US012116227B2

(12) **United States Patent**
Wada et al.

(10) **Patent No.: US 12,116,227 B2**
(45) **Date of Patent: Oct. 15, 2024**

(54) **IMAGE FORMING APPARATUS**

(71) Applicant: **FUJIFILM Business Innovation Corp.**, Tokyo (JP)

(72) Inventors: **Tomohiro Wada**, Kanagawa (JP); **Tomoaki Yoshioka**, Kanagawa (JP); **Satoshi Shigezaki**, Kanagawa (JP); **Yoko Miyamoto**, Kanagawa (JP); **Toshiaki Baba**, Kanagawa (JP); **Haruka Kobayashi**, Kanagawa (JP); **Kazuyoshi Hagiwara**, Kanagawa (JP); **Kazuki Kishi**, Kanagawa (JP)

(73) Assignee: **FUJIFILM Business Innovation Corp.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 100 days.

(21) Appl. No.: **17/964,048**

(22) Filed: **Oct. 12, 2022**

(65) **Prior Publication Data**

US 2023/0122708 A1 Apr. 20, 2023

(30) **Foreign Application Priority Data**

Oct. 15, 2021 (JP) 2021-169888

(51) **Int. Cl.**
B65H 29/04 (2006.01)
B41F 21/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B65H 29/06*** (2013.01); ***B41F 21/08*** (2013.01); ***B65H 5/085*** (2013.01); ***B65H 29/04*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC B41F 21/08; B65H 29/04; B65H 29/041; B65H 29/042; B65H 29/044; B65H 29/06; B65H 5/085
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,289,768 A * 3/1994 Keller B65H 29/044 101/183
8,254,817 B2 8/2012 Kamijo et al.
(Continued)

FOREIGN PATENT DOCUMENTS

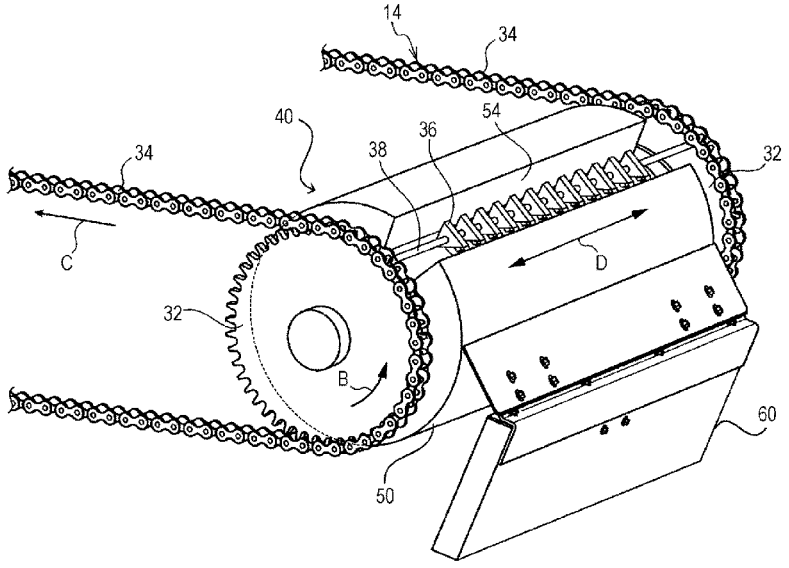
JP 5278687 9/2013

Primary Examiner — Luis A Gonzalez
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An image forming apparatus includes: a holding body configured to hold a formed image; a conveyance unit configured to convey a recording medium with a leading end of the recording medium gripped by a gripping portion; and a transfer body including a recessed portion that accommodates the gripping portion and is provided along a direction substantially orthogonal to a rotational direction, configured to sandwich the recording medium conveyed by the conveyance unit between the transfer body and the holding body to transfer an image on the holding body to the recording medium conveyed by the conveyance unit, and including a slope surface provided at a leading end of a portion of an outer circumference not including a portion where the recessed portion is provided, the leading end being on a front end side in the rotational direction, a distance from the slope surface to a rotational center becoming larger toward a downstream side in the rotational direction.

7 Claims, 22 Drawing Sheets



(51) **Int. Cl.**
B65H 5/08 (2006.01)
B65H 29/06 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 29/041*** (2013.01); ***B65H 29/042*** (2013.01); *B65H 2404/521* (2013.01); *B65H 2801/03* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,351,832	B2 *	1/2013	Kamijo	G03G 15/0131 399/388
2021/0294246	A1 *	9/2021	Yoshioka	G03G 15/2053
2022/0097993	A1 *	3/2022	Baba	B41J 11/057

* cited by examiner

FIG. 1

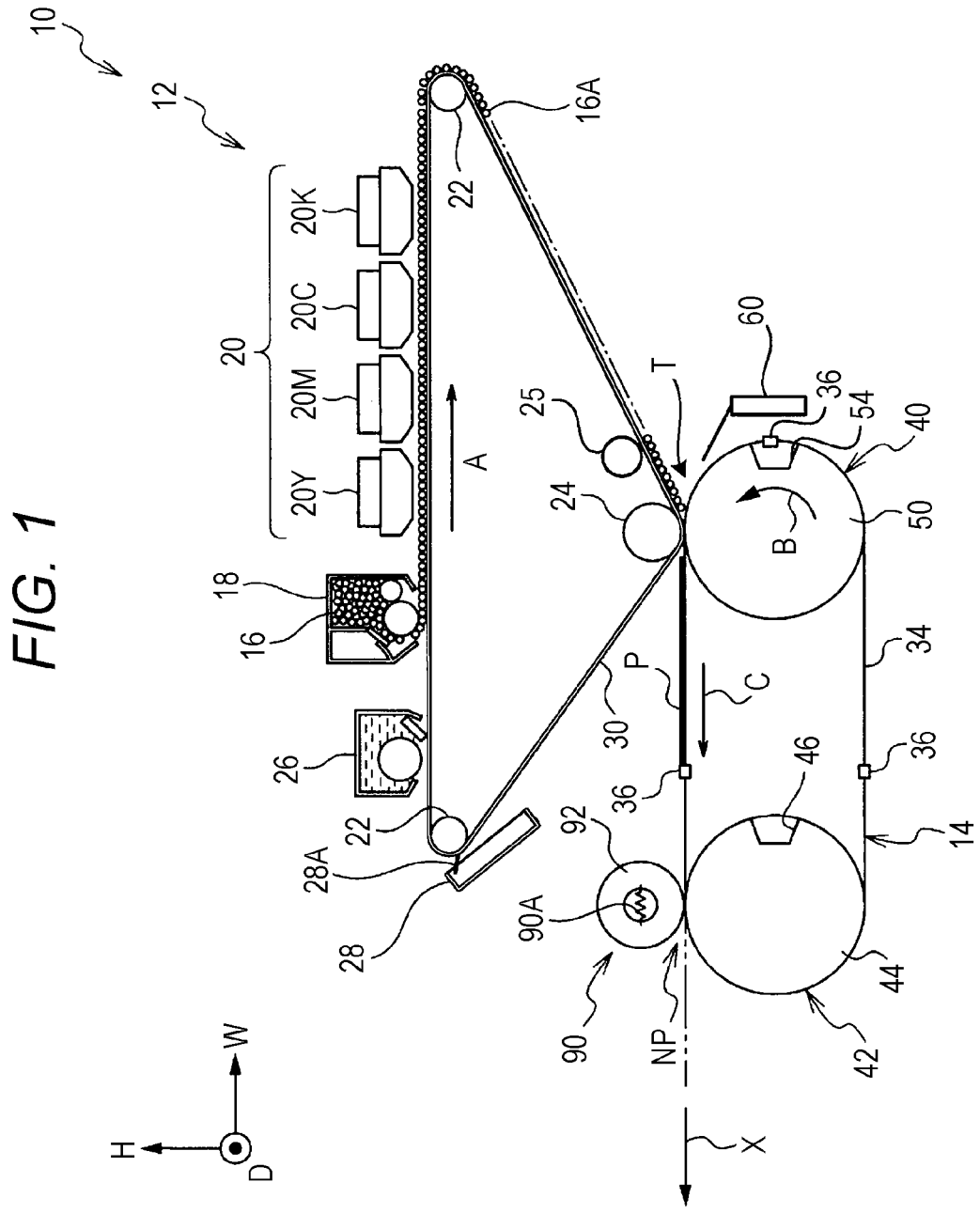

10
12
16A
22
20K
20C
20M
20Y
20
A
25
T
60
36
54
40
24
B
50
18
16
34
P
30
C
26
36
46
36
22
92
14
28A
90A
28
44
90
NP
42
X
W
H
D

