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Maeda

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(54) **PRINTING APPARATUS, CONTROL METHOD FOR PRINTING APPARATUS, AND STORAGE MEDIUM**

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(73) Assignee: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

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(22) Filed: **Dec. 3, 2015**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H04N 1/00 (2006.01)
G06K 15/02 (2006.01)
B41J 29/393 (2006.01)

(52) **U.S. Cl.**
CPC ***H04N 1/00795*** (2013.01); ***B41J 29/393*** (2013.01); ***G06K 15/027*** (2013.01); ***H04N 1/0032*** (2013.01); ***H04N 1/0057*** (2013.01); ***H04N 1/00694*** (2013.01); ***H04N 1/00708*** (2013.01); ***H04N 1/00724*** (2013.01); ***H04N 1/00734*** (2013.01); ***H04N 1/00745*** (2013.01); ***H04N 1/00779*** (2013.01)

(58) **Field of Classification Search**
CPC H04N 1/00795; H04N 1/0032; H04N 1/0057; H04N 1/00694; H04N 1/00708; H04N 1/00724; H04N 1/00734; H04N 1/00745; H04N 1/00779; B41J 29/393; G06K 15/027
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Canon USA, Inc. IP Division

(57) **ABSTRACT**

A control method in a printing apparatus includes printing, by a printing unit, an adjustment image for adjusting a printing position on a sheet, conveying, by a conveying unit, the sheet on which the adjustment image is printed, reading, by a reading unit, an image to generate image data, the reading unit being executable to perform reading by a first reading method for reading an image of a sheet without conveying the sheet or a second reading method for reading the image of the sheet while conveying the sheet, and determining, based on that a type of the sheet on which the adjustment image is to be printed is a specific type, to read the adjustment image by the first reading method.

1 Claim, 17 Drawing Sheets

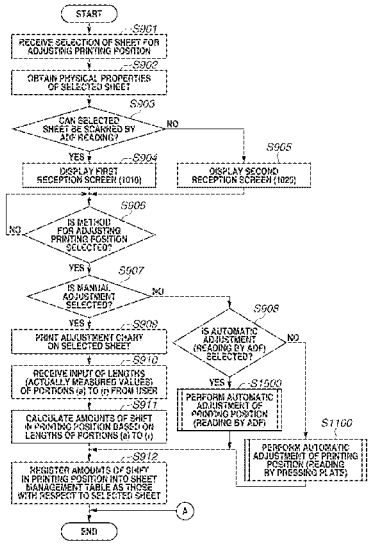


FIG.1

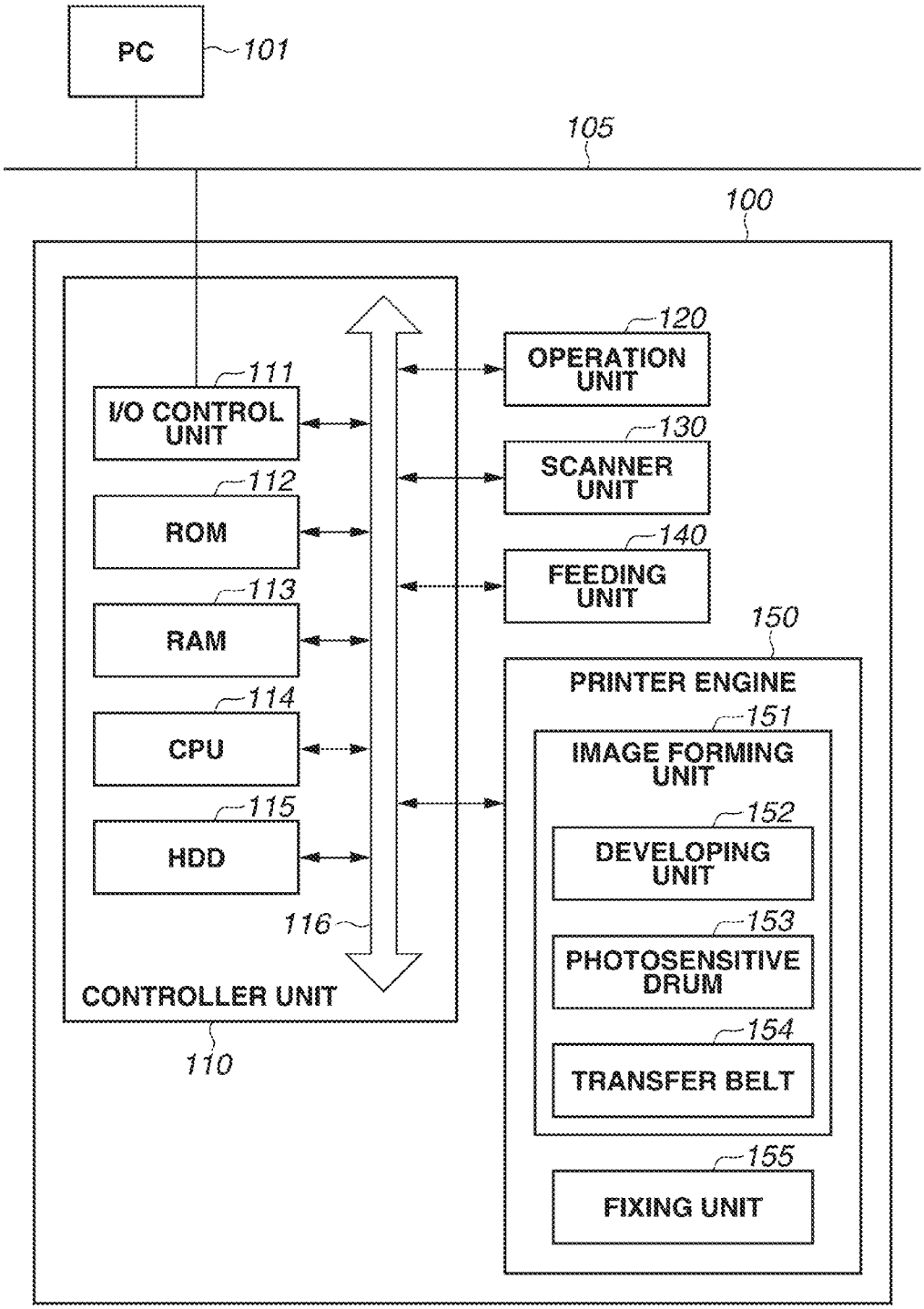
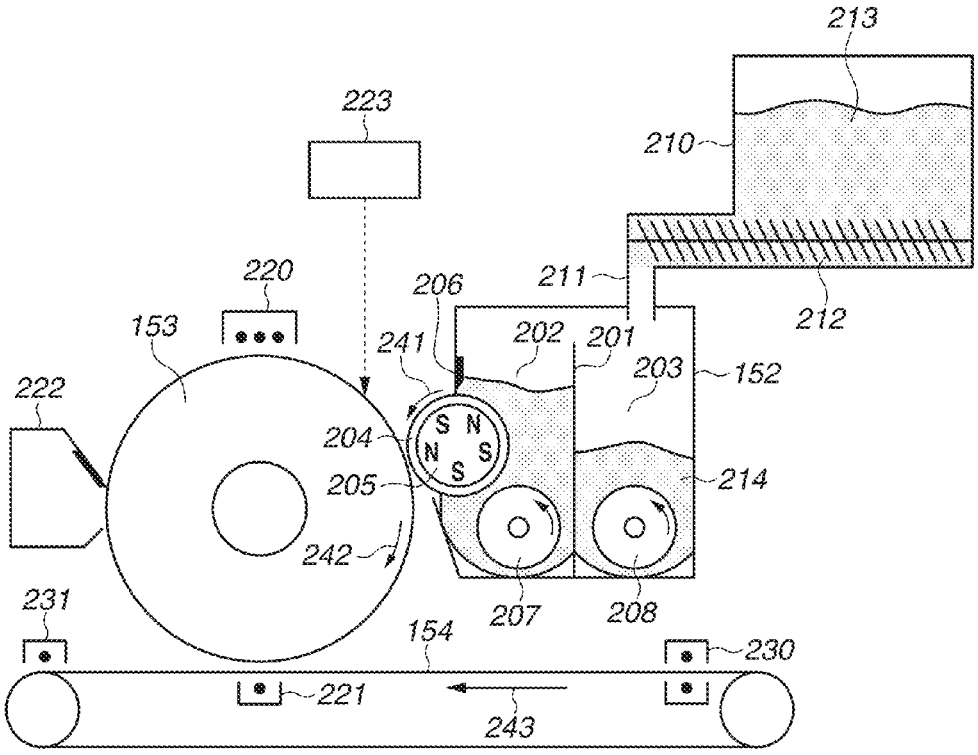

PC
101
105
100
120
OPERATION UNIT
111
I/O CONTROL UNIT
130
SCANNER UNIT
112
ROM
140
FEEDING UNIT
113
RAM
150
PRINTER ENGINE
114
CPU
151
IMAGE FORMING UNIT
115
HDD
152
DEVELOPING UNIT
116
153
PHOTOSENSITIVE DRUM
154
TRANSFER BELT
155
FIXING UNIT
CONTROLLER UNIT
110

FIG.2


213
223
210
220
206
211
153
241
202
201
212
222
203
152
204
S N
N S
214
205
242
231
207
208
154
230
221
243

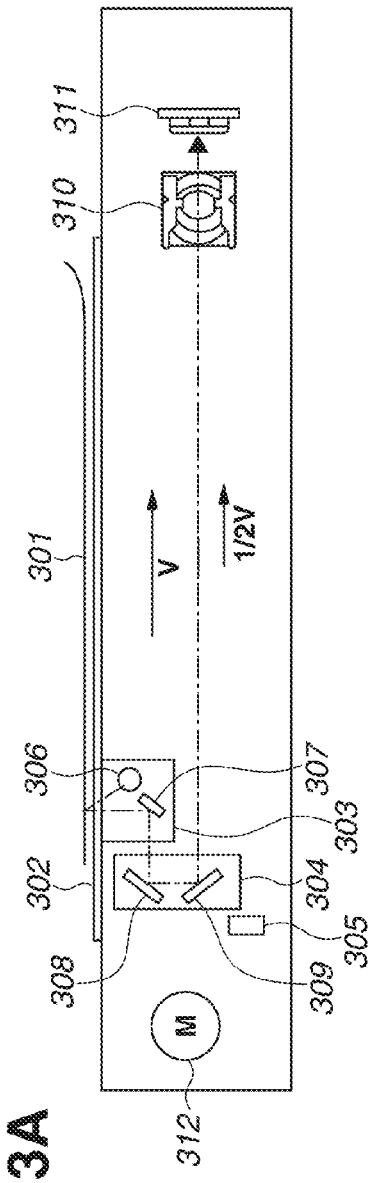

301
V
1/2V
302
303
304
305
306
307
308
309
310
311
312
M

FIG.3A

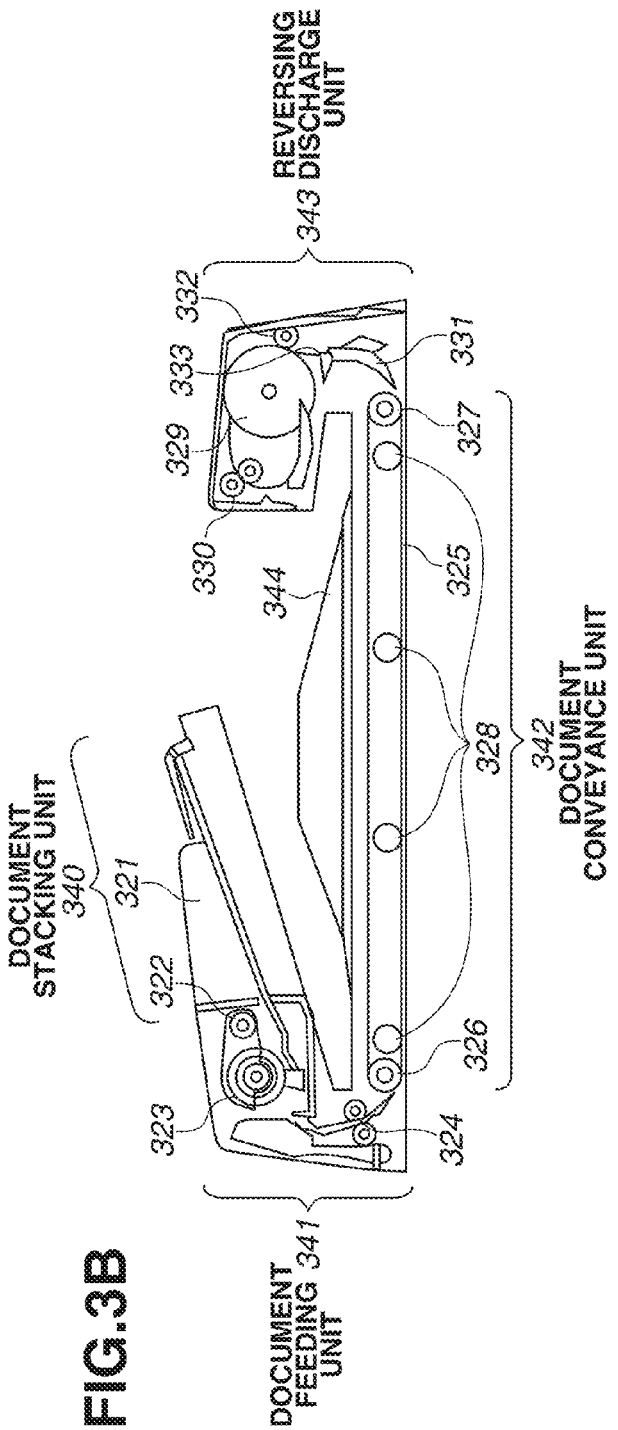

REVERSING DISCHARGE UNIT
343
DOCUMENT STACKING UNIT
340
DOCUMENT FEEDING UNIT
341
DOCUMENT CONVEYANCE UNIT
342
321
322
323
324
325
326
327
328
329
330
331
332
333
344

FIG.3B

FIG.4

400

411 SHEET NAME	412 SHEET LENGTH IN SUB SCANNING DIRECTION (mm)	413 SHEET LENGTH IN MAIN SCANNING DIRECTION (mm)	414 GRAMMAGE (g/m^2)	415 SURFACE PROPERTY	416 COLOR	417 PREPRINTED PAPER	420 AMOUNT OF SHIFT IN PRINTING POSITION (FRONT SURFACE)	421 AMOUNT OF SHIFT IN PRINTING POSITION (BACK SURFACE)
ABC PAPER CO., RECYCLED 1	210	297	75	PLAIN PAPER	WHITE	NO	LEAD POSITION: 0.3 mm SIDE POSITION: -0.1 mm MAIN SCANNING MAGNIFICATION: +0.02% SUB SCANNING MAGNIFICATION: -0.01%	LEAD POSITION: 0.2 mm SIDE POSITION: 0.1 mm MAIN SCANNING MAGNIFICATION: 0.02% SUB SCANNING MAGNIFICATION: -0.03%
ABC PAPER CO., RECYCLED 2	297	420	75	PLAIN PAPER	WHITE	NO	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%
DEF PAPER CO., EMBOSSED A-1	216	279	150	EMBOSSED	WHITE	NO	LEAD POSITION: 0.5 mm SIDE POSITION: -0.5 mm MAIN SCANNING MAGNIFICATION: +0.02% SUB SCANNING MAGNIFICATION: -0.02%	LEAD POSITION: -0.3 mm SIDE POSITION: 0.5 mm MAIN SCANNING MAGNIFICATION: +0.01% SUB SCANNING MAGNIFICATION: -0.03%
DEF PAPER CO., COATED PAPER P-1	279	432	128	TWO-SIDED COATED	WHITE	NO	LEAD POSITION: 0.4 mm SIDE POSITION: -0.2 mm MAIN SCANNING MAGNIFICATION: +0.12% SUB SCANNING MAGNIFICATION: -0.08%	LEAD POSITION: -0.2 mm SIDE POSITION: 0.6 mm MAIN SCANNING MAGNIFICATION: -0.02% SUB SCANNING MAGNIFICATION: -0.01%
XYZ PAPER CO., COLOR 81	210	297	75	PLAIN PAPER	ORANGE	NO	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%
XYZ PAPER CO., COLOR 82	210	297	75	PLAIN PAPER	PINK	NO	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%
FGH PAPER CO., GRAPH 75	210	297	75	PLAIN PAPER	WHITE	YES	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%	LEAD POSITION: 0.0 mm SIDE POSITION: -0.0 mm MAIN SCANNING MAGNIFICATION: +0.00% SUB SCANNING MAGNIFICATION: +0.00%
FGH PAPER CO., PLAIN PAPER 2	210	297	75	PLAIN PAPER	WHITE	NO	LEAD POSITION: -0.03 mm SIDE POSITION: -0.07 mm MAIN SCANNING MAGNIFICATION: +0.06% SUB SCANNING MAGNIFICATION: -0.01%	LEAD POSITION: -0.03 mm SIDE POSITION: -0.10 mm MAIN SCANNING MAGNIFICATION: +0.04% SUB SCANNING MAGNIFICATION: +0.02%

