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(54) IMAGE FORMING APPARATUS

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(57) **ABSTRACT**

An image forming apparatus includes: an image forming section on a main feed path for performing image formation on a first recording medium to be subjected to single-side printing and on a second recording medium to be subjected to double-side printing; and an output section for delivering these recording media. The apparatus has first to third positions between the apparatus and the output section at each of which a feed path branches off the main feed path. The apparatus further includes: a subsidiary feed path extending from the first position and joining the main feed path at an entrance of the main feed path; a first switchback feed path formed in a place extending from the second position for turning the second recording medium upside down; and a second switchback feed path formed in a place extending from the third position for turning the first recording medium upside down.

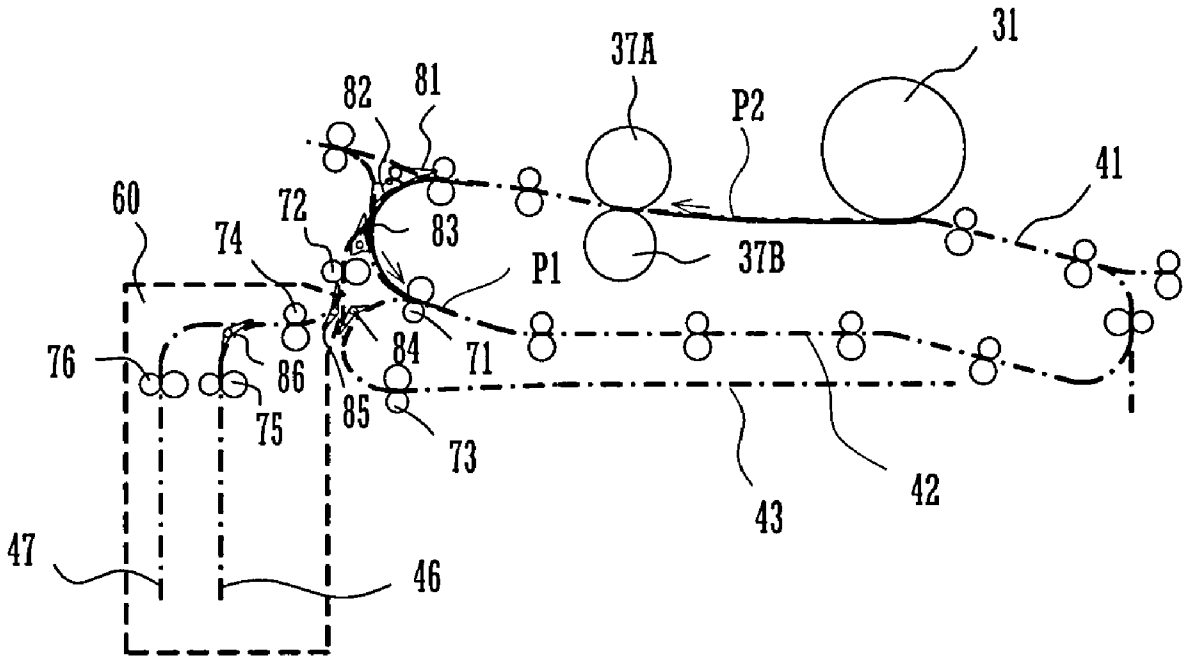
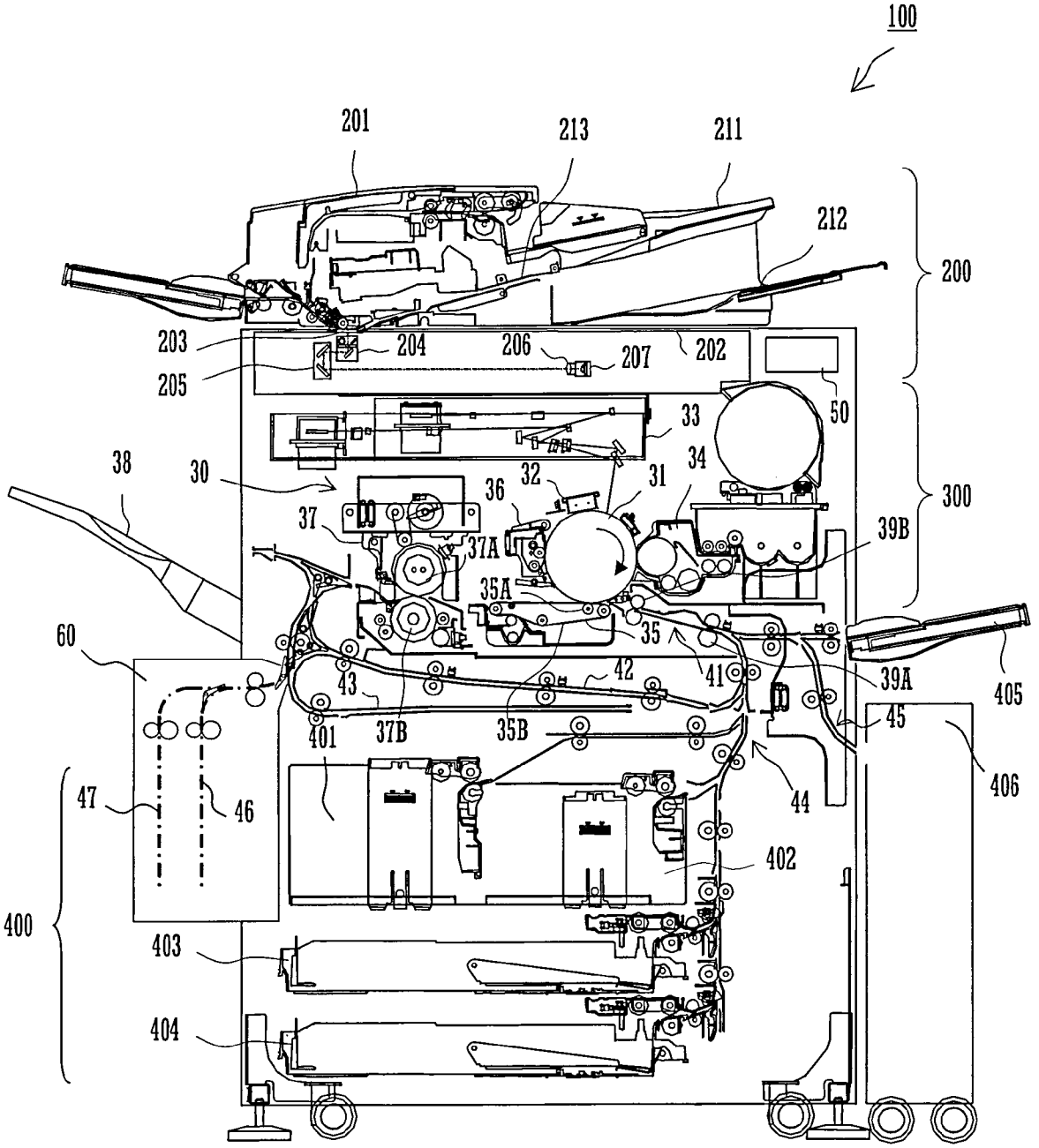


FIG.1


100
201
213
211
212
200
203
204
206
207
202
205
50
33
38
30
32
31
34
36
300
37
37A
39B
35A
35
60
43
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39A
405
401
37B
35B
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47
46
44
406
402
400
403
404

