US011873186B2

(12) **United States Patent**
Hagihara

(10) **Patent No.: US 11,873,186 B2**
(45) **Date of Patent: Jan. 16, 2024**

(54) **DOCUMENT CONVEYANCE DEVICE, IMAGE READING DEVICE AND IMAGE FORMING APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **17/547,453**

(22) Filed: **Dec. 10, 2021**

(65) **Prior Publication Data**

US 2022/0185606 A1 Jun. 16, 2022

(30) **Foreign Application Priority Data**

Dec. 16, 2020 (JP) 2020-208477

(51) **Int. Cl.**

B65H 7/02	(2006.01)
B65H 31/10	(2006.01)
B65H 1/18	(2006.01)
B65H 1/14	(2006.01)
B65H 29/50	(2006.01)

(52) **U.S. Cl.**

CPC ***B65H 7/02*** (2013.01); ***B65H 1/14*** (2013.01); ***B65H 1/18*** (2013.01); ***B65H 29/50*** (2013.01); ***B65H 31/10*** (2013.01); *B65H 2405/3321* (2013.01); *B65H 2511/15* (2013.01)

(58) **Field of Classification Search**

CPC ... B65H 1/08; B65H 1/14; B65H 1/18; B65H 7/02; B65H 7/04; B65H 7/14; B65H 7/20; B65H 29/50; B65H 43/02; B65H 43/06; B65H 43/08; B65H 2404/142; B65H 2404/1421; B65H 2405/3321; B65H 2511/15

See application file for complete search history.

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(57) **ABSTRACT**

A document conveyance device includes a supply tray, a discharge tray, a conveyance part, a discharge part, and a lifting and lowering part. The lifting and lowering part lifts the supply tray and the discharge part according to a feeding of the document. When the feeding of the document to the document conveyance path is completed and then the supply tray is lifted, in a small number of documents discharge state where the height of the documents stacked on the discharge tray is less than the specified value, the lifting and lowering part positions the supply tray at a taking out position depart upward from the specified value by a predetermined space.

6 Claims, 10 Drawing Sheets

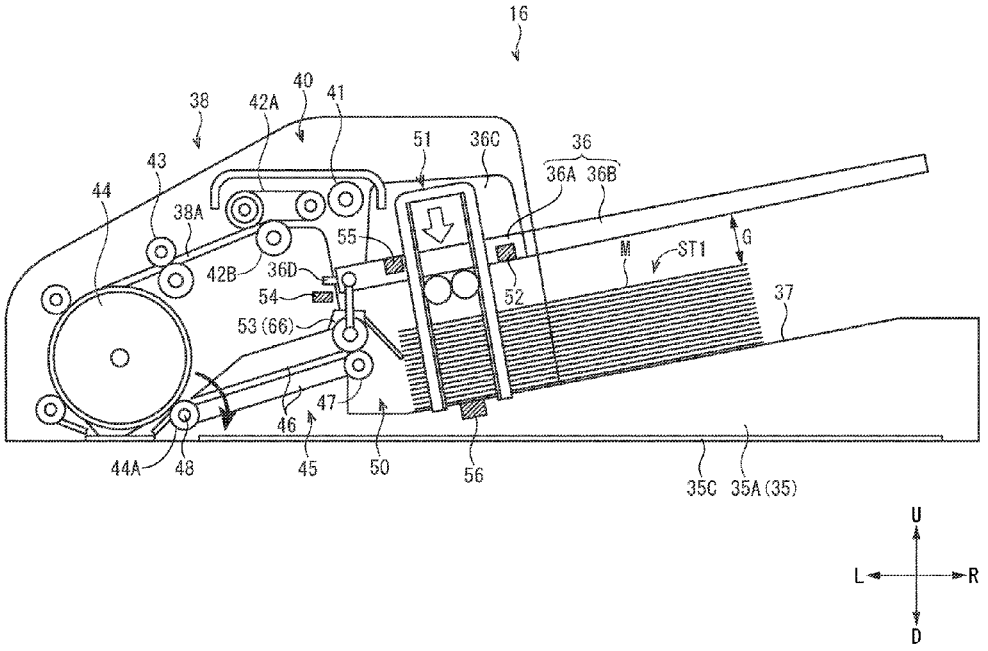


FIG. 1

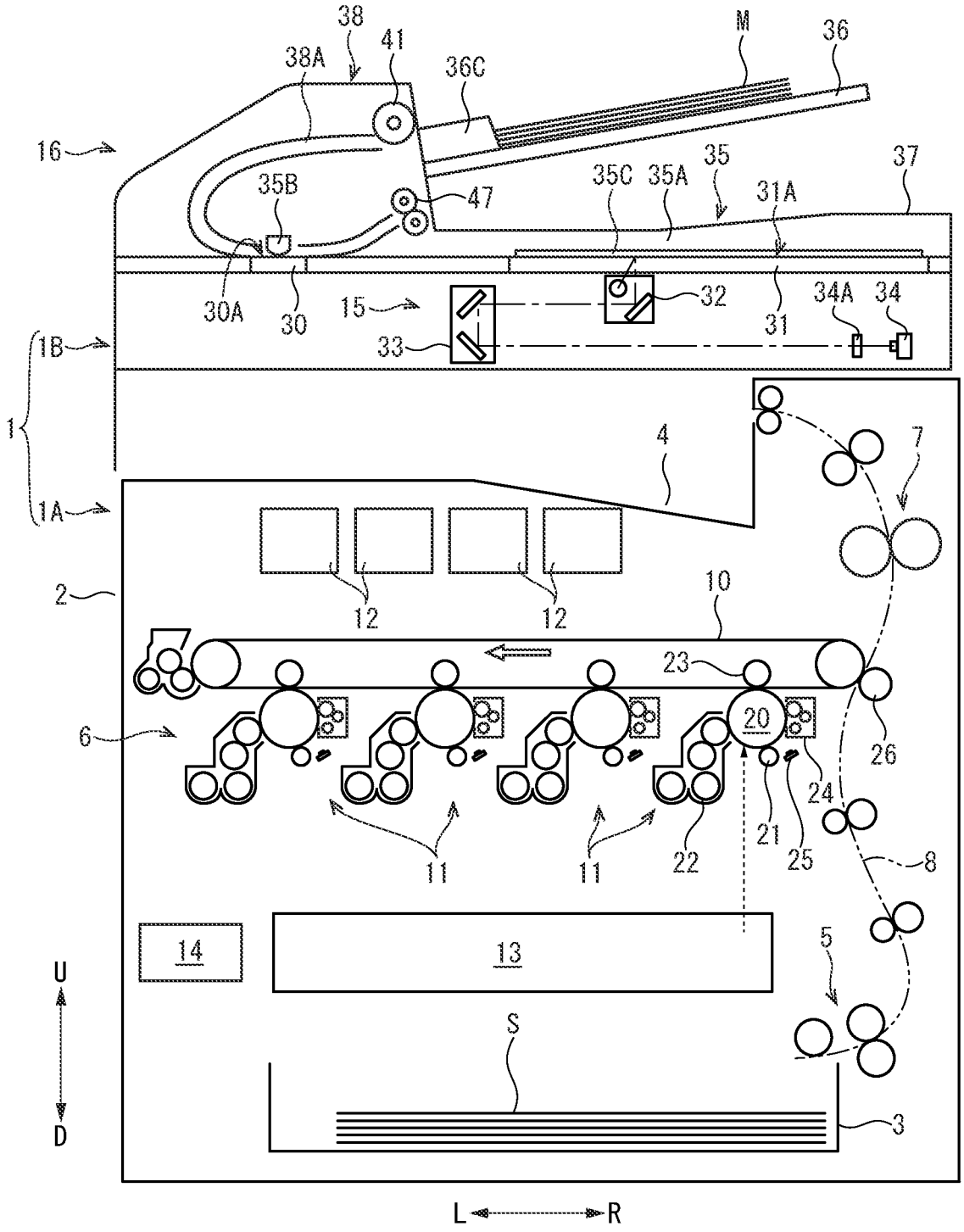

38
41
38A
36C
M
36
16
35B
47
35C
35A
35
37
31A
30A
30
15
32
34A
34
31
33
1B
1
1A
4
7
2
12
12
10
23
6
20
26
24
21
25
22
11
11
8
14
13
5
S
3
U
D
L
R

FIG. 2

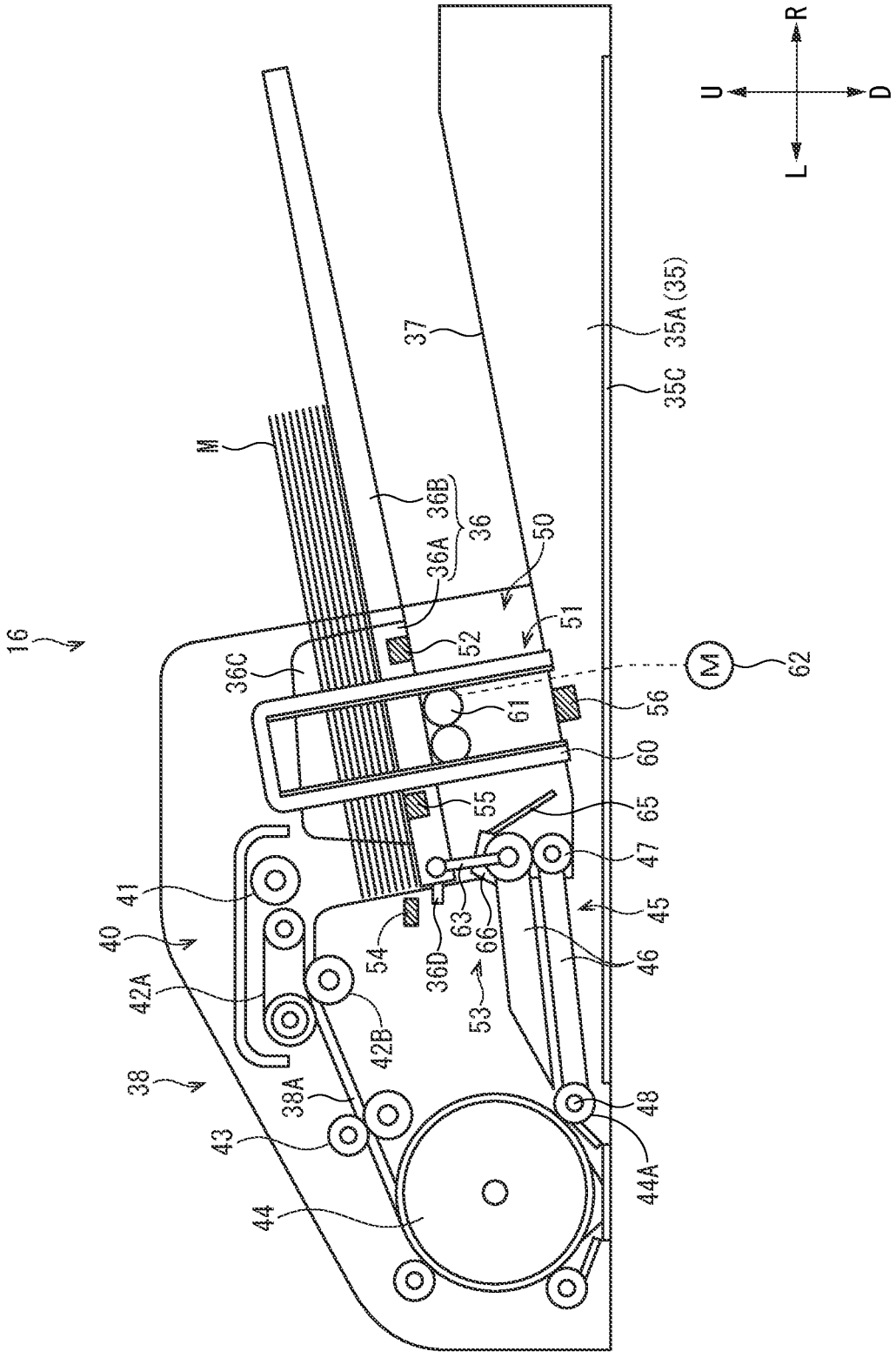

16
37
35A (35)
35C
M
36B
36
36A
50
51
52
36C
61
56
M
62
60
55
65
47
41
40
45
63
66
54
36D
46
42A
53
42B
38
38A
48
43
44A
44
U
D
L
R