FIG. 2

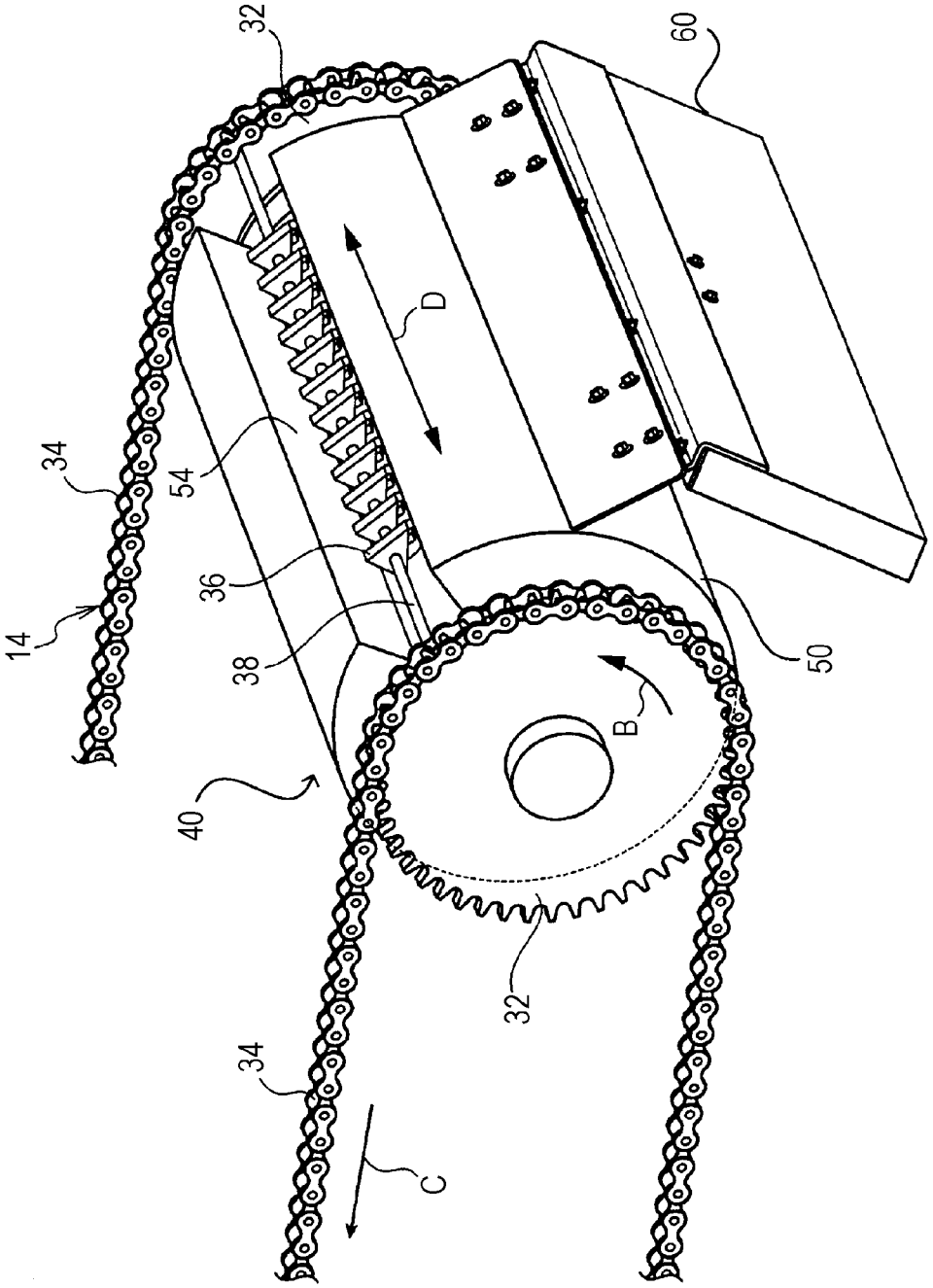


FIG. 3

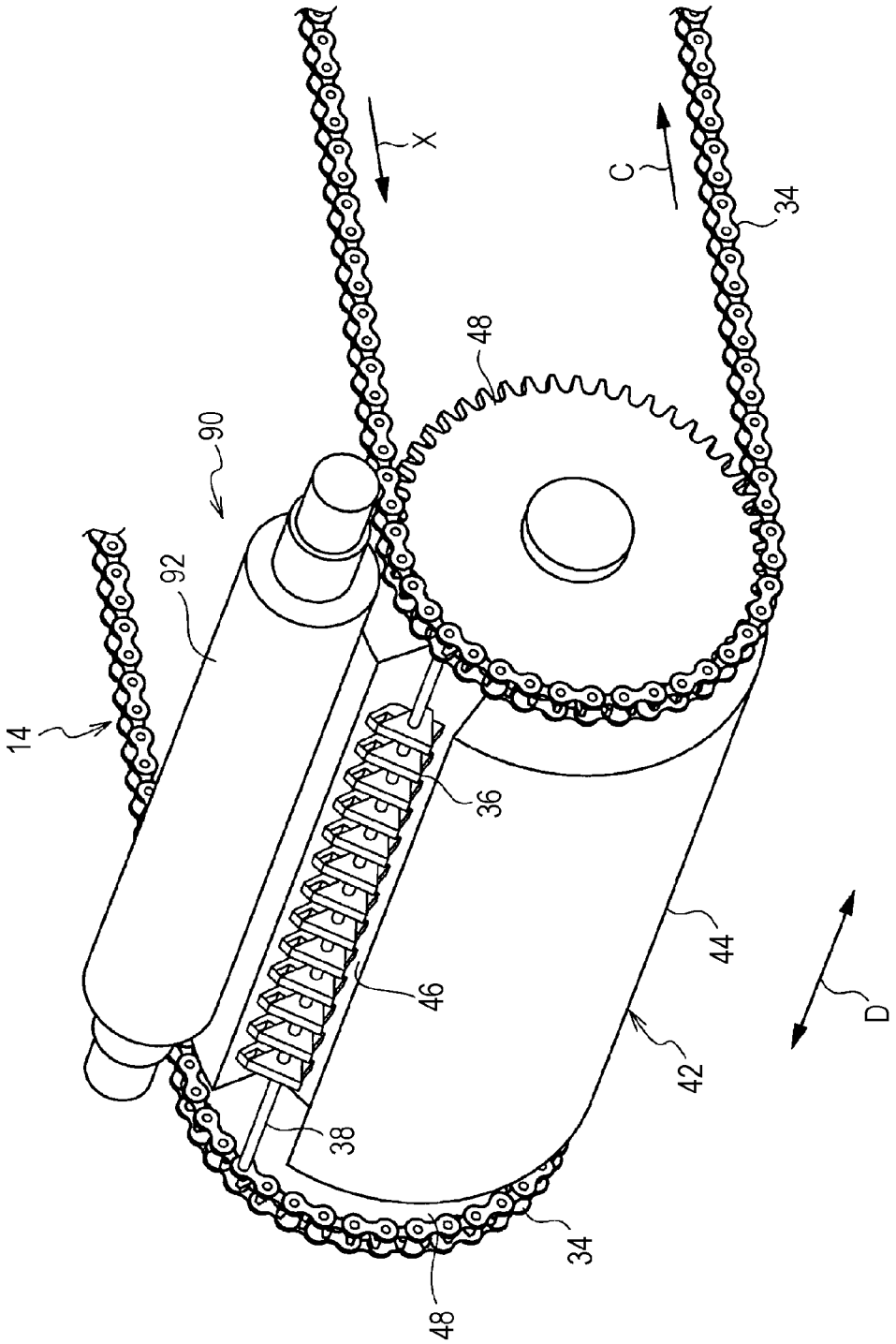


FIG. 4

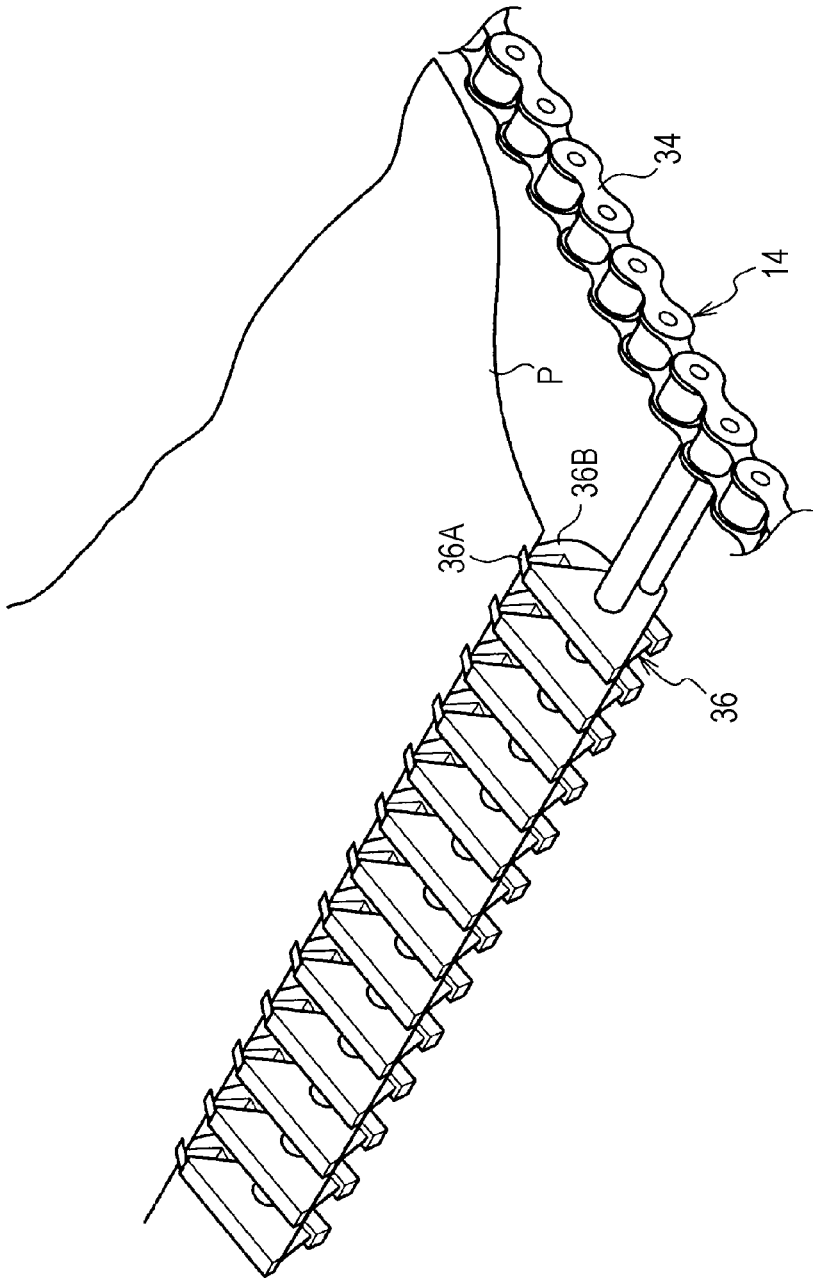


FIG. 5

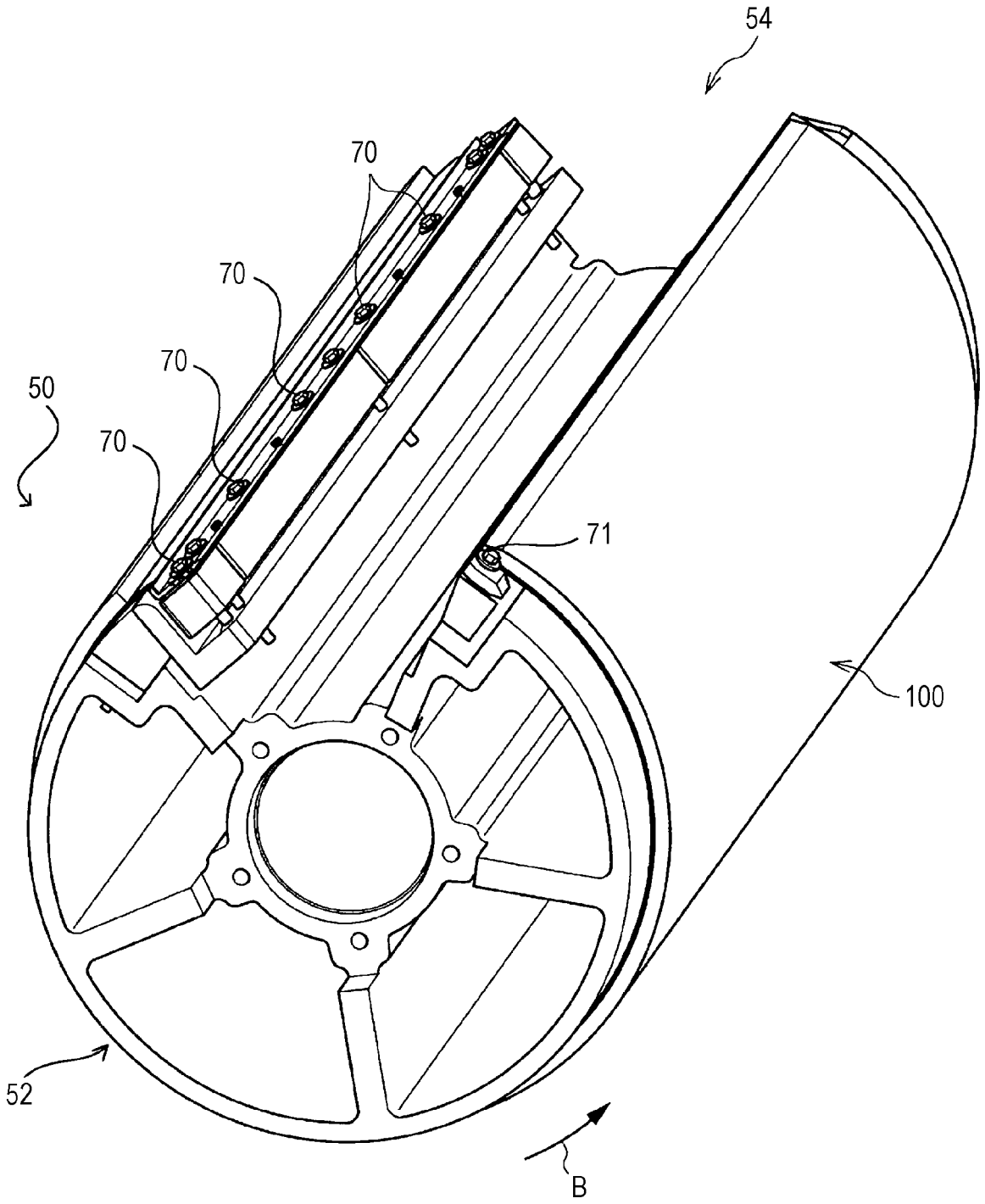


FIG. 6

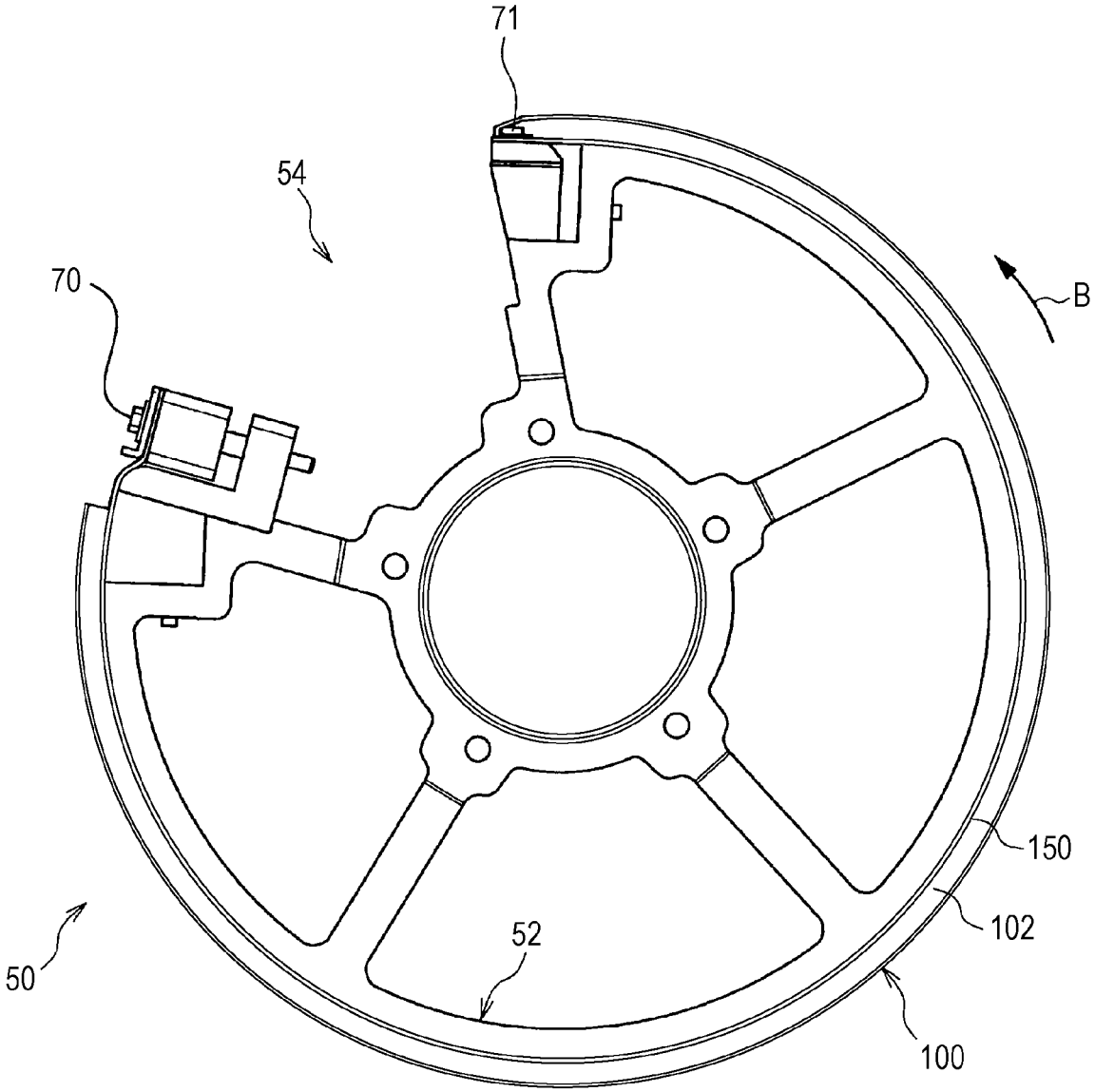


FIG. 7

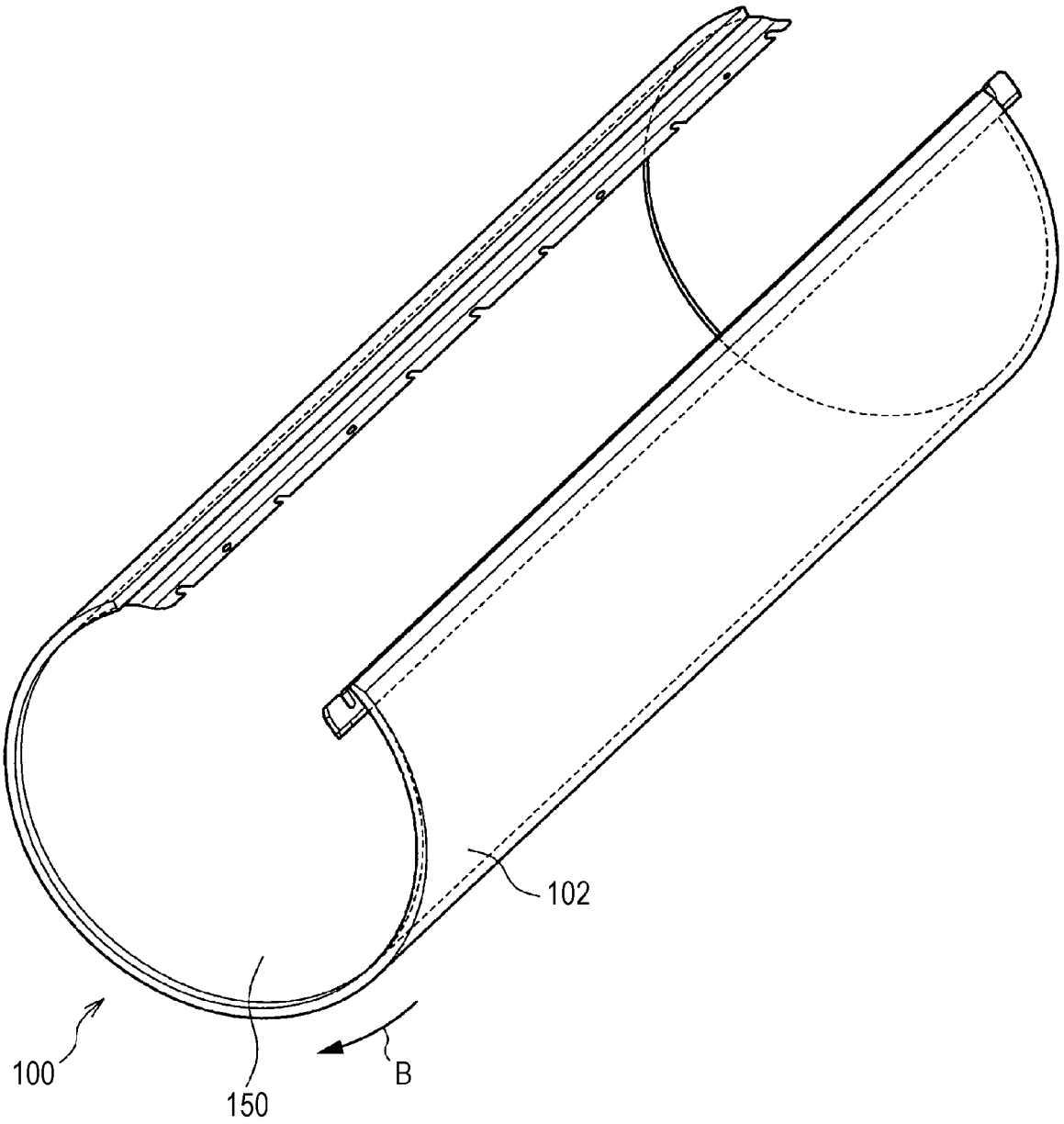


FIG. 8

