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Abstract

To provide an intermittent printing apparatus capable of preventing a slip and a deviation in printing registration from being caused when a base material to be printed is travelled.

A step-back roller 6 on a sheet introducing side and a step-back roller 10 on a sheet discharging side are synchronously and rotationally driven forwardly to make a base material to be printed W travel forwardly, so that image printing is effected on the base material to be printed by an impression cylinder 9 and a blanket cylinder 8, and the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side are synchronously and rotationally driven backwardly to make the base material to be printed W travel backwardly.

The base material to be printed W is wound around a peripheral surface of the impression cylinder 9 at a prescribed winding angle, the base material to be printed W is pressed against the peripheral surface of the impression cylinder 9 by a nip roller 42 for impression cylinder, and the impression cylinder 9 is rotationally driven forwardly and backwardly in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side.

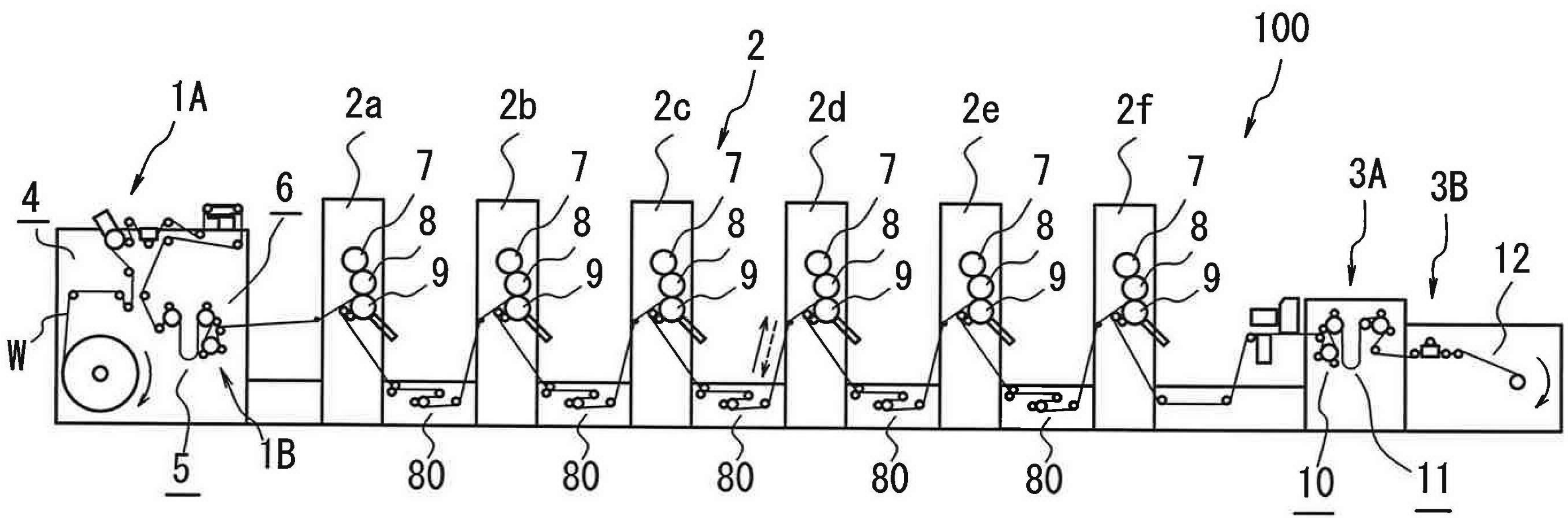

FIG. 1

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Title of the invention

INTERMITTENT PRINTING APPARATUS

Technical Field

[0001]

The present invention relates to an intermittent printing apparatus.

Background art

[0002]

An intermittent printing apparatus is a printer capable of printing images on a base material to be printed with small spaces in a top and bottom direction (vertical direction) by repeating steps of ; printing images on the base material to be printed while travelling it in a forward direction; then travelling it in a backward (reverse) direction without printing images ; and printing again while travelling it in the forward direction.

For example, an intermittent printing apparatus is disclosed in JP Patent Application Laid-Open No. H 2-75561.

According to the intermittent printing apparatus, a plurality of printing units each having a plate cylinder, a blanket cylinder and an impression cylinder is provided between two feeding rollers which are rotationally driven in the forward and backward (reverse) directions. A peripheral surface of the blanket cylinder has a large-diameter part to be pressed against a peripheral surface of the impression cylinder and a small-diameter part to be separated from the peripheral surface of the impression cylinder.

[0003]

And, when the base material to be printed is travelled in the forward direction by rotationally driving the two feeding rollers forwardly, images are printed on the base material to be printed by pressing the large-diameter part of the blanket cylinder against the peripheral surface of the impression cylinder. After images have been printed, the two feeding rollers are rotationally driven backwardly to make the base material to be printed travel backwardly. When the base material to be printed is travelled in the backward direction, as the base material to be printed passes through a gap between the small-diameter part of the blanket cylinder and the peripheral surface of the impression cylinder, image is not printed.

By repeating such operations, images may be printed on the base material to be printed with small spaces in the vertical direction.

Meanwhile, in the intermittent printing apparatus, as the base material to be printed passes through a gap between the small-diameter part of the blanket cylinder and the peripheral surface of the impression cylinder when the base material to be printed is travelled in the backward direction, the base material to be printed is not held between the impression cylinder and the blanket cylinder, its movement is thereby rendered unrestricted.

[0004]

For this reason, a deviation and looseness may be easily occurred in the base material to be printed while the base material to be printed is travelled in the backward direction. If the deviation and looseness are occurred in the base material to be printed, damages and printing stain etc. of the base material to be printed may be occurred when the base material to be printed is brought into contact with the blanket cylinder and the impression

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cylinder.

An intermittent printing apparatus capable of solving such problem is disclosed in JP Patent Application Laid-open No. 2006-247869.

This intermittent printing apparatus is configured so that a base material to be printed is wound around a peripheral surface of an impression cylinder at a prescribed winding angle and the impression cylinder is rotationally driven in the forward or backward direction in synchronization with two feeding rollers by providing two guide rollers.

According to such intermittent printing apparatus, as the base material to be printed is wound around the peripheral surface of the impression cylinder, the base material to be printed is prevented from moving when the base material to be printed is travelled in the backward direction. Therefore, the deviation and looseness never be occurred in the base material to be printed when the base material to be printed is travelled in the backward direction.

Summary of the invention

Problems to be solved by the invention

[0005]

When effecting (performing) printing by such intermittent printing apparatus as disclosed in JP Patent Application Laid-open No.2006-247869, in which the base material to be printed is wound around the peripheral surface of the impression cylinder and the impression cylinder is rotationally driven forwardly and backwardly, the deviation in printing registration (misregistration) has been sometimes occurred, in particular, the deviation in printing registration has been frequently occurred when effecting printing using a film as the base material to be printed.

Inventers of the present invention have carried out investigation into a cause of occurrence of the deviation in printing registration and found in the followings which result in the present invention.

As the base material to be printed is wound around the peripheral surface of the impression cylinder, it is difficult to travel the base material to be printed by sliding on the peripheral surface of the impression cylinder.

As a result, the base material to be printed is travelled in the forward and backward directions by the rotation of the impression cylinder, by rotationally driving the impression cylinder forwardly and backwardly in synchronization with feeding rollers.

[0006]

Accordingly, when the base material to be printed is travelled backwardly or made a turn, as the peripheral surface of the impression cylinder is separated from the small-diameter part of the blanket cylinder, so that the base material to be printed is not in contact with the small-diameter part of the blanket cylinder, the base material to be printed is travelled only by a frictional force generated between the peripheral surface of the impression cylinder and the base material to be printed without contacting with the small-diameter part of the blanket cylinder, a slip can be caused between the peripheral surface of the impression cylinder and the base material to be printed when the frictional force is small.

When the slip is caused between the peripheral surface of the impression cylinder and the base material to be printed, as a position where a front end of the large-diameter part of the blanket cylinder in the rotational direction starts to contact with the base material to be printed may be displaced in the vertical direction at the time of printing images on the base material to be printed while the base material to be printed is travelled forwardly, the printing registration may be displaced.

Moreover, as distance of slippage is not constant but dispersed, the deviation in printing registration may be occurred.

When effecting printing using the base material to be printed having high surface smoothness, as a slip between the base material to be printed and the peripheral surface of the impression cylinder may easily be caused, the printing registration may be frequently occurred.

[0007]

When a film is used as the base material to be printed, as the film is impermeable and its density is high, air remaining between the peripheral surface of the impression cylinder and the film cannot escape from the surface of the film through the film, while the film is wound around the peripheral surface of the impression cylinder.

Furthermore, when a rotational speed of the impression cylinder (a travelling speed of the base material to be printed) is increased, air may be drawn into a gap between the peripheral surface of the impression cylinder and the film, so that an air layer can be formed.

As mentioned above, when the film is used as the base material to be printed, as the frictional force between the peripheral surface of the impression cylinder and the film is small and the slip may easily be caused, the deviation in printing registration may be frequently occurred.

[0008]

The present invention has been made to resolve the above-mentioned problems, its object is to provide an intermittent printing apparatus in which the slip is not caused between a peripheral surface of an impression cylinder and a base material to be printed and the deviation in printing registration is not occurred while the base material to be printed is travelled.

[Means for solving problems]

[0009]

The present invention relates to an intermittent printing apparatus including a sheet introducing part feeding a base material to be printed, a printing part having a plurality of printing units for printing images on the base material to be printed fed out from the sheet introducing part, and a sheet discharging part for discharging the base material to be printed on which images have been printed,

wherein the sheet introducing part has a buffer device on a sheet introducing side for storing the base material to be printed in a loop shape and a step-back roller on the sheet introducing side which is rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the material to be printed travel backwardly,

the printing units each have an impression cylinder and a blanket cylinder having an image range which is brought into contact with a peripheral surface of the impression cylinder and a non-image range which does not contact with the peripheral surface of the impression cylinder,

the sheet discharging part has a step-back roller on a sheet discharging side which is rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly and a buffer device on the sheet discharging side for storing the base material to be printed on which images have been printed in a loop shape, the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side are synchronously and rotationally driven forwardly to make the base material to be printed travel forwardly, so that an image printing is effected on the base material to be printed by the peripheral surface of the impression cylinder and the image range of the blanket cylinder, the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side are synchronously and rotationally driven backwardly to make the base material to be printed travel backwardly through a gap between the peripheral surface of the impression cylinder and the non-image range of the blanket cylinder, and

there are provided a guide roller on the sheet discharging side and a guide roller on the sheet introducing side to wind the base material to be printed passing through between the peripheral surface of the impression cylinder and the blanket cylinder on the peripheral surface of the impression cylinder at a prescribed winding angle,

there is provided a nip roller for the impression cylinder for pressing the base material to be printed wound around the peripheral surface of the impression cylinder against the peripheral surface of the impression cylinder,

the impression cylinder is rotationally driven forwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, when the base material to be printed is travelled forwardly,

the impression cylinder is rotationally driven backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, when the base material to be printed is travelled backwardly,

there are provided a drying device for drying the base material to be printed wound around the peripheral surface of the impression cylinder and a cooling device of the impression cylinder for cooling the impression cylinder, and

the drying device is located on an upstream side of the nip roller for impression cylinder in a forward rotational direction of the impression cylinder.

[0010]

In the intermittent printing apparatus of the present invention, the guide roller on the sheet introducing side and the guide roller on the sheet discharging side are provided so that an extension line of a travelling path on the sheet introducing side between the guide roller on the sheet introducing side and the impression cylinder intersects with an extension line of a travelling path on the sheet discharging side between the guide roller on the sheet discharging side and the impression cylinder.

According to such intermittent printing apparatus, it is possible that a winding angle at which the base material to be printed is wound around the peripheral surface of the impression cylinder may be more than 180 degrees, then, a frictional force between the peripheral surface of the impression cylinder and the base material to be printed can be thereby increased and a slip can be securely prevented from causing.

[0011]

In the intermittent printing apparatus of the present invention, when printing images on the base material to be printed by rotating the blanket cylinder over the image range from a print starting position, the impression cylinder is rotationally driven forwardly at a same constant speed as that of the blanket cylinder,

when the blanket cylinder is rotated over the non-image range from a print ending position, the impression cylinder is stopped its rotation after having been rotationally driven forwardly while being decelerated from the constant speed, and after having been stopped its rotation, is rotationally driven backwardly while being accelerated up to a prescribed backward rotational driving speed, then is stopped its rotation after having been rotationally driven backwardly while being decelerated from the prescribed backward rotational driving speed, after having been stopped its rotation, is rotationally driven forwardly while being accelerated up to the constant speed, so that a rear end of a print image on the base material to be printed is brought into contact with a front end of a print range of the blanket cylinder.

According to such intermittent printing apparatus, as the impression cylinder is gradually stopped its rotation and is gradually started its rotation, the slip between the base material to be printed and the peripheral surface of the impression cylinder is prevented from causing and a failure or the like in a driving system of the impression cylinder never be occurred.

[0012]

In the intermittent printing apparatus of the present invention, a curve representing a change in a rotational driving speed ratio of the impression cylinder when being rotationally driven forwardly while being decelerated is linearly symmetrical with a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven forwardly while being accelerated, a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven backwardly while being accelerated is linearly symmetrical with a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven backwardly while being decelerated, the rotational driving speed ratio of the impression cylinder from the constant speed to the prescribed backward rotational driving speed and the rotational driving speed ratio from the prescribed backward rotational driving speed to the constant speed are smoothly changed along a nearly U-shaped curve.

According to such intermittent printing apparatus, as the speed of the impression cylinder is smoothly changed and the base material to be printed is smoothly travelled in backward and forward directions by turning its directions, the slip between the base material to be printed and the peripheral surface of the impression cylinder can be prevented from causing, and the printing can be accurately effected on the base material to be printed.

[0013]

In the intermittent printing apparatus of the present invention, a registration adjusting device is provided between respective printing units, the registration adjusting device is configured to adjust the printing registration by changing a length of a travelling path of the base material to be printed between the printing units.

According to such intermittent printing apparatus, as printing registration before effecting the printing is adjusted by changing the length of the travelling path between printing units, the printing registration can be adjusted while the base material to be printed is wound around the peripheral surface of the impression cylinder.

[0014]

In the intermittent printing apparatus of the present invention, the registration adjusting device has a pull roller on the sheet introducing side, a pull roller on the sheet discharging side and a movable roller, and is configured so that a length of the travelling path between the pull roller on the sheet introducing side and the pull roller on the sheet discharging side is changed by moving the movable roller, both pull rollers are rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, and there are provided nip rollers for pull rollers for pressing the base material to be printed wound around the peripheral surface of the both pull rollers against the peripheral surfaces of the both pull rollers.

According to such intermittent printing apparatus, as the slip is prevented from causing between the peripheral surface of the pull roller on the sheet introducing side and the base material to be printed, and the slip is also prevented from causing between the peripheral surface of the pull roller on the sheet discharging side and the base material to be printed, the deviation in printing registration never be occurred owing to the registration adjusting device.

[0015]

In the intermittent printing apparatus of the present invention, a rotational speed of the step-back roller on the sheet introducing side, a rotational speed of the step-back roller on the sheet discharging side, a rotational speed of the impression cylinder of respective printing units, a rotational speed of the pull roller on the sheet introducing side of each registration adjusting device and a rotational speed of the pull roller on the sheet discharging side are separately controllable.

According to such intermittent printing apparatus, tension applied to the base material to be printed can be adjusted for each printing unit.

[0016]

In the intermittent printing apparatus of the present invention, there are provided at least two pull rollers around which the base material to be printed is wound on the travelling path of the base material to be printed between the printing units, the pull rollers are rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, and there are provided nip rollers for pull roller for pressing the base material to be printed wound around the peripheral surface of each pull roller against the peripheral surface of each pull roller.

According to such intermittent printing apparatus, the deviation and looseness in the base material to be printed travelling the travelling path between the printing units are prevented from occurring.

Furthermore, the frictional force between the peripheral surface of the pull roller and the base material to be printed is increased, the slip between them never be caused and the deviation in printing registration is prevented from occurring owing to provision of pull rollers.

