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(54) **IMAGE FORMING APPARATUS AND METHOD FOR CONVEYING RECORDING MATERIAL**

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(57) **ABSTRACT**

The present invention provides an image forming apparatus including an image forming unit configured to form an image on a sheet, a conveying path along which the sheet is conveyed to the image forming unit, a sensor configured to detect the width of the sheet in a direction perpendicular to a conveying direction, and a control unit configured to determine a conveying state of the sheet in the direction perpendicular to the conveying direction according to an output of the sensor, and configured to control a conveyance interval of the sheet according to the determination result. The control unit sets the conveyance interval according to the width of the specified sheet and the width detectable by the sensor, regardless of the determination result.

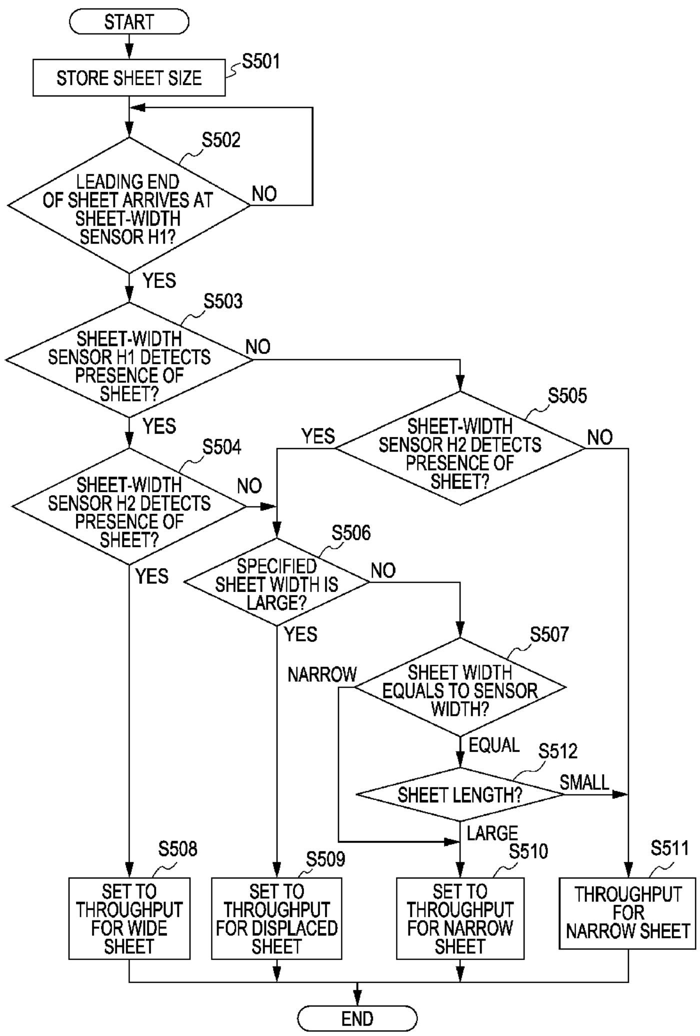


FIG. 1

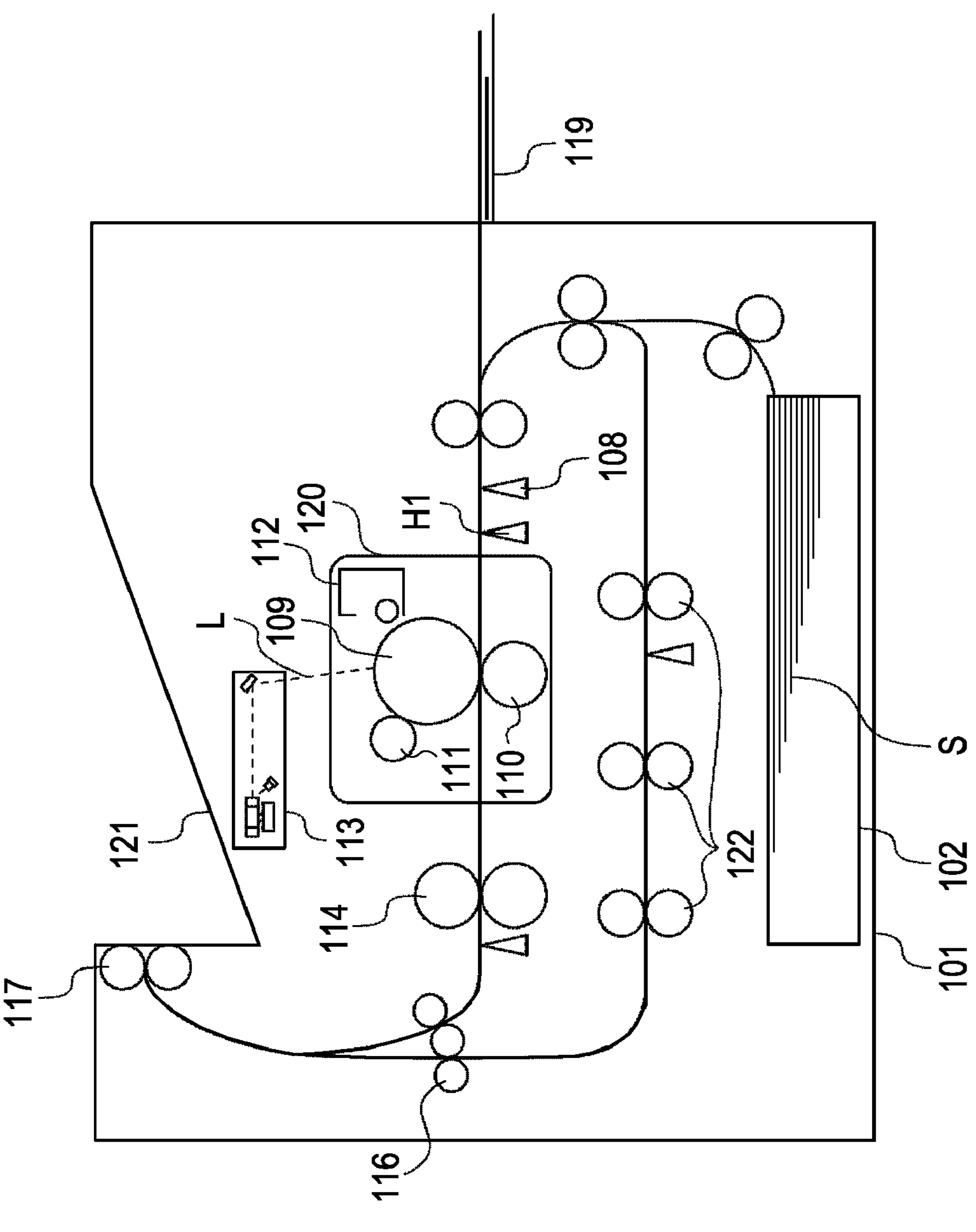


FIG. 2

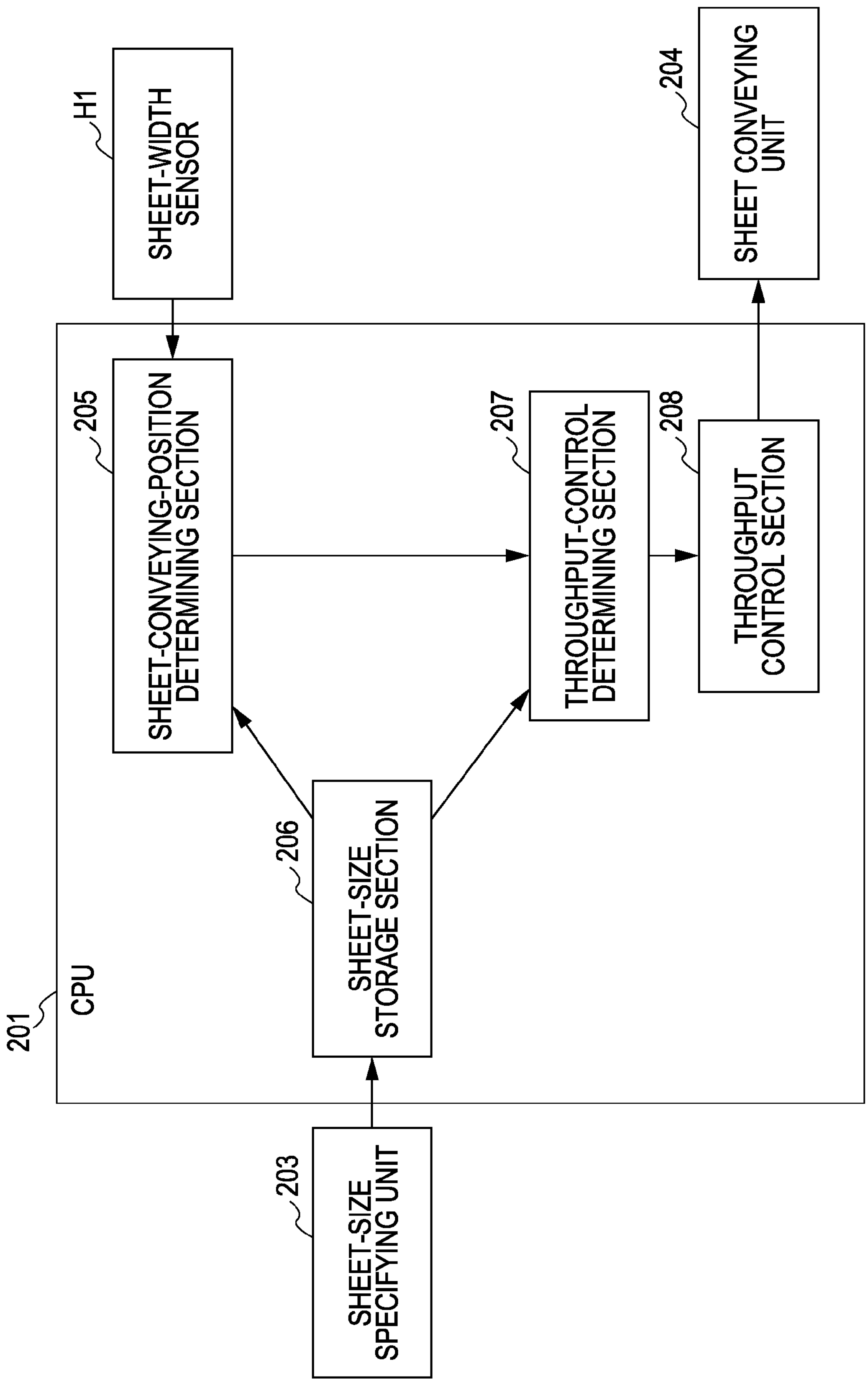

201
CPU
H1
SHEET-WIDTH SENSOR
205
SHEET-CONVEYING-POSITION DETERMINING SECTION
206
SHEET-SIZE STORAGE SECTION
207
THROUGHPUT-CONTROL DETERMINING SECTION
208
THROUGHPUT CONTROL SECTION
204
SHEET CONVEYING UNIT
203
SHEET-SIZE SPECIFYING UNIT

FIG. 3

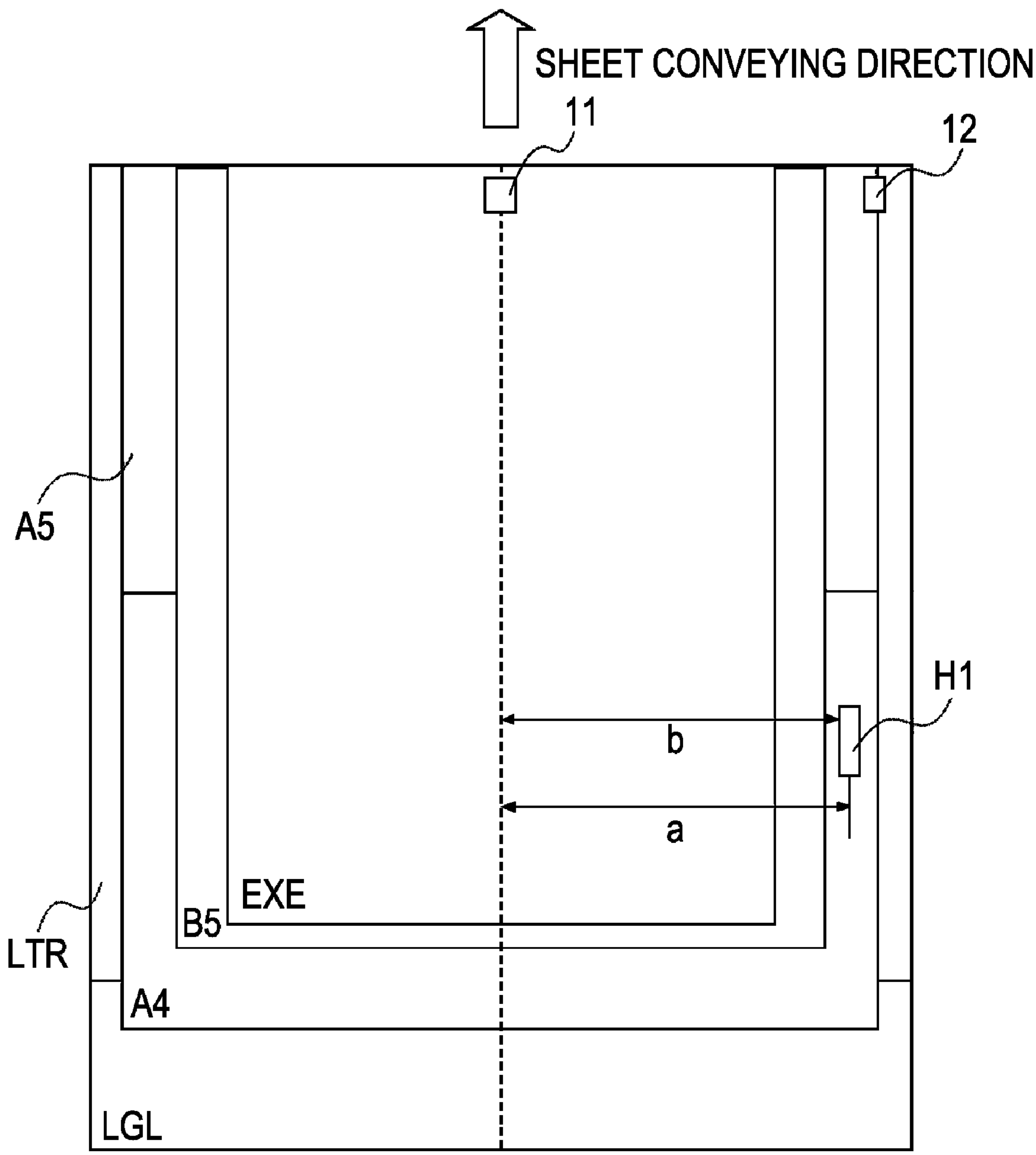


FIG. 4

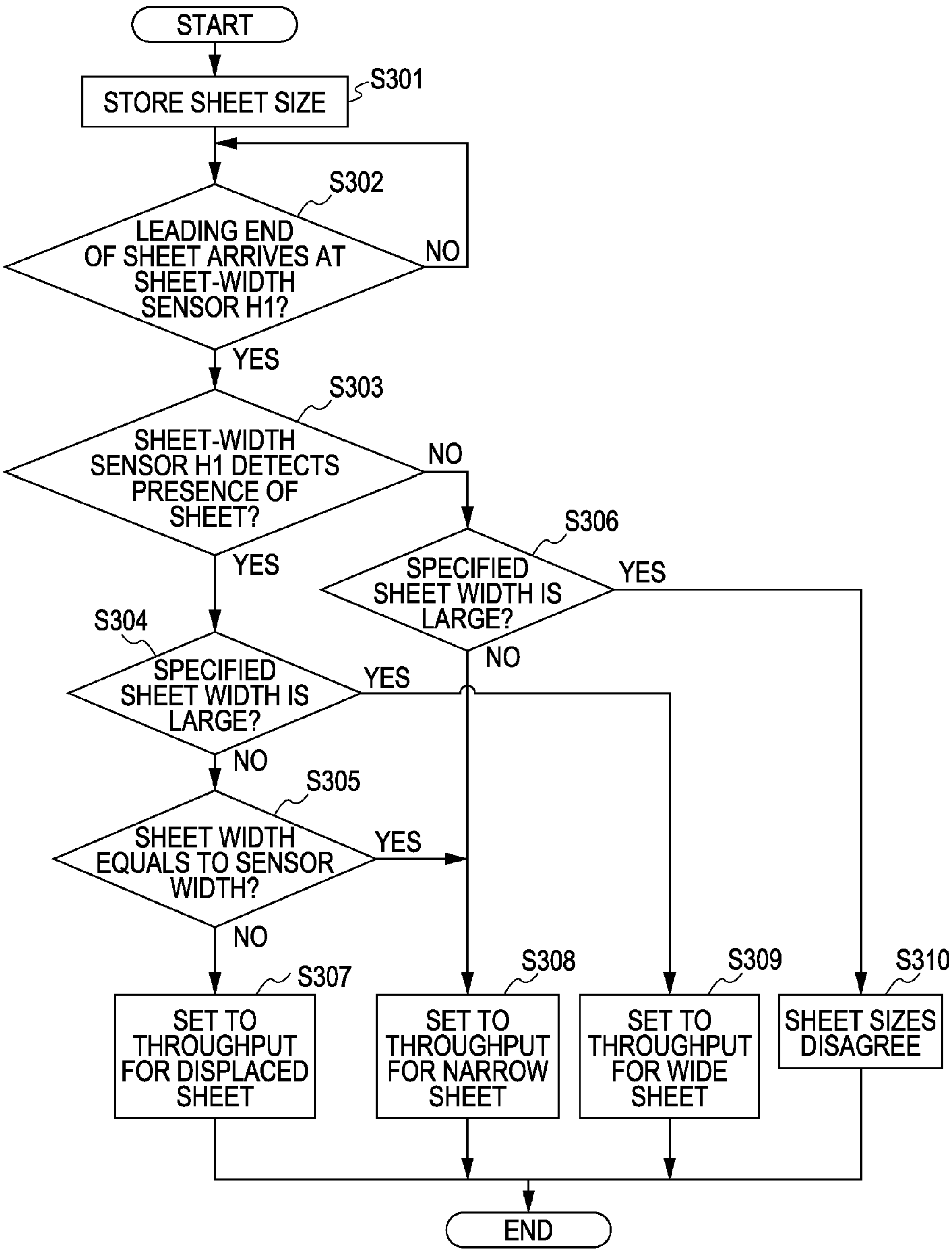

START
STORE SHEET SIZE
S301
S302
LEADING END OF SHEET ARRIVES AT SHEET-WIDTH SENSOR H1?
NO
YES
S303
SHEET-WIDTH SENSOR H1 DETECTS PRESENCE OF SHEET?
NO
YES
S306
SPECIFIED SHEET WIDTH IS LARGE?
YES
NO
S304
SPECIFIED SHEET WIDTH IS LARGE?
YES
NO
S305
SHEET WIDTH EQUALS TO SENSOR WIDTH?
YES
NO
S307
SET TO THROUGHPUT FOR DISPLACED SHEET
S308
SET TO THROUGHPUT FOR NARROW SHEET
S309
SET TO THROUGHPUT FOR WIDE SHEET
S310
SHEET SIZES DISAGREE
END