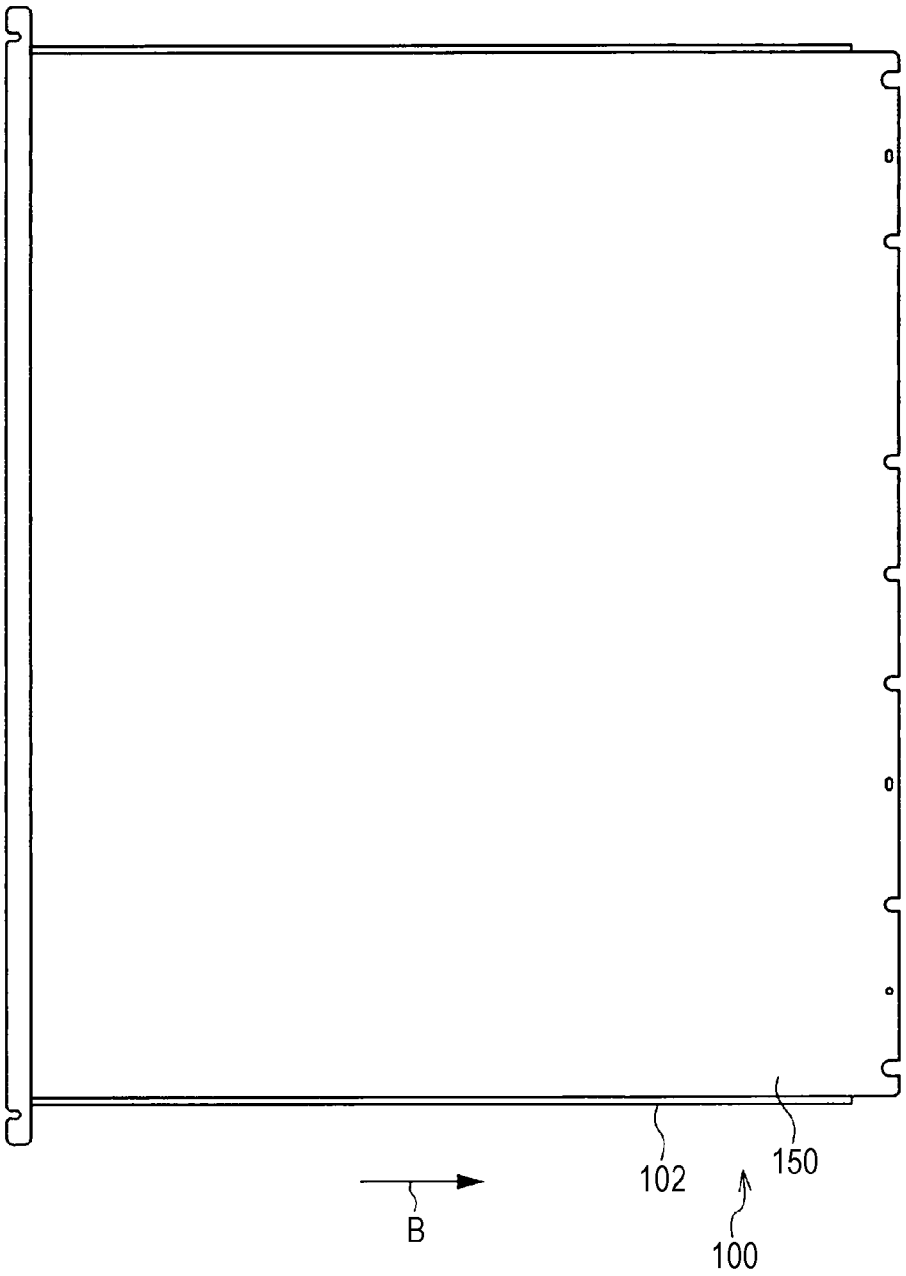


FIG. 9

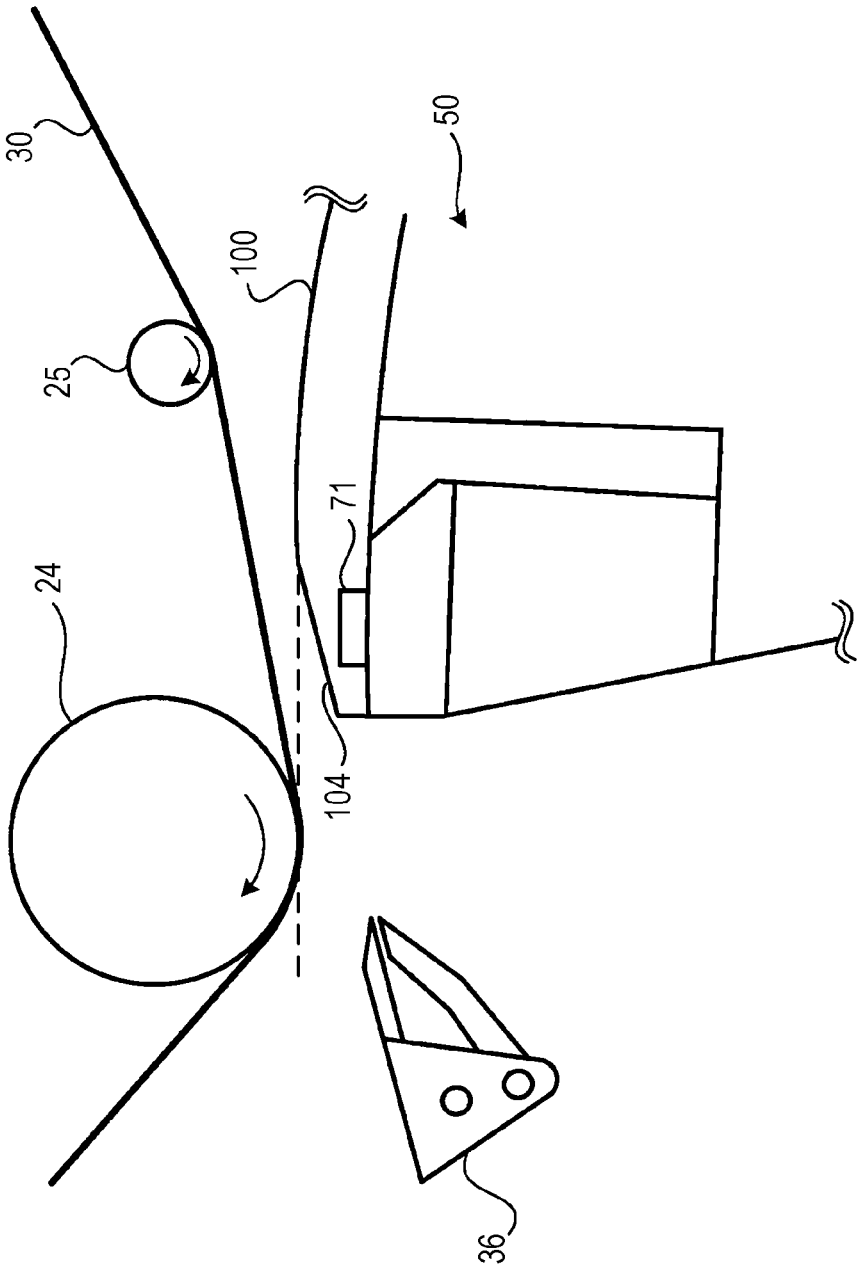


FIG. 10

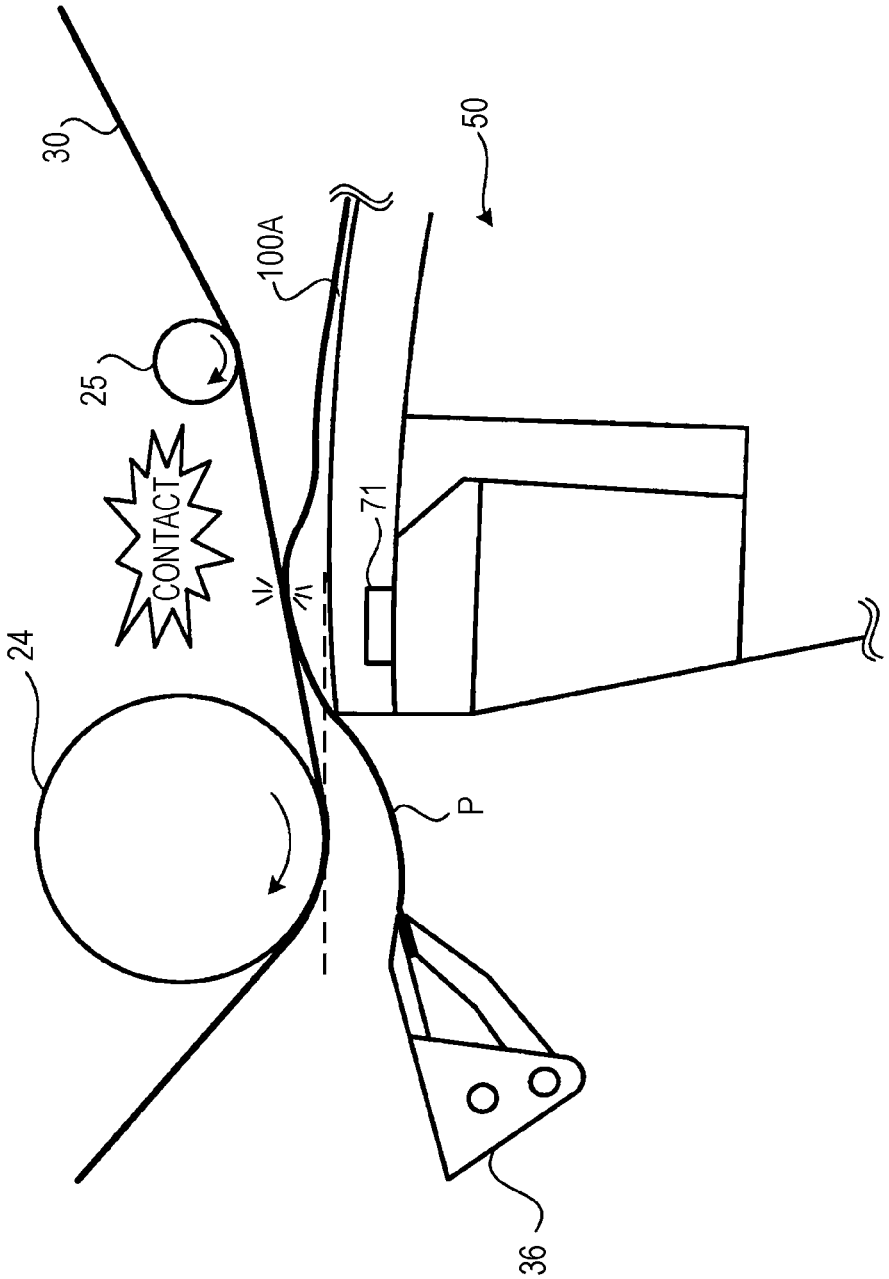


FIG. 11

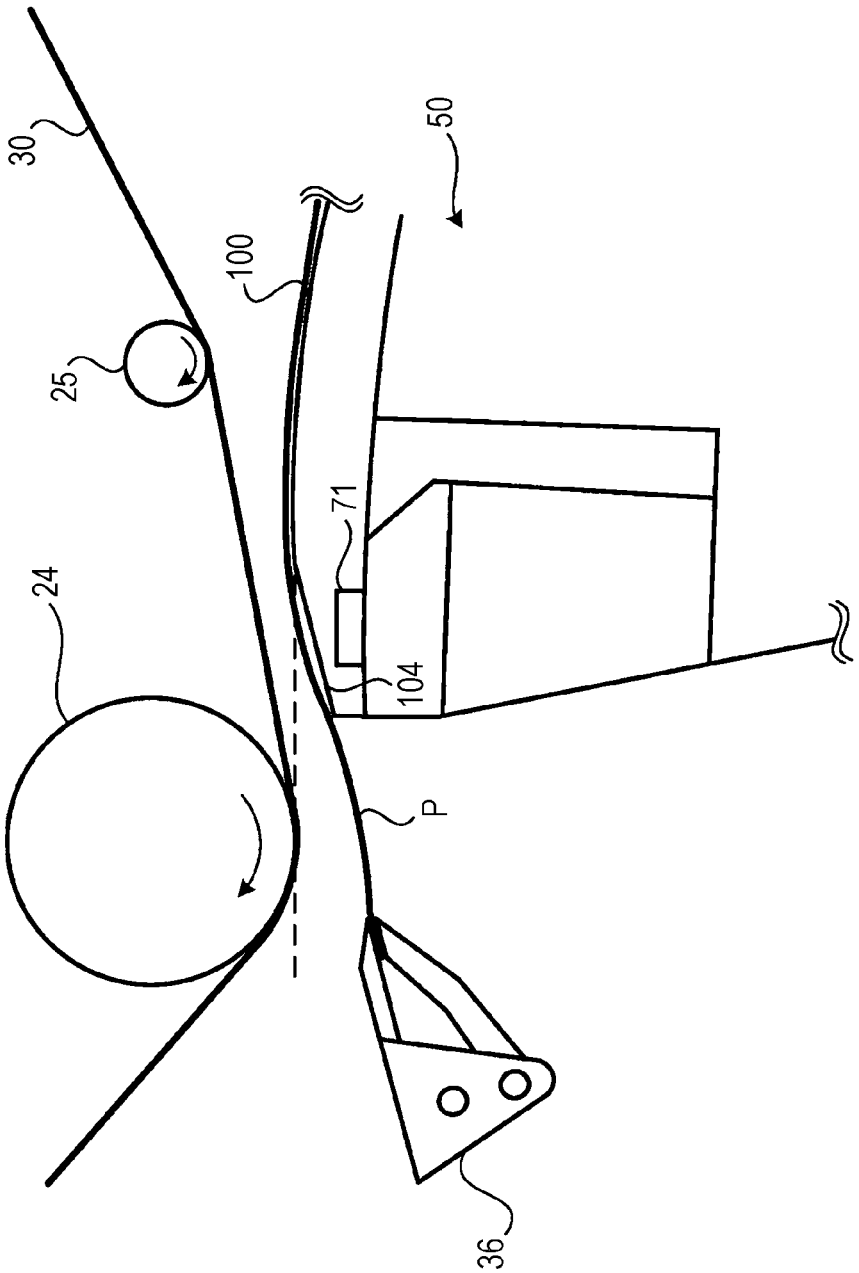


FIG. 12

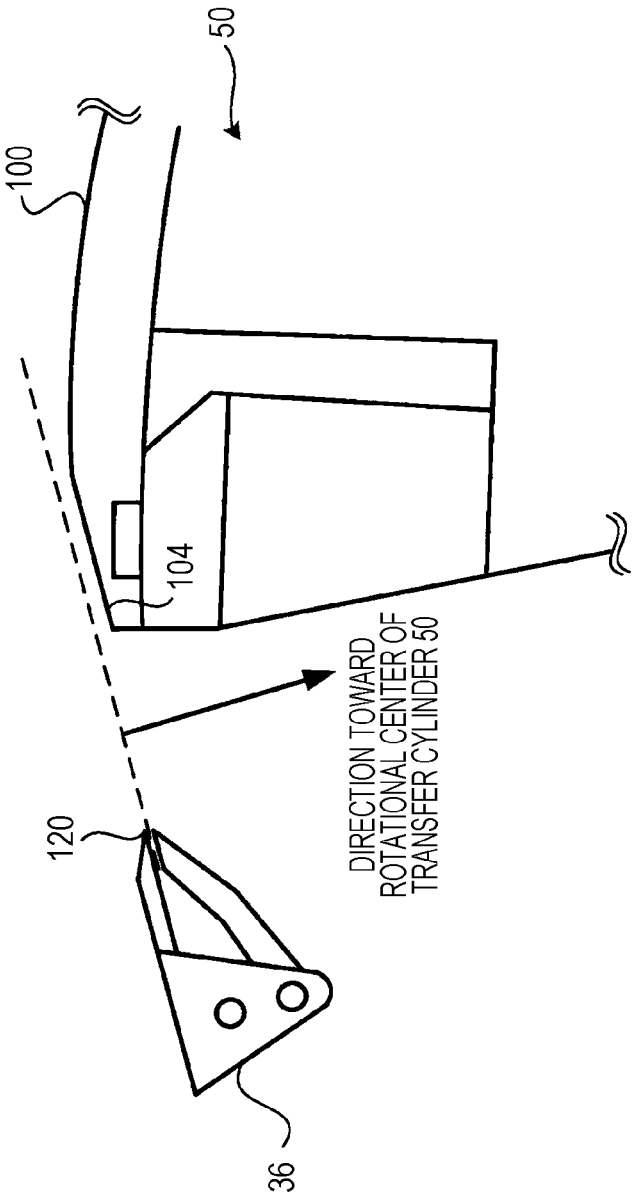

50
100
104
DIRECTION TOWARD
ROTATIONAL CENTER OF