[0017]

In the intermittent printing apparatus of the present invention, the base material to be printed may be a film.

According to such intermittent printing apparatus, images can be printed on the film without occurrence of the deviation in printing registration.

[0018]

According to the intermittent printing apparatus of the present invention, as the slip is not caused between the peripheral surface of the impression cylinder and the base material to be printed when the base material to be printed is travelled, the deviation in printing registration is not to be occurred.

As ink of images printed on the base material to be printed is fixed and dried by the drying device, there is no image disturbance due to contact with the nip roller for impression cylinder and the like and the nip roller for impression cylinder cannot be contaminated with adhered ink.

As the impression cylinder is cooled by the cooling device, temperatures of the impression cylinder and the base material to be printed would not be made high.

The base material to be printed can be stored in a loop shape by the buffer device on the sheet introducing side and the buffer device on the sheet discharging side, the base material to be printed can be smoothly travelled in the forward and backward directions.

Brief Description of Drawings

[0019]

Fig.1 is a front view of the whole of an intermittent printing apparatus of an embodiment of the present invention.

Fig.2 is an enlarged front view of a sheet feeding part and a sheet introducing part of the intermittent printing apparatus as shown in Fig.1.

Fig. 3 is an enlarged front view of a sheet discharging part and a post-processing part of the intermittent printing apparatus as shown in Fig.1.

Fig.4 is an enlarged front view of a part including two printing units of the intermittent printing apparatus as shown in Fig.1.

Figs.5A to 5C are views for explaining structures of a printing plate, a blanket cylinder and an impression cylinder.

Figs.6A to 6D are views for explaining an operation of a printing unit from the start of printing to the end of printing when carrying out first printing.

Figs. 7A to 7D are views for explaining an operation of the printing unit from the end of first printing to the start of second printing.

Figs. 8A to 8D are views for explaining an operation from the start of second printing to the end of printing.

Fig.9 is a diagram showing a rotation angle and a rotational driving speed ratio of the impression cylinder with respect to a rotation angle of the blanket cylinder.

Fig.10 is a diagram showing a change in the rotational driving speed of the impression cylinder.

Fig.11 is a view for explaining a printing unit to which a small-sized blanket is mounted.

Fig.12 is a diagram showing the rotation angle and the rotational driving speed ratio of the impression cylinder with respect to the rotation angle of the blanket cylinder.

Fig.13 is a view for explaining the printing unit to which a large-sized blanket is mounted.

Fig.14 is a diagram showing the rotation angle and the rotational driving speed ratio of the impression cylinder with respect to the rotation angle of the blanket cylinder.

Fig.15 is an enlarged front view of an impression cylinder part of the printing unit as shown in Fig.4.

Fig.16 is a front view of a mounting part of a nip roller for impression cylinder as shown in Fig.4.

Fig.17 is a sectional view of the mounting part of the nip roller for impression cylinder as shown in Fig.16 taken along the line A-A.

Fig.18 is a front view of a mounting part of the impression cylinder as shown in Fig.4.

Fig.19 is a sectional view of the mounting part of the impression cylinder in Fig.18 taken along the line B-B.

Fig.20 is an enlarged front view of a registration adjusting device as shown in Fig.4.

Fig.21 is a sectional view of the registration adjusting device as shown in Fig.20 taken along the line C-C.

Fig.22 is a view for explaining tension adjustment of a base material to be printed of each printing unit.

Fig.23 is a front view of a travelling path of the base material to be printed between printing units according to other embodiment.

Preferred embodiments of the Invention

[0020]

A basic structure of the whole of an intermittent printing apparatus of the present invention will be described with reference to Fig.1. Fig.1 is a front view of the whole of the intermittent printing apparatus of an embodiment of the present invention.

An intermittent printing apparatus 100 comprises a sheet feeding part 1A for feeding a base material to be printed W, a sheet introducing part 1B for feeding out the base material to be printed W fed from the sheet feeding part 1A, a printing part 2 for printing images on the base material to be printed W fed out from the sheet introducing part 1B, a sheet discharging part 3A for discharging the base material to be printed W on which images have been printed (hereinafter referred to as a base material to be printed W), and a post-processing part 3B for post-processing the base material to be printed W.

The base material to be printed W used in such intermittent printing apparatus 100 of this embodiment may be a film having a high surface smoothness and flexibility, for example, raw material for flexible packaging is used.

[0021]

In general, the flexible packaging means a general term for packaging materials using a single or laminated material which is thin and rich in flexibility such as polypropylene (PP), polyethylene (PE) and the like.

As these are film materials, they have higher surface smoothness and flexibility as compared to paper. As other similar base material to be printed W, film method synthetic paper may be also available.

[0022]

In the embodiment of the present invention, the sheet feeding part 1A is a sheet feeding device 4 for feeding the base material to be printed W which will be described later.

The sheet introducing part 1B has a buffer device 5 on a sheet introducing side for storing the base material to be printed W fed from the sheet feeding device 4 in a loop shape and a step-back roller 6 on the sheet introducing side for travelling the base material to be printed W stored in the buffer device 5 on the sheet introducing side.

The printing part 2 has a plurality of printing units, for example, 6 printing units, which are a first printing unit 2a for printing by using a color of Black(K), a second printing unit 2b for printing by using a color of Cyan(C), a third printing unit 2c for printing by using a color of Magenta (M), a fourth printing unit 2d for printing by using a color of Yellow(Y), a fifth printing unit 2e and a sixth printing unit 2f for white solid printing.

[0023]

Moreover, the first to fourth printing units 2a to 2d effect color-printing on the base material to be printed W with respective different one color.

After the completion of such color printing, white solid printing is carried out by the fifth and sixth printing units 2e, 2f.

The color printing can be visually recognized from a side opposite to a printing surface of the base material to be printed W through it. The white solid is used as a background color to improve visibility of the color printing.

Thus, as the printing part 2 has 6 printing units 2a,2b,2c,2d,2e,2f, a length of a travelling path of the base material to be printed W between step-back rollers (a distance from the step-back roller 6 on the sheet introducing side to a step-back roller 10 on a sheet discharging side which will be described later) is longer compared to that in the intermittent printing apparatus having 4 printing units as shown in JP Patent Application laid-open No. 2006-247869, the deviation in printing registration may easily be occurred.

[0024]

6 printing units 2a, 2b, 2c, 2d, 2e, 2f each have same structure and 3 cylinders which are a plate cylinder 7, a blanket cylinder 8 and an impression cylinder 9.

The sheet discharging part 3A has the step-back roller 10 on the sheet discharging side for making the base material to be printed W travel, a buffer device 11 on the sheet discharging side for storing the base material to be printed W travelled by the step-back roller 10 on the sheet discharging side in a loop shape, an automated printing registration device 38 and a monitoring device 39 which will be described later.

In the embodiment of the present invention, the post-processing part 3B is a winding device 12 for winding the base material to be printed W stored in the buffer device 11 on the sheet discharging side.

[0025]

A basic printing operation of such intermittent printing apparatus is as follows.

An image printing is carried out while travelling the base material to be printed W in a forward direction (a direction from the sheet introducing part 1B toward the sheet discharging part 3A) by rotationally driving forwardly and synchronously the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side and while the base material to be printed W is stored in a loop shape by the buffer device 5 on the sheet introducing side and the buffer device 11 on the sheet discharging side.

After the end of printing, the base material to be printed W is travelled in a backward direction (a direction from the sheet discharging part 3A toward the sheet introducing part 1B) by rotationally driving backwardly and synchronously the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side, and the image printing is carried out while the base material to be printed W is travelled in the forward direction by rotationally driving forwardly and synchronously the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side, after the rear end of printed image in the vertical direction has been adjusted so that it is positioned at a following print starting position.

Images are printed with small spaces in the vertical direction on the base material to be printed W by repeating such operations. In other words, the basic printing operation is the same as those of conventional intermittent printing apparatuses.

[0026]

As shown in Fig.2, the sheet feeding device 4 has a sheet feeding shaft 20 on which a rolled base material to be printed W is mounted, a feeding roller 21 for feeding out and delivering the base material to be printed W mounted on the sheet feeding shaft 20, a corona treating device 24 and a tension detection device 25 and a meandering preventing device 26 which will be described later. In other words, the sheet feeding device 4 includes the sheet feeding shaft 20 through the feeding roller 21.

A powder brake (not shown) is connected to the sheet feeding shaft 20 for imparting rotational resistance thereto.

The base material to be printed W fed out from the sheet feeding shaft 20 is wound around a peripheral surface of the feeding roller 21. A driving motor (not shown) is connected to the feeding roller 21, and the feeding roller 21 is rotationally driven only in a feeding direction of the base material to be printed W (clockwise direction in Fig.2) by the driving motor.

[0027]

The feeding roller 21 is not rotationally driven in a direction opposite to the feeding direction (counter-clockwise direction in Fig.2).

At least one nip roller 22 is pressed against the peripheral surface of the feeding roller 21.

The base material to be printed W is held by the nip roller 22 and the feeding roller 21 and is pulled with the feeding roller 21 rotationally driven by the driving motor, so that the rolled base material to be printed W can surely be fed out and delivered toward the buffer device 5 on the sheet introducing side by rotating the sheet feeding shaft 20. The nip roller 22 is pressed against the peripheral surface of the feeding roller 21 within a region around which the base material to be printed W is wound.

When the base material to be printed W is fed out, though the sheet feeding shaft 20 is rotated, as the rotational resistance is imparted to the sheet feeding shaft 20 by the powder brake, tensile force (tension) of a value corresponding to the rotational resistance (braking force) is induced in the base material to be printed W.

[0028]

The corona treating device 24, the tension detection device 25 and the meandering preventing device 26 are provided on a travelling path 23 of the base material to be printed W from the sheet feeding shaft 20 to the feeding roller 21.

The corona treating device 24 performs a corona treatment on the surface of the base material to be printed W. The surface of the base material to be printed W is modified by the corona treatment, so that fixing property of ink to the base material to be printed W is enhanced. As the base material to be printed W used in this embodiment is a flexible packaging material such as a film and the like, its fixing property is poor compared to paper, then, it is preferable to perform the corona treatment.

The tension detection device 25 detects tensile force applied to the base material to be printed W fed out from the sheet feeding shaft 20. A detected value of the tensile force is compared with a set value of the tensile force by a control unit (not shown). The control unit adjusts braking force of the powder brake so that the detected value of the tensile force matches the set value of the tensile force, whereby the base material to be printed W may be constantly fed out at the set value of the tensile force.

[0029]

The meandering preventing device 26 detects a position in the width direction of the base material to be printed W and move the base material to be printed W in the width direction to a prescribed position in the width direction when the position is displaced from the prescribed position. In this way, the position in the width direction of the base material to be printed W is prevented from displacing. Here, the width direction of the base material to be printed W is a direction perpendicular to the feeding direction.

The buffer device 5 on the sheet introducing side, as shown in Fig.2, has a box shaped upward recessed part 5a with an opening on top and a sucking device (not shown) for sucking air in the upward recessed part 5a, and stores the base material to be printed W in a loop shape in the upward recessed part 5a by sucking air in the upward recessed part 5a by the sucking device. Sucking force of the sucking device is controlled to provide the tensile force capable of preventing meandering of the base material to be printed W stored in the upward recessed part 5a.

Moreover, a rotational speed of the feeding roller 21 is controlled according to an output of a sensor (not shown) attached to the buffer device 5 so that a length of the base material to be printed W stored in the upward recessed part 5a falls within a prescribed range.

[0030]

The step-back roller 6 on the sheet introducing side has, as shown in Fig.2, two driving rollers 27 which are rotationally driven forwardly and backwardly by a driving motor (not shown) and at least two nip rollers 28 which are pressed against a peripheral surface of each of driving rollers 27. Two driving rollers 27 are spaced in the vertical direction.

The base material to be printed W is to be travelled in a converted S shape while being wound over two driving rollers 27 and is held by each driving roller 27 and nip roller 28 respectively. Two nip rollers 28 are each pressed against the peripheral surface of the driving roller 27 at separate positions in the rotational direction within the range of the base material to be printed W being wound around the peripheral surface of the driving roller 27.

Accordingly, the base material to be printed W can be accurately travelled in the forward and backward directions by rotationally driving the driving rollers 27 forwardly and backwardly.

[0031]

In this embodiment, the sheet feeding part 1A (the sheet feeding device 4), and the sheet introducing part 1B (the buffer device 5 on the sheet introducing side and the step-back roller 6 on the sheet introducing side) are configured as one unit, but it is not limited thereto.

For example, the sheet feeding part 1A (the sheet feeding device 4) may be configured as one unit and the sheet introducing part 1B (the buffer device 5 on the sheet introducing side and the step-back roller 6 on the sheet introducing side) may be configured as another unit. In this case, it is preferable to provide the feeding roller on the sheet feeding side of the buffer device 5 on the sheet introducing side. In other words, in the sheet feeding part 1A and the sheet introducing part 1B as shown in Fig.2, the feeding roller 21 of the sheet feeding device 4 may also serve as the feeding roller of the buffer device 5 on the sheet introducing side.

[0032]

The step-back roller 10 on the sheet discharging side has, as shown in Fig.3, two driving rollers 30 which are rotationally driven forwardly and backwardly by a driving motor (not shown) and at least two nip rollers 31 which are pressed against a peripheral surface of each of driving rollers 30. Two driving rollers 30 are spaced in the vertical direction.

The base material to be printed W is to be travelled in a converted S shape while being wound over two driving rollers 30 and is held by each driving roller 30 and nip rollers 31 respectively. Two nip rollers 31 are each pressed against the peripheral surface of the driving roller 30 at separate positions in the rotational direction within the range of the base material to be printed W being wound around the peripheral surface of the driving roller 30.

Accordingly, the base material to be printed W can be accurately travelled in the forward and backward directions by rotationally driving the driving rollers 30 forwardly and backwardly.

The step-back roller 10 on the sheet discharging side (driving rollers 30) and the step-back roller 6 on the sheet introducing side (driving rollers 27) are rotationally driven forwardly and backwardly in synchronization with each other.

[0033]

The buffer device 11 on the sheet discharging side has a box shaped upward recessed part 11a with an opening on top and a sucking device (not shown) for sucking air in the upward recessed part 11a, and a feeding roller 33 for feeding the base material to be printed W to the post-processing part 3B, and stores the base material to be printed W in a loop shape in the upward recessed part 11a by sucking air in the upward recessed part 11a by the sucking device.

Sucking force of the sucking device is controlled to provide the tensile force capable of preventing meandering of the base material to be printed W stored in the upward recessed part 11a.

Moreover, a rotational speed of the feeding roller 33 is controlled according to an output of a sensor (not shown) attached to the buffer device 11 so that a length of the base material to be printed W stored in the upward recessed part 11a falls within a prescribed range.

[0034]

The base material to be printed W fed out from the buffer device 11 on the sheet discharging side is wound around a peripheral surface of the feeding roller 33. A driving motor (not shown) is connected to the feeding roller 33, and the feeding roller 33 is rotationally driven only in a feeding direction of the base material to be printed W toward the post-processing part 3B (clockwise direction in Fig.3), and is not rotated in a direction opposite to the feeding direction toward the post-processing part 3B (counter-clockwise direction in Fig.3).

At least two nip rollers 34 are pressed against the peripheral surface of the feeding roller 33. The base material to be printed W is held by the nip rollers 34 and the feeding roller 33 and is pulled with the feeding roller 33 rotationally driven by the driving motor, so that the base material to be printed W can surely be fed toward the post-processing part 3B.

The two nip rollers 34 are pressed against the peripheral surface of the feeding roller 33 at separated positions in the rotational direction within the region around which the base material to be printed W is wound.

[0035]

The automated printing registration device 38 for detecting the deviation in printing registration and the monitoring device 39 are provided on a travelling path 37 of the base material to be printed W between the step-back roller 10 on the sheet discharging side and the printing part 2 (sixth printing unit 2f). The automated printing registration device 38 is located on a side of the printing part 2, and the monitoring device 39 is located on a side of the step-back roller 10 on the sheet discharging side.