FIG. 3

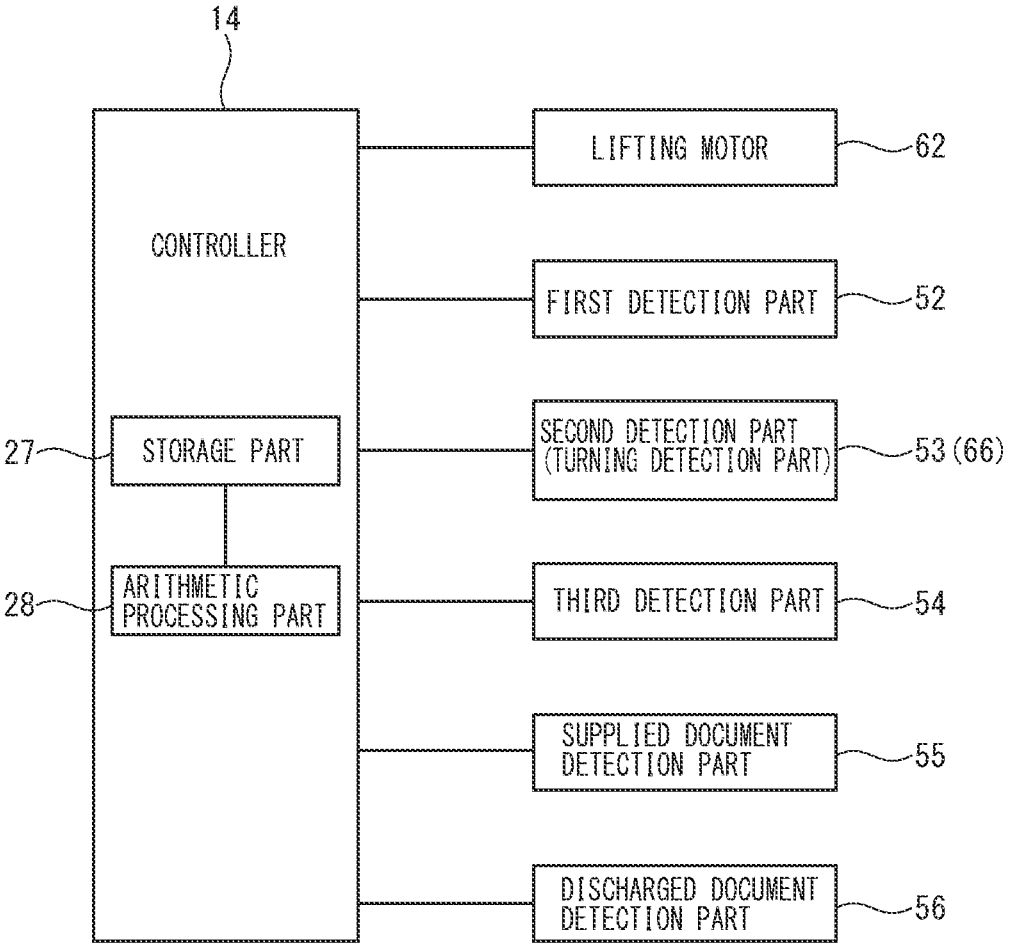

14
CONTROLLER
27
STORAGE PART
28
ARITHMETIC PROCESSING PART
LIFTING MOTOR
62
FIRST DETECTION PART
52
SECOND DETECTION PART (TURNING DETECTION PART)
53 (66)
THIRD DETECTION PART
54
SUPPLIED DOCUMENT DETECTION PART
55
DISCHARGED DOCUMENT DETECTION PART
56

FIG. 4

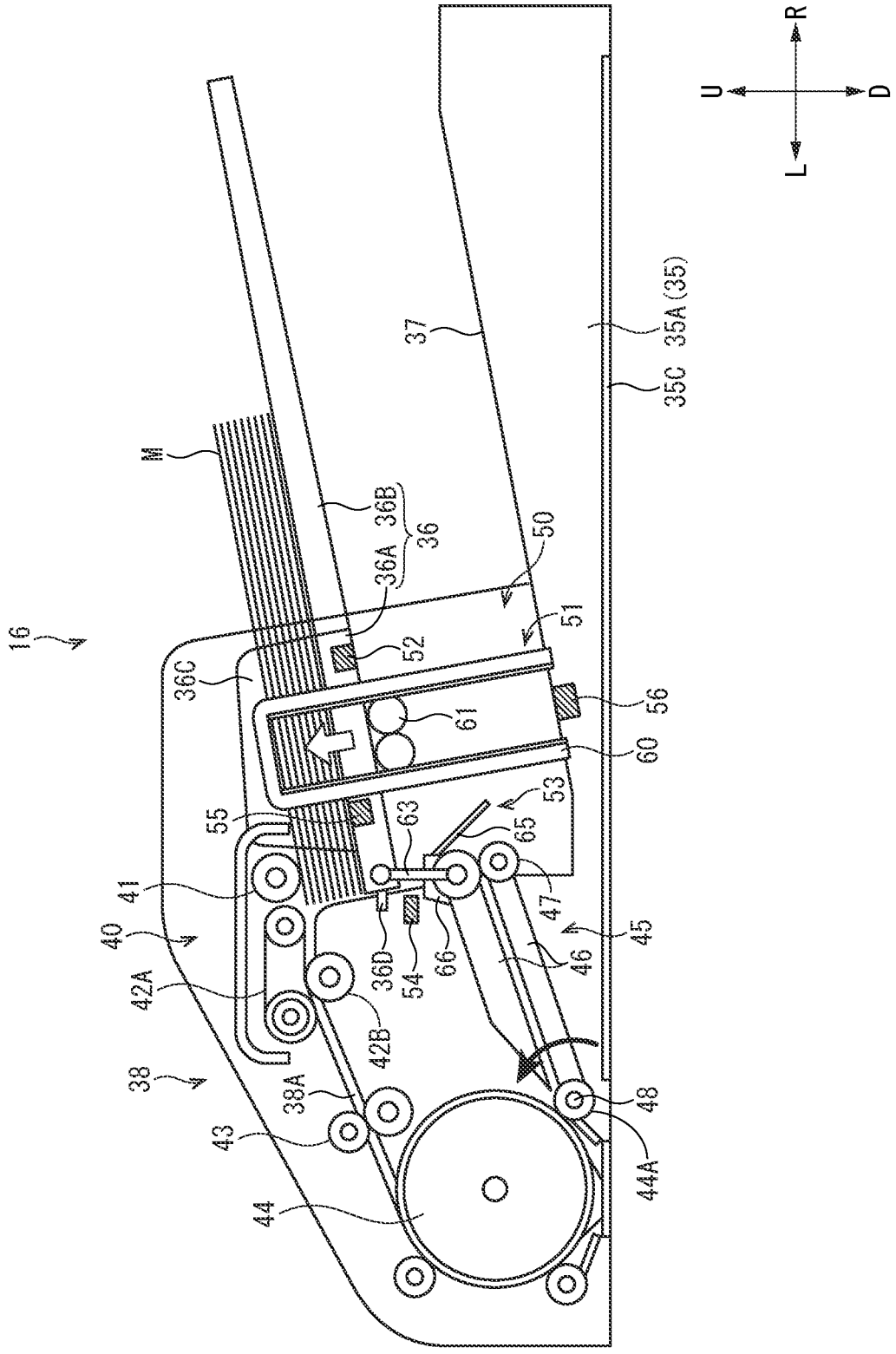

U
R
L
D
16
M
36B
36
36A
50
51
52
36C
61
56
60
53
55
63
65
41
40
47
45
36D
54
66
46
42A
42B
38
38A
43
48
44A
44
37
35A (35)
35C