TRANSFER CYLINDER 50
120
36

FIG. 13

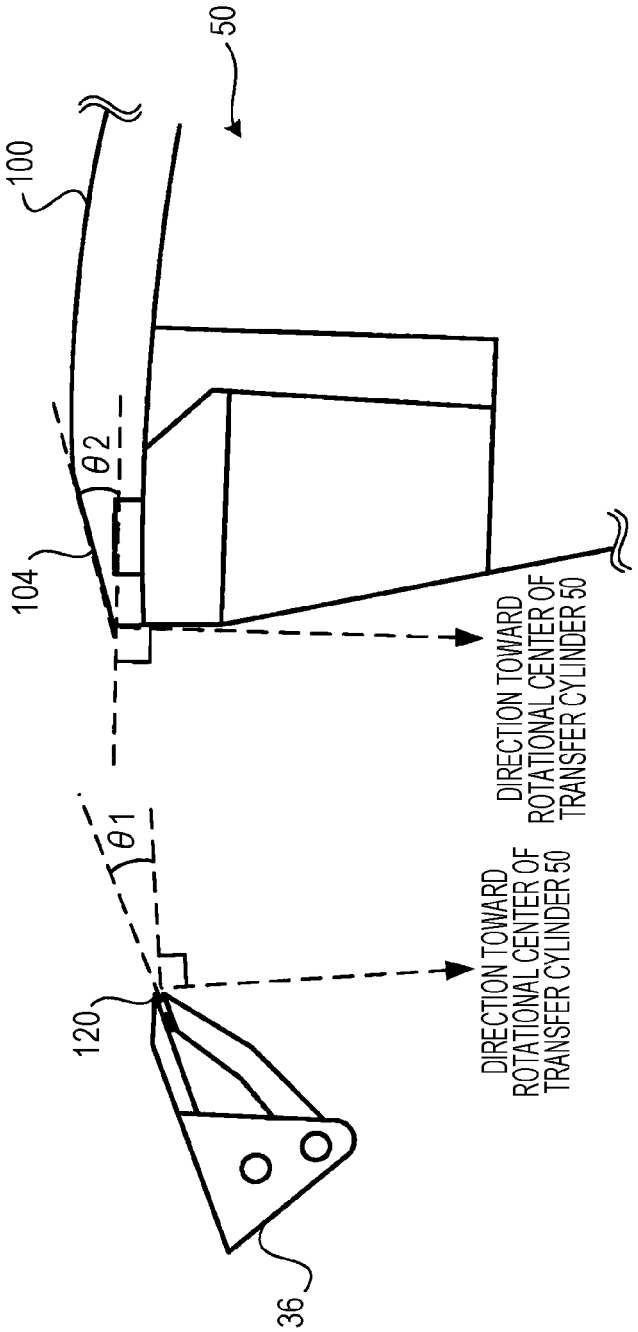

50
100
θ2
104
DIRECTION TOWARD ROTATIONAL CENTER OF TRANSFER CYLINDER 50
θ1
DIRECTION TOWARD ROTATIONAL CENTER OF TRANSFER CYLINDER 50
120
36

FIG. 14

$\theta 2-\theta 1$ (°)	−16	−12	−8	−4	0	4
EVALUATION OF IMAGE SHIFT AMOUNT	×	○	○	○	○	×