The automated printing registration device 38 reads dots printed on the base material to be printed W by respective printing units 2a to 2f, and finds displacement of the printing registration

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of respective printing units 2a to 2f by measuring a pitch between dots and performs a fine adjustment of the printing registration during printing operation. The fine adjustment of the printing registration by the automated printing registration device 38 is automatically performed by controlling respective printing units 2a to 2f based on preset printing apparatus information.

[0036]

The monitoring device 39 has a camera unit 39a taking photograph of printed images on the base material to be printed W and a monitor for displaying photographed images as video (not shown).

The camera unit 39a takes photograph of printing registration marks of respective colors printed on the base material to be printed W by respective printing units 2a to 2f, and photographed images are displayed as video on the monitor. As an operator can recognize by watching the video on the monitor that, in which printing unit, the printing registration is deviated in the top and bottom direction (vertical direction) and in the width direction, he can manually correct deviation in printing registration in top and bottom direction and in the width direction.

[0037]

It is configured that the printing registration in the vertical direction and the printing registration in the width direction are adjusted by driving a driving motor (not shown) for rotationally driving the plate cylinder 7 and the blanket cylinder 8 as shown in Fig.1 and a driving motor (not shown) for moving the plate cylinder 7 in the width direction.

Therefore, the printing registration in the vertical direction and the printing registration in the width direction are adjusted through an automated control of the respective driving motors by the automated printing registration device 38 and through an operational control of the respective driving motors by the operator based on a result of the monitoring device 39.

[0038]

The winding device 12 has, as shown in Fig.3, a winding shaft 32 for winding the base material to be printed W and a tension detection device 36 described later.

The winding shaft 32 is connected to a driving motor (not shown) at one end thereof so that it is rotationally driven only in the winding direction (clockwise direction in Fig.3) by the driving motor and is not rotated in a direction opposite to the winding direction (counter-clockwise direction in Fig.3).

On a travelling path 35 of the base material to be printed W from the feeding roller 33 to the winding shaft 32, the tension detection device 36 for detecting tension of the base material to be printed W travelling on the travelling path 35 is provided.

A detected tension value which is detected by the tension detection device 36 is compared with a tension value preset in a control unit (not shown), and rotational speeds of the winding shaft 32 and the feeding roller 33 are controlled so that the detected tension value may be the preset tension value.

[0039]

In other words, by making the rotational speed of the winding shaft 32 faster than the rotational speed of the feeding roller 33, the tension is generated in the base material to be printed W travelling on the travelling path 35, and as a magnitude of the tension is determined corresponding to a difference between rotational speeds of the feeding roller 33 and the winding shaft 32, the detected tension value may be matched with the preset tension value by changing rotational speed difference.

The post-processing part 3B is not limited to the winding device 12.

For example, a processing device for processing the base material to be printed W, an unit for transporting the base material to be printed W to another device provided on a downstream side, and a delivery unit and the like may be available as the post-processing part 3B.

[0040]

The printing units 2a to 2f will be described with reference to Fig.4. Fig.4 is an enlarged front view of a part including two printing units 2a, 2b of the intermittent printing apparatus as shown in Fig.1.

While the plate cylinder 7, the blanket cylinder 8, the impression cylinder 9 and respective members described below are provided within a machine frame 2A of the printing units, respective cylinders and respective members are indicated by solid lines to facilitate understanding.

The plate cylinder 7 and the blanket cylinder 8 are rotationally driven synchronously in opposite directions (directions of arrow in Fig.4) by one driving motor (not shown).

The impression cylinder 9 is rotationally driven forwardly and backwardly by a driving motor for driving the impression cylinder described below in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side.

[0041]

Structures of the plate cylinder 7, the blanket cylinder 8 and the impression cylinder 9 will be described with reference to Figs.5A to 5C. As shown in Figs. 5A to 5C, a printing plate 7a which is shorter than the whole peripheral length (a length of the peripheral surface in the peripheral direction) of the plate cylinder 7 is mounted on a peripheral surface of the plate cylinder 7. To the printing plate 7a of the plate cylinder 7, ink is supplied from an ink supplying device (not shown) provided adjacent to the plate cylinder 7.

A blanket 8a which is shorter than the whole peripheral length of the blanket cylinder 8 is mounted on a peripheral surface of the blanket cylinder 8.

As shown in Fig.5A, the plate cylinder 7 and the blanket cylinder 8 are configured so that the printing plate 7a and the blanket 8a are brought into contact with each other so as to transfer images on the printing plate 7a to the blanket 8a, a part of the peripheral surface of the plate cylinder 7 on which the printing plate 7a is not mounted and the blanket 8a of the blanket cylinder 8 never be brought into contact.

[0042]

As shown in Fig.5B, the blanket cylinder 8 and the impression cylinder 9 are configured so that the blanket 8a and the peripheral surface of the impression cylinder 9 are brought into contact with each other through the base material to be printed W to print images of the blanket 8a on the base material to be printed W. In other words, the blanket 8a is an image range of the blanket cylinder 8.

As shown in Fig.5C, the part of the peripheral surface of the blanket cylinder 8 on which the blanket 8a is not mounted never contact with the peripheral surface of the impression cylinder 9. In other words, the part of the peripheral surface of the blanket cylinder 8 on which the blanket 8a is not mounted is a non-image range of the blanket cylinder 8.

[0043]

An intermittent printing operation of the intermittent printing apparatus 100 according to an embodiment of the present invention will be described with reference to Figs. 6A to 6D, Figs. 7A to 7D and Figs. 8A to 8D.

In the embodiment, a length in the peripheral direction of the plate cylinder 7, a length in the peripheral direction of the blanket cylinder 8 and a length in the peripheral direction of the impression cylinder 9 are identical.

The plate cylinder 7 and the blanket cylinder 8 are continuously and rotationally driven at the same speed in opposite directions with each other (the plate cylinder 7 is rotationally driven in the clockwise direction and the blanket cylinder 8 is rotationally driven in the counter-clockwise direction) as indicated by solid arrows during the intermittent printing operation.

The impression cylinder 9 makes the base material to be printed W travel in the forward direction as indicated by a solid arrow, when being rotated in the clockwise direction as indicated by the solid arrow, in other words when being rotationally driven forwardly, and makes the base material to be printed W travel in the backward direction as indicated by a dotted arrow, when being rotated in the counter-clockwise direction as indicated by the dotted arrow, in other words when being rotationally driven backwardly. At this time, the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side which are not shown in Figs.6A to 6D, Figs.7A to 7D and Figs.8A to 8D are rotationally driven forwardly and backwardly in synchronization with the impression cylinder 9.

[0044]

An operation from the start to the end of printing at first printing (printing of the first page) will be described with reference to Figs.6A to 6D.

Figs.6A to 6D show changes in rotation angles of the blanket cylinder 8 and the impression cylinder 9 from the start to the end of first printing in time-series order.

As shown in Fig. 6A, the base material to be printed W is travelled in the forward direction when the impression cylinder 9 is rotationally driven forwardly, so that the base material to be printed W being in contact with the peripheral surface of the impression cylinder 9 is brought into contact with a front end 8a-1 of the blanket 8a and printing of images of the blanket 8a onto the base material to be printed W is started. The front end 8a-1 of the blanket 8a is an end on a downstream side in a rotational direction of the blanket 8a.

[0045]

From such state, the impression cylinder 9 is rotationally driven forwardly at the same constant speed as that of the blanket cylinder 8, and as shown in Fig. 6B, the first image of the blanket 8a is sequentially printed on the base material to be printed W while the blanket cylinder 8 and the impression cylinder 9 are rotationally driven. As shown in Fig. 6C, the first printing is completed when a rear end 8a-2 of the blanket 8a is brought into contact with the base material to be printed W being in contact with the peripheral surface of the impression cylinder 9.

The rear end 8a-2 of the blanket 8a is an end on an upstream side in the rotational direction of the blanket 8a.

In other words, images of the blanket 8a are firstly printed on the base material to be printed W by bringing the blanket 8a into contact with the base material to be printed W, while the step-back roller 6 on the sheet introducing side, the step-back roller 10 on the sheet discharging side and the impression cylinder 9 are rotationally driven forwardly in synchronization one another at a constant speed such that the base material to be printed W is travelled in the forward direction at a constant speed.

A rotation angle α of the blanket cylinder 8 is an angle formed by a straight line b connecting the rotation center 8b of the blanket cylinder 8 and the rotation center 9c of the impression cylinder 9 and the rear end 8a-2 of the blanket 8a, it is assumed that an angular position of the straight line b at the end of printing is 0 degree and a forward direction is positive. A rotation angle β of the impression cylinder 9 is an angle formed by the straight line b and a rear end G-1 of a print image G printed on the base material to be printed W, it is assumed that an angular position of the straight line b at the end of printing is 0 degree, and a forward direction is positive. In other words, at the end of printing in Fig.6C, $\alpha=0$ and $\beta=0$, and α, β are increased as the blanket cylinder 8 and the impression cylinder 9 are rotationally driven forwardly respectively from the state in which printing is ended.

[0046]

A length of the first print image G printed on the base material to be printed W (a distance from the rear end G-1 to a front end G-2 of the print image G), that is, a print range of 1 page is matched with a size of the blanket 8a (a distance from the front end 8a-1 to the rear end 8a-2 of the blanket 8a). The rear end G-1 of the print image G is an end on the upstream side of the impression cylinder 9 in a forward rotational direction. The front end G-2 of the print image G is an end on the downstream side of the impression cylinder 9 in the forward rotational direction.

At the end of printing, a rotation angle of the blanket cylinder 8 from the straight line *b* of the blanket cylinder 8 to the front end 8a-1 of the blanket 8a is a first rotation angle α-1 of the blanket cylinder, a rotation angle of the impression cylinder 9 from the straight line *b* of the impression cylinder 9 to the front end G-2 of the print image G is a first rotation angle β-1 of the impression cylinder. As rotation driving speeds of the blanket cylinder 8 and the impression cylinder 9 are same and the size of the blanket 8a and the length of print image G are same, α-1 and β-1 are the same angle.

It is noted that, while the print image G is printed on the surface of the base material to be printed W, in Figs.6A to 6D, it is shown as being inside the peripheral surface of the impression cylinder 9 for facilitating understanding. In both Figs.7A to 7D Figs.8A to 8D as described later, the print image is also shown as being inside the peripheral surface of the impression cylinder 9 for facilitating understanding.

[0047]

As the impression cylinder 9 is rotationally driven forwardly at a constant speed at the end of printing as shown in Fig.6C, after the end of printing, the impression cylinder 9 is rotationally driven forwardly while being decelerated so that rotation of the impression cylinder 9 may be decelerated and gradually stopped, whereby the slip between the base material to be printed W and the peripheral surface of the impression cylinder 9 may be prevented from causing and failure of a driving system of the impression cylinder 9 etc. may also be prevented from occurring. In other words, if the impression cylinder 9 is suddenly stopped while rotating by being rotationally driven forwardly at a constant speed, the slip between the base material to be printed W and the peripheral surface of the impression cylinder 9 may be caused, and an excessive force can be applied to the driving system of the impression cylinder 9 etc. which can result in the failure of it.

As the rotation of the impression cylinder 9 is gradually stopped after the end of printing, the rotation of the impression cylinder 9 is stopped at an angular position which is a forwardly rotated position by a prescribed rotation angle as shown in Fig.6D from a position at the end of printing as shown in Fig.6C. In other words, the rotation angle β of the impression cylinder 9 at the rotation stopping position is a second rotation angle β-2 of the impression cylinder.

[0048]

The rotation angle α of the blanket cylinder 8 is, as shown in Fig.6D, a second rotation angle α-2 of the blanket cylinder, while the impression cylinder 9 is at a standstill.

The second rotation angle α-2 of the blanket cylinder is larger than the second rotation angle β-2 of the impression cylinder. In other words, the blanket cylinder 8 is rotationally driven at a constant speed even after completion of printing, whereas the impression cylinder 9 is rotationally driven forwardly while being decelerated after the completion of printing, therefore, $\alpha\text{-}2>\beta\text{-}2$.

When the impression cylinder 9 is rotationally driven forwardly while being decelerated in the range from a position at the end of printing ($\beta=0$) to a position corresponding to the second rotation angle β-2 of the impression cylinder, as the base material to be printed W is separated from the blanket 8a and the base material to be printed W is not held between the impression cylinder 9 and the blanket cylinder 8, the slip is easily caused between the peripheral surface of the impression cylinder 9 and the base material to be printed W.

[0049]

An operation until starting of second printing (printing of the second page) after completion of the first printing will be described with reference to Figs.7A to 7D.

Figs.7A to 7D show a change in rotation angles of the blanket cylinder 8 and the impression cylinder 9 in time-series order until starting of the second printing after the rotation of the impression cylinder 9 is stopped.

As shown in Fig.7A, the impression cylinder 9 which is stopped rotation after the completion of the first printing is rotationally driven backwardly while being accelerated as indicated by a dotted arrow, so that the base material to be printed W is travelled in the backward direction as indicated by a dotted arrow.

As shown in Fig.7B, the impression cylinder 9 is configured to reach to a prescribed backward rotational driving speed when it is rotationally driven backwardly by the second rotation angle ß-2 of the impression cylinder and the rear end G-1 of the first print image G printed on the base material to be printed W is moved to a position (ß=0) at the end of printing. The prescribed backward rotational driving speed is the fastest backward rotational driving speed and is slower than the constant speed during printing.

[0050]

The rotation angle α of the blanket cylinder 8 in the state as shown in Fig.7B is the third rotation angle α-3 of the blanket cylinder, that is, α-3>α-2.

Thereafter, the impression cylinder 9 is rotationally driven backwardly while being decelerated and the rotation of the impression cylinder 9 is gradually stopped. As shown in Fig.7C, in the state in which the rotation of the impression cylinder 9 is stopped, the impression cylinder 9 is at a rotation position displaced toward the sheet introducing side from the rotation position at the end of printing (ß=0) by the third rotation angle ß-3 of the impression cylinder.

A magnitude of the third rotation angle ß-3 of the impression cylinder is the same as that of the second rotation angle ß-2 of the impression cylinder, that is ß-3 = ß-2.

The blanket cylinder 8 is rotated so that its rotation angle α becomes a fourth rotation angle α-4 (α-4>α-3) of the blanket cylinder, where the front end 8a-1 of the blanket 8a approaches a print starting position of the impression cylinder 9. An angle

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formed by the front end 8a-1of the blanket 8a and the straight line *b* is a fifth rotation angle α-5 of the blanket cylinder, that is α-5 > β-3, where α-5 = 360 degrees-(α-1+α-4). As the rotation of the impression cylinder 9 is gradually stopped, the slip between the base material to be printed W and the peripheral surface of the impression cylinder 9 can be prevented from causing and failure etc. is not occurred in the driving system of the impression cylinder 9.

[0051]

It is noted that the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side are rotationally driven like the impression cylinder 9.

As the base material to be printed W is, as shown in from Fig.7A through Fig.7C, travelled toward the sheet introducing part 1B side (travelled in the backward direction) through a gap between the part of the peripheral surface of the blanket cylinder 8 on which the blanket 8a is not mounted and the peripheral surface of the impression cylinder 9 and the base material to be printed W is not held by the impression cylinder 9 and the blanket cylinder 8, the slip may be easily caused between the peripheral surface of the impression cylinder 9 and the base material to be printed W when being travelled in the backward direction.

[0052]

As shown in Fig.7C, the impression cylinder 9 is rotationally driven forwardly and accelerated from a state in which the impression cylinder 9 is stopped rotation, the impression cylinder 9 is thereby gradually rotationally driven forwardly so that the base material to be printed W is travelled in the forward direction.

And, when the impression cylinder 9 is rotationally driven forwardly by the third rotation angle β-3 of the impression cylinder, as shown in Fig.7D, the rear end G-1 of the print image G is brought into contact with the front end 8a-1 of the blanket 8a (β-0).

In such state, the second printing is started while the impression cylinder 9 is rotationally driven forwardly at the same constant speed as that of the blanket cylinder 8. It is noted that the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side are rotationally driven like the impression cylinder 9.