FIG.5A

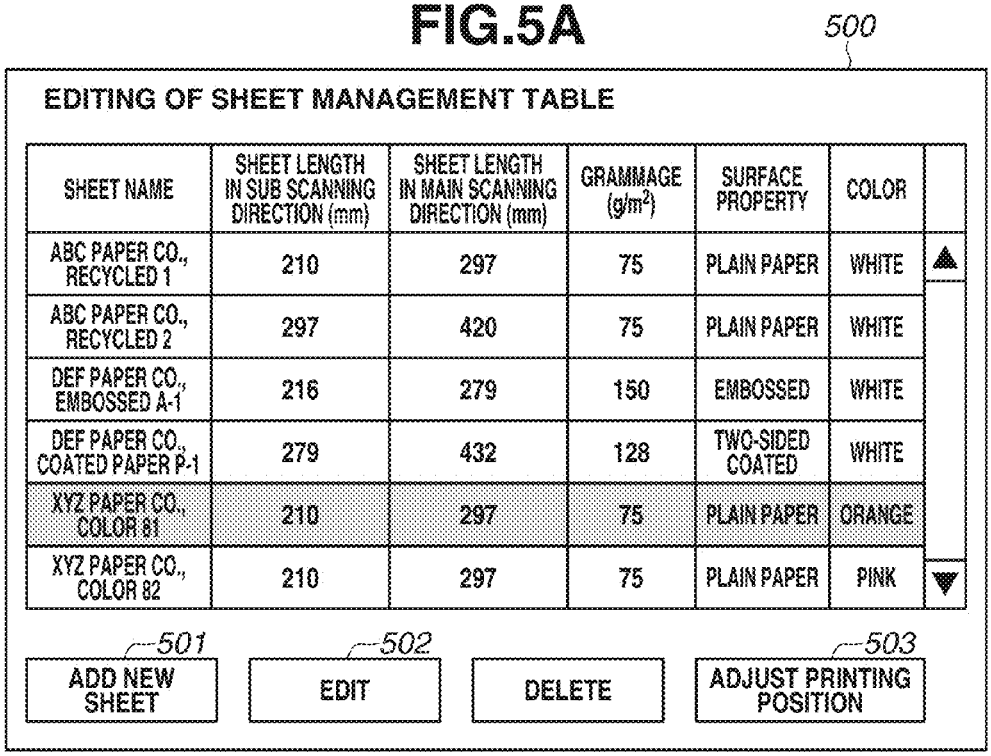

500
EDITING OF SHEET MANAGEMENT TABLE
SHEET NAME
SHEET LENGTH IN SUB SCANNING DIRECTION (mm)
SHEET LENGTH IN MAIN SCANNING DIRECTION (mm)
GRAMMAGE (g/m2)
SURFACE PROPERTY
COLOR
ABC PAPER CO., RECYCLED 1
210
297
75
PLAIN PAPER
WHITE
ABC PAPER CO., RECYCLED 2
297
420
75
PLAIN PAPER
WHITE
DEF PAPER CO., EMBOSSED A-1
216
279
150
EMBOSSED
WHITE
DEF PAPER CO., COATED PAPER P-1
279
432
128
TWO-SIDED COATED
WHITE
XYZ PAPER CO., COLOR 81
210
297
75
PLAIN PAPER
ORANGE
XYZ PAPER CO., COLOR 82
210
297
75
PLAIN PAPER
PINK
501
ADD NEW SHEET
502
EDIT
DELETE
503
ADJUST PRINTING POSITION

FIG.5B

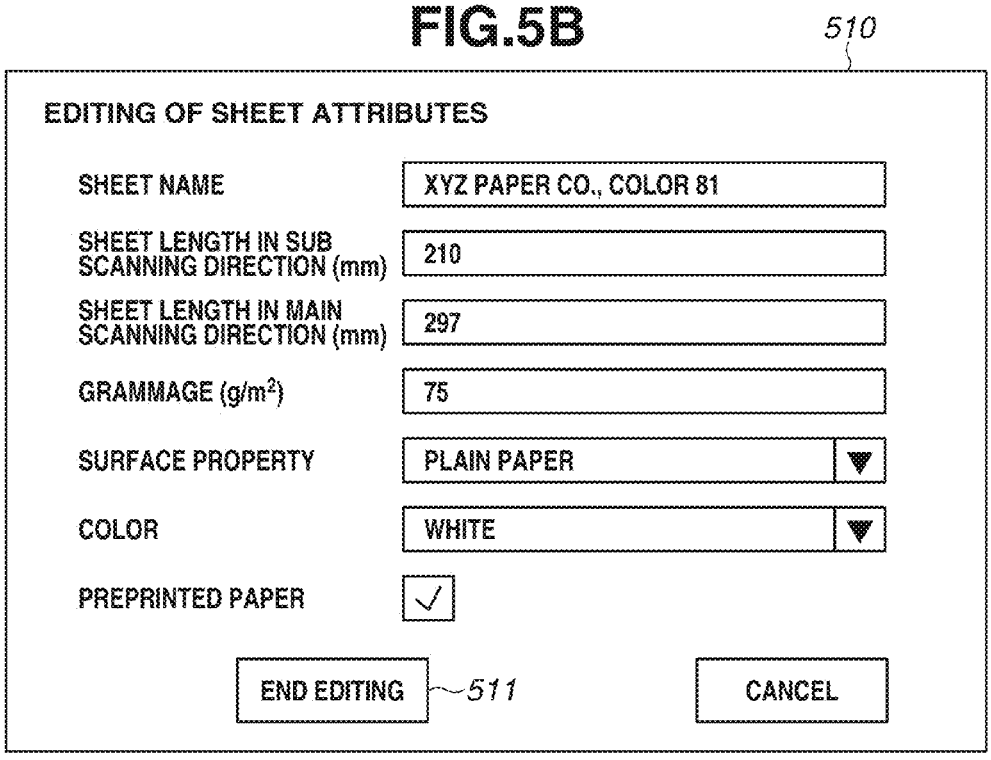

510
EDITING OF SHEET ATTRIBUTES
SHEET NAME
XYZ PAPER CO., COLOR 81
SHEET LENGTH IN SUB SCANNING DIRECTION (mm)
210
SHEET LENGTH IN MAIN SCANNING DIRECTION (mm)
297
GRAMMAGE (g/m2)
75
SURFACE PROPERTY
PLAIN PAPER
COLOR
WHITE
PREPRINTED PAPER
END EDITING
511
CANCEL

FIG.6

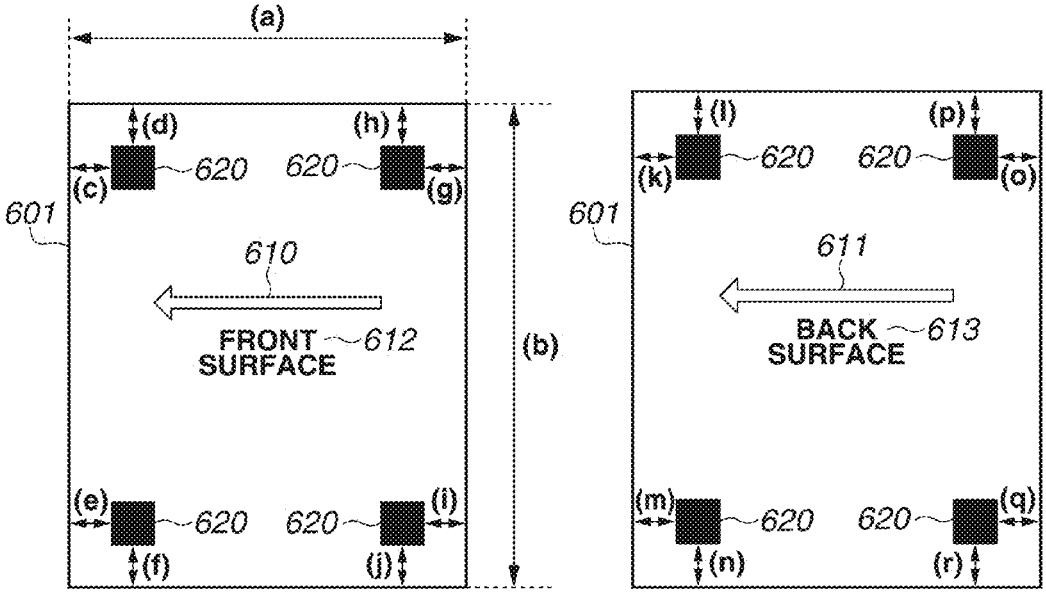

(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
(m)
(n)
(o)
(p)
(q)
(r)
620
601
610
611
612
613
FRONT SURFACE
BACK SURFACE

FIG.7

700

	710 MEASUREMENT VALUE	711 IDEAL VALUE	712 AMOUNT OF SHIFT IN PRINTING POSITION
LEAD POSITION (FRONT SURFACE)	$\frac{(c)+(e)}{2}$	1 cm	MEASUREMENT VALUE - IDEAL VALUE
SIDE POSITION (FRONT SURFACE)	$\frac{(f)+(j)}{2}$	1 cm	MEASUREMENT VALUE - IDEAL VALUE
MAIN SCANNING MAGNIFICATION (FRONT SURFACE)	$\frac{((b)-(d)-(f))+((b)-(h)-(j))}{2}$	(SHEET LENGTH IN MAIN SCANNING DIRECTION) - 2cm	$\frac{(\text{MEASUREMENT VALUE} - \text{IDEAL VALUE})}{\text{IDEAL VALUE}}$
SUB SCANNING MAGNIFICATION (FRONT SURFACE)	$\frac{((a)-(c)-(g))+((a)-(e)-(i))}{2}$	(SHEET LENGTH IN SUB SCANNING DIRECTION) - 2cm	$\frac{(\text{MEASUREMENT VALUE} - \text{IDEAL VALUE})}{\text{IDEAL VALUE}}$
LEAD POSITION (BACK SURFACE)	$\frac{(k)+(m)}{2}$	1 cm	MEASUREMENT VALUE - IDEAL VALUE
SIDE POSITION (BACK SURFACE)	$\frac{(n)+(r)}{2}$	1 cm	MEASUREMENT VALUE - IDEAL VALUE
MAIN SCANNING MAGNIFICATION (BACK SURFACE)	$\frac{((b)-(l)-(n))+((b)-(p)-(r))}{2}$	(SHEET LENGTH IN MAIN SCANNING DIRECTION) - 2cm	$\frac{(\text{MEASUREMENT VALUE} - \text{IDEAL VALUE})}{\text{IDEAL VALUE}}$
SUB SCANNING MAGNIFICATION (BACK SURFACE)	$\frac{((a)-(k)-(o))+((a)-(m)-(q))}{2}$	(SHEET LENGTH IN SUB SCANNING DIRECTION) - 2cm	$\frac{(\text{MEASUREMENT VALUE} - \text{IDEAL VALUE})}{\text{IDEAL VALUE}}$

FIG.8A

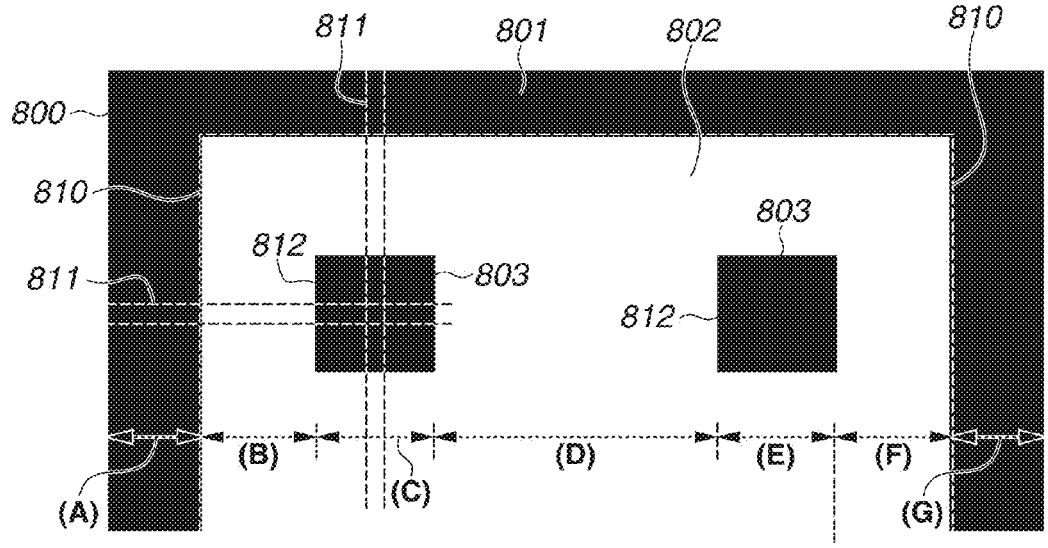

811
801
802
810
800
810
803
812
811
803
812
(A)
(B)
(C)
(D)
(E)
(F)
(G)

FIG.8B

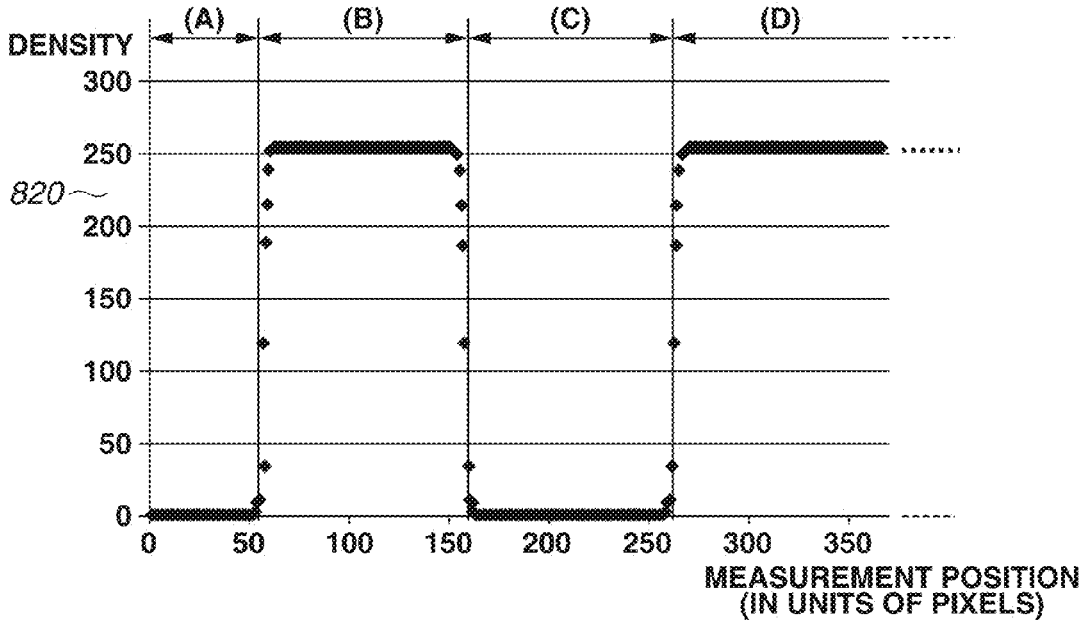

(A)
(B)
(C)
(D)
DENSITY
300
250
820
200
150
100
50
0
0
50
100
150
200
250
300
350
MEASUREMENT POSITION
(IN UNITS OF PIXELS)