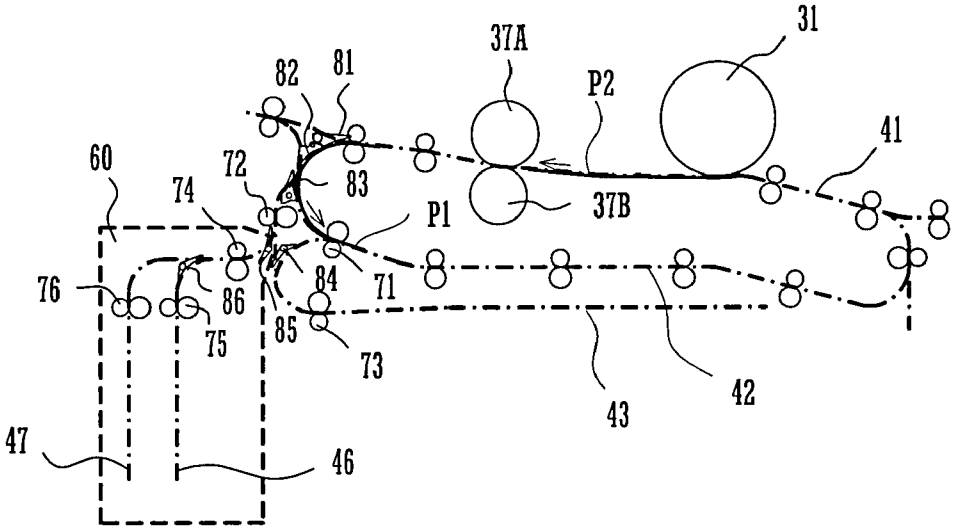


FIG.2A

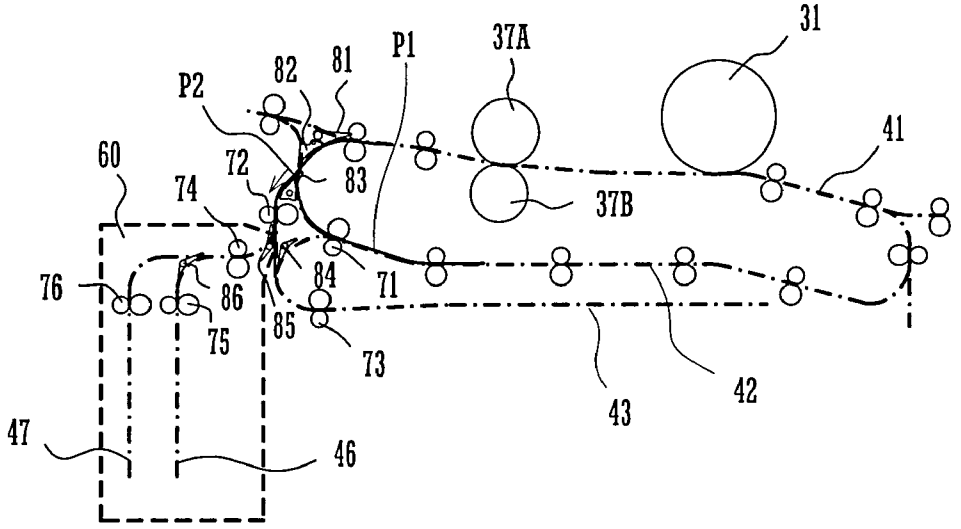


FIG.2B

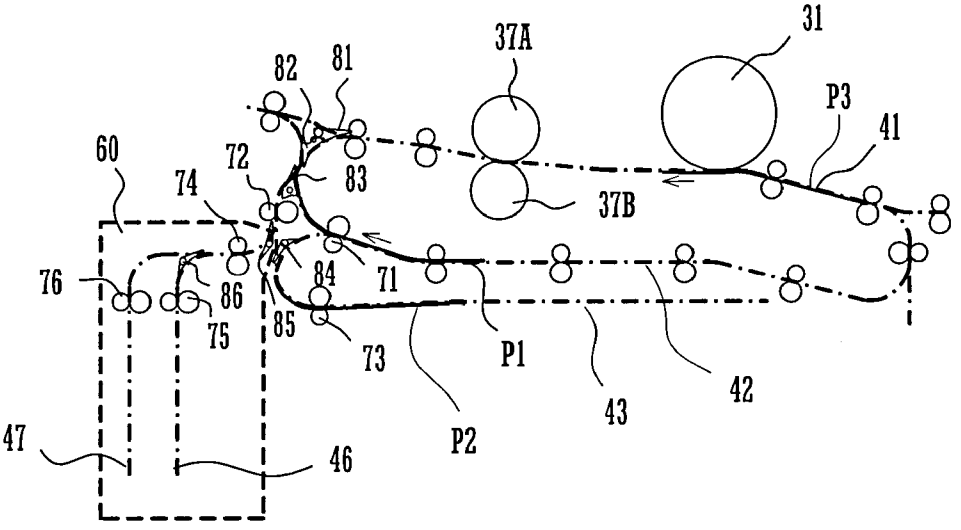


FIG.2C

FIG.3A

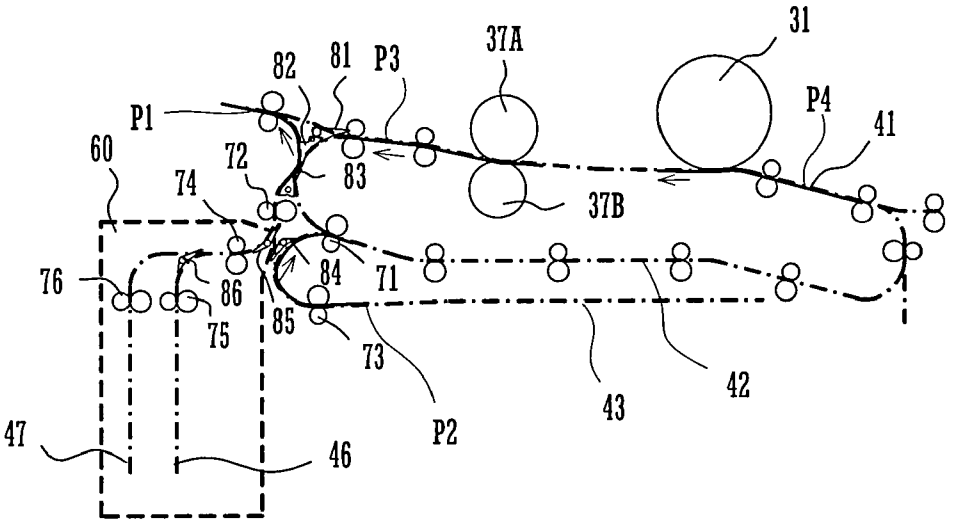


FIG.3B

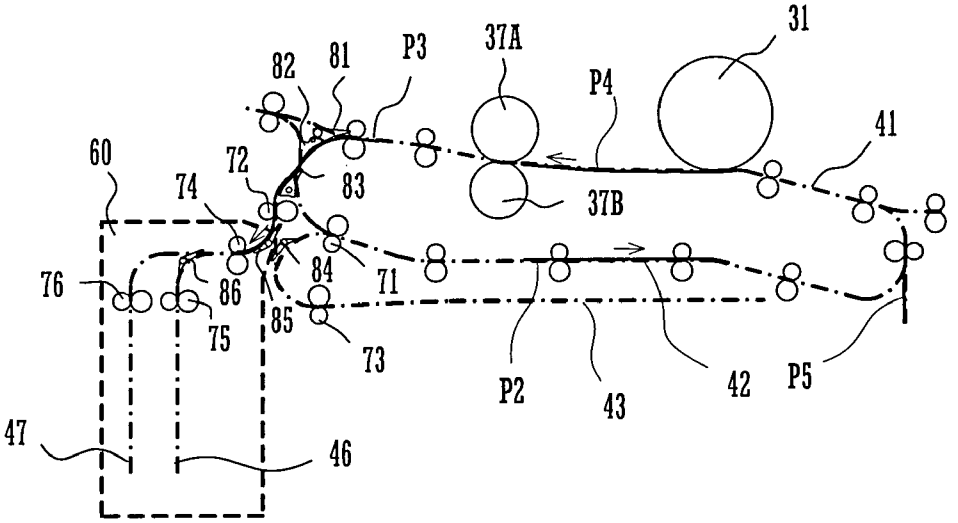
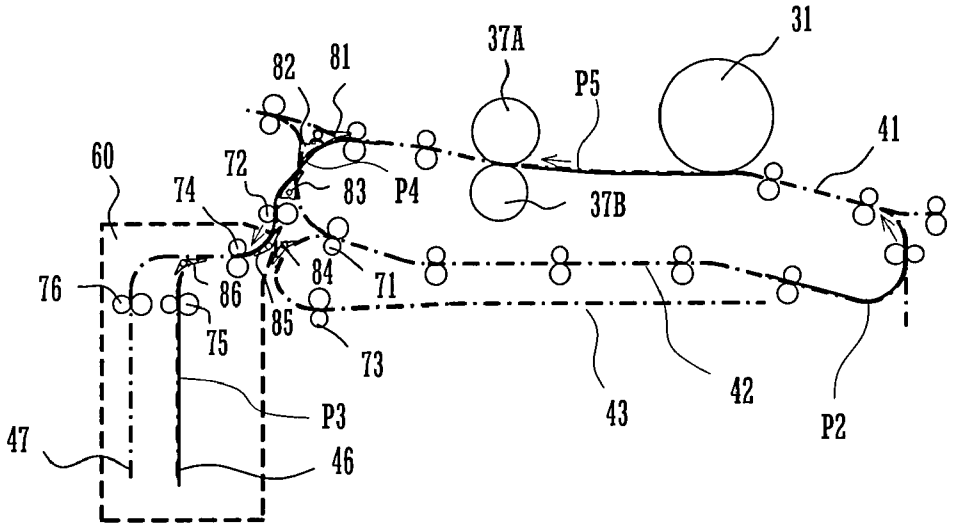