As the impression cylinder 9 starts to be rotated gradually, the slip between the base material to be printed W and the peripheral surface of the impression cylinder 9 can be prevented from causing and failure etc. is not occurred in the driving system of the impression cylinder 9.

Therefore, the blanket cylinder 8 is rotated one round (360 degrees) when carrying out the first printing. The impression cylinder 9 is forwardly rotated by just an angle according to a size of rotation of the blanket 8a (image range) during printing while the blanket cylinder 8 is rotated one round.

[0053]

In a period from when the impression cylinder 9 is stopped rotation after having been rotationally driven backwardly while being decelerated as shown in Fig.7C to when the impression cylinder 9 is rotationally driven in the forward direction until starting of printing as shown in Fig.7D after having been rotationally driven forwardly while being accelerated again, as the base material to be printed W and the blanket 8a are separated each other and the base material to be printed W is not thereby held by the impression cylinder 9 and the blanket cylinder 8, the slip between the peripheral surface of the impression cylinder 9 and the base material to be printed W is easily caused.

In other words, the operation from the end of the first printing to the start of the second printing is to travel the base material to be printed W forwardly and backwardly so that the rear end G-1 of the print image G may be at a second print starting position, by rotationally driving synchronously the step-back roller 6 on the sheet introducing side, the step-back roller 10 on the sheet discharging side and the impression cylinder 9 backwardly while being accelerated, backwardly while being decelerated or forwardly while being accelerated, after the rotation of the impression cylinder 9 is stopped at the end of the first printing.

[0054]

An operation from the start of printing to the end of printing when carrying out the second printing (printing of the second page) will be described with reference to Figs.8A to 8D.

Figs.8A to 8D show a change in rotation angles of the blanket cylinder 8 and the impression cylinder 9 from the start of second printing to the end of second printing in time-series order.

As shown in Fig.8A, the impression cylinder 9 and the blanket cylinder 8 are rotationally driven forwardly at the same constant speed while the rear end G-1 of the first print image G and the front end 8a-1 of the blanket 8a are in contact with each other so as to start the second printing. As shown in Fig.8B, a front end H-2 of a second print image H is continuous to the rear end G-1 of the first print image G.

When the impression cylinder 9 is rotationally driven forwardly by the first rotation angle β-1 of the impression cylinder as shown in Fig.8C, a rear end H-1 of the second print image H is matched with the rear end 8a-2 of the blanket 8a and the second printing is finished.

[0055]

From such state, the impression cylinder 9 is rotationally driven forwardly while being decelerated as shown in Fig.8D, the impression cylinder 9 is thereby rotated by the second rotation angle β-2 of the impression cylinder and stopped rotation. In other words, the second printing is carried out in the same way as the first printing.

The third and the following printings are carried out in the same way as the second printing.

[0056]

Based on Fig.9, there will be described the rotation angle and a rotational driving speed ratio and of the impression cylinder 9 with respect to the rotation angle of the blanket cylinder 8, in a period from when the printing is finished to when the printing is finished again after having been started, that is, the period for carrying out one printing operation.

Fig.9 is a diagram (graph) showing the rotation angle and the rotational driving speed ratio of the impression cylinder 9 with respect to the rotation angle of the blanket cylinder 8, the horizontal axis indicates the rotation angle of the blanket cylinder 8 by 0 to 360 degrees for one printing operation. In other words, the horizontal axis indicates the rotation angle α. The vertical axis indicates the rotation angle of the impression cylinder 9 and the

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rotational driving speed ratio of the impression cylinder 9, it is assumed that the rotation angles at the start and the end of printing of the impression cylinder 9 are 0 degree respectively, the rotation angle is shown with plus when being rotationally driven forwardly and with minus when being rotationally driven backwardly. In other words, the rotation angle of the impression cylinder 9 on the vertical axis is the rotation angle β. It is assumed that the rotational driving speed ratio is 100% for the speed during printing and 0% when the rotation of the impression cylinder 9 is stopped.

[0057]

The change in the rotational driving speed ratio of the impression cylinder 9 is indicated by a solid line X and the rotation angle of the impression cylinder 9 is indicated by a solid line Y.

A section 1 in Fig.9 shows a section from the end of printing in Fig.6C, Fig.8C to the stop of the rotation of the impression cylinder 9 in Fig.6D, Fig.8D.

In the section 1, the rotational driving speed ratio of the impression cylinder 9 is smoothly changed from a constant speed (100%) during printing to 0% when the rotation of the impression cylinder 9 is stopped as indicated by the solid line X. The rotation angle of the impression cylinder 9 is smoothly changed from 0 degree to the second rotation angle β-2 of the impression cylinder as indicated by the solid line Y.

The rotation angle of the blanket cylinder 8 is changed from 0 degree to the second rotation angle α-2 of the blanket cylinder.

[0058]

A section 2 in Fig.9 shows a section until the speed of the

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impression cylinder 9 in Figs.7A, B has reached to a prescribed backward rotational driving speed by rotationally driving the impression cylinder 9 backwardly while being accelerated.

In the section 2, the rotational driving speed ratio of the impression cylinder 9 is smoothly changed from 0% to the rotational driving speed ratio at the prescribed backward rotational driving speed as indicated by the solid line X. The rotation angle of the impression cylinder 9 is smoothly changed from the second rotation angle β-2 of the impression cylinder to 0 degree as indicated by the solid line Y.

The rotation angle of the blanket cylinder 8 is changed from the second rotation angle α-2 of the blanket cylinder to the third rotation angle α-3 of the blanket cylinder.

A magnitude of change in the rotation angle of the blanket cylinder 8 is bigger in the section 2 than in the section 1, this is because that the change in the rotational driving speed ratio of the impression cylinder 9 is more gradual in the section 2 than in the section 1.

[0059]

A section 3 in Fig.9 shows a section until the rotation of the impression cylinder 9 in Figs.7B, C has been stopped by rotationally driving it backwardly while being decelerated.

In the section 3, the rotational driving speed ratio of the impression cylinder 9 is smoothly changed from the rotational driving speed ratio at the prescribed backward rotational driving speed to 0% as indicated by the solid line X.

The rotation angle of the impression cylinder 9 is smoothly changed from 0 degree to the third rotation angle β-3 of the impression cylinder as indicated by the solid line Y.

The rotation angle of the blanket cylinder 8 is changed up to the fourth rotation angle α-4 of the blanket cylinder.

A section 4 in Fig.9 shows a section until the impression cylinder 9 in Figs.7C, D has reached a print starting position at a constant printing speed after having been rotationally driven forwardly while being accelerated.

[0060]

In the section 4, the rotational driving speed ratio of the impression cylinder 9 is smoothly changed from 0% to 100% during printing where the speed is a constant forward rotational driving speed as indicated by the solid line X. The rotation angle of the impression cylinder 9 is smoothly changed from the third rotation angle β-3 of the impression cylinder to 0 degree as indicated by the solid line Y.

The rotation angle of the blanket cylinder 8 is changed up to the sum of the fourth rotation angle α-4 of the blanket cylinder and the fifth rotation angle α-5 of the blanket cylinder.

The magnitude of change in the rotation angle of the blanket cylinder 8 is bigger in the section 3 than in the section 4, this is because the change in the rotational driving speed ratio of the impression cylinder is more gradual in the section 3 than in the section 4. The section 1 to section 4 are each a non-printing range.

A section 5 in Fig.9 shows a section during printing, where the rotational driving speed ratio of the impression cylinder 9 is 100% as indicated by the solid line X, the rotation angle of the impression cylinder 9 is linearly changed from 0 degree to the first rotation angle β-1 of the impression cylinder as indicated by the solid line Y. The section 5 is a printing range.

[0061]

A curve representing the change in the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly while being decelerated in the section 1 and a curve representing the change in the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly while being accelerated in the section 4 are symmetrical with a symmetrical line.

A curve representing the change in the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly while being accelerated in the section 2 and a curve representing the change in the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly while being decelerated in the section 3 are symmetrical with a symmetrical line.

Moreover, the rotational driving speed ratio of the impression cylinder 9 from the constant speed to the prescribed backward rotational driving speed and the rotational driving speed ratio from the prescribed backward rotational driving speed to the constant speed are smoothly changed along nearly U-shaped curves respectively.

[0062]

Fig.10 is a diagram showing change in the rotational driving speed of the impression cylinder in a case of two different printing speeds of rotational driving speed of the impression cylinder 9 with respect to the rotation angle of the blanket cylinder 8. As the speed change from the constant speed of the impression cylinder 9 during

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printing to the prescribed backward rotational driving speed and the speed change from the prescribed backward rotational driving speed to the constant speed during printing are smoothly occurred along the nearly U-shaped curves irrespective of the printing speeds. Moreover, as the speed of the impression cylinder 9 is smoothly changed and the base material to be printed W is smoothly travelled to turn in backward and forward directions, the slip between the base material to be printed W and the peripheral surface of the impression cylinder 9 can be prevented from causing, and the printing can be accurately effected on the base material to be printed W.

[0063]

As shown in Fig.11, when printing is carried out by rotationally driving the impression cylinder 9 as in the preceding embodiment, if a small sized blanket 8a is mounted on the blanket cylinder 8, the fifth rotation angle α-5 of the blanket cylinder formed by the front end 8a-1 of the blanket 8a and the straight line *b* becomes larger than the angle shown in Fig.7C, when the impression cylinder 9 is stopped rotation after having been rotationally driven backwardly while being accelerated and rotationally driven backwardly while being decelerated after the end of printing.

Therefore, as the rear end G-1 of the print image G and the front end 8a-1 of the blanket 8a are not brought into contact with each other at the start of printing by rotationally driving the impression cylinder 9 forwardly while being accelerated, correct printing cannot be carried out.

[0064]

In other words, while the change in the rotational driving speed ratio of the impression cylinder 9 is indicated by the solid line X and the rotation angle of the impression cylinder 9 is indicated by the solid line Y in Fig.12 like in Fig.9, as the size of the blanket 8a is smaller, then the rotation angle of the blanket cylinder 8 during printing in section 5 is smaller and the rotation angle of the blanket cylinder 8 until the start of printing after the end of printing is larger, correct printing cannot be carried out by rotationally driving the impression cylinder 9 in the same manner as in the preceding embodiment.

Therefore, as shown in Fig.12, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly and decelerated in the section 1, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly and accelerated in the section 2, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly and decelerated in section 3, and the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly and accelerated in section 4 are changed respectively, so that the rear end G-1 of the print image G is brought into contact with the front end 8a-1 of the blanket 8a at the print starting position. In other words, when the blanket 8a is smaller, the second rotation angle β-2 of the impression cylinder and the third rotation angle β-3 of the impression cylinder are made larger depending on the enlarged fifth rotation angle α-5 of the blanket cylinder.

[0065]

As shown in Fig.13, when printing is carried out by rotationally driving the impression cylinder 9 as in the preceding embodiment, if a large sized blanket 8a is mounted on the blanket cylinder 8, the fifth rotation angle α-5 of the blanket cylinder formed by the front end 8a-1 of the blanket 8a and the straight line *b* becomes smaller than the angle shown in Fig.7 C, when the impression cylinder 9 is stopped rotation after having been rotationally driven backwardly while being accelerated and rotationally driven backwardly while being decelerated after the end of printing.

Therefore, as the rear end G-1 of the print image G and the front end 8a-1 of the blanket 8a are not brought into contact with each other at the start of printing by rotationally driving the impression cylinder 9 forwardly while being accelerated, correct printing cannot be carried out.

[0066]

In other words, while the change in the rotational driving speed ratio of the impression cylinder 9 is indicated by the solid line X in Fig.14 like in Fig.9 and the rotation angle of the impression cylinder 9 is indicated by the solid line Y, as the size of the blanket 8a is larger, then the rotation angle of the blanket cylinder 8 during printing in the section 5 is larger and the rotation angle of the blanket cylinder 8 until the start of printing after the end of printing is smaller, correct printing cannot be carried out by rotationally driving the impression cylinder 9 in the same manner as in the preceding embodiment.

Therefore, as shown in Fig.14, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly and decelerated in the section 1, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly and accelerated in the section 2, the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven backwardly and decelerated in the section 3, and the rotational driving speed ratio of the impression cylinder 9 when being rotationally driven forwardly and accelerated in the section 4 are changed respectively, so that the rear end G-1 of the print image G is brought into contact with the front end 8a-1 of the blanket 8a at the print starting position. In other words, when the blanket 8a is larger, the second rotation angle β-2 of the impression cylinder and the third rotation angle β-3 of the impression cylinder are made smaller depending on the reduced fifth rotation angle α-5 of the blanket cylinder.

[0067]

For changing the number of print pages per unit time by changing printing speed, it is enough to change the acceleration in forward and backward driving rotation of the impression cylinder 9 without changing the rotation angle of the blanket cylinder 8 at the time when the impression cylinder 9 starts to be decelerated from a constant speed and at the time when it reaches to the constant speed.

For example, as shown in Fig.10, for making a printing speed indicated by a dotted line slower than that indicated by a solid line, the acceleration of the impression cylinder 9 when being rotationally driven forwardly and backwardly is decreased, without changing the rotation angle of the blanket cylinder 8 when the impression cylinder 9 starts to be decelerated from the constant speed and the rotation angle of the blanket cylinder 8 when the

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impression cylinder 9 reaches to the constant speed.

[0068]

Next, a structure to wind the base material to be printed W around the peripheral surface of the impression cylinder 9 will be described.

The base material to be printed W is, as shown in Fig.4, extended from a travelling path 15a on the sheet introducing side to a travelling path 15b on the sheet discharging side via the peripheral surface of the impression cylinder 9 around which it is wound.

The travelling path 15a on the sheet introducing side is a travelling path on the upstream side in the travelling direction when the base material to be printed W is forwardly travelled and a travelling path on the downstream side in the travelling direction when the base material to be printed W is backwardly travelled.

The travelling path 15b on the sheet discharging side is a travelling path on the downstream side in the travelling direction when the base material to be printed W is forwardly travelled and a travelling path on the upstream side in the travelling direction when the base material to be printed W is backwardly travelled.

The base material to be printed W having been travelled between the blanket cylinder 8 and the impression cylinder 9 is wound around the peripheral surface of the impression cylinder 9 at a prescribed winding angle by a guide roller 40 on the sheet introducing side and a guide roller 41 on the sheet discharging side.

[0069]

The guide roller 40 on the sheet introducing side is provided on the travelling path 15a on the sheet introducing side.

The guide roller 41 on the sheet discharging side is provided on the travelling path 15b on the sheet discharging side.

The winding angle of the base material to be printed W on the peripheral surface of the impression cylinder 9 may be changed by changing at least one of positions of a guide roller 40 on the sheet introducing side and the guide roller 41 on the sheet discharging side.

The guide roller 40 on the sheet introducing side and the guide roller 41 on the sheet discharging side are rollers which are freely rotatable and not rotationally driven by a driving motor and the like.

[0070]

As shown in Fig.15, the guide roller 40 on the sheet introducing side is provided at a position closer than the impression cylinder 9 to the sheet introducing part 1B.

A position 40a at which the peripheral surface of the guide roller 40 on the sheet introducing side and the base material to be printed W are in contact with each other is located lower than a position 9a on a peripheral surface of the impression cylinder 9 at which the base material to be printed W in contact with the blanket 8a of the blanket cylinder 8 (hereinafter referred to as a printing position), the base material to be printed W having been travelled on the travelling path 15a on the sheet introducing side is obliquely travelled between a lower part of the peripheral surface of the guide roller 40 on the sheet introducing side and an upper part of the peripheral surface of the impression cylinder 9, so that the position 40a where it is in contact with the guide roller 40 on the sheet introducing side is located to be lower than a position where it starts to contact with the peripheral surface of the impression cylinder 9.

Therefore, a wind starting position 16a on the sheet introducing side from where the base material to be printed W being travelled on the travelling path 15a on the sheet introducing side starts to be wound around the peripheral surface of the impression cylinder 9 (a position on the sheet introducing side where it starts to contact with the peripheral surface of the impression cylinder 9) is located closer than a printing position 9a of the impression cylinder 9 to the sheet introducing side and lower than the printing position 9a.