FIG.9

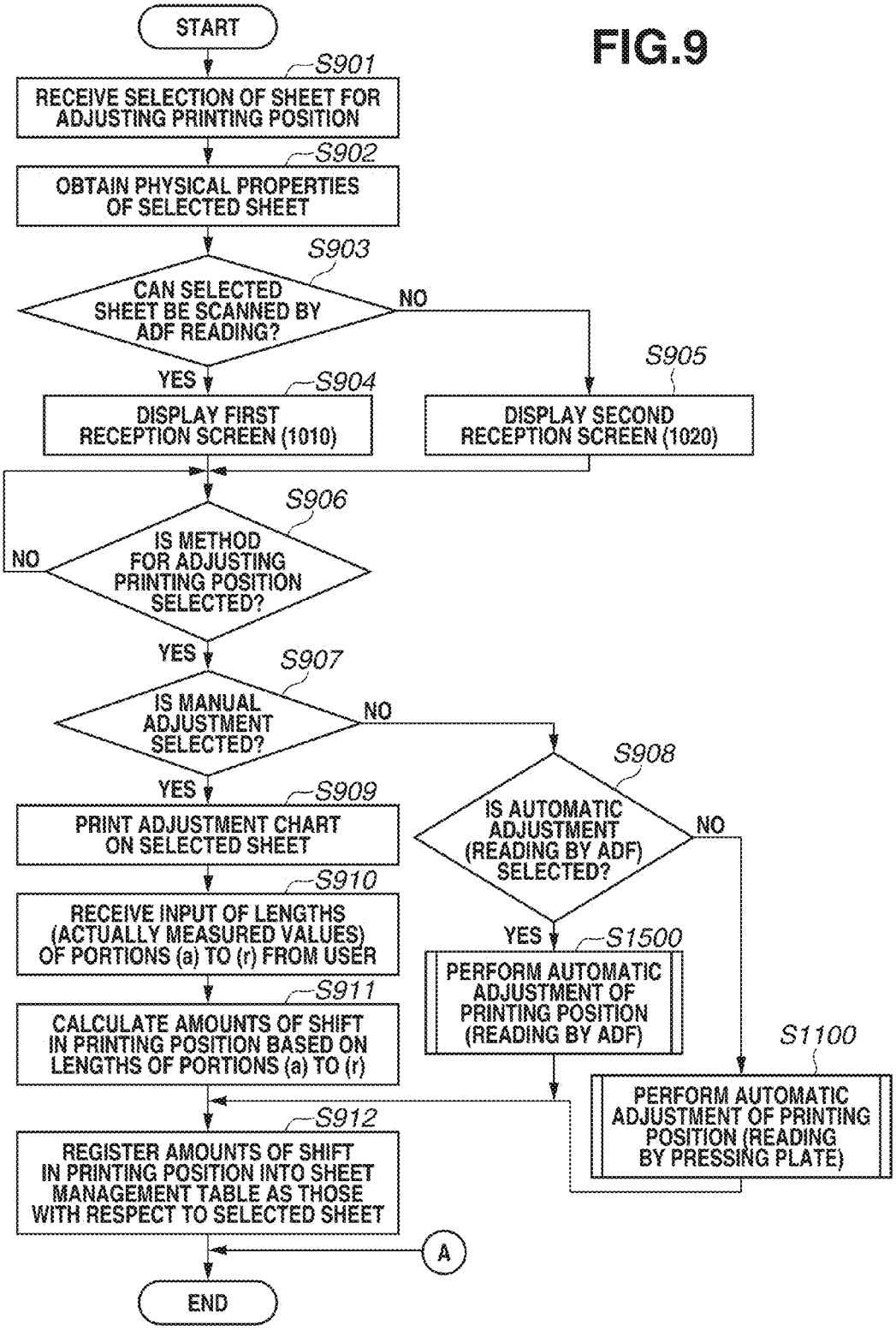

START
S901
RECEIVE SELECTION OF SHEET FOR ADJUSTING PRINTING POSITION
S902
OBTAIN PHYSICAL PROPERTIES OF SELECTED SHEET
S903
CAN SELECTED SHEET BE SCANNED BY ADF READING?
NO
YES
S904
DISPLAY FIRST RECEPTION SCREEN (1010)
S905
DISPLAY SECOND RECEPTION SCREEN (1020)
S906
IS METHOD FOR ADJUSTING PRINTING POSITION SELECTED?
NO
YES
S907
IS MANUAL ADJUSTMENT SELECTED?
NO
YES
S908
IS AUTOMATIC ADJUSTMENT (READING BY ADF) SELECTED?
NO
YES
S909
PRINT ADJUSTMENT CHART ON SELECTED SHEET
S910
RECEIVE INPUT OF LENGTHS (ACTUALLY MEASURED VALUES) OF PORTIONS (a) TO (r) FROM USER
S911
CALCULATE AMOUNTS OF SHIFT IN PRINTING POSITION BASED ON LENGTHS OF PORTIONS (a) TO (r)
S912
REGISTER AMOUNTS OF SHIFT IN PRINTING POSITION INTO SHEET MANAGEMENT TABLE AS THOSE WITH RESPECT TO SELECTED SHEET
S1500
PERFORM AUTOMATIC ADJUSTMENT OF PRINTING POSITION (READING BY ADF)
S1100
PERFORM AUTOMATIC ADJUSTMENT OF PRINTING POSITION (READING BY PRESSING PLATE)
A
END

FIG.10A

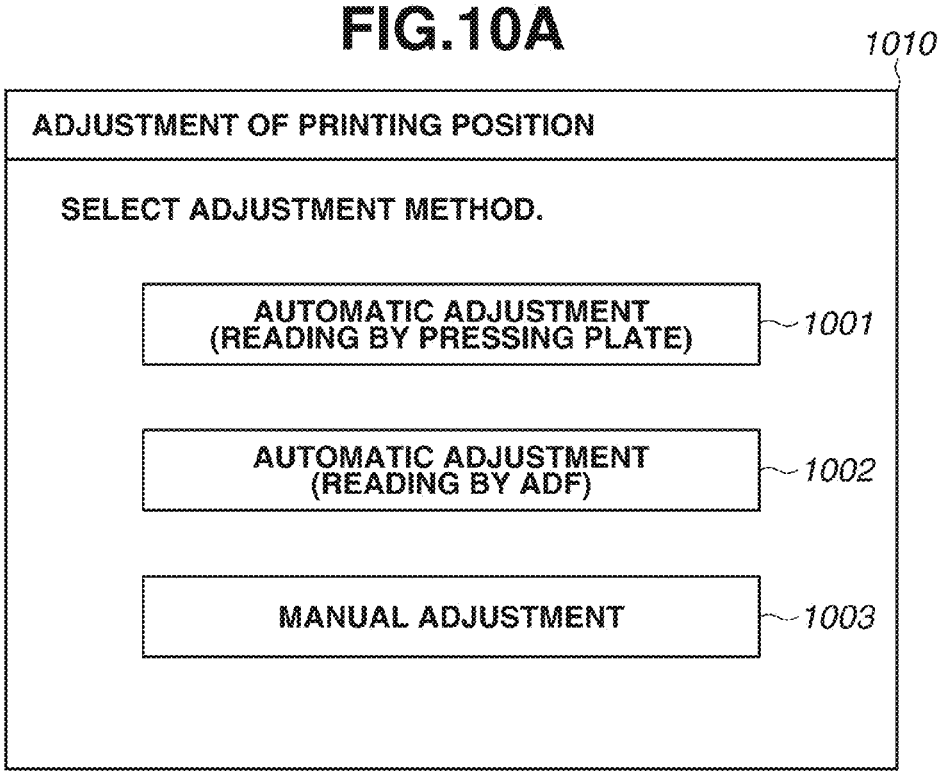


FIG.10B

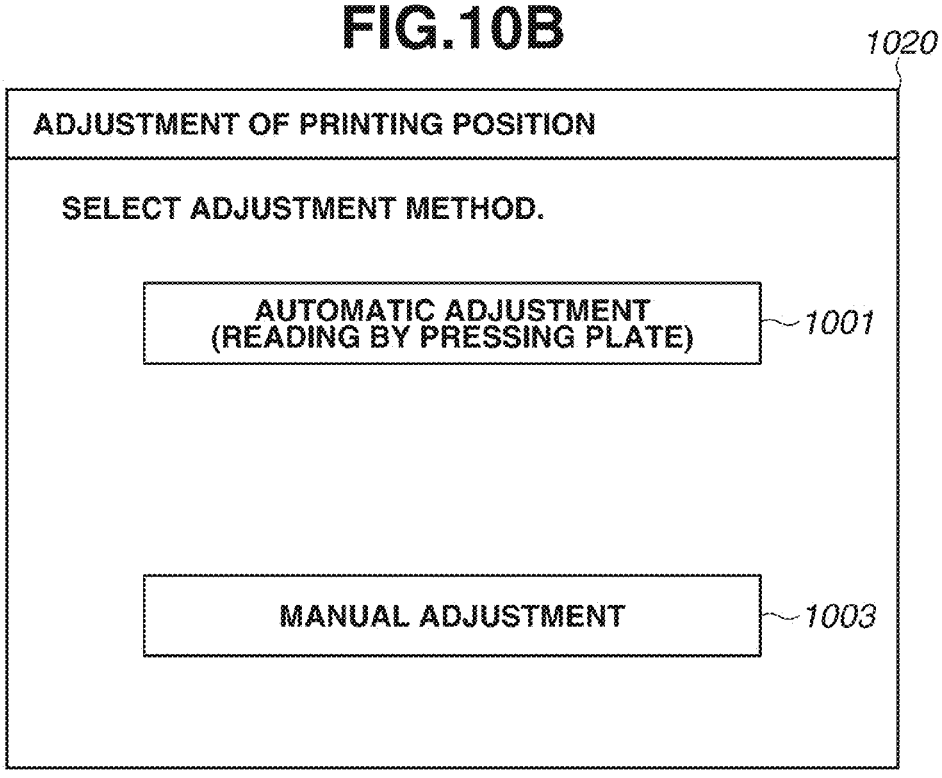


FIG.11

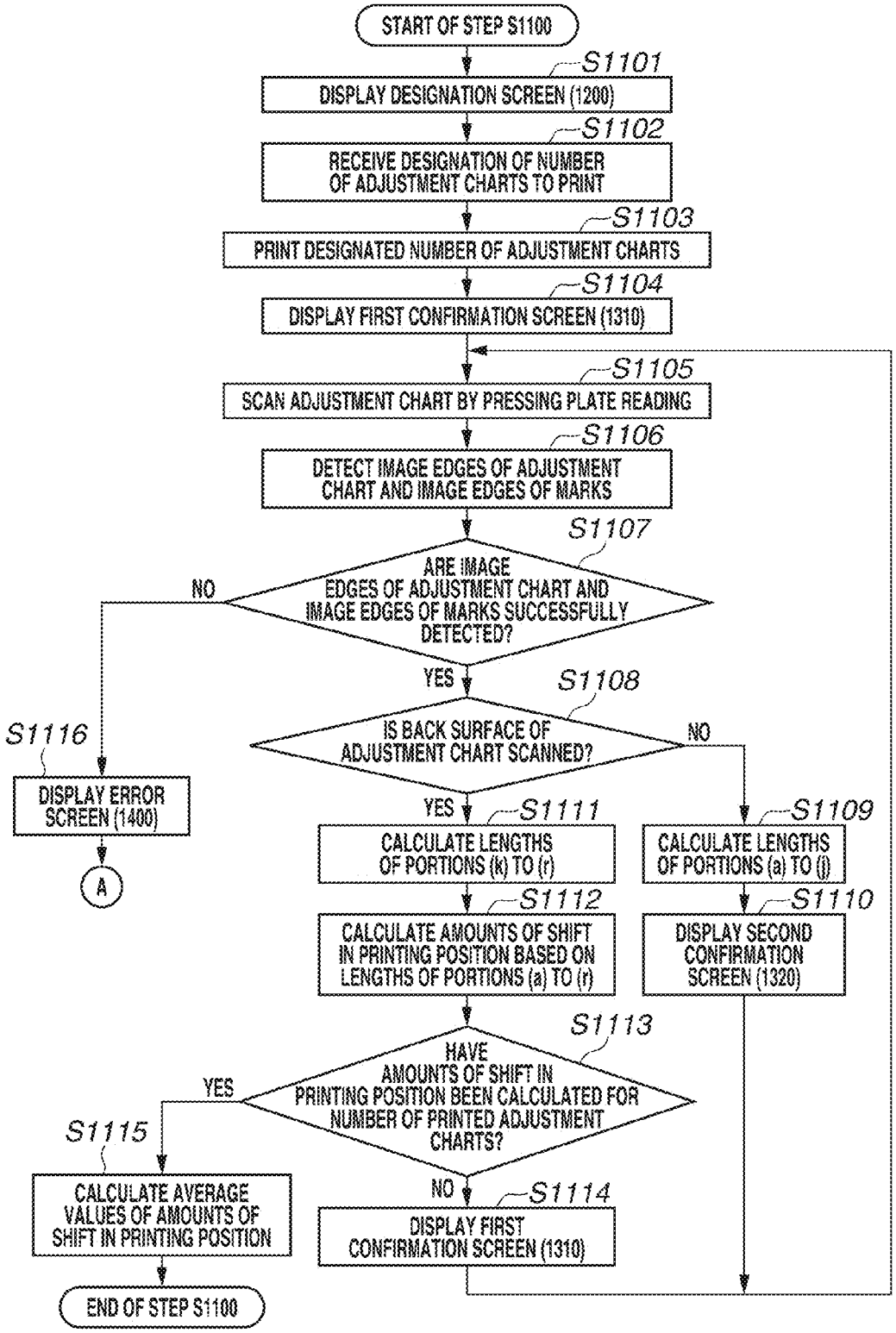

START OF STEP S1100
S1101
DISPLAY DESIGNATION SCREEN (1200)
S1102
RECEIVE DESIGNATION OF NUMBER OF ADJUSTMENT CHARTS TO PRINT
S1103
PRINT DESIGNATED NUMBER OF ADJUSTMENT CHARTS
S1104
DISPLAY FIRST CONFIRMATION SCREEN (1310)
S1105
SCAN ADJUSTMENT CHART BY PRESSING PLATE READING
S1106
DETECT IMAGE EDGES OF ADJUSTMENT CHART AND IMAGE EDGES OF MARKS
S1107
ARE IMAGE EDGES OF ADJUSTMENT CHART AND IMAGE EDGES OF MARKS SUCCESSFULLY DETECTED?
NO
YES
S1108
IS BACK SURFACE OF ADJUSTMENT CHART SCANNED?
NO
YES
S1116
DISPLAY ERROR SCREEN (1400)
A
S1111
CALCULATE LENGTHS OF PORTIONS (k) TO (r)
S1109
CALCULATE LENGTHS OF PORTIONS (a) TO (j)
S1112
CALCULATE AMOUNTS OF SHIFT IN PRINTING POSITION BASED ON LENGTHS OF PORTIONS (a) TO (r)
S1110
DISPLAY SECOND CONFIRMATION SCREEN (1320)
S1113
HAVE AMOUNTS OF SHIFT IN PRINTING POSITION BEEN CALCULATED FOR NUMBER OF PRINTED ADJUSTMENT CHARTS?
YES
NO
S1115
CALCULATE AVERAGE VALUES OF AMOUNTS OF SHIFT IN PRINTING POSITION
S1114
DISPLAY FIRST CONFIRMATION SCREEN (1310)
END OF STEP S1100

FIG.12

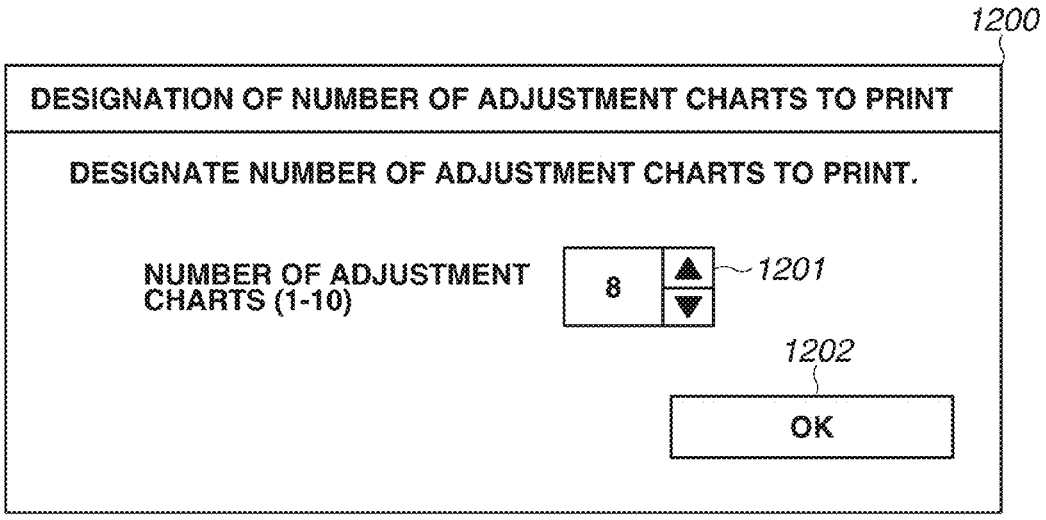

1200
DESIGNATION OF NUMBER OF ADJUSTMENT CHARTS TO PRINT
DESIGNATE NUMBER OF ADJUSTMENT CHARTS TO PRINT.
NUMBER OF ADJUSTMENT CHARTS (1-10)
8
1201
1202
OK

