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(12) **United States Patent**
Konishi

(10) **Patent No.: US 12,391,501 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **PAPER FEED DEVICE, IMAGE FORMATION SYSTEM, AND CONTROL PROGRAM FOR PAPER FEED DEVICE**

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(72) Inventor: **Hiroyuki Konishi**, Tokyo (JP)

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(21) Appl. No.: **17/829,201**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
B65H 9/00 (2006.01)
B65H 9/06 (2006.01)
B65H 9/20 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 9/20*** (2013.01); ***B65H 9/004*** (2013.01); ***B65H 9/06*** (2013.01); *B65H 2511/135* (2013.01); *B65H 2511/416* (2013.01); *B65H 2515/10* (2013.01); *B65H 2801/06* (2013.01)

(58) **Field of Classification Search**
CPC B65H 9/06
See application file for complete search history.

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(57) **ABSTRACT**

A paper feed device having regulation plates that are movable on a paper feed tray for loading paper and regulate edges of the paper, includes: a driver that moves the regulation plates; and a hardware processor that acquires paper information corresponding to a characteristic of the loaded paper, and causes the driver to move the regulation plates according to the acquired paper information.

19 Claims, 20 Drawing Sheets

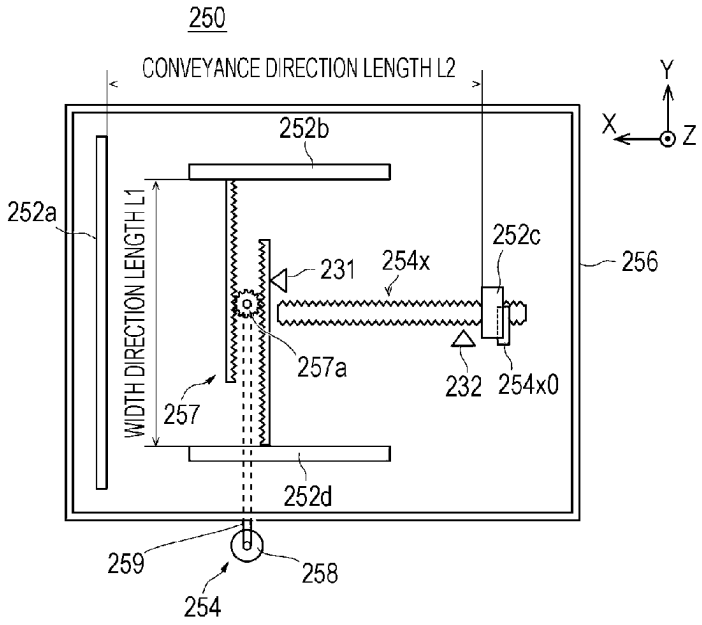


FIG. 1

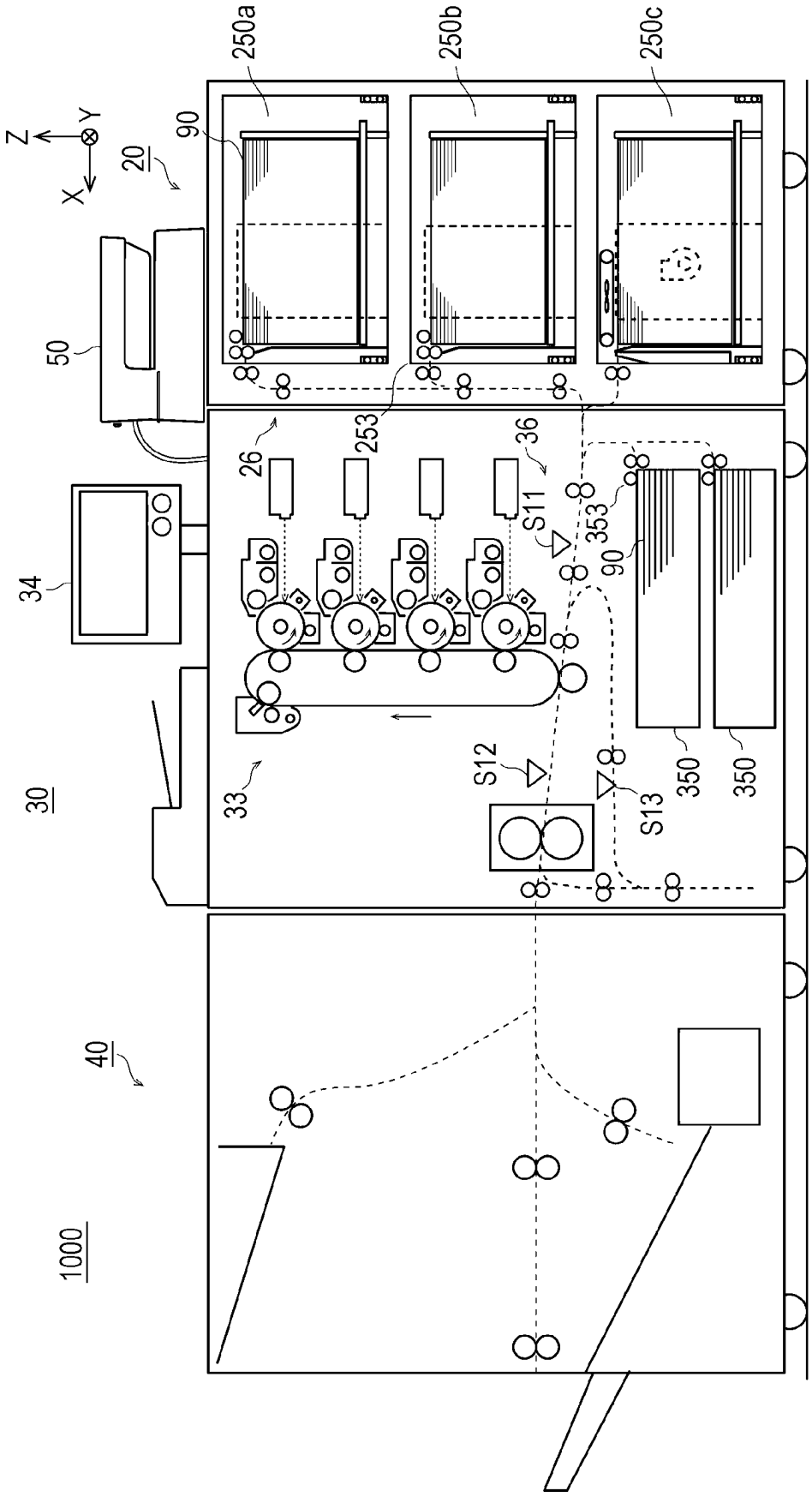

250a
250b
250c
Z
Y
X
90
20
50
253
26
36
S11
353
90
34
30
33
S12
S13
350
350
40
1000

FIG. 2

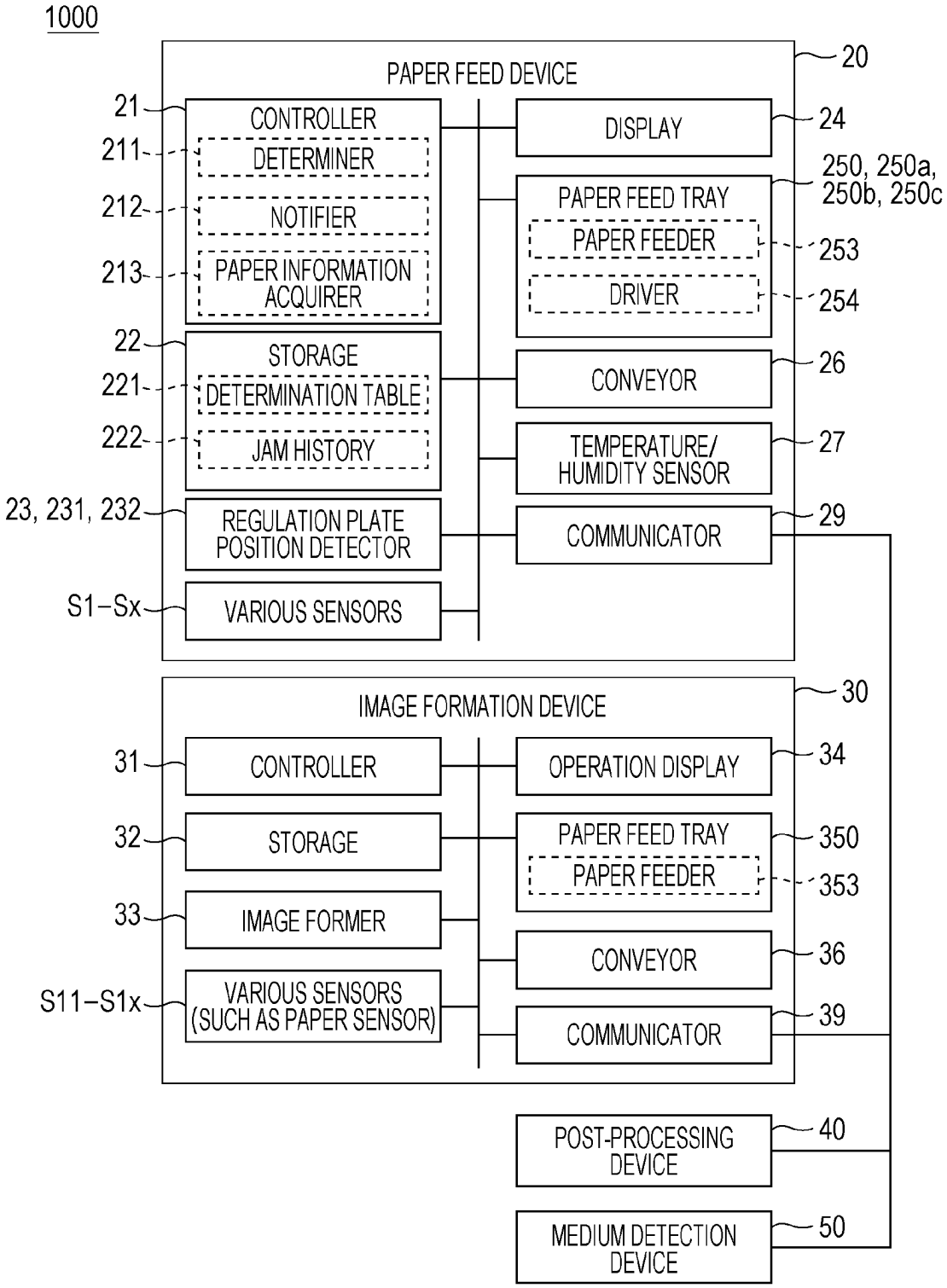

1000
PAPER FEED DEVICE
20
21
CONTROLLER
211
DETERMINER
212
NOTIFIER
213
PAPER INFORMATION ACQUIRER
22
STORAGE
221
DETERMINATION TABLE
222
JAM HISTORY
23, 231, 232
REGULATION PLATE POSITION DETECTOR
S1-Sx
VARIOUS SENSORS
DISPLAY
24
PAPER FEED TRAY
250, 250a, 250b, 250c
PAPER FEEDER
253
DRIVER
254
CONVEYOR
26
TEMPERATURE/ HUMIDITY SENSOR
27
COMMUNICATOR
29
IMAGE FORMATION DEVICE
30
31
CONTROLLER
32
STORAGE
33
IMAGE FORMER
S11-S1x
VARIOUS SENSORS (SUCH AS PAPER SENSOR)
OPERATION DISPLAY
34
PAPER FEED TRAY
350
PAPER FEEDER
353
CONVEYOR
36
COMMUNICATOR
39
POST-PROCESSING DEVICE
40
MEDIUM DETECTION DEVICE
50

FIG. 3A

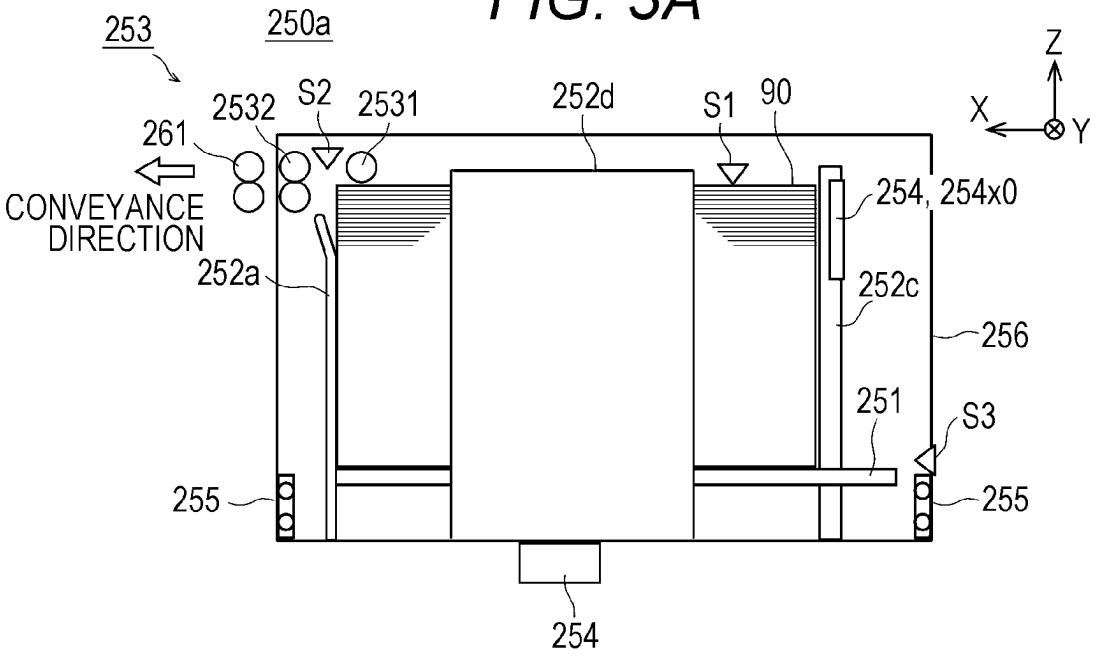

253
250a
2532
S2
2531
252d
S1
90
Z
X
Y
261
CONVEYANCE DIRECTION
254, 254x0
252a
252c
256
251
S3
255
255
254

FIG. 3B

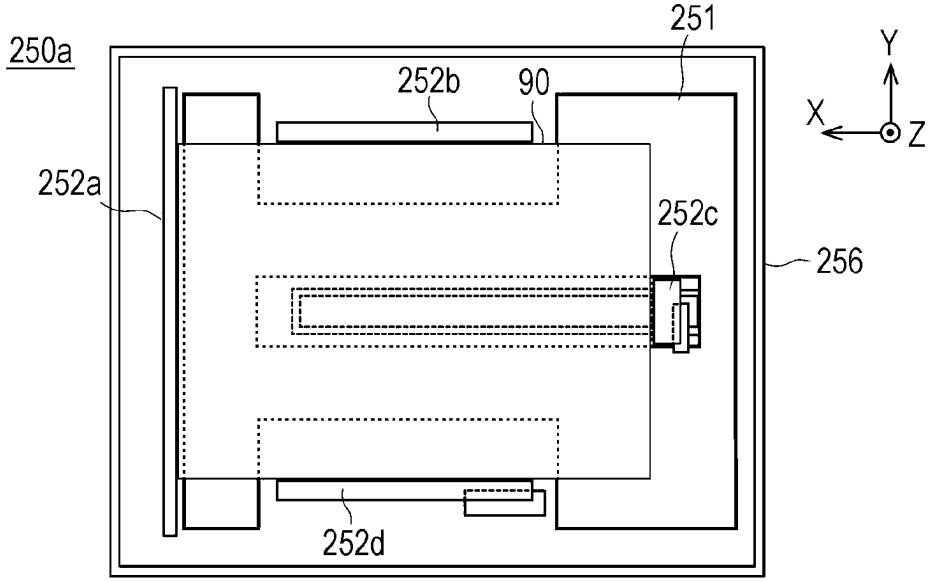

250a
251
252b
90
Y
X
Z
252a
252c
256
252d

FIG. 4

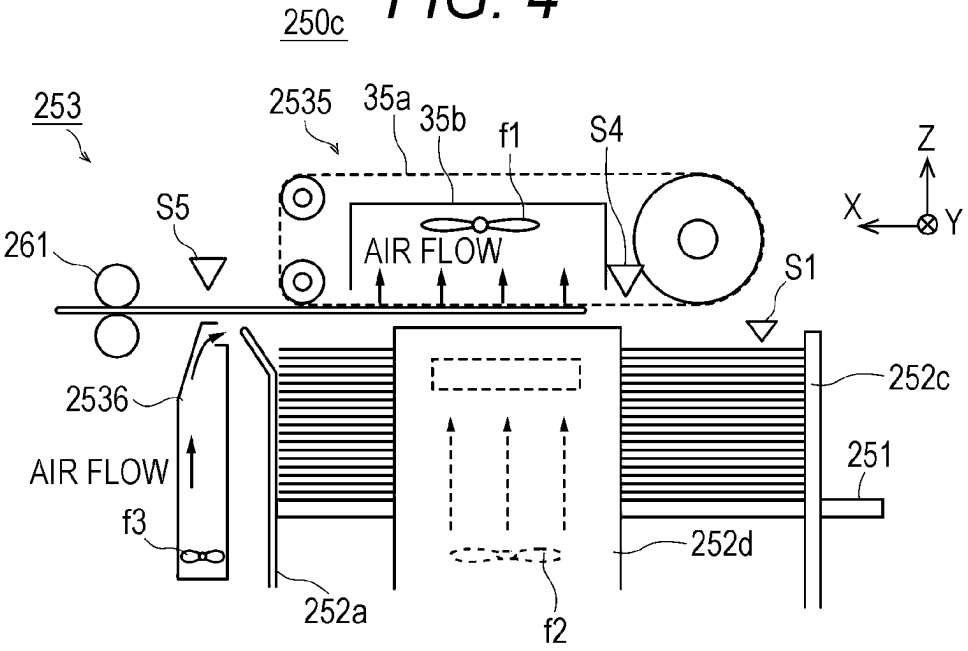

250c
253
2535
35a
35b
f1
S4
Z
X
Y
S5
261
AIR FLOW
S1
252c
2536
AIR FLOW
251
f3
252d
252a
f2

