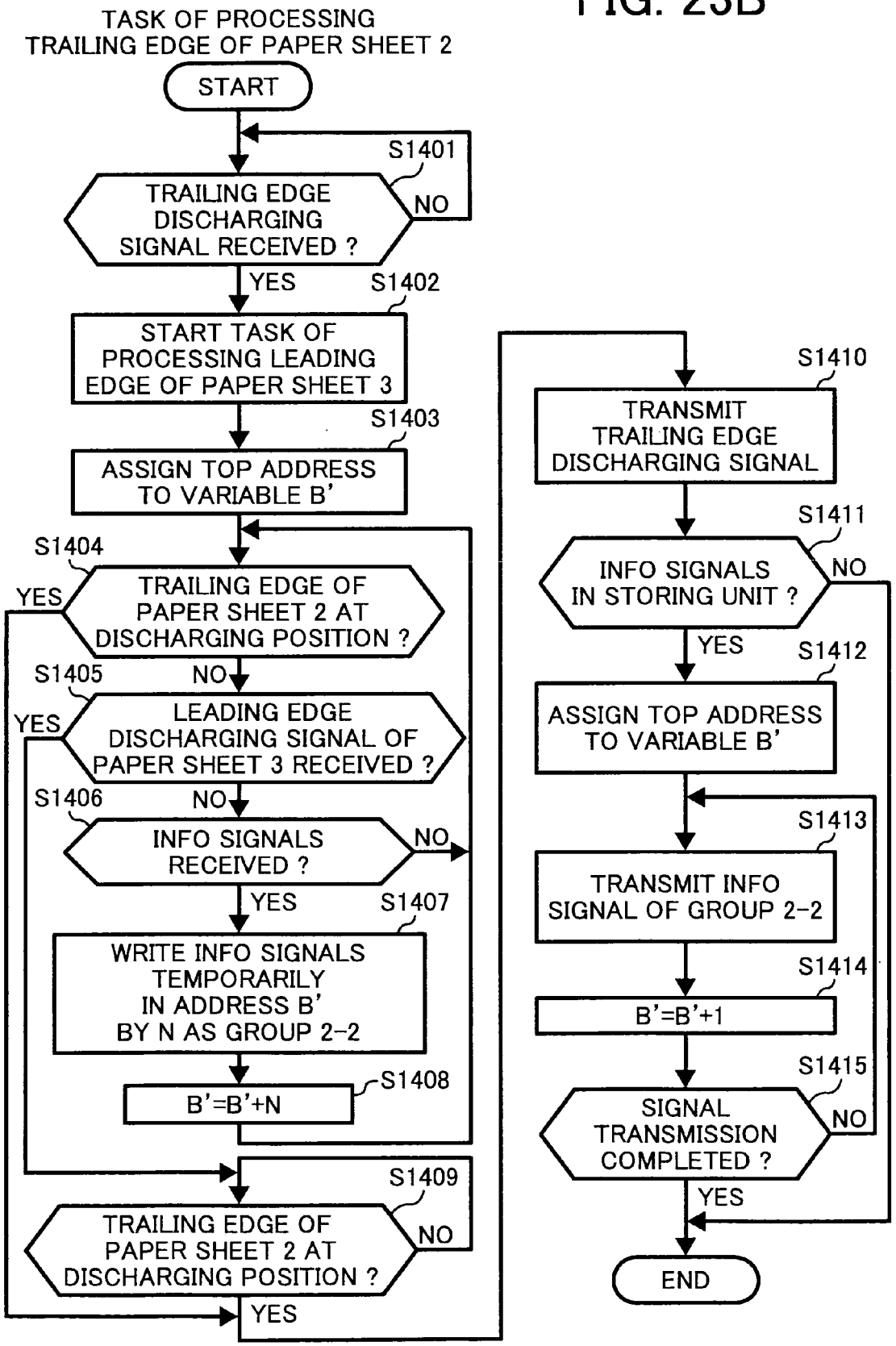

TASK OF PROCESSING TRAILING EDGE OF PAPER SHEET 2
START
S1401
TRAILING EDGE DISCHARGING SIGNAL RECEIVED ?
NO
YES
S1402
START TASK OF PROCESSING LEADING EDGE OF PAPER SHEET 3
S1403
ASSIGN TOP ADDRESS TO VARIABLE B'
S1404
YES
TRAILING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
S1405
NO
YES
LEADING EDGE DISCHARGING SIGNAL OF PAPER SHEET 3 RECEIVED ?
S1406
NO
INFO SIGNALS RECEIVED ?
NO
YES
S1407
WRITE INFO SIGNALS TEMPORARILY IN ADDRESS B' BY N AS GROUP 2-2
S1408
B'=B'+N
S1409
TRAILING EDGE OF PAPER SHEET 2 AT DISCHARGING POSITION ?
NO
YES
S1410
TRANSMIT TRAILING EDGE DISCHARGING SIGNAL
S1411
INFO SIGNALS IN STORING UNIT ?
NO
YES
S1412
ASSIGN TOP ADDRESS TO VARIABLE B'
S1413
TRANSMIT INFO SIGNAL OF GROUP 2-2
S1414
B'=B'+1
S1415
SIGNAL TRANSMISSION COMPLETED ?
NO
YES
END