FIG. 5

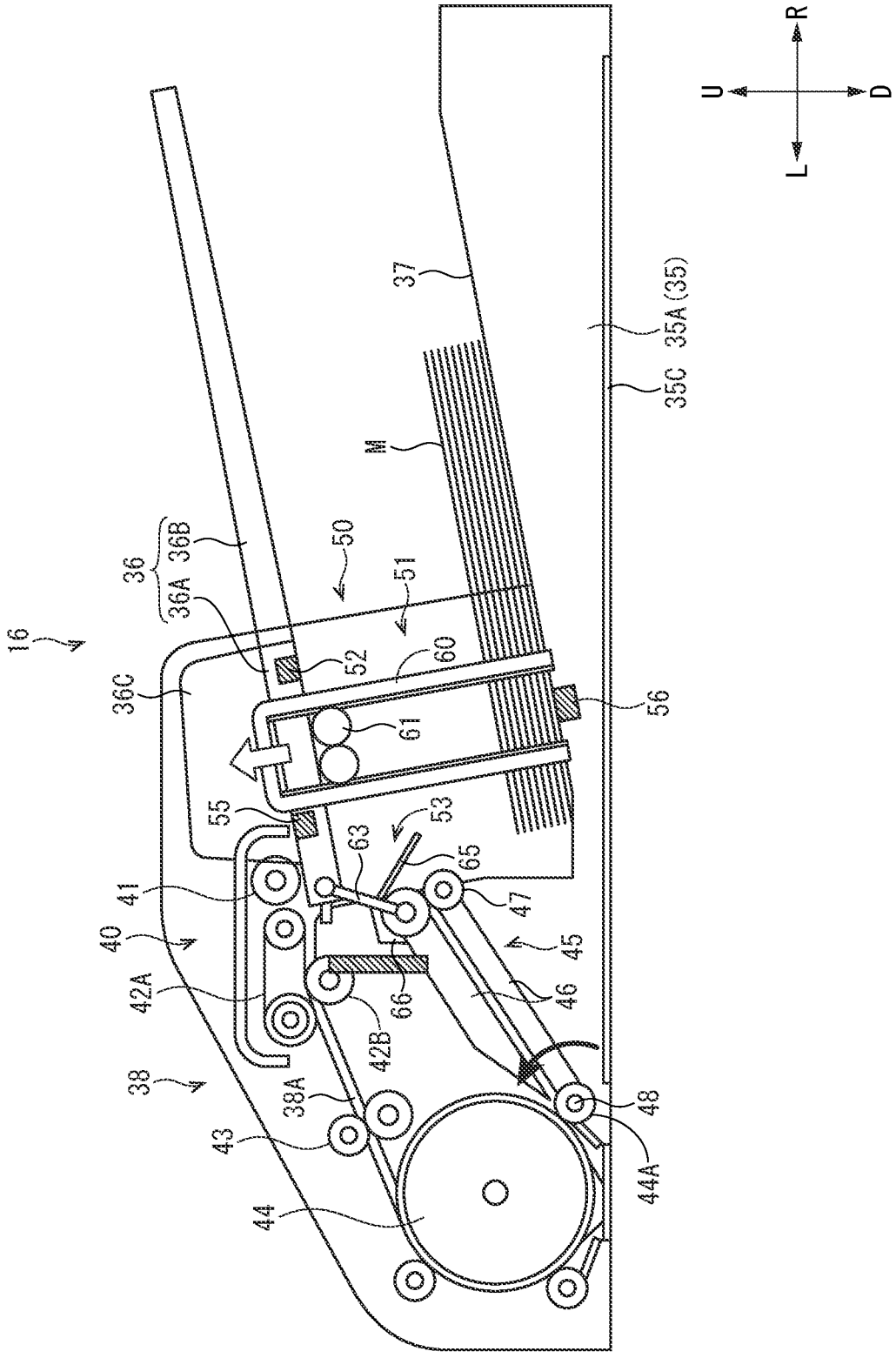

U
D
L
R
16
36
36A
36B
36C
37
35A (35)
35C
M
50
51
52
60
61
56
55
53
63
65
41
40
47
45
42A
66
46
42B
38
38A
48
43
44A
44

FIG. 6

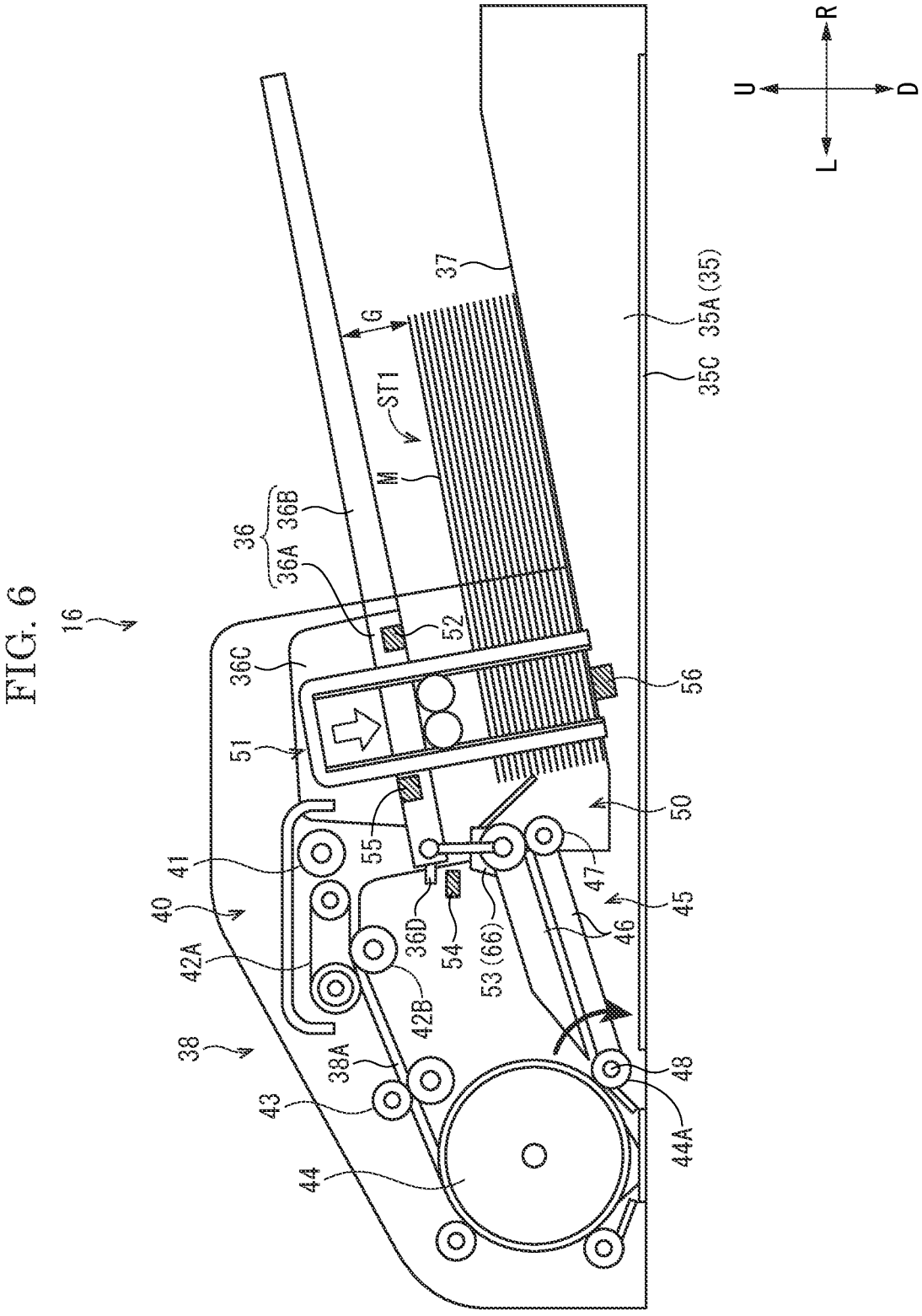

16
36
36A
36B
36C
37
35A (35)
35C
G
ST1
M
52
56
51
55
50
41
40
42A
36D
54
53 (66)
47
45
46
42B
38
38A
43
48
44
44A
U
D
L
R

FIG. 7

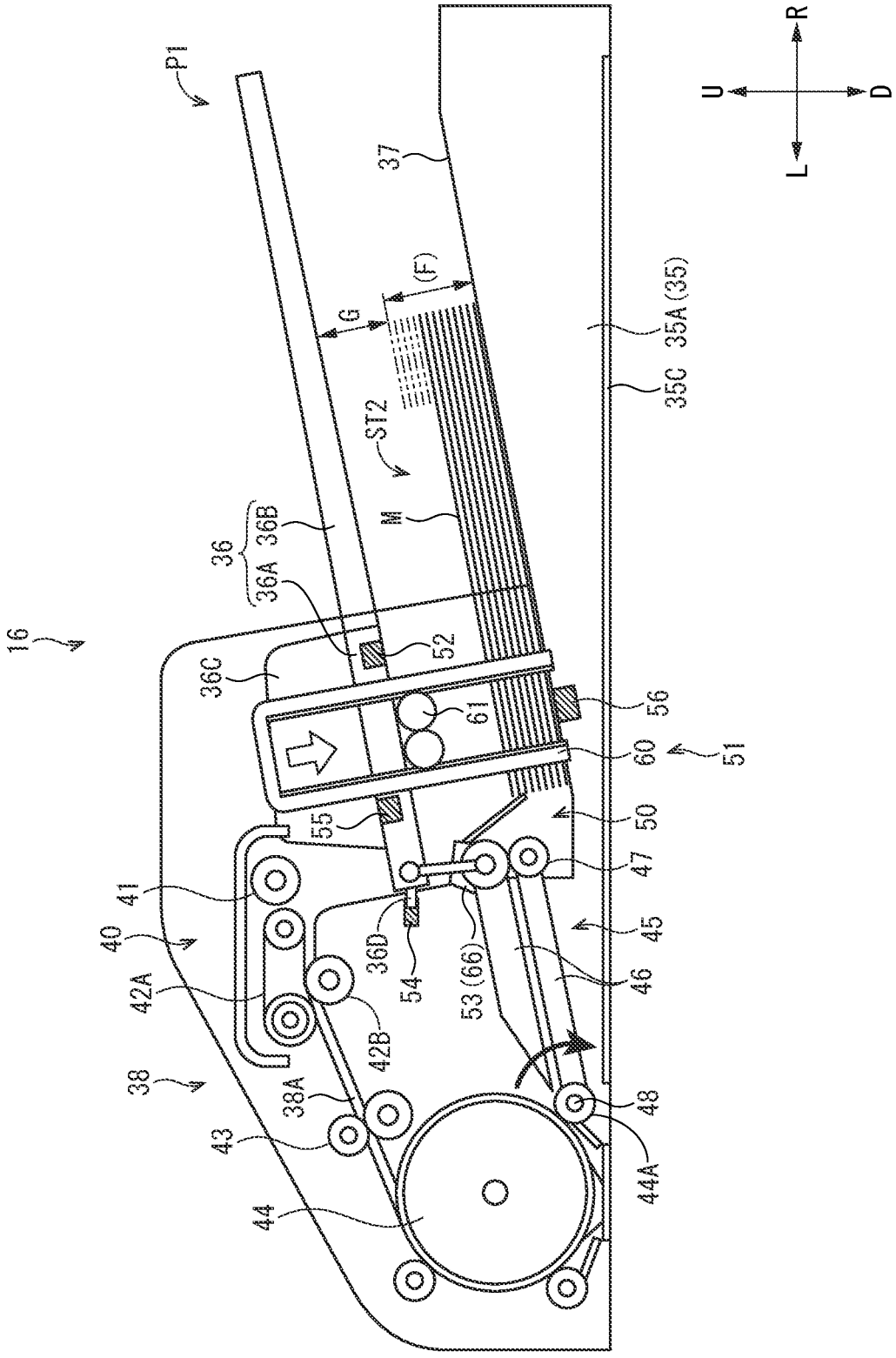

P1
37
G
(F)
35A (35)
35C
ST2
M
36
36B
36A
52
36C
61
56
60
51
55
50
47
41
40
45
36D
54
53 (66)
46
42A
42B
38
38A
48
43
44A
44
U
R
L
D