FIG.13A

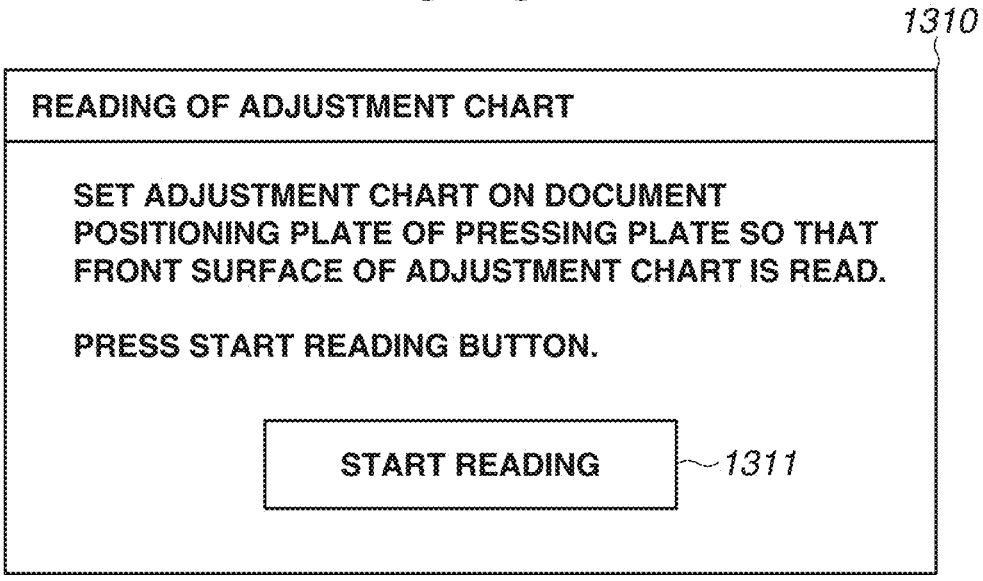


FIG.13B

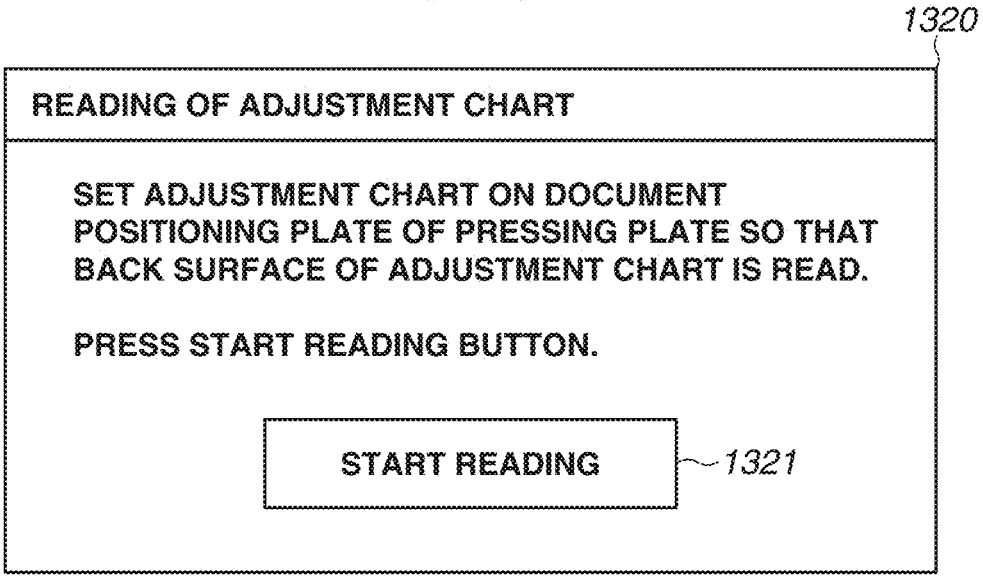


FIG.14

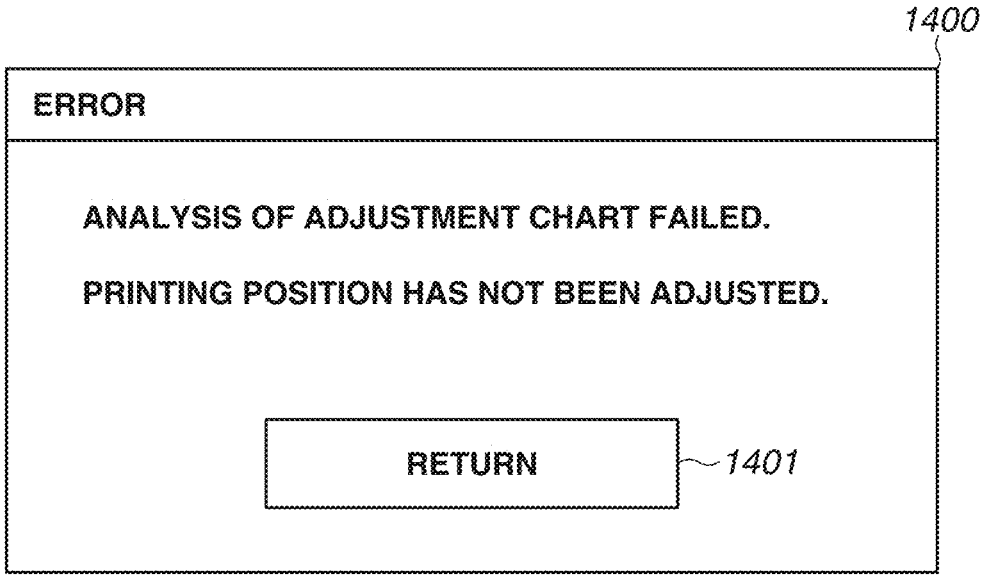

1400
ERROR
ANALYSIS OF ADJUSTMENT CHART FAILED.
PRINTING POSITION HAS NOT BEEN ADJUSTED.
RETURN
1401

FIG.15

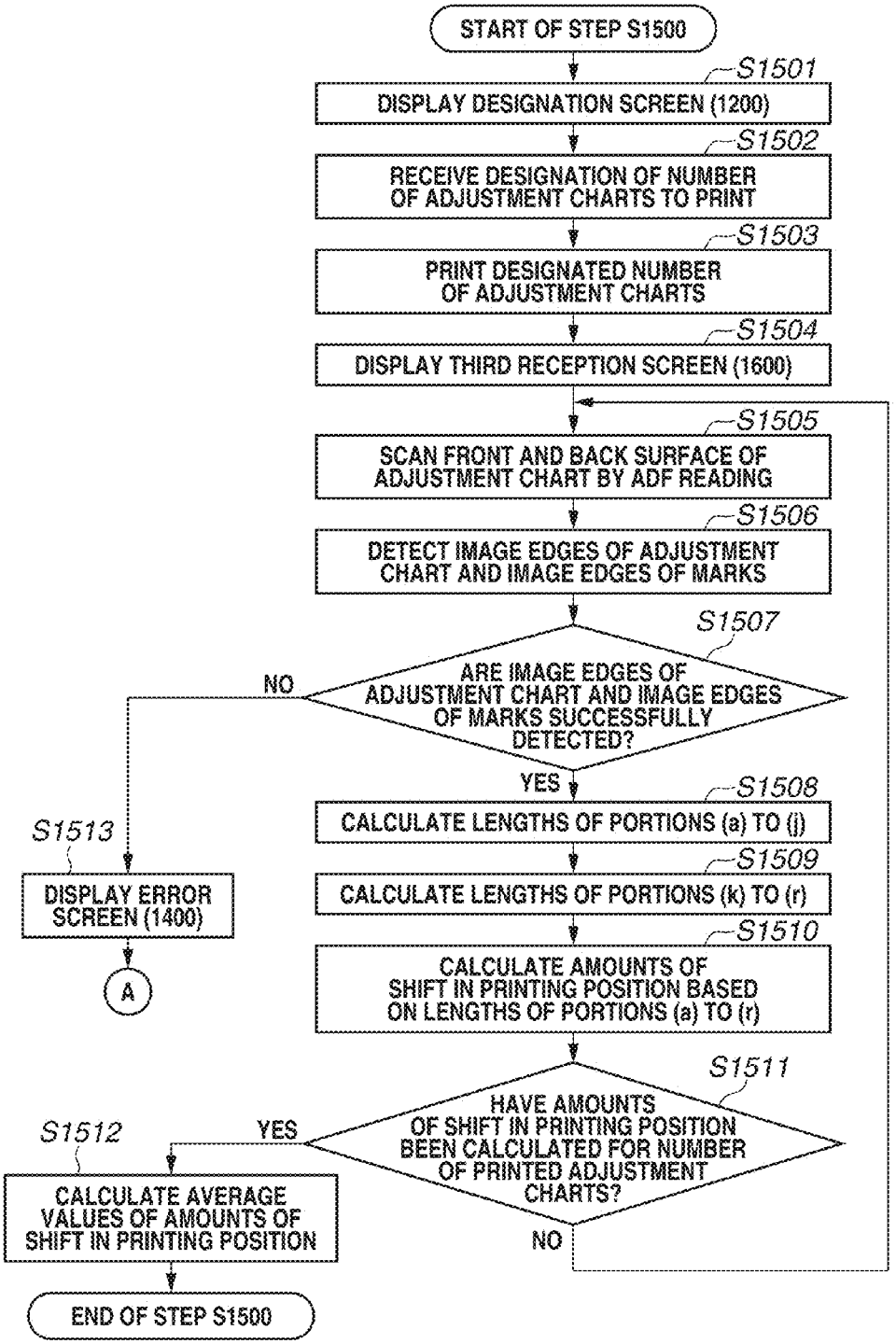

START OF STEP S1500
S1501
DISPLAY DESIGNATION SCREEN (1200)
S1502
RECEIVE DESIGNATION OF NUMBER OF ADJUSTMENT CHARTS TO PRINT
S1503
PRINT DESIGNATED NUMBER OF ADJUSTMENT CHARTS
S1504
DISPLAY THIRD RECEPTION SCREEN (1600)
S1505
SCAN FRONT AND BACK SURFACE OF ADJUSTMENT CHART BY ADF READING
S1506
DETECT IMAGE EDGES OF ADJUSTMENT CHART AND IMAGE EDGES OF MARKS
S1507
ARE IMAGE EDGES OF ADJUSTMENT CHART AND IMAGE EDGES OF MARKS SUCCESSFULLY DETECTED?
NO
YES
S1513
DISPLAY ERROR SCREEN (1400)
A
S1508
CALCULATE LENGTHS OF PORTIONS (a) TO (j)
S1509
CALCULATE LENGTHS OF PORTIONS (k) TO (r)
S1510
CALCULATE AMOUNTS OF SHIFT IN PRINTING POSITION BASED ON LENGTHS OF PORTIONS (a) TO (r)
S1511
HAVE AMOUNTS OF SHIFT IN PRINTING POSITION BEEN CALCULATED FOR NUMBER OF PRINTED ADJUSTMENT CHARTS?
YES
NO
S1512
CALCULATE AVERAGE VALUES OF AMOUNTS OF SHIFT IN PRINTING POSITION
END OF STEP S1500

FIG.16

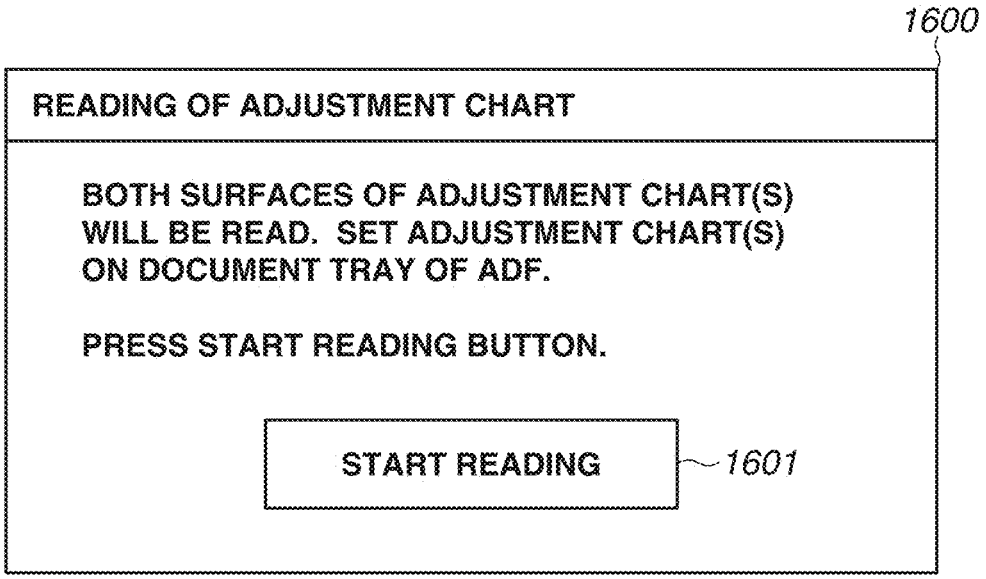
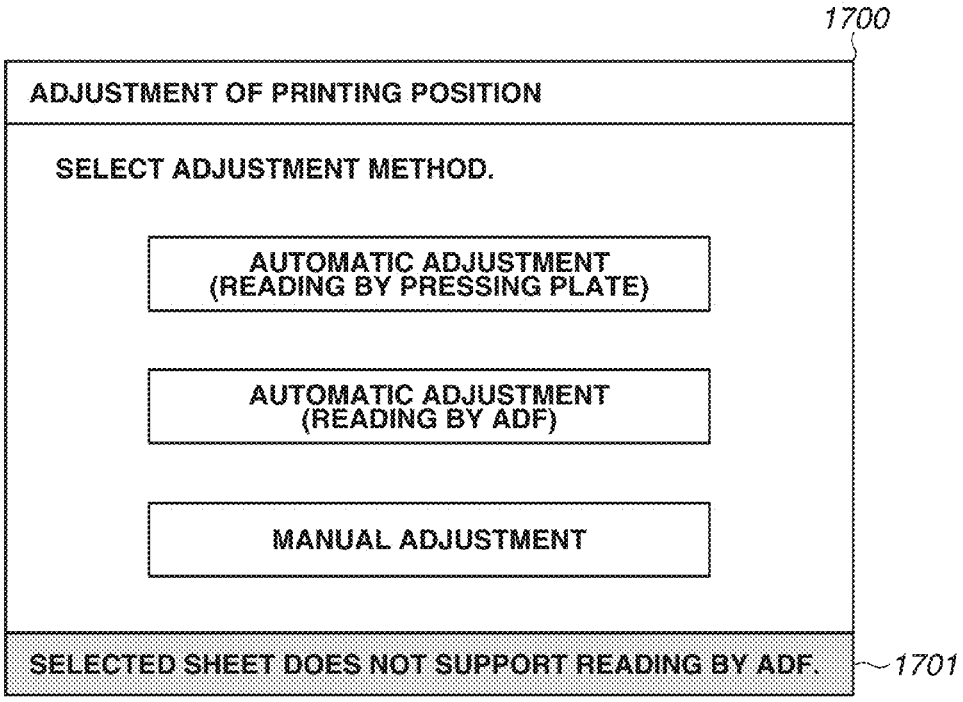

1600
READING OF ADJUSTMENT CHART
BOTH SURFACES OF ADJUSTMENT CHART(S) WILL BE READ. SET ADJUSTMENT CHART(S) ON DOCUMENT TRAY OF ADF.
PRESS START READING BUTTON.
START READING
1601

FIG.17


1700
ADJUSTMENT OF PRINTING POSITION
SELECT ADJUSTMENT METHOD.
AUTOMATIC ADJUSTMENT (READING BY PRESSING PLATE)
AUTOMATIC ADJUSTMENT (READING BY ADF)
MANUAL ADJUSTMENT
SELECTED SHEET DOES NOT SUPPORT READING BY ADF.
1701

PRINTING APPARATUS, CONTROL METHOD FOR PRINTING APPARATUS, AND STORAGE MEDIUM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a printing apparatus for printing an image on a sheet, a control method for the printing apparatus, and a storage medium.

Description of the Related Art

There is an image forming apparatus that reads a chart with a black image having a predetermined width being printed thereon in advance by using an auto document feeder (ADF) to diagnose misregistration at a leading edge (see Japanese Patent Application Laid-Open No. 2005-176045).

To read a document by using an ADF, for example, a document placed on a document tray of the ADF is conveyed while an image of the document is read at a fixed position of an optical system. To read a document by using a document positioning plate, for example, a document placed on the platen glass (document positioning plate) is fixed while an optical system is moved to read an image of the document.

For example, when images of a plurality of documents are read, it is more desirable to use the ADF for reading them than to use the document positioning plate for reading them. The reason is that the plurality of documents can be placed on the document tray of the ADF and the documents can be separated and conveyed one by one. This can reduce time taken for a user repeatedly placing the documents.

An amount of shift of a printing position depends on physical properties of the sheet to print. Thus, for example, when a shift in the printing position with respect to a sheet of high grammage is checked, a black image having a predetermined width needs to be printed on the sheet of high grammage to output a chart. The chart of high grammage is more desirably read by using the document positioning plate than by using the ADF. The reason is that the chart of high grammage is difficult to bend, and when the chart is conveyed from the document tray of the ADF, the chart may fail to form a loop and can cause a jam on the way.

However, the image forming apparatus discussed in Japanese Patent Application Laid-Open No. 2005-176045 scans a chart by using the ADF to diagnose misregistration at the leading edge. As a result, with a technique discussed in Japanese Patent Application Laid-Open No. 2005-176045, a jam can occur when a specific chart is scanned (for example, chart of high grammage) by the ADF, and the amount of shift of the registration at the leading edge may fail to be obtained.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, a printing apparatus includes, a printing unit configured to print an adjustment image for adjusting a printing position on a sheet, a conveying unit configured to convey the sheet on which the adjustment image is printed, a reading unit configured to read an image to generate image data, the reading unit being executable to perform reading by a first reading method for reading an image of a sheet without conveying the sheet and a second reading method for reading the image of the sheet while conveying the sheet, and a determining unit configured to determine, based on that a type of the sheet on which the adjustment image is printed is a specific type, to read the adjustment image by the first reading method.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a configuration of a printing system according to an exemplary embodiment of the present invention.