FIG. 5

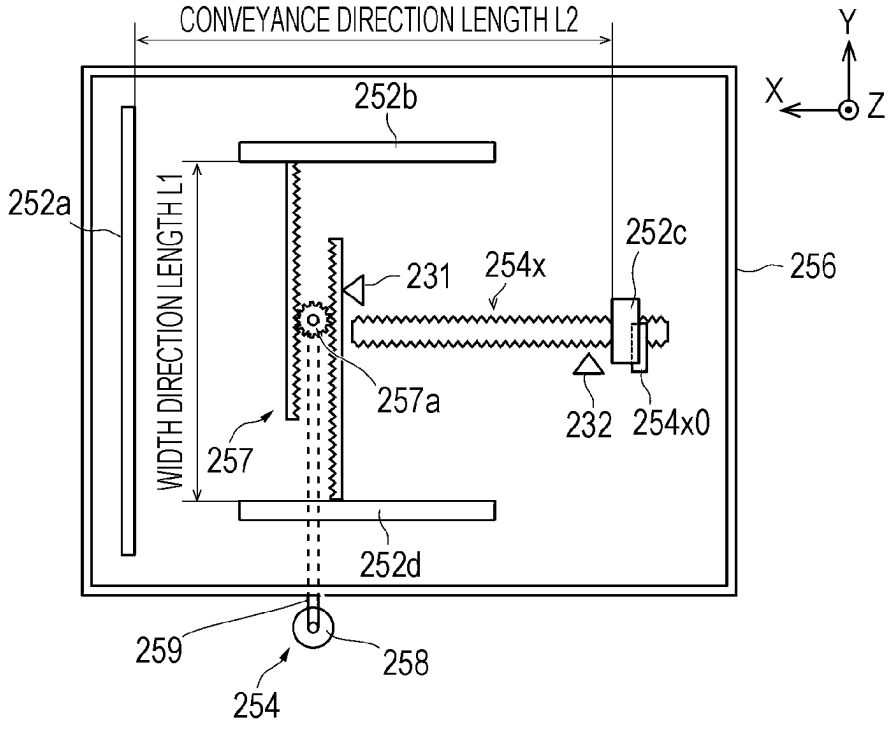

250
CONVEYANCE DIRECTION LENGTH L2
Y
X
Z
252b
252a
WIDTH DIRECTION LENGTH L1
231
254x
252c
256
257a
257
232
254x0
252d
259
258
254

FIG. 6

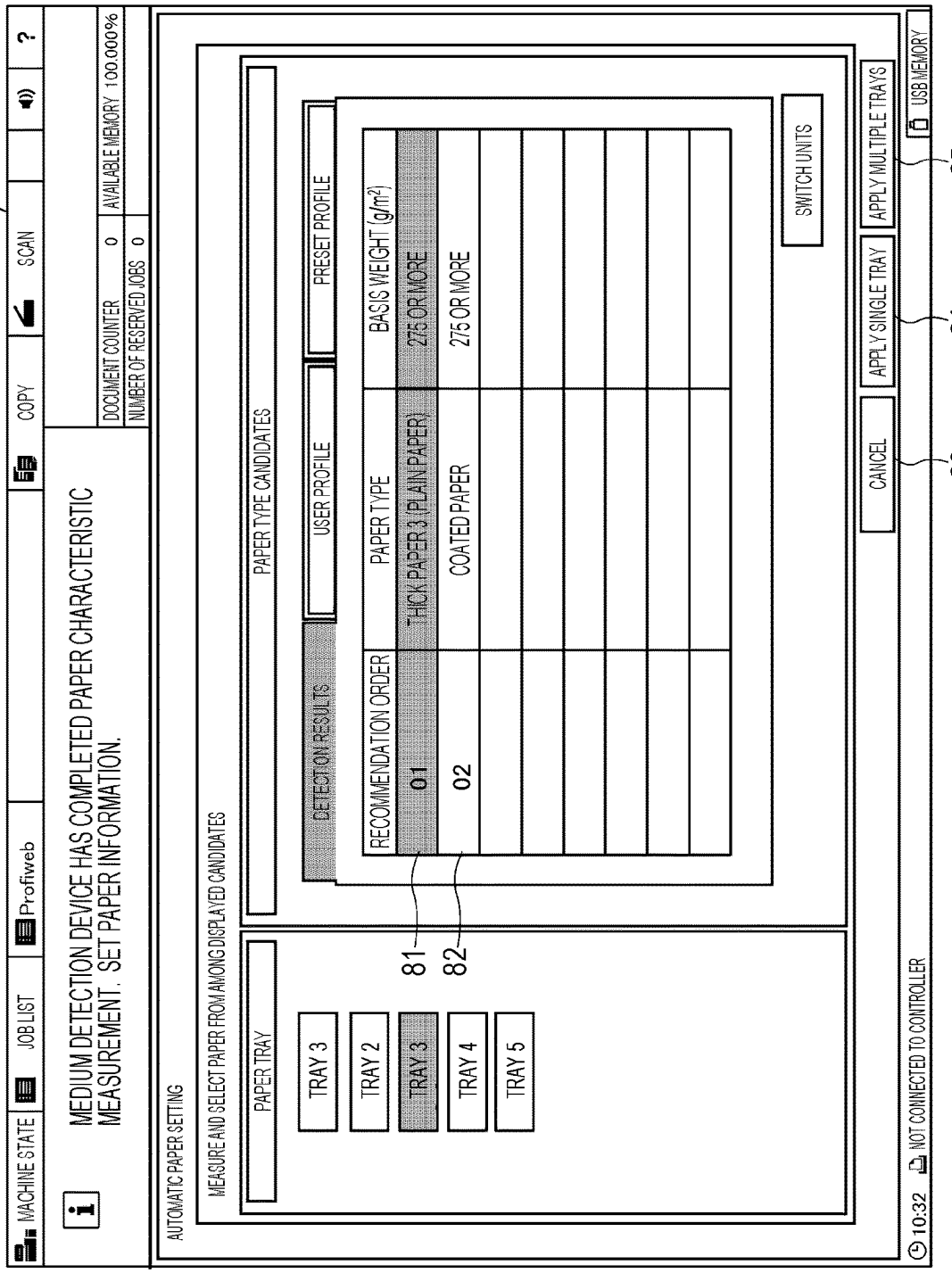

340, 34
MACHINE STATE
JOB LIST
Profiweb
COPY
SCAN
?
MEDIUM DETECTION DEVICE HAS COMPLETED PAPER CHARACTERISTIC MEASUREMENT. SET PAPER INFORMATION.
DOCUMENT COUNTER 0
AVAILABLE MEMORY 100.000%
NUMBER OF RESERVED JOBS 0
AUTOMATIC PAPER SETTING
MEASURE AND SELECT PAPER FROM AMONG DISPLAYED CANDIDATES
PAPER TRAY
TRAY 3
TRAY 2
TRAY 3
TRAY 4
TRAY 5
PAPER TYPE CANDIDATES
DETECTION RESULTS
USER PROFILE
PRESET PROFILE
RECOMMENDATION ORDER
PAPER TYPE
BASIS WEIGHT (g/m²)
01
THICK PAPER 3 (PLAIN PAPER)
275 OR MORE
02
COATED PAPER
275 OR MORE
81
82
SWITCH UNITS
CANCEL
APPLY SINGLE TRAY
APPLY MULTIPLE TRAYS
83
84
85
10:32
NOT CONNECTED TO CONTROLLER
USB MEMORY

FIG. 7

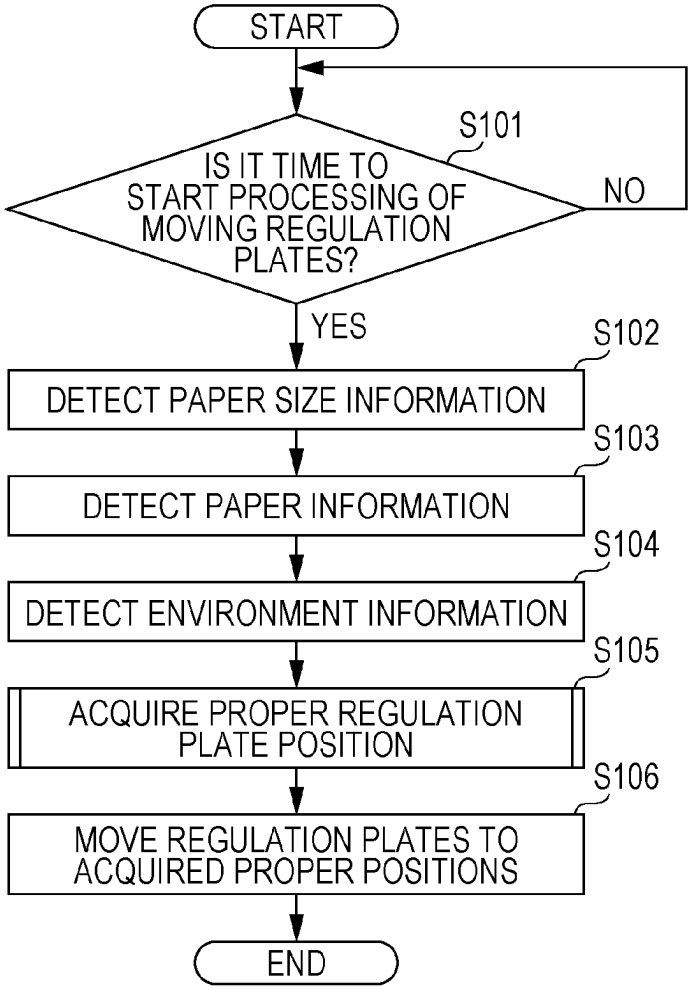

START
S101
IS IT TIME TO START PROCESSING OF MOVING REGULATION PLATES?
NO
YES
S102
DETECT PAPER SIZE INFORMATION
S103
DETECT PAPER INFORMATION
S104
DETECT ENVIRONMENT INFORMATION
S105
ACQUIRE PROPER REGULATION PLATE POSITION
S106
MOVE REGULATION PLATES TO ACQUIRED PROPER POSITIONS
END

FIG. 8A

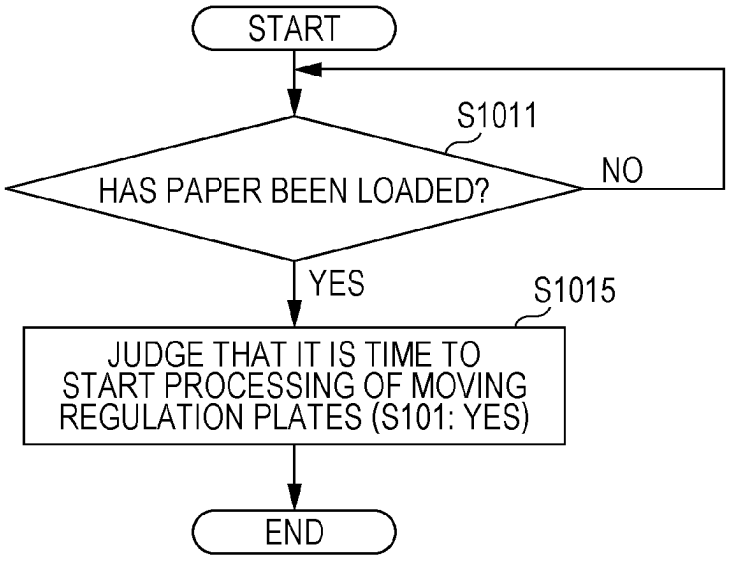

START
S1011
HAS PAPER BEEN LOADED?
NO
YES
S1015
JUDGE THAT IT IS TIME TO START PROCESSING OF MOVING REGULATION PLATES (S101: YES)
END

FIG. 8B

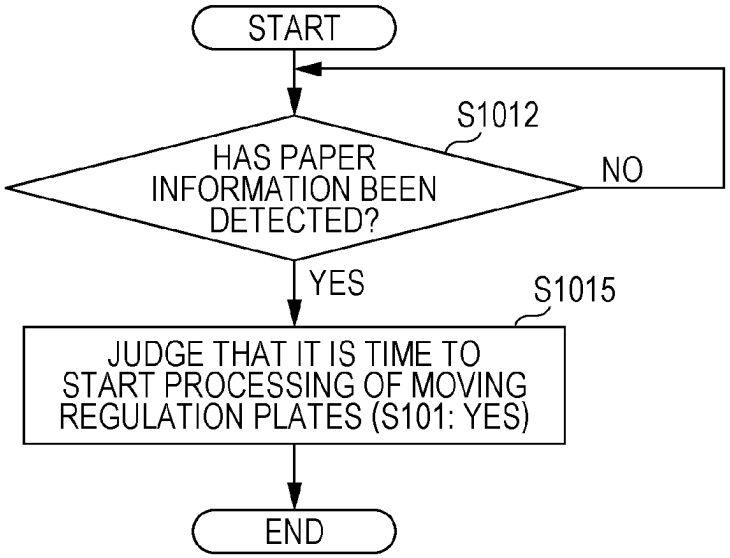

START
S1012
HAS PAPER INFORMATION BEEN DETECTED?
NO
YES
S1015
JUDGE THAT IT IS TIME TO START PROCESSING OF MOVING REGULATION PLATES (S101: YES)
END

FIG. 9

SIZE	PAPER TYPE	BASIS WEIGHT g/m^2	HUMIDITY	CD PROPER REGULATION PLATE POSITION mm
SRA3	PLAIN PAPER (THICKER THAN THICK PAPER 4)	257-	H	451.2
			M	451.5
			L	451.8
	PLAIN PAPER (THICK PAPER 3, 4)	210-256	H	450.7
			M	451.0
			L	451.3
	PLAIN PAPER (THICK PAPER 1, 2)	91-209	H	450.2
			M	450.5
			L	450.8
	PLAIN PAPER (NORMAL)	60-90	H	449.7
			M	450.0
			L	450.3
	PLAIN PAPER (THIN PAPER)	-59	H	449.2
			M	449.5
			L	449.8
	COATED PAPER	・・・	・・	・・・
	HIGH-QUALITY PAPER	・・・	・・	・・・
	・・・	・・・	・・	・・・
A3S	・・・	・・・	・・	・・・
	・・・	・・・	・・	・・・
・・・	・・・	・・・	・・	・・・
・・・	・・・	・・・	・・	・・・

FIG. 10

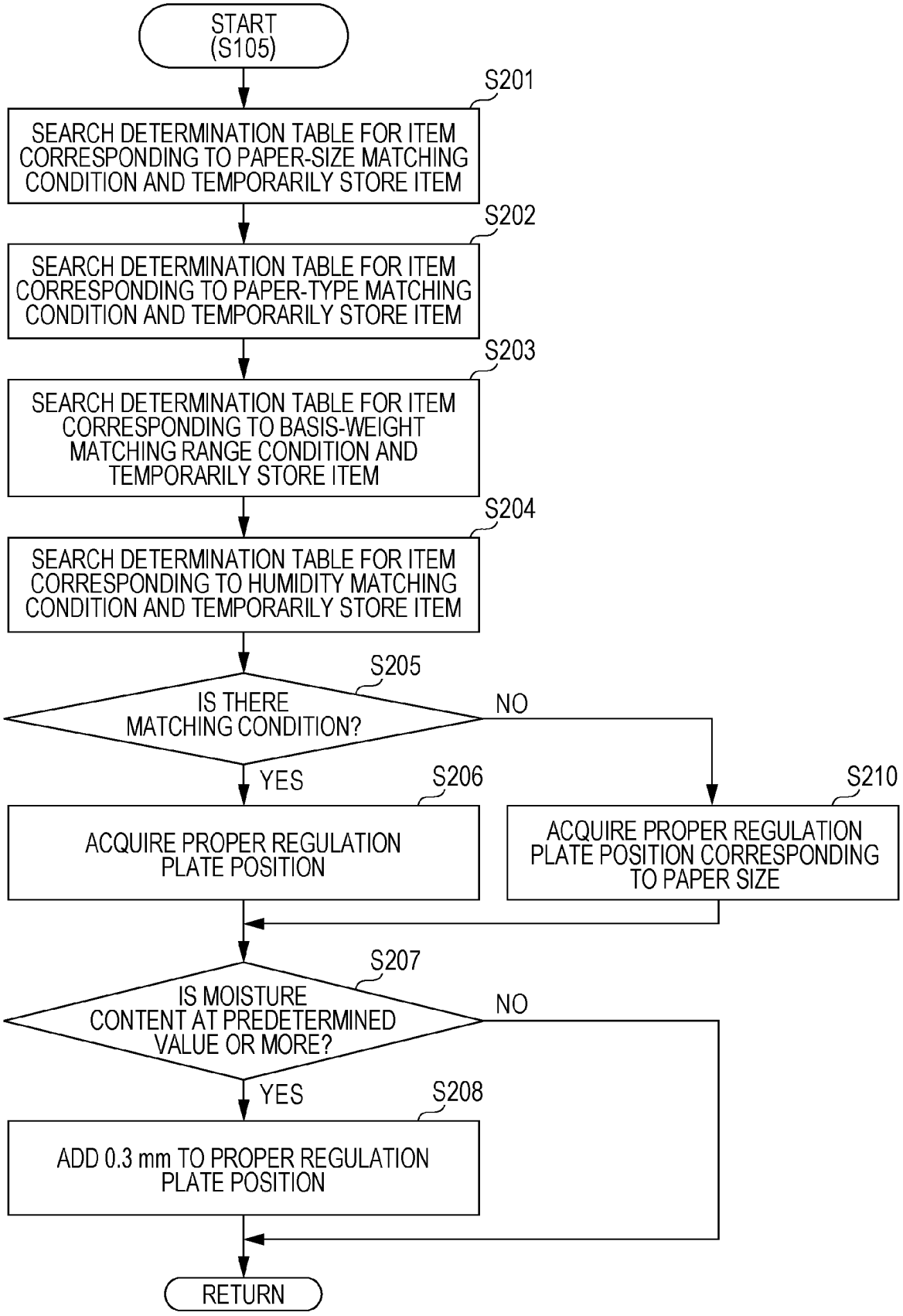

START
(S105)
S201
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO PAPER-SIZE MATCHING CONDITION AND TEMPORARILY STORE ITEM
S202
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO PAPER-TYPE MATCHING CONDITION AND TEMPORARILY STORE ITEM
S203
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO BASIS-WEIGHT MATCHING RANGE CONDITION AND TEMPORARILY STORE ITEM
S204
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO HUMIDITY MATCHING CONDITION AND TEMPORARILY STORE ITEM
S205
IS THERE MATCHING CONDITION?
NO
YES
S206
ACQUIRE PROPER REGULATION PLATE POSITION
S210
ACQUIRE PROPER REGULATION PLATE POSITION CORRESPONDING TO PAPER SIZE
S207
IS MOISTURE CONTENT AT PREDETERMINED VALUE OR MORE?
NO
YES
S208
ADD 0.3 mm TO PROPER REGULATION PLATE POSITION
RETURN

FIG. 11

SIZE	PAPER NAME (PAPER PROFILE)	HUMIDITY	CD PROPER REGULATION PLATE POSITION mm
SRA3	ABC COMPANY KENT PAPER 123	H	451.2
		M	451.5
		L	451.8
	DEF COMPANY COPIER PAPER 456	H	450.7
		M	451.0
		L	451.3
	ABC COMPANY HIGH-QUALITY PAPER No10	H	450.2
		M	450.5
		L	450.8
	GH COMPANY PAPER #1	H	449.7
		M	450.0
		L	450.3
	ABC COMPANY COPIER PAPER 123	H	449.2
		M	449.5
		L	449.8
	LMN COMPANY COPIER PAPER NUMBER 1	H	450.7
		M	451.0
		L	451.3
	XYZ COMPANY No1 PAPER A3 NOBI	H	449.7
		M	450.0
		L	450.3
	zzz COMPANY HIGH-QUALITY PAPER 123		. . .
A3S	xxx COMPANY COPIER PAPER RAS3		. . .
	. . .		. . .
. . .	. . .		. . .
. . .	. . .		. . .