FIG. 8

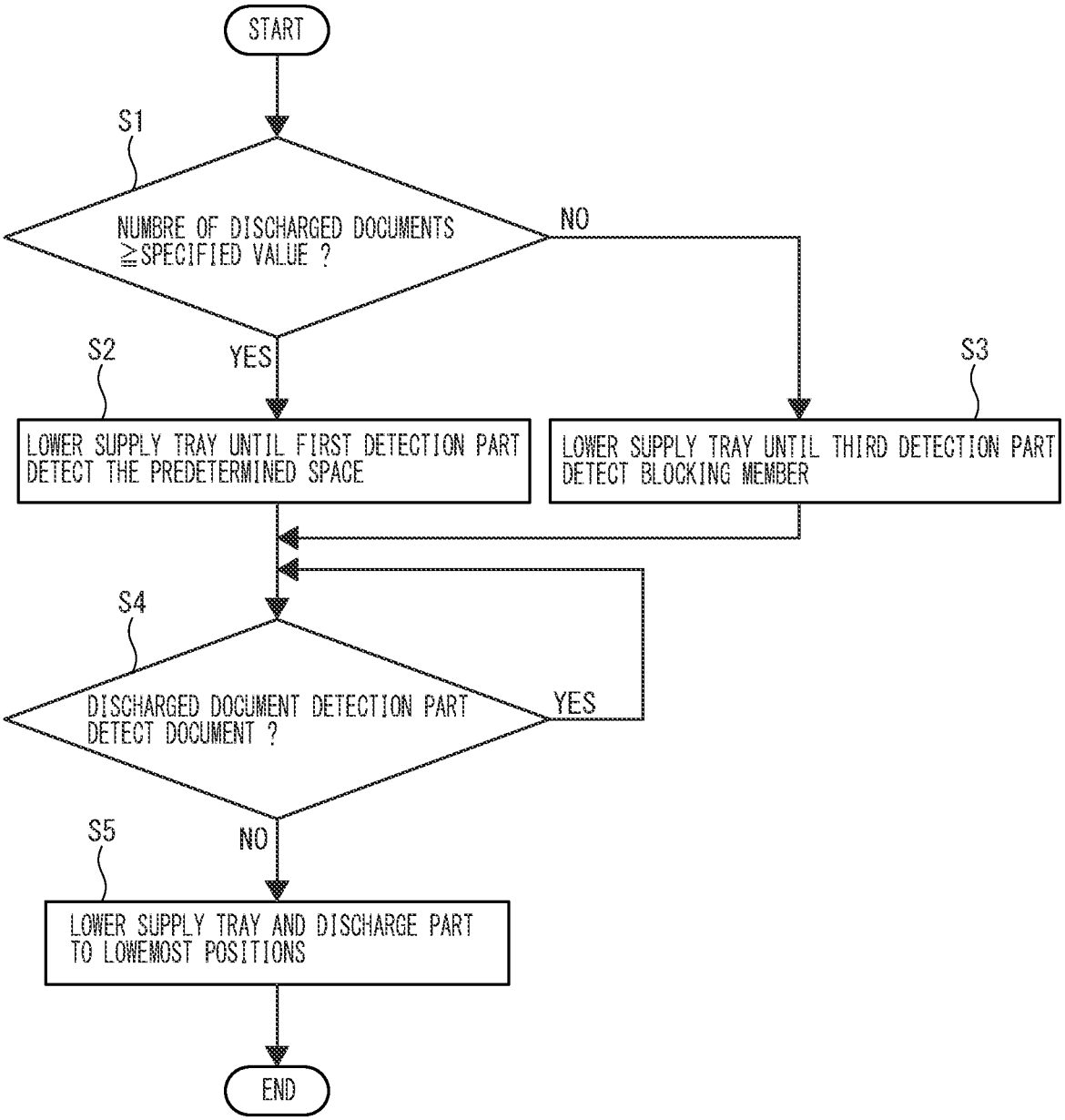

START
S1
NUMBRE OF DISCHARGED DOCUMENTS ≧SPECIFIED VALUE ?
NO
YES
S2
LOWER SUPPLY TRAY UNTIL FIRST DETECTION PART DETECT THE PREDETERMINED SPACE
S3
LOWER SUPPLY TRAY UNTIL THIRD DETECTION PART DETECT BLOCKING MEMBER
S4
DISCHARGED DOCUMENT DETECTION PART DETECT DOCUMENT ?
YES
NO
S5
LOWER SUPPLY TRAY AND DISCHARGE PART TO LOWEMOST POSITIONS
END

FIG. 9

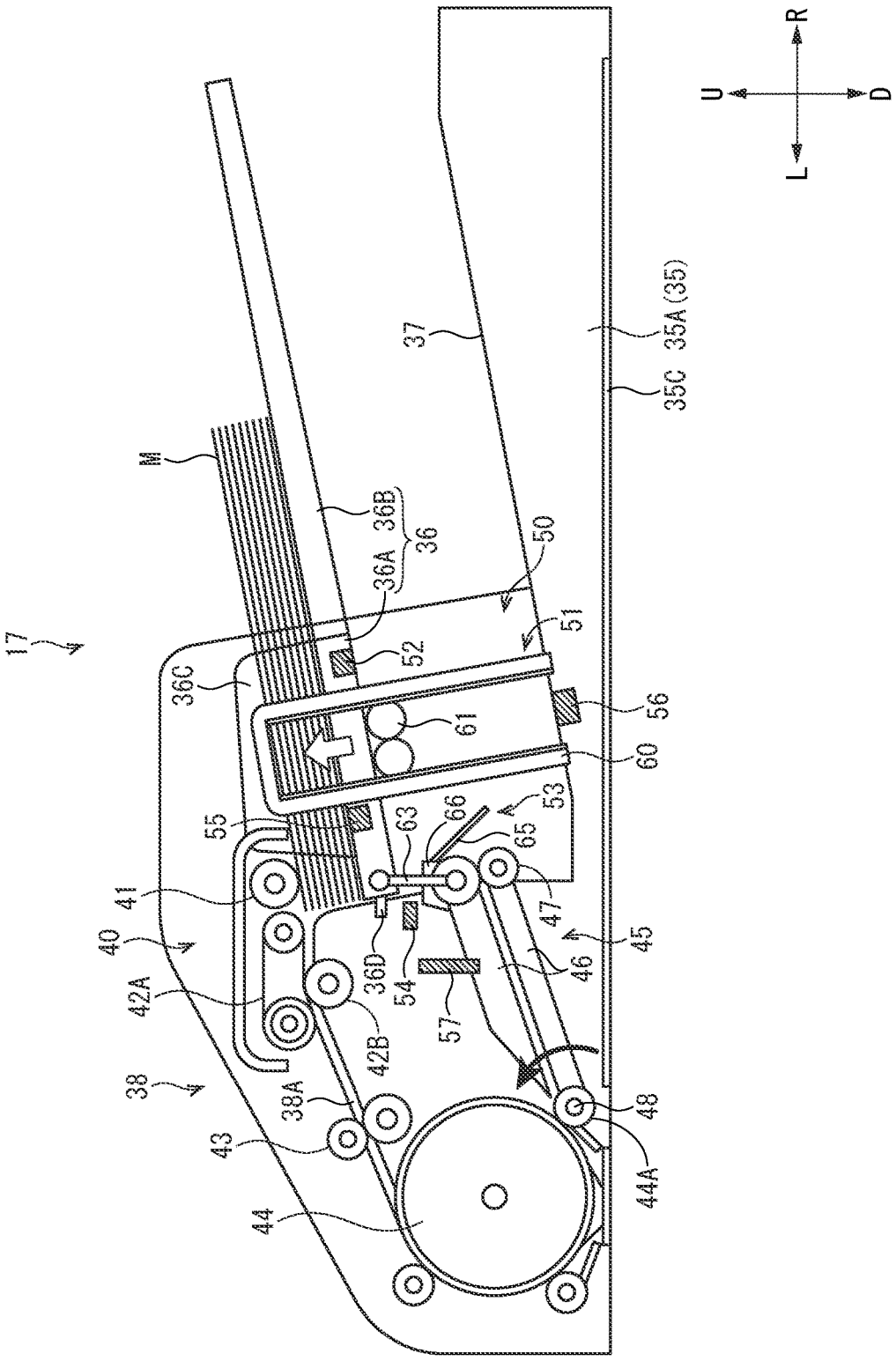
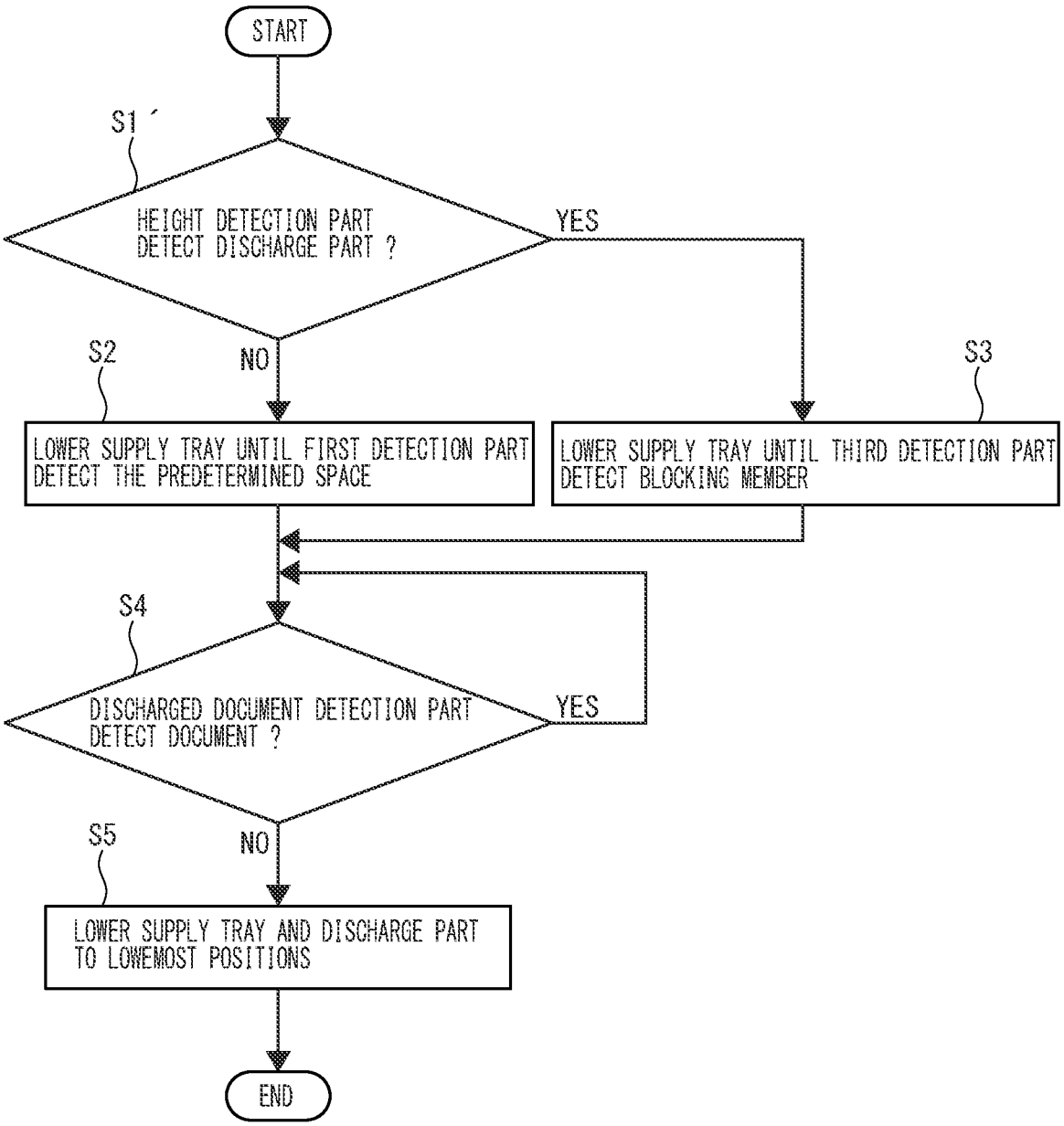

17
M
36B
36A
36
36C
37
35A (35)
35C
50
51
52
56
61
60
53
63
66
65
55
41
40
42A
36D
54
57
47
45
46
42B
38
38A
43
48
44
44A
U
D
L
R

FIG. 10


START
S1
HEIGHT DETECTION PART DETECT DISCHARGE PART ?
YES
NO
S2
S3
LOWER SUPPLY TRAY UNTIL FIRST DETECTION PART DETECT THE PREDETERMINED SPACE
LOWER SUPPLY TRAY UNTIL THIRD DETECTION PART DETECT BLOCKING MEMBER
S4
DISCHARGED DOCUMENT DETECTION PART DETECT DOCUMENT ?
YES
NO
S5
LOWER SUPPLY TRAY AND DISCHARGE PART TO LOWEMOST POSITIONS
END

DOCUMENT CONVEYANCE DEVICE, IMAGE READING DEVICE AND IMAGE FORMING APPARATUS

INCORPORATION BY REFERENCE

This application is based on and claims the benefit of priority from Japanese patent application No. 2020-208477 filed on Dec. 16, 2020, which is incorporated by reference in its entirety.