FIG. **2** is an example of a sectional view illustrating a configuration of an image forming apparatus according to an exemplary embodiment of the present invention.

FIGS. **3**A and **3**B are examples of a sectional view illustrating a configuration of a scanner unit according to an exemplary embodiment of the present invention.

FIG. **4** is an example of a table according to an exemplary embodiment of the present invention.

FIGS. **5**A and **5**B are diagrams illustrating configurations of screens according to an exemplary embodiment of the present invention.

FIG. **6** is an example of a schematic diagram illustrating an adjustment chart according to an exemplary embodiment of the present invention.

FIG. **7** is an example of a table according to an exemplary embodiment of the present invention.

FIGS. **8**A and **8**B are diagrams illustrating detection processing according to an exemplary embodiment of the present invention.

FIG. **9** is a flowchart illustrating a control example according to a first exemplary embodiment.

FIGS. **10**A and **10**B are diagrams illustrating configurations of screens according to the first exemplary embodiment.

FIG. **11** is a flowchart illustrating a control example according to the first exemplary embodiment.

FIG. **12** is a diagram illustrating a configuration of a screen according to the first exemplary embodiment.

FIGS. **13**A and **13**B are diagrams illustrating configurations of screens according to the first exemplary embodiment.

FIG. **14** is a diagram illustrating a configuration of a screen according to the first exemplary embodiment.

FIG. **15** is a flowchart illustrating a control example according to the first exemplary embodiment.

FIG. **16** is a diagram illustrating a configuration of a screen according to the first exemplary embodiment.

FIG. **17** is a diagram illustrating a configuration of a screen according to another exemplary embodiment.

DESCRIPTION OF THE EMBODIMENTS

Exemplary embodiments of the present invention will be described in detail below with reference to the accompanying drawings. It should be noted that the following exemplary embodiments are not intended to limit the present invention set forth in the claims, and all combinations of the features described in the exemplary embodiments are not necessarily indispensable to the solving means of the present invention. Elements of one embodiment may be implemented by hardware, firmware, software or any combination thereof. The term hardware generally refers to an element having a physical structure such as electronic, electromagnetic, optical, electro-optical, mechanical, electro-mechanical parts, etc. A hardware implementation may include

analog or digital circuits, devices, processors, applications specific integrated circuits (ASICs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), or any electronic devices. The term software generally refers to a logical structure, a method, a procedure, a program, a routine, a process, an algorithm, a formula, a function, an expression, etc. The term firmware generally refers to a logical structure, a method, a procedure, a program, a routine, a process, an algorithm, a formula, a function, an expression, etc., that is implemented or embodied in a hardware structure (e.g., flash memory, ROM, EPROM). Examples of firmware may include microcode, writable control store, micro-programmed structure. When implemented in software or firmware, the elements of an embodiment may be the code segments to perform the necessary tasks. The software/firmware may include the actual code to carry out the operations described in one embodiment, or code that emulates or simulates the operations. The program or code segments may be stored in a processor or machine accessible medium. The "processor readable or accessible medium" or "machine readable or accessible medium" may include any medium that may store information. Examples of the processor readable or machine accessible medium that may store include a storage medium, an electronic circuit, a semiconductor memory device, a read only memory (ROM), a flash memory, a Universal Serial Bus (USB) memory stick, an erasable programmable ROM (EPROM), a floppy diskette, a compact disk (CD) ROM, an optical disk, a hard disk, etc. The machine accessible medium may be embodied in an article of manufacture. The machine accessible medium may include information or data that, when accessed by a machine, cause the machine to perform the operations or actions described above. The machine accessible medium may also include program code, instruction or instructions embedded therein. The program code may include machine readable code, instruction or instructions to perform the operations or actions described above. The term "information" or "data" here refers to any type of information that is encoded for machine-readable purposes. Therefore, it may include program, code, data, file, etc. All or part of an embodiment may be implemented by various means depending on applications according to particular features, functions. These means may include hardware, software, or firmware, or any combination thereof. A hardware, software, or firmware element may have several modules coupled to one another. A hardware module is coupled to another module by mechanical, electrical, optical, electromagnetic or any physical connections. A software module is coupled to another module by a function, procedure, method, subprogram, or subroutine call, a jump, a link, a parameter, variable, and argument passing, a function return, etc. A software module is coupled to another module to receive variables, parameters, arguments, pointers, etc. and/or to generate or pass results, updated variables, pointers, etc. A firmware module is coupled to another module by any combination of hardware and software coupling methods above. A hardware, software, or firmware module may be coupled to any one of another hardware, software, or firmware module. A module may also be a software driver or interface to interact with the operating system running on the platform. A module may also be a hardware driver to configure, set up, initialize, send and receive data to and from a hardware device. An apparatus may include any combination of hardware, software, and firmware modules.

A configuration of a printing system according to a first exemplary embodiment of the present invention will be described with reference to FIG. **1**. In the following description of the first exemplary embodiment, scanning a document by an optical system moving method using a document positioning plate will be defined as "pressing plate reading". Scanning a document by a feed reading method using an ADF will be defined as "ADF reading".

In the first exemplary embodiment, a central processing unit (CPU) **114** instructs an image forming unit **151** to print an adjustment chart on a sheet for adjusting a shift at a printing position. Based on physical properties of the sheet, the CPU **114** then determines whether the printed adjustment chart can be scanned by ADF reading. If it is determined that the printed adjustment chart can be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select either of "scanning by ADF reading" and "scanning by pressing plate reading" to perform automatic adjustment of the printing position. On the other hand, if it is determined that the printed adjustment chart cannot be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select "scanning by pressing plate reading" to perform automatic adjustment of the printing position, but not "scanning by ADF reading". In the first exemplary embodiment, a method for adjusting the printing position is thus appropriately presented to the user based on the physical properties of the sheet on which the adjustment chart is printed.

A detailed description will be given below.

The printing system according to the present exemplary embodiment includes a printing apparatus **100** and a personal computer (PC) **101**, which is an example of an external apparatus.

The printing apparatus **100** includes an image reading function for reading a document to generate image data, and a print function for printing an image on a sheet based on the generated image data (i.e., copy function). The printing apparatus **100** also includes a print function for receiving a print job from the PC **101** and printing characters and/or images on a sheet based on data for which a print instruction is received (PC print function). The print functions may implement either color or monochrome printing.

A controller unit (control unit) **110** of the printing apparatus **100** is connected to the PC **101** via a network cable **105**. The controller unit **110** and the PC **101** are not limited to the configuration of being connected via the network cable **105**. The controller unit **110** and the PC **101** may be connected via a local area network (LAN). The controller unit **110** and the PC **101** may be connected via a wide area network (WAN) such as the Internet, or via a dedicated printer cable. FIG. **1** illustrates an example of a configuration where one PC **101** is connected to the printing apparatus **100** via the network cable **105**. However, it is not limited thereto. A plurality of PCs **101** may be connected to the printing apparatus **100** via the network cable **105**.

For example, the PC **101** generates image data by using application software, and transmits the generated image data to the printing apparatus **100**. The PC **101** also generates page description language (PDL) data, for example, by using application software and/or a printer driver. The controller unit **110** rasterizes the PDL data transmitted from the PC **101** via the network cable **105** to generate bitmap data. A program used for performing the rasterizing operation is stored in a read-only memory (ROM) **112** or a hard disk drive (HDD) **115** to be described below.

In the present exemplary embodiment, the PC **101** is described as an example of the external apparatus. However, it is not limited thereto. The external apparatus may be a portable information terminal such as a personal digital

assistance (PDA) and a smartphone, a network-connected device, or an external dedicated apparatus.

Next, a block diagram of the printing apparatus **100** according to the present exemplary embodiment will be described with reference to FIG. **1**. The printing apparatus **100** includes the controller unit **110**, a printer engine **150**, which is an image output device, the scanner unit **130**, which is an image input device, a feeding unit **140**, and an operation unit **120**. Such units are electrically connected with each other, and transmit and receive control commands and data to/from each other.

The controller unit **110** collectively controls an operation of the printing apparatus **100**, and performs input/output control of image information and device information. The controller unit **110** includes the CPU **114**, an input/output (I/O) control unit **111**, the ROM **112**, a random access memory (RAM) **113**, and the HDD **115** as a plurality of functional blocks. Such modules are connected to each other via a system bus **116**.

The CPU **114** is a processor for controlling the entire printing apparatus **100**. The CPU **114** collectively controls access with various connected devices based on a control program stored in the ROM **112**. The CPU **114** also collectively controls various types of processing performed in the controller unit **110**.

The I/O control unit **111** is a module for performing communication control with an external network.

The RAM **113** is a readable and writable memory. The RAM **113** also serves as a system work memory used for the CPU **114** operating. The RAM **113** stores image data input from the scanner unit **130** and the PC **101**, various programs, and setting information.

The ROM **112** is a read-only memory. The ROM **112** is a boot ROM. A boot program of the printing system is stored in the ROM **112** in advance.

The HDD **115** mainly stores information (system software) required to activate and operate the computer, and image data.

If the controller unit **110** includes a nonvolatile RAM (NVRAM) (not illustrated), the system software, image data, and setting information received via the operation unit **120** to be described below may be stored in the NVRAM.

The RAM **113** or the HDD **115** stores a sheet management table **400** for managing attribute information about sheets to be used for printing by the printing apparatus **100** in a list form. Details of the sheet management table **400** will be described below with reference to FIG. **4**.

The ROM **112** or the HDD **115** stores various control programs to be executed by the CPU **114**, necessary to perform various types of processing of flowcharts to be described below. The ROM **112** or the HDD **115** also stores a display control program for causing a displaying unit (not illustrated) of the operation unit **120** including a user interface screen (hereinafter, UI screen) to display various UI screens. The CPU **114** reads the programs stored in the ROM **112** or the HDD **115** and loads the programs into the RAM **113** to perform various operations according to the present exemplary embodiment.

The printer engine **150** includes the image forming unit **151** and a fixing unit **155**. Further, the image forming unit **151** includes a developing unit **152**, a photosensitive drum **153**, and a transfer belt **154**. Details of the image forming unit **151** and the fixing unit **155** will be described below with reference to FIG. **2**.

The scanner unit **130** scans an image of a document (sheet) by using an optical sensor to obtain scan image data. Details of the scanner unit **130** will be described below with reference to FIG. **3**.

The feeding unit **140** is a unit for feeding sheets from a plurality of sheet holding units (such as a sheet feeding cassette, a sheet feeding deck, and a manual tray). Each sheet holding unit can hold a plurality of types of sheets and can hold a plurality of sheets. The sheets held in the sheet holding unit are separated one by one from the top and conveyed to the image forming unit **151**. The image forming unit **151** prints an image on the sheet fed from the sheet holding unit based on image data input from the scanner unit **130** or the PC **101**.

The operation unit **120** corresponds to an example of a user interface unit. The operation unit **120** includes the displaying unit (not illustrated) and a key input unit (not illustrated). The operation unit **120** has a function for receiving various settings from the user via the displaying unit and the key input unit. The operation unit **120** also has a function for providing information to the user via the displaying unit.

The displaying unit includes a liquid crystal display (LCD) displaying unit and a touch panel sheet including transparent electrodes (may be of electrostatic capacity type) attached onto the LCD. The LCD displays an operation screen as well as a state of the printing apparatus **100**. The key input unit includes, for example, a start key used to instruct execution of scanning start or copying start, and a stop key used to instruct an operation stop of scanning or copying in operation.

Next, an example of a sectional view illustrating a configuration of the image forming unit **151** will be described with reference to FIG. **2**.

The image forming unit **151** forms a toner image on the periphery of the photosensitive drum **153** by using the developing unit **152** according to image data generated by the controller unit **110**.

The developing unit **152** is arranged to oppose the photosensitive drum **153**. The inside of the developing unit **152** is divided into a developing portion **202** and an agitation portion **203** by a partition wall **201** extending in a vertical direction.

A nonmagnetic developing sleeve **204** rotating in the direction of the arrow **241** is arranged in the developing portion **202**. A magnet **205** is fixedly arranged inside the developing sleeve **204**.

The developing sleeve **204** conveys a developer (e.g., two-component developer, including magnetic carrier and nonmagnetic toner) taken out by a blade **206**. The developing sleeve **204** supplies the developer to the photosensitive drum **153** in a developing area opposing the photosensitive drum **153**, whereby an electrostatic latent image on the photosensitive drum **153** is developed. To improve the developing efficiency, i.e., the rate of attachment of the toner to the electrostatic latent image, a developing bias voltage obtained by superposing an alternating-current voltage on a direct-current voltage is applied to the developing sleeve **204**.

Screws **207** and **208** for agitating the developer are arranged in the developing portion **202** and the agitation portion **203**, respectively. The screw **207** agitates the developer in the developing portion **202** and conveys the agitated developer. The screw **208** agitates toner **213** supplied from a toner discharge port **211** of a toner replenishment tank **210** by rotation of a conveyance screw **212**, and a developer **214**

already existing in the developing unit **152**. The screw **208** conveys the agitated developer to uniformize toner density.

The partition wall **201** has developer passages (not illustrated) for communicating the developing portion **202** and the agitation portion **203** with each other at near and far ends in FIG. **2**. The developer, of which the toner density has dropped due to toner consumption by the developing, in the developing portion **202** is moved into the agitation portion **203** through one of the developer passages by conveyance force of the screws **207** and **208**. The developer of which the toner density is restored in the agitation portion **203** is moved into the developing portion **202** through the other developer passage.

The photosensitive drum **153** is driven to rotate in the direction of the arrow **242**. A primary charging unit **220**, the developing unit **152**, a transfer unit **221**, and a drum cleaner **222** are arranged around the photosensitive drum **153** in this order in the rotation direction of the photosensitive drum **153**. The primary charging unit **220** uniformly charges the photosensitive drum **153**. The transfer unit **221** is intended to transfer a developed visible toner image to a sheet.

An image exposure device **223** is arranged above the photosensitive drum **153**. The image exposure device **223** includes a semiconductor laser, a polygon mirror, and a reflection mirror. The image exposure device **223** receives input of a digital pixel signal (video data) corresponding to an image converted into a digital signal by the controller unit **110**, and emits a laser beam modulated according to the digital pixel signal.

The image exposure device **223** irradiates the photosensitive drum **153** with the laser beam to scan the photosensitive drum **153** in its generatrix direction between the primary charging unit **220** and the developing unit **152**. A drum surface of the photosensitive drum **153** is thereby exposed to form an electrostatic latent image. The photosensitive drum **153** then rotates and the electrostatic latent image is developed into a visible toner image by the developing unit **152**.

The transfer belt **154** for conveying a sheet in the direction of the arrow **243** is arranged under the photosensitive drum **153**. The transfer belt **154** is stretched around a plurality of rollers.

A sheet fed from the feeding unit **140** is conveyed from the right side of the transfer belt **154**. The sheet is then borne on the transfer belt **154** by the action of attraction charging units **230** arranged opposing each other across the transfer belt **154**, and conveyed to the left side of the transfer belt **154** (in the direction of the arrow **243**). When the sheet passes between the photosensitive drum **153** and the transfer unit **221**, the visible toner image developed on the photosensitive drum **153** is transferred to the sheet by the action of the transfer unit **221**. The sheet to which the toner image is transferred is separated from the transfer belt **154** by a discharging charging unit **231**, and conveyed to the fixing unit **155**.

The sheet then passes between a pressure roller (not illustrated) and a heating roller (not illustrated) of the fixing unit **155**, whereby the toner is melted and pressed. As a result, the toner image is fixed to the sheet. After the transfer of the toner to the sheet, toner remaining on the photosensitive drum **153** is removed by the drum cleaner **222**.

Next, an example of sectional views illustrating a configuration of the scanner unit **130** will be described with reference to FIGS. **3**A and **3**B.

There are two methods for reading an image of a document **301**, namely, a feed reading method and an optical system moving method. In the feed reading method, the document **301** is placed on a document stacking unit (also referred to as a document tray) **340**. The document **301** is conveyed by an ADF while the image of the document **301** is read at a fixed position of an optical system. In the optical system moving method, the document **301** is placed on a platen glass (document positioning plate) **302**. The optical system is moved while reading the image of the document **301** at a fixed document position.

The scanner unit **130** according to the present exemplary embodiment will be described assuming a case where both a configuration for scanning the document **301** by using the ADF and a configuration for scanning the document **301** by using the document positioning plate are included therein. However, the present exemplary embodiment is not limited thereto. In the first exemplary embodiment, the scanner unit **130** may only be required to include at least either one of the configuration for scanning the document **301** by using the ADF and the configuration for scanning the document **301** by using the platen glass **302**.