FIG.3C



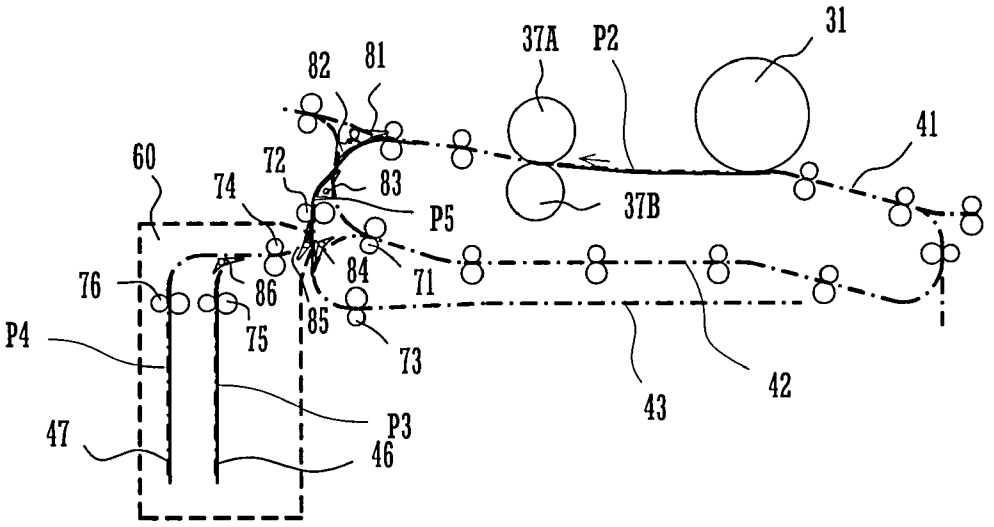


FIG.4A

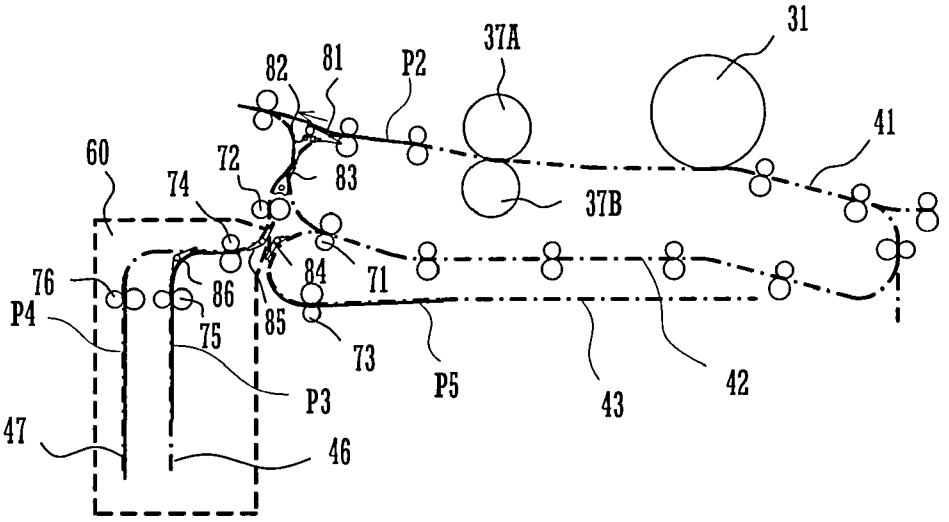


FIG.4B

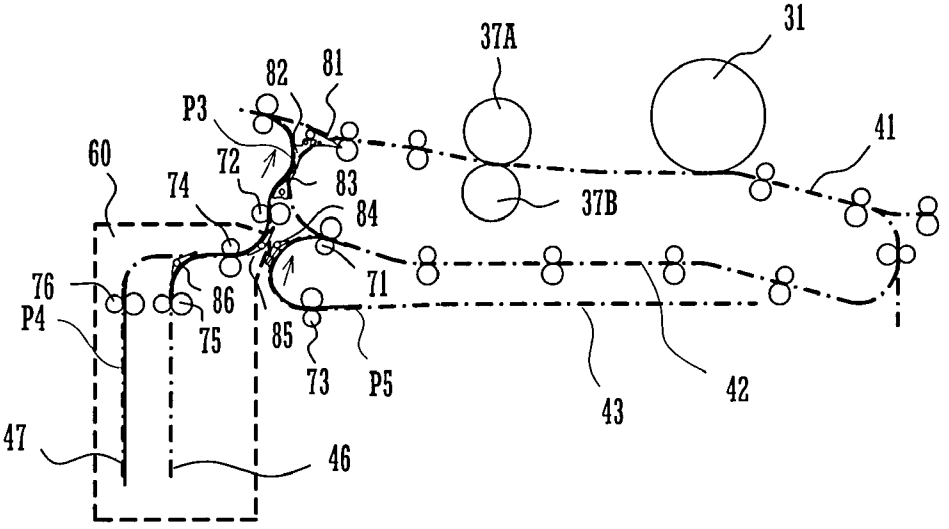


FIG.4C

FIG.5A

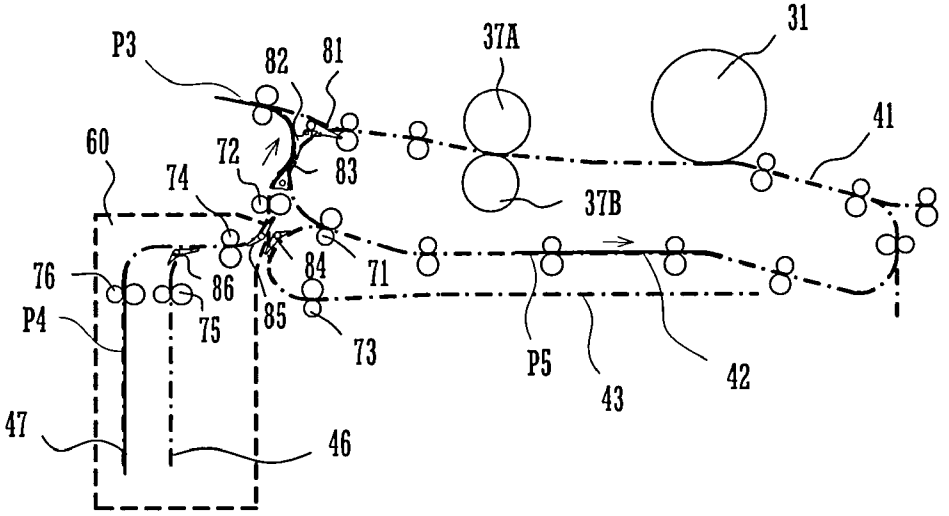


FIG.5B

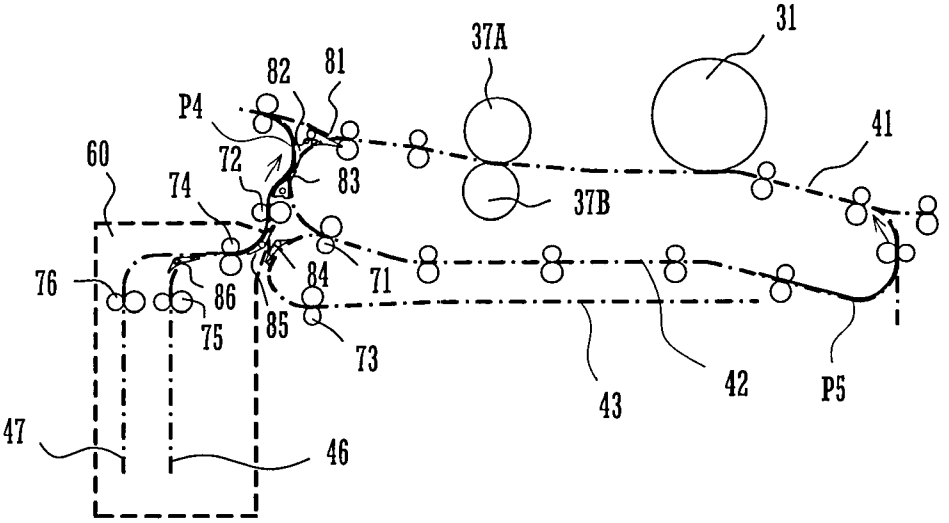


FIG.5C

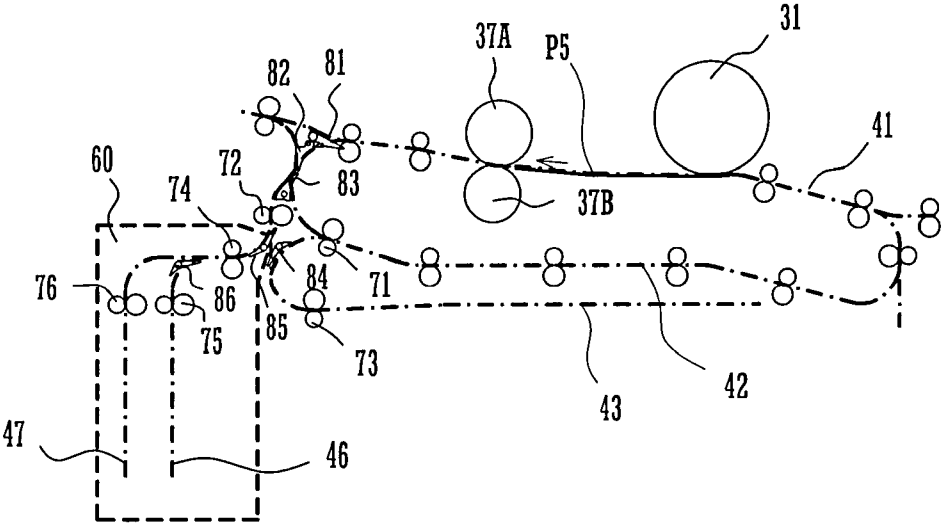


FIG.6

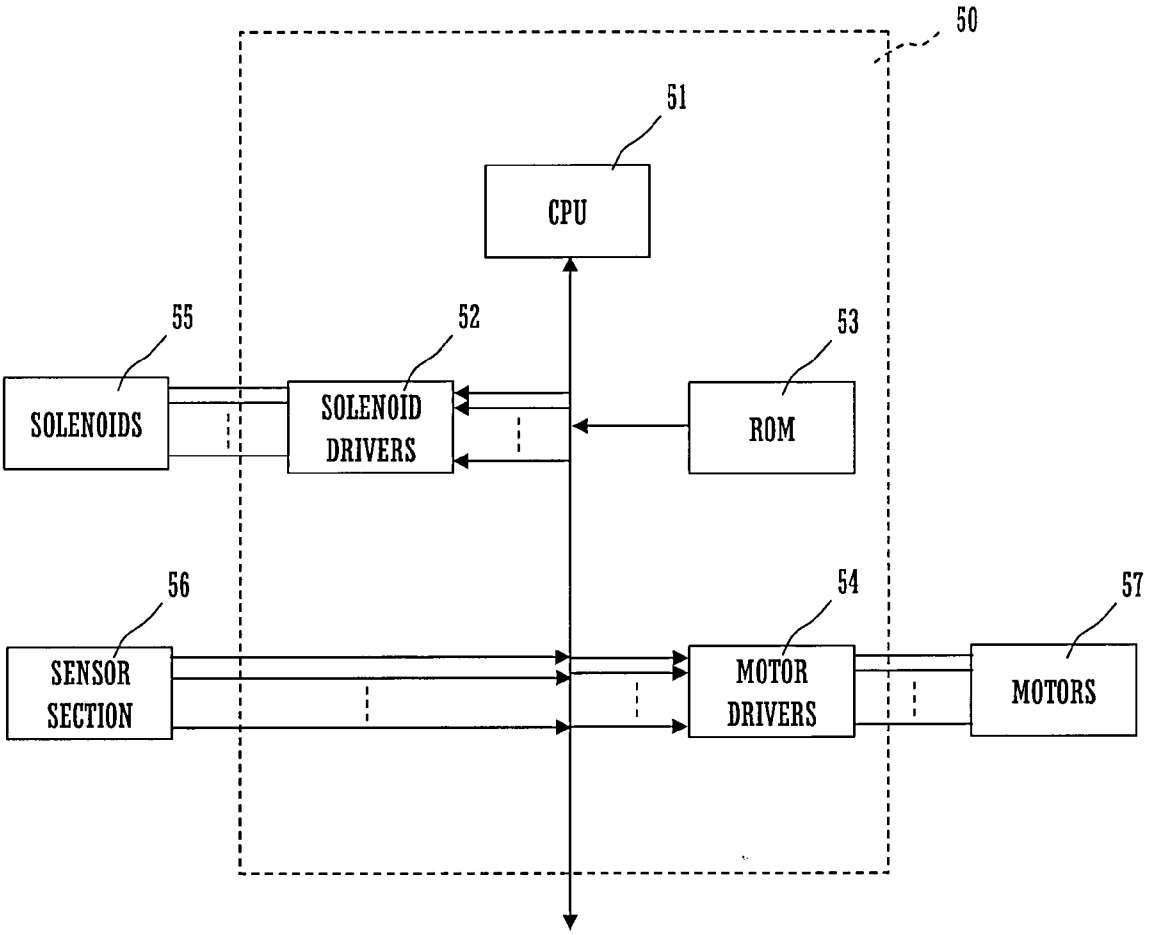

50
51
CPU
55
52
53
SOLENOIDS
SOLENOID DRIVERS
ROM
56
54
57
SENSOR SECTION
MOTOR DRIVERS
MOTORS

FIG.7

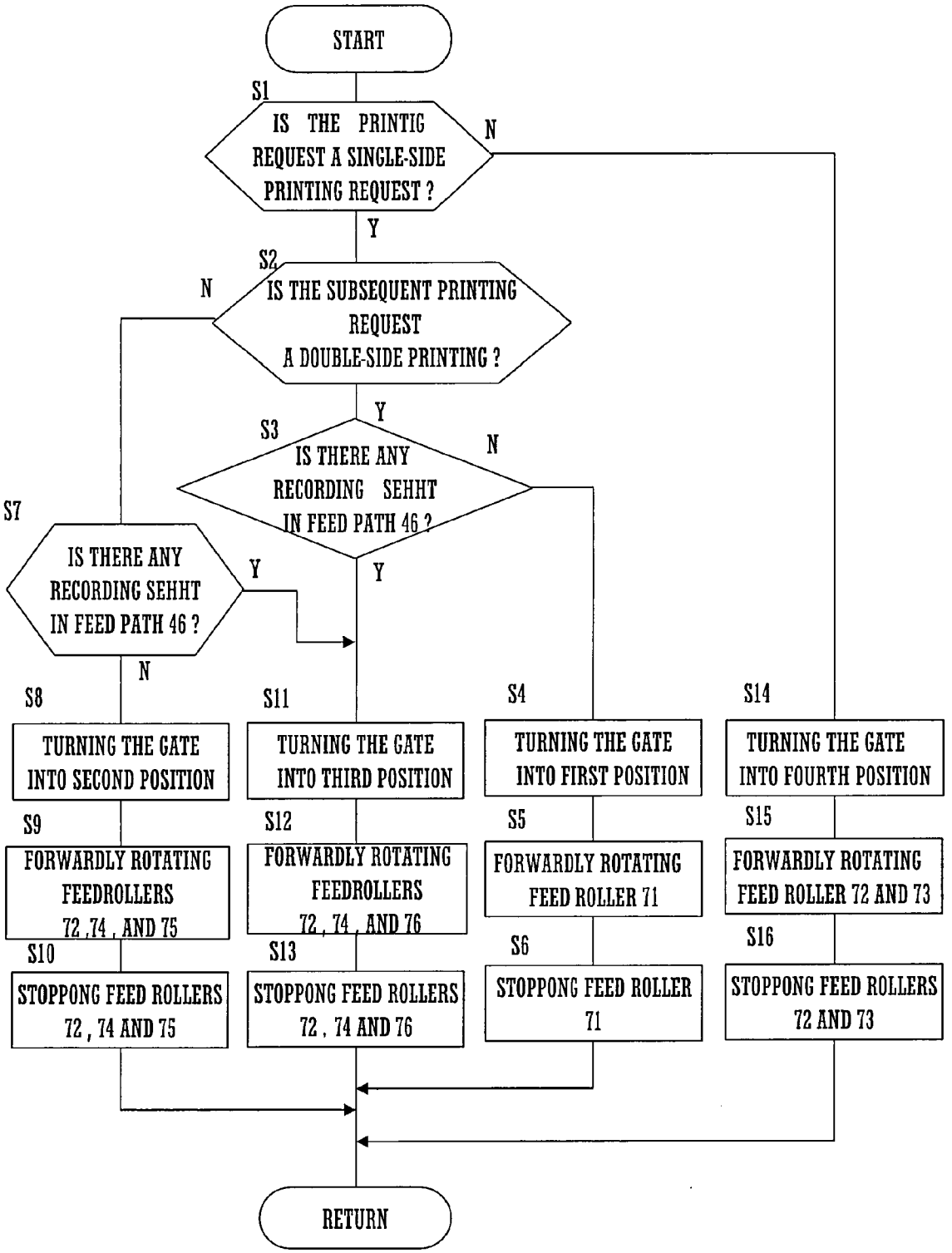

START
S1
IS THE PRINTIG REQUEST A SINGLE-SIDE PRINTING REQUEST ?
N
Y
S2
IS THE SUBSEQUENT PRINTING REQUEST A DOUBLE-SIDE PRINTING ?
N
Y
S3
IS THERE ANY RECORDING SEHHT IN FEED PATH 46 ?
N
Y
S7
IS THERE ANY RECORDING SEHHT IN FEED PATH 46 ?
Y
N
S8
TURNING THE GATE INTO SECOND POSITION
S9
FORWARDLY ROTATING FEEDROLLERS 72 ,74 , AND 75
S10
STOPPONG FEED ROLLERS 72 , 74 AND 75
S11
TURNING THE GATE INTO THIRD POSITION
S12
FORWARDLY ROTATING FEEDROLLERS 72 , 74 , AND 76
S13
STOPPONG FEED ROLLERS 72 , 74 AND 76
S4
TURNING THE GATE INTO FIRST POSITION
S5
FORWARDLY ROTATING FEED ROLLER 71
S6
STOPPONG FEED ROLLER 71
S14
TURNING THE GATE INTO FOURTH POSITION
S15
FORWARDLY ROTATING FEED ROLLER 72 AND 73
S16
STOPPONG FEED ROLLERS 72 AND 73
RETURN