BACKGROUND

The present disclosure relates to a document conveyance device, an image reading device and an image forming apparatus.

A document feeding device is known, which feeds a document from a document bundle placed on a sheet feeding tray one by one and discharges it on a document discharge tray. The document feeding device includes a lifting and lowering mechanism which lifts the sheet feeding tray from the lowermost position depending on a decrease in thickness of the document bundle placed on the sheet feeding tray. By lifting and lowering the sheet feeding tray, it becomes possible to increases a number of the documents placed on the sheet feeding tray.

In the document feeding device described above, after the feeding of the document is completed, the lifted sheet feeding tray is lowered to such a height where it does not interfere with the document on the document discharge tray. Therefore, in a case where a number of the documents on the document discharge tray is small, the sheet feeding tray is lowered almost the lowermost position. Then, because a space between the sheet feeding tray and the document discharge tray is narrow, it becomes difficult for a user to enter his hand into the space and to take out the document discharged on the document discharge tray.

SUMMARY

In accordance with an aspect of the present disclosure, a document conveyance device includes a supply tray, a discharge tray, a conveyance part, a discharge part, and a lifting and lowering part. On the supply tray, a document is placed. The discharge tray is disposed below the supply tray. The conveyance part feeds the document on the supply tray to a document conveyance path one by one and conveys the document along the document conveyance path. The discharge part discharges the document conveyed by the conveyance part to the discharge tray. The lifting and lowering part lifts and lowers the supply tray and the discharge part. The lifting and lowering part lifts the supply tray and the discharge part according to a feeding of the document. When the feeding of the document to the document conveyance path is completed and then the supply tray is lifted, in a large number of documents discharge state where a height of the documents stacked on the discharge tray is more than a specified value, the lifting and lowering part positions the supply tray at a height depart upward from an uppermost document of the documents stacked on the discharge tray by a predetermined space. When the feeding of the document to the document conveyance path is completed and then the supply tray is lifted, in a small number of documents discharge state where the height of the documents stacked on the discharge tray is less than the specified value, the lifting and lowering part positions the supply tray at a taking out position depart upward from the specified value by the predetermined space.

In accordance with an aspect of the present disclosure, an image reading device includes the document conveyance device and a reading part which reads an image of the document conveyed along the document conveyance path by the conveyance part.

In accordance with an aspect of the present disclosure, an image forming apparatus includes the image reading device.

The other features and advantages of the present disclosure will become more apparent from the following description. In the detailed description, reference is made to the accompanying drawings, and preferred embodiments of the present disclosure are shown by way of example in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view schematically showing an inner structure of an image forming apparatus according to one embodiment of the present disclosure.

FIG. **2** is a sectional view showing a document conveyance device according to the first embodiment of the present disclosure.

FIG. **3** is a block diagram showing a controller and the others of the document conveyance device according to the first embodiment of the present disclosure.

FIG. **4** is a sectional view showing the document conveyance device according to the first embodiment of the present disclosure, in a state where the uppermost document is pressed on a pickup roller.

FIG. **5** is a sectional view showing the document conveyance device according to the first embodiment of the present disclosure, in a state where the supply tray is lifted to the uppermost position.

FIG. **6** is a sectional view showing the document conveyance device in a large number of documents discharge state, according to the first embodiment of the present disclosure.

FIG. **7** is a sectional view showing the document conveyance device in a small number of documents discharge state, according to the first embodiment of the present disclosure.

FIG. **8** is a flowchart showing a control of a lifting and lowering mechanism of the document conveyance device according to the first embodiment of the present disclosure.

FIG. **9** is a sectional view showing the document conveyance device according to the second embodiment of the present disclosure, in a state where the uppermost document is pressed on the pickup roller.

FIG. **10** is a flowchart showing a control of a lifting and lowering mechanism of the document conveyance device according to the second embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, with reference to the attached drawings, one embodiment of the present disclosure will be described. L, R, U and D in the drawings indicate left, right, upper and lower, and the front side of the drawing is defined as the front side. Although directional and positional terms are used in the specification, they are used for convenience of explanation and are not intended to limit the scope of the present disclosure.

With reference to FIG. **1**, an image forming apparatus **1** will be described. FIG. **1** is a front view schematically showing an internal structure of the image forming apparatus **1**.

[Outline of Image Forming Apparatus]

As shown in FIG. **1**, the image forming apparatus **1** includes an image forming device **1**A and an image reading device **1**B. The image forming device **1**A forms an image on a sheet S in an electrophotographic manner. The image reading device **1**B optically reads an image of a document M and converts it into digital data. The image forming apparatus **1** includes a controller **14** which appropriately controls the image forming device **1**A and the image reading device **1**B.

[Image Forming Device]

In the lower portion of the device main body **2** of the image forming device **1**A, a sheet feeding cassette **3** in which a bundle of the paper sheets S is stored is detachably attached. On the upper surface of the device main body **2**, a discharge tray **4** on which the sheet S on which an image is formed is received is provided. The sheet S is not limited to the paper sheet, but may be a resin film or the like.

The image forming device **1**A includes a sheet feeding part **5**, an image forming part **6** and a fixing part **7** inside the device main body **2**. The sheet feeding part **5** is disposed on the upstream side on a conveyance path **8** extending from the sheet feeding cassette **3** to the sheet discharge tray **4**. The fixing part **7** is disposed on the downstream side on the conveyance path **8**, and the image forming part **6** is disposed between the sheet feeding part **5** and the fixing part **7** on the conveyance path **8**.

The image forming part **6** includes an intermediate transfer belt **10**, four image forming units **11**, four toner containers **12** and an exposure unit **13**. The four image forming units **11** are disposed side by side in the left-and-right direction below the intermediate transfer belt **10**. The exposure unit **13** is disposed below the image forming units **11**. The four toner containers **12** are disposed above the intermediate transfer belt **10**, and store toners (developers) of four colors (yellow, magenta, cyan and Black) for replenishment.

Each image forming unit **11** includes a photosensitive drum **20**, a charge device **21**, a development device **22**, a primary transfer roller **23**, a cleaning device **24** and a static eliminator **25**. Since the four image forming units **11** have the same configuration, one image forming unit **11** will be described below.

The photosensitive drum **20** is driven to be rotated while coming into contact with the intermediate transfer belt **10**. The charge device **21**, the development device **22**, the primary transfer roller **23**, the cleaning device **24** and the static eliminator **25** are disposed around the photosensitive drum **20** in the order of the image forming process. The primary transfer roller **23** faces the photosensitive drum **20** across the intermediate transfer belt **10**. A secondary transfer roller **26** comes into contact with the right side portion of the intermediate transfer belt **10**.

The controller **14** includes a storage part **27** which stores a program, data and the others, and an arithmetic processing part **28** which executes arithmetic processing according to the program and the others (see FIG. **3**). Various devices of the image forming apparatus **1** are electrically connected to the controller **14**, and the controller **14** overall controls the image forming apparatus **1**.

[Image Formation Process]

An operation of the image forming device **1**A will be described. The image forming device **1**A forms the image on the sheet S based on the image data read by the image reading device **1**B or image data transmitted from an external terminal (a personal computer or the like). The controller **14** controls the image forming device **1**A based on the input image data to perform the image forming process in the following manner.

The charge device **21** charges the surface of the photosensitive drum **20**. The exposure unit **13** exposures the photosensitive drum **20** corresponding to the image data to form an electrostatic latent image on the surface of the photosensitive drum **20**. The development device **22** develops the electrostatic latent image on the photosensitive drum **20** into a toner image by using the toner supplied from the toner container **12**. The toner images of the four colors carried on the four photosensitive drums **20** are primarily transferred in order to the intermediate transfer belt **10** by the primary transfer rollers **23** to which a primary transfer bias is applied. Thus, a full-color toner image is formed on the surface of the intermediate transfer belt **10**.

On the other hand, the sheet feeding part **5** feeds the sheet S in the sheet feeding cassette **3** to the conveyance path **8**. The secondary transfer roller **26** secondarily transfers the toner image on the intermediate transfer belt **10** to the sheet S passing between the secondary transfer toller **26** and the intermediate transfer belt **10**. The fixing part **7** thermally fixes the toner image on the sheet S. Thereafter, the sheet S is discharged to the discharge tray **4**. The cleaning device **24** removes the waste toner (the residual toner) remaining on the surface of the photosensitive drum **20** after the primary transferring. The static eliminator **25** irradiates the photosensitive drum **20** with static eliminator light to remove the charge of the photosensitive drum **20**.

[Image Reading Device]

Next, the image reading device **1**B will be described. As shown in FIG. **1**, the image reading device **1**B includes a reading part **15** and a document conveyance device **16**. The reading part **15** reads the image of the document M conveyed along a document conveyance path **38**A by a conveyance part **38** described below. The document conveyance device **16** is disposed above the reading part **15** and automatically sends the document M one by one to a document conveyance surface **30**A.

<Reading Part>

The reading part **15** includes a contact glass **30**, a platen glass **31**, an optical scanning unit **32**, a reflection unit **33** and an image sensor **34**.

(Contact Glass, Platen Glass)

The contact glass **30** is provided on the left upper surface of the device main body **2**, and constitutes the document conveyance surface **30**A along which the document M is passed. The platen glass **31** is disposed on the right side of the contact glass **30**, and constitutes a document placement surface **31**A on which the document M is placed.

(Optical Scanning Unit)

The optical scanning unit **32** is stopped at a position facing the document conveyance surface **30**A, and irradiates the document M being conveyed on the contact glass **30** with light. The optical scanning unit **32** irradiates the document M on the platen glass **31** (the document placement surface **31**A) with the light while moving rightward in FIG. **1** from the position facing the document conveyance surface **30**A.