FIG. 24

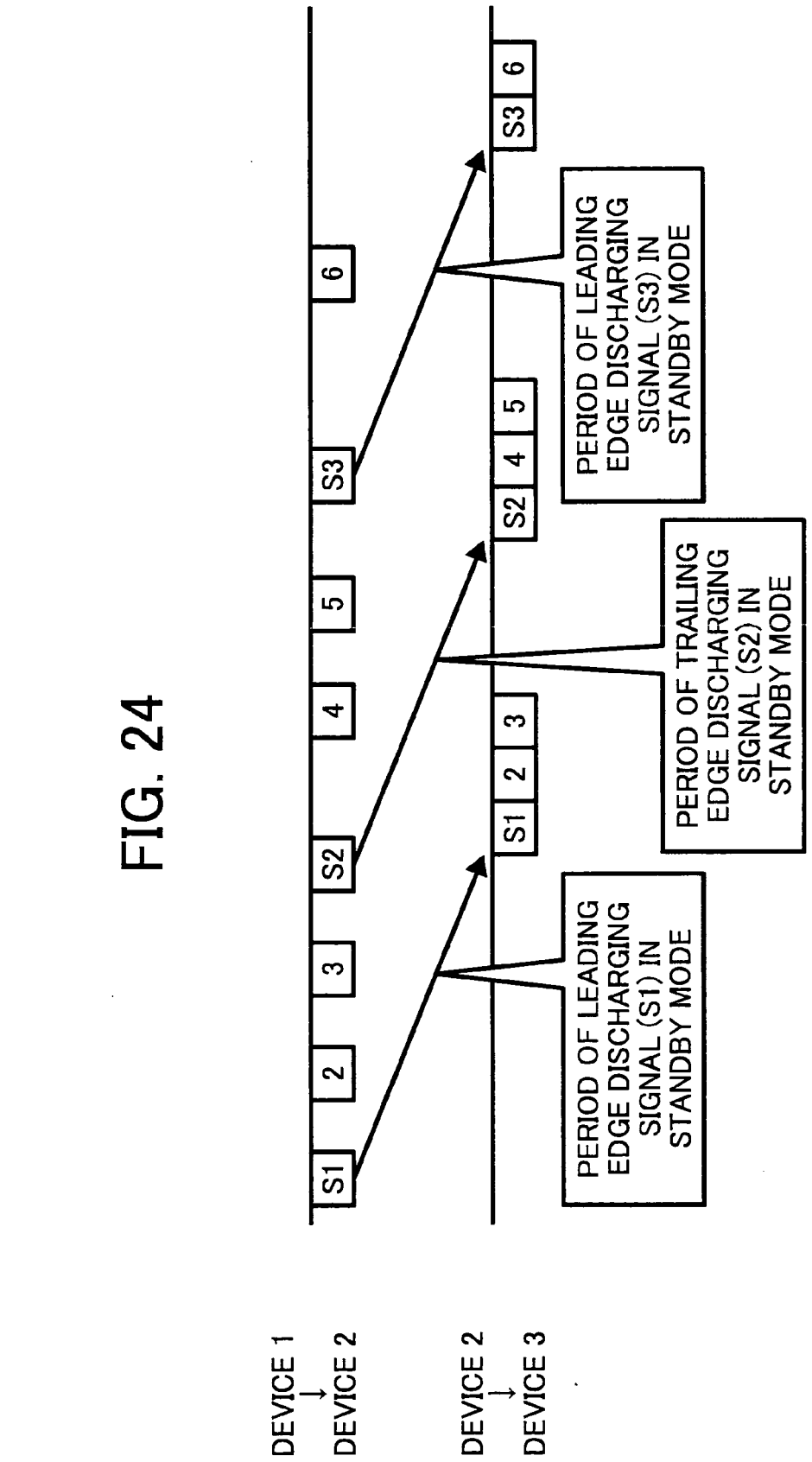