○: GOOD
×: BAD

L (mm)	2	3	5
EVALUATION OF IMAGE SHIFT AMOUNT	×	O	O

O: GOOD
×: BAD

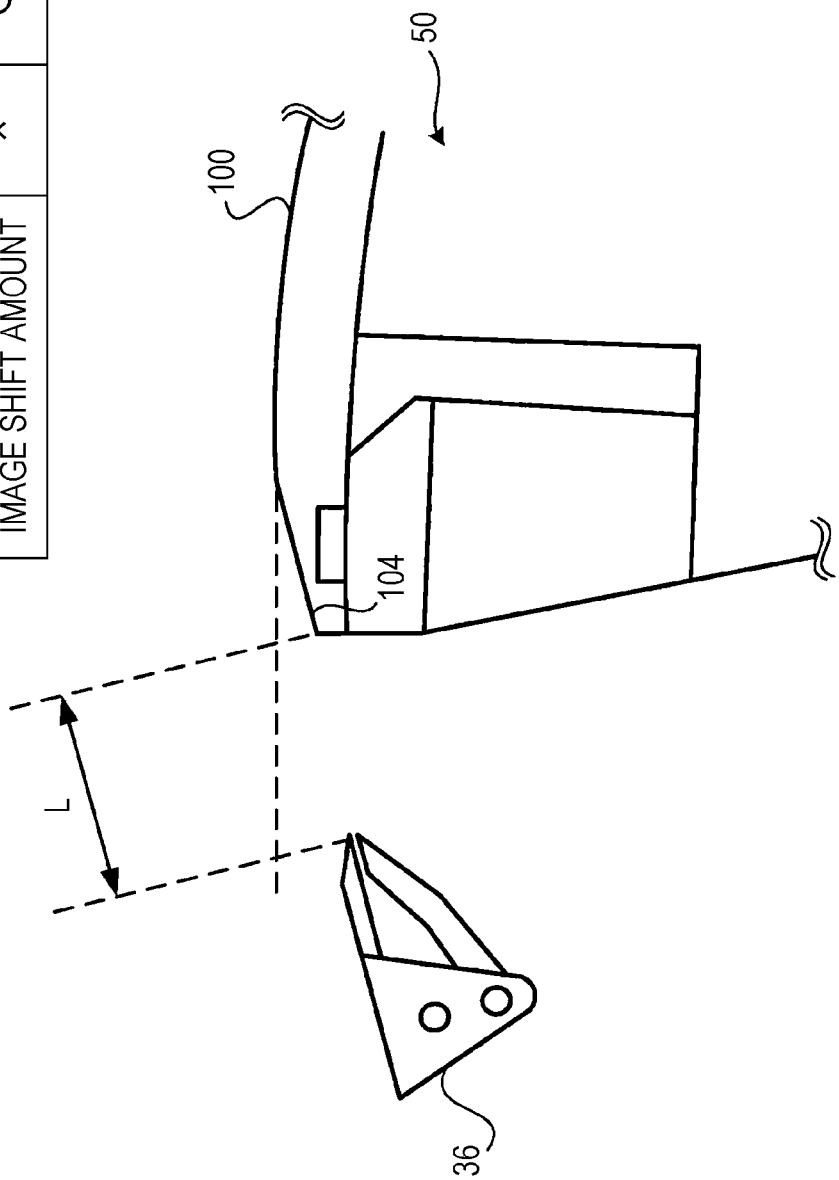


FIG. 15

FIG. 16

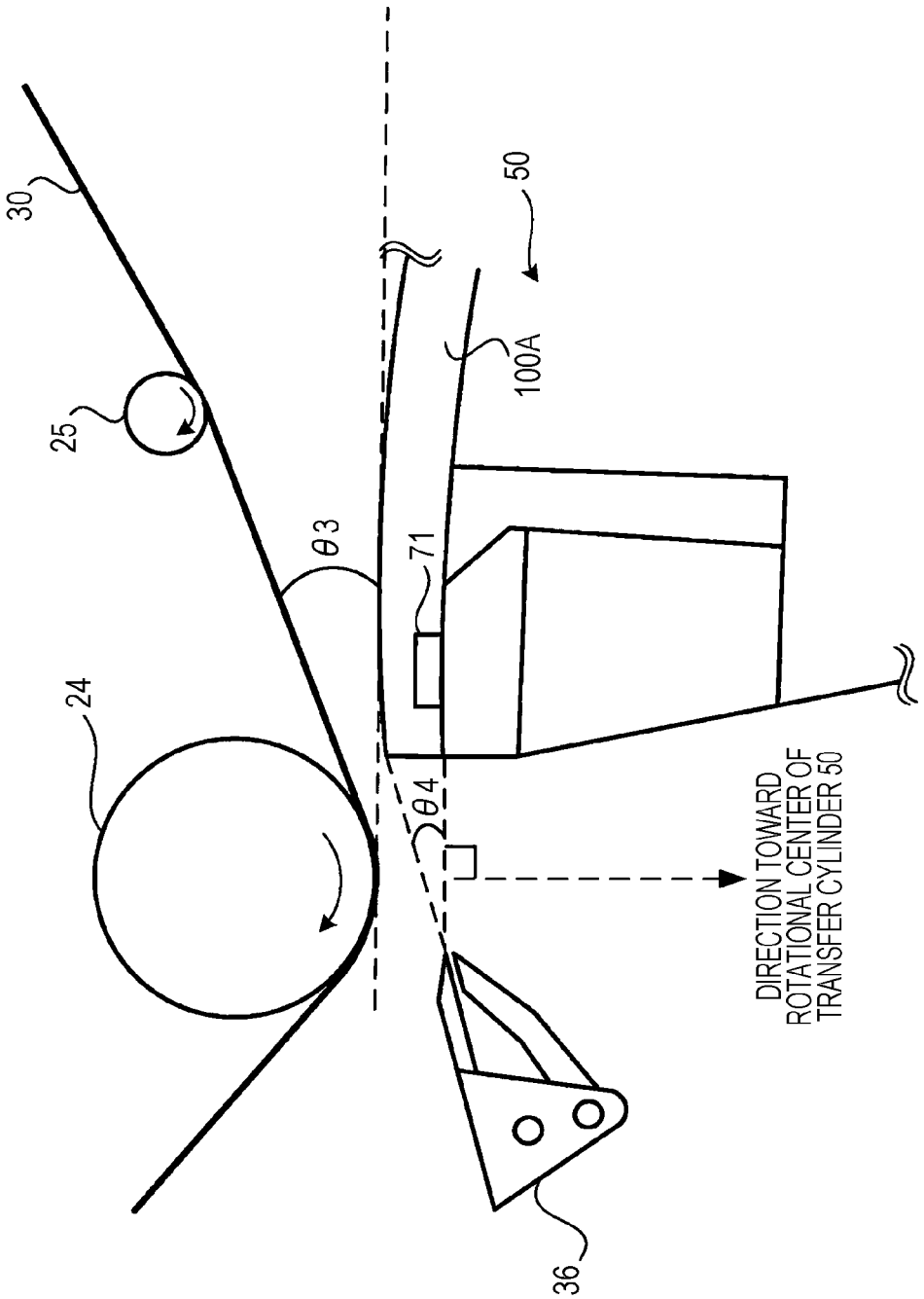

30
25
24
θ3
θ4
71
50
100A
36
DIRECTION TOWARD
ROTATIONAL CENTER OF
TRANSFER CYLINDER 50

FIG. 17

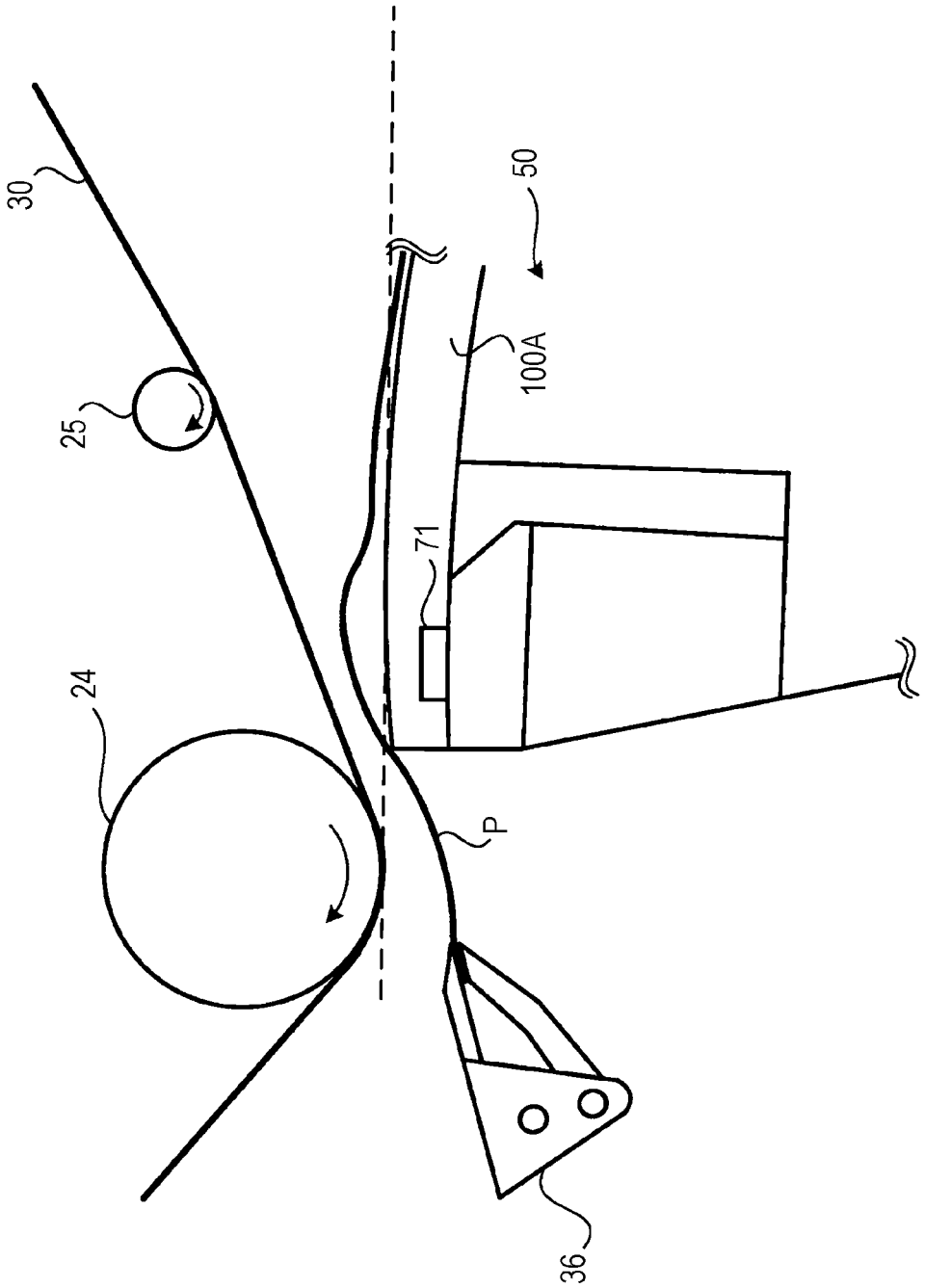


FIG. 18

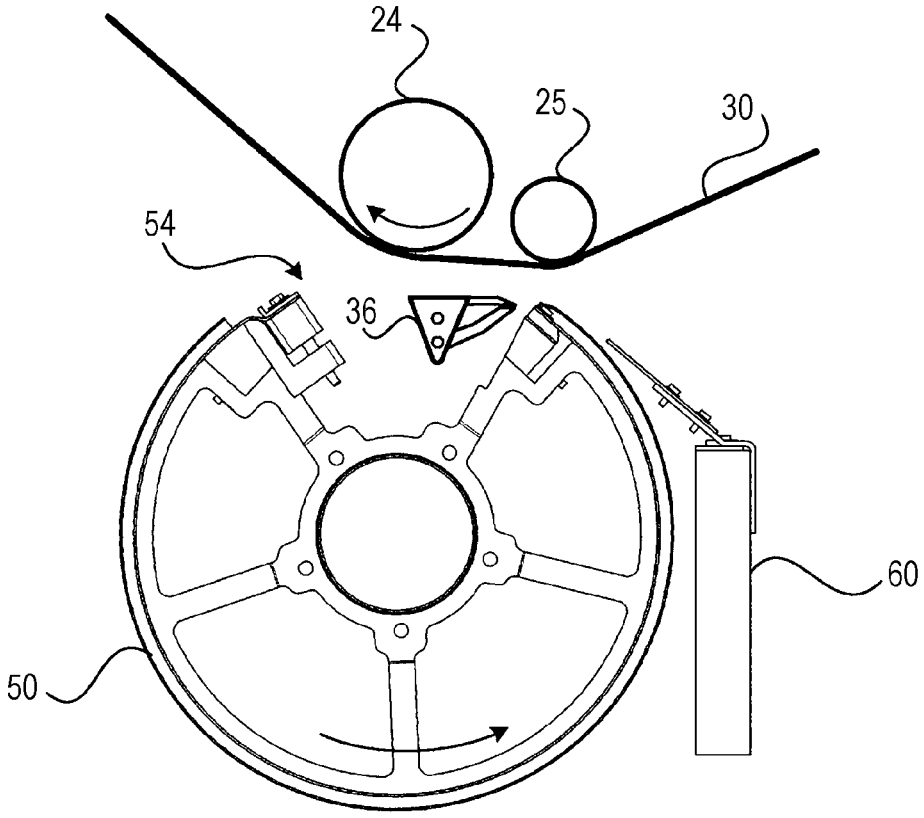


FIG. 19

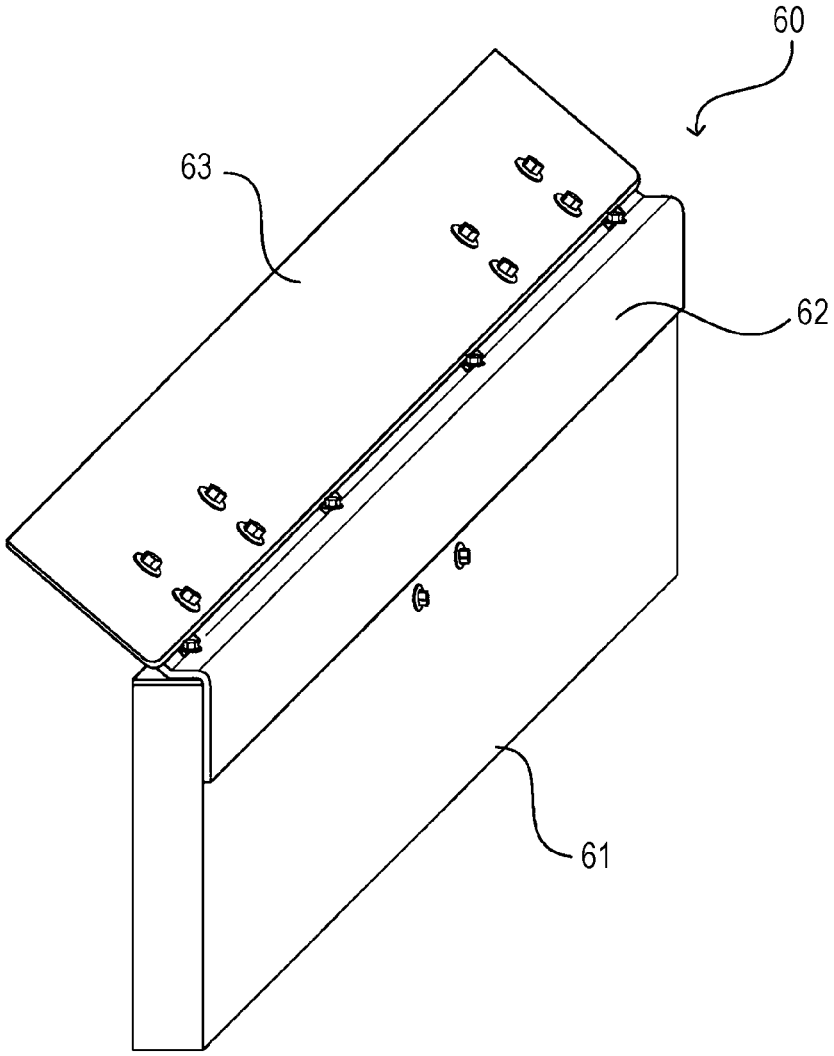


FIG. 20

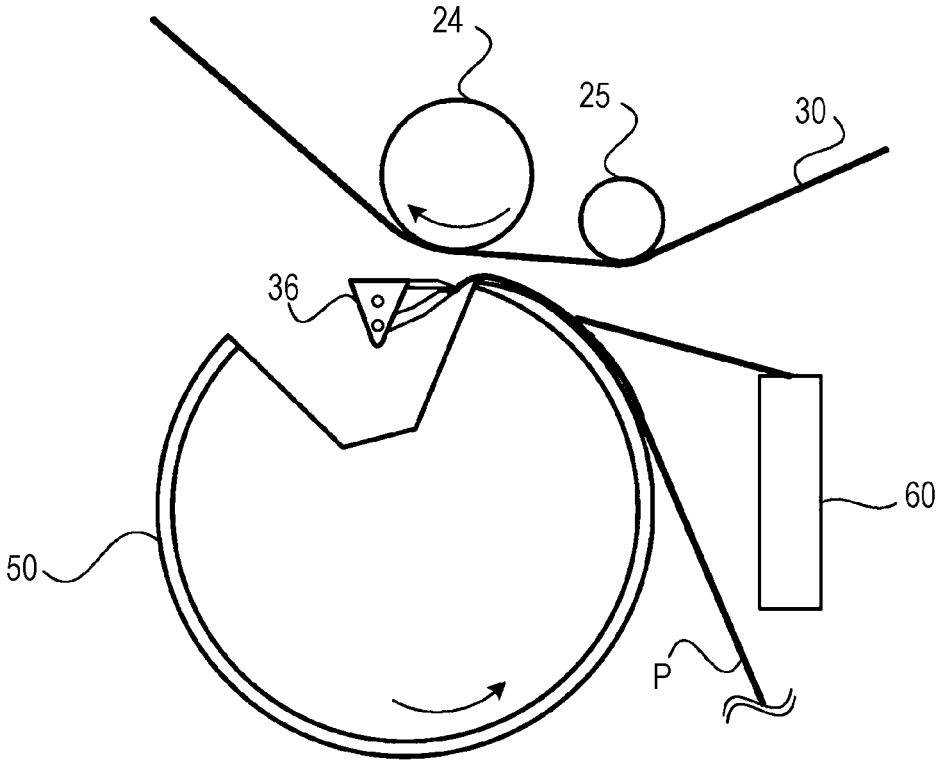


FIG. 21

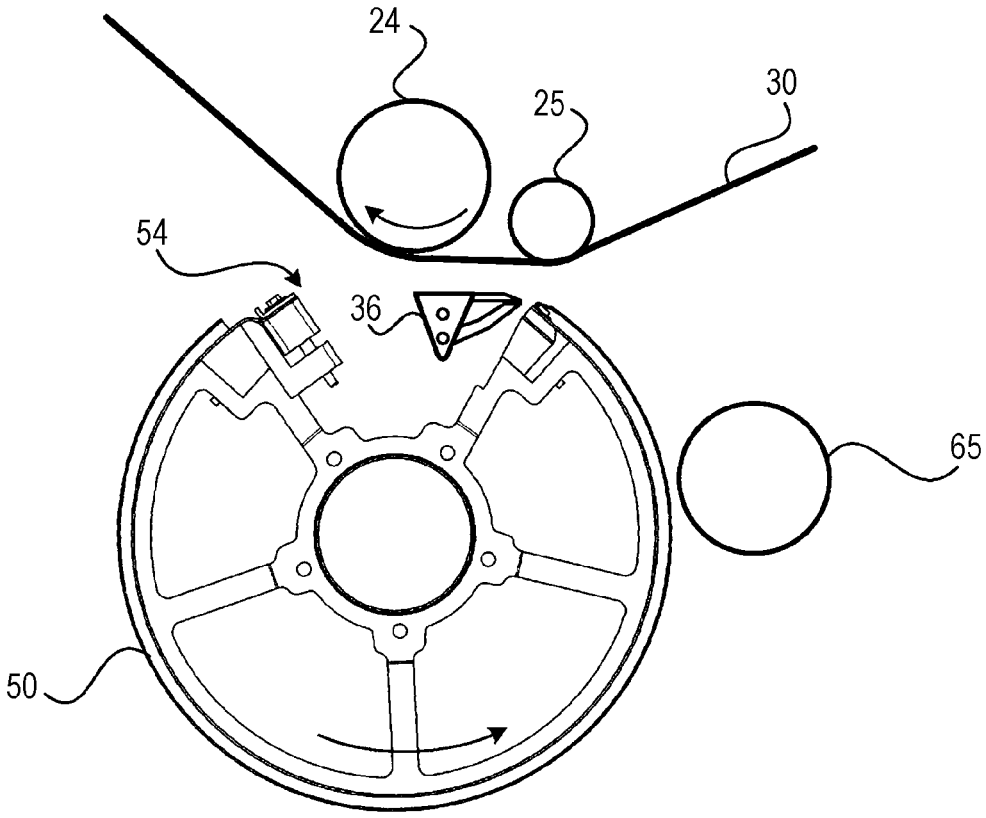


FIG. 22

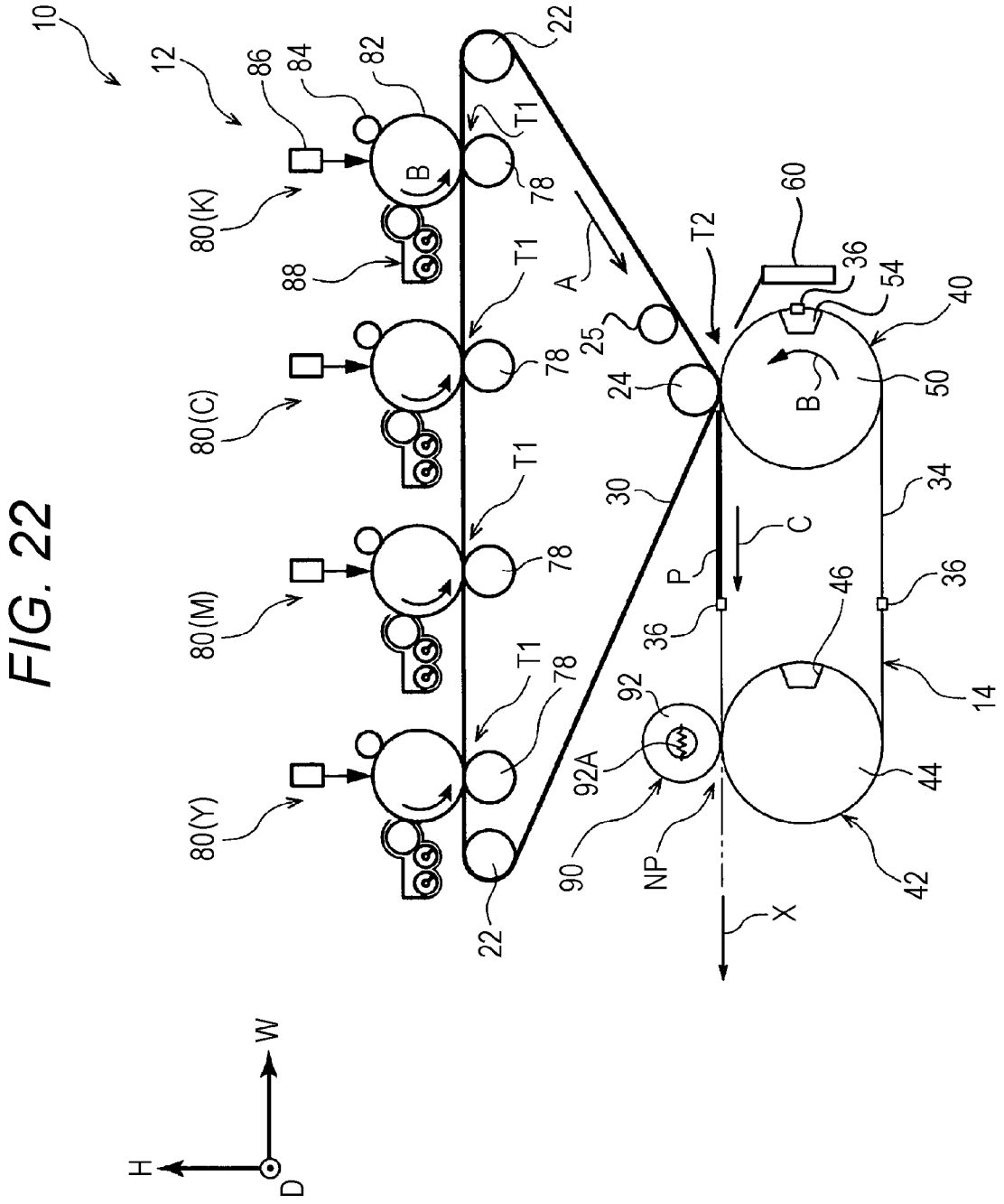

10
12
86
84
82
22
T1
78
80(K)
88
B
A
T2
60
36
54
40
25
24
50
80(C)
30
34
C
P
80(M)
36
46
36
14
92
80(Y)
92A
44
90
NP
42
X
22
W
H
D

IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2021-169888 filed Oct. 15, 2021.