An instruction to start a read operation (also referred to as a scan operation) of the image on the document **301** by the scanner unit **130** is given, for example, by the user pressing the start key for instructing a scanning start. Alternatively, an instruction to start the scan operation may be given, for example, by the user pressing a start button displayed on the displaying unit of the operation unit **120**.

The case of reading the image on the document **301** by using the document positioning plate will initially be described with reference to FIG. **3**A.

If an instruction to start the scan operation is given, to read the image on the document **301** placed on the platen glass **302**, a motor **312** is driven to once return a first mirror unit **303** and a second mirror unit **304** to a position where a home position sensor **305** is disposed. A document illumination lamp **306** is turned on to irradiate the document **301** with the light. Reflected light from the document **301** is transmitted via a first mirror **307** in the first mirror unit **303**, a second mirror **308** in the second mirror unit **304**, and a third mirror **309** in the second mirror unit **304**. The reflected light from the third mirror **309** is transmitted through a lens **310** to form an image on a charge coupled device (CCD) sensor **311**, and input to the CCD sensor **311** as a light signal.

The second mirror unit **304** moves at a half speed of the speed (V) of the first mirror unit **303**, i.e., V/2. The entire surface of the document **301** is scanned in such a manner.

In the present exemplary embodiment, the scanner unit **130** is described to include a reduction optical system with which the reflected light from the document **301** forms an image on the CCD sensor **311**. However, it is not limited thereto. The scanner unit **130** may include an equal magnification optical system with which the reflected light from the document **301** forms an image on a contact image sensor (CIS).

Next, the case of reading the image on the document **301** by using the ADF will be described with reference to FIG. **3**B.

If a document (not illustrated) is detected to be set on the document stacking unit **340** by a document detection sensor (not illustrated) arranged between a pickup roller **322** and a feed roller **323**, the scan operation of the document by using the ADF is started.

If an instruction to start the scan operation is received, then, a document feeding unit **341** separates the topmost sheet (document) of the document bundle by a friction separation method one by one, and conveys the separated document to a registration roller pair **324**. To feed the document, the pickup roller **322** moves down on the docu-

ment bundle and a lifting plate moves up to press the document bundle against the feed roller **323** to enter a preliminary operation for document feeding. With a motor (not illustrated) as a driving source, the feed roller **323** and the pickup roller **322** then rotate clockwise to convey the document. The second and subsequent sheets to be conveyed subsequent to the topmost sheet are stopped by a friction piece (not illustrated) and remain on the document stacking unit **340**. The separation of the document is detected by a separation sensor (not illustrated) arranged downstream from the feed roller **323**.

The separated document then passes between guide plates (not illustrated) and conveyed to the registration roller pair **324**. When the leading edge of the document reaches the registration roller pair **324**, the registration roller pair **324** is stopped. The conveyance by the feed roller **323** loops the document to correct skew, and the document is conveyed to a document conveyance unit **342**.

The document conveyance unit **342** rotates a conveyance belt **325**, which is stretched around a driving roller **326** and a driven roller **327**. The conveyance belt **325** is pressed against the platen glass **302** by pressure rolls **328**. The document conveyed to between the conveyance belt **325** and the platen glass **302** passes over the platen glass **302** by frictional force of the conveyance belt **325**.

The document conveyed from the document feeding unit **341** to the document conveyance unit **342** is conveyed to a predetermined position of the platen glass **302** by the conveyance belt **325**. Then, the driving motor (not illustrated) is stopped to stop conveyance. The scanner unit **130** then reads the image of the document by moving the first and second mirror units **303** and **304** illustrated in FIG. **3**A.

After the reading by the scanner unit **130** ends, the document is conveyed to a reversing discharge unit **343** by the conveyance belt **325**. At that time, a reversing flapper **331** for regulating the traveling path of the sheet near an inlet of the reversing discharge unit **343** is controlled by a solenoid (not illustrated) to convey the document to a reversing roller **329**. The document is then nipped between the reversing roller **329** rotating counterclockwise and a reversing roller **332** opposing the reversing roller **329**, and conveyed to a conveyance roller pair **330**.

When the trailing edge of the document reaches a point after passing through a discharge flapper **333**, the discharge flapper **333** turns clockwise and the reversing roller **329** makes reverse rotation, i.e., clockwise. This starts switchback conveyance of the document. In this way, the document conveyed by the clockwise rotation of the reversing roller **329** is discharged to a document discharge unit **344**. When there is a subsequent document, the subsequent document is conveyed to the predetermined position by the rotation of the conveyance belt **325** like the preceding document. The image of the document stopped at the reading position according to the stop of the driving motor is then read by the scanner unit **130** by moving the first and second mirror units **303** and **304** illustrated in FIG. **3**A. During the execution of such a scan operation, the preceding document is reversed by the reversing discharge unit **343**, which operates independently, and conveyed to the document discharge unit **344**.

In the example illustrated in FIG. **3**B, a method is described in which the document **301** is conveyed to the position at which the document **301** is read by using the document positioning plate, and the conveyance of the document **301** is stopped for scanning (optical system moving method), when the image of the document **301** is read by using the ADF. However, it is not limited thereto. For example, the method for reading the image of the document **301** by using the ADF may include conveying the document **301** at constant speed while scanning the document **301** by the scanner unit **130**, with the first and second mirror units **303** and **304** fixed at a position without moving them (feed reading method).

To scan the back surface of the document **301** by using the ADF, after the front surface of the document **301** is scanned, the document **301** may be reversed and conveyed to successively scan the back surface of the document **301** (referred to as two-sided reversing reading). Alternatively, if the scanner unit **130** includes two reading sensors above and below the conveyance path of the document **301**, the front and back surfaces of the document **301** may be simultaneously scanned by feed reading (referred to as two-sided simultaneous reading).

In the following description of the present exemplary embodiment, scanning the document **301** by the "optical system moving method using the document positioning plate" will be defined as "pressing plate reading". Scanning the document **301** by the "feed reading method using the ADF" will be defined as "ADF reading".

Next, details of the sheet management table **400** for managing the attribute information about the sheets used for printing in the printing apparatus **100** will be described with reference to FIG. **4**.

Examples of the sheets used for printing in the printing apparatus **100** include sheets to be used normally, sheets evaluated by printer makers, and user-defined sheets, which are standard sheets or evaluated sheets of which attribute information is customized by the user. The attribute information about such the plurality of sheets is stored in the RAM **113** or the HDD **115** in a list form using the sheet management table **400**. The pieces of data registered in the sheet management table **400** are digital information such as of Extensible Markup Language (XML) and comma-separated values (CSV). Software modules can read and write the sheet management table **400** stored in the RAM **113** or the HDD **115**.

Next, details of the data registered in the sheet management table **400** (attribute information about sheets) will be described below.

A sheet name **411** is information for identifying the sheets used for printing from each other.

A sheet length in a sub scanning direction **412**, a sheet length in a main scanning direction **413**, grammage of a sheet **414**, and a surface property of the sheet **415** are physical properties of the sheet used for printing. The surface property of the sheet **415** is an attribute for indicating a physical property of the surface of the sheet. Examples include "coated" which indicates the application of surface coating for improved glossiness, and "embossed" which indicates the presence of surface projections and depressions.

Color of a sheet **416** is an attribute for indicating the background color of the sheet. Preprinted paper **417** is information for identifying whether the sheet used for printing is preprinted paper.

The printing apparatus **100** adjusts a shift in the printing position with respect to a sheet at the time of execution of printing so that an image is printed at an ideal printing position. The amount of shift in the printing position with respect to the front surface of a sheet **420** is information indicating the amount of positional shift from an ideal printing position on the front surface of the sheet. The amount of shift in the printing position with respect to the back surface of a sheet **421** is information indicating the

amount of positional shift from an ideal printing position on the back surface of the sheet.

Examples of the amounts of shift in the printing position **420** and **421** include the amount of shift in the printing position in the sub scanning direction (hereinafter, referred to as the amount of shift in a lead position) with respect to the sheet. The lead position refers to the start position of printing an image, with the leading edge of the adjustment chart in the conveyance direction of the sheet as the origin. An initial value of the lead position is zero. When the amount of shift in the lead position is adjusted, the radiation start timing of the laser beam from the image exposure device **223** onto the photosensitive drum **153** is adjusted. As a result, the start position of printing the image with respect to the leading edge of the adjustment chart in the conveyance direction of the sheet can be changed.

Examples of the amounts of shift in the printing position **420** and **421** include the amount of shift in the printing position in the main scanning direction (hereinafter, referred to as the amount of shift in a side position) with respect to the sheet. The side position refers to the start position of printing an image, with the left edge of the adjustment chart in the conveyance direction of the sheet as the origin. An initial value of the side position is zero. When the amount of shift in the side position is adjusted, the radiation start timing of the laser light from the image exposure device **223** onto the photosensitive drum **153** is adjusted. As a result, the start position of printing the image with respect to the left edge of the adjustment chart in the conveyance direction of the sheet can be changed.

Examples of the amounts of shift in the printing position **420** and **421** include the amount of shift in an image length (magnification to an ideal length) in the sub scanning direction (hereinafter, referred to as sub scanning magnification) and the amount of shift in an image length (magnification to an ideal length) in the main scanning direction (hereinafter, referred to as main scanning magnification). Initial values of the sub scanning magnification and the main scanning magnification are zero. The sub scanning magnification is adjusted by controlling a driving speed of the transfer belt **154**. On the other hand, the main scanning magnification is adjusted by controlling a clock frequency of the laser beam when the image exposure device **223** modulates the digital image signal into the laser beam.

The amounts of shift in the printing position **420** and **421** are calculated by the scanner unit **130** scanning an adjustment chart on which predetermined marks are printed, and detecting the positions of the marks on the adjustment chart. Details of the adjustment chart on which the predetermined marks are printed will be described below with reference to FIG. **6**.

As described above, it is described that the amounts of shift in the printing position **420** and **421** are adjusted, for example, by adjusting the radiation timing of the laser beam. However, it is not limited thereto. A shift in the printing position may be adjusted by shifting the image to be printed on the sheet itself by a predetermined amount during printing. When the amounts of shift in the printing position are adjusted, the user may be allowed to arbitrarily designate the amounts of shift of the image to be printed on the sheet.

The user can edit the attribute information about the sheets registered in the sheet management table **400** and additionally register a new sheet into the sheet management table **400** by using an editing screen **500** illustrated in FIG. **5**A. For example, the editing screen **500** is displayed on the displaying unit of the operation unit **120** or a monitor (not illustrated) of the PC **101**.

A sheet selected by the user via the editing screen **500** is highlighted. In the example illustrated in FIG. **5**A, the sheet "XYZ paper co., color **81**" is highlighted. The user can press a button **501** on the editing screen **500** to add a new sheet to be registered in the sheet management table **400**. The user can press a button **502** on the editing screen **500** to edit the attribute information about the selected sheet (highlighted sheet). If the button **501** or **502** is pressed by the user, an editing screen **510** illustrated in FIG. **5**B is called. For example, the editing screen **510** is displayed on the displaying unit of the operation unit **120** or the monitor (not illustrated) of the PC **101**.

On the editing screen **510**, the user can input respective pieces of data about, for example, the sheet name, sheet length in the sub scanning direction, sheet length in the main scanning direction, grammage, surface property, color, and preprinted paper. The surface property is selected from a list of surface properties that can be supported by the printing apparatus **100**. The color is selected from a list of colors registered in advance. If the user inputs the pieces of data and then presses a button **511** on the editing screen **510**, the data (attribute information about the sheet) input at that time is finalized and registered in the sheet management table **400**.

On the editing screen **510**, the user can input attribute information about the sheet name, sheet length in the sub scanning direction, sheet length in the main scanning direction, grammage, surface property, and color. For the surface property, the user selects one from the list of surface properties that can be supported by the printing apparatus **100**. For the color, the user can select arbitrary one from the list of colors registered in advance. On the editing screen **510**, the user can input information about whether the sheet to be edited is preprinted paper.

If the user presses an end editing button **511** on the editing screen **510**, the sheet attributes input at that time are finalized and registered in the sheet management table **400**.

The user can press a button **503** on the editing screen **500** to perform a series of processing for adjusting the printing position with respect to the selected sheet (highlighted sheet). Details of the series of processing for adjusting the printing position will be described below with reference to FIGS. **8** to **10**.

Next, an example of a schematic diagram illustrating an adjustment chart used to adjust the printing position will be described with reference to FIG. **6**.

Image data for an adjustment chart **601** is stored in the RAM **113** or the HDD **115**. When printing the adjustment chart **601**, the image data on the adjustment chart **601** is read from the RAM **113** or HDD **115** and transferred to the printer engine **150**.

When the printing position on the front surface is adjusted with respect to a sheet, the marks **620** are printed at specific positions (for example, on four corners) of the front surface of the sheet. When the printing position on the back is adjusted with respect to the sheet, the marks **620** are printed at specific positions (e.g., on four corners) of the back surface of the sheet. The marks **620** are formed by using toner of a color that has a large difference in reflectance with respect to a normal sheet (e.g., black toner). In this way, four marks **620** are printed on the front surface and four on the back surface of the adjustment chart **601** (i.e., a total of eight marks **620**).

An image **610** for identifying the conveyance direction of the adjustment chart **601** and an image **612** for identifying the front or back surface of the adjustment chart **601** are printed on the front surface of the adjustment chart **601**. An

image **611** for identifying the conveyance direction of the adjustment chart **601** and an image **613** for identifying the front or back surface of the adjustment chart **601** are printed on the back surface of the adjustment chart **601**.

In other words, to position two-sided images when two-sided printing is performed, the images **610** and **612** are printed on the front surface of the adjustment chart **601**, and the images **611** and **613** are printed on the back surface of the adjustment chart **601**. On the other hand, to adjust the printing position when one-sided printing is performed, at least the images **610** and **612** are printed on the front surface of the adjustment chart **601**.

The images **610** and **611** for identifying the conveyance direction of the adjustment chart **601** have only to be printed when the adjustment chart **601** is scanned by ADF reading. When the adjustment chart **601** is scanned by pressing plate reading, the images **610** and **611** do not need to be printed.

As illustrated in FIG. **6**, examples of the images **610** and **611** are arrows with which the user can identify the conveyance direction of the adjustment chart **601**. On the other hand, examples of the images **612** and **613** are characters with which the user can identify the front and back surfaces of the adjustment chart **601**.

The marks **620**, if printed at ideal positions, are arranged to be printed at positions with predetermined distances from the edges of the adjustment chart **601**. The positions of the marks **620** printed on the front surface of the adjustment chart **601** are measured to calculate (or obtain) the amount of shift in the printing position on the front surface of the sheet.

The position of the marks **620** printed on the back surface of the adjustment chart **601** is measured to calculate (or obtain) the amount of shift in the printing position on the back surface of the sheet.

Relative positions between the respective marks **620** printed on the front and back surfaces of the adjustment chart **601** may be measured to calculate (or obtain) the amounts of shifts in the printing position on the back surface with respect to the printing position on the front surface, or the amounts of shifts in the printing position on the front surface with respect to the printing position on the back surface.

Next, a case of adjusting the printing position by using the adjustment chart **601** will be described below with reference to FIG. **6**.

To measure the positions of the marks **620** on the front and back surfaces of the adjustment chart **601**, portions (a) to (j) on the front surface of the adjustment chart **601** and portions (k) to (r) on the back surface of the adjustment chart **601** are measured, respectively.

The portion (a) is the length of the adjustment chart **601** in the sub scanning direction. The portion (b) is the length of the adjustment chart **601** in the main scanning direction. The ideal length of the portion (a) is the sheet length in the sub scanning direction **412** registered in the sheet management table **400**. The ideal length of the portion (b) is the sheet length in the main scanning direction **413** registered in the sheet management table **400**. The lengths of the portions (c) to (r) are the distances from the respective marks **620** to the closest edges of the adjustment chart **601**.

The lengths of the portions (a) to (r) may be measured by a manual measurement method or an automatic calculation method. In the manual measurement method, the user actually measures the lengths of the portions (a) to (r) of the adjustment chart **601** by using a ruler.

On the other hand, in the automatic calculation method, the scanner unit **130** scans the adjustment chart **601**. Then, the CPU **114** analyzes the image data generated by reading the images of the adjustment chart **601**. As a result of the analysis, the CPU **114** detects the edges of the adjustment chart **601** and the edges of the marks **620** (i.e., the borders between the background of the adjustment chart **601** and the marks **620**) based on a difference in density. Then, the CPU **114** calculates the lengths of the portions (a) to (r) from the detected edges of the adjustment chart **601** and the edges of the marks **620**. Details of the processing for analyzing the image data on the adjustment chart **601** will be described below with reference to FIG. **8**.

Next, a method for calculating the amounts of shift in the printing position based on the measured positions of the marks **620** will be described with reference to FIG. **7**.

FIG. **7** illustrates a table **700** which defines measurement value **710**, ideal value **711**, and the amount of shift in the printing position **712** of the "lead position", "side position", "main scanning magnification", and "sub scanning magnification" on the front and back surfaces of the adjustment chart **601**. The table **700** is stored in the RAM **113** or the HDD **115**.