[0071]

The guide roller 41 on the sheet discharging side is provided at a position closer than the impression cylinder 9 to the sheet introducing part 1B and provided at a position in proximity of the travelling path 15a on the sheet introducing side. A position 41a on the impression cylinder 9 side where the peripheral surface of the guide roller 41 on the sheet discharging side and the base material to be printed W start to contact with each other is located upper than a lower position 9b on the peripheral surface of the impression cylinder 9, the base material to be printed W having been travelled on the impression cylinder 9 side of the guide roller 41 on the sheet discharging side in the direction of the travelling path 15b on the discharging side is obliquely travelled between a lower part of the peripheral surface of the impression cylinder 9 and an upper part of the peripheral surface of the guide roller 41 on the sheet discharging side, so that the position where it starts to contact with the peripheral surface of the impression cylinder 9 is located to be lower than the position 41a where it starts to contact with the guide roller 41 on the sheet discharging side. The lower position 9b of the peripheral surface of the impression cylinder 9 is an intersection between the straight line *a* extending through the center 9c of the impression cylinder 9 and the printing position 9a and the lower part of the peripheral surface of the impression cylinder 9.

Therefore, a wind starting position 16b on the sheet discharging side where the base material to be printed W being travelled on the travelling path 15b on the sheet discharging side starts to be wound around the peripheral surface of the impression cylinder 9 (a position on the sheet discharging side where the base material to be printed W starts to be in contact with the peripheral surface of the impression cylinder 9) is located closer than the lower position 9b of the peripheral surface of the impression cylinder 9 to the sheet introducing side and is higher than the lower position 9b.

[0072]

In other words, a straight line connecting the position 40a at which the base material to be printed W contacts with the peripheral surface of the guide roller 40 on the sheet introducing side and the wind starting position 16a on the sheet introducing side on the peripheral surface of the impression cylinder 9 (an extended line of the travelling path 15a on the sheet introducing side between the guide roller 40 on the sheet introducing side and the impression cylinder 9) and a straight line connecting the position 41a at which the base material to be printed W contacts

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with the peripheral surface of the guide roller 41 on the sheet discharging side and a wind starting position 16b on the sheet discharging side on the peripheral surface of the impression cylinder 9 (an extended line of the travelling path 15b on the sheet discharging side between the guide roller 41 on the sheet discharging side and the impression cylinder 9) cross each other.

Therefore, the winding angle θ at which the base material to be printed W is wound around the peripheral surface of the impression cylinder 9 is an angle larger than 180 degrees, e.g. 270 degrees as shown in Fig.15, so that a contact area between the base material to be printed W and the peripheral surface of the impression cylinder 9 is enlarged, a frictional force generated between them is large.

[0073]

Possible reason why the frictional force is large would be as follows.

As the base material to be printed W is wound around the peripheral surface of the impression cylinder 9, a force directed to the center 9c of the impression cylinder 9 from the base material to be printed W toward the impression cylinder 9 would be generated in its wound area.

A vertical drag would be generated in the base material to be printed W as a reaction against the force in the area where the base material to be printed W is wound around the peripheral surface of the impression cylinder 9.

As the frictional force applied to the base material to be printed W is proportional to the vertical drag for the whole area where the base material to be printed W is wound around the peripheral surface of the impression cylinder 9, the frictional force becomes larger as the area where the base material to be printed W is wound around the peripheral surface of the impression cylinder 9 becomes wider.

[0074]

Therefore, when a winding angle θ at which the base material to be printed W is wound around the peripheral surface of the impression cylinder 9 is larger, the frictional force generated between the base material to be printed W and the peripheral surface of the impression cylinder 9 would also be larger.

When the frictional force generated between the base material to be printed W and the peripheral surface of the impression cylinder 9 is large, the slip caused between the peripheral surface of the impression cylinder 9 and the base material to be printed W would be suppressed while the base material to be printed W is backwardly travelled by rotationally driving the impression cylinder 9 backwardly.

[0075]

As shown in Fig.4. a drying device 43 and a nip roller 42 for impression cylinder are provided so as to being pressed against a part in the peripheral surface of the impression cylinder 9 around which the base material to be printed W is wound (a peripheral part between the wind starting position 16a on the sheet introducing side and the wind starting position 16b on the sheet discharging side as shown in Fig.15).

There is provided the nip roller 42 for impression cylinder while being pressed against the peripheral surface of the impression cylinder 9, the base material to be printed W is travelled while being constantly held by the nip roller 42 for impression cylinder and the peripheral surface of the impression cylinder 9. In other words, the nip roller 42 for impression cylinder is for pressing the base material to be printed W against the peripheral surface of the impression cylinder 9.

By providing the nip roller 42 for impression cylinder, the frictional force caused between the base material to be printed W and the peripheral surface of the impression cylinder 9 is increased and becomes to be a large value in an area of the peripheral surface of the impression cylinder 9 against which the nip roller 42 for impression cylinder is pressed.

[0076]

Moreover, when the base material to be printed W is backwardly travelled by rotationally driving the impression cylinder 9 backwardly, as the peripheral surface of the impression cylinder 9 and the peripheral surface of the blanket cylinder 8 are separated from each other and the base material to be printed W is not in contact with the blanket cylinder 8, the base material to be printed W being backwardly travelled is pulled toward in the travelling direction on the downstream side of a portion (a nip position 42a in Fig.15) which is pressed against the peripheral surface of the impression cylinder 9 by the nip roller 42 for impression cylinder.

When the base material to be printed W is pulled toward in the travelling direction, the force toward the center 9c of the impression cylinder 9 is generated, which is applied to the peripheral surface of the impression cylinder 9 from the base material to be printed W.

Due to such force, as air remained between the peripheral surface of the impression cylinder 9 and the base material to be printed W escapes, whereby formation of air layer may be suppressed, reduction of the frictional force between the peripheral surface of the impression cylinder 9 and the base material to be printed W due to the air layer may scarcely be occurred.

[0077]

Moreover, by the force toward the center of the impression cylinder 9 from the base material to be printed W applied to the peripheral surface of the impression cylinder 9, the frictional force between the peripheral surface of the impression cylinder 9 and the base material to be printed W is increased.

By all of these, no slip may be caused between the base material to be printed W and the peripheral surface of the impression cylinder 9; when the base material to be printed W is backwardly travelled by rotationally driving the impression cylinder 9, the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side backwardly; when the base material to be printed W is forwardly travelled until the impression cylinder 9 stops rotation from the print starting position; and when the base material to be printed W which has been backwardly travelled is forwardly travelled to the print starting position (in other words, when the base material to be printed W is separated from the blanket 8a and the base material to be printed W is travelled without being held by the impression cylinder 9 and the blanket cylinder 8).

Therefore, it is possible to prevent generation of the deviation in printing registration.

[0078]

The longer the length of a portion of pulled base material to be printed W which is in contact with the peripheral surface of the impression cylinder 9 (a length from the wind starting position 16a on the sheet introducing side to the wind starting position 16b on the sheet discharging side in Fig.15) is, the bigger effect can be obtained in increasing the frictional force between the peripheral surface of the impression cylinder 9 and the base material to be printed W as described above, the formation of the air layer is suppressed.

As a result, as shown in Fig.15, the nip roller 42 for impression cylinder is arranged so that the nip position 42a where it is pressed against the peripheral surface of the impression cylinder 9 is located closer than the printing position 9a of the impression cylinder to the guide roller 41 on the sheet discharging side.

In other words, the nip position 42a of the nip roller 42 for impression cylinder where it is pressed against the peripheral surface of the impression cylinder 9 is on the upstream side in the travelling direction of the base material to be printed W (on the upstream side in the backwardly rotational direction) of the printing position 9a of the impression cylinder 9, when the base material to be printed W is backwardly travelled.

[0079]

Furthermore, such nip position 42a is preferably at the nearest position to the guide roller 41 on the sheet discharging side within the range not exceeding the wind starting position 16b on the sheet discharging side.

If the nip position 42a exceed the wind starting position 16b on the sheet discharging side, as described later, the winding angle at which the base material to be printed W is wound around the peripheral surface of the impression cylinder 9 is changed and a length of travelling path is also changed, which result in the deviation in printing registration, when the nip roller 42 for impression cylinder is separated from the peripheral surface of the impression cylinder 9.

The nip roller 42 for impression cylinder is movable between a position where it is pressed against the peripheral surface of the impression cylinder 9 and a position separated therefrom.

[0080]

A mounting structure of the nip roller 42 for the impression cylinder will be described with reference to Fig.16 and Fig.17.

The machine frame 2A of a printing unit comprises one frame 2A-1 on the operation side perpendicular to the travelling direction of the base material to be printed W and the other frame 2A-2 on the driving side.

A supporting shaft 50 of the guide roller 41 on the sheet discharging side is positioned in its axial direction and is rotatably mounted between the frame 2A-1 on the operation side and the frame 2A-2 on the driving side, the guide roller 41 on the sheet discharging side is rotatably mounted on the supporting shaft 50. Moreover, an end of the supporting shaft 50 in its longitudinal direction projects outward from the frame 2A-1 on the operation side.

Supporting arms 51 are fixedly attached to two mutually separated positions of the supporting shaft 50 in its longitudinal direction at its base end portions so as not to rotate. A nip roller shaft 52 is fixedly attached between base ends of the two supporting arms 51, the nip roller 42 for impression cylinder is rotatably mounted on the nip roller shaft 52.

[0081]

A cylinder 53 for moving nip roller is rotatably attached on an outer face (surface) of the frame 2A-1 on the operation side of the machine frame 2A of the printing unit, a base end portion of a lever 54 is rotatably attached to a piston rod 53a of the cylinder 53 for moving nip roller. The supporting shaft 50 is fixedly attached to the front end of the lever 54 so as not to rotate.

Moreover, by extracting the piston rod 53a of the cylinder 53 for moving nip roller, the lever 54 is rotated in the counter-clockwise direction in Fig.16 and the supporting shaft 50 is rotated in the counter-clockwise direction for a prescribed rotation angle, so that the supporting arm 51 is rotated toward the peripheral surface of the impression cylinder 9 and the nip roller 42 for impression cylinder is moved to a position where it is pressed against the peripheral surface of the impression cylinder 9.

[0082]

By contracting the piston rod 53a of the cylinder 53 for moving nip roller, the lever 54 is rotated in the clockwise direction in Fig.16 and the supporting shaft 50 is rotated in the clockwise direction for the prescribed rotation angle, so that the supporting arm 51 is rotated away from the peripheral surface of the impression cylinder 9, the nip roller 42 for impression cylinder is moved to a position separated from the peripheral surface of the impression cylinder 9.

Therefore, as the slip may be prevented from causing by moving the nip roller 42 for impression cylinder to the position where it is pressed against the peripheral surface of the impression cylinder 9 when carrying out printing, and the nip roller 42 may be moved to the position separated from the peripheral surface of the impression cylinder 9 when conducting maintenance and inspection works, then, maintenance and inspection works and the like may be easily conducted.

[0083]

Moreover, as the peripheral surface of the impression cylinder 9 and the blanket 8a of the blanket cylinder 8 are in contact with each other through the base material to be printed W while printing images on the base material to be printed W, the slip may not be caused between the peripheral surface of the impression cylinder 9 and the base material to be printed W, even if without the nip roller 42 for impression cylinder (see Figs.6A to 6D). Still more, the length of the travelling path 15b on the sheet discharging side along a straight line connecting the position 41a on the impression cylinder 9 side where the base material to be printed W starts to contact with the peripheral surface of the guide roller 41 on the sheet discharging side and the wind starting position 16b on the sheet discharging side on the peripheral surface of the impression cylinder 9 never be changed, even when the nip roller 42 for impression cylinder is separated from the peripheral surface of the impression cylinder 9. Therefore, the deviation in printing registration never be occurred even when the nip roller 42 for impression cylinder is separated from the peripheral surface of the impression cylinder 9 (see Fig.15).

[0084]

As shown in Fig.4, the drying device 43 carries out fixing and drying of ink of images printed on the base material to be printed W. In this embodiment, as printing is carried out using UV-curable printing ink, the drying device which carries out drying by irradiating ultraviolet lay is used. As a UV light source, while mercury lamp, metal halide lamp, LED lamp and the like may be selectable, LED lamp is suitable to reduce a thermal effect on the base material to be printed W.

The drying device 43 is arranged between the printing position 9a of the impression cylinder 9 and the nip roller 42 for impression cylinder. In other words, the drying device 43 is arranged on the upstream side of the nip roller 42 for impression cylinder in the forwardly rotational direction of the impression cylinder.

As a result, as ink of printed image is brought into contact with the nip roller 42 for impression cylinder after having been fixed and dried, the image never be disturbed by the nip roller 42 for impression cylinder when being brought into contact therewith.

[0085]

Temperatures of the impression cylinder 9 and the base material to be printed W may sometimes become high by heat generated in the drying device 43, the base material to be printed W can be adversely affected by heat. Particularly, when a flexible packaging raw material such as the film is used as the base material to be printed W, it is susceptible to adverse effect by heat. The deviation in printing registration and the like can be occurred

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due to elongation of the base material to be printed W by heat, which can be enumerated as such adverse effect by heat.

For coping with this, a cooling device 72 is provided for the impression cylinder 9 to cool the impression cylinder 9 in order that temperatures of the impression cylinder 9 and the base material to be printed W do not become high at which the impression cylinder 9 and the base material to be printed W would be adversely affected by heat.

[0086]

The cooling device 72 of the impression cylinder 9 will be described with reference to Fig.18 and Fig.19.

The impression cylinder 9 is hollow which has a cylindrical body 60, one end plate 61 for closing one opening part of the cylindrical body 60 and the other end plate 62 for closing the other opening part of the cylindrical body 60.

One supporting shaft 63 is provided on the one end plate 61, the one supporting shaft 63 is rotatably supported by the frame 2A-1 on the operation side through an eccentric bearing 64.

The other supporting shaft 65 is provided on the other end plate 62, the other supporting shaft 65 is rotatably supported by the frame 2A-2 on the driving side through an eccentric bearing 64. Moreover, a motor eccentrically fixing component 64a for fixing a driving motor 68 for impression cylinder is attached to the other eccentric bearing 64.

[0087]

A motor supporting frame 67 is attached to the frame 2A-2 on the driving side through a stay 66, the motor eccentrically fixing component 64a is rotatably attached to the motor supporting frame

67, and the driving motor 68 for impression cylinder is mounted on the motor eccentrically fixing component 64a.

A rotating shaft (not shown) of the driving motor 68 for impression cylinder and the other supporting shaft 65 are connected by a coupling (not shown).

The impression cylinder 9 is rotationally driven forwardly and backwardly by the driving motor 68 for impression cylinder.

The driving motor 68 for impression cylinder is synchronously controlled with a driving motor of the step-back roller 6 on the sheet introducing side and a driving motor of the step-back roller 10 on the sheet discharging side, independently of a driving motor(s) (not shown) of the plate cylinder 7 and the blanket cylinder 8.

[0088]

Therefore, the impression cylinder 9 is rotationally driven forwardly and backwardly in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side.

A pipe for flowing cooling water (not shown) is provided within the hollow part of the impression cylinder 9. The pipe passes through the one end plate 61 and the one supporting shaft 63, projects outward from the frame 2A-1 on the operation side and is connected to a cooling water supplying piping 70 and a cooling water discharging piping 71 via a rotary joint 69. The cooling water supplying piping 70 is connected to the discharging side of a cooling water supplying pump, the cooling water discharging piping 71 is connected to a cooling water tank.

[0089]

And cooling water flows into the pipe from the cooling water supplying piping 70, flows through the pipe and is discharged from the cooling water discharging piping 71.

In this way, the impression cylinder 9 is cooled by flowing cooling water in the pipe, thus the cooling device 72 of the impression cylinder may be constituted.

As the center of rotation of each eccentric bearing 64 and the motor eccentrically fixing component 64a are eccentric to the center of rotation of the supporting shaft 63, 65, the impression cylinder 9 and the driving motor 68 for impression cylinder are eccentrically rotated for a prescribed rotation angle by rotating each eccentric bearing 64 for the prescribed rotation angle with a rotating mechanism 73.