(Reflection Unit)

The reflection unit **33** reflects the light irradiated from the optical scanning unit **32** and reflected on the document M toward a condenser lens **34**A. When the optical scanning unit **32** irradiates the document M on the document placement surface **31**A with the light, the reflection unit **33** moves

in the same direction as the optical scanning unit **32** so as to keep an optical path length between the document M and the condenser lens **34**A constant.

(Image Sensor) The image sensor **34** is a semiconductor element which photoelectrically converts the light received via the condenser lens **34**A. The condenser lens **34**A is disposed coincident with the light receiving part of the image sensor **34**. The image sensor **34** and the condenser lens **34**A are fixed to the housing of the reading part **15**.

<Document Conveyance Device>

Next, with reference to FIG. **1** and FIG. **2**, the document conveyance device **16** according to the first embodiment will be described. FIG. **2** is a sectional view showing the document conveyance device **16**.

As shown in FIG. **1**, the document conveyance device **16** includes a document holding part **35**, a supply tray **36**, a discharge tray **37** and the conveyance part **38**. Hereinafter, "upstream" and "downstream" respectively indicate an upstream and a downstream in a conveyance direction of the document M.

(Document Holding Part)

The document holding part **35** includes a holding part main body **35**A, a holding member **35**B and a holding plate **35**C. The holding part main body **35**A is formed so as to cover the glasses **30** and **31** of the reading part **15**. The holding member **35**B is provided on the lower surface of the holding part main body **35**A so as to face the contact glass **30**. The holding plate **35**C is provided on the lower surface of the holding part main body **35**A so as to face the platen glass **31**.

The holding part main body **35**A is attached to the upper rear surface of the device main body **2** of the image reading device **1**A by a hinge (not shown). The holding part main body **35**A is turnable (openable and closable) around the hinge. When the front side end portion of the holding part main body **35**A is lifted (opened), the contact glass **30** (the document conveyance surface **30**A) and the platen glass **31** (the document placement surface **31**A) are exposed. The holding member **35**B has a function of holding the document M being conveyed by the conveyance part **38** on the document conveyance surface **30**A. The holding plate **35**C has a function of holding the document M on the document placement surface **31**A.

(Supply Tray)

As shown in FIG. **2**, the supply tray **36** is formed so as to extend from the conveyance part **38** upward in the right oblique direction. The supply tray **36** is disposed depart upward from the holding part main body **35**A. On the supply tray **36**, the documents M (the bundle of the documents M) are placed. The supply tray **36** has a downstream side tray **36**A disposed on the downstream side in the conveyance direction and an upstream side tray **36**B disposed on the upstream side in the conveyance direction.

The downstream side tray **36**A is provided with a pair of cursors **36**C which aligns both front and rear edges of the placed documents M and aligns the center of the documents M in the width direction with the center of the supply tray **36** in the width direction. The downstream side tray **36**A is provided with a supplied document detection part **55** which detects whether the document M is placed on the supply tray **36**. The supplied document detection part **55** is constituted by, for example, a reflection type optical sensor, and is connected to the controller **14** via a predetermined circuit (not shown). The upstream side tray **36**B is connected to the upstream end of the downstream side tray **36**A in a turnable manner. When a user flips up the upstream side tray **36**B as necessary, an upper space above the discharge tray **37** is opened, and the documents M can be easily taken out from the discharge tray **37**.

(Discharge Tray)

The discharge tray **37** is disposed below the supply tray **36** and above the document holding part **35**. Specifically, the upper surface of the holding part main body **35**A disposed on the platen glass **31** is configured as the discharge tray **37** (see also FIG. **1**). The discharge tray **37** receives the documents M conveyed to and discharged from the conveyance part **38**. The discharge tray **37** is provided with a discharged document detection part **56** which detects the document M stacked on the discharge tray **37**. The discharged document detection part **56** is constituted by, for example, a reflection type optical sensor, and is connected to the controller **14** via a predetermined circuit (not shown). The supplied document detection part **55** and the discharged document detection part **56** are not limited to the reflection type optical sensor, but may be a camera, a microswitch or the like.

(Conveyance Part)

As shown in FIG. **1**, the conveyance part **38** is provided on the left side of the holding part main body **35**A. In the conveyance part **38**, the substantially U-shaped document conveyance path **38**A is formed so as to connect the supply tray **36** to the discharge tray **37**. The conveyance part **38** feeds the documents M on the supply tray **36** to the document conveyance path **38**A one by one, and discharges the documents M passed through the document conveyance path **38**A from a discharge part **45** to the discharge tray **37**.

As shown in FIG. **2**, in the conveyance part **38**, a conveyance mechanism part **40** which supports the conveyance mechanism is provided. In the conveyance mechanism part **40**, a pickup roller **41**, a feed belt **42**A, a separation roller **42**B, a pair of registration rollers **43** and a conveyance roller **44** are supported in a rotatable manner around respective axes. The conveyance mechanism part **40** further includes the discharge part **45** which constitutes the downstream end portion of the document conveyance path **38**A. A pair of discharge rollers **47** is supported in the discharge part **45** in a rotatable manner around axes. In the pair of registration rollers **43** and the pair of discharge rollers **47**, one roller is driven to be rotated and the other roller is driven by the one roller to be rotated.

The pickup roller **41** is disposed above the upstream end portion of the document conveyance path **38**A, comes into contact with the uppermost document M, and then is driven to be rotated to feed the document M to the document conveyance path **38**A. The feed belt **42**A and the separation roller **42**B are disposed on the downstream side of the pickup roller **41**. The separation roller **42**B comes into contact with the feed belt **42**A from below, and the document M fed by the pickup roller **41** is conveyed while being held between the feed belt **42**A and the separation roller **42**B. Even if two or more of the documents M are fed by the pickup roller **41**, the conveyance speed of the document M other than the uppermost document is reduced by the frictional force with the separation roller **42**B, and the uppermost document M is conveyed earlier. That is, the separation roller **42**B prevents the multi feeding of the document M. The pair of registration rollers **43** is disposed on the downstream side of the separation roller **42**B, and the conveyance roller **44** is disposed on the downstream side of the pair of registration rollers **43** and on the upstream side of the contact glass **30** (the document conveyance surface **30**A).

The discharge part **45** has a conveyance guide **46** constituting the document conveyance path **38**A on the down-

stream side of the contact glass **30**. The pair of discharge rollers **47** is disposed on the downstream end portion of the conveyance guide **46**. The upstream end portion of the conveyance guide **46** is supported in a turnable manner around a turning shaft **48** in the upper-and-lower direction. The turning shaft **48** is also used as a rotating shaft of the driven roller **44**A coming into contact with the conveyance roller **44**.

[Image reading Process]

With reference to FIG. **1** and FIG. **2**, an operation of the image reading device **1**B will be described. The document M set on the supply tray **36** is formed into a sheet-like shape. On the other hand, the document M set on the platen glass **31** (the document placement surface **31**A) is not limited to a sheet, and may be a booklet, a card or the like.

First, a case where the document M is set on the supply tray **36** in a state where the holding part main body **35**A (the document holding part **35**) is closed will be described. When the user sets the document M (or the bundle of the documents M) on the supply tray **36** and inputs a reading instruction, the controller **14** controls the image reading device **1**B and performs the image reading process as follows.

The pickup roller **41** feeds the document M set on the supply tray **36** to the document conveyance path **38**A, and the feed belt **42**A and the separation roller **42**B feeds the document M to the downstream one by one. The pair of registration rollers **43** adjusts a timing at which the document M is fed to the contact glass **30** (the document conveyance surface **30**A). The conveyance roller **44** is driven to be rotated to send the document M between the contact glass **30** and the holding member **35**B. The document M is conveyed while being held on the contact glass **30** (the document conveyance surface **30**A) by the holding member **35**B. The optical scanning unit **32** irradiates the document M being conveyed on the document conveyance surface **30**A with the light, and the light reflected on the document M is received by the image sensor **34** to be converted into an electric signal. Then, the image of the document M is read as the image data. The pair of discharge rollers **47** sends (discharges) the document M passed the contact glass **30** (the document conveyance surface **30**A) to the discharge tray **37**.

Next, a case where the holding part main body **35**A (the document holding part **35**) is opened and the document M is set on the platen glass **31** will be described. When a reading instruction is input from the user, the optical scanning unit **32** irradiates the document M on the platen glass **31** (the document placement surface **31**A) with the light while moving rightward. The light reflected on the document M is received to the image sensor **34** and converted into the electric signal, whereby the image of the document M is read as the image data.

The image data read in the above-described manner is stored in the storage part **27** of the controller **14**, and the controller **14** performs the image forming process (printing) described above. The image data may be stored in an external terminal without being printed.

[Lifting and Lowering Part]

The document conveyance device **16** includes a lifting and lowering part **50** which lifts and lowers the supply tray **36** and the discharge part **45** depending on the thickness (the height) of the bundle of documents M placed on the supply tray **36**. By lifting and lowering the supply tray **36** and the discharge part **45**, a large number of the document M can be placed on the supply tray **36**, and a large number of the document M can be discharged on the discharge tray **37**.

Hereinafter, with reference to FIG. **2** and FIG. **3**, the lifting and lowering part **50** of the document conveyance device **16** will be described. FIG. **3** is a block diagram showing the controller **14** and the others of the document conveyance device **16**.

As shown in FIG. **2**, the lifting and lowering part **50** includes a lifting and lowering mechanism **51**, a first detection part **52**, a second detection part **53**, a third detection part **54** and the controller **14** (see FIG. **3**). The controller **14** is a component of the image forming apparatus **1**, but is also a component of the lifting and lowering part **50**.

<Lifting and Lowering Mechanism>

The lifting and lowering mechanism **51** has a function of lifting and lowering the supply tray **36** and the discharge part **45** by the same height in an interlocking manner. The lifting and lowering mechanism **51** lifts and lowers the supply tray **36** and the discharge part **45** between the lowermost position (see FIG. **2**) and the uppermost position (see FIG. **5**). As shown in FIG. **2**, the lifting and lowering mechanism **51** includes a rack **60**, a pinion **61**, a lifting motor **62** and a link member **63**. Although the rack **60**, the pinion **61** and the link member **63** are provided in pairs on both front and rear sides of the conveyance mechanism part **40**, only one of the pair is shown in the drawings.

The rack **60** is fixed to the side portion of the frame (not shown) of the conveyance mechanism part **40**. The pinion **61** is supported on the side portion of the downstream side tray **36**A in a rotatable manner around an axis. The pair of right and left pinions **61** are connected by a shaft (not shown). One pinion **61** is connected to the output shaft of the lifting motor **62** via a power transmission mechanism such as a gear train. For example, the rack **60** is formed in an approximately inverted U-shape having internal teeth, and the pinion **61** is meshed with the internal teeth of the rack **60**. The lifting motor **62** is electrically connected to the controller **14** via a drive circuit (not shown). The pinion **61** is driven by the lifting motor **62** to be rotated, and is moved in the upper-and-lower direction while meshing with the rack **60**.