FIG. 12

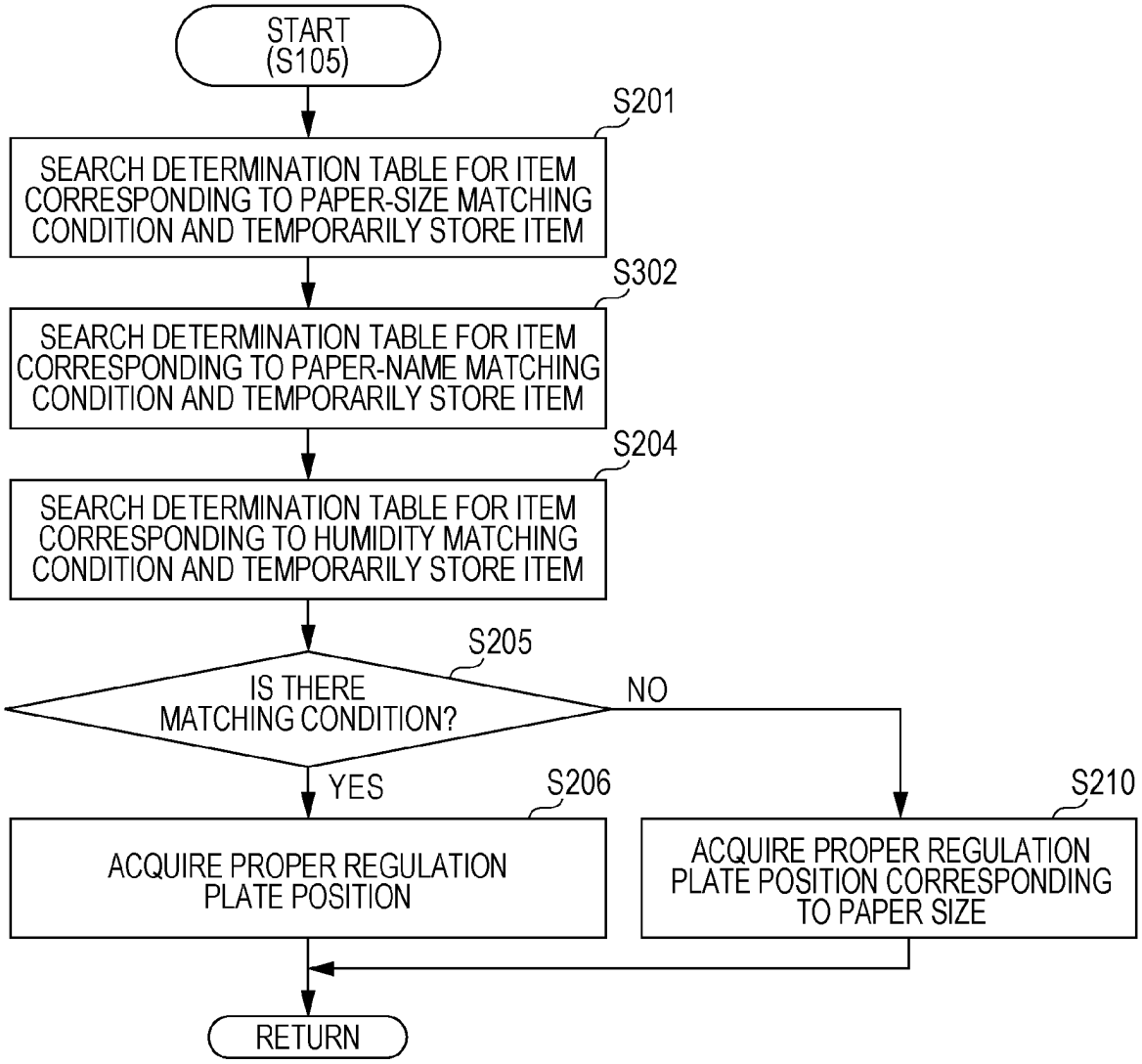

START
(S105)
S201
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO PAPER-SIZE MATCHING CONDITION AND TEMPORARILY STORE ITEM
S302
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO PAPER-NAME MATCHING CONDITION AND TEMPORARILY STORE ITEM
S204
SEARCH DETERMINATION TABLE FOR ITEM CORRESPONDING TO HUMIDITY MATCHING CONDITION AND TEMPORARILY STORE ITEM
S205
IS THERE MATCHING CONDITION?
NO
YES
S206
ACQUIRE PROPER REGULATION PLATE POSITION
S210
ACQUIRE PROPER REGULATION PLATE POSITION CORRESPONDING TO PAPER SIZE
RETURN

FIG. 13

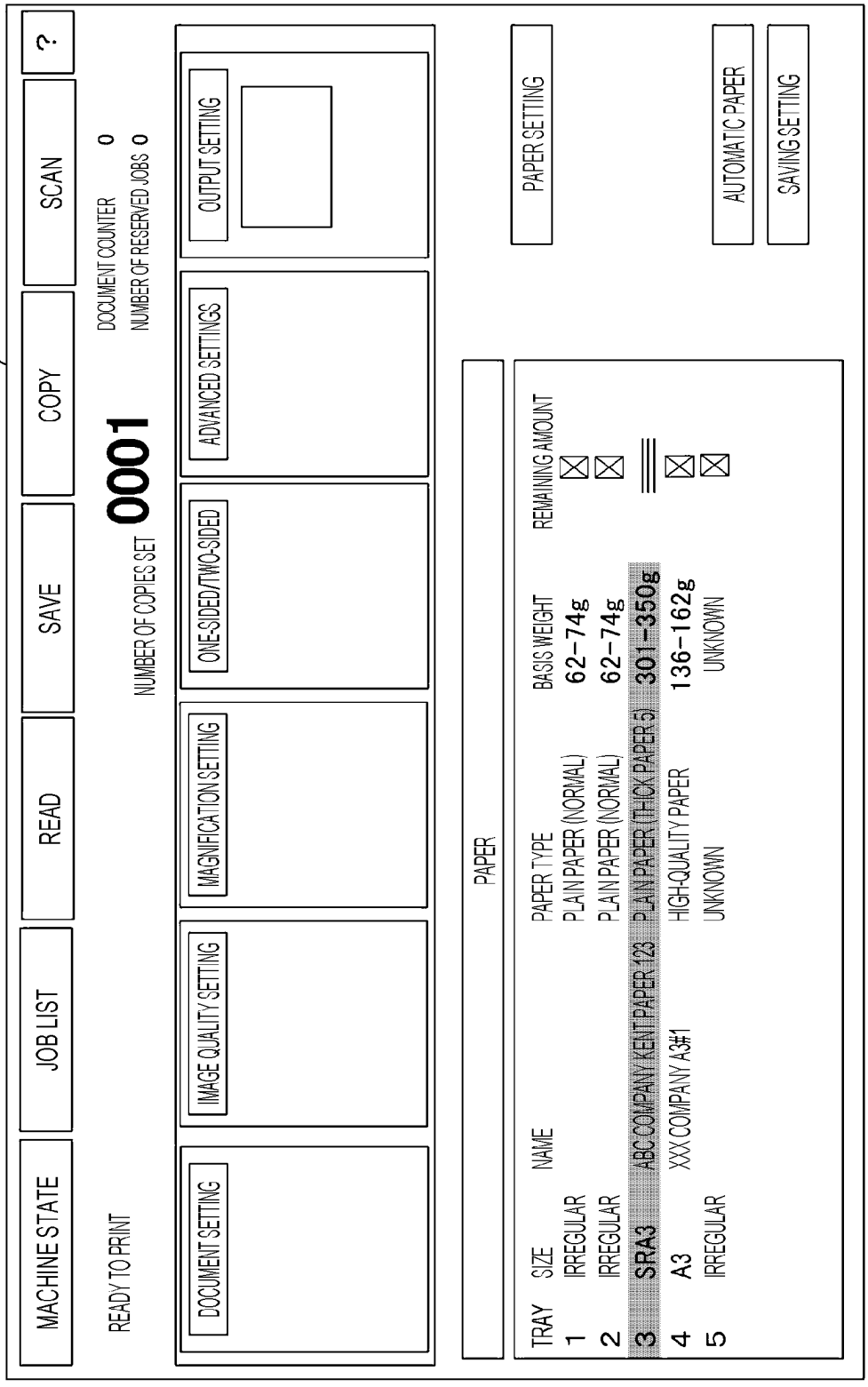

341, 34
MACHINE STATE
JOB LIST
READ
SAVE
COPY
SCAN
?
READY TO PRINT
NUMBER OF COPIES SET 0001
DOCUMENT COUNTER 0
NUMBER OF RESERVED JOBS 0
DOCUMENT SETTING
IMAGE QUALITY SETTING
MAGNIFICATION SETTING
ONE-SIDED/TWO-SIDED
ADVANCED SETTINGS
OUTPUT SETTING
PAPER
PAPER SETTING
TRAY SIZE NAME PAPER TYPE BASIS WEIGHT REMAINING AMOUNT
1 IRREGULAR PLAIN PAPER (NORMAL) 62–74g
2 IRREGULAR PLAIN PAPER (NORMAL) 62–74g
3 SRA3 ABC COMPANY KENT PAPER 123 PLAIN PAPER (THICK PAPER 5) 301–350g
4 A3 XXX COMPANY A3#1 HIGH-QUALITY PAPER 136–162g
5 IRREGULAR UNKNOWN UNKNOWN
AUTOMATIC PAPER
SAVING SETTING

FIG. 14

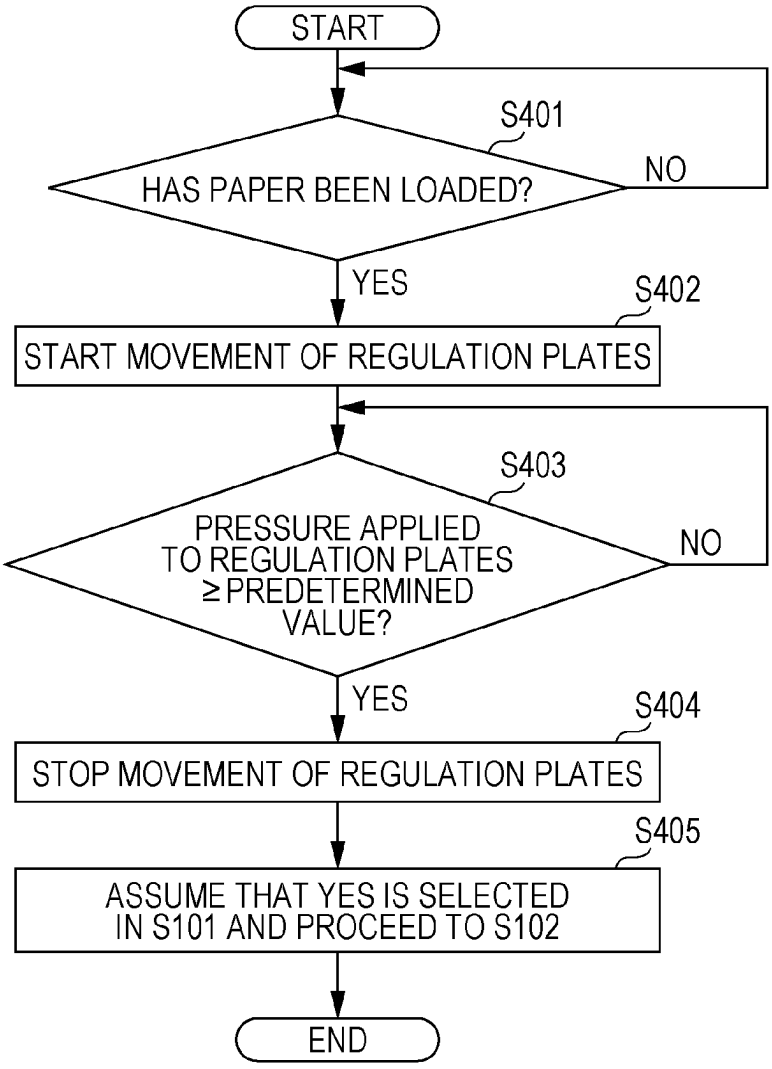

START
S401
HAS PAPER BEEN LOADED?
NO
YES
S402
START MOVEMENT OF REGULATION PLATES
S403
PRESSURE APPLIED TO REGULATION PLATES ≥ PREDETERMINED VALUE?
NO
YES
S404
STOP MOVEMENT OF REGULATION PLATES
S405
ASSUME THAT YES IS SELECTED IN S101 AND PROCEED TO S102
END

FIG. 15

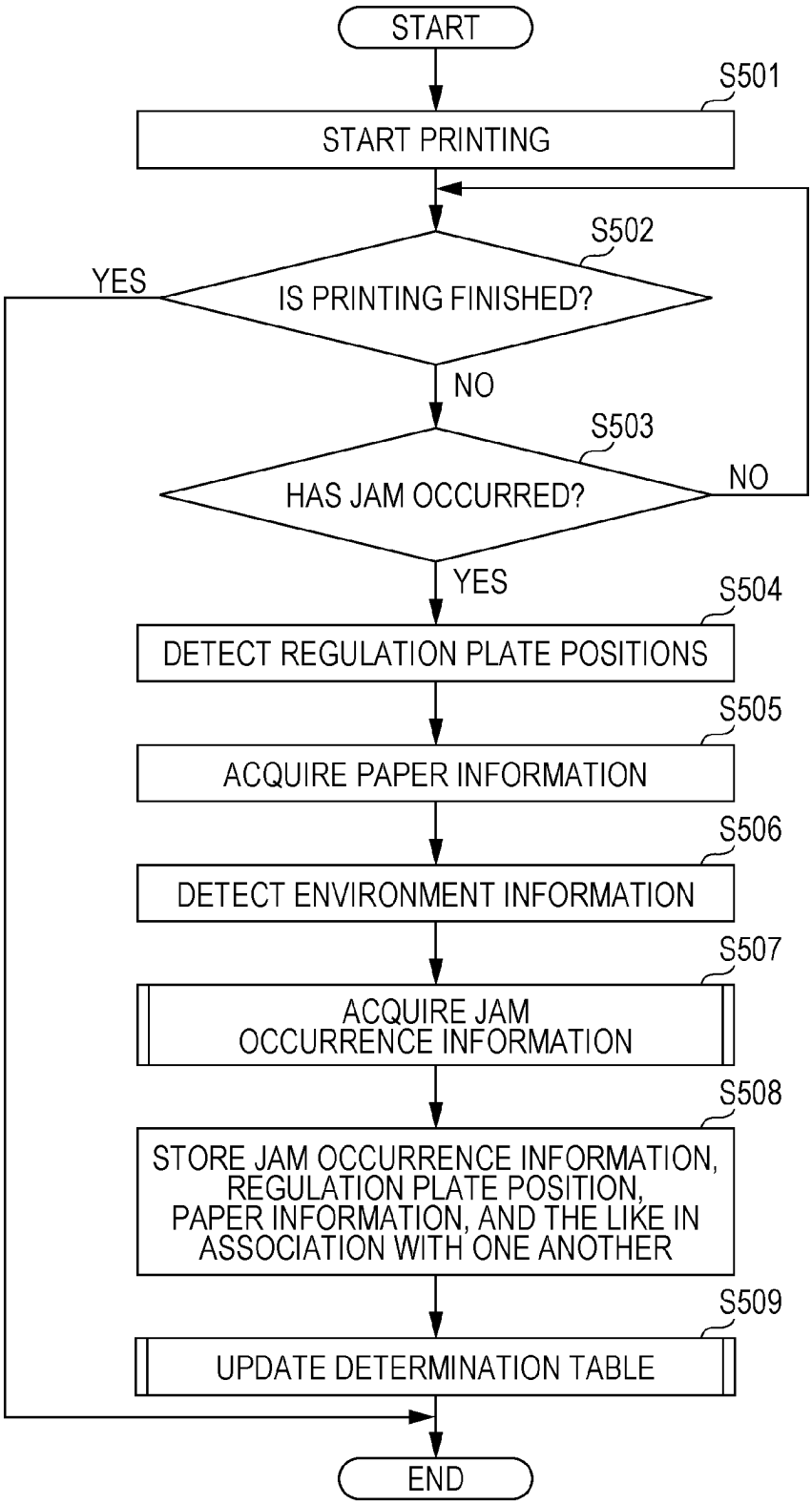

START
S501
START PRINTING
S502
IS PRINTING FINISHED?
YES
NO
S503
HAS JAM OCCURRED?
NO
YES
S504
DETECT REGULATION PLATE POSITIONS
S505
ACQUIRE PAPER INFORMATION
S506
DETECT ENVIRONMENT INFORMATION
S507
ACQUIRE JAM OCCURRENCE INFORMATION
S508
STORE JAM OCCURRENCE INFORMATION, REGULATION PLATE POSITION, PAPER INFORMATION, AND THE LIKE IN ASSOCIATION WITH ONE ANOTHER
S509
UPDATE DETERMINATION TABLE
END

FIG. 16

SIZE	PAPER TYPE	BASIS WEIGHT g/m^2	HUMIDITY	CD REGULATION PLATE POSITION mm	NUMBER OF A JAM OCCURRENCES	NUMBER OF B JAM OCCURRENCES
SRA3	PLAIN PAPER (THICKER THAN THICK PAPER 4)	257–	H	451.0	0	0
				451.1	0	0
	JAM1 ---------->			451.2	2→3	0
				451.3	0	0
				451.4	0	0
			M	451.3	0	0
				451.4	0	4
	JAM2 ---------->			451.5	0	2→3
				451.6	0	0
				451.7	0	0
			L	・・・	・・・	・・・
	PLAIN PAPER (THICK PAPER 3, 4)	210–256	・・	・・・	・・・	・・・
	PLAIN PAPER (THICK PAPER 1, 2)	91–209	・・	・・・	・・・	・・・
	PLAIN PAPER (NORMAL)	60–90	・・	・・・	・・・	・・・
	PLAIN PAPER (THIN PAPER)	–59	・・	・・・	・・・	・・・
	COATED PAPER	・・・	・・	・・・	・・・	・・・
	HIGH-QUALITY PAPER	・・・	・・	・・・	・・・	・・・
A3S	・・・	・・・	・・	・・・	・・・	・・・
	・・・	・・・	・・	・・・	・・・	・・・
・・・	・・・	・・・	・・	・・・	・・・	・・・
・・・	・・・	・・・	・・	・・・	・・・	・・・