FIG.8

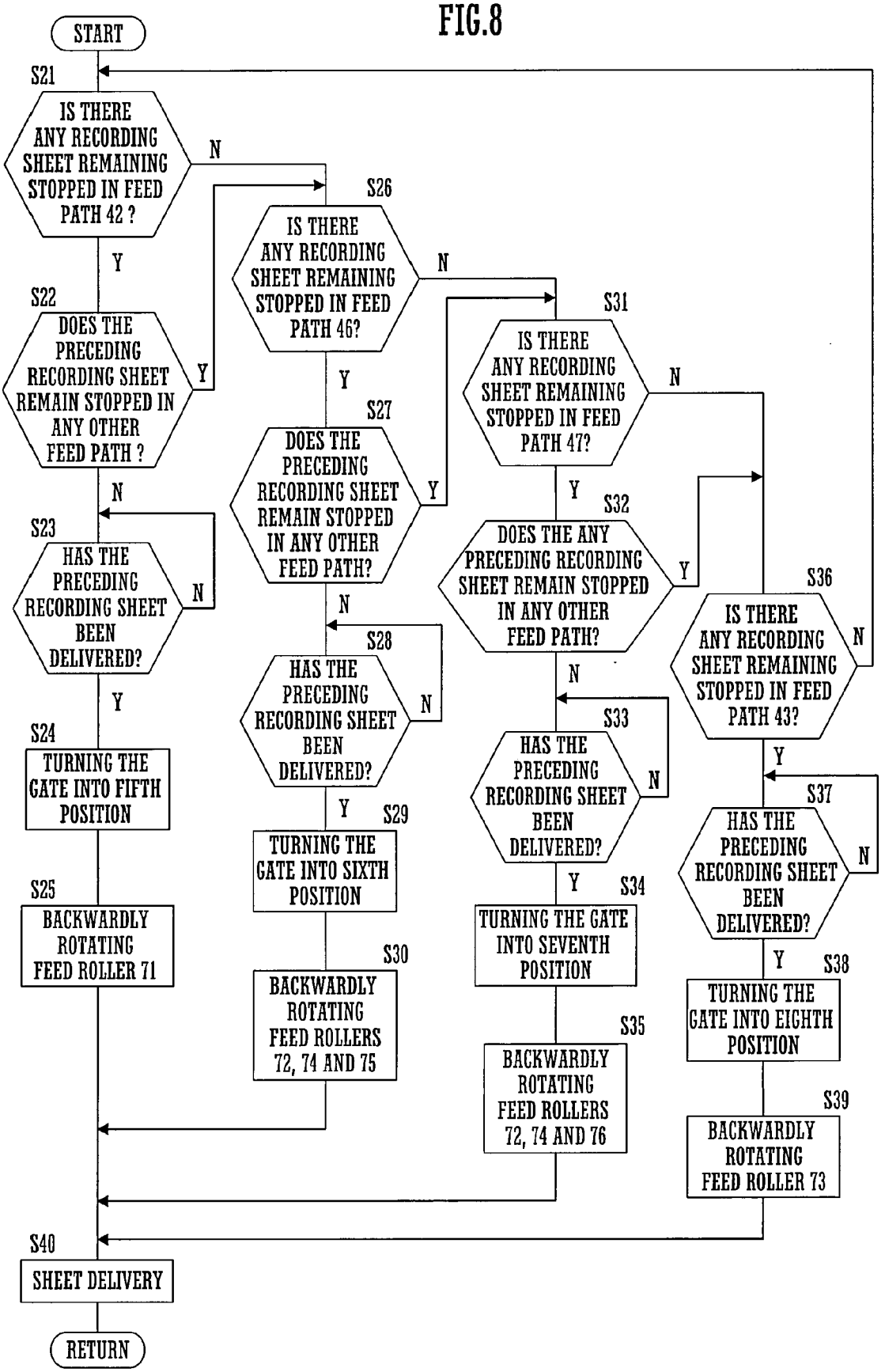

START
S21
IS THERE ANY RECORDING SHEET REMAINING STOPPED IN FEED PATH 42 ?
N
Y
S22
DOES THE PRECEDING RECORDING SHEET REMAIN STOPPED IN ANY OTHER FEED PATH ?
Y
N
S23
HAS THE PRECEDING RECORDING SHEET BEEN DELIVERED?
N
Y
S24
TURNING THE GATE INTO FIFTH POSITION
S25
BACKWARDLY ROTATING FEED ROLLER 71
S26
IS THERE ANY RECORDING SHEET REMAINING STOPPED IN FEED PATH 46?
N
Y
S27
DOES THE PRECEDING RECORDING SHEET REMAIN STOPPED IN ANY OTHER FEED PATH?
Y
N
S28
HAS THE PRECEDING RECORDING SHEET BEEN DELIVERED?
N
Y
S29
TURNING THE GATE INTO SIXTH POSITION
S30
BACKWARDLY ROTATING FEED ROLLERS 72, 74 AND 75
S31
IS THERE ANY RECORDING SHEET REMAINING STOPPED IN FEED PATH 47?
N
Y
S32
DOES THE ANY PRECEDING RECORDING SHEET REMAIN STOPPED IN ANY OTHER FEED PATH?
Y
N
S33
HAS THE PRECEDING RECORDING SHEET BEEN DELIVERED?
N
Y
S34
TURNING THE GATE INTO SEVENTH POSITION
S35
BACKWARDLY ROTATING FEED ROLLERS 72, 74 AND 76
S36
IS THERE ANY RECORDING SHEET REMAINING STOPPED IN FEED PATH 43?
N
Y
S37
HAS THE PRECEDING RECORDING SHEET BEEN DELIVERED?
N
Y
S38
TURNING THE GATE INTO EIGHTH POSITION
S39
BACKWARDLY ROTATING FEED ROLLER 73
S40
SHEET DELIVERY
RETURN

IMAGE FORMING APPARATUS

CROSS REFERENCE

[0001] This Nonprovisional application claims priority under 35 U.S.C. §119(a) on Patent Application No. 2007-316586 filed in Japan on Dec. 7, 2007, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to an image forming apparatus configured to deliver a recording medium in an overturned state after having been subjected to image forming processing.

[0003] Among image forming apparatuses such as digital copiers, there are image forming apparatuses of the type configured to turn an image bearing side of each recording medium down after image forming processing in successive image formation on plural recording media.

[0004] Conventionally, a switchback feed path is known as a mechanism for overturning a recording medium having been subjected to image forming processing (see Japanese Patent Laid-Open Publication No. JP-H09-301597 for example). Such a switchback feed path is provided with a feed roller for feeding recording media. An image forming apparatus of the aforementioned type has a single switchback feed path, feeds a single image recording medium having been subjected to image forming processing into the switchback feed path, feeds the recording medium backwardly in the switchback feed path, and then delivers the recording medium toward a sheet output section. Thereafter, a succeeding recording medium is fed into the switchback feed path. In this way, the aforementioned image forming apparatus feeds recording media one by one by way of the switchback feed path.

[0005] To meet the demand existing in recent years for increase in image formation speed, an image forming apparatus having such a switchback feed path is provided with a higher speed motor for rotating the feed roller of the switchback feed path.

[0006] However, the increase in the speed of such a motor is limited. With only the increase in motor speed relied upon, it is difficult to smoothly turn individual recording media upside down after image forming processing.

[0007] When single-side printing and double-side printing are performed mixingly, passage of recording media one by one via the switchback feed path results in poor feeding efficiency. From this point of view, there is also a limitation on an increase in the rate of delivery of recording media per unit time relying only upon the increase in motor speed when single-side printing and double-side printing are performed mixingly.

[0008] An object of the present invention is to provide an image forming apparatus which is capable of increasing the rate of delivery of recording media per unit time even when recording media intended for single-side printing and those intended for double-side printing are mixed in overturning recording media after image forming processing.

SUMMARY OF THE INVENTION

[0009] An image forming apparatus according to the present invention includes an image forming section, a output section, a main feed path, a subsidiary feed path, a first switchback feed path, a second switchback feed path, and a control section.

[0010] The image forming section is configured to perform image forming processing on recording media. Such recording media include a first recording medium to be subjected to single-side printing, and a second recording medium to be subjected to double-side printing. The output section is configured to store therein recording media having been subjected to image formation thereon. The main feed path forms a feed path reaching the output section through the image forming section. The subsidiary feed path forms a feed path extending from a first position between the image forming section and the output section at which the subsidiary feed path branches off the main feed path and reaching (returning to) an entrance of the main feed path. That is, the subsidiary feed path joins the main feed path at the entrance of the main feed path (at a location upstream of the image forming section). The first switchback feed path is formed in a place extending from a second position between the image forming section and the output section at which the first switchback feed path branches off the main feed path. The first switchback feed path is configured to turn the recording medium for double-side printing upside down. The second switchback feed path is formed in a place extending from a third position between the image forming section and the output section at which the second switchback feed path branches off the main feed path. The second switchback feed path is configured to turn the recording medium for single-side printing upside down.

[0011] The control section is configured to control feeding of the first and second recording media having been subjected to image formation thereon by the image forming section to any one of the output section, the subsidiary feed path, the first switchback feed path and the second switchback feed path.

[0012] The image forming apparatus according to the present invention, which includes the first switchback feed path for turning the second recording medium for double-side printing upside down, and the second switchback feed path for turning the first recording medium for double-side printing upside down, is capable of increasing the rate of delivery of recording media per unit time by reducing the spacing between adjacent recording media when requests for both of single-side printing and double-side printing are made mixingly.