BACKGROUND

(i) Technical Field

The present invention relates to an image forming apparatus.

(ii) Related Art

JP5278687B discloses an image forming apparatus in which a transfer material such as paper is electrostatically attracted to a secondary transfer roller when the transfer material passes through a secondary transfer nip in a secondary transfer unit while being gripped by a transfer material gripping mechanism in a recessed groove provided in a roller body.

Some large-sized image forming apparatuses employ such a configuration that an image on a holding body such as an intermediate transfer body is transferred to a recording medium by the recording medium being conveyed in a state where a holding unit holding a leading end of the recording medium such as a sheet is accommodated in a recessed portion of a transfer body. In the image forming apparatus having such a configuration, since the leading end of the recording medium is held at a position further inward than a surface of the transfer body, the recording medium may be lifted, losing close contact with the transfer body. When the recording medium is lifted from the transfer body, the recording medium and the intermediate transfer body may contact each other before the recording medium advances to a transfer position, which may cause a shift in transferring an image.

SUMMARY

Aspects of non-limiting embodiments of the present disclosure relate to an image forming apparatus capable of suppressing the lifting of a recording medium from a transfer body when an image on a holding body is transferred to the recording medium by the recording medium being conveyed in a state where a leading end of the recording medium is held at a position further inward than a surface of the transfer body, as compared with a case where no slope surface is provided on a leading end of an outer circumference of the transfer body. Aspects of certain non-limiting embodiments of the present disclosure address the above advantages and/or other advantages not described above. However, aspects of the non-limiting embodiments are not required to address the advantages described above, and aspects of the non-limiting embodiments of the present disclosure may not address advantages described above.

According to an aspect of the present disclosure, there is provided an image forming apparatus according to a first aspect of the present invention includes a holding body that holds a formed image,

a conveyance unit configured to convey a recording medium in a state where a leading end of is gripped by a gripping portion, and

a transfer body including a recessed portion that accommodates the gripping portion and is provided along a direction substantially orthogonal to a rotational direction, configured to sandwich the recording medium conveyed by the conveyance unit between the transfer body and the holding body to transfer an image on the holding body to the recording medium conveyed by the conveyance unit, and including a slope surface provided at a leading end of a portion of an outer circumference not including a portion where the recessed portion is provided, the leading end being on a front end side in the rotational direction, a distance from the slope surface to a rotational center becoming larger toward a downstream side in the rotational direction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram illustrating an image forming apparatus **10** according one embodiment of the present invention.

FIG. **2** is a perspective view illustrating a configuration of a transfer unit **40** according to one embodiment of the present invention.

FIG. **3** is a perspective view illustrating a configuration of a fixing device **90** according to one embodiment of the present invention.

FIG. **4** is a perspective view illustrating a gripper **36** according to one embodiment of the present invention.

FIG. **5** is a perspective view of a transfer body **50** according to one embodiment of the present invention.

FIG. **6** is a cross-sectional view of the transfer body **50** according to one embodiment of the present invention.

FIG. **7** is a perspective view of a sheet member **100** according to one embodiment of the present invention.

FIG. **8** is a plan view of a sheet member **100** according to one embodiment of the present invention as viewed from a metal layer **150** side.

FIG. **9** is an enlarged view of a front end side in a rotational direction of the transfer body **50**.

FIG. **10** is a view illustrating an example state of a recording medium P where a sheet member **100**A provided with no tapered surface **104** is used.

FIG. **11** is a view illustrating an example state of the recording medium P where the sheet member **100** provided with a tapered surface **104** is used.

FIG. **12** is a view for explaining a relationship between the tapered surface **104** and a gripping surface **120** with which the gripper **36** grips the recording medium P.

FIG. **13** is a view for explaining a relationship between an angle θ**1** and an angle θ**2**, the angle θ**1** being an angle between the gripping surface **120** with which the gripper **36** grips the recording medium P and a plane orthogonally intersecting, at a distal end of the gripper **36**, a line extending from the distal end of the gripper **36** toward a rotational center of the transfer body **50**, the angle θ**2** being an angle between the tapered surface **104** and a plane orthogonally intersecting, at a leading end of the tapered surface **104**, a line extending from the leading end of the tapered surface **104** toward the rotational center of the transfer body **50**.

FIG. **14** is a figure showing evaluation results of image shift amounts resulting from varied relationship between the angle θ**1** of the gripping surface **120** of the gripper **36** and the angle θ**2** which is a slope angle of the tapered surface **104**.

FIG. **15** is a figure for explaining a distance L between the leading end of the sheet member **100** and the distal end of the gripper **36**.

FIG. **16** is a figure illustrating a state in which the set position of a support roller **25** is adjusted to set an angle θ3 to be larger than an angle θ4.

FIG. **17** is a figure illustrating an example state of the recording medium P where θ4<θ3.

FIG. **18** is a view illustrating an enlarged transfer position at which an image on a transfer belt **30** is transferred to a recording medium P and the surroundings of the transfer position.

FIG. **19** is a perspective view of a sliding member **60** illustrated in FIG. **9**.

FIG. **20** is a figure illustrating an example state of the recording medium P where the sliding member **60** is provided.

FIG. **21** is a figure for explaining a configuration in which a conveyance load is applied to the recording medium P by a roller **65**.

FIG. **22** is a schematic diagram illustrating a configuration of another image forming apparatus **10** according to one embodiment of the present invention.

DETAILED DESCRIPTION

An embodiment according to the present invention will be described in detail below with reference to the drawings. For convenience of description, in FIG. **1**, a direction along an arrow H is referred to as an up-down direction of an image forming apparatus **10**, a direction along an arrow W is referred to as a width direction of the image forming apparatus **10**, and a direction along an arrow D is referred to as a front-rear direction of the image forming apparatus **10**.

FIG. **1** illustrates the image forming apparatus **10** having a configuration in which an ink image is formed on a recording medium P by, for example, an inkjet method. The image forming apparatus **10** includes an image forming unit **12**, a conveyance unit **14**, and a fixing device **90**.

Now, the image forming unit **12**, the conveyance unit **14**, and the fixing device **90** of the image forming apparatus **10** will be described, and then a transfer body **50** as an example of a body member will be described.

<Image Forming Unit **12**>

As illustrated in FIG. **1**, the image forming unit **12** has a function of forming an ink image on the recording medium P. To describe specifically, the image forming unit **12** includes a transfer belt **30** as an example of an intermediate transfer body, two rollers **22**, an opposing roller **24** as an example of a rotating member, an adhesive layer forming device **26**, a particle supply device **18**, a discharge head **20**, a transfer unit **40**, and a cleaner **28**.

The transfer belt **30** is formed as an endless belt, and is looped around the two rollers **22**, the opposing roller **24**, and a support roller **25** so as to have an inverted triangular shape in a view along the front-rear direction. The transfer belt **30** takes a form of a belt, and circulates in the direction indicated by an arrow A by at least one of the two rollers **22** being rotationally driven.

The adhesive layer forming device **26**, the particle supply device **18**, the discharge head **20**, the transfer unit **40**, and the cleaner **28** are disposed on the outer circumferential surface side of the transfer belt **30** in this order from the upstream side along the circulating direction of the transfer belt **30** (hereinafter referred to as "belt circulating direction").

The adhesive layer forming device **26** is disposed at an end on one side (left side in the figure), regarding the width direction of the apparatus, of a horizontal section of the transfer belt **30** taking a form of an inverted triangular shape. The adhesive layer forming device **26** houses an adhesive, and is configured to form an adhesive layer (not illustrated) by applying the adhesive to the outer circumferential surface of the circulating transfer belt **30**. Examples of the adhesive include, for example, glues and organic solvents.

The particle supply device **18** is disposed on the downstream side (right side in the figure), regarding the belt circulating direction, of the adhesive layer forming device **26** along the horizontal section of the transfer belt **30**. The particle supply device **18** holds therein ink absorbing particles **16** capable of absorbing ink droplets, and is configured to supply the ink absorbing particles **16** to the transfer belt **30** on which the adhesive layer is formed.

That is, the ink absorbing particles **16** supplied onto the transfer belt **30** by the particle supply device **18** adhere to the adhesive layer by the adhesive force of the adhesive layer to form an ink absorbing particle layer **16**A on the transfer belt **30**.

The discharge head **20** is disposed on the downstream side (right side in the figure), regarding the belt circulating direction, of the particle supply device **18** along the horizontal section of the transfer belt **30**. A plurality of discharge heads **20** are provided so as to form ink images in respective colors. In the embodiment, the discharge heads **20** for the four colors of yellow (Y), magenta (M), cyan (C), and black (K) are provided. In FIG. **1**, an alphabetical letter Y, M, C, or K is added after the reference numeral **20** of the corresponding color.

The discharge head **20** of each of the colors is configured to form an ink image based on image data by discharging ink droplets from nozzles (not illustrated) onto the ink absorbing particle layer **16**A by a known method, such as a thermal method or a piezoelectric method. That is, the ink droplets discharged from the discharge heads **20** of the respective colors are absorbed by the ink absorbing particle layer **16**A to form an ink image.

In this manner, the transfer belt **30** functions as a holding body that holds the formed image.

The transfer unit **40** is disposed below the transfer belt **30**. As illustrated in FIG. **2**, the transfer unit **40** includes the transfer body **50** disposed so as the axial direction of the transfer body **50** to be the same as the axial direction of the opposing roller **24**, and a sliding member **60** disposed close to the transfer body **50**. The transfer body **50** is disposed so as to oppose the transfer belt **30**, and forms a nip region T where the transfer belt **30** is sandwiched between the transfer body **50** and the opposing roller **24**. That is, the opposing roller **24** presses the transfer belt **30** from the inner side to form the nip region T which is a transfer position. The sliding member **60** will be described in detail later.

In the embodiment, by circulation of the transfer belt **30**, the ink image formed in the ink absorbing particle layer **16**A is conveyed to the nip region T, and the conveyance unit **14** conveys the recording medium P to the nip region T. The recording medium P and the ink image conveyed to the nip region T are sandwiched between the transfer body **50** and the transfer belt **30** and pressed, and thereby the ink image is transferred to the recording medium P.

In FIG. **1**, the conveyance direction of the recording medium P is indicated by an arrow X. When sandwiching and pressing the recording medium P and the ink image between the transfer body **50** and the transfer belt **30** in the nip region T, the transfer body **50** may heat the recording medium P and the ink image. At a portion of the outer circumferential surface of the transfer body **50**, a recess **54**, which is a recessed portion in which a gripper **36** and a support member **38** which will be described later are accommodated, is formed.

A configuration of the transfer unit **40** of the embodiment will be described with reference to a perspective view in FIG. **2**. As illustrated in FIG. **2**, a pair of sprockets **32** is provided at two ends in the axial direction of the transfer body **50**. A pair of sprockets **32** is disposed coaxially with the transfer body **50**, and integrally rotates with the transfer body **50**. The transfer body **50** is rotationally driven by a drive unit (not illustrated). Chains **34** are looped around a pair of sprockets **32**.

The sliding member **60** functions as a load-applying unit that applies a conveyance load to the recording medium P conveyed to the transfer position where the image on the transfer belt **30** is transferred to the recording medium P. Specifically, the sliding member **60** is disposed close to but without contacting the surface of the transfer body **50**, and is configured to slide against the recording medium P that is being conveyed. The term "sliding" means such a state that two objects move while touching each other.

The phrase "disposed close to" means that the sliding member **60** is disposed such that the sliding member **60** and the transfer body **50** are not in direct contact with each other when the recording medium P is not conveyed, but when the recording medium P is conveyed in such a state that the recording medium P is not closely attached to, that is, lifted from, the transfer body **50**, the recording medium P and the sliding member **60** contact each other. Note that, the distance between the sliding member **60** and the transfer body **50** may be set such that when the recording medium P is thin and closely attached to the transfer body **50**, the sliding member **60** is not in contact with the recording medium P.

As illustrated in FIG. **1**, the cleaner **28** is disposed on the downstream side of the nip region T but on the upstream side of the adhesive layer forming device **26** regarding the belt circulating direction. The cleaner **28** includes a blade **28**A that contacts the outer circumferential surface of the transfer belt **30**. The cleaner **28** is configured to remove with the blade **28**A, along with circulation of the transfer belt **30**, the adhesive layer, the ink absorbing particles **16**, ink, and other objects (for example, paper dust, when the recording medium P is paper) that have passed through the nip region T and remained on the transfer belt **30**.

The opposing roller **24** is configured to be movable, by a moving mechanism-for-transfer (not illustrated) using a cam or the like, between a contact position where the opposing roller **24** indirectly contacts the transfer body **50** and a separated position where the opposing roller **24** is separated from the transfer body **50**. To describe specifically, the opposing roller **24**, for example, is configured to be always pushed or pulled by the elastic force of an elastic member such as a spring toward the contact position, and move by the moving mechanism-for-transfer to the separated position against the elastic force.