FIG. 17

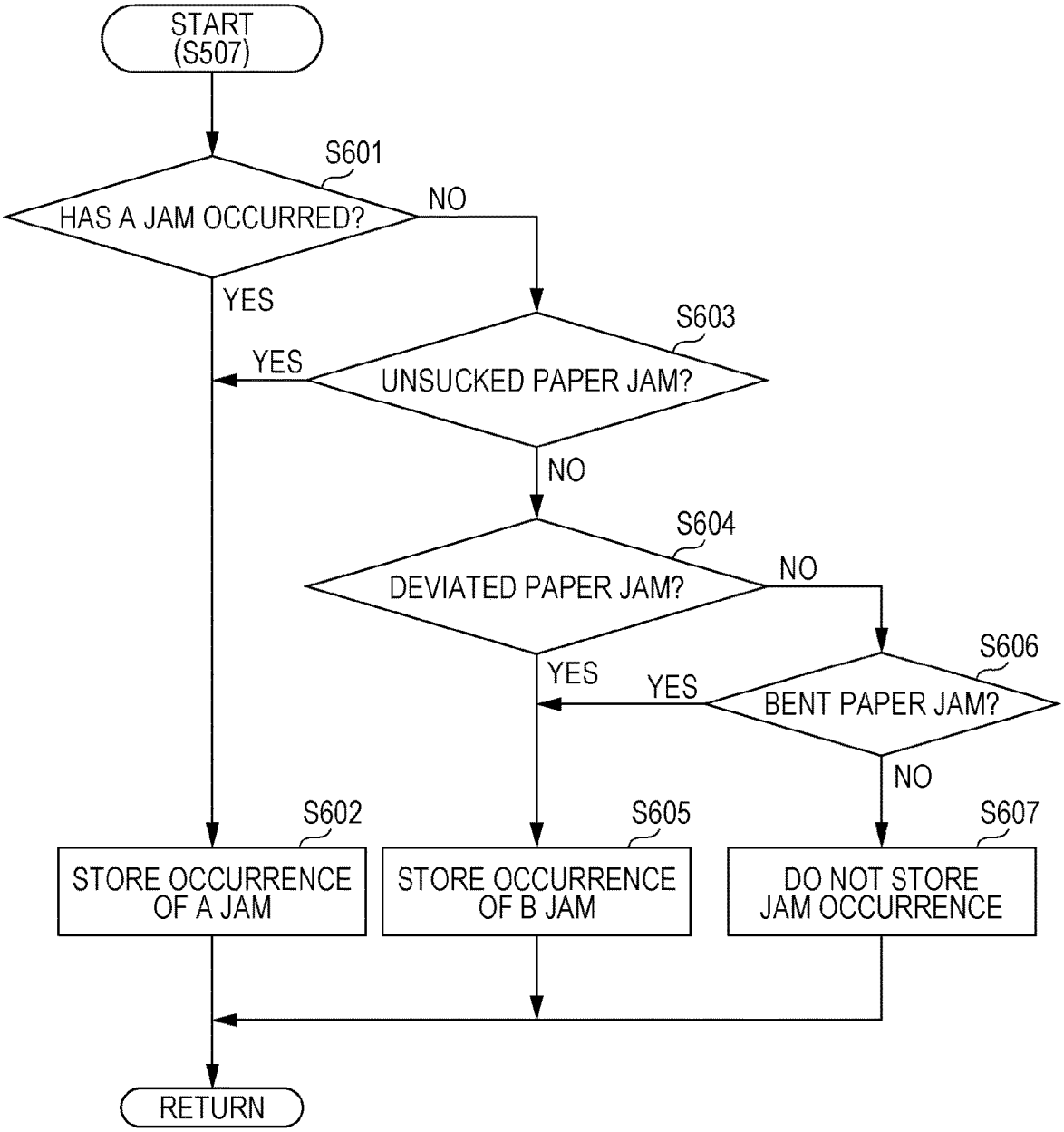

START
(S507)
S601
HAS A JAM OCCURRED?
NO
YES
S603
YES
UNSUCKED PAPER JAM?
NO
S604
DEVIATED PAPER JAM?
NO
S606
YES
YES
BENT PAPER JAM?
NO
S602
S605
S607
STORE OCCURRENCE OF A JAM
STORE OCCURRENCE OF B JAM
DO NOT STORE JAM OCCURRENCE
RETURN

FIG. 18

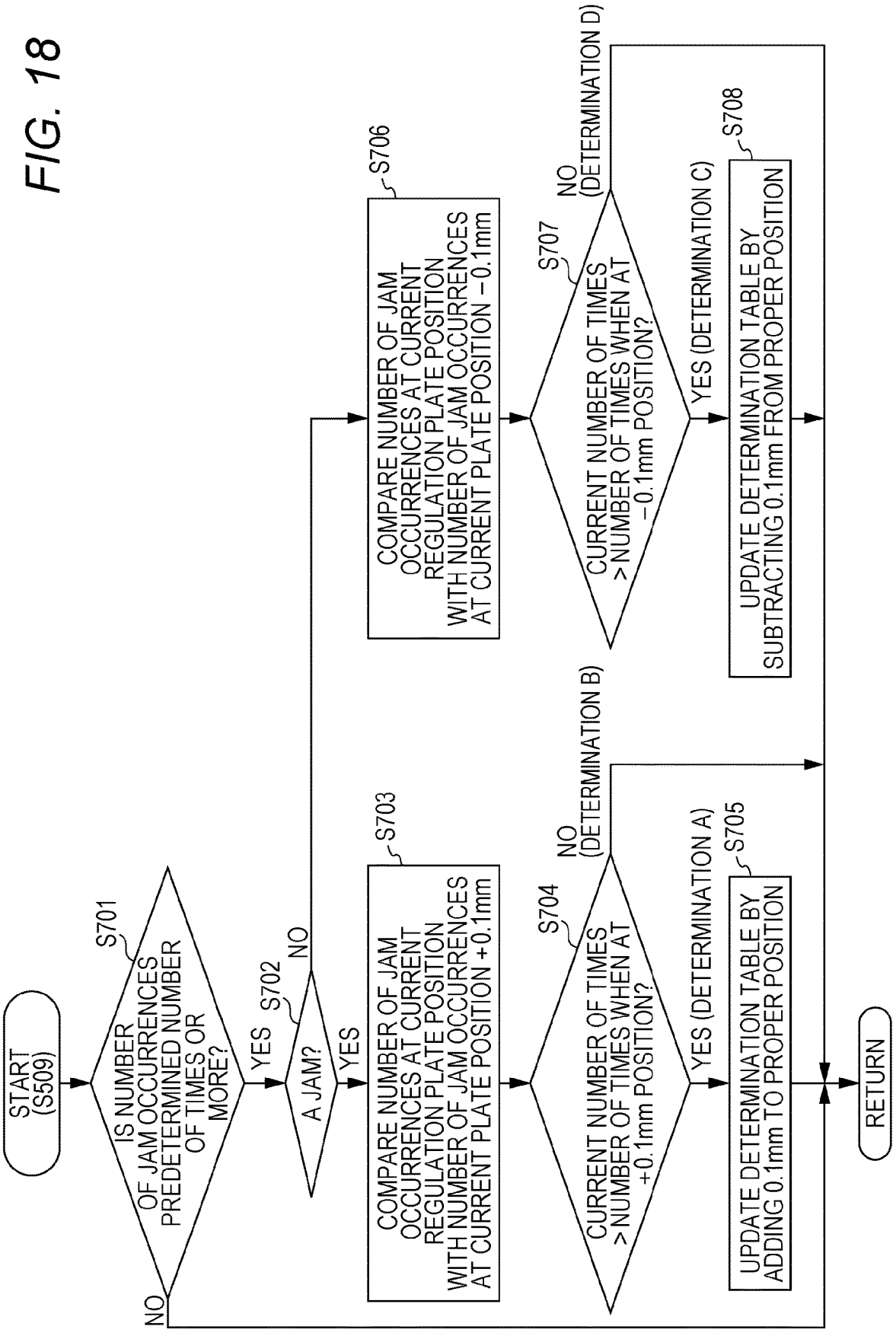

START (S509)
S701
IS NUMBER OF JAM OCCURRENCES PREDETERMINED NUMBER OF TIMES OR MORE?
YES
NO
S702
A JAM?
YES
NO
S703
COMPARE NUMBER OF JAM OCCURRENCES AT CURRENT REGULATION PLATE POSITION WITH NUMBER OF JAM OCCURRENCES AT CURRENT PLATE POSITION +0.1mm
S704
CURRENT NUMBER OF TIMES >NUMBER OF TIMES WHEN AT +0.1mm POSITION?
YES (DETERMINATION A)
NO (DETERMINATION B)
S705
UPDATE DETERMINATION TABLE BY ADDING 0.1mm TO PROPER POSITION
S706
COMPARE NUMBER OF JAM OCCURRENCES AT CURRENT REGULATION PLATE POSITION WITH NUMBER OF JAM OCCURRENCES AT CURRENT PLATE POSITION −0.1mm
S707
CURRENT NUMBER OF TIMES >NUMBER OF TIMES WHEN AT −0.1mm POSITION?
YES (DETERMINATION C)
NO (DETERMINATION D)
S708
UPDATE DETERMINATION TABLE BY SUBTRACTING 0.1mm FROM PROPER POSITION
RETURN

FIG. 19

SIZE	PAPER TYPE	BASIS WEIGHT g/m^2	HUMIDITY	CD PROPER REGULATION PLATE POSITION mm
SRA3	PLAIN PAPER (THICKER THAN THICK PAPER 4)	257–	H	451.2→451.2
			M	451.5
			L	451.8
	PLAIN PAPER (THICK PAPER 3, 4)	210–256	H	450.7
			M	451.0
			L	451.3
	PLAIN PAPER (THICK PAPER 1, 2)	91–209	H	450.2
			M	450.5
			L	450.8
	PLAIN PAPER (NORMAL)	60–90	H	449.7
			M	450.0
			L	450.3
	PLAIN PAPER (THIN PAPER)	–59	H	449.2
			M	449.5
			L	449.8
	COATED PAPER	・・・	・・	・・・
	HIGH-QUALITY PAPER	・・・	・・	・・・
	・・・	・・・	・・	・・・
A3S	・・・	・・・	・・	・・・
	・・・	・・・	・・	・・・
・・・	・・・	・・・	・・	・・・
・・・	・・・	・・・	・・	・・・

FIG. 20

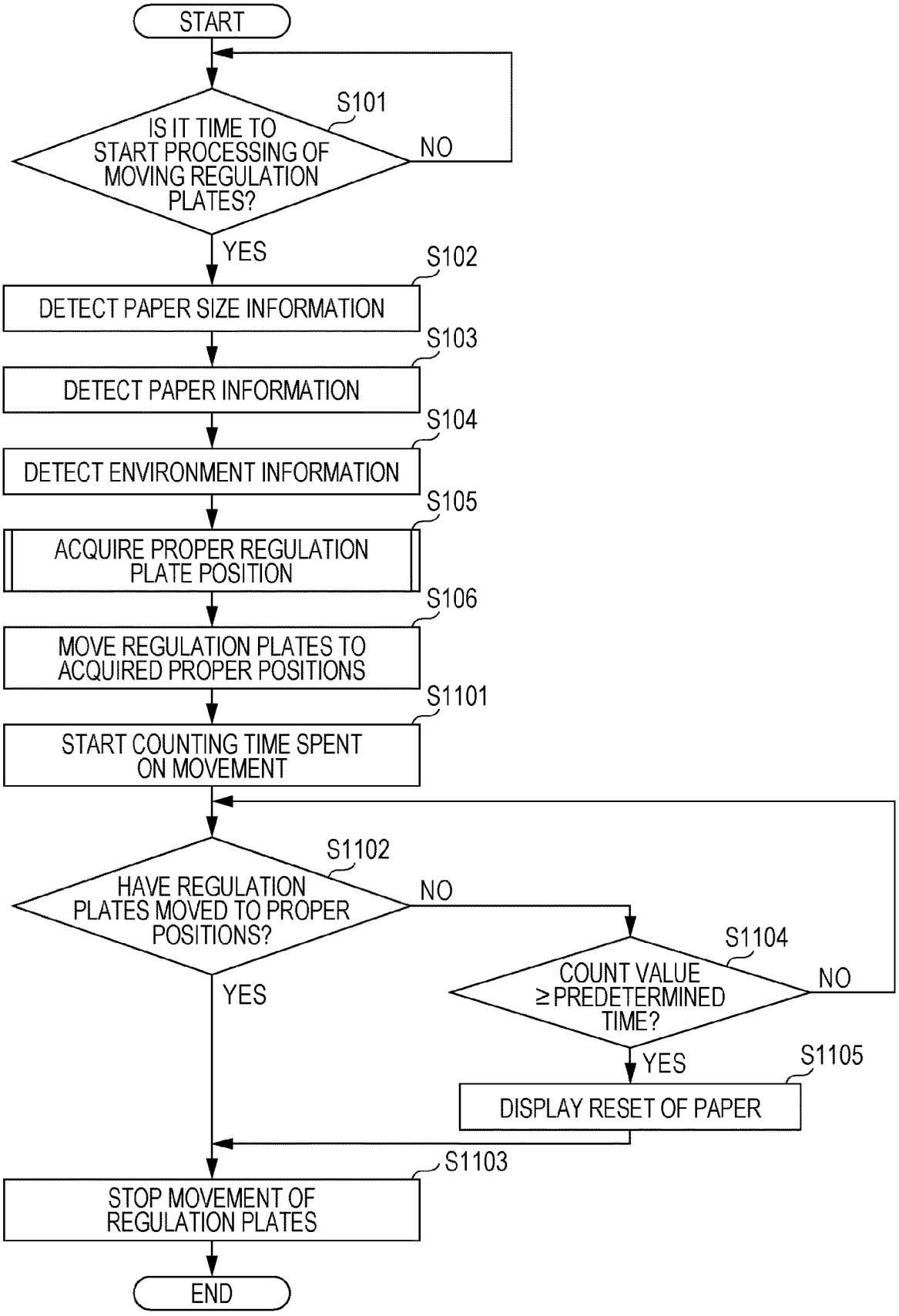
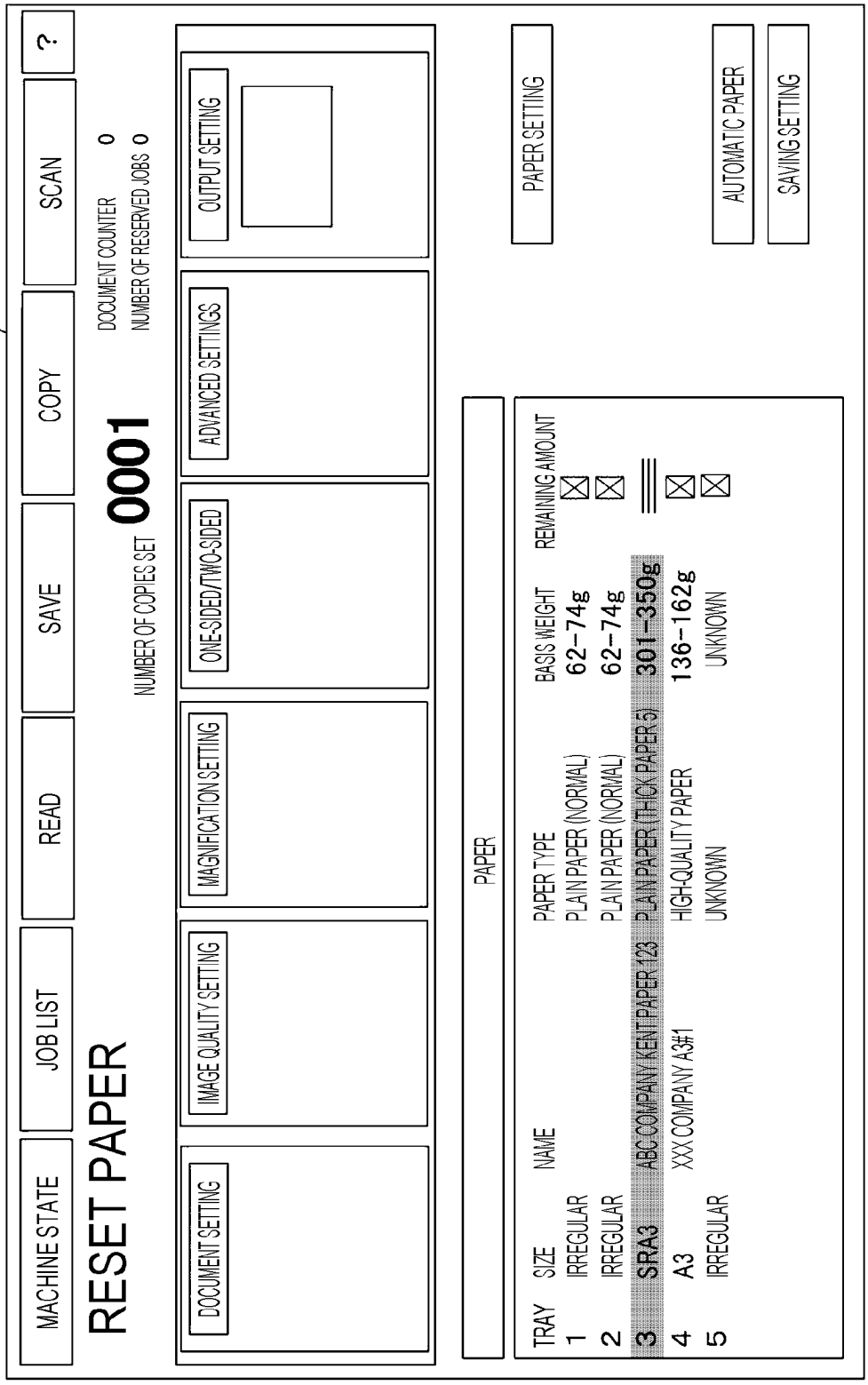

START
S101
IS IT TIME TO START PROCESSING OF MOVING REGULATION PLATES?
NO
YES
S102
DETECT PAPER SIZE INFORMATION
S103
DETECT PAPER INFORMATION
S104
DETECT ENVIRONMENT INFORMATION
S105
ACQUIRE PROPER REGULATION PLATE POSITION
S106
MOVE REGULATION PLATES TO ACQUIRED PROPER POSITIONS
S1101
START COUNTING TIME SPENT ON MOVEMENT
S1102
HAVE REGULATION PLATES MOVED TO PROPER POSITIONS?
NO
YES
S1104
COUNT VALUE ≥ PREDETERMINED TIME?
NO
YES
S1105
DISPLAY RESET OF PAPER
S1103
STOP MOVEMENT OF REGULATION PLATES
END

FIG. 21


341, 34
MACHINE STATE
JOB LIST
READ
SAVE
COPY
SCAN
?
RESET PAPER
NUMBER OF COPIES SET 0001
DOCUMENT COUNTER 0
NUMBER OF RESERVED JOBS 0
DOCUMENT SETTING
IMAGE QUALITY SETTING
MAGNIFICATION SETTING
ONE-SIDED/TWO-SIDED
ADVANCED SETTINGS
OUTPUT SETTING
PAPER
PAPER SETTING
TRAY SIZE NAME PAPER TYPE BASIS WEIGHT REMAINING AMOUNT
1 IRREGULAR PLAIN PAPER (NORMAL) 62–74g
2 IRREGULAR PLAIN PAPER (NORMAL) 62–74g
3 SRA3 ABC COMPANY KENT PAPER 123 PLAIN PAPER (THICK PAPER 3) 301–350g
4 A3 XXX COMPANY A3#1 HIGH-QUALITY PAPER 136–162g
5 IRREGULAR UNKNOWN UNKNOWN
AUTOMATIC PAPER
SAVING SETTING

PAPER FEED DEVICE, IMAGE FORMATION SYSTEM, AND CONTROL PROGRAM FOR PAPER FEED DEVICE

The entire disclosure of Japanese patent Application No. 2021-094950, filed on Jun. 7, 2021, is incorporated herein by reference in its entirety.