[0013] The foregoing and other features and attendant advantages of the present invention will become more apparent from the reading of the following detailed description of the invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a view showing a configuration of an image forming apparatus according to an embodiment of the present invention;

[0015] FIGS. **2**A to **2**C are views each showing a state of a first stage in subjecting successive recording sheets to printing and feeding in the image forming apparatus according to the embodiment of the present invention;

[0016] FIGS. **3**A to **3**C are views each showing a state of a second stage in subjecting successive recording sheets to printing and feeding in the image forming apparatus according to the embodiment of the present invention;

[0017] FIGS. **4**A to **4**C are views each showing a state of a third stage in subjecting successive recording sheets to printing and feeding in the image forming apparatus according to the embodiment of the present invention;

[0018] FIGS. **5**A to **5**C are views each showing a state of a fourth stage in subjecting successive recording sheets to printing and feeding in the image forming apparatus according to the embodiment of the present invention;

[0019] FIG. **6** is a block diagram showing a partial configuration of a control section **50** included in the image forming apparatus according to the embodiment of the present invention;

[0020] FIG. **7** is a flowchart showing a procedure for controlling feeding of recording sheets to a destination in response to a printing request made to the image forming apparatus according to the embodiment of the present invention; and

[0021] FIG. **8** is a flowchart showing a procedure for delivering a recording sheet stopped in a feed path in the image forming apparatus according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] Hereinafter, an image forming apparatus according to the best mode of the present invention will be described in detail with reference to the drawings.

[0023] FIG. **1** is a view showing a configuration of an image forming apparatus according to an embodiment of the present invention. The image forming apparatus **100** includes an image reading unit **200**, an image recording unit **300**, a sheet feeding unit **400**, and a control section **50**.

[0024] The image reading unit **200** includes an automatic document feeder (ADF) **201**, a first document platen **202**, a second document platen **203**, a first mirror base **204**, a second mirror base **205**, a lens **206**, and a solid-state image sensor (CCD: Charge Coupled Device) **207**.

[0025] The ADF **201** defines a document feed path **213** extending from a document tray **211** to a delivery tray **212** via the second document platen **203**. The ADF **201** feeds document sheets one by one into the document feed path **213**. The ADF **201** is pivotable about its the rear side to cover the top surface of the first document platen **202** openably. When the top surface of the first document platen **202** is exposed by turning the ADF **201** so as to move the front side thereof upwardly, a document sheet is allowed to be placed on the first document platen **202** manually.

[0026] The first and second document platens **202** and **203** each comprise a hard glass plate.

[0027] The first mirror base **204** and the second mirror base **205** are horizontally movable below the first and second document platens **202** and **203**. The traveling speed of the second mirror base **205** is ½ as high as that of the first mirror base **204**. The first mirror base **204** carries thereon a light source and a first mirror. The second mirror base **205** carries thereon a second mirror and a third mirror.

[0028] In reading an image on a document sheet fed by the ADF **201**, the first mirror base **204** is at rest below the second document platen **203**. Light from the light source is directed toward the image bearing side of the document sheet passing over the second document platen **203**, and reflected light from the image bearing side of the document sheet is reflected by the first mirror toward the second mirror base **205**.

[0029] In reading an image on a document sheet placed on the first document platen **202**, the first and second mirror bases **204** and **205** move horizontally below the first document platen **202**. Light from the light source is directed toward the image bearing side of the document sheet placed on the first document platen **202**, and reflected light from the image bearing side of the document sheet is reflected by the first mirror toward the second mirror base **205**.

[0030] Reflected light from the image bearing side of a document sheet passes along an optical path length made constant irrespective of whether or not the ADF **201** is used, and becomes incident on the CCD **207** through the lens **206** by means of the second and third mirrors.

[0031] The CCD **207** outputs electric signals in accordance with light quantities of light reflected by the image bearing side of a document sheet. Such electric signals are inputted as image data to the image recording unit **300** via the control section **50**.

[0032] The image recording unit **300** includes a photosensitive drum **31**, an electrostatic charger **32**, an exposure device **33**, a developing device **34**, a transfer device **35**, a cleaning unit **36**, and a fixing device **37**. An image forming section **30** is constructed of the photosensitive drum **31**, electrostatic charger **32**, exposure device **33**, developing device **34**, transfer device **35**, cleaning unit **36** and fixing device **37**.

[0033] The photosensitive drum **31** has a photosensitive layer over its periphery and rotates in a direction indicated by arrow. The electrostatic charger **32** electrostatically charges the periphery of the photosensitive drum **31** at a predetermined uniform potential. The electrostatic charger **32** may be of a non-contact type employing a charger or of a contact type employing a roller or a brush.

[0034] The exposure device **33**, which is an LSU (Laser Scanning Unit) for example, axially scans the periphery of the photosensitive drum **31** with laser light modulated according to the image data by way of a polygonal mirror. Thus, an electrostatic latent image is formed on the periphery of the photosensitive drum **31** by the photoconductive action of the photosensitive layer. Instead of the LSU, it is possible to use an exposure device having an array of light-emitting devices such as ELs or LEDs.

[0035] The developing device **34** supplies toner (i.e., developer) onto the periphery of the photosensitive drum **31** to turn the electrostatic latent image into a visible toner image (i.e., developer image).

[0036] The transfer device **35** includes a transfer roller **35**A and a transfer belt **35**B. The transfer belt **35**B is entrained around plural rollers to form a loop below the photosensitive drum **31**. The transfer belt **35**B has a resistivity of about 1×10^{9} to about 1×10^{13} Ω·cm. The transfer roller **35**A pressed against the photosensitive drum **31** across the transfer belt **35**B is located internally of the loop-shaped track of movement of the transfer belt **35**B. A predetermined transfer voltage is applied to the transfer roller **35**A to transfer the toner image carried on the photosensitive drum **31** to a recording sheet passing between the transfer belt **35**B and the photosensitive drum **31**. Such a recording sheet is an example of a recording medium.

[0037] The cleaning unit **36** collects residual toner which remains on the periphery of the photosensitive drum **31** after the toner image has been transferred to the recording sheet.

[0038] The fixing device **37** includes a heating roller **37**A and a press roller **37**B. The heating roller **37**A is heated by an internal heat source to a temperature that allows the toner to fuse. The press roller **37**B is pressed against the heating roller **37**A with a predetermined pressure. The fixing device **37**

heats and pressurizes the recording sheet passing between the heating roller **37**A and the press roller **37**B, thereby firmly fixing the toner image to the recording sheet. The recording sheet having passed through the fixing device **37** is delivered to a copy receiving tray **38**. The copy receiving tray **38** is equivalent to the output section defined by the present invention.

[0039] The sheet feeding unit **400** includes sheet feed cassettes **401** to **404** and a manual feed tray **405**. The sheet feed cassettes **401** to **404** each contain plural recording sheets of the same size. The manual feed tray **405** is adapted to receive recording sheets having a size or a paper quality for use with a low frequency.

[0040] The sheet feeding unit **400** feeds recording sheets one by one from any one of the sheet feed cassettes **401** to **404** or the manual feed tray **405**. The image forming apparatus **100** includes a main feed path **41**, a subsidiary feed path **42**, a first switchback feed path **43**, sheet feed paths **44** and **45**, and second switchback feed paths **46** and **47**.

[0041] The main feed path **41** forms a feed path reaching the copy receiving tray **38** (i.e., output section) through the image forming section **30**.

[0042] The subsidiary feed path **42** forms a feed path extending from a first position between the image forming section **30** and the copy receiving tray **38** (i.e., output section) at which the subsidiary feed path **42** branches off the main feed path **41** and reaching the entrance of the main-feed path **41** to join the main feed path **41** at a location upstream of the image forming section **30**.

[0043] The first switchback feed path **43** is formed in a place extending from a second position between the image forming section **30** and the copy receiving tray **38** (i.e., output section) at which the first switchback feed path **43** branches off the main feed path **41**. The first switchback feed path **43** turns a recording sheet for double-side printing (i.e., second recording medium) upside down.

[0044] The second switchback feed paths **46** and **47** are formed in a place extending from a third position between the image forming section **30** and the copy receiving tray **38** (i.e., output section) at which the second switchback feed paths **46** and **47** branch off the main feed path **41**. The second switchback feed paths **46** and **47** each turn a recording sheet for single-side printing (i.e., first recording medium) upside down.

[0045] The subsidiary feed path **42** may be used as a switchback feed path for turning a recording sheet for single-side printing (i.e., first recording medium) upside down. By using the subsidiary feed path **42** as the switchback feed path, it is possible to reduce the spacing between adjacent ones of a larger number of recording sheets, thereby to increase the rate of delivery of recording sheets per unit time in volume printing. The second switchback feed paths **46** and **47** are accommodated in an option unit **60**. The option unit **60** is made removable from the image forming apparatus **100** toward its sheet output side. The provision of the option unit **60** made removable from the image forming apparatus **100** makes it possible to reduce the size of the image forming apparatus **100** by removing the option unit **60** from the image forming apparatus **100** in low-volume printing, as well as to increase the rate of delivery of recording sheets per unit time by attaching the option unit **60** to the image forming apparatus **100** in high-volume printing. A recording sheet fed from any one of the sheet feed cassettes **401** to **404** is fed to the image forming section **30** through the sheet feed path **44** and the main feed path **41** by means of rollers including a pre-registration roller **39**A.

[0046] The subsidiary feed path **42** and the first switchback feed path **43** are displaceable between their respective accommodated positions in which these feed paths communicate with the main feed path **41** and their respective exposed positions in which the feed paths drawn out of the main body of the apparatus are exposed to the outside. When one of the subsidiary feed path **42** and the first switchback feed path **43** is in its exposed position, the other feed path and the main feed path **41** are made to cooperate with each other to feed recording sheets therebetween smoothly.