For example, the measurement value **710** of the "lead position" on the front surface of the adjustment chart **601** is calculated from the actually measured values of the portions (c) and (e) illustrated in FIG. **6** by using the formula illustrated in the table **700**. More specifically, the lead position is an average of the distances from the leading edge of the adjustment chart **601** in the conveyance direction of the sheet to the respective corresponding marks **620**.

For example, the measurement value **710** of the "side position" on the front surface of the adjustment chart **601** is calculated from the actually measured values of the portions (f) and (j) illustrated in FIG. **6** by using the formula illustrated in the table **700**. More specifically, the side position is an average of the distances from the left edge of the adjustment chart **601** in the conveyance direction of the sheet to the respective corresponding marks **620**.

For example, the measurement value **710** of the "main scanning magnification" on the front surface of the adjustment chart **601** is calculated from the actually measured values of the portions (b), (d), (f), (h), and (j) illustrated in FIG. **6** by using the formula illustrated in the table **700**. More specifically, the main scanning magnification is an average of the distances between the marks **620** arranged on the same scanning lines in the main scanning direction.

For example, the measurement value **710** of the "sub scanning magnification" on the front surface of the adjustment chart **601** is calculated from the actually measured values of the portions (a), (c), (e), (g), and (i) illustrated in FIG. **6** by using the formula illustrated in the table **700**. More specifically, the sub scanning magnification is an average of the distances between the marks **620** arranged on the same scanning lines in the sub scanning direction.

As illustrated in the table **700**, the ideal values **711** of the "lead position" and the "side position" are both 1 cm. In other words, the marks **620** can ideally be printed at positions 1 cm from the respective corresponding edges of the adjustment chart **601**.

As illustrated in the table **700**, the ideal value **711** of the "main scanning magnification" is a value obtained by subtracting 2 cm from the sheet length in the main scanning direction of each sheet registered in the sheet management table **400**. Similarly, the ideal value **711** of the "sub scanning magnification" is a value obtained by subtracting 2 cm from the sheet length in the sub scanning direction of each sheet registered in the sheet management table **400**.

As illustrated in the table **700**, the amounts of shift in the printing position **712** in terms of the "lead position", "side position", "main scanning magnification", and "sub scanning magnification" are calculated by using the respective corresponding measurement values **710** and ideal values **711**.

More specifically, the amounts of shift in the printing position **712** of the "lead position" and the "side position" are calculated by subtracting the ideal values **711** from the measurement values **710** (in units of "mm"). The amounts of shift in the printing position **712** of the "main scanning magnification" and the "sub scanning magnification" are calculated by subtracting the ideal values **711** from the measurement values **710**, divided by the ideal values **711** (in units of "%").

The amounts of shift in the printing position **712** calculated above are registered in the sheet management table **400** as the attribute information about the sheet.

Next, a method for detecting image edges of the adjustment chart **601** and image edges of the marks **620** based on image data **800** generated by scanning the adjustment chart **601** by the scanner unit **130** will be described with reference to FIGS. **8**A and **8**B.

In the example illustrated in FIGS. **8**A and **8**B, the adjustment chart **601** is assumed to be scanned by pressing plate reading, with a backing sheet (not illustrated) of a black image put over the adjustment chart **601** that is placed on the platen grass **302**. To scan the adjustment chart **601** by ADF reading, an adjustment chart (not illustrated) obtained by forming black marks in contact with part of the edges of the adjustment chart **601** may be scanned instead of the scanning with the backing sheet. In such a case, the same description applies.

Part of the image data **800** generated by scanning the adjustment chart **601** by pressing plate reading will be described with reference to FIG. **8**A.

An area **801** is an image data area of the image data **800** based on the backing sheet (not illustrated). An area **802** is an image data area of the image data **800** based on the background of the adjustment chart **601**. Areas **803** are image data areas of the image data **800** based on the marks **620** of the adjustment chart **601**. Edges **810** are the edges of the area **802** (i.e., the image edges of the adjustment chart **601**). Edges **812** are the edges of the areas **803** (i.e., the image edges of the marks **620**).

Analysis ranges **811** are ranges where the image data **800** is analyzed therein (in other words, ranges of interest of analysis processing). The image data **800** is analyzed by measuring changes in density in the main scanning direction and the sub scanning direction from the image edges of the image data **800** in units of pixels. The CPU **114** then detects the areas **801**, **802**, and **803**, and the edges **810** and **812** from the measurement result. The units of measurement may be smaller than or greater than pixels. The reading may be performed at regular pitches or in a thinned manner.

Next, an example of an analysis result of the image data **800** in an analysis range **811** will be described with reference to FIG. **8**. The measurement of the density of the image data **800** in the analysis range **811** starts at an image edge of the image data **800**.

First, the CPU **114** detects the density of the area **801** (corresponding to a section (A) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **802** lying between the areas **801** and **803** (corresponding to a section (B) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **803** lying between the areas **802** and **812** (corresponding to a section (C) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **802** lying between the areas **803** (corresponding to a section (D) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **803** lying between the areas **802** (corresponding to a section (E) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **802** lying between the areas **803** and **801** (corresponding to a section (F) in FIGS. **8**A and **8**B). Then, the CPU **114** detects the density of the area **801** (corresponding to a section (G) in FIGS. **8**A and **8**B).

Based on these measurement results, the CPU **114** calculates the ranges of the images printed on the adjustment chart **601** from the measured positions of the sections (A) to (G) of the image data **800**. The CPU **114** further detects that the areas **803** in the sections (C) and (E) are based on the density of the marks **620** printed on the printing apparatus **601**. The CPU **114** further detects that the areas **801** in the sections (A) and (G) are based on the density of the background of the backing sheet (not illustrated).

From such a detection result, the CPU **114** detects a point where the density switches between the sections (A) and (B) as an edge **810** (i.e., image edge (left edge) of the adjustment chart **601**). The CPU **114** further detects a point where the density switches between the sections (B) and (C) as an edge **812** (i.e., image edge (left edge) of the left mark **620**). The CPU **114** further detects a point where the density switches between the sections (C) and (D) as an edge **812** (i.e., image edge (right edge) of the left mark **620**). The CPU **114** further detects a point where the density switches between the sections (D) and (E) as an edge **812** (i.e., image edge (left edge) of the right mark **620**). The CPU **114** further detects a point where the density switches between the sections (E) and (F) as an edge **812** (i.e., image edge (right edge) of the right mark **620**). The CPU **114** further detects a point where the density switches between the sections (F) and (G) as an edge **810** (i.e., image edge (right edge) of the adjustment chart **601**).

Based on the above-described detection result, the CPU **114** then calculates the distance from the image edge (left edge) of the adjustment chart **601** to the image edge (left edge) of the left mark **620** as the length of the portion (c) of the adjustment chart **601**.

The CPU **114** further calculates the distance from the image edge (right edge) of the right mark **620** to the image edge (right edge) of the adjustment chart **601** as the length of the portion (g) of the adjustment chart **601**.

The CPU **114** further calculates the distance from the image edge (left edge) of the adjustment chart **601** to the image edge (right edge) of the adjustment chart **601** as the length of the portion (a) of the adjustment chart **601**.

While the method of calculating the lengths of the portions (c) and (g) of the adjustment chart **601** is described above, the lengths of the portions (e) and (i), (d) and (f), and (h) and (j) of the adjustment chart **601** can also be calculated by a similar way. While the method for calculating the length of the portion (a) of the adjustment chart **601** is described above, the length of the portion (b) of the adjustment chart **601** can also be calculated by a similar way.

In this way, since the image edges of the adjustment chart **601** and the image edges of the marks **620** are detected, the CPU **114** can automatically calculate the lengths of the portions (a) to (r) of the adjustment chart **601**.

In the first exemplary embodiment, the CPU **114** instructs the image forming unit **151** to print the adjustment chart **601** on a sheet used for adjusting a shift in the printing position. Then, the CPU **114** determines whether the printed adjustment chart **601** can be scanned by ADF reading, based on the physical properties of the sheet. If the CPU **114** determines

that the printed adjustment chart **601** can be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select either of "scanning by ADF reading" and "scanning by pressing plate reading" to perform automatic adjustment of the printing position. On the other hand, if the CPU **114** determines that the printed adjustment chart **601** cannot be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select "scanning by pressing plate reading" to perform automatic adjustment of the printing position, but not "scanning by ADF reading". In the first exemplary embodiment, a method for adjusting the printing position is thus appropriately presented to the user based on the physical properties of the sheet on which the adjustment chart **601** is printed.

A detailed description will be given below.

A series of processing by which the printing apparatus **100** according to the first exemplary embodiment adjusts the printing position will be described with reference to the flowchart illustrated in FIG. **9**. Such processing is performed by the CPU **114** of the controller unit **110** executing a control program that is read from the ROM **112** or the HDD **115** and loaded into the RAM **113**. The processing in FIG. **9** is started, for example, in a state where the editing screen **500** illustrated in FIG. **5**A is displayed on the displaying unit of the operation unit **120**.

In step S**901**, the CPU **114** receives selection of a sheet for adjusting the printing position from the user on the editing screen **500**. Then, the processing proceeds to step S**902**. If the user presses the button **503** with a sheet highlighted on the editing screen **500**, the highlighted sheet is selected as the sheet for adjusting the printing position.

In step S**902**, the CPU **114** obtains the physical properties (e.g., the sheet length in the sub scanning direction **412**, the sheet length in the main scanning direction **413**, the grammage of the sheet **414**, and the surface property of the sheet **415**) of the sheet selected in step S**901**. Then, the processing proceeds to step S**903**. In addition, the CPU **114** obtains the physical properties of the sheet selected in step S**901** by referring to the attribute data (sheet lengths, grammage, and surface property) of the sheet registered in the sheet management table **400**.

In step S**903**, the CPU **114** determines whether the sheet selected in step S**901** (i.e., the sheet for adjusting the printing position) can be scanned by ADF reading. The CPU **114** determines whether the sheet can be scanned by ADF reading, based on the physical properties of the sheet obtained in step S**902**.

For example, if the length of the sheet in the main scanning direction is greater than a maximum guide width of the document stacking unit **340** of the ADF, the sheet cannot be set on the document stacking unit **340**. Therefore, the CPU **114** determines that the sheet cannot be scanned by ADF reading.

A specific example will be described here. The length of a sheet of "A**3** size" in the main scanning direction is 297 mm. If the document stacking unit **340** has a maximum guide width of 297 mm, a sheet of "12×18 size" having a length of 304.8 mm in the main scanning direction or a sheet of "13×19 size" having a length of 330.2 mm in the main scanning direction is unable to be set on the document stacking unit **340**. A sheet of "12×18" size and a sheet of "13×19" size can be stored in a sheet holding unit such as a sheet feeding cassette, a sheet feeding deck, and a manual tray, and therefore images can be printed on such sheets. Thus, there are sizes of sheets that are printable by the image forming unit **151** but not able to be scanned by ADF reading.

For example, if a sheet has a grammage beyond the range of grammage supported as being capable of scanning by ADF reading, the sheet corresponds to a parameter condition that can cause a jam on the conveyance path of the ADF. Therefore, the CPU **114** determines that the sheet cannot be scanned by ADF reading.

A specific example will be described here. If the range of grammage supported as being capable of scanning by ADF reading is 64 g/m^2 to 150 g/m^2, a sheet having a grammage of 181 g/m^2 cannot be scanned by ADF reading.

For example, if the type of the sheet is "tab paper" or "cardboard", the stiffness of the sheet is so high (i.e., the sheet is so stiff) that a jam can occur on the conveyance path of the ADF. For example, if the type of the sheet is "overhead projector (OHP) sheet" or "transparent film", the stiffness of the sheet is so low (i.e., the sheet is so soft) that a jam can occur on the conveyance path of the ADF. If the type of the sheet is a specific one (e.g., "tab paper", "cardboard", "OHP sheet", and "transparent film"), the CPU **114** determines that the sheet cannot be scanned by ADF reading.

As a result of the determination in step S**903**, if the CPU **114** determines that the sheet can be scanned by ADF reading (YES in step S**903**), the processing proceeds to step S**904**. On the other hand, if the CPU **114** determines that the sheet cannot be scanned (NO in step S**903**), the processing proceeds to step S**905**.

In step S**904**, the CPU **114** displays a selection screen **1010** (also referred to as a first reception screen) illustrated in FIG. **10**A on the displaying unit of the operation unit **120**. Then, the processing proceeds to step S**906**. The selection screen **1010** is a screen for allowing the user to select one from among performing automatic adjustment of the adjustment chart **601** by pressing plate reading **1001**, performing automatic adjustment by ADF reading **1002**, and manual adjustment **1003** as a method for adjusting the printing position.

In step S**905**, the CPU **114** displays a selection screen **1020** (also referred to as a second reception screen) illustrated in FIG. **10**B on the displaying unit of the operation unit **120**. Then, the processing proceeds to step S**906**. The selection screen **1020** is a screen for allowing the user to select either performing automatic adjustment of the adjustment chart **601** by pressing plate reading **1001** or manual adjustment **1003** as a method for adjusting the printing position. Unlike the selection screen **1010**, the selection screen **1020** is configured so that the user cannot give an instruction to perform automatic adjustment of the adjustment chart **601** by ADF reading. While FIG. **10**B illustrates the selection screen **1020** where the button **1002** is hidden, the button **1002** may be displayed by a gray-out display. A warning message (not illustrated) that "the automatic adjustment of the adjustment chart **601** cannot be performed by ADF reading" may be further displayed over the selection screen **1020**.

In step S**906**, the CPU **114** determines whether a method for adjusting the printing position is selected by the user on either of the selection screens **1010** and **1020**. If any one of the buttons **1001**, **1002**, and **1003** on the selection screen **1010** and the buttons **1001** and **1003** on the selection screen **1020** is pressed (YES in step S**906**), the processing proceeds to step S**907**. If none of the buttons **1001**, **1002**, and **1003** on the selection screen **1010** and the buttons **1001** and **1003** on the selection screen **1020** is pressed (NO in step S**906**), the processing of step S**906** is repeated.

In step S**907**, the CPU **114** determines whether manual adjustment is selected by the user as the method for adjust-

ing the printing position. If the button **1003** on the selection screen **1010** or the button **1003** on the selection screen **1020** is pressed (YES in step S**907**), the processing proceeds to step S**909**. On the other hand, if the button **1001** or **1002** on the selection screen **1010** or the button **1001** on the selection screen **1020** is pressed (NO in step S**906**), the processing proceeds to step S**908**.

In step S**908**, the CPU **114** determines whether automatic adjustment (reading by ADF) is selected by the user as the method for adjusting the printing position. If the button **1002** on the selection screen **1010** is pressed (YES in step S**908**), the processing proceeds to step S**1500**. In step S**1500**, the CPU **114** performs automatic adjustment of the printing position by scanning the adjustment chart **601** by ADF reading. Then, the processing proceeds to step S**912**. Details of the processing of step S**1500** will be described below with reference to FIG. **12**.

On the other hand, if the button **1001** on the selection screen **1010** or the button **1001** on the selection screen **1020** is pressed (NO in step S**908**), the CPU **114** determines it to be "NO" and the processing proceeds to step S**1100**. In step S**1100**, the CPU **114** performs automatic adjustment of the printing position by scanning the adjustment chart **601** by pressing plate reading. Then, the processing proceeds to step S**912**. Details of the processing of step S**1100** will be described below with reference to FIG. **11**.

In step S**909**, the CPU **114** instructs the image forming unit **151** to print the adjustment chart **601** on the sheet selected in step S**901**. Receiving the print instruction, the image forming unit **151** prints the adjustment chart **601** on the selected sheet fed from the feeding unit **140**. The sheet on which the adjustment chart **601** is printed is discharged from the printing apparatus **100**. After the processing of step S**909**, the processing proceeds to step S**910**.

In step S**910**, the CPU **114** receives input of the lengths (actually measured values) of the portions (a) to (r) manually measured from the user on the editing screen **510** illustrated in FIG. **5**B. Then, the processing proceeds to step S**911**.

In step S**911**, the CPU **114** calculates the amounts of shift in the printing position **712** based on the lengths of the portions (a) to (r) input in step S**910**. Then, the processing proceeds to step S**912**. The amounts of shift in the printing position **712** are calculated by using the formulas described above with reference to FIG. **7**.

In step S**912**, the CPU **114** registers the amounts of shift in the printing position **712** into the sheet management table **400** as those with respect to the sheet selected on the editing screen **500**. For example, in step S**912**, the lead positions, side positions, main scanning magnifications, and sub scanning magnifications are registered as information indicating the amounts of shift in the printing position on the front surface **420** and the amounts of shift in the printing position on the back surface **421** with respect to the sheet selected in step S**901**. After the processing of step S**912**, the series of processing related to FIG. **9** ends.

That is the details of the series of processing for adjusting the printing position (FIG. **9**).