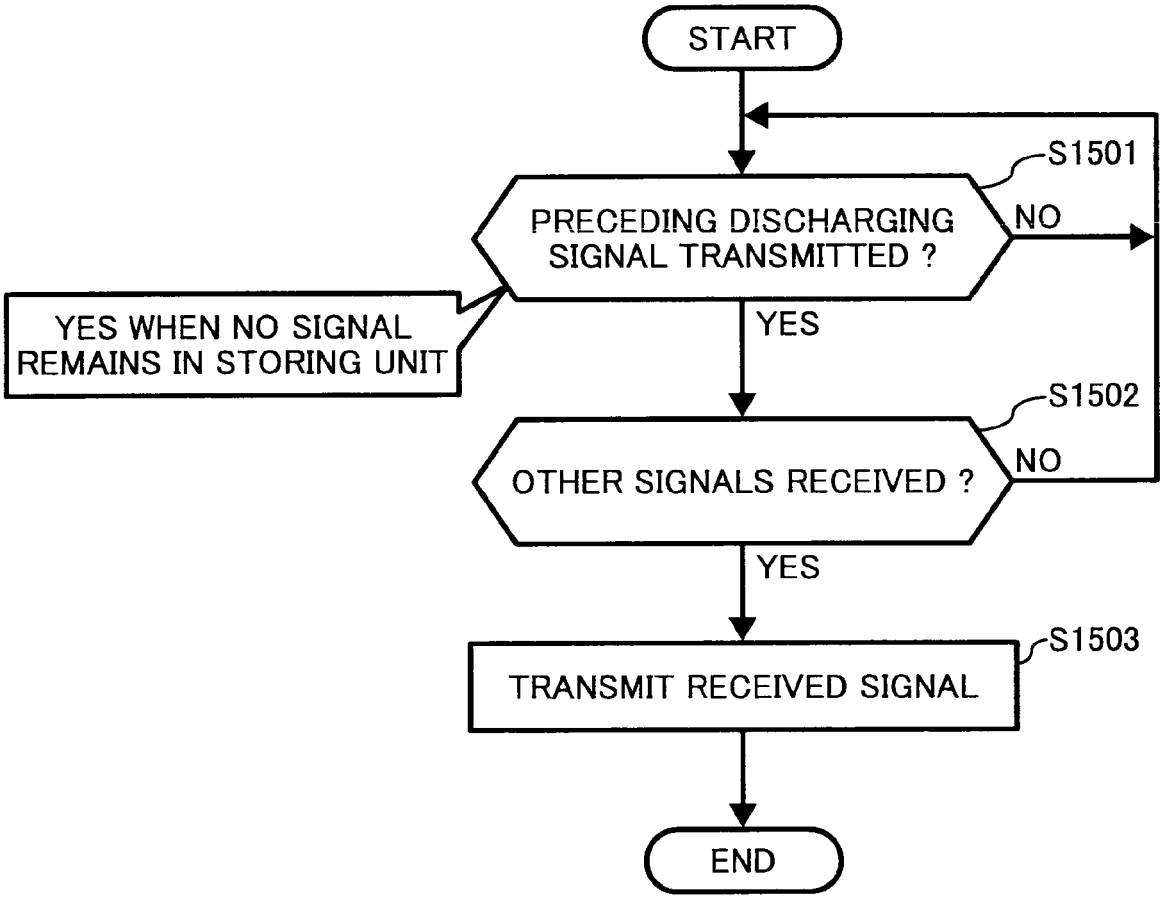