[0047] A registration roller **39**B is disposed downstream of the pre-registration roller **39**A in the sheet feed direction. The leading edge of a recording sheet fed by the pre-registration roller **39**A is butted against the registration roller **39**B at rest. The registration roller **39**B has a rotating shaft extending in directions perpendicular to the sheet feed direction. When the recording sheet is positioned askew, skew correction is made by butting the leading edge of the recording sheet against the registration roller **39**B.

[0048] The registration roller **39**B starts rotating with such timing as to allow the leading edge of the recording sheet to be registered with the leading edge of the toner image formed on the periphery of the photosensitive drum **31**, to feed the recording sheet between the photosensitive drum **31** and the transfer belt **35**. Thus, the toner image is transferred and fixed to the recording sheet as described above and then the recording sheet is delivered to the copy receiving tray **38**.

[0049] A large capacity cassette (LCC) **406** may be placed on a lateral side of the image forming apparatus **100** and below the manual feed tray **405**. The LCC **406** contains a large number of recording sheets. A recording sheet fed from the LCC **406** is fed to the image forming section **30** through the sheet feed path **45** and the main feed path **41**.

[0050] FIGS. **2** to **5** are views showing stages in subjecting successive recording sheets to printing and feeding in the image forming apparatus according to the embodiment of the present invention.

[0051] Description is directed to an exemplary case of printing on five recording sheets in which the first, third and fourth recording sheets are intended for single-side printing while the second and fifth recording sheets intended for double-side printing.

[0052] When image formation starts, a feed control in the first stage shown in FIGS. **2**A to **2**C is performed.

[0053] As shown in FIG. **2**A first, the first recording sheet P**1** (for single-side printing) is subjected to image formation on an obverse side thereof by the image forming section **30** and then fed into the subsidiary feed path **42**. Subsequently, the second recording sheet P**2** (for double-side printing) is subjected to image formation on an obverse side thereof by the image forming section **30** and then fed with a predetermined spacing from the first recording sheet P**1**.

[0054] In this case the first recording sheet P**1** (for single-side printing) is fed into the subsidiary feed path **42**. By so doing, the second switchback feed paths **46** and **47** can be left vacated. For this reason, when a recording sheet for single-side printing follows the second recording sheet P**2** (for double-side printing), the spacing between adjacent recording sheets can be reduced and, hence, the rate of delivery of recording sheets per unit time can be increased.

[0055] Subsequently, as shown in FIG. **2**B, the first recording sheet P**1** (for single-side recording) is stopped when fed into the entrance of the subsidiary feed path **42**. The second recording sheet P**2** (for double-side printing) is fed into the first switchback feed path **43**.

[0056] Subsequently, as shown in FIG. **2**C, the first recording sheet P**1** (for single-side recording) starts being fed in an overturned state. The second recording sheet P**2** (for double-side printing) is stopped in the first switchback feed path **43**. The third recording sheet P**3** (for single-side printing) is subjected to image formation on an obverse side thereof by the image forming section **30**.

[0057] Subsequently, a feed control is performed in the second stage shown in FIGS. **3**A to **3**C.

[0058] As shown in FIG. **3**A, the first recording sheet P**1** (for single-side printing) is fed toward the copy receiving tray **38**. The second recording sheet P**2** (for double-side printing) is turned upside down and fed into the subsidiary feed path **42**. The third recording sheet P**3** (for single-side printing) is fed toward the second switchback feed path **46** so as to replace the first recording sheet P**1** (for single-side printing). The fourth recording sheet P**4** (for single-side printing) is fed toward the image forming section **30**. Here, since the third recording sheet P**3** (for single-side printing) is a recording sheet following the second recording sheet P**2** (for double-side printing), the third recording sheet P**3** (for single-side printing) is fed into the second switchback feed path **46**. By so doing, the subsidiary feed path **42** can be left vacated and, hence, the recording sheet for double-side printing in the first switchback feed path **43** can be fed in an overturned state smoothly.

[0059] Subsequently, as shown in FIG. **3**B, the second recording sheet P**2** (for double-side printing) is fed through the subsidiary feed path **42** toward the main feed path **41**. The third recording sheet P**3** (for single-side printing) is fed toward the second switchback feed path **46**. The fourth recording sheet P**4** (for single-side printing) is subjected to image formation on an obverse side thereof by the image forming section **30**. The fifth recording sheet P**5** (for double-side printing) is fed toward the main feed path **41**.

[0060] Subsequently, as shown in FIG. **3**C, the second recording sheet P**2** (for double-side printing) is fed from the subsidiary feed path **42** toward the main feed path **41**. The third recording sheet P**3** (for single-side printing) is stopped in the second switchback feed path **46**. The fourth recording sheet P**4** (for single-side printing) is fed toward the second switchback feed path **47**. The fifth recording sheet P**5** (for double-side printing) is subjected to image formation on an obverse side thereof by the image forming section **30**.

[0061] Subsequently, a feed control is performed in the third stage shown in FIGS. **4**A to **4**C.

[0062] As shown in FIG. **4**A, the second recording sheet P**2** (for double-side printing) is subjected to image formation on the reverse side thereof by the image forming section **30**. The third recording sheet P**3** (for single-side printing) remains stopped in the second switchback feed path **46**. The fourth recording sheet P**4** (for single-side printing) is stopped in the second feedback path **47**. The fifth recording sheet P**5** (for double-side printing) is fed toward the first switchback feed path **43**.

[0063] Subsequently, as shown in FIG. **4**B, the second recording sheet P**2** (for double-side printing) is fed toward the copy receiving tray **38**. The third recording sheet P**3** (for single-side printing) starts being fed in an overturned state so as to replace the fifth recording sheet P**5** (for double-side printing). The fourth recording sheet P**4** (for single-side printing) remains stopped in the second switchback feed path **47**. The fifth recording sheet P**5** (for double-side printing) is stopped in the first switchback feed path **43**.

[0064] Subsequently, as shown in FIG. **4**C, the third recording sheet P**3** (for single-side printing) is fed toward the copy receiving tray **38**. The fourth recording sheet P**4** (for single-side printing) remains stopped in the second switchback feed path **47**. The fifth recording sheet P**5** (for double-side printing) is turned upside down and fed toward the subsidiary feed path **42**.

[0065] Subsequently, as shown in FIG. **5**A, the third recording sheet P**3** is fed toward the copy receiving tray **38**. The fourth recording sheet P**4** remains stopped in the second switchback feed path **47**. The fifth recording sheet P**5** is fed through the subsidiary feed path **42**.

[0066] Subsequently, a feed control is performed in the fourth stage shown in FIGS. **5**A to **5**C.

[0067] As shown in FIG. **5**A, the fourth recording sheet P**4** (for single-side printing) is fed toward the copy receiving tray **38**. The fifth recording sheet P**5** (for double-side printing) is fed from the subsidiary feed path **42** toward the main feed path **41**.

[0068] Subsequently, as shown in FIG. **5**C, the fifth recording sheet P**5** (for double-side printing) is subjected to image formation on the reverse side thereof by the image forming section **30**.

[0069] FIG. **6** is a block diagram showing a partial configuration of the control section **50** included in the image forming apparatus according to the embodiment of the present invention.

[0070] The control section **50** includes a CPU **51** having ROM **53** and connected to solenoid drivers **52**, to motor drivers **54** and to a sensor section **56**.

[0071] The sensor section **56** includes plural detection sensors at least one of which is provided on each of the main feed path **41**, subsidiary feed path **42**, first switchback feed path **43** and second switchback feed paths **46** and **47**. The plural sensors are placed at different predetermined locations on the feed paths **41**, **42**, **43**, **46** and **47**. When each of the sensors is turned on, the sensor outputs a detection signal indicative of detection of a recording sheet to the CPU **51**.

[0072] When any one of the detection sensors starts inputting the detection signal to the CPU **51**, the CPU **51** judges that the detection sensor of concern has detected the leading edge of a recording sheet. If continuous inputting of the detection signal from the sensor is terminated within a predetermined time period from the start of inputting, the CPU **51** judges that the trailing edge of the recording sheet has passed the location of the sensor of concern. Alternatively, if continuous inputting of the detection signal from the sensor lasts for more than the predetermined time period with unexpected timing, the CPU **51** judges that a sheet jam occurs at the location of the sensor of concern.

[0073] According to a program previously stored in the ROM **52**, the CPU **51** outputs driving data to the solenoid drivers **52** and the motor drivers **54** by referencing the detection signal inputted thereto from the sensor section **56**.

[0074] The solenoid drivers **52** are connected to respective solenoids **55**. The solenoid drivers **52** drive the solenoids **55** based on the driving data outputted from the CPU **51**.

[0075] The solenoids **55** drive gates **81** to **86**.

[0076] The motor drivers **54** are connected to respective motors **57**. The motor drivers **54** drive the motors **57** based on the driving data outputted from the CPU **51**.

[0077] The motors **57** rotate the photosensitive drum **31**, fixing device **37**, feed rollers **71** to **76**, and the like.

[0078] FIG. **7** is a flowchart showing a procedure for controlling feeding of recording sheets to a destination in response to a printing request made to the image forming apparatus according to the embodiment of the present invention.