BACKGROUND

Technological Field

The present invention relates to a paper feed device, an image formation system, and a control program for the paper feed device.

Description of the Related Art

A paper feed device is used in an image formation device. The paper feed device loads and stores paper on a paper feed tray, feeds the sheets of paper one by one from the loaded stack of paper (referred to as a paper stack), and sends the paper to the image formation device.

The paper feed tray has regulation plates for aligning edges of the loaded paper. The regulation plates are in contact with respective edge surfaces of four sides of the paper to regulate a paper feed direction and a position of an entire paper stack in a direction orthogonal to the paper feed direction (width direction). In order to support various paper sizes, the regulation plates are provided such that an interval between one regulation plate and another facing regulation plate (referred to as an interval between regulation plates) can be changed.

An interval between regulation plates affect paper feed performance. For example, in a case where an interval between regulation plates is narrower than an appropriate range, excessive load may be applied to the paper at a time of paper feed. Accordingly, the paper may be folded or not be fed, or paper may be separated from the paper stack, causing a paper feed failure or conveyance failure (including conveyance stop). Conversely, in a case where the interval between the regulation plates is wider than the appropriate range, the loaded paper may be inclined or a position thereof may be deviated, causing a defective image with image bending, image shift, or the like.

Some among conventional paper feed devices include regulation plates of which operation is motorized. In such a paper feed device, regulation plates are moved in directions of narrowing intervals between regulation plates at a timing when paper is set on a paper feed tray, and the regulation plates are stopped when a drive torque of the regulation plates reaches a predetermined value. Accordingly, the conventional paper feed devices can automatically eliminate a gap between a regulation plate and a paper edge, enabling positioning of regulation plates at positions corresponding to various paper sizes.

Patent Literature 1: JP H11-292305 A

However, there has been a problem that, even if the paper sizes are the same, normal paper feed at the same positions of the regulation plates cannot be achieved depending on a type or state of paper, causing a paper feed failure, a conveyance failure, a defective image, or the like.

SUMMARY

Therefore, an object of the present invention is to provide a paper feed device capable of moving regulation plates to positions suitable for a paper characteristic, an image formation system including the paper feed device, and a control program for the paper feed device.

To achieve the abovementioned object, according to an aspect of the present invention, a paper feed device having regulation plates that are movable on a paper feed tray for loading paper and regulate edges of the paper, reflecting one aspect of the present invention comprises: a driver that moves the regulation plates; and a hardware processor that acquires paper information corresponding to a characteristic of the loaded paper, and causes the driver to move the regulation plates according to the acquired paper information.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinbelow and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention:

FIG. **1** is a schematic configuration diagram of an image formation system;

FIG. **2** is a block diagram of the image formation system;

FIGS. **3**A and **3**B are explanatory diagrams for describing a configuration of a roller-type paper feed tray, in which FIG. **3**A is a side view of the paper feed tray, and FIG. **3**B is a top view of the paper feed tray;

FIG. **4** is a side view for describing an air-conveyance type paper feed tray;

FIG. **5** is a schematic diagram illustrating an internal configuration of the paper feed tray;

FIG. **6** is a screen example of an operation display on which a determination result (paper type/basis weight division) is displayed;

FIG. **7** is a flowchart illustrating a procedure for controlling movement of regulation plates;

FIGS. **8**A and **8**B are flowcharts illustrating procedures for judging a regulation-plate movement processing start timing;

FIG. **9** is an example of a determination table illustrating a correspondence between paper characteristics and proper regulation plate positions;

FIG. **10** is a flowchart illustrating a procedure in step S**105** in FIG. **7**;

FIG. **11** is a diagram illustrating an example of a determination table illustrating a correspondence between paper profiles and proper regulation plate positions;

FIG. **12** is a flowchart illustrating a procedure in step S**105** in an example of acquiring proper positions of the regulation plates from a paper profile;

FIG. **13** is a screen example of an operation display on which an input screen is displayed;

FIG. **14** is a flowchart illustrating a procedure of another example of the regulation-plate movement processing start timing;

FIG. **15** is a flowchart illustrating a procedure for saving a regulation plate position, paper information, and jam occurrence information in association with one another;

FIG. **16** is an example of jam history;

FIG. **17** is a flowchart illustrating a procedure for acquiring jam information in step S**507** in FIG. **15**;

FIG. **18** is a flowchart illustrating a procedure for updating a determination table in step S**509** in FIG. **15**;

FIG. **19** is an explanatory diagram for describing an example of updating the determination table;

FIG. **20** is a flowchart illustrating a procedure for controlling movement of regulation plates in a fifth embodiment; and

FIG. **21** is a screen example of an operation display in which display prompting paper reset is performed.

DETAILED DESCRIPTION OF EMBODIMENTS

Hereinafter, one or more embodiments of the present invention will be described with reference to the drawings. However, the scope of the invention is not limited to the disclosed embodiments. In description of the drawings, the same or corresponding components are denoted by the same reference signs, and redundant description thereof is omitted. In addition, dimension ratios in the drawings are exaggerated for convenience of description, and may be different from actual ratios. In the drawings, a Z direction represents a vertical direction, a Y direction represents a front-surface to back-surface direction of an image formation system, and an X direction represents a direction orthogonal to the Y and Z directions. In the following description, the X direction may be referred to as a conveyance direction (feed direction: FD) of paper, and the Y direction intersecting the conveyance direction may be referred to as a width direction (cross direction: CD) of the paper. In the present embodiment, the "paper" includes print paper and various kinds of film. In particular, the print paper includes paper produced by using plant-derived mechanical pulp and/or chemical pulp. In addition, the paper types include gloss paper (also referred to as coated paper), matte paper, plain paper, high-quality paper, high-gloss paper, and the like.

First Embodiment

A basic embodiment according to the present invention will be described.

(Image Formation System)

FIG. **1** is a schematic configuration diagram of an image formation system **1000**, and FIG. **2** is a block diagram of the image formation system **1000**.

As illustrated in FIG. **1**, the image formation system **1000** includes a paper feed device **20**, an image formation device **30**, a post-processing device **40**, and an external medium detection device **50**. The paper feed device **20**, the image formation device **30**, and the post-processing device **40** are connected in that order along a conveyance direction of paper **90**.

(Paper Feed Device)

As illustrated in FIG. **1**, the paper feed device **20** includes a plurality of paper feed trays **250***a*, **250***b*, and **250***c*. Each of the paper feed trays **250***a*, **250***b*, and **250***c* includes regulation plates that regulate four sides of the loaded paper **90** (also referred to as a paper stack). Hereinafter, the paper feed trays **250***a*, **250***b*, and **250***c* are also referred to as a paper feed tray **250** in a case where they are collectively referred to, or are not distinguished from each other.

The paper feed tray **250***a* is a paper feed tray **250** of a roller-conveyance type that feeds and conveys uppermost sheets of paper **90** in the paper stack one by one by separating rollers.

The paper feed tray **250***b* is a roller-conveyance type paper feed tray **250** having the same configuration as the paper feed tray **250***a*.

The paper feed tray **250***c* is an air-conveyance type paper feed tray **250**, and separates an uppermost sheet of the paper **90** from the paper stack with airflow formed by a fan, and feeds the paper **90** separated by a suction belt having negative pressure inside and a plurality of small holes.

Details of these paper feed trays **250** will be described later. Note that the configuration of the paper feed trays **250** illustrated in FIG. **1** and the like is merely an example, and the paper feed device **20** can include any number of paper feed trays **250** of the roller-conveyance type or the air-conveyance type.

As illustrated in FIG. **2**, the paper feed device **20** includes a controller **21**, a storage **22**, a regulation plate position detector **23**, various sensors S**1** to Sx, a display **24**, the paper feed tray **250**, a conveyor **26**, a temperature/humidity sensor **27**, a driver **28**, and a communicator **29** as a configuration for control.

(Controller)

The controller **21** includes a central processing unit (CPU) and a memory. The CPU is a control circuit including a multi-core processor or the like that controls each of the above-described units or various kinds of arithmetic processing according to a program. Each function of the paper feed device **20** is exerted by the CPU executing a program corresponding thereto. The memory is a main storage device that can be accessed at high speed and, as a work area, temporarily stores a program or data. The memory is, for example, a dynamic random access memory (DRAM), a synchronous dynamic random access memory (SDRAM), a static random access memory (SRAM), or the like. In addition, a read only memory (ROM) is used as a memory for persistent storage of some programs and data.

The controller **21** controls an entire paper feed device **20**. The controller **21** causes the driver **254** to move regulation plates (to be described later) according to paper information acquired by a paper information acquirer **213**. The paper information acquirer **213** cooperates with the medium detection device **50** to acquire paper information corresponding to a characteristic of the paper **90**. Furthermore, the paper information acquirer **213** acquires paper information corresponding to the characteristic of the paper **90** from a paper profile input from an operation display **34** or a paper profile transmitted via the communicator **29**.

The controller **21** functions as a notifier **212** in cooperation with the communicator **29**, the display **24**, the operation display **34**, or the like. The function of the notifier **212** is, for example, display of paper information, display of a jam determination result, error display or warning display for when movement of the regulation plates to positions based on the paper information cannot be completed, or the like. Note that such a notification may be not only displayed, but also emitted as sound by a speaker (not illustrated) or emitted as warning sound.

Note that the controller **21** of the paper feed device **20** may be provided alone in the paper feed device **20**, or a controller (referred to as an image formation controller **31**) of the image formation device **30** may control the paper feed device **20**. In such a case, the image formation controller **31** of the image formation device **30** also serves as the controller **21** of the paper feed device **20**.

The storage **22** is a large-capacity auxiliary storage device that stores various programs including an operating system, and various data. As the storage **22**, for example, a hard disk, a solid-state drive, a flash memory, or the like is adopted. The storage **22** stores a determination table **221** for moving the regulation plates to proper positions, and data of jam history **222** in which jam occurrence information is accumulated.

The various sensors S**1** to Sx include optical sensors (sensors S**2** and S**5** (in FIGS. **3**A, **3**B, and **4** to be described

later)) that detect presence or absence of the paper **90** conveyed in a conveyance path or the like, and sensors (sensors **S1**, **S3**, and **S4** (in FIGS. **3**A, **3**B, and **4** to be described later)) that are combinations of an optical sensor and an actuator. Each of these sensors functions as a jam information acquirer that acquires jam information indicating an occurrence of a jam of the paper **90** at a time of paper feed or paper conveyance.

The display **24** is, for example, an LED or a liquid crystal display, and is provided on an upper portion of a main body of the paper feed device **20** or a front panel of each paper feed trays **250**. For example, in a case where the display **24** includes an LED, color of the LED is changed, or a plurality of LEDs is turned on or off as appropriate, by which the display **24** indicates to a user that positions of the regulation plates fall (or are changed to fall) within an appropriate range, or that the positions of the regulation plates are (or are changed to be) out of the appropriate range. Note that the display **24** may not be provided on the main body of the paper feed device **20**, and, instead, the operation display **34** of the image formation device **30** may also serve as the display **24**.

(Paper Feed Tray)

FIGS. **3**A and **3**B are explanatory diagrams for describing a configuration of the roller-type paper feed tray **250***a*. FIG. **3**A is a side view of the paper feed tray **250***a*, and FIG. **3**B is a top view of the paper feed tray **250***a*. Note that a configuration of the paper feed tray **250***b* is the same as a configuration of the paper feed tray **250***a*, and description thereof is omitted.

As illustrated in FIGS. **3**A and **3**B, the paper feed tray **250***a* includes a placing plate **251** on which a paper stack of the loaded paper **90** is placed, regulation plates **252***a* to **252***d* that regulate four side edges (four sides) of the paper stack on the placing plate **251**, a paper feeder **253**, the driver **254**, a pair of left and right slide rails **255**, and a housing **256**. Hereinafter, the regulation plates **252***a* to **252***d* are also referred to as a regulation plate **252** in a case where they are collectively referred to, or are not distinguished from each other.

The placing plate **251** moves up and down by a lifting mechanism (not illustrated) including a wire, a pulley, a motor, an encoder, or the like, while staying horizontal. The lifting mechanism detects height of the placing plate **251**. A sensor **S1** detects an uppermost sheet of the paper **90** in the paper stack placed on the placing plate **251** reaching a predetermined position. The sensor **S1** turns on when an upper surface of the paper stack reaches a predetermined height. At a time of paper feed, the controller **21** controls the lifting mechanism according to output by the sensor **S1** so that height of the uppermost sheet of the paper **90** in the paper stack is at the predetermined position. The controller **21** may also determine a remaining amount of paper from the height of the placing plate **251**.

The paper feeder **253** includes a pickup roller **2531** and a pair of separating rollers **2532** downstream of the pickup roller **2531**. The separating rollers **2532** convey the paper **90** sent out in the conveyance direction by the pickup roller **2531** to conveyance rollers **261** of the conveyor **26** on a downstream side. A lower roller of the separating rollers **2532** rotates in a direction opposite to a direction in which an upper roller of the separating rollers **2532** rotates within a range of torque equal to or less than a predetermined value by a torque limiter, such that the paper **90** is sent. The lower roller of the separating rollers **2532** has a function to separate a second and lower sheets of the paper **90** from a first uppermost sheet of the paper **90** when the pickup roller **2531** sends out two or more sheets of the paper **90**, thereby preventing double feeding.

Each of the paper feed trays **250** is supported by a pair of left and right slide rails **255** extending in the Y direction so as to be drawable from a main body of the paper feed device **20**. A sensor **S3** detects the paper feed tray **250** being drawn or being loaded in the main body of the paper feed device **20**. In addition, power is supplied to the regulation plate position detector **23** even in a state where the paper feed tray **250** is drawn (a state where the paper feed tray **250** is not completely removed from the main body), and positions of the regulation plates **252** can be detected.

Next, the air-conveyance type paper feed tray **250***c* will be described. FIG. **4** is a side view for describing the air-conveyance type paper feed tray **250***c*.

As illustrated in FIG. **4**, the paper feeder **253** of the paper feed tray **250***c* includes a suction unit **2535**, a leading-edge blower **2536**, and fans **f1**, **f2**, and **f3** as air pressure generators. In the suction unit **2535**, three paper feed belts **35***a* are arranged in parallel in the width direction, and these endless paper feed belts **35***a* are wound around a plurality of rollers connected to a drive motor (not illustrated) and are rotatably supported. The paper feed belts **35***a* are provided with a large number of small-diameter through holes, and a duct **35***b* is disposed inside each of the through holes. A suction port facing the paper feed belts **35***a* is provided below the duct **35***b*, and an inside of each of the paper feed belts **35***a* is subjected to negative pressure by a suction fan **f1**. Air sucked by the suction fan **f1** is exhausted to a back surface side of the device via the duct **35***b*.

The suction fan **f1** always operates during image formation (during paper feed operation), and the suction unit **2535** sucks, with the paper feed belts **35***a*, an uppermost sheet of the paper **90** blown upward from the paper stack by air blowing described later. A sensor **S4** detects, with an ON signal, the paper **90** having been sucked onto a surface of a paper feed belt **35***a*. Therefore, the sensor **S4** is also referred to as a suction sensor. The controller **21** starts the operation of the drive motor in response to the ON signal (paper suction OK) of the sensor **S4**, and rotates the paper feed belts **35***a*. The paper **90** sucked onto the front surface is conveyed to a downstream side (X direction) in a paper conveyance direction according to the rotation, and is fed toward the conveyance path. By a sensor **S5** disposed on the downstream side of the paper feed belts **35***a* outputting the ON signal, a controller **110** judges that the paper **90** is normally conveyed and starts driving the conveyance rollers **261** at a predetermined timing.

Respective blowing fans **f2** disposed on both sides in the width direction blow air for separation from an opening (indicated by a dashed-line rectangle in FIG. **4**) to an upper side surface of the paper stack via a duct integrally formed with the regulation plate **252***d* (**252***b*). Accordingly, at a time of paper feed, the blowing fans **f2** separate an uppermost sheet of the paper **90** from the paper stack and allow the sheet to be easily sucked to the suction unit **2535**. A plurality of sheets of the paper **90** may be blown upward from the paper stack by air blowing through the opening by the blowing fans **f2**. The leading-edge blower **2536** has a function of separating sheets of the paper **90** other than the uppermost sheet sucked onto the paper feed belts **35***a*. Specifically, a blowing fan **0** of the leading-edge blower **2536** blows air toward an upstream side via the opening. Thus, among the plurality of sheets of the paper **90** blown upward, the sheets of the paper **90** other than the uppermost sheet are separated.

(Regulation Plates and Regulation Plate Driver)

FIG. **5** is a schematic diagram illustrating an internal configuration of the paper feed tray **250**. In FIG. **5**, the placing plate **251** and paper **90** are omitted.