The support roller **25** that supports the transfer belt **30** is disposed on the upstream side of the opposing roller **24** in the conveyance direction. By moving the set position of the support roller **25** closer to or away from the opposing roller **24**, the pressure and the contact area of a contact region between the transfer belt **30** and the transfer body **50** can be adjusted.

As described above, the transfer body **50** has a substantially circular cross section, and includes the recess **54** that accommodates the gripper **36** and is provided along a direction substantially orthogonal to the rotational direction. The transfer body **50** and the transfer belt **30** sandwich therebetween the recording medium P conveyed by the conveyance unit **14**, and thereby the image on the transfer belt **30** is transferred to the recording medium P that is conveyed by the conveyance unit **14**. The phrase "substantially orthogonal" means that the angle between two directions is in a range from 85 to 95 degrees.

<Fixing Device **90**>

As illustrated in FIG. **1**, the fixing device **90** fixes the ink image that has been transferred to the recording medium P onto the recording medium P. To describe specifically, the fixing device **90** includes a pressing body **42** and a heating roller **92** that are disposed on the downstream side of the recording medium P in the conveyance direction in the conveyance unit **14**.

A configuration of the fixing device **90** in the embodiment will be described with reference to a perspective view in FIG. **3**. As illustrated in FIG. **3**, the pressing body **42** includes a pressing roller **44** disposed so as the axial direction of the pressing roller **44** to be the same as the axial direction of the transfer body **50**, and a pair of sprockets **48** is provided at two ends in the axial direction of the pressing roller **44**. A pair of sprockets **48** is disposed coaxially with the pressing roller **44**, and integrally rotates with the pressing roller **44**. The chains **34** described above is looped around a pair of sprockets **48**.

As illustrated in FIG. **1**, the heating roller **92** and the pressing roller **44** are arranged along the up-down direction. That is, the heating roller **92** is disposed above the pressing roller **44**. The heating roller **92** includes therein a heating source **90**A (see FIG. **1**) such as a halogen lamp. Hereinafter, a place at which the recording medium P is sandwiched by the heating roller **92** and the pressing roller **44** is referred to as a nip position NP.

The heating roller **92** is configured to be movable, by a moving mechanism-for-fixing (not illustrated) using a cam or the like, between a contact position where the heating roller **24** directly or indirectly contacts the pressing roller **44** and a separated position where the heating roller **92** is separated from the pressing roller **44**. To describe specifically, the heating roller **92**, for example, is configured to be always pressed or pulled toward the contact position by the elastic force of an elastic member such as a spring, and move to the separated position against the elastic force by the moving mechanism-for-fixing. The heating roller **92** is configured to sandwich the recording medium P with the pressing roller **44** at the contact position.

In the embodiment, the heating roller **92** is rotationally driven, whereby the pressing roller **44** is driven to rotate, but the heating roller **92** and the pressing roller **44** may be both rotationally driven. At a portion of the outer circumferential surface of the pressing roller **44**, a recess **46** may be formed to accommodate the gripper **36** and the support member **38** which will be described later.

<Conveyance Unit **14**>

As illustrated in FIGS. **1** to **3**, the conveyance unit **14** has a function of conveying the recording medium P to pass through the nip region T and the nip position NP. The conveyance unit **14** includes a pair of chains **34** and the gripper **36**. A pair of chains **34** is an example of a driving force transmission member, and the gripper **36** is an example of a gripping portion that holds the leading end portion of the recording medium P. In FIG. **1**, the chain **34** and the gripper **36** are illustrated in a simplified manner. Accordingly, the conveyance unit **14** conveys the recording medium P with the gripper **36**, which is a gripping portion, gripping the leading end of the recording medium P.

As illustrated in FIG. **1**, each of a pair of chains **34** is formed in an annular shape. As illustrated in FIGS. **2** and **3**, a pair of chains **34** is disposed to be separated from each other along the depth direction of apparatus. That is, a pair

of chains **34** is looped around a pair of sprockets **32** provided coaxially with the transfer body **50** and a pair of sprockets **48** provided coaxially with the pressing roller **44**.

When the transfer body **50** is rotationally driven by the drive unit (not illustrated), a pair of sprockets **32** is also integrally rotationally driven in a rotational direction B (direction indicated by an arrow B), whereby the chains **34** circulate in a circulating direction C (direction indicated by an arrow C). This causes the pressing roller **44** to rotate. That is, the rotational driving force of the transfer body **50** is transmitted to the pressing roller **44** by a pair of chains **34** that circulates in the circulating direction C (see FIG. **1**).

As illustrated in FIGS. **2** and **3**, the support member **38** to which the gripper **36** is attached is bridged between a pair of chains **34** in the depth direction of apparatus. In the present embodiment, three support members **38** are provided and fixed to a pair of chains **34** at a predetermined interval along the circumferential direction (circulating direction C) of the chains **34**.

A plurality of grippers **36** are attached to the support members **38** in such a manner as to be arranged at a predetermined interval in the depth direction of apparatus. That is, the grippers **36** are attached to the chains **34** via the support members **38**. Each gripper **36** has a function of holding the leading end of the recording medium P.

To describe specifically, as illustrated in FIG. **4**, the gripper **36** includes a plurality of claws **36**A and a plurality of claw bases **36**B. The gripper **36** holds the recording medium P by sandwiching the leading end of the recording medium P between the claws **36**A and the claw bases **36**B. Thus, the gripper **36** is an example of a sandwiching portion that sandwiches the recording medium P in the thickness direction.

The gripper **36** is configured to hold the leading end of the recording medium P from the downstream side in the conveyance direction of the recording medium P. The gripper **36** is configured such that, for example, the claw **36**A is pressed against the claw base **36**B by a spring or the like, and the claw **36**A is separated from the claw base **36**B by the action of a cam or the like.

In this manner, in the conveyance unit **14**, the leading end of the recording medium P fed from a container (not illustrated) is held by the gripper **36**. The conveyance unit **14** is configured that circulation of the chains **34** in the circulating direction C with the gripper **36** holding the leading end of the recording medium P moves the gripper **36** to convey the recording medium P, and the recording medium P still being held by the gripper **36** passes through the nip region T together with the gripper **36**.

Each of a pair of chains **34** has a length that is an integral multiple of the outer circumference of the sprocket **32** of the transfer unit **40** and the sprocket **48** of the pressing body **42**. Three support members **38** are provided at places on the chain **34** corresponding to the positions of the recess **54** of the transfer body **50** and the recess **46** of the pressing roller **44**. Therefore, when the gripper **36** arrives at the transfer body **50** along with circulation of the chains **34**, the gripper **36** is accommodated in the recess **54** of the transfer body **50** and in this state integrally moves with the transfer body **50**. Similarly, when the gripper **36** arrives at the pressing roller **44** along with circulation of the chains **34**, the gripper **36** is accommodated in the recess **46** of the pressing roller **44** and in this state integrally moves with the pressing roller **44**.

The conveyance unit **14** of the embodiment is configured that, when the heating roller **92** is at the separated position, the recording medium P is conveyed toward the nip position NP with the gripper **36** holding the leading end of the recording medium P. The conveyance unit **14** is also configured to release holding of the leading end of the recording medium P when the recording medium P is conveyed to the nip position NP.

That is, the conveyance unit **14** is configured to release holding of the leading end of the recording medium P after the gripper **36** has passed through the nip position NP. At the timing of this release, the pressing roller **44** is kept rotating, in other words, the chains **34** is kept circulating.

That the recording medium P has been conveyed to the nip position NP is detected by, for example, an elapsed time after a detector provided on the upstream side of the nip position NP in the conveyance direction detects the leading end of the recording medium P. The detector may detect the support member **38** or the gripper **36** instead of the leading end of the recording medium P.

After the gripper **36** has passed through the nip position NP and holding of the leading end of the recording medium P by the gripper **36** has been released, the heating roller **92** starts moving from the separated position to the contact position to sandwich the recording medium P, which has been conveyed to the nip position NP, between the heating roller **92** and the pressing roller **44**. The heating roller **92** starts rotating with the recording medium P sandwiched between the heating roller **92** and the pressing roller **44** to convey the recording medium P.

The heating roller **92** may start moving from the separated position to the contact position before holding of the leading end of the recording medium P by the gripper **36** is released as long as sandwiching of the recording medium P by the heating roller **92** and the pressing roller **44** is completed after releasing of holding of the leading end of the recording medium P by the gripper **36**.

As described above, the fixing device **90** is configured to fix the ink image transferred to the recording medium P onto the recording medium P by heating and pressing the recording medium P while the recording medium P is being conveyed and sandwiched by the heating roller **92** and the pressing roller **44**.

<Transfer Body **50**>

Next, the transfer body **50** will be described. FIG. **5** is a perspective view of the transfer body **50**, and FIG. **6** is a cross-sectional view of the transfer body **50**.

As illustrated in FIGS. **5** and **6**, the transfer body **50** as an example of a body member includes a body part **52**, and a sheet member **100** that has a sheet-like form wrapped around the body part **52**. Hereinafter, the axial direction, the radial direction, and the circumferential direction of the body part **52** may be simply referred to as "axial direction", "radial direction", and "circumferential direction", respectively.

Hereinafter, the upstream in the rotational direction (the direction indicated by the arrow B) of the transfer body **50** may be simply referred to as "upstream", and the downstream in the rotational direction (the direction indicated by the arrow B) of the transfer body **50** may be simply referred to as "downstream". When the circumferential direction and the axial direction are used in the description of the sheet member **100**, those directions are along the sheet member **100** wrapped around the body part **52**. A direction along a short side of the sheet member **100** having a rectangular shape in a plan view is referred to as a width direction, and a direction along a long side is referred to as a length direction.

At a portion regarding the circumferential direction of the body part **52**, a single recess **54** is provided along the axial direction of the body part **52**. The cross-sectional shape of the body part **52** is substantially circular, specifically, the

outer profile of the cross-section perpendicular to the axial direction is substantial circular. The recess **54** as an example of a recessed portion has a depth along the radial direction of the body part **52**. The body part **52** is made of a metal material such as stainless steel and aluminum. In the embodiment, the depth direction of the recess **54** is the same as the radial direction. It is not necessary that the depth direction is the same as the radial direction. The depth direction may be inclined by, for example, about 5° to 10° from the radial direction.

The body part **52** has the length along the axial direction of the body part **52** longer than the width of the sheet member **100** along the axial direction of the sheet member **100**. The sheet member **100** is wrapped so as the central portion, in the width direction, of the sheet member **100** overlaps the central portion, in the axial direction, of the body part **52**. The width of the sheet member **100** is larger than the maximum width of the recording medium P (see FIG. **4**).

The term "sheet-like" refers to a form of paper, a thin plate, or the like and having a thickness allowing deformation along the outer circumference of the body part **52**. The length of the sheet member **100** in the circumferential direction (length direction) is substantially the same as the circumferential length of the body part **52** not including the recess **54**.

As illustrated in FIG. **6**, the sheet member **100** includes a metal layer **150** that is wrapped to make contact with the outer circumferential surface of the body part **52**, and an outer layer **102** that is laminated on and bonded to the outer circumferential surface of the metal layer **150**.

The metal layer **150** of the embodiment is made of a metal material such as stainless steel, aluminum, and copper. The thickness of the metal layer **150** of the embodiment is, for example, 0.1 mm.

As the outer layer **102** of the embodiment, a solid rubber-based material such as nitrile rubber, chloroprene rubber, ethylene propylene diene rubber, acrylonitrile butadiene rubber, and silicon rubber and a conductive resin material such as polyimide, polyamideimide, polyurethane, polyethylene, and a mixture thereof are used. The thickness of the outer layer **102** of the embodiment is larger than the thickness of the metal layer **150**, and is, for example, 7.0 mm.

In the embodiment, one end of the sheet member **100** is fixed to the body part **52** by a mounting screw **71**, and the other end of the sheet member **100** is fixed by a fixing screw **70**. Therefore, the sheet member **10** is easily attached to and detached from the body part **52**.

FIG. **7** is a perspective view of the sheet member **100** that has been detached from the body part **52**. FIG. **8** is a plan view of the sheet member **100** of the embodiment as viewed from the metal layer **150** side.

FIG. **9** is an enlarged view of the front end side in the rotational direction of the transfer body **50**. Referring to FIG. **9**, a tapered surface **104** that is a slope surface of which distance to the rotational center increases toward the downstream side in the rotational direction is provided on the leading end of the transfer body **50**, the leading end being on the front end side, in the rotational direction, of a portion of the outer circumference not including a portion where the recess **54** is provided. As described above, since the transfer body **50** includes the body part **52** including the recess **54** provided along the direction substantially orthogonal to the rotational direction, and the sheet member **100** wrapped around the body part **52**, the tapered surface **104** is provided on the leading end, which is on the front end side regarding the rotational direction, of the sheet member **100**.

Since the sheet member **100** is provided with the tapered surface **104**, lifting of the recording medium P from the transfer body **50** is suppressed. FIG. **10** illustrates an assumed example state of the recording medium P where the sheet member **100**A provided with no tapered surface **104** is used.

Referring to FIG. **10**, the recording medium P gripped by the gripper **36** is pushed up by the leading end of the sheet member **100**A to cause lifting, and contacts the transfer belt **30** by a portion which is not yet arrived at the normal transfer position.

In contrast, FIG. **11** illustrates an example state of the recording medium P where the sheet member **100** provided with the tapered surface **104** is used.

Referring to FIG. **11**, lifting is suppressed since the recording medium P gripped by the gripper **36** is not pushed up by the leading end of the sheet member **100**, and this prevents the recording medium P from contacting the transfer belt **30** by an unintended portion.

It is more preferable that the relationship among the position of the gripper **36**, the orientation of the gripping surface with which the gripper **36** grips the recording medium P, and the slope angle of the tapered surface **104** provided on the sheet member **100** satisfies a specific condition.

Specifically, it is preferable that, as illustrated in FIG. **12**, in a state where the gripper **36** is accommodated in the recess **54**, the tapered surface **104** is positioned closer to the rotational center of the transfer body **50** than a plane including the gripping surface **120** with which the gripper **36** grips the recording medium P.

Furthermore, as illustrated in FIG. **13**, it is preferable that an angle $\theta 2$ is smaller than an angle $\theta 1$, where the angle $\theta 1$ is an angle between the gripping surface **120** with which the gripper **36** grips the recording medium P and a plane orthogonally intersecting, at a distal end of the gripper **36**, a line extending from the distal end of the gripper **36** toward the rotational center of the transfer body **50**, and the angle $\theta 2$ is an angle between the tapered surface **104** and a plane orthogonally intersecting, at a leading end of the tapered surface **104**, a line extending from the leading end of the tapered surface **104** toward the rotational center of the transfer body **50**. That is, when it is configured to satisfy $\theta 2 < \theta 1$, the recording medium P gripped by the gripper **36** is more likely to be above the tapered surface **104**. As a result, the recording medium P being pushed up by the transfer body **50** is prevented, which suppresses lifting of the recording medium P from the transfer body **50**.