[0079] Upon a printing request, judgment is made as to whether or not the printing request is a single-side printing request (step S**1**). If the printing request is judged as the single-side printing request, judgment is made as to whether or not a subsequent printing request is a double-side printing request (step S**2**). If the subsequent printing request is judged as the double-side printing request, judgment is made as to whether or not any recording sheet is present in the second switchback feed path **46** (step S**3**). If it is judged that any recording sheet is not present, a gate is set into a first position (step S**4**). The first position of the gate is a position that enables a recording sheet to be fed to the subsidiary feed path **42**. Subsequently, the feed roller **71** is rotated forwardly to feed the recording sheet to the subsidiary feed path **42** (step S**5**) and then stopped to stop feeding the recording sheet (step S**6**).

[0080] If it is judged in step S**2** that the printing request is not the double-side printing request, judgment is made as to whether or not any recording sheet is present in the second switchback feed path **46** (step S**7**). If it is judged that any recording sheet is not present, the gate is set into a second position (step S**8**). The second position of the gate is a position that enables a recording sheet to be fed to the second switchback feed path **46**. Subsequently, the feed rollers **72**, **74** and **75** are rotated forwardly to feed the recording sheet to the second switchback feed path **46** (step S**9**) and then stopped to stop feeding the recording sheet (step S**10**).

[0081] If it is judged in step S**3** or S**7** that a recording sheet is present in the second switchback feed path **46**, the gate is set into a third position (step S**11**). The third position of the gate is a position that enables a recording sheet to be fed to the second switchback feed path **47**. Subsequently, the feed rollers **72**, **74** and **76** are rotated forwardly to feed the recording sheet to the second switchback feed path **47** (step S**12**) and then stopped to stop feeding the recording sheet (step S**13**).

[0082] If it is judged in step S**1** that the printing request is not the single-side printing request, the gate is set into a fourth position (step S**14**). The fourth position of the gate is a position that enables a recording sheet to be fed to the first switchback feed path **43**. Subsequently, the feed rollers **72** and **73** are rotated forwardly to feed the recording sheet to the first switchback feed path **43** (step S**15**) and then stopped to stop feeding the recording sheet (step S**16**).

[0083] FIG. **8** is a flowchart showing a procedure for delivering a recording sheet stopped in a feed path in the image forming apparatus according to the embodiment of the present invention.

[0084] Initially, judgment is made as to whether or not any recording sheet remains stopped in the subsidiary feed path **42** (step S**21**). If it is judged that a recording sheet remains stopped therein, judgment is made as to whether or not the recording sheet that precedes this recording sheet remains stopped in any other feed path (step S**22**). If it is judged that the preceding recording sheet does not remain stopped in any other feed path, judgment is made as to whether or not the preceding recording sheet has been delivered (step S**23**). If it is judged that the preceding recording sheet has been delivered, the gate is set into a fifth position (step S**24**). The fifth position of the gate is a position that enables a recording sheet to be fed from the subsidiary feed path **42** to the copy receiving tray **38**. Subsequently, the feed roller **71** is rotated backwardly (step S**25**) to feed the recording sheet present in the subsidiary feed path **42** to the copy receiving tray **38** (step S**40**).

[0085] If it is judged in step S**21** that no recording sheet remains stopped in the subsidiary feed path **42** or if it is judged in step S**22** that the preceding sheet remains stopped in any other feed path, judgment is made as to whether or not any recording sheet remains stopped in the second switchback feed path **46** (step S**26**). If it is judged that a recording sheet remains stopped in the second switchback feed path **46**, judgment is made as to whether or not the recording sheet that precedes this recording sheet remains stopped in any other feed path (step S**27**). If it is judged that the preceding recording sheet does not remain stopped in any other feed path, judgment is made as to whether or not the preceding recording sheet has been delivered (step S**28**). If it is judged that the preceding recording sheet has been delivered, the gate is set into a sixth position (step S**29**). The sixth position of the gate is a position that enables a recording sheet to be fed from the second switchback feed path **46** to the copy receiving tray **38**. Subsequently, the feed rollers **72**, **74** and **75** are rotated backwardly (step S**30**) to feed the recording sheet present in the second switchback feed path **46** to the copy receiving tray **38** (step S**40**).

[0086] If it is judged in step S**26** that no recording sheet remains stopped in the second switchback feed path **46** or if it is judged in step S**27** that the preceding sheet remains stopped in any other feed path, judgment is made as to whether or not any recording sheet remains stopped in the second switchback feed path **47** (step S**31**). If it is judged that a recording sheet remains stopped in the second switchback feed path **47**, judgment is made as to whether or not the recording sheet that precedes this recording sheet remains stopped in any other feed path (step S**32**). If it is judged that the preceding recording sheet does not remain stopped in any other feed path, judgment is made as to whether or not the preceding recording sheet has been delivered (step S**33**). If it is judged that the preceding recording sheet has been delivered, the gate is set into a seventh position (step S**34**). The seventh position of the gate is a position that enables a recording sheet to be fed from the second switchback feed path **47** to the copy receiving tray **38**. Subsequently, the feed rollers **72**, **74** and **76** are rotated backwardly (step S**35**) to feed the recording sheet present in the second switchback feed path **47** to the copy receiving tray **38** (step S**40**).

[0087] If it is judged in step S**31** that no recording sheet remains stopped in the second switchback feed path **47** or if it is judged in step S**32** that the preceding sheet remains stopped in any other feed path, judgment is made as to whether or not any recording sheet remains stopped in the first switchback feed path **43** (step S**36**). If it is judged that a recording sheet remains stopped in the first switchback feed path **43**, judgment is made as to whether or not the preceding recording sheet has been delivered (step S**37**). If it is judged that the preceding recording sheet has been delivered, the gate is set into an eighth position (step S**38**). The eighth position of the gate is a position that enables a recording sheet to be fed from

the first switchback feed path **43** to the copy receiving tray **38**. Subsequently, the feed roller **73** is rotated backwardly (step S**39**) to feed the recording sheet to the copy receiving tray **38** by passing the recording sheet through the subsidiary feed path **42** and the main feed path **41** sequentially (step S**40**).

[0088] By feeding recording sheets in this way, it is possible to deliver the recording sheets in the order of pages and increase the rate of delivery of recording sheets per unit time by reducing the spacing between adjacent recording sheets when requests for both of single-side printing and double-side printing are made mixingly.

[0089] While the foregoing embodiment has a single switchback feed path as the first switchback feed path and two switchback feed paths as the second switchback feed path, each of the first and second switchback feed paths may be increased in number. With increasing number of switchback feed paths, the spacing between adjacent ones of a larger number of recording sheets can be reduced, thus leading to a higher rate of delivery of recording sheets per unit time in volume printing.

[0090] While the foregoing embodiment has been applied to the case of reducing the spacing between adjacent recording sheets when requests for both of single-side printing and double-side printing are made mixingly, the foregoing embodiment is not limited to this case. By applying the foregoing embodiment to the case of single-side printing only or double-side printing only, it is possible to reduce the spacing between adjacent recording sheets, thereby to increase the rate of delivery of recording sheets per unit time.

[0091] The foregoing embodiment is illustrative in all points and should not be construed to limit the present invention. The scope of the present invention is defined not by the foregoing embodiment but by the following claims. Further, the scope of the present invention is intended to include all modifications within the meanings and scopes of claims and equivalents.

What is claimed is:

1. An image forming apparatus comprising:

an image forming section configured to perform image forming processing on a first recording medium to be subjected to single-side printing and on a second recording medium to be subjected to double-side printing;

an output section configured to store therein the first and second recording media having been subjected to image formation thereon by the image forming section;

a main feed path forming a feed path reaching the output section through the image forming section;

a subsidiary feed path forming a feed path extending from a first position between the image forming section and the output section at which the subsidiary feed path branches off the main feed path and reaching an entrance of the main feed path to join the main feed path at a location upstream of the image forming section;

a first switchback feed path formed in a place extending from a second position between the image forming section and the output section at which the first switchback feed path branches off the main feed path, the first switchback feed path being configured to turn the second recording medium upside down;

a second switchback feed path formed in a place extending from a third position between the image forming section and the output section at which the second switchback feed path branches off the main feed path, the second switchback feed path being configured to turn the first recording medium upside down; and

a control section configured to control feeding of the first and second recording media having been subjected to image formation thereon by the image forming section to any one of the output section, the subsidiary feed path, the first switchback feed path and the second switchback feed path.

2. The image forming apparatus according to claim **1**, wherein the control section feeds the first recording medium to the subsidiary feed path to turn the first recording medium upside down.

3. The image forming apparatus according to claim **1**, wherein the control section feeds the first recording medium to the subsidiary feed path to turn the first recording medium upside down when the second recording medium is fed to follow the first recording medium.

4. The image forming apparatus according to claim **1**, wherein the control section feeds the first recording medium to the second switchback feed path to turn the first recording medium upside down when the second recording medium is fed to precede the first recording medium.

5. The image forming apparatus according to claim **1**, wherein at least one of the first switchback feed path and the second switchback feed path comprises a plurality of feed paths.

6. The image forming apparatus according to claim **1**, further comprising an option unit removably attached to a recording sheet output side of an image forming apparatus body, wherein the second switchback feed path is accommodated in the option unit.

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