Among the regulation plates **252***a* to **252***d*, a regulation plate **252***a* on the downstream side in the conveyance direction is fixedly disposed in the housing **256**. Meanwhile, the regulation plates **252***b* to **252***d* are held so as to be movable with respect to the housing **256** in order to correspond to various paper sizes. In particular, the regulation plates **252***b* to **252***d* are held so as to be movable by the driver **254** with respect to the housing **256**.

A configuration of the regulation plates **252***a* to **252***d* and a configuration of the driver **254** are the same for the roller-type paper feed trays **250***a* and **250***b* and the air-conveyance type paper feed tray **250***c*.

The regulation plates **252***b* and **252***d* to be in contact with both edge surfaces in the width direction of the paper **90** are provided so as to be movable in a direction perpendicular to the paper feed direction, and an interval between the regulation plates can be changed.

The regulation plates **252***b* and **252***d* are a pair of regulation plates, and are held so as to be movable by the driver **254**. The regulation plates **252***b* and **252***d* regulate side edge surfaces (hereinafter referred to as edge surfaces) in the width direction of the paper (paper stack). The driver **254** includes a rack and pinion **257** (which may include another gear mechanism), a motor **258**, and a belt and pulley **259** for transmitting driving force of the motor **258** to a pinion gear **258***a*. The driver **254** moves a pair of regulation plates **252***b* and **252***d* to positions facing each other and away from a central position by the same distance in the width direction. The controller **21** rotates the motor **258** to move the positions of the regulation plates **252***b* and **252***d*.

The user draws the paper feed tray **250***a* from the main body of the paper feed device **20** forward, and then places the paper stack on the placing plate **251**. At this time, the regulation plates **252***b* and **252***d* can be moved to arbitrary positions by the user. In addition, if a paper size has been input in advance before the user draws the paper feed tray **250***a*, the regulation plates **252***b* and **252***d* are moved to positions corresponding thereto according to a command from the controller **21**.

After the paper stack is set, the controller **21** controls the regulation plates **252***b* and **252***d* to further move to maintain an appropriate position of the paper stack. The control of the regulation plates **252***b* and **252***d* after the paper stack setting will be described later.

(Regulation Plate Position Detector)

A regulation plate position detector **231** includes an optical sensor, a mechanical sensor, or the like. For example, in a case of the optical sensor, a line image sensor (or an area image sensor) or the like may be disposed in vicinity of a regulation plate **252** to detect a position of the regulation plate **252**. In a case of the mechanical sensor, a position of a regulation plate **252** can be detected by converting movement of a rack or the like connected to the regulation plate **252** into a rotation amount of a pinion gear or the like.

A gap between inner surfaces of the regulation plates **252***b* and **252***d*, that is, a length L**1** in the width direction (hereinafter, also referred to as a regulation plate position) is detected by detecting a movement position of the regulation plate **252***b* and/or **252***d* in the Y direction (a position where the regulation plate has stopped after the movement). Position information of the detected regulation plates **252***b* and **252***d* is stored in the storage **22**.

Similarly, in the conveyance direction, a regulation plate position detector **232** is provided to detect a position of the regulation plate **252***c*. Position information of the detected regulation plate **252***c* is stored in the storage **22**. Position of the regulation plate **252***c* is manually movable by a position adjustment member **254***x*. The position adjustment member **254***x* includes a gear rack (or a slide bar), a lock groove, and the like. When a gripping member **254***x***0** attached to the position adjustment member **254***x* is pressed by the user, the position adjustment member **254***x* is unlocked to allow the regulation plate **252***c* to move. The user moves the regulation plate **252***c* to a position where the regulation plate **252***c* abuts against a rear edge of the paper stack in the conveyance direction, and then returns the gripping member **254***x***0**, by which the regulation plate **252***c* is fixed to the housing **256**.

Note that the position of the regulation plate **252***c* may not be as exact as the paper width direction regulated by the regulation plates **252***b* and **252***d*. Paper position in the paper conveyance direction (especially, a position of a leading edge of the paper **90**) is positioned by a registration roller or the like in the image formation device **30**. Therefore, the paper position in the conveyance direction in the paper feed device **20** is only required to be regulated to a position that does not interfere with paper feed. Of course, the driver **254** may be provided to move the regulation plate **252***c*, and the regulation plate **252***c* may be moved under control of the controller **21**.

Similarly, the regulation plate position detector **232** includes an optical sensor, a mechanical sensor, or the like, and can detect a gap between inner surfaces of the facing regulation plates **252***a* and **252***c*, that is, a length L**2** in the conveyance direction, by detecting an adjustment position of the regulation plate **252***c* in the X direction.

Resolution (minimum detector) of the regulation plate position detectors **231** and **232** is, for example, 0.1 mm or 0.05 mm.

(Conveyor)

The conveyor **26** includes a plurality of conveyance rollers (conveyance rollers **261** or the like) and a drive motor (not illustrated) disposed on a conveyance path, and conveys the paper **90** fed from each paper feed tray **250** of the paper feed device **20** to the image formation device **30** via the conveyance path in the paper feed device **20**.

(Temperature/Humidity Sensor)

The temperature/humidity sensor **27** is an environment detector. The temperature/humidity sensor **27** detects temperature and humidity outside the paper feed device **20**. The environment detector may be a temperature sensor or a humidity sensor that detects only temperature or only humidity. The environment detector may detect temperature and/or humidity inside the paper feed device **20**.

(Communicator)

The communicator **29** is an interface for communicating with another device such as the image formation device **30**. To and from the image formation device **30** or the like, the communicator **29** transmits and receives various setting values, various types of information necessary for operation timing control, and the like. In addition, the communicator **29** transmits paper information from the image formation device **30** and the medium detection device **50** to the paper information acquirer **213**.

(Image Formation Device **30**)

Refer to FIGS. **1** and **2** again. The image formation device **30** includes the image formation controller **31**, a storage **32**,

an image former **33**, various sensors S**11** to S**1***x*, the operation display **34**, a paper feed tray **350**, a conveyor **36**, and a communicator **39**.

Among these, the image formation controller **31**, the storage **32**, the paper feed tray **350** (paper feeder **353**), the conveyor **36**, and the communicator **39** have configurations corresponding to configurations of the controller **21**, storage **22**, paper feed tray **250***a* (paper feeder **253**), conveyor **26**, and communicator **29** in the above-described paper feed device **20**, respectively. Therefore, description thereof is omitted.

The image former **33** forms an image on the paper **90** conveyed from the paper feed device **20**, or on the paper **90** fed and conveyed from the paper feed tray **350** of the self-device. The image former **33** forms an image on the paper **90** by using a well-known electrophotographic image forming process including each step of, for example, charging, exposure, development, transfer, and fixing.

The sensors S**11** to S**13** disposed on the conveyance path are optical sensors similarly to the sensor S**2**, and detect conveyance of the paper **90**. Note that, in FIG. **1**, only the sensors S**11** to S**13** are displayed as a representative example. In this regard, a greater number of sensors S1*x* may be disposed on the conveyance path. Each of the sensors S**11** to S1*x* detects presence or absence of the paper **90** on the conveyance path at an installed position, and sends a detection result to the image formation controller **31**. In a case where the paper **90** is present or absent at a detection position of each of the sensors S**11** to S1*x* at a predetermined timing, the image formation controller **31** judges that a jam such as a paper feed failure or a conveyance failure has occurred. In the present embodiment, a case where conveyance of paper (image forming operation) is stopped in response to a stop instruction from the user is also regarded as occurrence of a jam (described later).

Jam information indicating occurrence of a jam is transmitted to the controller **21** via the communicator **39** and the communicator **29**, and is stored in the storage **22** as jam history **222**. The jam information is conveyance stop occurrence information, and the storage **22** that stores the jam history **222** serves as an event information storage.

Note that some of the sensors S**1** to S1*x* may include line image sensors, and may continuously detect positions of edges of the conveyed paper **90** to detect skew feeding or deviation of the paper **90**. Skew feeding or deviation of the paper **90** in the image formation device can be detected by using a line image sensor as the sensor S**11**. The line image sensor is, for example, a contact image sensor (CIS) or the like, and is an image sensor that reads a one-dimensional image by arranging photoelectric conversion elements in one line or a plurality of lines.

The operation display **34** includes a touch panel, numeric keys, a start button, a stop button, and the like, and is used to display various information and input various instructions. Via the operation display **34**, the user can input paper information such as a size, type, paper profile of the paper **90** stored in each paper feed tray **250**. The image formation controller **31** stores, in the storage **22**, the paper information input by the user. In the present embodiment, paper information input from the operation display **34** is also used in the controller **21** of the paper feed device **20**. Therefore, in the paper feed device **20**, the operation display **34** serves as an inputter that receives input from the user. In a case where there is a defect in an image formed on the paper **90**, the user inputs stop (halfway stop) of printing (image formation) from the operation display **34**. When such a halfway stop is input, the image formation controller **31** transmits the input of the halfway stop to the controller **21** as an aspect of a jam. The controller **21** having received the notification causes the storage **22** to store the halfway stop as jam history **222**.

In a case of an irregular paper size, the paper size is set by the user inputting the size by using the numeric keys on the operation display **34**. A regular paper size may be similarly input by the user. Alternatively, the image formation controller **31** may automatically set a regular size that matches a combination of lengths in the vertical direction (conveyance direction) and horizontal direction (CD) calculated from the respective positions of the regulation plates **252**, the lengths being detected by the regulation plate position detector **23**.

(Post-Processing Device)

The post-processing device **40** includes a post-processor, the conveyance path, and a paper ejection tray. The post-processor performs processing such as stapling processing, cutting processing, or punching processing (punched hole) on the paper **90** conveyed from the image formation device **30**. In addition to the components described above, the post-processing device **40** includes a controller, a storage, and a communicator (all not illustrated) that are connected to one another via a signal line, such as a bus, for exchanging signals.

(Medium Detection Device)

The medium detection device **50** is a paper information detector. The medium detection device **50** detects paper information corresponding to a characteristic of the paper **90** in cooperation with the paper information acquirer **213**. The paper information is, for example, at least one characteristic selected from among groups of paper type of the paper **90**, basis weight of the paper **90**, moisture content of the paper **90**, charging rate of the paper **90**, and smoothness of the paper **90**. Therefore, the medium detection device **50** includes a paper thickness detector, a basis weight detector, a surface property detector, and a moisture content detector (all not illustrated). In the medium detection device **50**, the paper **90** is inserted into a paper passing area of the device, and a characteristic of the paper **90** is detected. The detected characteristic of the paper **90** is transmitted to the controller **21** as paper information.

In the example illustrated in FIG. **1**, in the paper feed device **20**, the medium detection device **50** is disposed above a position of the loaded paper **90**. However, disposition of the medium detection device **50** is not limited thereto, and for example, the medium detection device **50** may be a built-in type device configured to use the conveyance path of the image formation device **30** as a measurement area. Alternatively, the medium detection device **50** may be an external device disposed separately from the paper feed device **20**.

The paper thickness detector includes a pair of conveyance rollers and a measure. At least either one of the conveyance rollers is movable according to thickness of the paper **90** passing through a nip. The measure measures a distance between shafts of the pair of the conveyance rollers. The measure includes, for example, an actuator, an encoder, and a light emitter/receiver. The paper thickness detector stores a result of measuring thickness of the paper **90** (measurement value 1) in the storage **22**.

The basis weight detector is a sensor that detects basis weight of the paper **90**, includes a light emitter and a light receiver, and measures the basis weight according to an amount of attenuation of light transmitted through the paper **90**. For example, the light emitter of the basis weight sensor is disposed below the paper passing area (paper passage) into which the paper **90** is inserted, and the light receiver of

the basis weight sensor is disposed above the paper passing area. The basis weight sensor detects the basis weight of the paper **90** with intensity of light received by the light receiver when the paper **90** is caused to pass between the light emitter and the light receiver, and stores a measurement result (measurement value 2) in the storage **22**.

The surface property detector includes a housing, a light emitter, a collimator lens, and a plurality of light receivers, and optically detects regular reflection light and diffuse reflection light from a paper surface as described below. A guide plate above the paper passing area is provided with an opening (measurement area), and the opening serves as an irradiation area of the light receiver. The paper **90** inserted up to the opening is pressed by a pressing mechanism lifted from below the paper passing area. In this state, irradiation light made substantially parallel by the collimator lens is emitted from the light emitter at an incident angle of 75° with respect to a reference plane. A wavelength of the irradiation light is, for example, 465 nm. The plurality of light receivers receives regular reflection light and diffuse reflection light. For example, the light receivers are disposed at three places at a reflection angle of 30 degrees (for diffuse reflection light), 60 degrees (for diffuse reflection light), and 75 degrees (for regular reflection light), or two places at 60 degrees and 75 degrees. The surface property detector stores a signal of the light receiver in the storage **22** as a result of measuring the paper characteristic (measurement value 3).

The moisture content detector includes, for example, a near-infrared light type moisture content sensor that optically detects a light absorption amount of an OH group. The moisture content sensor utilizes a property of an absorption rate of light that changes according to a moisture content of the paper **90** on which light of a predetermined wavelength in the near-infrared region is emitted. In addition, as another example of the measurement of the moisture content, the moisture content may be measured by irradiating the paper **90** with light separated by a deflection filter and measuring change in a light amount of a reflection light component from inside of the paper **90**. The moisture content detector stores, for example, the moisture content in the storage **22** as a result of measuring the paper characteristic.

The paper type and the basis weight are discriminated basically by using the result of paper characteristic measurement by the medium detection device **50** as described below. Alternatively, the user may manually input a paper type or basis weight through the operation display **34** or the like. In this case, the user can refer to and input information described on a package of the paper **90**, for example.

The storage **32** of the image formation device **30** stores a model pre-trained by machine learning. The pre-trained model is used for paper type discrimination. This is a pre-trained model generated by supervised learning using training data, in which detection output of the paper **90** by the medium detection device **50** is an input value, and paper type information set by the user of the paper **90** is a ground truth label. For example, a paper type score of the paper type selected by the user is set to 1 (100%), and a paper type score of the paper type other than ground truth is set to 0 (0%).

The image formation controller **31** of the image formation device **30** obtains a basis weight conversion value, a paper thickness conversion value, and a surface property measurement value by using measurement results (measurement values 1 to 3) obtained by measuring the paper **90** by the paper thickness detector, basis weight detector, and surface property detector of the medium detection device **50**.

As the basis weight conversion value, a basis weight and a basis weight difference (basis weight index value) are calculated from values of a first basis weight and a second basis weight with a coefficient and a calculation formula. The coefficient is determined by a surface property measurement value of the measurement value 3 and surrounding environment information (temperature, humidity (detected by the temperature/humidity sensor **27**, for example)) of the image formation system **1000**. Here, basis weight difference=first basis weight−second basis weight. The basis weight detector includes a plurality of LEDs that emits irradiation light having different wavelengths. The first basis weight is obtained by using a first LED that outputs irradiation light having a wavelength of 750 nm to 900 nm, and by determining transmission amount of the irradiation light transmitted through the paper **90**. The second basis weight is obtained by using a second LED that outputs irradiation light having a wavelength of 400 nm to 470 nm, and by determining transmission amount of the irradiation light transmitted through the paper **90**.

Regarding the paper type discrimination, the surface property measurement value, the basis weight difference, and density (=basis weight/paper thickness) are input by using a pre-trained model, and a "paper type score" of each candidate paper type is obtained as an output.

Basis weight division probability is calculated from the basis weight calculated as a basis weight conversion value. Examples of the basis weight divisions include the following five divisions. Note that the number of divisions and the range are merely examples, and more divisions, for example, 12 divisions in a range of less than 60 to 351 or more, may be used.

Less than 59 g/m^2,
60 g/m^2 to 90 g/m^2,
91 g/m^2 to 209 g/m^2,
210 g/m^2 to 256 g/m^2,
257 g/m^2 or more

Assuming that the calculated basis weight varies with a predetermined standard deviation according to normal distribution, a probability (basis weight division probability) that calculated basis weight is included in each division is determined. For example, when the calculated basis weight is close to a mean of any of the divisions, probability that the basis weight obtained by measurement is included in the division is high and close to 100%. Meanwhile, the farther from the mean of the division, that is, the closer to a boundary of the division, the lower the probability. The basis weight division probability is output as a "basis weight division score".

The image formation controller **31** displays one or a plurality of candidates of paper type/basis weight in descending order of probability according to the basis weight division score and the paper type score, and presents the candidates to the user. FIG. **6** is a screen example of an operation display on which a determination result (paper type/basis weight division) is displayed.

As illustrated in FIG. **6**, on an operation screen **340** of the operation display **34**, two candidates of the paper type/basis weight are displayed in descending order of the score of the paper type/basis weight division as the determination result. When accepting the determination result in a field **81** (plain paper/basis weight **301** to **350**) as a first candidate, the user operates a button **84** to apply the determination result in the selected field **81** to a tray **3** (paper feed tray **250***a*). The applied determination result is stored in the storage **32**. Note that, in a case where the determination result is related to the paper feed tray **250** of the paper feed device **20**, the determination result may also be stored in the storage **22**. In a case where a field **82** (coated paper/basis weight **301** to

350) as a second candidate is applied, the user selects the field **82** and then operates the button **84**. Meanwhile, in a case where it is desired to apply the selected determination result to a plurality of paper feed trays **250** such as the trays **3** and **4**, the user operates a button **85** after selecting the plurality of paper feed trays **250**. Furthermore, the user can discard the determination result by operating a cancel button **83**, without adopting the determination result. The determination result selected by the user may be accumulated in a cloud server or the like as ground-truth data and utilized as training data for subsequent machine learning.

(Position Control for Regulation Plates)

Next, position control for the regulation plates will be described. FIG. **7** is a flowchart illustrating a procedure for controlling movement of the regulation plates. The position control for the regulation plates is performed by the controller **21** of the paper feed device **20** executing a program created according to the procedure described here. Here, the regulation plates **252***b* and **252***d* are controlled to proper positions according to a characteristic of the paper **90**.

First, the controller **21** judges whether or not it is time to start processing of moving the regulation plates **252***b* and **252***d* (S**101**).

FIGS. **8**A and **8**B are flowcharts illustrating a procedure for judging a timing of starting processing of movement of the regulation plates **252***b* and **252***d*. As illustrated in FIG. **8**A, for example, the controller **21** judges whether or not the paper **90** (paper stack) has been loaded in the paper feed tray **250** (S**1011**). Here, if the paper **90** is not loaded (S**1011**: NO), the controller **21** waits for the paper **90** to be loaded. Then, if the paper **90** is loaded (S**1011**: YES), the controller **21** judges that it is time to start processing of moving the regulation plates **252***b* and **252***d* (S**1015**). The judgment in step S**1011** may be made not only at a time when the paper stack is loaded in the paper feed tray **250**, but also at a time when the paper feed tray **250** removed from the paper feed device **20** is loaded again into the paper feed device **20**.