The link member **63** is installed between the discharge part **45** and the downstream side tray **36**A. Specifically, the link member **63** is disposed between the end portion of the upper roller of the pair of discharge rollers **47** and the side portion of the downstream side tray **36**A. Both the upper and lower end portions of the link member **63** are rotatably supported by the rotating shaft of the roller and a connecting shaft projected on the downstream side tray **36**A.

<First Detection Part>

The first detection part **52** is composed of, for example, a reflection type optical sensor (a distance sensor), and is provided on the supply tray **36**. Specifically, the first detection part **52** is provided on the lower surface of the downstream side tray **36**A with the light receiving part and the light emitting part facing downward. The first detection part **52** detects a distance between the uppermost document M stacked on the discharge tray **37** and the supply tray **36**.

<Second Detection Part>

The second detection part **53** is provided in the downstream end portion of the discharge part **45**. The second detection part **53** includes a turning member **65** and a turning detection part **66**.

The turning member **65** is formed into a rod-like shape, and one end portion of the turning member **65** is supported by the turning detection part **66** in a rotatable manner. The turning member **65** is disposed so as to be able to comes into contact with the document M discharged from the discharge part **45**. The turning member **65** is lifted by the discharged

document M and lowered (returned) by its own weight after the passage of the document M. The turning detection part **66** is, for example, a transmission type optical sensor including a light emitting part and a light receiving part disposed on both the sides of the turning member **65**. The turning member **65** described above is disposed so as to block the optical path from the light emitting part to the light receiving part in an initial state, for example, and is deviated from the optical path when lifted by the discharged document M. That is, when the receiving part receives the light emitted from the light emitting part, the turning detection part **66** detects that the document M passes through the discharge part **45**. In other words, the second detection part **53** detects a number of the documents M discharged on the discharge tray **37**. The one end portion of the turning member **65** may be supported by the rotating shaft of the roller in a rotatable manner. The turning member **65** may be provided so as to be deviated from the optical path in the initial state and to block the optical path when lifted by the discharged document M. And, the turning detection part **66** may detect that the document M passes through the discharge part **45** when the turning member **65** blocks the optical path.

<Third Detection Part>

The third detection part **54** is composed of, for example, a transmission type optical sensor, and is provided in the conveyance part **38** (the frame of the conveyance mechanism part **40**). The third detection part **54** is disposed in a middle position between the lowermost position and the uppermost position of the supply tray **36**. As described later in detail, when the supply tray **36** is disposed at a taking out position P**1** set between the lowermost position and the uppermost position of the supply tray **36**, the light blocking member **36**D protruded on the downstream end portion of the supply tray **36** is positioned between the light emitting part and the light receiving part of the third detection part **54**. When the light emitted from the light emitting part is blocked, the third detection part **54** detects that the supply tray **36** is positioned at the taking out position P**1**. The shape of the light blocking member D may be changed so as to block the light emitted from the light emitting part when the supply tray **36** is positioned at the taking out position P**1** (this example is not shown).

As shown in FIG. **3**, the first detection part **52**, the second detection part **53** (the turning detection part **66**) and the third detection part **54** are electrically connected to the controller **14** via respective control circuits. The detection results (the electric signals) of the detection parts **52** to **54** are transmitted to the controller **14**.

[Control of Lifting and Lowering Part]

Next, with reference to FIG. **2**, and FIG. **4** to FIG. **8**, the control of the lifting and lowering part **50** will be described. FIG. **4** is a sectional view showing a state where the uppermost document M is pressed on the pickup roller **41**. FIG. **5** is a sectional view showing a state where the supply tray **36** is lifted to the uppermost position. FIG. **6** is a sectional view showing a large number of documents discharge state ST**1**. FIG. **7** is a sectional view showing a small number of documents discharge state ST**2**. FIG. **8** is a flowchart showing the control of the lifting and lowering part **50**.

In an initial state before the document M is placed (set) on the supply tray **36**, the supply tray **36** and the discharge part **45** are positioned at the respective lowermost positions (see FIG. **2**). The document conveyance device **16** is provided with a sensor (not shown) which detects the supply tray **36** (or the discharge part **45**) is positioned at the lowermost position, and the supply tray **36** and the others are controlled so as to be stopped at the lowermost positions. On the supply tray **36** positioned at the lowermost position, 500 sheets of the documents M (a plain paper) can be placed at the maximum. The maximum number of the documents M placeable on the supply tray **36** may be suitably changed.

<Control of Lifting and Lowering Part During Image Reading Process>

When the supplied document detection part **55** detects that the documents M are placed on the supply tray **36** and the user inputs the reading instruction of the document M, the controller **14** drives the lifting motor **62** to lift the supply tray **36** from the lowermost position and to press the uppermost document M on the pickup roller **41** (see FIG. **4**). Thereafter, the image reading process described above is performed. Whether the uppermost document M is pressed on the pickup roller **41** is detected by an upper limit detection switch (not shown) provided in the pickup roller **41** or near the pickup roller **41**. The detection signal of the upper limit switch is monitored by the controller **14** during a period where the documents M placed on the supply tray **36** are fed. With the lifting of the supply tray **36**, the discharge part **45** is turned upward around the turning shaft **48** to be lifted from the lowermost position.

The lifting and lowering part **50** (the lifting and lowering mechanism **51**) lifts the supply tray **36** and the discharge part **45** depending on the feeding of the documents M (see the white blank arrow and the thick solid arrow in FIG. **4**). That is, when the documents M are fed and the thickness of the bundle of documents M becomes thin (lower), the controller **14** lifts the supply tray **36** until the upper limit switch detects the document M. The controller **14** gradually lifts the supply tray **36** until all the documents M placed on the supply tray **36** are fed (until the supplied document detection part **55** no longer detects the document M) (see FIG. **5**). The second detection part **53** detects the document M discharged from the discharge part **45** to the discharge tray **37**, and the controller **14** stores a value obtained by integrating the detection results of the second detection part **53** (the number of the discharged documents M) in the storage part **27**.

When the feeding of the documents M to the document conveyance path **38**A is completed (the supplied document supply part **55** no longer detects the document M) and the second detection part **53** detects the discharging of the last document M, the image reading process is completed (see FIG. **5**). At the time of the completion of the image reading process, the supply tray **36** is positioned at the uppermost position (or near the uppermost position) (see FIG. **5**). The document conveyance device **16** is provided with a sensor (not shown) which detects that the supply tray **36** is disposed at the uppermost position, and the supply tray **36** is controlled to be stopped at the uppermost position.

<Control of Lifting and Lowering Part after Completion of Image Reading Process>

After the image reading process is completed, the controller **14** estimates a height of the documents M stacked on the discharge tray **37** from the detection result of the second detection part **53** (the number of the documents M). Specifically, the controller **14** (the lifting and lowering part **50**) determines whether it is a large number of documents discharge state ST**1** or a small number of documents discharge state ST**2** based on the detection result of the second detection part **53**. The large number of documents discharge state ST**1** shows a state where the height of the documents M stacked on the discharge tray **37** is more than a specified value (F). The small number of documents discharge state ST**2** shows a state where the height of the documents M

stacked on the discharge tray **37** is less than the specified value (F). "The specified value (F)" indicates, for example, a height at which 320 sheets of the documents M are stacked, and the specified value (F) is obtained experimentally in advance and stored in the storage part **27**. Therefore, as shown in FIG. **8**, the controller **14** compares the number of the documents M stored in the storage part **27** with the specified value (F) based on the detection result of the second detection part **53** (step S**1**). The number of sheets of the documents M indicating the specified value (F) is not limited to 320 sheets, and can be freely set, for example, according to the maximum distance between the supply tray **36** and the discharge tray **37**.

In the large number of documents discharge state ST**1** (the number of sheets of the documents M the specified value (F)) (YES in S**1**), the controller **14** (the lifting and lowering part **50**) lifts the supply tray **36** at a height above the uppermost document M by a predetermined space G (step S**2**). Specifically, the controller **14** drives the lifting motor **62** to lower the supply tray **36** until the first detection part **52** detects the predetermined space G (see FIG. **6**). When the first detection part **52** detects the predetermined space G, the controller **14** stops the lifting motor **62**. That is, in the large number of documents discharge state ST**1**, the lifting and lowering part **50** controls the height of the supply tray **36** based on the detection result of the first detection part **52**. The predetermined space G is a space such that the supply tray **36** does not interfere with the uppermost document M, and is, for example, a space of several mm to several tens mm. When 500 sheets of the documents M are discharged, the supply tray **36** may be held at the uppermost position without being lowered. That is, in the state where 500 sheets of the documents M are stacked on the discharge tray **37**, the predetermined space G (or more) is formed between the uppermost document M and the supply tray **36** positioned at the uppermost position.

On the other hand, in the small number of documents discharge state ST**2** (the number of sheets of the documents M<the specified value (F)) (NO in S**1**), the controller **14** (the lifting and lowering part **50**) lowers the supply tray **36** at a taking out position P**1** depart upward from the specified value (F) by the predetermined space (G) (step S**3**). Specifically, the controller **14** drives the lifting motor **62** to lower the supply tray **36** until the third detection part **54** detects the light blocking member **36**D (the light blocking member **36**D blocks the optical path) (see FIG. **7**). When the third detection part **54** detects the light blocking member **36**D, the controller **14** stops the lifting motor **62**. That is, in the small number of documents discharge state ST**2**, the third detection part **54** detects the supply tray **36** positioned at the taking out position P**1**, and the lifting and lowering part **50** controls the height of the supply tray **36** based on the detection result of the third detection part **54**. The taking out position P**1** is a position where the user can easily enter his hand into the space between the supply tray **36** and the discharge tray **37**, and can be obtained experimentally. The height of the supply tray **36** in the large number of documents discharge state ST**1** is set to be equal to or higher than the taking out position P**1**.

In the large number of documents discharge state ST**1**, since the bundle of documents M stacked on the discharge tray **37** is thick (high), the space between the supply tray **36** and the discharge tray **37** is sufficiently wide (see FIG. **6**). Therefore, the user can easily take out the document M by entering his hand into the space between the supply tray **36** and the discharge tray **37**. On the other hand, in the small number of documents discharge state ST**2**, since the supply tray **36** is held at least at the specified value (F) (the taking out position P**1**), the user can easily enter his hand into the space between the supply tray **36** and the discharge tray **37** (see FIG. **7**). Therefore, the user can easily take out the documents M.

Next, the controller **14** determines whether the documents M exist on the discharge tray **37** based on the detection result of the discharged document detection part **56** (step S**4**). When the documents M exist on the discharge tray **37** (the discharged document detection part **56** still detects the documents M) (YES in S**4**), the controller **14** (the lifting and lowering part **50**) positions the supply tray **36** at a position higher than the taking out position P**1**. That is, the controller **14** does not drive the lifting motor **62** to keep the supply tray **36** at the current position.

When the discharged document detection part **56** that has detected the documents M no longer detects the documents M (NO in S**4**), the controller **14** (the lifting and lowering part **50**) lowers the supply tray **36** to the lowermost position and lowers the discharge part **45** to the lowermost position (step S**5**). Specifically, the controller **14** drives the lifting motor **62** to lower the supply tray **36** to the lowermost position. The discharge part **45** is lowered to the lowermost position with the lowering of the supply tray **36**. Thereby, the supply tray **36** and the discharge part **45** are positioned at the respective lowermost positions (see FIG. **2**).