With an eccentric rotation of the impression cylinder 9, a position of the impression cylinder 9 relative to the blanket cylinder 8 is changed, a contact pressure (applying pressure) between the peripheral surface of the impression cylinder 9 and the blanket 8a of the blanket cylinder 8 is thereby adjusted.

[0090]

The rotating mechanism 73 will be described.

A rotating shaft 74 is rotatably mounted between the frame 2A-1 on the operation side and the frame 2A-2 on the driving side. A worm gear 75 mounted on the rotating shaft 74 is meshed with a worm 77 mounted on a shaft 76. The rotating shaft 74 is rotated by rotating a handle 76a fixed to the shaft 76.

A sector gear 78 is mounted on each eccentric bearing 64, each gear 78 is meshed with each of gears 79 mounted on both end of the rotating shaft 74 in its longitudinal direction.

Therefore, each eccentric bearing 64 is rotated for a prescribed rotation angle by rotating the shaft 76 with the handle 76a.

[0091]

As shown in Fig.1, the registration adjusting devices 80 are provided between respective printing units of the printing part 2. Specifically, the registration adjusting devices 80 are provided between the first printing unit 2a and the second printing unit 2b, between the second printing unit 2b and the third printing unit 2c, between the third printing unit 2c and the fourth printing unit 2d, between the fourth printing unit 2d and the fifth printing unit 2e, and between the fifth printing unit 2e and the sixth printing unit 2f respectively.

The registration adjusting device 80 is for adjusting the printing registration depending on an image length to be printed in the vertical direction before effecting printing.

[0092]

In a conventional intermittent printing apparatus disclosed in JP Patent Application Laid-open No.H2-75561, while the printing registration is adjusted by moving the printing units and changing a distance between each printing unit in a state where the rotation of the impression cylinder is stopped, such way of adjustment of the printing registration cannot be applied to the intermittent printing apparatus of the present invention.

That reason is as follows, in the intermittent printing apparatus of the present invention, as the base material to be printed W is wound around the peripheral surface of the impression cylinder 9, when the printing units 2a to 2f are moved, the impression cylinders 9 are also moved so that the base material to be printed W can be cut by being pulled or loosened.

According to the registration adjusting device 80 of the present invention, the printing registration is adjusted by changing the length of the travelling path of the base material to be printed W (length of sheet path) between respective printing units.

Therefore, the printing registration can be adjusted even when the base material to be printed W is wound around the peripheral surface of the impression cylinder 9.

[0093]

The registration adjusting device 80 comprises, as shown in Fig.4, a pull roller 81 on the sheet introducing side, a pull roller 82 on the sheet discharging side arranged lower than the pull roller 81 on the sheet introducing side, a movable roller 83 arranged between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side and moving in a horizontal direction, and a guide roller 84 arranged closer than the pull roller 82 on the sheet discharging side to the sheet discharging side.

The base material to be printed W is travelled from the pull roller 81 on the sheet introducing side to the movable roller 83, from the movable roller 83 to the pull roller 82 on the sheet discharging side, and from the pull roller 82 on the sheet discharging side to the guide roller 84 while being wound in order.

In other words, when the base material to be printed W is forwardly travelled(in the direction indicated by the solid arrow), the base material to be printed W is travelled from the printing unit on the sheet introducing side (the first printing unit 2a) to the pull roller 81 on the sheet introducing side, then wound around the movable roller 83 to change the travelling direction, then wound around the pull roller 82 on the sheet discharging side to change the travelling direction again, and travelled to the printing unit on the sheet discharging side (the second printing unit 2b) via the guide roller 84.

[0094]

When the base material to be printed W is backwardly travelled (in the direction indicated by the dotted arrow), the base material to be printed W is travelled from the printing unit on the sheet discharging side (the second printing unit 2b) to the guide roller 84, then wound around the pull roller 82 on the sheet discharging side to change the travelling direction, then wound around the movable roller 83 to change the travelling direction again, and travelled to the printing unit on the sheet introducing side (the first printing unit 2a) via the pull roller 81 on the sheet introducing side.

The movable roller 83 can move between a position 83a on the sheet introducing side and a position 83b on the sheet discharging side. The length of a travelling path 85a of the base material to be printed W between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side is changed by moving the movable roller 83. In other words, as the travelling path 85a between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side is formed in a loop shape which is turned down at the movable roller 83, the length of the travelling path 85a is changed by moving the movable roller 83.

Therefore, the length of a travelling path 85 of the base material to be printed W between the printing position 9a of the first printing unit 2a and the printing position 9a of the second printing unit 2b (hereinafter referred to as the travelling path 85 of the base material to be printed W between printing units) is changed, when the length of the travelling path 85a between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side is changed.

[0095]

The length of the travelling path 85 of the base material to be printed W between printing units is the shortest when the movable roller 83 is at the position 83a on the sheet introducing side. The length of the travelling path 85 of the base material to be printed W between printing units is the longest when the movable roller 83 is at the position 83b on the sheet discharging side.

Therefore, as the travelling path 85 of the base material to be printed W between printing units is changed by moving the movable roller 83 between the position 83a on the sheet introducing side and the position 83b on the sheet discharging side, the printing registration can be adjusted before effecting printing. For example, the length of the travelling path 85 of the base material to be printed W between printing units is set to an integral multiple of the image length to be printed in the vertical direction.

While respective rollers 81, 82, 83, 84 are provided within a frame body 80A of the registration adjusting device 80, respective rollers 81, 82, 83, 84 are illustrated by a solid line to facilitate understanding.

[0096]

The pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side are controlled so as to be rotationally driven by separate driving motors (not shown). Moreover, the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side are rotationally driven forwardly and backwardly in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side.

The movable roller 83 is rotatably attached to a movable body (not shown) movably provided in the frame body 80A. The movable roller 83 is moved by moving the movable body through a moving mechanism (not shown).

As the moving mechanism, such mechanisms as the ones using a feeding screw which is engaged with a screw hole of the movable body and rotated by a motor, using rack and pinion, using cylinder and the like are available.

[0097]

As the base material to be printed W is wound around the peripheral surface of the movable roller 83 within the range of 180 degrees, the winding angle is constantly maintained to be 180 degrees when the movable roller 83 is moved, the length of the travelling path 85 of the base material to be printed W between the printing units can be exactly changed as much as two times of the moving length of the movable roller 83. However, as the base material to be printed W is wound within the range of 180 degrees, the contact area between the base material to be printed W and the peripheral surface of the movable roller 83 is wide, travel resistance of the base material to be printed W may be increased. Therefore, when the base material to be printed W is forwardly travelled, the slip may be easily caused between the peripheral surface of the pull roller 82 on the sheet discharging side and the base material to be printed W, and when the base material to be printed W is backwardly travelled, the slip maybe easily caused between the peripheral surface of the pull roller 81 on the sheet introducing side and the base material to be printed W.

For coping with this, a nip roller 86 for pull roller on the sheet introducing side which is pressed against the peripheral surface of the pull roller 81 on the sheet introducing side and a nip roller 87 for pull roller on the sheet discharging side which is pressed against the pull roller 82 on the sheet discharging side are provided respectively.

[0098]

Moreover, the base material to be printed W is held by the peripheral surface of the pull roller 81 on the sheet introducing side and the nip roller 86 for pull roller on the sheet introducing side, and the base material to be printed W is held by the peripheral surface of the pull roller 82 on the sheet discharging side and the nip roller 87 for pull roller on the sheet discharging side.

Therefore, as the frictional force between the peripheral surface of the pull roller 81 on the sheet introducing side and the base material to be printed W is increased, the slip is thereby prevented from causing between them and the frictional force between the peripheral surface of the pull roller 82 on the sheet discharging side and the base material to be printed W is increased, the slip is not thereby caused between them, the deviation in printing registration never be occurred owing to the registration adjusting device 80.

The nip roller 86 for pull roller on the sheet introducing side is movable between a position pressed against the peripheral surface of the pull roller 81 on the sheet introducing side and a position where it is separated therefrom.

The nip roller 87 for pull roller on the sheet discharging side is movable between a position where it is pressed against the peripheral surface of the pull roller 82 on the sheet discharging side and a position separated therefrom.

[0099]

A mounting structure of the nip roller 86 for pull roller on the sheet introducing side will be described with reference to Fig.20 and Fig.21. The frame body 80A comprises one frame 80A-1 on the operation side perpendicular to the travelling direction of the base material to be printed W and the other frame 80A-2 on the driving side.

A supporting shaft 90 is positioned in its axial direction and is rotatably mounted between the frame 80A-1 on the operation side and the frame 80A-2 on the driving side, one end in the longitudinal direction of the supporting shaft 90 projects outward from the frame 80A-1 on the operation side.

Base ends of the supporting arm 91 are each fixedly attached to one of two positions of the supporting shaft 90 separated from each other in the longitudinal direction so as not to rotate. A nip roller shaft 92 is fixedly attached between front ends of the two supporting arms 91, the nip roller 86 for pull roller on the sheet introducing side is rotatably mounted on the nip roller shaft 92.

[0100]

A cylinder 93 for moving nip roller is rotatably attached to an outer face (surface) of the frame 80A-1 on the operation side of the frame body 80A. A base end portion of a lever 94 is rotatably attached to a piston rod 93a of the cylinder 93 for moving nip roller. The supporting shaft 90 is fixedly attached to a front end of the lever 94 so as not to rotate.

Moreover, the lever 94 is rotated in the clockwise direction in Fig, 20 by extracting the piston rod 93a of the cylinder 93 for moving nip roller, the supporting shaft 90 is rotated in the clockwise direction by the prescribed rotation angle, so that the supporting arm 91 is rotated toward the peripheral surface of the pull roller 81 on the sheet introducing side and the nip roller 86 for pull roller on the sheet introducing side is moved to a position where it is pressed against the peripheral surface of the pull roller 81 on the sheet introducing side.

The lever 94 is rotated in the counter-clockwise direction in Fig.20 by contracting the piston rod 93a of the cylinder 93 for moving nip roller, the supporting shaft 90 is rotated in the counter-clockwise direction by the prescribed rotation angle, so that the supporting arm 91 is rotated away from the peripheral surface of the pull roller 81 on the sheet introducing side and the nip roller 86 for pull roller on the sheet introducing side is moved away from the peripheral surface of the pull roller 81 on the sheet introducing side.

Note that, as the nip roller 87 for pull roller on the sheet discharging side is also similarly mounted, description will be omitted by giving the same reference number to the same member.

[0101]

Moreover, when the nip roller 86 for pull roller on the sheet introducing side and the nip roller 87 for pull roller on the sheet discharging side are moved to separated positions, work to pass the base material to be printed W through inside the registration adjusting device 80 (paper (sheet)-passing work) and inspection and maintenance work of rollers are easily carried out before starting printing.

When the movable roller 83 is moved, the nip roller 42 for impression cylinder, the nip roller 86 for pull roller on the sheet introducing side, the nip roller 87 for pull roller on the sheet discharging side and other nip rollers are moved to respective separated positions, so that the base material to be printed W may be moved by moving the movable roller 83 while sliding along respective rollers.

[0102]

According to the intermittent printing apparatus of the present invention, the base material to be printed W is wound around the peripheral surfaces of the impression cylinder 9 of each of printing units 2a to 2f, and the nip roller 42 for impression cylinder is pressed against the peripheral surface of each impression cylinder 9. The nip roller 86 for pull roller on the sheet introducing side is pressed against the peripheral surface of the pull roller 81 on the sheet introducing side of each registration adjusting device 80, the nip roller 87 for pull roller on the sheet discharging side is pressed against the peripheral surface of the

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pull roller 82 on the sheet discharging side.

Therefore, the tension applied to the base material to be printed W travelling through respective printing units 2a to 2f and respective registration adjusting devices 80 does not become uniform, even if the rotational speed of the step-back roller 6 on the sheet introducing side and the rotational speed of the step-back roller 10 on the sheet discharging side are controlled. The tension applied to the base material to be printed W travelling through respective printing units 2a to 2f and respective registration adjusting devices 80 cannot be set to a prescribed value, even if the rotational speed of the step-back roller 6 on the sheet introducing side and the rotational speed of the step-back roller 10 on the sheet discharging side are controlled.

[0103]

Accordingly, in the intermittent printing apparatus of the present invention, the tension applied to the base material to be printed W travelling through respective printing units 2a to 2f, and respective registration adjusting devices 80 is made to be a prescribed value by separately and rotationally driving respective rollers and separately controlling rotational speeds of rollers which are the step-back roller 6 on the sheet introducing side, the impression cylinders 9 of respective printing units 2a to 2f, the pull rollers 81 on the sheet introducing side, the pull rollers 82 on the sheet discharging side in respective registration adjusting devices 80 and the step-back roller 10 on the sheet discharging side. Such adjusting operation of the tension is successively carried out for each printing unit from the first printing unit 2a to the sixth printing unit 2f.

[0104]

For example, as shown in Fig.22, the tension is controlled independently, which is the tension of the base material to be printed W travelling through a section 17a between the step-back roller 6 on the sheet introducing side and the impression cylinder 9 of the first printing unit 2a; the tension of the base material to be printed W travelling through a section 17b between the impression cylinder 9 of the first printing unit 2a and the pull roller 81 on the sheet introducing side; tension of the base material to be printed W travelling through a section 17c between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side; the tension of the base material to be printed W travelling through a section 17d between the pull roller 82 on the sheet discharging side and the impression cylinder 9 of the second printing unit 2b; the tension of the base material to be printed W travelling through a section 17e between the impression cylinder 9 of the second printing unit 2b and the pull roller 81 on the sheet introducing side; the tension of the base material to be printed W travelling through a section 17f between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side; the tension of the base material to be printed W travelling through a section 17g between the pull roller 82 on the sheet discharging side and the impression cylinder 9 of the third printing unit 2c; the tension of the base material to be printed W travelling through a section 17h between the impression cylinder 9 of the third printing unit 2c and the pull roller 81 on the sheet introducing side; and the tension of the base material to be printed W travelling through a section 17i between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side.

[0105]

Still more, the tension in the following is controlled independently, which is the tension of the base material to be printed W travelling through a section 17j between the pull roller 82 on the sheet discharging side and the impression cylinder 9 of the fourth printing unit 2d; the tension of the base material to be printed W travelling through a section 17k between the impression cylinder 9 of the fourth printing unit 2d and the pull roller 81 on the sheet introducing side; the tension of the base material to be printed W travelling through a section 17l between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side; the tension of the base material to be printed W travelling through a section 17m between the pull roller 82 on the sheet discharging side and the impression cylinder 9 of the fifth printing unit 2e; the tension of the base material to be printed W travelling through a section 17n between the impression cylinder 9 of the fifth printing unit 2e and the pull roller 81 on the sheet introducing side; the tension of the base material to be printed W travelling through a section 17o between the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side; the tension of the base material to be printed W travelling through a section 17p between the pull roller 82 on the sheet discharging side and the impression cylinder 9 of the sixth printing unit 2f; and the tension of the base material to be printed W travelling through a section 17q between the impression cylinder 9 of the sixth printing unit 2f and the step-back roller 10 on the sheet discharging side.

[0106]

When controlling the tension of the base material to be printed W travelling through respective sections, the rotational speed of each roller on downstream side in the travelling direction of the base material to be printed W is made faster than the rotational speed of each roller on the upstream side in the travelling direction so that a feeding amount of the base material to be printed W by the rollers on the downstream side is much more than a feeding amount of the base material to be printed W by the rollers on the upstream side.

For example, when the base material to be printed W is forwardly travelled, the tension of the base material to be printed W travelling through the section 17q between the impression cylinder 9 of the sixth printing unit 2f and the step-back roller 10 on the sheet discharging side is made larger than the tension of the base material to be printed W travelling through the section 17a between the step-back roller 6 on the sheet introducing side and the impression cylinder 9 of the first printing unit 2a, the tension of the base material to be printed W travelling through other sections is made the same as the tension of the base material to be printed W travelling through the section 17a between the step-back roller 6 on the sheet introducing side and the impression cylinder 9 of the first printing unit 2a.