Next, a series of processing for performing automatic adjustment of the printing position by scanning the adjustment chart **601** by pressing plate reading will be described with reference to the flowchart illustrated in FIG. **11**. Such processing is performed by the CPU **114** of the controller unit **110** executing a control program that is read from the ROM **112** or the HDD **115** and loaded into the RAM **113**.

In step S**1101**, the CPU **114** displays a designation screen **1200** illustrated in FIG. **12** on the displaying unit of the operation unit **120**. Then, the processing proceeds to step S**1102**. The designation screen **1200** is a screen for receiving designation of the number of adjustment charts **601** to print for adjusting the printing position from the user. A plurality (e.g., ten) of adjustment charts **601** can be scanned and the amounts of shift in the printing position can be averaged to increase the accuracy of the amounts of shift in the printing position. Therefore, the user designates, on the designation screen **1200**, the number of adjustment charts **601** to print for adjusting the printing position.

In step S**1102**, the CPU **114** receives the designation of the number of adjustment charts **601** to print from the user on the designation screen **1200**. Then, the processing proceeds to step S**1103**.

In step S**1103**, the CPU **114** instructs the image forming unit **151** to print the adjustment charts **601** as many as designated in step S**1102**. At that time, the image data of the adjustment chart **601** is read from the RAM **113** or the HDD **115** and transferred to the printer engine **150**. Receiving the print instruction, the image forming unit **151** prints the adjustment chart **601** on the sheets fed from the feeding unit **140** (i.e., the sheet selected in step S**901**). The sheets on which the adjustment chart **601** is printed are discharged from the printing apparatus **100**. After the processing of step S**1103**, the processing proceeds to step S**1104**.

In step S**1104**, the CPU **114** displays a confirmation screen **1310** (referred to as a first confirmation screen) illustrated in FIG. **13**A on the displaying unit of the operation unit **120**. The confirmation screen **1310** is a screen for prompting the user to set an adjustment chart **601** on the platen glass **302** (document positioning plate) so that the images on the front surface of the adjustment chart **601** are read. If the user presses a button **1311** (start reading button) on the confirmation screen **1310**, the processing proceeds to step S**1105**.

In step S**1105**, the CPU **114** instructs the scanner unit **130** to scan the adjustment chart **601** printed in step S**1103** by pressing plate reading. Then, the processing proceeds to step S**1106**.

In step S**1106**, the CPU **114** performs image analysis on image data generated by scanning the adjustment chart **601**. The CPU **114** performs the image analysis on the image data by the method described above with reference to FIGS. **8**A and **8**B. Based on the image analysis, the CPU **114** detects the image edges of the adjustment chart **601** and the image edges of the marks **620**, focusing on a difference in density. Then, the processing proceeds to step S**1107**.

In step S**1107**, the CPU **114** determines whether the image edges of the adjustment chart **601** and the image edges of the marks **620** are successfully detected as a result of the detection processing in step S**1106**. If the CPU **114** determines that the detection has succeeded (YES in step S**1107**), the processing proceeds to step S**1108**. On the other hand, if the CPU **114** determines that the detection has failed (NO in step S**1107**), the processing proceeds to step S**1116**. Examples of the case where the CPU **114** determines it to be "NO" in step S**1107** include a case where a difference in density between the background of the sheet on which the adjustment chart **601** is printed and the marks **620** is so small that the image edges of the marks **620** fail to be properly detected.

In step S**1108**, the CPU **114** determines whether the back surface of the adjustment chart **601** is scanned by the scan processing in step S**1105**. The CPU **114** can determine which side of surface of the adjustment chart **601** is scanned, the front surface or back surface, by performing image analysis on the image data based on the image **612** or **613** for identifying the front or back surface of the adjustment chart **601**. If the CPU **114** determines that the back surface is

scanned (YES in step S1108), the processing proceeds to step S1111. On the other hand, if the CPU 114 determines that the back surface is not scanned (NO in step S1108), the processing proceeds to step S1109.

In step S1109, the CPU 114 calculates the lengths of the portions (a) to (j) illustrated in FIG. 6 from the image edges of the adjustment chart 601 and the image edges of the marks 620 detected in step S1106. Then, the processing proceeds to step S1110.

In step S1110, the CPU 114 displays a confirmation screen 1320 (referred to as a second confirmation screen) illustrated in FIG. 13B on the displaying unit of the operation unit 120. The confirmation screen 1320 is a screen for prompting the user to set the adjustment chart 601 on the platen glass 302 (document positioning plate) so that the images on the back surface of the adjustment chart 601 are read. If the user presses a button 1321 (start reading button) on the confirmation screen 1320, the processing returns to step S1105 and the CPU 114 continues the subsequent processing.

In step S1111, the CPU 114 calculates the lengths of the portions (k) to (r) illustrated in FIG. 6 from the image edges of the adjustment chart 601 and the image edges of the marks 620 detected in step S1106. Then, the processing proceeds to step S1112.

In step S1112, the CPU 114 calculates the amounts of shift in the printing position 712 based on the lengths of the portions (a) to (j) calculated in step S1109 and the lengths of the portions (k) to (r) calculated in step S1111. Then, the processing proceeds to step S1113. The amounts of shift in the printing position 712 are calculated by using the formulas described above with reference to FIG. 7.

In step S1113, the CPU 114 determines whether the amounts of shift in the printing position have been calculated for the number of printed adjustment charts 601 (i.e., the number of adjustment charts 601 designated in step S1102). The CPU 114 performs the determination processing of step S1113 by storing the number of times of processing of step S1112 into the HDD 115 or the RAM 113 as a counter, and comparing the value of the stored counter with the number of adjustment charts 601 designated in step S1102. As a result of the determination in step S1113, if the CPU 114 determines it to be "YES" (YES in step S1113), the processing proceeds to step S1115. On the other hand, if the CPU 114 determines it to be "NO" (NO in step S1113), the processing proceeds to step S1114.

In step S1114, the CPU 114 displays the confirmation screen 1310 (first confirmation screen) illustrated in FIG. 13A on the displaying unit of the operation unit 120. If the user presses the button 1311 (start reading button) on the confirmation screen 1310, the processing returns to step S1105 and the CPU 114 continues the subsequent processing.

In step S1115, the CPU 114 calculates average values of the amounts of shift in the printing position for the number of printed adjustment charts 601, based on the amounts of shift in the printing position calculated in step S1112. The CPU 114 then determines the average values calculated in step S1115 to be the amounts of shift in the printing position with respect to the sheet selected in step S901 of FIG. 9. After the processing of step S1115, the series of processing related to FIG. 11 ends. Then, the processing proceeds to step S912 of FIG. 9.

In step S1116, the CPU 114 displays an error screen 1400 illustrated in FIG. 14 on the displaying unit of the operation unit 120. The error screen 1400 is a screen for notifying the user that the analysis of the image data on the adjustment chart 601 failed and the printing position has not been adjusted. After the processing of step S1116, the series of processing related to FIG. 11 ends and the series of processing related to FIG. 9 ends.

That is the details of the series of processing (step S1100 in FIG. 11) for performing automatic adjustment of the printing position by scanning the adjustment chart 601 by pressing plate reading.

Next, a series of processing for performing automatic adjustment of the printing position by scanning the adjustment chart 601 by ADF reading will be described with reference to the flowchart illustrated in FIG. 15. The processing is performed by the CPU 114 of the controller unit 110 executing a control program that is read from the ROM 112 or the HDD 115 and loaded into the RAM 113.

In step S1501, the CPU 114 displays the designation screen 1200 illustrated in FIG. 12 on the displaying unit of the operation unit 120. Then, the processing proceeds to step S1502.

In step S1502, the CPU 114 receives designation of the number of adjustment charts 601 to print from the user on the designation screen 1200. Then, the processing proceeds to step S1503.

In step S1503, the CPU 114 instructs the image forming unit 151 to print adjustment charts 601 as many as designated in step S1502. At that time, the image data on the adjustment chart 601 is read from the RAM 113 or the HDD 115 and transferred to the printer engine 150. Receiving the print instruction, the image forming unit 151 prints the adjustment chart 601 on the sheets fed from the feeding unit 140 (i.e., the sheet selected in step S901). The sheets on which the adjustment chart 601 is printed are discharged from the printing apparatus 100. After the processing of step S1503, the processing proceeds to step S1504.

In step S1504, the CPU 114 displays a confirmation screen 1600 (referred to as a third reception screen) illustrated in FIG. 16 on the displaying unit of the operation unit 120. The confirmation screen 1600 is a screen for prompting the user to set the adjustment charts 601 on the document stacking unit 304 (document tray) of the ADF to read the images on the front and back surfaces of the adjustment charts 601. If the user presses a button 1601 (start reading button) on the confirmation screen 1600, the processing proceeds to step S1505.

In step S1505, the CPU 114 instructs the scanner unit 130 to scan the front and back surfaces of the adjustment chart 601 printed in step S1503 by ADF reading. Then, the processing proceeds to step S1506.

In step S1506, the CPU 114 performs image analysis on image data generated by scanning the front and back surfaces of the adjustment chart 601. The CPU 114 performs the image analysis on the image data by the method described above with reference to FIGS. 8A and 8B. Based on the image analysis, the CPU 114 detects the image edges of the adjustment chart 601 (front and back surfaces) and the image edges of the marks 620, focusing on a difference in density. The processing proceeds to step S1507.

In step S1507, the CPU 114 determines whether the image edges of the adjustment chart 601 (front and back surfaces) and the image edges of the marks 620 are successfully detected as a result of the detection processing of step S1506. If the image edges are determined to be successfully detected (YES in step S1507), the processing proceeds to step S1508. On the other hand, if it is determined that the detection has failed (NO in step S1507), the processing proceeds to step S1513. Examples of the case where the CPU 114 determines it to be "NO" in step S1507 include where a difference in density between the background of the

sheet on which the adjustment chart **601** is printed and the marks **620** is so small that the image edges of the marks **620** fail to be properly detected.

In step **S1508**, the CPU **114** calculates the lengths of the portions (a) to (j) illustrated in FIG. **6** from the image edges of the adjustment chart **601** (front surface) and the image edges of the marks **620** detected in step **S1506**. Then, the processing proceeds to step **S1509**.

In step **S1509**, the CPU **114** calculates the lengths of the portions (k) to (r) illustrated in FIG. **6** from the image edges of the adjustment chart **601** (back surface) and the image edges of the marks **620** detected in step **S1506**. Then, the processing proceeds to step **S1510**.

In step **S1510**, the CPU **114** calculates the amounts of shift in the printing position **712** based on the lengths of the portions (a) to (j) calculated in step **S1508** and the lengths of the portions (k) to (r) calculated in step **S1509**. Then, the processing proceeds to step **S1511**. The amounts of shift in the printing position **712** are calculated by using the formulas described above with reference to FIG. **7**.

In step **S1511**, the CPU **114** determines whether the amounts of shift in the printing position have been calculated for the number of printed adjustment charts **601** (i.e., the number of adjustment charts **601** designated in step **S1502**). The CPU **114** performs the determination processing of step **S1511** by storing the number of times of processing of step **S1511** into the HDD **115** or the RAM **113** as a counter, and comparing the value of the stored counter with the number of adjustment charts **601** designated in step **S1502**. As a result of the determination in step **S1511**, if the CPU **114** determines it to be "YES" (YES in step **S1511**), the processing proceeds to step **S1512**. On the other hand, if the CPU **114** determines it to be "NO" (NO in step **S1511**), the processing returns to step **S1505** and the CPU **114** continues the subsequent processing.

In step **S1512**, the CPU **114** calculates the average values of the amounts of shift in the printing position for the number of printed adjustment charts **601** based on the amounts of shift in the printing position calculated in step **S1510**. The CPU **114** then determines the average values calculated in step **S1512** to be the amounts of shift in the printing position with respect to the sheet selected in step **S901** of FIG. **9**. After the processing of step **S1512**, the series of processing related to FIG. **15** ends. Then, the processing proceeds to step **S912** of FIG. **9**.

In step **S1513**, the CPU **114** displays the error screen **1400** illustrated in FIG. **14** on the displaying unit of the operation unit **120**. After the processing of step **S1513**, the series of processing related to FIG. **15** ends and the series of processing related to FIG. **9** ends.

That is the details of the series of processing (step **S1500** in FIG. **15**) for performing automatic adjustment of the printing position by scanning the adjustment chart **601** by ADF reading.

As described above, in the first exemplary embodiment, the CPU **114** instructs the image forming unit **151** to print the adjustment chart **601** on a sheet for adjusting a shift in the printing position. Then, the CPU **114** determines whether the printed adjustment chart **601** can be scanned by ADF reading, based on the physical properties of the sheet. If the CPU **114** determines that the printed adjustment chart **601** can be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select either of "scanning by ADF reading" and "scanning by pressing plate reading" to perform automatic adjustment of the printing position. On the other hand, if the CPU **114** determines that the printed adjustment chart **601** cannot be scanned by ADF reading, the CPU **114** controls a screen display so that the user can arbitrarily select "scanning by pressing plate reading" to perform automatic adjustment of the printing position, but not "scanning by ADF reading". In this way, according to the first exemplary embodiment, a method for adjusting the printing position can be appropriately presented to the user based on the physical properties of the sheet on which the adjustment chart **601** is printed. In particular, if a plurality of adjustment charts **601** is to be scanned to improve the accuracy of the amounts of shift in the printing position, the user can easily check whether the adjustment charts **601** can be scanned by ADF reading. This improves the user's convenience.

In the first exemplary embodiment, the case is described in which the CPU **114** controls, if it is determined that the printed adjustment chart **601** cannot be scanned by ADF reading, a screen display as illustrated in FIG. **10**B so that the user cannot select "scanning by ADF reading". However, it is not limited thereto. In another embodiment, the CPU **114** displays a selection screen **1700** illustrated in FIG. **17** on the displaying unit of the operation unit **120** instead of the selection screen **1020** illustrated in FIG. **10**B. More specifically, even if it is determined that the printed adjustment chart **601** cannot be scanned by ADF reading, the CPU **114** may allow the user to select "scanning by ADF reading" after notifying the user of a warning **1701** that ADF reading is not supported.

The present invention is not limited to the above-described exemplary embodiments. Various modifications (including organic combinations of the exemplary embodiments) may be made based on the gist of the present invention, and such modifications are not intended to be excluded from the scope of the present invention.

For example, in the above-described exemplary embodiments, the CPU **114** of the controller unit **110** of the printing apparatus **100** serves as the main constituent for the above-described various controls. However, it is not limited thereto. A print controlling unit such as an external controller in a housing separate from the printing apparatus **100** may be configured to be able to perform part or all of the above-described various controls.

The exemplary embodiments to which the present invention is applied are described by using the printing apparatus **100** including the image forming unit **151** that uses monochrome toner. However, it is not limited thereto. The exemplary embodiments to which the present invention is applied can be a color printing apparatus **100** including an image forming unit **151** that uses toners of a plurality of colors. For example, if a full-color printing apparatus **100** uses four colors of cyan (C), magenta (M), yellow (Y), and black (K), the printing apparatus **100** may adjust a printing position by using black toner. The printing positions of the other colors may be adjusted with reference to the printing position of black.

While various examples and exemplary embodiments of the present invention have been described above, the gist and scope of the present invention are not limited to the specific descriptions in this specification document.

Other Embodiments

Embodiments of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions recorded on a storage medium (e.g., non-transitory computer-readable storage medium) to perform the functions of one or more of the above-described embodiment(s) of the present invention, and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the

computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more of a central processing unit (CPU), micro processing unit (MPU), or other circuitry, and may include a network of separate computers or separate computer processors. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD™), a flash memory device, a memory card, and the like.

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

This application claims the benefit of Japanese Patent Application No. 2014-249412, filed Dec. 9, 2014, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A printing apparatus comprising:

a printing unit configured to print an adjustment image for adjusting a printing position on a sheet;

a conveying unit configured to convey the sheet on which the adjustment image is printed;

a reading unit configured to read an image to generate image data, the reading unit being executable to perform reading using a first reading method for reading an image of a sheet without conveying the sheet or a second reading method for reading the image of the sheet while conveying the sheet;

a receiving unit configured to receive a first instruction for causing the reading unit to read the adjustment image using the first reading method or a second instruction for causing the reading unit to read the adjustment image using the second reading method;

a displaying unit configured to display on a screen a first button via which the receiving unit receives the first instruction from a user and a second button via which the receiving unit receives the second instruction from the user;

an obtaining unit configured to obtain, in a case where the first instruction is received from the user via the first button, an amount of shift in the printing position based on image data generated by reading, using the first reading method, the adjustment image printed on the sheet, and obtain, in a case where the second instruction is received from the user via the second button, the amount of shift in the printing position based on image data generated by reading, using the second reading method, the adjustment image printed on the sheet; and

a print controlling unit configured to control the printing unit based on the amount of shift in the printing position so that an image is printed on the sheet,

wherein the displaying unit displays, in a case where a type of the sheet on which the adjustment image is to be printed is a specific type, the first button without displaying the second button on the screen.

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