The document conveyance device **16** according to the first embodiment described above has a configuration that in the small number of documents discharge state ST**2**, the lifting and lowering part **50** positions the supply tray **36** at the taking out position P**1** depart upward from the specified value (F) by the predetermined space G. According to the configuration, even if the number of sheets of the discharged documents M is small, it becomes possible to restrict the lowering of the supply tray **36**. Therefore, even in the configuration that the supply tray **36** is lifted and lowered, it becomes possible to take out a small number of sheets of the documents M easily. Further, by lowering the supply tray **36**, it becomes possible to place the document M to be read next time on the supply tray **36**.

According to the document conveyance device **16** of the first embodiment, the second detection part **53** detects the number of sheets of the documents M stacked on the discharge tray **37**, so that it becomes possible to estimate the height of the documents M and it becomes possible to correctly determine whether the state of the discharge tray **37** is in the large number of documents discharge state ST**1** or the small number of documents discharge state ST**2**. Furthermore, the first detection part **52** detects the distance between the uppermost document M and the supply tray **36**, so that it becomes possible to position the supply tray **36** at a position where the supply tray **36** does not interfere with the uppermost document M. Furthermore, the supply tray **36** is moved such that the third detection part **54** detects the supply tray **36**, so that it becomes possible to position the supply tray **36** at the taking out position P**1**.

According to the document conveyance device **16** of the first embodiment, while the documents M are stacked on the discharge tray **37**, the discharged document detection part **56** continuously detects the documents M, so that it becomes possible to separate the supply tray **36** from the discharge tray **37** and to take out the documents M from the discharge tray **37** easily. On the other hand, when the document M is taken out from the discharge tray **37**, the discharged document detection part **56** no longer detects the documents M, so that it becomes possible to return the supply tray **36** and

the others to their lowermost positions. Then, it becomes possible to set the document M to be read next time on the supply tray **36**.

[Second Embodiment]

Next, with reference to FIG. **9** and FIG. **10**, the document conveyance device **17** according to the second embodiment will be described. FIG. **9** is a sectional view showing a state where the uppermost document M is pressed on the pickup roller **14**. FIG. **10** is a flowchart showing a control of the lifting and lowering part **50**. The same structures as (the structures corresponding to) the document conveyance device **16** of the first embodiment are marked with the same reference number, and the description of the same or corresponding to structures of the document conveyance device **16** are omitted.

As shown in FIG. **9**, in the document conveyance device **17** according to the second embodiment, the lifting and lowering part **50** includes a height detection part **57** provided in the conveyance part **38** (the frame of the conveyance mechanism part **40**). The height detection part **57** is, for example, a transmission type optical sensor, and detects a height of the discharge part **45**. The height detection part **57** is electrically connected to the controller **14** via a control circuit or the like, and the controller **14** receives the detection result (an electric signal) of the height detection part **57**. The document conveyance device **17** according to the second embodiment includes the second detection part **53**.

Specifically, the height detection part **57** detects a height of the discharge part **45** (the conveyance guide **46**) when the supply tray **36** is lifted from the lowermost position to press the uppermost document M on the pickup roller **41** at the start time of the image reading process. When less than 320 sheets of the documents M are placed on the supply tray **36**, at the start time of the image reading process, the discharge part **45** (the conveyance guide **46**) is positioned between the light emitting part and the light receiving part of the height detection part **57**, and the light emitted from the light emitting part is blocked. When the detection result of the height detection part **57** is received, the controller **14** estimates that less than 320 sheets of the documents M placed on the supply tray **36** will be discharged to the discharge tray **37**. The detection result of the height detection part **57** is stored in the storage part **27**. The discharge part **45** may be provided with a blocking member so as to separate from the space between the light emitting part and the light receiving part of the height detection part **57** when less than 320 sheets of the documents M are placed on the supply tray **36** (this example is not shown).

<Control of Lifting and Lowering Part at Completion of Image Reading Process>

As shown in FIG. **10**, after the image reading process is completed, the controller **14** (the lifting and lowering part **50**) determines whether it is in the large number of documents discharge state ST**1** or the small number of documents discharge state ST**2** based on the detection result of the height detection part **57** (the detection result stored in the storage part **27**) (step S**1**'). That is, when the height detection part **57** does not detects the discharge part **45** (NO in step S**1**'), the controller **14** determines that it is in the large number of document discharge state ST**1**, and when the height detection part **57** detects the discharge part **45** (YES in step S**1**'), the controller **14** determines that it is in the small number of documents discharge state ST**2**. The processes after step S**1**' are the same as the steps of the lifting and lowering part **50** of the document conveyance device **16** according to the first embodiment, and their descriptions are omitted.

According to the document conveyance device **17** of the second embodiment described above, even if the number of sheets of the discharged documents M is small, the same effects as the first embodiment can be obtained, for example, it becomes possible to restrict the lowering of the supply tray **36** and for the user to take out the documents M on the discharge tray **37** easily. Further, the height detection part **57** detects the height of the discharge part **45** so that it becomes possible to correctly determine whether the state of the discharge tray **37** is in the large number of document discharge state ST**1** or in the small number of document discharge state ST**2**.

The document conveyance devices **16** and **17** according to the first and the second embodiments are configured such that the supply tray **36** and the discharge tray **37** are coupled to each other by the link member **63** so as to be liftable and lowerable by the lifting and lowering mechanism **51**, but the present disclosure it not limited to the configuration. The lifting and lowering part **50** may include a mechanism for lifting and lowering the supply tray **36** and another mechanism for lifting and lowering the discharge tray **37** separately (this example is not shown).

The document conveyance devices **16** and **17** according to the first and the second embodiments are configured such that the lifting and lowering mechanism **51** includes the rack **60** and the pinion **62**, but the present disclosure is not limited to the configuration. For example, the lifting and lowering mechanism **51** may include a pulley and a wire, or a piston and cylinder (this example is not shown).

In the document conveyance devices **16** and **17** according to the first and the second embodiments, the first detection part **52** is a reflection type optical sensor, but it is not limited thereto, and may be, for example, a laser range meter or an ultrasonic range meter (not shown). Although the second detection part **53** includes the turning member **65** which blocks the optical path of the turning detection part **66**, the present disclosure is not limited thereto. For example, the second detection part **53** may include a microswitch pressed by the turned turning member **65**, or may be composed only of a sensor for optically detecting the document M (these examples are not shown). Although the third detection part **54** is a transmission type optical sensor, the present disclosure is not limited thereto. For example, the third detection part **54** may be a reflection type optical sensor which detects the supply tray **36** disposed at the taking out position P**1**, or a microswitch pressed by the supply tray **36** disposed at the taking out position P**1** (these examples are not shown). Further, although the height detection part **57** is a transmission type optical sensor, the present disclosure is not limited thereto. For example, the height detection part **57** may be a reflection type optical sensor which detects the discharge part **45** that has lifted to the predetermined position, a microswitch pressed by the discharge part **45** that has lifted to the predetermined position, an angle sensor which detects the rotation angle of the discharge part **45**, or the like (not shown).

Further, in the document conveyance device **16** according to the first embodiment, the second detection part **53** detects the number of sheets of the documents M discharged to the discharge tray **37**, and estimates the height of the documents M on the discharge tray **37**. In the document conveyance device **17** according to the second embodiment, the height detection part **57** detects the height of the discharge part **45**, and estimates the height of the document M on the discharge tray **37**. However, the present disclosure is not limited thereto. For example, an optical sensor or an ultrasonic sensor which directly detects that the height of the document

M stacked on the discharge tray **37** reaches the specified value (F) may be provided (these examples are not shown).

In the document conveyance devices **16** and **17** according to the first and the second embodiments, the lifting and lowering part **50** is controlled by the controller **14** provided in the image forming apparatus **1**, but a dedicated controller for controlling the lifting and lowering part **50** may be provided separately from the controller **14** (this example is not shown).

Further, in the description of the present embodiment, the case where the present invention is applied to the image forming apparatus **1** (the multifunction peripheral) is shown as an example, but the present invention is not limited thereto, and the present invention may be applied to, for example, a copying machine, a facsimile machine, an image reading dedicated machine, or the like.

The description of the above embodiment shows one aspect of the document conveyance device, the image reading device, and the image forming apparatus according to the present invention, and the technical range of the present invention is not limited to the above embodiment. The present disclosure may be modified, substituted, or changed in various ways without departing from the spirit of the technical idea, and the claims include all embodiments which may be included within the scope of the technical idea.

The invention claimed is:

1. A document conveyance device comprising:

a supply tray on which a document is placed;

a discharge tray disposed below the supply tray;

a conveyance part which feeds the document on the supply tray to a document conveyance path one by one and conveys the document along the document conveyance path;

a discharge part which discharges the document conveyed by the conveyance part to the discharge tray; and

a lifting and lowering part which lifts and lowers the supply tray and the discharge part, wherein

the lifting and lowering part lifts the supply tray and the discharge part according to a feeding of the document,

when the feeding of the document to the document conveyance path is completed and then the supply tray is lifted, in a large number of documents discharge state where a height of the documents stacked on the discharge tray is more than a specified value, the lifting and lowering part positions the supply tray at a taking out position depart upward from an uppermost document of the documents stacked on the discharge tray by a predetermined space,

when the feeding of the document to the document conveyance path is completed and then the supply tray is lifted, in a small number of documents discharge state where the height of the documents stacked on the discharge tray is less than the specified value, the lifting and lowering part positions the supply tray at a taking out position depart upward from the specified value by the predetermined space.

2. The document conveyance device according to claim **1**, wherein

the lifting and lowering part includes:

a first detection part which is provided in the supply tray and detects a distance between the uppermost document on the discharge tray and the supply tray;

a second detection part which is provided in the discharge part and detects a number of sheets of the documents discharged on the discharge tray; and

a third detection part which is provided in the conveyance part and detects the supply tray disposed at the taking out position, wherein

the lifting and lowering part determines whether it is in the large number of document discharge state or the small number of documents discharge state, based on a detection result of the second detection part,

in the large number of documents discharge state, the lifting and lowering part controls a height of the supply tray based on a detection result of the first detection part, and

in the small number of documents discharge state, the lifting and lowering part controls the height of the supply tray based on a detection result of the third detection part.

3. The document conveyance device according to claim **1**, further comprising a discharged document detection part which detects the documents stacked on the discharge tray, wherein

while the discharged document detection part detects the document, the lifting and lowering part positions the supply tray at a position higher than the taking out position, and

when the discharged document detection part that has detected the document no longer detects the document, the lifting and lowering part lowers the supply tray to a lowermost position and lowers the discharge part to a lowermost position.

4. The document conveyance device according to claim **1**, wherein

the predetermined space is a space in which a user can enter his hand.

5. An image reading device comprising:

the document conveyance device according to claim **1**; and

a reading part which reads an image of the document conveyed along the document conveyance path by the conveyance part.

6. An image forming apparatus comprising the image reading device according to claim **5**.

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