As described above, it is more preferable that $\theta 2 < \theta 1$ is satisfied, that is, the difference between the two angles, $\theta 2 - \theta 1$, takes a negative value instead of 0.

However, setting the angle $\theta 1$ of the gripping surface **120** of the gripper **36** too large may not be good for some cases, and setting the angle $\theta 2$, which is the slope angle of the tapered surface **104**, too small increases a leading end margin which is a region starting from the front end of the recording medium P and in which no image is formed.

In this regard, the image shift amount was evaluated for cases with varied relationship between the angle $\theta 1$ of the gripping surface **120** of the gripper **36** and the angle $\theta 2$ which is the slope angle of the tapered surface **104**. Results of evaluation are shown in FIG. **14**.

Specifically, an image of a thin line having a width of two dots was formed in a direction orthogonal to the conveyance direction of the recording medium P, and was evaluated based on to what degree the width of the thin line has broadened. If there is no image shift, the width of the thin

line image remains as it is, but when any image shift amount occurs, the width of the thin line broadens. Whether the broadened width of a thin line image is within an allowable range was evaluated.

Based on the results of evaluation, cases in which the angle difference of θ2−θ1 is in a range from −12° to 0° showed good evaluation result. That is, by setting θ2−θ1, which is the difference between the angle θ1 of the gripping surface **120** of the gripper **36** and the angle θ2 which is the slope angle of the tapered surface **104**, to be in a range from −12° to 0°, lifting of the recording medium P from the body part **50** is suppressed, and the image shift amount falls within the allowable range.

Note that, the difference between the two angles, θ2−θ1, being in a range from −16° to 4° may be allowed depending on the balance between the amount of the leading end margin and the quality of the formed image.

Furthermore, as illustrated in FIG. **15**, it is more preferable that a distance L between the leading end, which is on the front end side in the rotational direction, of the sheet member **100** and the distal end of the region, in which the recording medium P is gripped, of the gripper **36** is equal to or more than 3 mm. However, there is a limit for how far the gripper **36** is positioned from the transfer body **50**, because positioning the gripper **36** far from the leading end of the transfer body **50** increases the leading end margin that starts from the front end of the recording medium P and in which no image is formed.

In this regard, the distance L between the distal end of the gripper **36** and the leading end of the tapered surface **104** was varied to evaluate the image shift amount. The evaluation results are shown in FIG. **15**. The evaluation method for obtaining the evaluation results shown in FIG. **15** is the same as the evaluation method for obtaining the evaluation results shown in FIG. **14**.

The evaluation results show that the image shift amount is within the allowable range when the distance L is equal to or more than 3 mm, and the image shift amount is out of the allowable range when the distance L is 2 mm. As described above, positioning the gripper **36** to be far separated with too large distance L results in an increase in the leading end margin.

Note that, even when the recording medium P is lifted from the transfer body **50**, no image shift will occur if the recording medium P does not contact the transfer belt **30**. Thus, as illustrated in FIG. **16**, it is better to adjust the installation position of the support roller **25** so as an angle θ3 between the transfer belt **30**, which is between the opposing roller **24** and the support roller **25**, and a horizontal plane to be larger than an angle θ4 between a line connecting the distal end of the gripper **36** and the leading end of the sheet member **100**A and a plane orthogonally intersecting, at the distal end of the gripper **36**, a line extending from the distal end of the gripper **36** to the rotational center of the transfer body **50**.

FIG. **17** illustrates an example state of the recording medium P where θ4<θ3 is satisfied as described above. By positioning the support roller **25** so as to satisfy θ4<θ3, as illustrated in FIG. **17**, even when the recording medium P is pushed up by the leading end of the sheet member **100**A and lifted from the transfer body **50**, the recording medium P contacting the transfer belt **30** at an unintended portion is prevented.

Providing the sheet member **100** with the tapered surface **104** also has an effect of reducing the impact given by the opposing roller **24** making contact with the transfer body **50** at the transfer position. However, there are limits for the distance and a slope of the tapered surface **104**, because when the tapered surface **104** provided to the sheet member **100** is given a moderate slope which thereby gives a long distance, the leading end margin starting from the front end of the recording medium P and in which no image is formed increases.

In this regard, lifting of the recording medium P from the transfer body **50** may be suppressed not only by providing the tapered surface **104** on a surface at the front end in the rotational direction of the transfer body **50** but also by employing a configuration described below.

FIG. **18** is a view illustrating the transfer position at which an image on the transfer belt **30** is transferred to the recording medium P and the surroundings of the transfer position, where the transfer body **50** and the opposing roller **24** are close to each other.

FIG. **18** illustrates the transfer body **50** rotating with the gripper **36** accommodated in the recess **54**. It can be understood that the sliding member **60** is disposed close to the transfer body **50** on the downstream side of the transfer position in the rotational direction.

FIG. **19** is a perspective view of the sliding member **60**. Referring to FIG. **19**, the sliding member **60** includes a main body **61**, a fixing attachment **62**, and a plate part **63**. The plate part **63** is a member that contacts the recording medium P that is being conveyed to apply a conveyance load to the recording medium P, and is fixed to the fixing attachment **62** with screws or the like. With the fixing attachment **62** fixed to the main body **61** with screws or the like, the plate part **63** is fixed to the main body **61** via the fixing attachment **62**.

The plate part **63** is a member that directly contacts the recording medium P that is being conveyed, and includes, for example, a material made of rubber or the like having a coefficient of friction of 1.0 or more and 1.5 or less against the recording medium P. The material constituting the plate part **63** is not limited to rubbers, and other materials such as resin materials and metal materials can be used.

Now, why a conveyance load is applied, by the sliding member **60**, to the recording medium P being conveyed will be described.

FIG. **20** illustrates an example in which the sliding member **60** is provided and a conveyance load is applied to the recording medium P being conveyed. Referring to FIG. **20**, it can be understood that the recording medium P is pulled toward the downstream side in the conveyance direction by the recording medium P gripped by the gripper **36** and the sliding member **60** sliding against each other, and thereby lifting of the recording medium P is suppressed. In particular, in the image forming apparatus **10** of the embodiment, the recording medium P is conveyed with the leading end of the recording medium P being gripped by the gripper **36**, so that the effect of suppressing the lifting of the recording medium P by pulling the recording medium P toward the downstream side in the conveyance direction is significant.

Note that, since the sliding member **60** of the embodiment has a form of a plate, the effect of suppressing the lifting of the recording medium P varies by adjusting the distance between the distal end of the sliding member **60** and the opposing roller **24** and the distance between the distal end of the sliding member **60** and the surface of the transfer body **50**.

Specifically, the effect of suppressing the lifting is greater for a shorter distance between the distal end of the sliding member **60** and the opposing roller **24**. However, when the sliding member **60** is positioned so close to the opposing roller **24**, the possibility of the sliding member **60** contacting

the transfer belt **30** increases. A shorter distance between the distal end of the sliding member **60** and the surface of the transfer body **50** gives a larger conveyance resistance applied to the recording medium P and enables applying a conveyance resistance also to a thin recording medium P.

For example, the effect of suppressing the lifting of the recording medium P from the transfer body **50** can be obtained by positioning the distal end of the sliding member **60** so as a distance A from the center of the opposing roller **24** to be equal to or less than 50 mm and a distance B from the surface of the transfer body **50** to be equal to or less than 2 mm.

To reliably apply a conveyance resistance to the recording medium P being conveyed, that is, to apply a conveyance resistance to the recording medium P being conveyed regardless of the thickness of the recording medium P, the sliding member **60** may be positioned so as to contact the surface of the transfer body **50**. However, in such a position, ink absorbing particles and the like adhering to the transfer body **50** may adhere to the sliding member **60**, which may smear the recording medium P that is being conveyed. Moreover, the sliding member **60** and the transfer body **50** that are always in contact with each other wear and may deteriorate quickly.

In consideration of smearing of an image transferred onto the recording medium P deterioration of the transfer body **50** and the sliding member **60** due to wearing, and an effect of the recording medium P that is being conveyed receiving a conveyance resistance, it is preferable that the sliding member **60** is disposed so as not to contact the transfer body **50**.

Described above is the configuration in which a conveyance load is applied, by the plate-shaped sliding member **60**, to the recording medium P that is being conveyed by the conveyance unit **14**. However, a conveyance load may be applied to the recording medium P by other configurations.

For example, as illustrated in FIG. **21**, a conveyance load may be applied to the recording medium P by a roller **65** which is a rotating member that is positioned close to the surface of the transfer body **50** without contact and rotates while making contact with the recording medium P that is conveyed.

The roller **65** may be a rotating member that rotates by making contact with the surface of the transfer body **50**.

The roller **65** may be a driven roller that is rotated by a frictional force produced against the surface of the transfer body **50** or the recording medium P, or may be a driving roller driven by an external driving force. Note that, when the roller **65** is driven, the roller **65** will rotate at a surface speed lower than the surface speed of the transfer body **50**.

Note that, when applying a conveyance load to the recording medium P by the roller **65**, the effect of suppressing the lifting of the recording medium P from the transfer body **50** can also be obtained by positioning the roller **65** so as the distance between the center of the roller **65** and the center of the opposing roller **24** to be equal to or less than 50 mm and the distance between the surface of the roller **65** and the surface of the transfer body **50** to be equal to or less than 2 mm.

Similar to the sliding member **60** described above, the member constituting the roller **65** may include, for example, a material made of rubber or the like having a coefficient of friction of 1.0 or more and 1.5 or less against the recording medium P. The material of the roller **65** is not limited to rubbers, and other materials such as resin materials and metal materials may be used.

Note that, a sufficient conveyance load as described above may not be applied to the recording medium P due to various restrictions in a real configuration of apparatus.

Thus, to improve the overall quality of an image formed on the recording medium P, the above-described configuration in which the tapered surface **104** is provided on the leading end of the sheet member **100** and the above-described configuration in which a conveyance load is applied to the recording medium P by the sliding member **60** or the like are combined to suppress lifting of the recording medium P from the transfer body **50** while preventing enlarging of the leading end margin.

<Another Image Forming Apparatus>

FIG. **22** is a schematic diagram illustrating a configuration of another image forming apparatus **10** according to one embodiment of the present invention. The image forming apparatus **10** according to the embodiment is not limited to an inkjet type as described above, and may be, for example, an electrophotographic type as illustrated in FIG. **22**. That is, instead of the adhesive layer forming device **26**, the particle supply device **18**, and the discharge head **20**, toner-image forming units **80** that form toner images (an example of an image) of respective colors may be provided.

Each of the toner-image forming units **80** (**80**Y, **80**M, **80**C, and **80**K) for the respective colors includes a photoconductor **82** that has a cylindrical shape and rotates in one direction (the direction indicated by an arrow B). Around each of the photoconductors **82**, a charger **84**, an exposure device **86**, and a developing device **88** are disposed in this order from the upstream side in a rotational direction of the photoconductor **82**.

In each of the toner-image forming units **80**, the charger **84** charges the surface of the photoconductor **82**, and the exposure device **86** exposes the surface of the photoconductor **82** charged by the charging device **84** to light to form an electrostatic latent image on the surface of the photoconductor **82**. The developing device **88** develops the electrostatic latent image formed by the exposure device **86** on the surface of the photoconductor **82**, and thereby a toner image is formed.

Primary transfer rollers **78** are provided on the inner circumferential surface side of the transfer belt **30**, and face the corresponding photoconductors **82** with the transfer belt **30** therebetween. The toner images formed by the toner-image forming units **80** for the respective colors are sequentially and overlappingly transferred, as a primary transfer, to the transfer belt **30** at the respective primary transfer positions T**1** where the respective primary transfer rollers **78** are provided. The overlapping toner images are transferred, as a secondary transfer, to the recording medium P at a secondary transfer position T**2**.

<Others>

Note that, the present invention is not limited to the embodiments described above, and can be modified in design as appropriate without departing from the gist of the present invention.

For example, the body part **52** may have a substantially columnar shape instead of a substantially cylindrical shape. In the embodiment, a toner image is taken as an example of an image and is formed by a dry electrophotographic method. However, the present invention is not limited such a configuration. For example, a toner image may be formed by a wet electrophotographic method.

What is claimed is:

1. An image forming apparatus comprising:

a holding body comprising a belt configured to hold a formed image;

a conveyance unit comprising a gripping portion including a gripper configured to convey a recording medium with a leading end of the recording medium gripped by the gripping portion; and

a transfer body including a recessed portion that accommodates the gripping portion and is provided along a direction substantially orthogonal to a rotational direction, configured to sandwich the recording medium conveyed by the conveyance unit between the transfer body and the holding body to transfer an image on the holding body to the recording medium conveyed by the conveyance unit, and including a slope surface provided at a leading end of a portion of an outer circumference not including a portion where the recessed portion is provided, the leading end being on a front end side in the rotational direction, a distance from the slope surface to a rotational center becoming larger toward upstream side in the rotational direction,

wherein a second angle is smaller than a first angle, the first angle being an angle between the gripping surface with which the gripping portion grips the recording medium and a plane orthogonally intersecting, at a leading end of the gripping portion, a line extending from the leading end of the gripping portion toward the rotational center of the transfer body, the second angle being an angle between the slope surface and a plane orthogonally intersecting, at a leading end of the slope surface, a line extending from the leading end of the slope surface toward the rotational center of the transfer body.

2. The image forming apparatus according to claim **1**, wherein

in a state in which the gripping portion is accommodated in the recessed portion, the slope surface is positioned closer to the rotational center of the transfer body than a plane including a gripping surface with which the gripping portion grips the recording medium.

3. The image forming apparatus according to claim **1**, wherein a distance between a leading end, which is on a front end side in the rotational direction, of a surface of the transfer body and a distal end of a region of the gripping portion that grips the recording medium is equal to or more than 3 mm.

4. The image forming apparatus according to claim **1**, wherein

the transfer body includes a body part having a substantially circular cross-sectional shape and including the recessed portion that accommodates the gripping portion and is provided along the direction substantially orthogonal to the rotational direction, and a sheet member wrapped around the body part, and

the slope surface is provided on a leading end, which is on a front end side in the rotational direction, of the sheet member, a thickness of the sheet member becoming larger toward the upstream side in the rotational direction to form the slope surface sloping with respect to a plane orthogonal to a direction toward the rotational center of the transfer body.

5. The image forming apparatus according to claim **1**, further comprising

an applying unit that applies a conveyance load to the recording medium that is conveyed to a transfer position at which an image on the holding body is transferred to the recording medium.

6. The image forming apparatus according to claim **5**, wherein

the applying unit is a sliding member that is disposed adjacent to but without contacting a surface of the transfer body and slides against the recording medium that is conveyed.

7. The image forming apparatus according to claim **5**, wherein

the applying unit is a rotating member that is disposed adjacent to but without contacting a surface of the transfer body and rotates while making contact with the recording medium that is conveyed.

* * * * *