FIG. 5

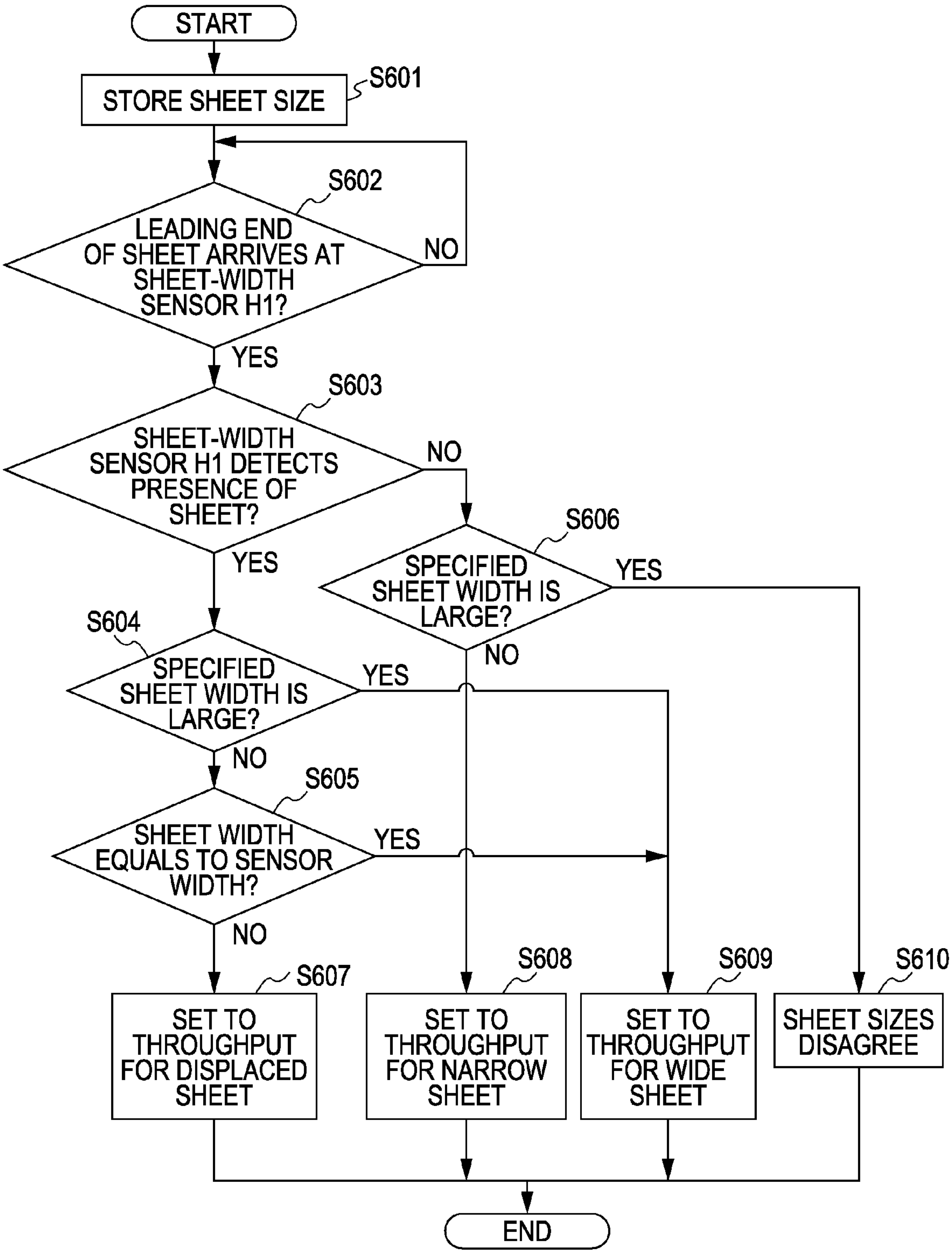
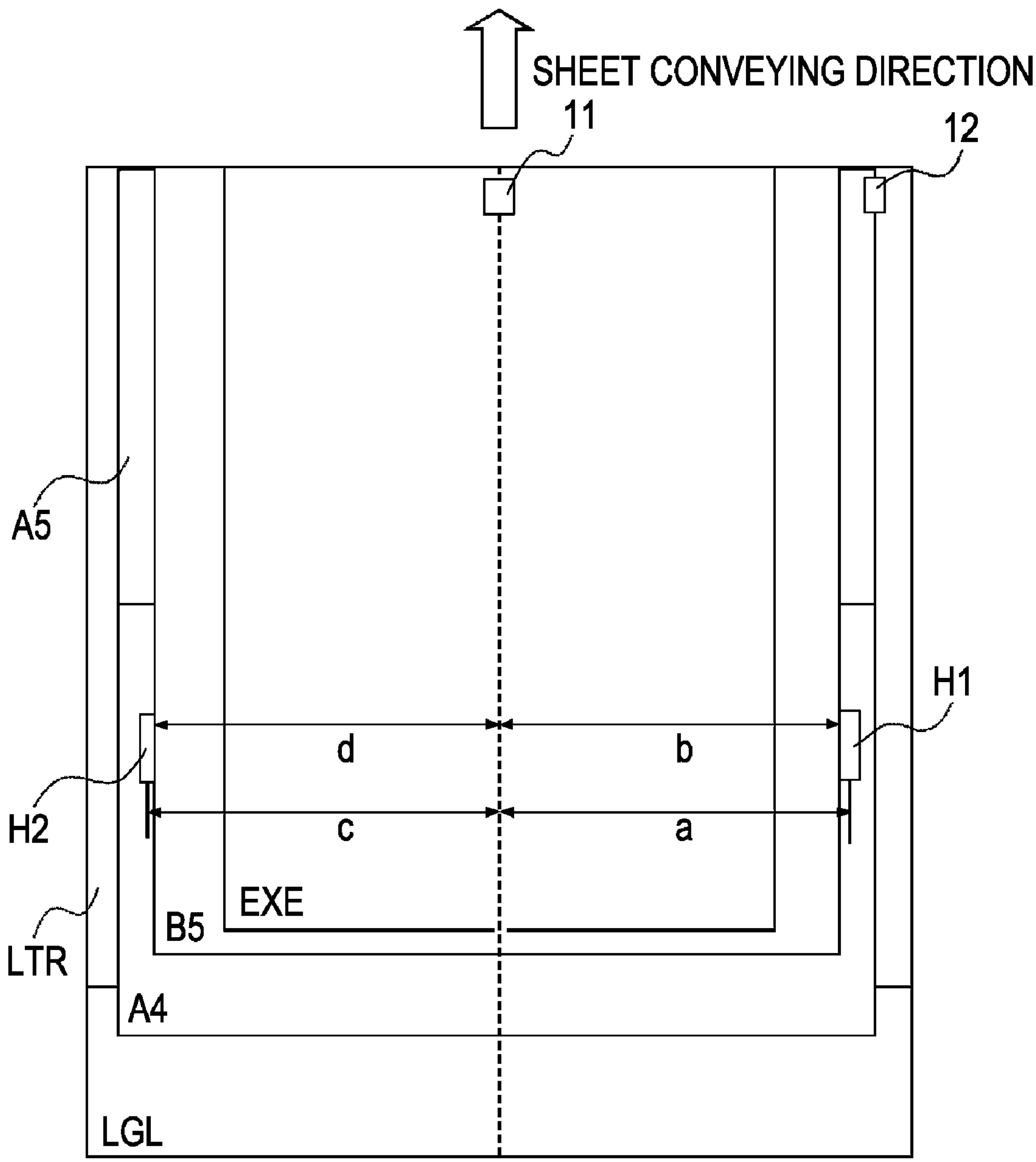

START
STORE SHEET SIZE
S601
LEADING END OF SHEET ARRIVES AT SHEET-WIDTH SENSOR H1?
S602
NO
YES
SHEET-WIDTH SENSOR H1 DETECTS PRESENCE OF SHEET?
S603
NO
YES
SPECIFIED SHEET WIDTH IS LARGE?
S606
YES
NO
SPECIFIED SHEET WIDTH IS LARGE?
S604
YES
NO
SHEET WIDTH EQUALS TO SENSOR WIDTH?
S605
YES
NO
SET TO THROUGHPUT FOR DISPLACED SHEET
S607
SET TO THROUGHPUT FOR NARROW SHEET
S608
SET TO THROUGHPUT FOR WIDE SHEET
S609
SHEET SIZES DISAGREE
S610
END