[0107]

When the base material to be printed W is backwardly travelled, the tension of the base material to be printed W travelling through the section 17a between the step-back roller 6 on the sheet introducing side and the impression cylinder 9 of the first printing unit 2a is made larger than the tension of the base material to be printed W travelling through the section 17q between the impression cylinder 9 of the sixth printing unit 2f and the step-back roller 10 on the sheet discharging side, the tension of the base material to be printed W travelling through other sections is made the same as the tension of the base material to be printed W travelling through the section 17q between the impression cylinder 9 of the sixth printing unit 2f and the step-back roller 10 on the sheet discharging side.

[0108]

In the intermittent printing apparatus of the present invention, image printings on the base material to be printed W have been carried out in three different states, and the deviation in printing registration in the vertical direction has been measured for each state. The deviation in printing registration has been measured by the printing registration device 38 and the monitoring device 39.

In a first state, the impression cylinders 9 are each rotationally driven forwardly and backwardly in synchronization with the step- back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side, in the state that the nip roller 42 for impression cylinder is separated from the peripheral surface of the impression cylinder 9, the pull roller 81 on the sheet introducing side is freely rotatable without being rotationally driven, and the nip roller 86 for pull roller on the sheet introducing side is separated from the peripheral surface of the pull roller 81 on the sheet introducing side so as to work the pull roller 81 on the sheet introducing side in the same way as the guide roller, the pull roller 82 on the sheet discharging side is freely rotatable without being rotationally driven, and the nip roller 87 for pull roller on the sheet discharging side is separated from the peripheral surface of the pull roller 82 on the sheet discharging side so as to work the pull roller 82 on the sheet discharging side in the same way as the guide roller.

In a second state, the impression cylinder 9 is rotationally driven forwardly and backwardly in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side, in the state that the nip roller 42 for impression cylinder is pressed against the peripheral surface of the impression cylinder 9 in the first state.

[0109]

In a third state, the impression cylinder 9, the step-back roller 6 on the sheet introducing side, the step-back roller 10 on the sheet discharging side, the pull roller 81 on the sheet introducing side and the pull roller 82 on the sheet discharging side are rotationally and synchronously driven forwardly and backwardly, in the state that the nip roller 42 for impression cylinder is pressed against the peripheral surface of the impression cylinder 9, the nip roller 86 for pull roller on the sheet introducing side is pressed against the peripheral surface of the pull roller 81 on the sheet introducing side and the nip roller 87 for pull roller on the sheet discharging side is pressed against the peripheral surface of the pull roller 82 on the sheet discharging side (while respective nip rollers 42, 86, 87 are moved to positions where they are pressed against).

As a result, the deviation in printing registration is occurred most when effecting printing in the first state, second most when effecting printing in the second state, and least when effecting printing in the third state.

From these, it is found that it is effective to provide the nip roller 42 for impression cylinder, nip rollers 86, 87 for pull roller (pull roller 81, 82) for preventing the deviation in printing registration.

[0110]

In the embodiment, while the registration adjusting device 80 is provided between printing units, such registration adjusting device 80 may not necessarily be provided.

In such case, pull rollers may be provided in the travelling path 85 of the base material to be printed W between the printing units to prevent the deviation and looseness from occurring in the base material to be printed W.

For example, as shown in Fig. 23, pull rollers 110 are provided closer to the sheet introducing side and closer to the sheet discharging side in the travelling path 85 of the base material to be printed W between the printing units, and the base material to be printed W is wound around the peripheral surface of each pull roller 110. Each pull roller 110 is rotatably provided within a frame body 120 between printing units. Each pull roller 110 is rotationally driven forwardly and backwardly by separate driving motors (not shown) in synchronization with the step-back roller 6 on the sheet introducing side and the step-back roller 10 on the sheet discharging side.

[0111]

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Therefore, the deviation and looseness never be occurred in the base material to be printed W travelling on the travelling path 85 between printing units.

Still more, there is provided a nip roller 111 for pull roller to press the base material to be printed W wound around a peripheral surface of each pull roller 110 against the peripheral surface of the pull roller 110, the base material to be printed W is held by the peripheral surface of each pull roller 110 and the nip roller 111 for pull roller.

Therefore, the frictional force between the peripheral surface of each pull roller 110 and the base material to be printed W is increased, then the slip may not be caused between them, and the deviation in printing registration never be occurred by providing the pull roller 110.

The nip roller 111 for each pull roller is movable between the position where it is pressed against the peripheral surface of each pull roller 110 and the position where it is separated therefrom.

[0112]

For example, a pair of supporting arms 113 are fixed to a supporting shaft 112 rotatably attached to the frame body 120, a shaft 114 is fixed between the pair of supporting arms 113. The nip roller 111 for pull roller is rotatably mounted on the shaft 114.

A lever 116 which is rotated by a cylinder 115 is fixed on the supporting shaft 112, the supporting shaft 112 is rotated by a prescribed rotation angle by rotating the lever 116, the nip roller 111 for pull roller is moved between the position where it is pressed against the pull roller 110 and the position where it is separated therefrom by rotating the supporting arms 113. This structure is

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the same as the structure to move the nip roller for pull roller of the registration adjusting device 80.

[0113]

Note that, there may be provided more than three pull rollers 110. In other words, it is enough to provide at least two pull rollers 110.

Moreover, it is possible to configure so that the length of travelling path can be changed by providing the movable roller either or both between two pull rollers 110 or between the pull roller 110 and printing unit in the travelling path 85 of the base material to be printed W.

[0114]

Through-out the specification and claims the word “comprise” and its derivatives is intended to have an inclusive rather than exclusive meaning unless the context requires otherwise.

Orientational terms used in the specification and claims such as vertical, horizontal, top, bottom, upper and lower are to be interpreted as relational and are based on the premise that the component, item, article, apparatus, device or instrument will usually be considered in a particular orientation, typically with the assembly uppermost.

It will be appreciated by those skilled in the art that many modifications and variations may be made to the methods of the invention described herein without departing from the spirit and scope of the invention.

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What is claimed is:

1. An intermittent printing apparatus comprising;

a sheet introducing part feeding a base material to be printed,

a printing part having a plurality of printing units for printing images on the base material to be printed fed out from the sheet introducing part, and

a sheet discharging part for discharging the base material to be printed on which images have been printed,

wherein the sheet introducing part has a buffer device on a sheet introducing side for storing the base material to be printed in a loop shape and a step-back roller on the sheet introducing side which is rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly,

the printing units each have an impression cylinder and a blanket cylinder having an image range which is brought into contact with a peripheral surface of the impression cylinder and a non-image range which does not contact with the peripheral surface of the impression cylinder,

the sheet discharging part has a step-back roller on a sheet discharging side which is rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly and a buffer device on the sheet discharging side for storing the base material to be printed on which images have been printed in a loop shape,

the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side are synchronously and rotationally driven forwardly to make the base material to be printed travel forwardly, so that an image printing is effected on the base material to be printed by the peripheral surface of the impression cylinder and the image range of the blanket cylinder,

the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side are synchronously and rotationally driven backwardly to make the base material to be printed travel backwardly through a gap between the peripheral surface of the impression cylinder and the non-image range of the blanket cylinder, and

characterized in that there are provided a guide roller on the sheet discharging side and a guide roller on the sheet introducing side to wind the base material to be printed passing through between the peripheral surface of the impression cylinder and the blanket cylinder on the peripheral surface of the impression cylinder at a prescribed winding angle,

there is provided a nip roller for impression cylinder for pressing the base material to be printed wound around the peripheral surface of the impression cylinder against the peripheral surface of the impression cylinder,

the impression cylinder is rotationally driven forwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, when the base material to be printed is travelled forwardly,

the impression cylinder is rotationally driven backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, when the base material to be printed is travelled backwardly,

there are provided a drying device for drying the base material to be printed wound around the peripheral surface of the impression cylinder and a cooling device of the impression cylinder for cooling the impression cylinder, and

the drying device is located on an upstream side of the nip roller for impression cylinder in a forward rotational direction of the impression cylinder.

2. The intermittent printing apparatus according to claim 1, wherein the guide roller on the sheet introducing side and the guide roller on the sheet discharging side are provided so that an extension line of a travelling path on the sheet introducing side between the guide roller on the sheet introducing side and the impression cylinder intersects with an extension line of a travelling path on the sheet discharging side between the guide roller on the sheet discharging side and the impression cylinder.

3. The intermittent printing apparatus according to claim 1 or 2, wherein when printing images on the base material to be printed by rotating the blanket cylinder over the image range from a print starting position, the impression cylinder is rotationally driven forwardly at a same constant speed as that of the blanket cylinder,

when the blanket cylinder is rotated over the non-image range from a print ending position, the impression cylinder is stopped its rotation after having been rotationally driven forwardly while being decelerated from the constant speed, and after having been stopped its rotation, is rotationally driven

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backwardly while being accelerated up to a prescribed backward rotational driving speed, then is stopped its rotation after having been rotationally driven backwardly while being decelerated from the prescribed backward rotational driving speed, after having been stopped its rotation, is rotationally driven forwardly while being accelerated up to the constant speed, so that a rear end of a print image on the base material to be printed is brought into contact with a front end of a print range of the blanket cylinder.

4. The intermittent printing apparatus according to claim 3, wherein a curve representing a change in a rotational driving speed ratio of the impression cylinder when being rotationally driven forwardly while being decelerated is linearly symmetrical with a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven forwardly while being accelerated,

a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven backwardly while being accelerated is linearly symmetrical with a curve representing a change in the rotational driving speed ratio of the impression cylinder when being rotationally driven backwardly while being decelerated, and

the rotational driving speed ratio of the impression cylinder from the constant speed to the prescribed backward rotational driving speed and the rotational driving speed ratio from the prescribed backward rotational driving speed to the constant speed are smoothly changed along a nearly U-shaped curve.

5. The intermittent printing apparatus according to any one of claims 1 to 4, further comprising a registration adjusting device which is provided between respective printing units, the registration adjusting device is configured to adjust the printing registration by changing a length of a travelling path of the base material to be printed between the printing units.

6. The intermittent printing apparatus according to claim 5, wherein

the registration adjusting device has a pull roller on the sheet introducing side, a pull roller on the sheet discharging side and a movable roller, and is configured so that a length of a travelling path between the pull roller on the sheet introducing side and the pull roller on the sheet discharging side is changed by moving the movable roller,

both pull rollers are rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, and

there are provided nip rollers for pull rollers for pressing the base material to be printed wound around the peripheral surface of the both pull rollers against the peripheral surfaces of the both pull rollers.

7. The intermittent printing apparatus according to claim 6, wherein a rotational speed of the step-back roller on the sheet

introducing side, a rotational speed of the step-back roller on the sheet discharging side, a rotational speed of the impression cylinder of respective printing units, a rotational speed of the pull roller on the sheet introducing side of each registration adjusting device and a rotational speed of the pull roller on the sheet discharging side are separately controllable.

8. The intermittent printing apparatus according to any one of claims 1 to 4, further comprising at least two pull rollers around which the base material to be printed is wound on a travelling path of the base material to be printed between the printing units, the pull rollers are rotationally driven forwardly to make the base material to be printed travel forwardly and rotationally driven backwardly to make the base material to be printed travel backwardly in synchronization with the step-back roller on the sheet introducing side and the step-back roller on the sheet discharging side, and

there are provided nip rollers for pull roller for pressing the base material to be printed wound around the peripheral surface of each pull roller against the peripheral surface of each pull roller.

9. The intermittent printing apparatus according to any one of claims 1 to 8, wherein the base material to be printed is a film.

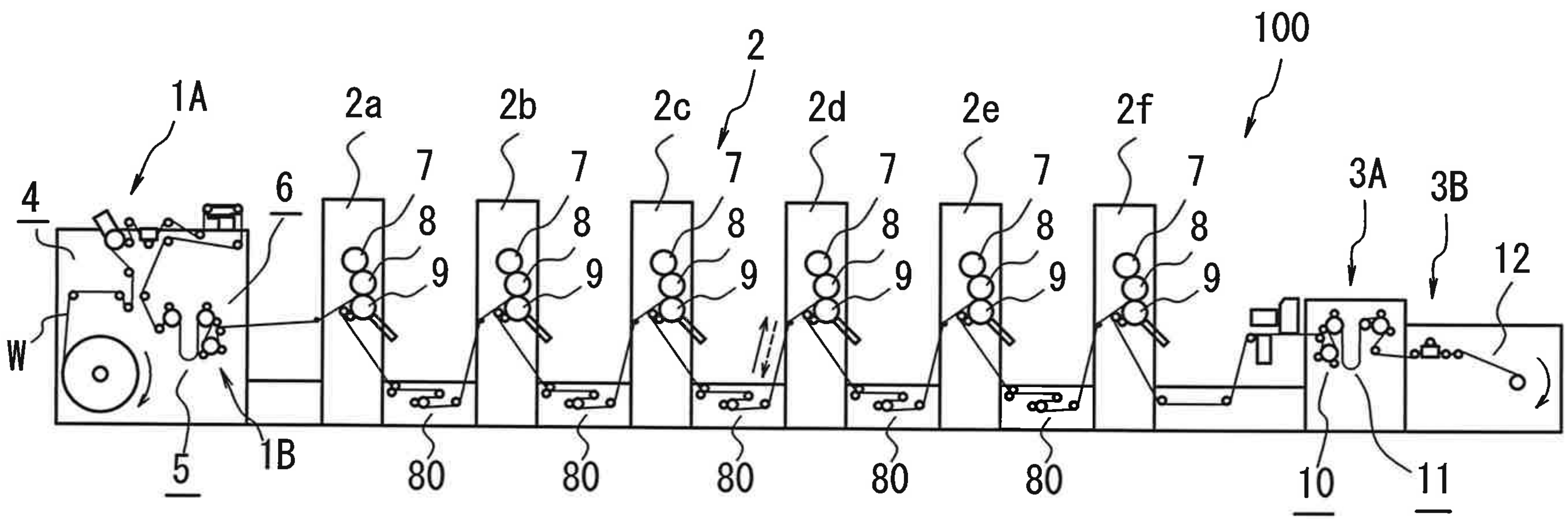

FIG. 1

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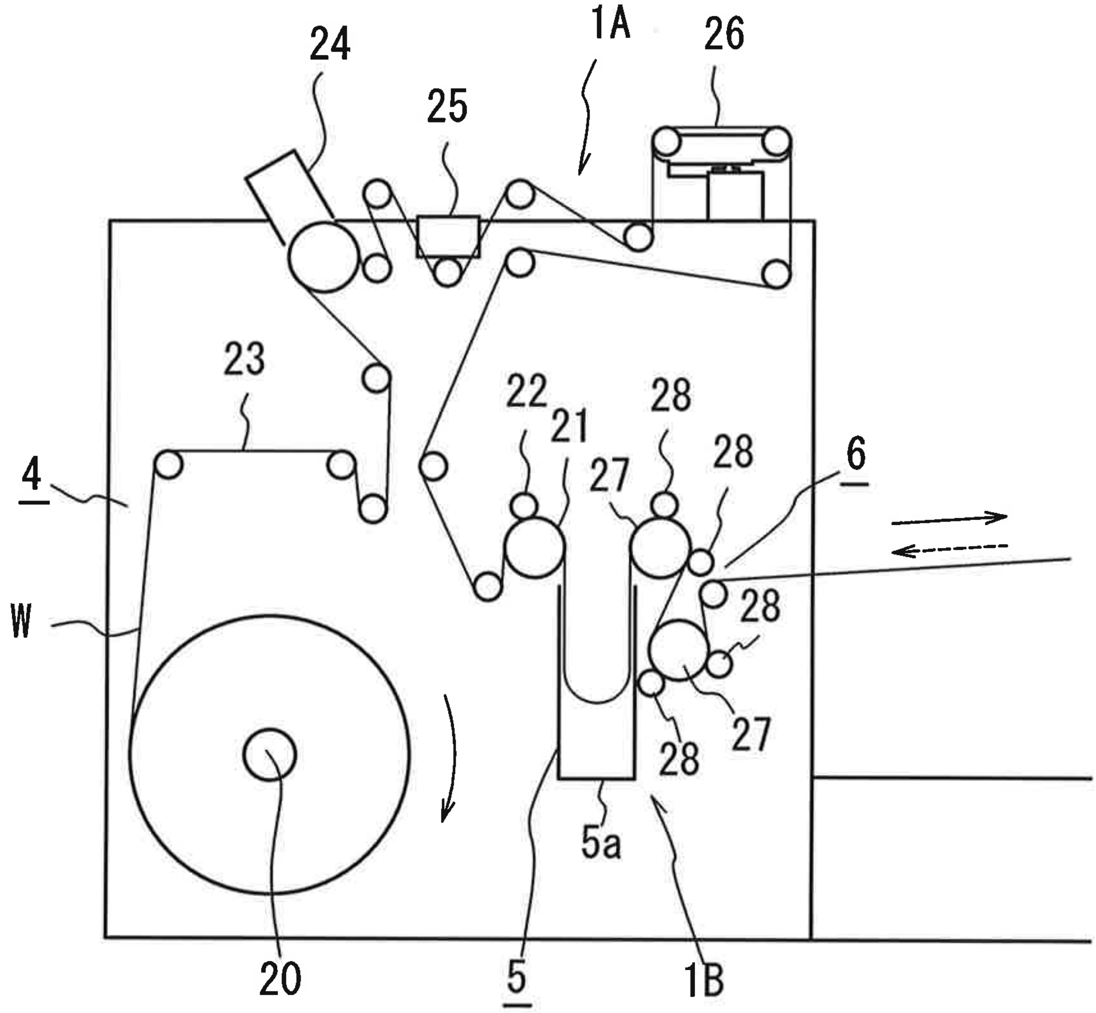