DEVICE 1
DEVICE 2
DEVICE 2
DEVICE 3
S1
2
3
S2
4
5
S3
6
S1
2
3
S2
4
5
S3
6
PERIOD OF LEADING EDGE DISCHARGING SIGNAL (S1) IN STANDBY MODE
PERIOD OF TRAILING EDGE DISCHARGING SIGNAL (S2) IN STANDBY MODE
PERIOD OF LEADING EDGE DISCHARGING SIGNAL (S3) IN STANDBY MODE

FIG. 25


START
S1501
PRECEDING DISCHARGING SIGNAL TRANSMITTED ?
NO
YES
YES WHEN NO SIGNAL REMAINS IN STORING UNIT
S1502
OTHER SIGNALS RECEIVED ?
NO
YES
S1503
TRANSMIT RECEIVED SIGNAL
END

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 06 25 4313

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | US 2005/042007 A1 (FUJII SHUHJI [JP] ET AL) 24 February 2005 (2005-02-24)<br>* figures 1-9 *<br>* paragraphs [0029] - [0108] *<br>----- | 1-10, 15-18 | INV. G03G15/00 |
| X | WO 00/57367 A (RUE DE INT LTD [GB]; BROOKS STEPHEN DEREK [GB]; KIRK BRIAN ROBINSON [G) 28 September 2000 (2000-09-28)<br>* figures 1-5 *<br>* page 5, line 16 - page 15, line 34 *<br>* page 3, line 16 - page 5, line 2 *<br>----- | 1-3,5-17 | |
| X | JP 09 040284 A (TOKYO SHIBAURA ELECTRIC CO) 10 February 1997 (1997-02-10)<br>* figures 1-7 *<br>* paragraphs [0021], [0027] - [0059] *<br>----- | 1,2,4 | |
| X | JP 2005 195858 A (KONICA MINOLTA BUSINESS TECHNO) 21 July 2005 (2005-07-21)<br>* figures 1-12 *<br>* paragraphs [0016] - [0058] *<br>----- | 1-3, 5-10, 15-18 | TECHNICAL FIELDS SEARCHED (IPC)<br>G03G |
| X | EP 0 377 331 A2 (PITNEY BOWES [US]) 11 July 1990 (1990-07-11)<br>* figures 1,2,5-11 *<br>* column 6, line 12 - line 13 *<br>* column 6, line 30 - column 10, line 42 *<br>* column 12, line 1 - column 21, line 58 *<br>* column 24, line 16 - line 50 *<br>----- | 1-3,5-17 | |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 6 November 2006 | Billmann, Frank |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 25 4313

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-11-2006

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2005042007 A1 | 24-02-2005 | CN 1584751 A | 23-02-2005 |
| | | JP 2005070078 A | 17-03-2005 |
| WO 0057367 A | 28-09-2000 | AT 301856 T | 15-08-2005 |
| | | AU 3305200 A | 09-10-2000 |
| | | DE 60021864 D1 | 15-09-2005 |
| | | DE 60021864 T2 | 13-04-2006 |
| | | EP 1166231 A1 | 02-01-2002 |
| | | US 6640156 B1 | 28-10-2003 |
| JP 9040284 A | 10-02-1997 | NONE | |
| JP 2005195858 A | 21-07-2005 | NONE | |
| EP 0377331 A2 | 11-07-1990 | AU 630646 B2 | 05-11-1992 |
| | | AU 4735089 A | 05-07-1990 |
| | | CA 2006025 A1 | 30-06-1990 |
| | | DE 68924148 D1 | 12-10-1995 |
| | | DE 68924148 T2 | 15-02-1996 |
| | | JP 2288901 A | 28-11-1990 |
| | | US 4992950 A | 12-02-1991 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- JP 2005238045 A **[0400]**
- JP 2005267401 A **[0400]**
- JP 2006001511 A **[0400]**
- JP 2006133744 A **[0400]**