As illustrated in FIG. **8**B, for example, the controller **21** judges whether or not paper information of the paper stack loaded in the paper feed tray **250** has been detected (S**1012**). Then, if the paper information has been detected (S**1012**: YES), the controller **21** judges that it is time to start processing of moving the regulation plates **252***b* and **252***d* (S**1015**). Note that, in a case of S**1012**, it is assumed that step of paper information detection (S**103**) described later is performed first. The paper information detection includes input of paper information from the operation display **34**.

According to judgment of the timing of starting processing of movement of the regulation plates **252***b* and **252***d* described above, when it is time to start movement of the regulation plates **252***b* and **252***d* (S**101**: YES), the controller **21** acquires size information of the loaded paper **90** (S**102**). Size information is input from the screen of the operation display **34**. Note that the size information may be acquired from the medium detection device **50**, or may be acquired from a width direction length L**1** when the regulation plates **252***b* and **252***d* are moved (described later).

Subsequently, the controller **21** acquires paper information (S**103**). The paper information is a characteristic of the paper **90** detected by the medium detection device **50**, and specifically, for example, a type, basis weight, moisture content, charging rate (amount of static electricity), smoothness of paper edge surfaces, or the like of the paper **90**. Note that the paper information may be input from the screen of the operation display **34**. In addition, the paper information may be stored in a server (computer) or the like, and may be acquired therefrom via the communicator **29**.

Subsequently, the controller **21** acquires environment information (S**104**). The environment information is acquired by the temperature/humidity sensor **27**. In the present embodiment, humidity outside the paper feed device **20** (outside the housing) is detected as environment information on three scales of humidity that are high humidity (H), medium humidity (M), and low humidity (L). However, the environment information may be not only humidity but also temperature or both temperature and humidity. Further, the environment information may be not only humidity outside the paper feed device **20**, but also temperature and/or humidity inside the paper feed device **20**.

Subsequently, on the basis of the acquired paper size, paper information, and environment information, the controller **21** acquires proper positions of the regulation plates **252***b* and **252***d* from the determination table **221** stored in advance in the storage **22** (S**105**).

Subsequently, the controller **21** causes the regulation plates **252***b* and **252***d* to move to the acquired proper positions of the regulation plates **252***b* and **252***d* (S**106**).

(Determination Table)

FIG. **9** is an example of a determination table illustrating a correspondence between characteristics of the paper **90** and proper regulation plate positions. The determination table **221** illustrated in FIG. **9** describes proper positions of the regulation plates **252***b* and **252***d* in the CD direction corresponding to paper characteristics such as paper size, type (paper type) of the paper **90**, basis weight, and humidity. Note that FIG. **9** illustrates only standard paper sizes as paper sizes. However, the paper size is not limited to a regular size, and may be an irregular size or the like.

(Step S**105**)

Next, a detailed procedure in step S**105** will be described. FIG. **10** is a flowchart illustrating a procedure in step S**105** in FIG. **7**. Described here is a case as an example where the paper **90** of paper size "SRA3 (320×450 mm)", paper type "plain paper (thicker than thick paper 4)", and basis weight "257-g/m^2" (257 g/m^2 or more) is loaded, and an environmental condition falls within humidity "M".

First, the controller **21** searches the determination table **221** (Refer to FIG. **9**. Hereinafter the same.) for an item corresponding to a condition that matches the paper size (S**201**). If there is a matching paper size in the determination table **221** as a result of the search, the controller **21** temporarily stores the item. In a specific example, the matching paper size "SRA3" is temporarily stored.

Subsequently, the controller **21** searches the determination table **221** for an item corresponding to a condition that matches the paper type (Type of the paper **90**. Herein after the same.) (S**202**). If there is a matching paper type in the determination table **221** as a result of the search, the controller **21** temporarily stores the item. In a specific example, the matching paper type "plain paper (thicker than thick paper 4)" is temporarily stored.

Subsequently, the controller **21** searches the determination table **221** for an item corresponding to a condition that matches the basis weight (S**203**). If there is a matching basis weight in the determination table **221** as a result of the search, the controller **21** temporarily stores the item. In a specific example, the matching basis weight "257-g/m^2" is temporarily stored.

Subsequently, the controller **21** searches the determination table **221** for an item corresponding to a condition that matches the humidity (S**204**). If there is a matching humidity in the determination table **221** as a result of the search, the controller **21** temporarily stores the item. In a specific example, the matching humidity "M" is temporarily stored.

Subsequently, the controller **21** judges whether or not there is a matching condition in the temporary storage (S**205**). Here, if there is a matching condition (S**205**: YES), the controller **21** acquires proper positions of the regulation plates **252***b* and **252***d* for an item corresponding to the matching condition in the determination table **221** (S**206**). In a specific example, "451.5 mm", which is the proper regulation plate position that matches each of the conditions described above, is acquired from the determination table **221**.

Meanwhile, if there is no matching condition (S**205**: NO), the controller **21** acquires the proper regulation plate position corresponding to the paper size (S**210**). Note that proper regulation plate positions according to paper sizes are stored not in the determination table **221** but in the storage **22** as standard interval (proper positions) of the regulation plates for the respective paper sizes. (The proper regulation plate positions according to paper sizes may be described in the determination table **221** as standard values.) For example, in a case where a proper regulation plate position cannot be acquired from the determination table **221**, if the paper size is SRA3, the paper size in the CD direction is 450.0 mm, which is designated and acquired as the proper position.

Subsequently, the controller **21** judges whether or not the moisture content is at a predetermined value or more (S**207**). Here, if the moisture content is at the predetermined value or more (S**207**: YES), the controller **21** adds 0.3 mm to the proper regulation plate position acquired in S**206** or S**210**. Thereafter, the controller **21** brings forward the processing to S**106** (return). If the moisture content is not at the predetermined value or more (S**207**: NO), the controller **21** brings forward the processing as is to S**106** (return). Specifically, for example, assuming that the predetermined value of the moisture content is 8%, if the detected moisture content is 8% or more, the controller **21** adds 0.3 mm to the proper regulation plate position. If the detected moisture content is less than 8%, the controller **21** sets the proper regulation plate position as is.

Note that the value to be added according to the moisture content may not be 0.3 mm, and moisture content and a corresponding addition value may be described in detail in the determination table **221** (or in a dedicated table). For example, every time the moisture content increases by 3%, the proper regulation plate position is increased by 0.1 mm, or the like.

In step S**208**, the proper regulation plate position is changed according to moisture content of the paper **90**. However, the embodiment is not limited thereto. In addition to moisture content of the paper **90**, characteristics that can be detected from the paper **90** by the medium detection device **50** can be utilized for changing the proper position. Specifically, examples of the characteristics include charging amount of the paper **90**, Bekk smoothness of the paper edge surfaces of the paper, and the like. Specifically, for example, in a case where a surface of the paper has an electric resistance of $10^{13}\Omega$ or more, the proper regulation plate position is increased by 0.3 mm. For example, in a case where the Bekk smoothness is 200 seconds or less, the proper regulation plate position is increased by 0.3 mm. Of course, these values can be arbitrarily set.

In the present embodiment, the proper regulation plate position in the CD direction is defined in advance in the determination table **221**. This is because the positions of the regulation plates **252***b* and **252***d* in the CD direction are more likely to cause a defect during image formation than the position of the regulation plate **252***c* in the FD direction is. However, not limited to the CD direction, proper positions of the regulation plates in the FD direction may also be defined in advance in the determination table **221**.

As described above, according to the first embodiment, proper positions of the regulation plates **252***b* and **252***d* are obtained from the determination table **221** on the basis of characteristics of the paper **90** detected by using the medium detection device **50**, and the regulation plates **252***b* and **252***d* are moved to the proper positions. Accordingly, according to the present embodiment, it is possible to reduce chances of occurrence of a paper jam caused by inappropriate positions of the regulation plates **252***b* and **252***d*.

Second Embodiment

A second embodiment is an example of acquiring proper positions of regulation plates **252***b* and **252***d* from a paper profile. A device configuration of an image formation system **1000** and the like is similar to the device configuration in the first embodiment. A procedure for moving regulation plates **252***b* and **252***d* is similar to the procedure for moving the regulation plates **252***b* and **252***d* in the first embodiment except for processing of acquiring proper positions of the regulation plates **252***b* and **252***d* from a paper profile.

FIG. **11** is a diagram illustrating an example of a determination table **221** illustrating a correspondence between paper profiles and proper regulation plate positions. In the determination table **221** illustrated in FIG. **11**, a paper name (product name) is used as a paper profile, and a proper regulation plate position in a CD direction is determined corresponding to the paper name.

FIG. **12** is a flowchart illustrating a procedure in step S**105** in an example of acquiring proper positions of the regulation plates from a paper profile. Note that, in the following description, the same processing as processing in the flowchart illustrated in FIG. **10** is denoted by the same step number (S number), and description of a part of the processing is omitted. Described here is a specific example of a case where paper **90** having a paper name "ABC company Kent paper **123**" is loaded, and an environmental condition is humidity "M".

First, a controller **21** searches the determination table **221** (Refer to FIG. **11**. Hereinafter the same.) for an item corresponding to a condition that matches the paper size (S**201**). A search result is temporarily stored.

Subsequently, the controller **21** searches the determination table **221** for an item corresponding to a condition that matches the paper name (paper profile) (S**302**). If there is a matching paper name in the determination table **221** as a result of the search, the controller **21** temporarily stores the item. In the specific example, the matching paper name "ABC company Kent paper **123**" is temporarily stored.

Here, the paper name as the paper profile is input from an operation display **34**. Therefore, the operation display **34** serves as a paper profile inputter. FIG. **13** is a screen example of the operation display **34** on which an input screen is displayed.

As illustrated in FIG. **13**, a screen for inputting a paper name is displayed on an operation screen **341** of the operation display **34**. The operation screen **341** displays paper names of a plurality of paper profiles stored in advance, and a user can select a paper name from among the paper profiles. In this screen example, the paper name "ABC company Kent paper **123**" is selected. In addition to the paper name, a stored paper profile is, for example, at least one of paper type, paper size, basis weight, image formation condition for paper, and the like of the paper **90**. The image formation condition for paper is, for example, charging

potential of a photoreceptor, a development condition, an exposure condition, a transfer condition, or the like defined for each paper type. Although not illustrated, smoothness of edge surfaces of the paper **90** may be described in the paper profile. Furthermore, the paper type, paper size, basis weight, image formation condition for paper, and the like of the paper **90** may be not only input as a paper profile but also input from the operation display **34** separately from the paper profile. In this case, the operation display **34** serves as an inputter (paper type inputter) that receives input thereof.

Subsequently, the controller **21** searches the determination table **221** for an item corresponding to a condition that matches the humidity (S**204**). A search result is temporarily stored. In a specific example, the matching humidity "M" is temporarily stored.

Subsequently, the controller **21** judges whether or not there is a matching condition in the temporary storage (S**205**). Here, if there is a matching condition (S**205**: YES), the controller **21** acquires a proper regulation plate position for an item corresponding to the matching condition in the determination table **221** (S**206**). In a specific example, "451.5 mm", which is the proper regulation plate position that matches each of the conditions described above, is acquired from the determination table **221**.

Meanwhile, if there is no matching condition (S**205**: NO), the controller **21** acquires the proper regulation plate position corresponding to the paper size (S**210**). Note that proper regulation plate positions according to paper sizes are stored not in the determination table **221** but in the storage **22** as standard interval (proper positions) of the regulation plates for the respective paper sizes. (The proper regulation plate positions according to paper sizes may be described in the determination table **221** as standard values.) For example, in a case where a proper regulation plate position cannot be acquired from the determination table **221**, if the paper size is SRA3, the paper size in the CD direction is 450.0 mm, which is acquired as the proper position.

Thereafter, the controller **21** brings forward the processing to S**106** (return).

Thus, by acquiring a proper regulation plate position from paper profiles stored in advance, it is possible to obtain a proper regulation plate position corresponding to a paper profile without using the medium detection device **50**.

In the second embodiment, the regulation plates **252***b* and **252***d* are moved according to a paper profile stored in advance. Further, the medium detection device **50** may detect a characteristic of the paper **90**. In a case where a characteristic of the paper **90** is detected by the medium detection device **50**, the stored paper profile may be updated according to the detected paper characteristic, or the proper regulation plate position may be acquired by utilizing the detected paper characteristic as in the first embodiment to move the regulation plates.

In the second embodiment also, a proper regulation plate position in an FD direction may be defined in advance in the determination table **221**.

Third Embodiment

A third embodiment is another example in which regulation-plate movement processing start timing is obtained in step S**101** already described. According to the third embodiment, regulation-plate movement processing start timing is judged by pressure applied to regulation plates. A device configuration of an image formation system **1000** and the like is similar to the device configuration in the first embodiment. A procedure for moving regulation plates is similar to the procedure for moving the regulation plates in the first or second embodiment except for processing for regulation-plate movement processing start timing.

FIG. **14** is a flowchart illustrating a procedure of another example of the regulation-plate movement processing start timing.

First, a controller **21** judges whether or not paper **90** (paper stack) has been loaded in a paper feed tray **250** (S**401**). Here, if the paper **90** is not loaded (S**401**: NO), the controller **21** waits for the paper **90** to be loaded.

At this time, regulation plates **252***b* and **252***d* are opened so as to have a width that allows maximum-size paper **90** to be loaded.

Then, if the paper **90** is loaded (S**401**: YES), the controller **21** starts movement of the regulation plates (S**402**).

Subsequently, the controller **21** judges whether or not pressure applied to the regulation plates **252***b* and **252***d* is at a predetermined value or more (S**403**). Here, if the pressure applied to the regulation plates **252***b* and **252***d* is less than the predetermined value (S**403**: NO), the controller **21** waits until the pressure exceeds the predetermined value. The pressure applied to the regulation plates **252***b* and **252***d* is obtained, for example, by measuring torque of a motor of a driver **254**. In addition, a pressure gauge may be attached to each of the regulation plates **252***b* and **252***d* on a side in contact with a paper edge surface to measure pressure applied to the regulation plates **252***b* and **252***d*. Pressure values obtained by these measurement methods vary depending on the measurement method. Therefore, a predetermined value may be determined by measuring pressure of when the regulation plates **252***b* and **252***d* are brought into contact with paper edge surfaces according to the measurement method.

If the pressure applied to the regulation plates exceeds the predetermined value (S**403**: YES), the controller **21** stops the movement of the regulation plates (S**404**). Accordingly, the regulation plates **252***b* and **252***d* stop while being in contact with the edge surfaces in the width direction of the paper **90**.

Thereafter, the controller **21** assumes that YES is selected in step S**101** in the flowchart illustrated in FIG. **7**, and proceeds to processing in S**102** (S**405**). Thereafter, as described above, the controller **21** moves the regulation plates to proper positions by executing the processing in and after S**201**.

Thus, according to the third embodiment, the regulation plates **252***b* and **252***d* are first brought into contact with the edge surfaces of the paper **90** with a certain degree of force, and then moved to proper positions. Therefore, according to the third embodiment, it is possible to move the regulation plates **252***b* and **252***d* to proper positions even when the paper **90** of an unknown size is loaded or when a paper size is not input.

Fourth Embodiment

According to a fourth embodiment, a regulation plate position, paper information, and jam occurrence information are saved in association with one another. A device configuration of an image formation system **1000** is similar to the device configuration in the first embodiment. A procedure for moving the regulation plates is similar to the procedure for moving the regulation plates in any one of the first to third embodiments.

FIG. **15** is a flowchart illustrating a procedure for saving a regulation plate position, paper information, and jam occurrence information in association with one another. This

procedure is performed by a controller **21** and an image formation controller **31** in cooperation with each other. Note that, in a case where the image formation controller **31** also functions as the controller **21** of the paper feed device **20**, processing is performed by the image formation controller alone. In addition, this processing procedure is processing performed after paper **90** (paper stack) is set in a paper feed device **20** and the regulation plates are moved to proper positions.

First, print start input from an operation display **34** causes the image formation controller **31** to start image formation (S**501**).

Subsequently, the image formation controller **31** judges whether or not printing is finished (S**502**). The finish of printing is judged on the basis of, for example, whether or not a last sheet in a job has been ejected and printing operation by an image formation device **30** has stopped. Here, if the printing is finished (S**502**: YES), the image formation controller **31** ends the processing.

Meanwhile, if the printing is not finished (S**502**: NO), the image formation controller **31** subsequently judges whether or not a jam has occurred during printing (S**503**). The jam occurrence is determined on the basis of whether or not the paper **90** has reached each of sensors S**2** and S**11** to S**13**. In the present embodiment, a stop instruction by a user is also regarded as a jam occurrence. If a jam has not occurred (S**503**: NO), the processing returns to S**502**, and the image formation controller **31** continues the printing operation.

Meanwhile, if occurrence of a jam is detected during printing (S**503**: YES), the image formation controller **31** transmits the occurrence of the jam to the controller **21**, and the controller **21** detects a position of the regulation plate **252** at that time from a regulation plate position detector **23** (S**504**).

Subsequently, the controller **21** acquires paper information (S**505**). The paper information acquired here is paper information detected by a medium detection device **50** (first embodiment), paper information stored as a paper profile (second embodiment), or the like, and is read from a storage **22** and acquired. In particular, here, a paper type and basis weight are acquired.

Subsequently, the controller **21** acquires environment information (S**506**). The environment information acquired here is humidity at this time.

Subsequently, the controller **21** acquires jam information (S**507**). A procedure for acquiring jam information will be described later.

Subsequently, the controller **21** updates jam history **222** (S**508**). FIG. **16** is a diagram illustrating an example of the jam history **222**.

As illustrated in FIG. **16**, the jam history **222** is table data in which a paper size, paper type, and basis weight of the paper **90**, humidity, regulation plate position, the number of occurrences of A jam, and the number of occurrences of B jam are associated with one another. When a jam occurs, the controller **21** increments and updates a numerical value of the number of occurrences of A jam or the number of occurrences of B jam as the jam history **222**.

The A jam is a jam in which conveyance of the paper **90** is stopped during feeding of the paper **90**. For example, in a case where the paper **90** does not reach the sensors S**2** and S**11** to S**13** in the paper feed device **20** and in the image formation device **30**, it is determined that an A jam has occurred. Specifically, for example, this is a case where the paper **90** does not reach a sensor (S**2** in FIG. **3**A), which detects the paper **90** first after the paper **90** is started to be fed and conveyed from the paper feed tray **250**. Thus, a jam in which paper feed itself is not performed is referred to as an unfed paper jam. Such an A jam corresponds to first jam information caused by regulation plate positions being narrower than an appropriate range.