FIG. 6



SHEET CONVEYING DIRECTION
11
12
A5
H1
d
b
H2
c
a
EXE
B5
LTR
A4
LGL

FIG. 7

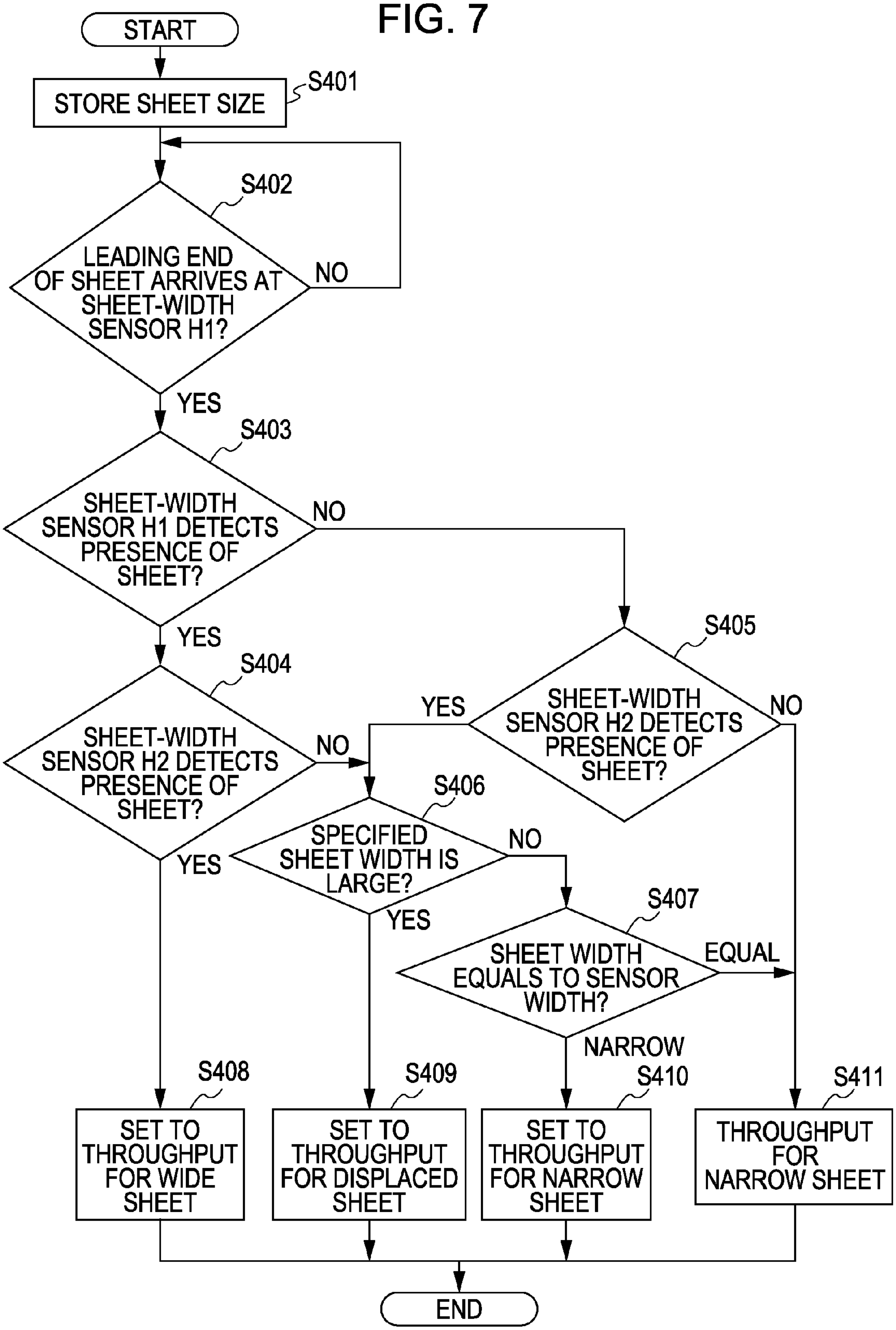

START
STORE SHEET SIZE
S401
S402
LEADING END OF SHEET ARRIVES AT SHEET-WIDTH SENSOR H1?
NO
YES
S403
SHEET-WIDTH SENSOR H1 DETECTS PRESENCE OF SHEET?
NO
YES
S404
SHEET-WIDTH SENSOR H2 DETECTS PRESENCE OF SHEET?
NO
YES
S405
SHEET-WIDTH SENSOR H2 DETECTS PRESENCE OF SHEET?
YES
NO
S406
SPECIFIED SHEET WIDTH IS LARGE?
NO
YES
S407
SHEET WIDTH EQUALS TO SENSOR WIDTH?
EQUAL
NARROW
S408
SET TO THROUGHPUT FOR WIDE SHEET
S409
SET TO THROUGHPUT FOR DISPLACED SHEET
S410
SET TO THROUGHPUT FOR NARROW SHEET
S411
THROUGHPUT FOR NARROW SHEET
END

FIG. 8

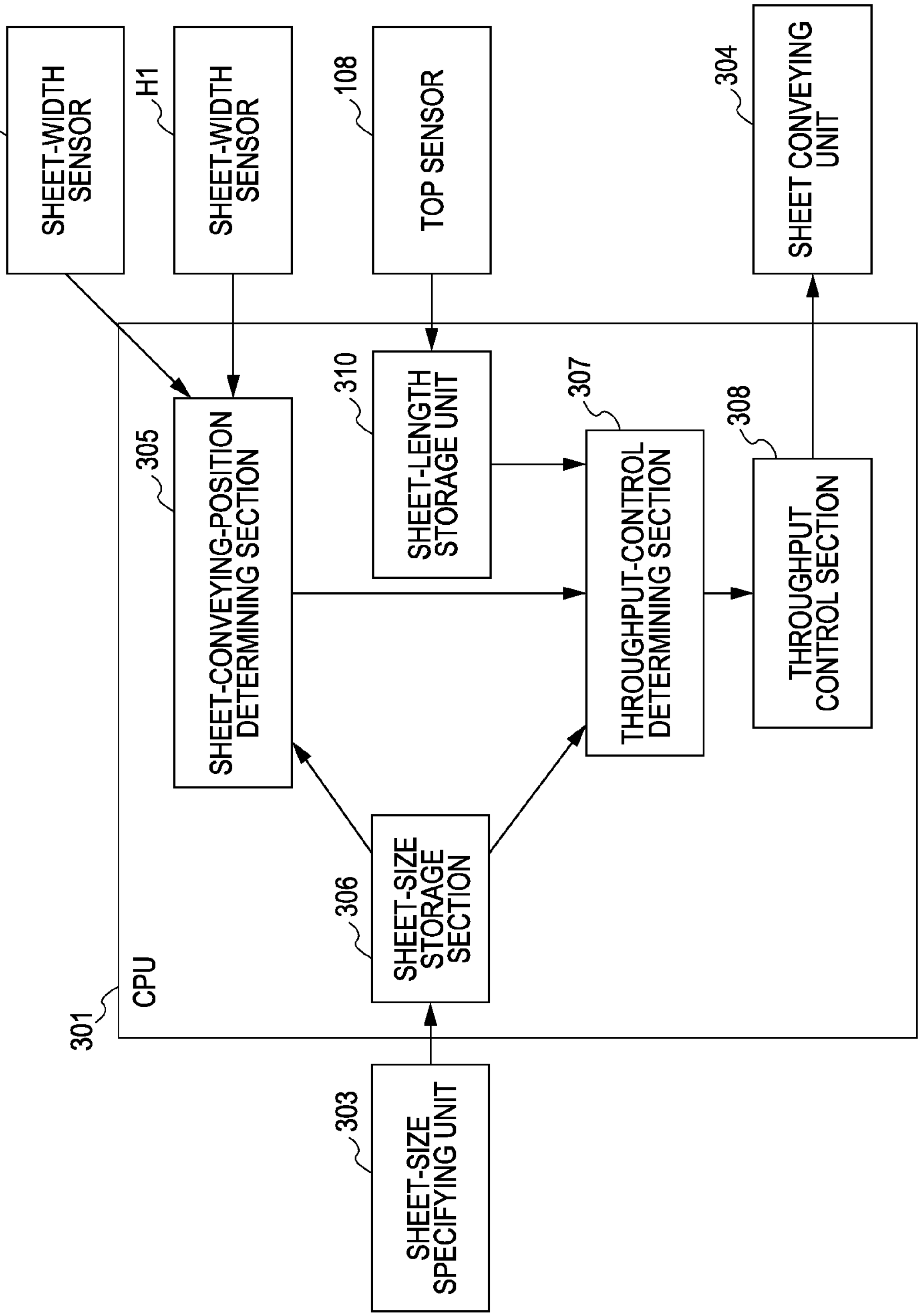

H2
SHEET-WIDTH SENSOR
H1
SHEET-WIDTH SENSOR
108
TOP SENSOR
304
SHEET CONVEYING UNIT
301
CPU
305
SHEET-CONVEYING-POSITION DETERMINING SECTION
310
SHEET-LENGTH STORAGE UNIT
307
THROUGHPUT-CONTROL DETERMINING SECTION
308
THROUGHPUT CONTROL SECTION
306
SHEET-SIZE STORAGE SECTION
303
SHEET-SIZE SPECIFYING UNIT

FIG. 9

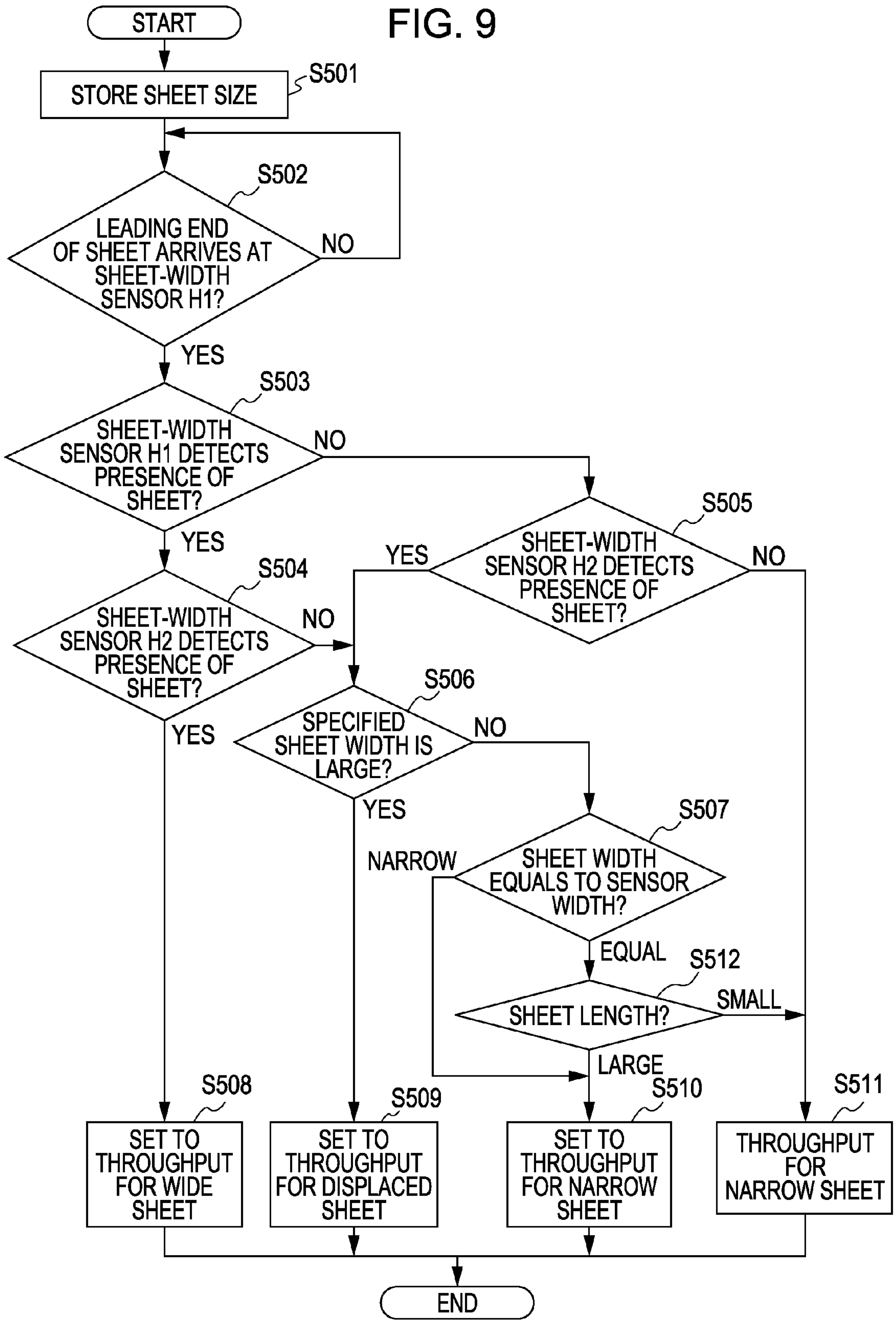

START
STORE SHEET SIZE
S501
S502
LEADING END OF SHEET ARRIVES AT SHEET-WIDTH SENSOR H1?
NO
YES
S503
SHEET-WIDTH SENSOR H1 DETECTS PRESENCE OF SHEET?
NO
YES
S505
SHEET-WIDTH SENSOR H2 DETECTS PRESENCE OF SHEET?
YES
NO
S504
SHEET-WIDTH SENSOR H2 DETECTS PRESENCE OF SHEET?
NO
YES
S506
SPECIFIED SHEET WIDTH IS LARGE?
NO
YES
S507
SHEET WIDTH EQUALS TO SENSOR WIDTH?
NARROW
EQUAL
S512
SHEET LENGTH?
SMALL
LARGE
S508
SET TO THROUGHPUT FOR WIDE SHEET
S509
SET TO THROUGHPUT FOR DISPLACED SHEET
S510
SET TO THROUGHPUT FOR NARROW SHEET
S511
THROUGHPUT FOR NARROW SHEET
END

IMAGE FORMING APPARATUS AND METHOD FOR CONVEYING RECORDING MATERIAL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an image forming apparatus for forming an image on a recording material and to a method for conveying a recording material. More specifically, the present invention relates to control of conveyance of a recording material in an image forming apparatus, such as a copier or a printer.

[0003] 2. Description of the Related Art

[0004] An image forming apparatus, such as a copier or a printer, for forming an image on a sheet serving as a recording material includes a controller for controlling operation of the apparatus. The controller can know the size of a sheet from sheet-size information specified by a user through a computer connected to a printer or from information obtained by a sheet-size detecting sensor provided in the apparatus. The size of the sheet in a direction perpendicular to a conveying direction (hereinafter also referred to as "sheet width") and the conveying position are detected by a sensor provided in the sheet conveying path in the apparatus.

[0005] The controller controls the speed at which the sheet is conveyed, according to the sheet width. When the speed is high, the number of sheets conveyed per unit time (hereinafter also referred to as "throughput") increases. In contrast, when the speed is low, throughput decreases.

[0006] Typically, when a standard-sized wide sheet is conveyed, throughput is increased, and, when a standard-sized narrow sheet is conveyed or when a sheet-conveying position is displaced to one side in the direction perpendicular to the conveying direction, throughput is reduced. The purpose of reducing throughput is to prevent image failure caused by heating up of an end portion of a fixing roller for fixing an image on a sheet, which is caused by no sheet passing over the end. When reducing throughput is not enough, sheet conveyance is aborted.

[0007] Japanese Patent Laid-Open No. 2006-106485 discloses an image forming apparatus having two sensors for detecting the sheet width. When the sensors detect that a sheet displaced to one side is being conveyed, image formation is not performed.

[0008] However, in image forming apparatuses, sheets whose sizes are not specified are sometimes conveyed. When performing image formation using a nonstandard-sized sheet, a user specifies "nonstandard-sized sheet" instead of "standard-sized sheet" (for example, a regulation-sized sheet such as an A4 sheet or a letter-sized sheet) and instructs image formation. In this case, the sheet width is confirmed by the outputs of the sheet-width detecting sensors to control throughput. The widths of sheets that are actually conveyed vary. Thus, depending on the conveying state of the sheets, the sheet-width sensors may detect the sheet being conveyed and incorrectly determine the sheet width. That is, the conveying state of the sheets is incorrectly determined. For example, if it is incorrectly determined that a sheet is displaced to one side (i.e., one side in the direction perpendicular to the conveying direction), throughput is reduced or the sheet conveyance is aborted, resulting in a decrease in printing efficiency. Users sometimes face a throughput decrease or abortion of image formation even though a narrow sheet is not conveyed. The purpose of reducing throughput when a narrow sheet or a sheet displaced to one side is conveyed is to prevent heating up of an end, in the direction perpendicular to the conveying direction, of the fixing unit for fixing an image on the sheet.

SUMMARY OF THE INVENTION

[0009] According to an aspect of the present invention, an image forming apparatus includes: an image forming unit configured to form an image on a recording material; a conveying path along which the recording material is conveyed to the image forming unit; a sensor provided in the conveying path, the sensor being configured to detect the width of the recording material in a direction perpendicular to a conveying direction; and a control unit configured to determine a conveying state of the recording material in the direction perpendicular to the conveying direction according to an output of the sensor, and configured to control a conveyance interval of the recording material according to the determination result. The control unit sets the conveyance interval regardless of the determination result, according to the width of the specified recording material and the width detectable by the sensor.

[0010] According to another aspect of the present invention, a method for conveying a recording material includes: determining a conveying state of a recording material by detecting the width of the recording material in a direction perpendicular to a conveying direction with a sensor; setting a conveyance interval of the recording material according to the determined conveying state of the recording material; and setting the conveyance interval according to the width of the specified recording material and the width detectable by the sensor, regardless of the determination.