The B jam is a jam in which a defect occurs in image formation due to the paper **90** being conveyed at an angle, or the like, and printing is stopped. Such a B jam corresponds to second jam information caused by regulation plate positions being wider than an appropriate range.

As an example, in JAM 1 illustrated in FIG. **16**, paper size=SRA3, paper type=plain paper (thicker than thick paper 4), basis weight=257 g/m^2 or more, humidity=H, regulation plate position=451.2, and the current number of occurrences of A jam is 2. When an A jam further occurs in the paper **90**, the controller **21** increments the number of occurrences of A jam to 3 and updates storage of the jam history **222**. Similarly, in JAM 2, paper size=SRA3, paper type=plain paper (thicker than thick paper 4), basis weight=257 g/m^2 or more, humidity=M, regulation plate position=451.5, and the current number of occurrences of B jam is 2. When a B jam further occurs in the paper **90**, the controller **21** increments the number of occurrences of B jam to 3 and updates storage of the jam history **222**.

Subsequently, the controller **21** updates a determination table **221** for determining a proper regulation plate position on the basis of the updated jam history **222** (S**509**).

Thereafter, when the paper **90** is loaded in the paper feed device **20**, regulation plates **252***b* and **252***d* are moved to proper positions according to any one of the first to third embodiments in accordance with the updated determination table **221**.

FIG. **17** is a flowchart illustrating a procedure for acquiring jam information in step S**507**.

First, the controller **21** judges whether or not the jam that has occurred in S**503** is an A jam (unfed paper jam) (S**601**). In a case where the jam that has occurred is an A jam (S**601**: YES), the controller **21** stores the occurrence of the A jam to the paper **90** as the jam history **222** (S**602**).

Meanwhile, in a case where the jam that has occurred is not an A jam (S**601**: NO), the controller **21** judges whether or not the jam is an unsucked paper jam (S**603**). After paper feed is started, a sensor S**4** (refer to FIG. **4**) determines whether or not the paper **90** in a paper feed tray **250***c* is sucked up by a suction fan, raised, and sucked onto a paper feed belt. When there is no ON signal (paper suction OK) from the sensor S**4**, the controller **21** judges that an unsucked paper jam has occurred (S**603**: YES). An unsucked paper jam is also one of the A jams in which paper is not fed and conveyed. Therefore, the controller **21** stores the occurrence of the A jam to the paper **90** as the jam history **222** (S**602**).

If the jam is not an unsucked paper jam (S**603**: NO), the controller **21** determines whether or not the jam that has occurred is a deviated paper jam (S**604**). A deviated paper jam is not a jam due to a paper jam, and is detected by a deviation detection sensor installed at a predetermined position on a paper conveyance path. As described in the first embodiment, for example, a line image sensor is configured as a sensor S**11** and is used as a deviation sensor. If deviation of a predetermined amount or more occurs with the paper **90** under conveyance on which an image is formed, the image cannot be correctly formed (deviation of the image cannot be completely corrected). Therefore, the user determines that a defective image is generated and stops the printing operation. In a case of a deviated paper jam (in a case of detection by the deviation sensor and an image formation

stop instruction) (S604: YES), the controller **21** stores the occurrence of the B jam to the paper **90** as the jam history **222** (S605).

If the jam is not a deviated paper jam (S604: NO), the controller **21** determines whether or not the jam that has occurred is a bent paper jam (S606). Similarly to a deviated paper jam, a bent paper jam also causes image formation defect. Bent paper can also be detected by detecting a paper width and length by using the sensor S11 as a line image sensor. For example, the controller **21** detects a paper width and a paper length from an image obtained by the sensor S11, and, if the paper **90** is smaller than a regulation size, determines (or the image formation controller **31** may determine) this state to be a bent paper jam. In a case where the jam that has occurred is a bent paper jam (S606: YES), the controller **21** stores the occurrence of a B jam to the paper **90** as the jam history **222** (S605).

If the jam is not a bent paper jam (S606: NO), the controller **21** does not store the occurrence of the jam (S607). This is processing for not leaving jams unclassified in S601 to S606 in the jam history **222**.

FIG. **18** is a flowchart illustrating a procedure for updating the determination table **221** in step S509.

First, the controller **21** judges whether or not the number of jams stored in step S508 is a predetermined number of times or more (S701). Here, if the number of jams is less than the predetermined number of times (S701: NO), the controller **21** returns to an original state (refer to FIG. **15**), and the processing ends. In this case, the determination table **221** is not updated.

Here, for example, it is assumed that the controller **21** updates the number of jams, which has been 2 in S508, to 3 and stores the number of jams as 3. Then, if the predetermined number of times is 3, the controller **21** judges that the number of times is equal to or more than the predetermined number of times (S701: YES).

Subsequently, the controller **21** determines whether or not the occurred jam is an A jam (S702). In the present embodiment, if the jam is not an A jam, the jam is a B jam.

In a case where it is judged in step S702 that the jam is an A jam (S702: YES), subsequently, the controller **21** compares the number of occurrences of A jam at a current regulation plate position with the number of occurrences of A jam at the current plate position+0.1 mm (S703).

In a case where the number of jam occurrences at the current regulation plate position is larger than when at the +0.1 mm position (S704: YES (referred to as determination A)) as a result of the comparison, the controller **21** adds 0.1 mm to the proper regulation plate position shown in the table to update the determination table **221** (S705).

Meanwhile, in a case where the number of jam occurrences at the current regulation plate position is less than when at the +0.1 mm position (S704: NO (referred to as determination B)), the controller **21** returns to an original state, and the processing ends. In this case, the determination table **221** is not updated.

In a case where it is judged in step S702 that the jam is not an A jam (S702: NO), that is, in a case where it is judged that the jam is a B jam, subsequently, the controller **21** compares the number of occurrences of B jam at a current regulation plate position with the number of occurrences of B jam at the current plate position −0.1 mm (S706).

In a case where the number of jam occurrences at the current regulation plate position is larger than when at the −0.1 mm position (S707: YES (referred to as determination C)) as a result of the comparison, the controller **21** subtracts 0.1 mm from the proper regulation plate position shown in the table to update the determination table **221** (S708). Thereafter, the controller **21** ends the processing.

Meanwhile, in a case where the number of jam occurrences at the current regulation plate position is less than when at the −0.1 mm position (S707: NO (referred to as determination D)), the controller **21** returns to an original state, and the processing ends. In this case, the determination table **221** is not updated.

An example of updating the determination table will be described. FIG. **19** is an explanatory diagram for describing an example of updating the determination table **221**.

For example, as in JAM 1 illustrated in FIG. **16**, in a case where the current regulation plate position is 451.2 mm, and the number of occurrences of A jam in that case is updated from 2 to 3 and stored, the controller **21** compares the number of occurrences of A jam with the number of occurrences of A jam 0 in a case of +0.1 mm (regulation plate position 451.3 mm). As a result of the comparison, the number of occurrences of A jam at the current regulation plate position of 451.2 mm is larger. In such a case, as the determination A (S703: YES), as illustrated in FIG. **19**, the controller **21** adds 0.1 mm to 451.2 mm of the proper regulation plate position shown in the table, and updates the determination table **221** such that the proper regulation plate position is set to 451.3 mm (S705).

Further, as in JAM 2 illustrated in FIG. **16**, in a case where the current regulation plate position is 451.5 mm, and the number of occurrences of B jam in that case is updated from 2 to 3 and stored, the controller **21** compares the number of occurrences of B jam with the number of occurrences of B jam 4 in a case of −0.1 mm (regulation plate position 451.4 mm). As a result of the comparison, the number of occurrences of B jam in the case of −0.1 mm (regulation plate position 451.4 mm) is larger. In such a case, as the determination D (S706: NO), the controller **21** ends the processing as is.

Accordingly, in the present embodiment, in a case where the number of occurrences of jam increases at a current proper regulation plate position, the proper regulation plate position is updated in increments of 0.1 mm.

Note that, in an update of the determination table **221**, instead of the above-described processing, for example, the number of occurrences of jam may be recorded in advance for each of a plurality of regulation plate positions, and a regulation plate position having a smallest number of occurrences of jam and having a narrowest regulation plate position may be adopted as an optimum regulation plate position for each jam occurrence. Specifically, for example, as illustrated in FIG. **16**, the number of occurrences of jam at five regulation plate positions recorded for each humidity level of each paper **90** is recorded. Then, when a jam occurs, the controller **21** compares them, and stores a regulation plate position that meets a condition of having a smallest number of occurrences of jam and having a narrowest regulation plate position as an optimum value for the paper **90** at a time of the humidity level. Thereafter, the controller **21** uses the optimum value for the same paper **90** and humidity level.

Fifth Embodiment

Next, error processing will be described. A fifth embodiment is a processing example in a case where movement of regulation plates is not completed within a predetermined time. A device configuration of an image formation system **1000** and a procedure for moving the regulation plates is similar to the device configuration of the image formation

system **1000** and procedure for moving the regulation plates in any one of the first to fourth embodiments.

FIG. **20** is a flowchart illustrating a procedure for controlling movement of the regulation plates in the fifth embodiment.

First, a controller **21** executes steps S**101** to S**106** (refer to FIG. **7**) in the first embodiment. After starting movement of regulation plates **252***b* and **252***d* (S**106**), the controller **21** starts counting time spent on the movement (S**1101**).

Subsequently, the controller **21** judges whether or not the regulation plates **252***b* and **252***d* have moved to the proper positions (S**1102**). Here, if the movement is completed (S**1102**: YES), the controller **21** stops the movement of the regulation plates **252***b* and **252***d* (S**1103**). Thereafter, the controller **21** ends all of the processing.

In step S**1102**, if the movement of the regulation plates **252***b* and **252***d* to the proper positions is not completed (S**1102**: NO), the controller **21** judges whether or not a count value (time) is equal to or longer than a predetermined time (S**1104**). The predetermined time is, for example, time spent on movement of the regulation plates **252***b* and **252***d* from a maximum to minimum width therebetween. Specifically, in a case where a maximum loadable paper size is A3 Nobi (also referred to as A3+) (=329×483 mm) and a minimum loadable paper size is A6 (=105×148 mm), the predetermined time is about 15 seconds. Here, if the count value (time) is not equal to or longer than the predetermined time (S**1104**: NO), the processing returns to step S**1102** and the controller **21** continues the processing.

Meanwhile, if the count value (time) is equal to or longer than the predetermined time (S**1104**: YES), the controller **21** causes a display **24** or an operation display **34** to display reset of paper **90** (S**1105**). The display of reset of the paper **90** is processing of notifying the user that some error has occurred during movement of the regulation plates **252***b* and **252***d*. As a cause of not completing the movement of the regulation plates **252***b* and **252***d* within the predetermined time, for example, it can be considered that the paper is greatly bent at a time of paper setting, and such a failure in setting the paper **90** is highly likely to be resolved by resetting the paper **90**. In addition, as another cause of not completing the movement of the regulation plates **252***b* and **252***d* within the predetermined time, for example, abnormality of the device itself such as a motor or a sensor can be considered. In a case of such device abnormality, the device abnormality may be separately detected and an error may be displayed, or the like.

Thereafter, the controller **21** stops the movement of the regulation plates **252***b* and **252***d* (S**1103**), and ends all the processing.

FIG. **21** is a screen example of an operation display **34** in which display prompting paper reset is performed.

As illustrated in FIG. **21**, in S**1105**, a message such as "Reset paper **90**" is displayed on the operation display **34** according to an instruction from the controller **21**.

Accordingly, according to the fifth embodiment, in a case where it takes a predetermined time or longer to move the regulation plates **252***b* and **252***d*, it is possible to stop the movement of the regulation plates **252***b* and **252***d*, assuming that there is some abnormality. Further, according to the fifth embodiment, in a case where it takes the predetermined time or longer to move the regulation plates **252***b* and **252***d*, a message prompting the user to reset the paper **90** is displayed. Accordingly, according to the fifth embodiment, it is possible to immediately eliminate simple abnormality that occurs when the regulation plates **252***b* and **252***d* are moved, such as a failure in setting the paper **90**.

The present invention is not limited to the embodiments described above. The conditions, numerical values, and the like used in the description of the embodiments are merely exemplary, and do not restrict the present invention.

A program according to an embodiment of the present invention can be implemented with a dedicated hardware circuit. The program can be provided by a computer-readable recording medium such as a universal serial bus (USB) memory or a digital versatile disc-read only memory (DVD-ROM), or can be provided online via a network such as the Internet without depending on a recording medium. In a case where the program is provided online, the program is recorded on a recording medium (storage **240**) such as a magnetic disk in a computer connected to a network.

Embodiments of the present invention can be variously modified on the basis of the configurations set forth in the claims, and such modifications are also within the scope of the present invention.

Although embodiments of the present invention have been described and illustrated in detail, the disclosed embodiments are made for purposes of illustration and example only and not limitation. The scope of the present invention should be interpreted by terms of the appended claims.

What is claimed is:

1. A paper feed device having regulation plates that are movable on a paper feed tray for loading paper and regulate edges of the paper, the paper feed device comprising:

a driver that moves the regulation plates to be in contact with edge surfaces of a loaded paper; and

a hardware processor that acquires paper information corresponding to a characteristic of the loaded paper detected by a paper information detector, and causes the driver to move the regulation plates to positions in contact with the edge surfaces of the loaded paper based on the acquired paper information detected by the paper information detector so as to align edges of the loaded paper in an appropriate position,

wherein the paper information includes moisture content, and

the hardware processor sets an interval between the regulation plates of a case where the moisture content is equal to or more than a predetermined value wider than an interval between the regulation plates of a case where the moisture content is less than the predetermined value.

2. The paper feed device according to claim **1**,

wherein the hardware processor includes the paper information detector that detects, from the paper, at least one more characteristic selected from among groups of paper type of the paper, basis weight of the paper, charging rate of the paper, and smoothness of the paper, as the paper information.

3. The paper feed device according to claim **2**,

wherein the paper information detector is disposed on a conveyance path for the paper.

4. The paper feed device according to claim **2**,

wherein the paper information detector is disposed at a position where the paper is loaded.

5. The paper feed device according to claim **2**,

wherein the hardware processor causes the regulation plates to move to positions based on at least either the paper information obtained from an input type of the paper or the paper information detected by the paper information detector.

6. The paper feed device according to claim 1,

wherein the hardware processor includes a paper type inputter that receives, from a user, input of information of a type of the paper.

7. The paper feed device according to claim 1, the paper feed device further comprising a storage that stores a paper profile including the paper information and position information of the regulation plates, the position information corresponding to the paper profile,

wherein the hardware processor includes a paper profile inputter that receives input of the paper profile from a user, and

the hardware processor acquires positions of the regulation plates from the storage, the positions corresponding to the input paper profile, and causes the regulation plates to move.

8. The paper feed device according to claim 7,

wherein the paper profile includes at least one piece of information selected from among groups of paper type of the paper, basis weight of the paper, and image formation condition for the paper, as the paper information.

9. The paper feed device according to claim 1,

wherein, after the paper is loaded in the paper feed tray, the hardware processor causes the regulation plates to move until force of a predetermined amount or more is applied to the regulation plates, and further causes the regulation plates to move to positions based on the paper information.

10. The paper feed device according to claim 1, the paper feed device further comprising an environment detector that detects at least either temperature or humidity inside and/or outside the paper feed device as environment information,

wherein the hardware processor causes the regulation plates to move to positions based on the environment information and the paper information.

11. The paper feed device according to claim 1, the paper feed device further comprising an event information storage that stores, in association with one another, positions of the regulation plates at a time of paper feeding, the paper information, and conveyance stop occurrence information of a case where conveyance of the paper is stopped after the paper is fed and conveyed,

wherein the hardware processor causes the regulation plates to move to positions based on information stored in the event information storage.

12. The paper feed device according to claim 11,

the paper feed device further comprising an environment detector that detects at least either temperature or humidity inside and/or outside the paper feed device as environment information,

wherein the hardware processor causes the regulation plates to move to positions based on the environment information and the paper information, and

wherein the event information storage further stores the environment information in association with the positions of the regulation plates, the paper information, and the conveyance stop occurrence information.

13. The paper feed device according to claim 11,

wherein the conveyance stop occurrence information is paper feed jam occurrence information.

14. The paper feed device according to claim 13,

wherein the paper feed jam occurrence information is first jam information, the first jam being caused by an interval between the regulation plates being narrower than a predetermined interval, and is second jam information, the second jam being caused by an interval between the regulation plates being wider than a predetermined interval.

15. The paper feed device according to claim 1,

wherein the paper information includes a charging rate, and

the hardware processor sets an interval between the regulation plates of a case where the charging rate is equal to or more than a predetermined value wider than an interval between the regulation plates of a case where the charging rate is less than the predetermined value.

16. The paper feed device according to claim 1,

wherein the hardware processor notifies a user of information, and

the hardware processor provides notification of reset of the paper in a case where the regulation plates fail to complete movement to positions based on the paper information within a preset time period.

17. An image formation system comprising:

the paper feed device according to claim 1; and

an image formation device that forms an image on paper fed from the paper feed device.

18. A paper feed device having regulation plates that are movable on a paper feed tray for loading paper and regulate edges of the paper, the paper feed device comprising:

a driver that moves the regulation plates to be in contact with edge surfaces of a loaded paper; and

a hardware processor that acquires paper information corresponding to a characteristic of the loaded paper detected by a paper information detector, and causes the driver to move the regulation plates to positions in contact with the edge surfaces of the loaded paper based on the acquired paper information detected by the paper information detector so as to align edges of the loaded paper in an appropriate position,

wherein the paper information includes smoothness of edge surfaces the paper, and

the hardware processor sets an interval between the regulation plates of a case where the smoothness is less than a predetermined value wider than an interval between the regulation plates of a case where the smoothness is equal to or more than the predetermined value.

19. A non-transitory recording medium storing a computer readable control program for a paper feed device having regulation plates that are movable on a paper feed tray for loading paper and regulate edges of the paper, and a driver that moves the regulation plates to be in contact with edge surfaces of a loaded paper, the non-transitory recording medium storing a computer readable control program causing a computer to perform:

acquiring paper information corresponding to a characteristic of the loaded paper detected by a paper information detector, wherein the paper information includes moisture content;

causing the driver to move the regulation plates to be in contact with edge surfaces of the loaded paper and to move to positions based on the acquired paper information detected by the paper information detector so as to align edges of the loaded paper in an appropriate position, and

setting an interval between the regulation plates of a case where the moisture content is equal to or more than a predetermined value wider than an interval between the regulation plates of a case where the moisture content is less than the predetermined value.

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