[0011] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a schematic sectional view of an image forming apparatus of the present invention.

[0013] FIG. **2** is a control block diagram of the image forming apparatus of the present invention.

[0014] FIG. **3** shows the arrangement of a sheet-width sensor according to a first embodiment in a width direction.

[0015] FIG. **4** is a flowchart showing an operation according to the first embodiment.

[0016] FIG. **5** is a flowchart showing an operation according to a second embodiment.

[0017] FIG. **6** shows the arrangement of sheet-width sensors according to a third embodiment.

[0018] FIG. **7** is a flowchart showing an operation according to the third embodiment.

[0019] FIG. **8** is a control block diagram of an image forming apparatus according to a fourth embodiment.

[0020] FIG. **9** is a flowchart showing an operation according to the fourth embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0021] Embodiments of the present invention will be described below in detail with reference to the drawings. However, it is to be noted that the components disclosed in the following embodiments are examples. The technical scope of the present invention is defined by the claims, not by the following embodiments.

[0022] In the following embodiments, the present invention is applied to a laser beam printer that employs an electrophotography method. However, the present invention may be applied to an image forming apparatus such as a copier and a facsimile.

[0023] FIG. **1** shows a schematic diagram of an image forming apparatus according to a first embodiment of the invention. FIG. **1** is a schematic sectional view of a laser beam printer **101**, which is an exemplary image forming apparatus according to this embodiment.

[0024] The laser beam printer **101**, upon receipt of a print instruction from a computer or the like (not shown) connected thereto, feeds a sheet S, serving as a recording material, stored in a sheet cassette **102** or a multi-tray **119**, serving as a recording material storing portion.

[0025] A top sensor **108** for detecting the presence or absence of a recording material is disposed in the conveying path. The top sensor **108** detects the leading end of the sheet S after being fed. The top sensor **108** keeps detecting the presence of the sheet until the trailing end of the sheet S leaves the top sensor **108**. By measuring the time during which the top sensor **108** indicates the presence of the sheet, the length of the sheet S in the conveying direction can be identified. When the trailing end of the sheet S has left the top sensor **108**, the top sensor **108** detects the absence of the sheet S. Thus, it is determined that the sheet S has left the top sensor **108**.

[0026] When printing is continuously performed on a plurality of sheets, a next sheet is fed after a predetermined period of time has passed since the top sensor **108** has detected the leading end or trailing end of the sheet S. Thus, the conveyance of the plurality of sheets is controlled. The number of sheets conveyed per unit time (the number of prints) can be controlled by varying the aforementioned time. The number of sheets conveyed per unit time is called "throughput".

[0027] A sheet-width sensor Hi detects the size of the sheet S in the direction perpendicular to the conveying direction (hereinafter, "sheet width"). If the sheet S is equal to or larger than a predetermined size, the sheet-width sensor H**1** detects the presence of the sheet S and outputs "ON". Thus, whether or not the width of the sheet S is equal to or larger than a predetermined size can be detected. If the output of the sheet-width sensor H**1** does not become "ON" after a predetermined period of time has passed since the sheet S left the top sensor **108**, it is determined that a narrow sheet is to be fed. If the output of the sheet-width sensor H**1** does not become "ON" when the sheet S is specified as a standard-sized sheet having at least a predetermined width, it is determined that the sheet widths disagree. Then, processing such as conveyance is aborted.

[0028] Image formation on the sheet S will be schematically described. The sheet S after being fed is conveyed to an image forming unit **120**. The image forming unit **120** includes a photosensitive drum **109**, a transfer roller **110**, a charging roller **111**, and a developing apparatus **112**. The photosensitive drum **109** is uniformly charged by the charging roller **111** and irradiated with laser light L emitted from a laser exposure apparatus **113** according to an image signal. Thus, an electrostatic latent image is formed on the surface of the photosensitive drum **109**. The developing apparatus **112** applies toner to the electrostatic latent image, making it visible as a toner image. The photosensitive drum **109** is rotated to convey the toner image to a transfer position. The sheet S is also conveyed to the transfer position in synchronization with the rotation of the photosensitive drum **109**. A voltage having a polarity opposite to that of the toner image is applied to the transfer roller **110** at the transfer position to transfer the toner image on the photosensitive drum **109** to the sheet S.

[0029] The sheet S, to which the toner image has been transferred, is conveyed to the fixing unit **114**, where the sheet S is heated and pressed so that the toner image is fixed on the sheet S. The fixing unit **114** accommodates a heating member (not shown) and a thermistor for measuring and monitoring the temperature of the heating member. When the temperature detected by the thermistor is higher than a predetermined temperature, throughput is reduced to prevent the fixing unit from having an abnormal temperature.

[0030] The sheet S, on which the toner image is fixed, is conveyed through intermediate eject rollers **116** and eject rollers **117** and is output onto a paper output tray **121**. Thus, the printing operation is completed. When an image is to be formed on each side of the sheet S, the sheet S, on one side of which an image is formed, is reversed and conveyed by duplex conveying rollers **122** again to the image forming unit **120**. A below-described central processing unit (CPU, refer to FIG. **2**) controls these operations.

[0031] Referring to FIG. **2**, a control unit of the image forming apparatus will be described. FIG. **2** is a control block diagram of the image forming apparatus according to this embodiment. The laser beam printer **101** includes a CPU **201** for controlling the operation thereof. The CPU **201** accommodates an arithmetic processing circuit, a read-only memory (ROM), a random-access memory (RAM), and the like. Operation is performed according to a program stored in the ROM.

[0032] The CPU **201** includes a sheet-conveying-position determining section **205**, a sheet-size storage section **206**, a throughput-control determining section **207**, and a throughput control section **208**. The CPU **201** is connected to the sheet-width sensor H**1**, a sheet-size specifying unit **203**, and a sheet conveying unit **204**.

[0033] FIG. **3** shows, in the image forming apparatus according to this embodiment, the positions of the sheet-width sensor H**1**, a main thermistor **11** for monitoring the temperature of the central portion of the heating member (not shown), and a sub-thermistor **12** for monitoring the temperature of an end portion of the heating member. The main thermistor **11** and the sub-thermistor **12** are provided in the fixing unit **114**. In the image forming apparatus according to this embodiment, sheets are positioned and conveyed while aligning the center lines thereof with the reference position. In FIG. **3**, the dotted line indicates the center line of the sheets. The sheet-width sensor H**1** is disposed at a position where it can detect A4 and larger sheets. More specifically, as shown in FIG. **3**, the sheet-width sensor H**1** is disposed at a distance a from the center line. If the sheet size specified by the sheet-size specifying unit **203** is wide, such as letter size (denoted by "LTR" in FIG. **3**), legal size (denoted by "LGL" in FIG. **3**), or A4 size, the output of the sheet-width sensor H**1** becomes "ON". Thus, it is determined that a wide sheet is being conveyed.

[0034] In contrast, in the case of a narrow sheet, such as B5 size, executive size (denoted by "EXE" in FIG. **3**), or A5 size, the output of the sheet-width sensor H**1** does not become "ON". Thus, it is determined that a narrow sheet is being conveyed. Throughput-control determining section **207** determines the sheet width. Then, throughput control section **208** controls throughput according to the determination. That is, when a narrow sheet is conveyed, throughput is reduced compared to a case where a wide sheet is conveyed.

[0035] This control prevents the end portion of the heating member of the fixing unit **114** from heating up when a narrow sheet is being conveyed, and solves a problem such as image failure occurring during fixing of the toner image due to an abnormally high temperature (toner offset). If the output of the sheet-width sensor H**1** becomes "ON" while a narrow sheet is being conveyed, it is determined that a sheet displaced to one side in the direction perpendicular to the conveying direction is being conveyed, and throughput is reduced. Throughput in the case where it is determined that a sheet displaced to one side is set lower than that for a narrow sheet. Throughput is set by adjusting the sheet-conveyance-interval. That is, assuming that the conveyance speeds are equal, if the sheet-conveyance interval is large, throughput is low, and if the sheet-conveyance interval is small, throughput is high.

[0036] In the image forming apparatus according to this embodiment, the relationship between the sheet width and the conveyance interval (throughput) is set as follows. Where the conveyance interval for wide sheets is referred to as a "first conveyance interval", the conveyance interval for narrow sheets is referred to as a "second conveyance interval" and the conveyance interval for sheets displaced to one side is referred to as a "third conveyance interval", the following relationship holds:

first conveyance interval<second conveyance interval<third conveyance interval

[0037] The values of conveyance intervals can be preliminarily set according to the sheet conveyance speed and the temperature of the end portion of the fixing unit **114**.

[0038] However, when a nonstandard-, unknown-sized sheet is to be conveyed, a user specifies the sheet size through the sheet-size specifying unit **203**. At this time, if the specified sheet size has the distance, b, between the center line and an edge that is substantially equal to the distance a, it may be incorrectly determined that the sheet is being conveyed in a displaced state because of variation of sheet conveyance. If the sheet has a sheet width that is substantially equal to the distance a from the center line, throughput does not need to be reduced to throughput for sheets displaced to one side. In this case, by setting throughput to that for narrow sheets, the influence due to heating up of the end portion of the heating member of the fixing unit **114** is less likely to occur. That is, throughput is reduced when it should not be reduced, on the basis of incorrect determination.

[0039] Accordingly, if the sheet size specified through the sheet-size specifying unit **203** has the distance, b, between the center line and an edge that is substantially equal to the distance a, the determination that the sheet is displaced to one side is invalidated so that throughput is not reduced. That is, the sheet is conveyed at throughput for wide sheets. In this embodiment, the determination that the sheet is displaced to one side is invalidated if the difference between the distance b and the distance a is 2 mm or less. This value, 2 mm, is determined taking into consideration the conveyance speed and flapping of the sheet in the conveying path. Thus, the value can be changed if the conveyance speed or the structure of the conveying path is changed.

[0040] FIG. **4** is an operation flowchart of throughput control according to this embodiment.

[0041] First, in step S**301**, a specified sheet size is stored. Then, in step S**302**, control is withheld until the sheet S, after being fed, reaches the sheet-width sensor H**1**. The sheet-size specifying unit **203** specifies the sheet size.

[0042] In step S**303**, information output from the sheet-width sensor H**1** is acquired at the timing of the sheet S reaching the sheet-width sensor H**1**. If the presence of the sheet S (ON) cannot be detected within a predetermined period of time in step S**303**, the process proceeds to step S**306**. In step S**306**, whether or not the width of the sheet S being conveyed is larger than the stored (specified) sheet size is determined. In step S**306**, if it is determined that the sheet S being conveyed is a wide sheet, the process proceeds to step S**310**, where it is determined that the sheet sizes disagree. Then, image formation is aborted, and the sheet S, with no image printed thereon, is output onto the paper output tray **121**. If it is determined that the width of the sheet S being conveyed is a narrow sheet in step S**306**, the process proceeds to step S**308**, where throughput is set to a smaller value than throughput for wide sheets.

[0043] In step S**303**, if the presence of the sheet S (ON) is detected within a predetermined period of time, the process proceeds to step S**304**. In step S**304**, similarly to step S**306**, if it is determined that the sheet S being conveyed has a larger width than the stored sheet size, the process proceeds to step S**309**, where throughput is set to that for wide sheets. If it is determined that the sheet S being conveyed is a narrow sheet in step S**304**, the process proceeds to step S**305**.

[0044] In step S**305**, if the stored sheet size does not have a width detectable by the sheet-width sensor H**1**, it is determined that the sheet S is being conveyed in a displaced state. Then, in step S**307**, throughput is reduced to a lower level than that for narrow sheets to prevent image failure caused by heating up of the end portion of the heating member of the fixing unit **114**. In this embodiment, throughput for sheets displaced to one side is the lowest. This is because the end portion of the fixing unit **114** is heated most intensively when the sheet S is conveyed in a displaced state.

[0045] However, if the sheet S is a nonstandard-sized sheet and has a width substantially equal to the width detectable by the sheet-width sensor H**1**, the sheet-width sensor H**1** may detect the sheet S because of variation of sheet conveyance. In such a case, the sheet-width sensor H**1** incorrectly determines that the sheet S exists, and the sheet S that can be conveyed at throughput for narrow sheets is conveyed at slower throughput, i.e., throughput for sheets displaced to one side.

[0046] Thus, in step S**305**, if it is determined that the stored sheet size has a width substantially equal to the width detectable by the sheet-width sensor H**1**, the process proceeds to step S**308**, where throughput is set to that for narrow sheets, and the determination that the sheet S is conveyed in a displaced state is invalidated (in other words, it is not determined that the sheet S is conveyed in a displaced state).

[0047] By invalidating the determination, a decrease in printing efficiency due to incorrect determination that the sheet S is conveyed in a displaced state can be prevented. If the sub-thermistor **12** detects heating up of the end portion of the heating member of the fixing unit **114** when the determination is invalidated, the heating up of the end portion of the heating member can be coped with by reducing throughput.

[0048] In this embodiment, the sheet-width sensor H**1** is disposed on the right side of the central position as viewed in the conveying direction, serving as a reference (hereinafter, "central reference"). However, a sheet-width sensor disposed on the opposite side of the central reference provides the same advantage.

[0049] Furthermore, in this embodiment, when the determination that the sheet S is conveyed in a displaced state is invalidated, throughput is set to that for narrow sheets. However, throughput is not limited thereto as long as the influence of heating up of the end portion of the heating member is negligible. For example, throughput may be set to an intermediate speed, which is higher than throughput for narrow sheets and lower than throughput for wide sheets.

[0050] Thus, this embodiment prevents a decrease in throughput or abortion of sheet conveyance caused by incorrect detection by the sheet-width detecting sensor during conveyance of a nonstandard-sized sheet.

[0051] A second embodiment of the present invention differs from the first embodiment in that the sheet-width sensor H**1** is provided at a position farther from the center line of the sheet S than that according to the first embodiment. Because the control block diagram according to this embodiment is the same as FIG. **2**, which is referred to in the first embodiment, an explanation thereof will be omitted. FIG. **5** is a flowchart showing an operation according to this embodiment.

[0052] In FIG. **5**, because steps S**601** to S**604** and steps S**606** to S**610** are the same as steps S**301** to S**304** and steps S**306** to S**310** according to the first embodiment, an explanation thereof will be omitted and characteristic parts will be described below.

[0053] The operation flowchart shown in FIG. **5** applies if the distance, a, between the center line and the sheet-width sensor H**1**, shown in FIG. **3**, is larger than that according to the first embodiment.

[0054] The sheet-width sensor H**1** is provided at a distance greater than the distance a from the center line. Thus, even if the sheet S is conveyed to a position above the sheet-width sensor H**1**, the problems such as heating up of the end portion of the heating member and toner offset during image fixing do not affect. Accordingly, if the stored sheet size does not have a width detectable by the sheet-width sensor H**1**, it is determined that the sheet S is conveyed in a displaced state. Then, in step S**607**, throughput is set to that for sheets displaced to one side.

[0055] However, if the specified sheet width has a width substantially equal to the width detectable by the sheet-width sensor H**1**, the sheet-width sensor H**1** may detect the sheet S because of variation of sheet conveyance and may incorrectly determine that the sheet S exists. In this case, the sheet S that can be conveyed at throughput for wide sheets is conveyed at throughput for sheets displaced to one side.

[0056] Accordingly, in step S**605**, if it is determined that the stored sheet size has a width substantially equal to the width detectable by the sheet-width sensor H**1** (YES in step S**605**), the process proceeds to step S**609**, where the determination that the sheet S is conveyed in a displaced state is invalidated and throughput is set to that for wide sheets. This control prevents a decrease in printing efficiency due to incorrect determination.

[0057] Similarly to the first embodiment, when the sub-thermistor **12** detects heating up of the end portion of the heating member, throughput can be reduced.

[0058] In this embodiment, the sheet-width sensor H**1** is disposed on the right side of the central reference as viewed in the conveying direction. However, a sheet-width sensor disposed on the opposite side of the central reference provides the same advantage.

[0059] Thus, this embodiment prevents a decrease in throughput or abortion of sheet conveyance caused by incorrect detection by the sheet-width detecting sensor during conveyance of a nonstandard-sized sheet.

[0060] In the above-described first and second embodiments, if a sheet displaced to the opposite side of the central reference from the sheet-width sensor H**1** is conveyed, the conveying position of the sheet may not be detected. Accordingly, another sheet-width sensor is provided on the opposite side of the central reference from the sheet-width sensor H**1** to enable more accurate determination of the conveying position of the sheet.

[0061] Because the control block diagram according to a third embodiment is the same as FIG. **2**, an explanation thereof will be omitted.

[0062] FIG. **6** shows the arrangement of a sheet-width sensor H**2**. The sheet-width sensor H**2** has the same structure as the sheet-width sensor H**1** and detects the width of a sheet.

[0063] The sheet-width sensor H**2** is disposed on the opposite side of the central reference from the sheet-width sensor H**1**. The sheet-width sensor H**2** is disposed at a distance c from the center line, where it can detect a wide sheet, such as a letter-sized sheet, an A4 sheet, and a legal-sized sheet, when such a sheet is conveyed while aligning the center line thereof with the reference position.

[0064] FIG. **7** is a flowchart showing an operation according to this embodiment. Because steps S**401** to S**403** are the same as steps S**301** to S**303** according to the first embodiment, and step S**406** is the same as steps S**304** and S**306** according to the first embodiment, an explanation thereof will be omitted and characteristic parts will be described below.

[0065] In step S**405**, the sheet-width sensor H**2** detects the width of the sheet S. If the outputs of the sheet-width sensors H**1** and H**2** indicate the presence of the sheet S (ON), it is determined that the sheet S is a wide sheet. Then, in step S**408**, throughput is set to that for wide sheets. If the outputs of the sheet-width sensors H**1** and H**2** indicate the absence of the sheet S (OFF), it is determined that the sheet S is a narrow sheet. Then, in step S**411**, throughput is set to that for narrow sheets.

[0066] If one of the outputs of the sheet-width sensors H**1** and H**2** indicates the presence of the sheet S (ON), the process proceeds to step S**406**. In step S**406**, if the specified sheet width is large, the process proceeds to step S**409**, where it is determined that the sheet sizes disagree. Then, image formation is aborted, and the sheet S, with no image printed thereon, is output onto the paper output tray **121**.

[0067] In step S**406**, if the specified sheet width is small, the process proceeds to step S**407**. In step S**407**, if the distance (a+b)−(b+d) is larger than a predetermined value, it is determined that the sheet S is conveyed in a displaced state. The distance (a+b) corresponds to the distance between the sheet-width sensors H**1** and H**2**, and the distance (b+d) corresponds to the sheet size stored in step S**401**. In this embodiment, the predetermined value is 4 mm. This value, 4 mm, is determined taking into consideration the conveyance speed and flapping of the sheet in the conveying path. Thus, if the conveyance speed or the structure of the conveying path is changed, the value can be changed.

[0068] Then, in step S**410**, throughput is set to that for sheets displaced to one side. In step S**407**, if it is determined that the sheet size is substantially equal to the distance between the sheet-width sensors H**1** and H**2** ((a+c)−(b+d)<4 mm), the determination that the sheet S is conveyed in a displaced state is invalidated (it is not determined that the sheet S is conveyed in a displaced state) since variation of sheet conveyance may lead to incorrect determination. Then, in step S411, throughput is set to that for narrow sheets.

[0069] The provision of a plurality (two) of sheet-width sensors, namely, H1 and H2, at opposite positions, more accurately prevents incorrect determination that the sheet S is conveyed in a displaced state and minimizes a decrease in printing efficiency.

[0070] Similarly to the first embodiment, when the sub-thermistor 12 detects heating up of the end portion of the heating member, throughput can be reduced.

[0071] In this embodiment, when the determination that the sheet S is conveyed in a displaced state is invalidated, throughput is set to that for narrow sheets. However, when the distance between the sheet-width sensors H1 and H2 is large, as in the case of the second embodiment, throughput can be set to that for wide sheets. This further improves the printing efficiency.

[0072] Thus, this embodiment prevents a decrease in throughput or abortion of sheet conveyance caused by incorrect detection by the sheet-width detecting sensors during conveyance of a nonstandard-sized sheet.

[0073] In the above-described first to third embodiments, whether or not the determination that the sheet S is conveyed in a displaced state is invalidated is determined according to the information output from the sheet-width sensor(s) to set throughput. However, when the determination is performed only on the basis of the sheet width, if the determination that the sheet S is conveyed in a displaced state is invalidated when a sheet having a large length in the conveying direction is conveyed, the end portion of the heating member of the fixing unit 114 may be intensively heated up, decreasing the durability of the fixing unit 114 or causing image failure. The reason why the end portion of the heating member is intensively heated up is that a sheet having a large length in the conveying direction requires a long time to fix an image on the sheet at the fixing unit 114.

[0074] In a fourth embodiment, in addition to the above-described first to third embodiments, the length of the sheet S in the conveying direction is measured, and throughput is set according to the measured sheet length, the detected sheet width, and the specified sheet size.

[0075] Referring to FIG. 8, a control unit of an image forming apparatus according to this embodiment will be described. FIG. 8 is a control block diagram of the image forming apparatus according to this embodiment. Because reference numerals 301 and 303 to 308 denote the same components as reference numerals 201 and 203 to 208 according to the first embodiment, an explanation thereof will be omitted.

[0076] In FIG. 8, a sheet-length storage unit 310 stores the length of the sheet S in the conveying direction, which is obtained by measuring the time from the arrival of the leading end of the sheet S at the top sensor 108 to the leaving of the trailing end of the sheet S from the top sensor 108. A throughput-control determining section 307 determines whether or not the determination that the sheet S is conveyed in a displaced state should be invalidated, according to the length of the sheet S stored in the sheet-length storage unit 310.

[0077] FIG. 9 is a flowchart showing the operation according to this embodiment. Because steps S501 to S511 are the same as steps S401 to S411 according to the third embodiment, an explanation thereof will be omitted and characteristic parts will be described below.

[0078] In step S512, assuming that the distance between the sheet-width sensors H1 and H2 and the specified sheet size are determined to be substantially equal in step S507, setting of throughput of the sheet S is determined according to the length of the sheet S measured by the top sensor 108. If it is determined that the length of the sheet S is larger than the reference sheet length, throughput-control determining section 307 sets throughput to throughput for sheets displaced to one side. In step S412, if it is determined that the length of the sheet S is smaller than the reference sheet length, throughput-control determining section 307 invalidates the determination that the sheet S is conveyed in a displaced state, and sets throughput to throughput for narrow sheets.

[0079] Thus, whether or not the determination that the sheet S is conveyed in a displaced state should be invalidated is determined according to the measured sheet length. This prevents a decrease in printing efficiency even if the length of the sheet S in the conveying direction is large, and prevents occurrence of image failure without reducing the durability of the fixing unit 114.

[0080] Similarly to the first embodiment, when the sub-thermistor 12 detects heating up of the end portion of the heating member, throughput can be reduced.

[0081] In this embodiment, when the determination that the sheet S is conveyed in a displaced state is invalidated, throughput is set to that for narrow sheets. However, when the distance between the sheet-width sensors H1 and H2 is large, as in the case of the second embodiment, throughput can be set to that for wide sheets. This further improves the printing efficiency.

[0082] Thus, this embodiment prevents a decrease in throughput or abortion of sheet conveyance caused by incorrect detection by the sheet-width detecting sensors during conveyance of a nonstandard-sized sheet.

[0083] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications and equivalent structures and functions.

[0084] This application claims the benefit of Japanese Patent Application No. 2008-115733 filed Apr. 25, 2008 and No. 2009-070182 filed Mar. 23, 2009, which are hereby incorporated by reference herein in their entirety.

1. An image forming apparatus comprising:
an image forming unit configured to form an image on a recording material;
a conveying path along which the recording material is conveyed to the image forming unit;
a sensor provided in the conveying path, the sensor being configured to detect the width of the recording material in a direction perpendicular to a conveying direction; and
a control unit configured to determine a conveying state of the recording material in the direction perpendicular to the conveying direction according to an output of the sensor, and configured to control a conveyance interval of the recording material according to the determination result,
wherein the control unit sets the conveyance interval regardless of the determination result, according to the width of the specified recording material and the width detectable by the sensor.

2. The image forming apparatus according to claim **1**, wherein the control unit sets the conveyance interval if the difference between the width of the specified recording material and the width detectable by the sensor is equal to or smaller than a predetermined value, regardless of the determination result.

3. The image forming apparatus according to claim **2**, wherein the control unit sets the conveyance interval to a first conveyance interval if the sensor detects the recording material and if the width of the specified recording material is larger than a predetermined width.

4. The image forming apparatus according to claim **3**, wherein the control unit sets the conveyance interval to a second conveyance interval that is larger than the first conveyance interval when the sensor does not detect the recording material and when the width of the specified recording material is smaller than a predetermined width.

5. The image forming apparatus according to claim **2**, wherein the control unit sets the conveyance interval to a third conveyance interval that is larger than the second conveyance interval if the sensor detects the recording material and if the width of the specified recording material is smaller than a predetermined width.

6. The image forming apparatus according to claim **1**, wherein the sensor is provided at a predetermined distance away from the center of the width serving as a reference.

7. The image forming apparatus according to claim **1**, further comprising a plurality of the sensors,

wherein the control unit sets the conveyance interval to a predetermined conveyance interval according to the width of the specified recording material and the width detectable by the plurality of sensors, regardless of the determination result.

8. The image forming apparatus according to claim **7**, wherein the control unit sets the conveyance interval to the predetermined conveyance interval if the difference between the width of the specified recording material and the width detectable by the plurality of sensors is equal to or smaller than a predetermined value, regardless of the determination result.

9. The image forming apparatus according to claim **1**, further comprising a measuring unit configured to measure the length of the recording material in the conveying direction,

wherein the control unit selects whether or not the conveyance interval is set using the determination result, according to the length of the recording material in the conveying direction measured by the measuring unit.

10. A method for conveying a recording material in an image forming apparatus, the method comprising:

determining a conveying state of a recording material by detecting the width of the recording material in a direction perpendicular to a conveying direction with a sensor;

setting a conveyance interval of the recording material according to the determined conveying state of the recording material; and

setting the conveyance interval according to the width of the specified recording material and the width detectable by the sensor, regardless of the determination.

11. The method according to claim **10**, wherein the conveyance interval is set regardless of the determination, if the difference between the width of the specified recording material and the width detectable by the sensor is equal to or smaller than a predetermined value.

12. The method according to claim **11**, wherein the conveyance interval is set to a first conveyance interval if the sensor detects the recording material and if the width of the specified recording material is larger than a predetermined width.

13. The method according to claim **12**, wherein the conveyance interval is set to a second conveyance interval that is larger than the first conveyance interval when the sensor does not detect the recording material and when the width of the specified recording material is smaller than a predetermined width.

14. The method according to claim **12**, wherein the conveyance interval is set to a third conveyance interval that is larger than the second conveyance interval, if the sensor detects the recording material and if the width of the specified recording material is smaller than a predetermined width.

15. The method according to claim **10**, wherein whether or not the conveyance interval is set using the determination result is selected according to the length of the recording material in the conveying direction measured by a measuring unit.

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