FIG. 2

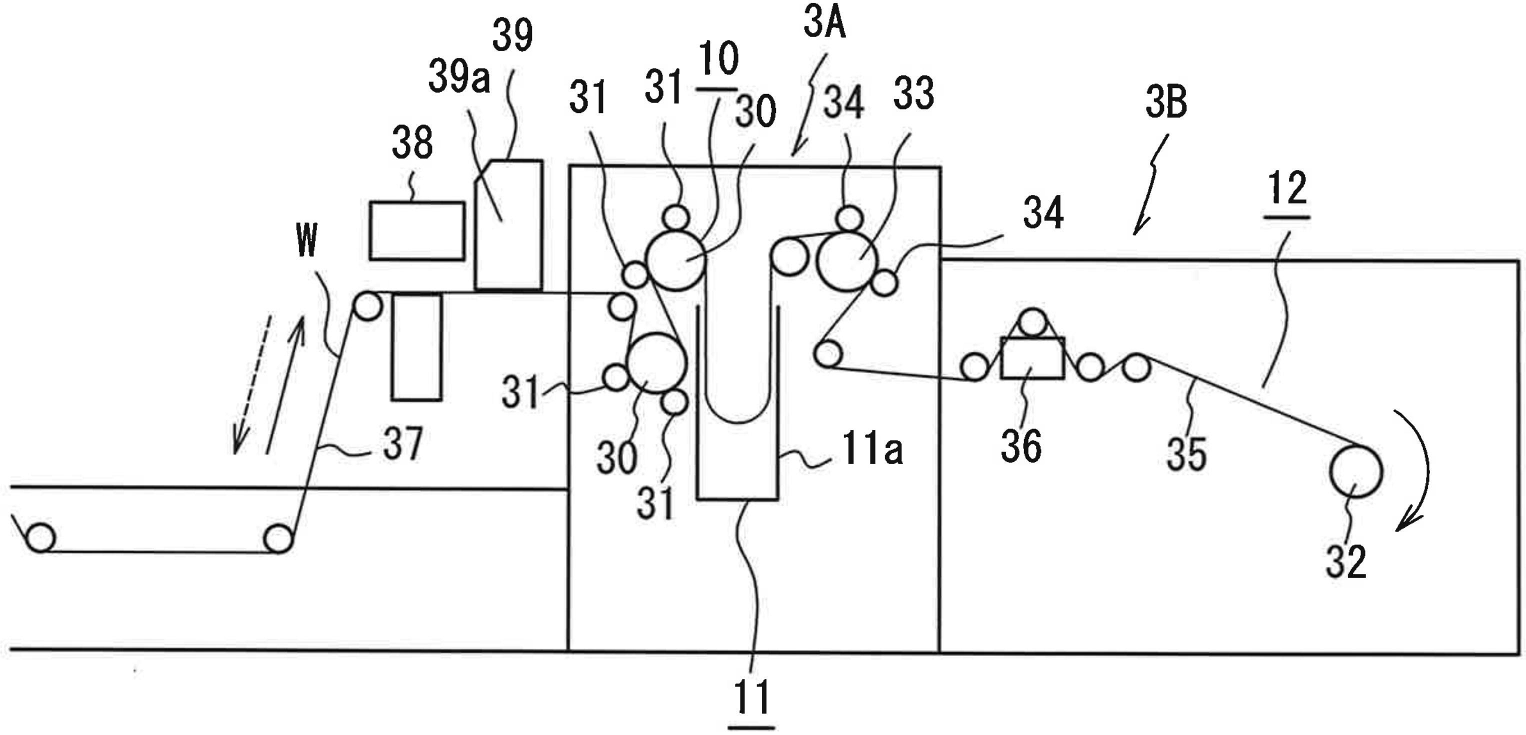

FIG. 3

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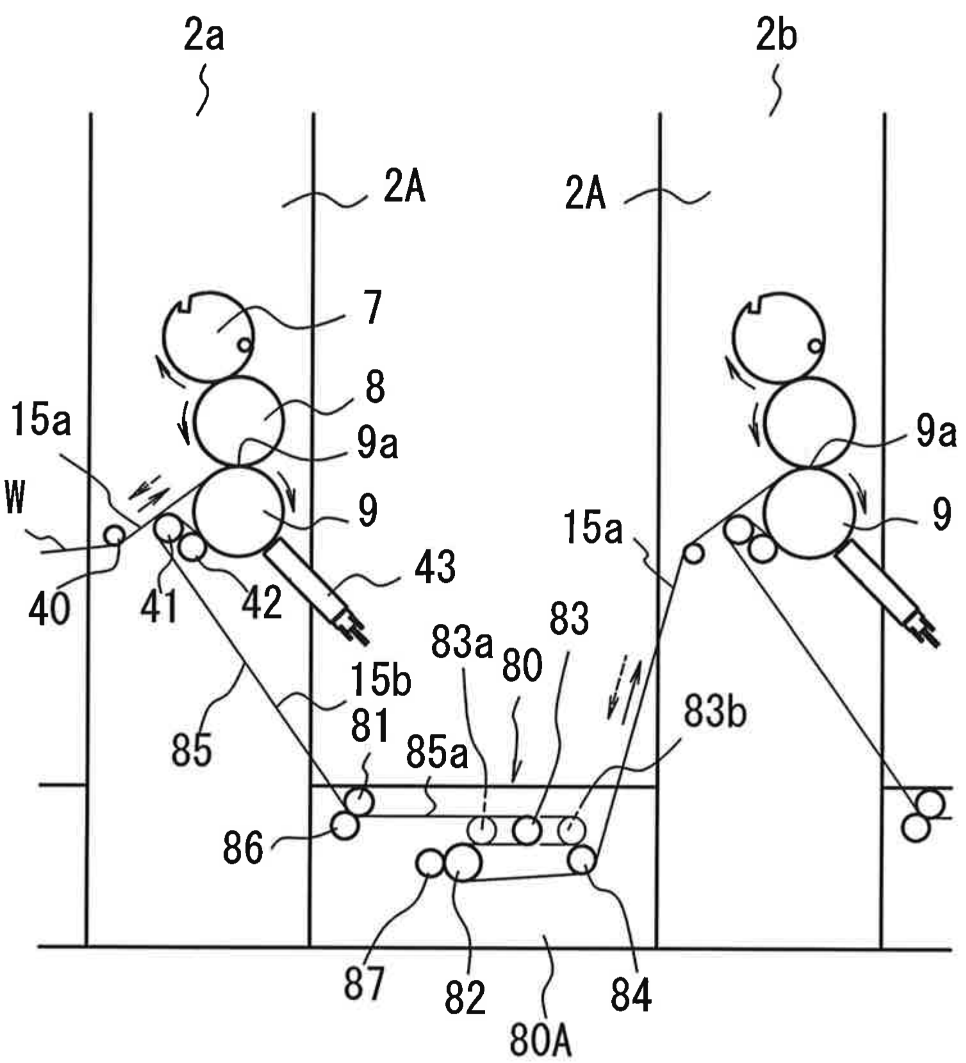

FIG. 4

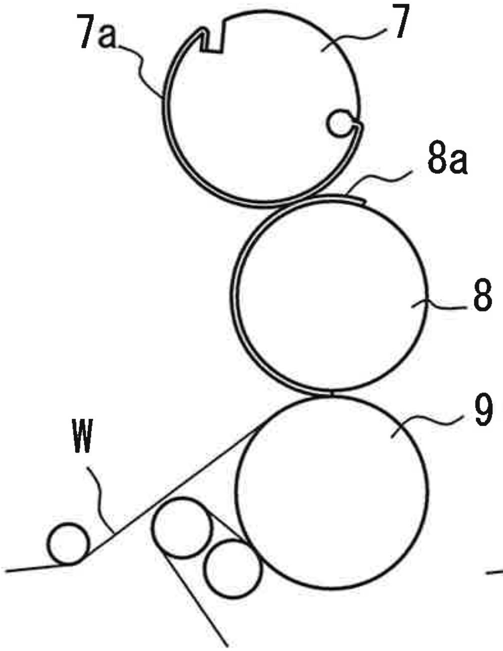

FIG. 5A

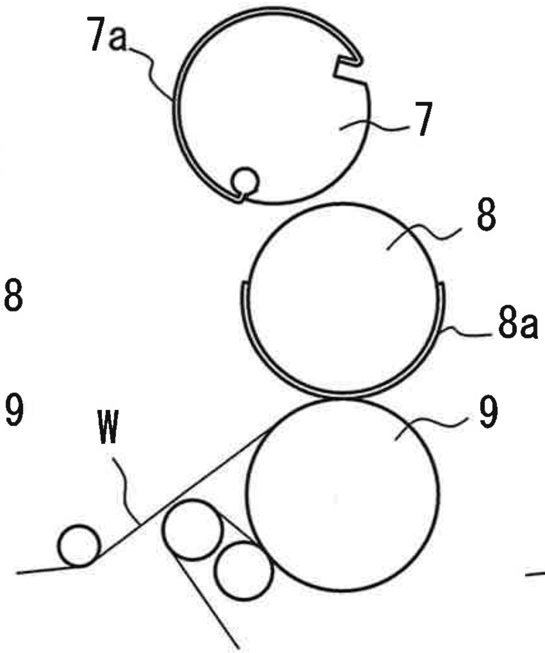

FIG. 5B

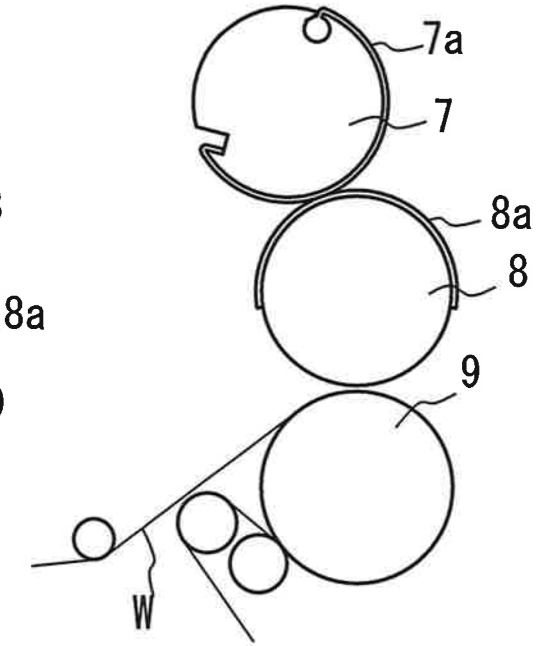

FIG. 5C

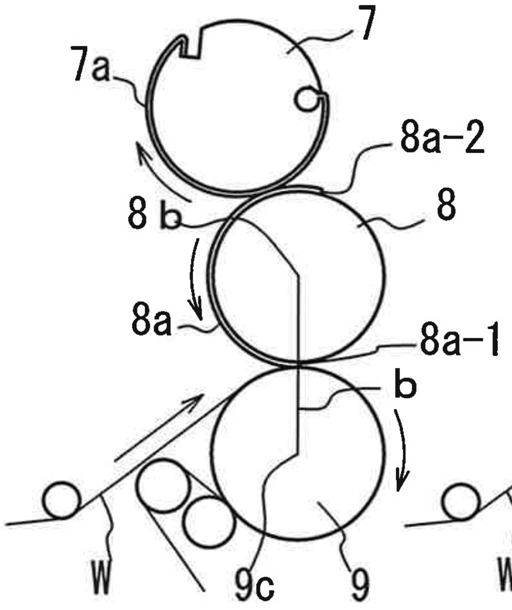

FIG. 6A

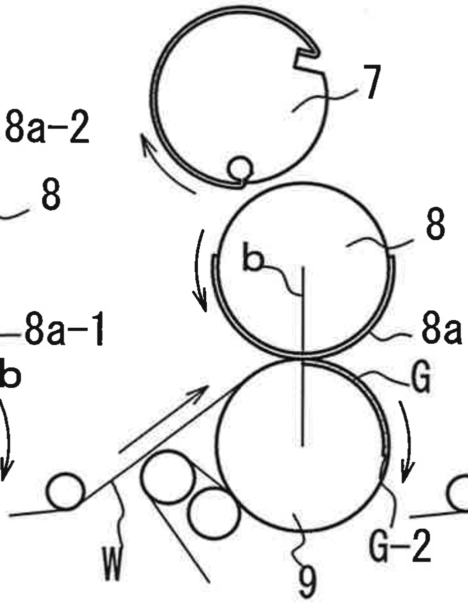

FIG. 6B

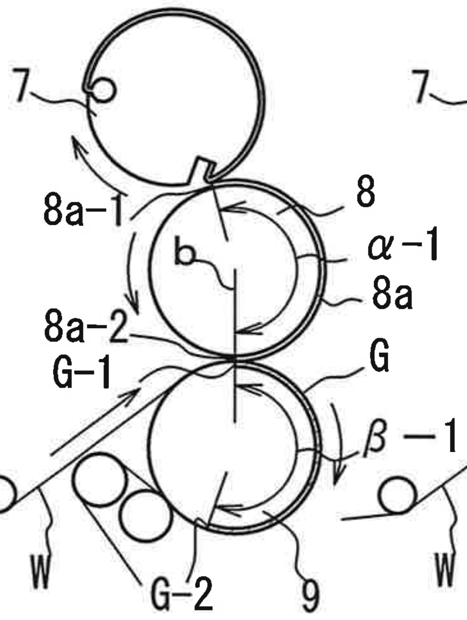

FIG. 6C

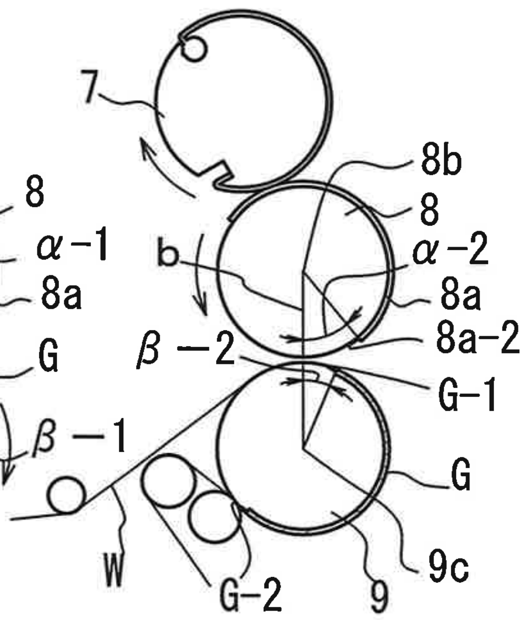

FIG. 6D

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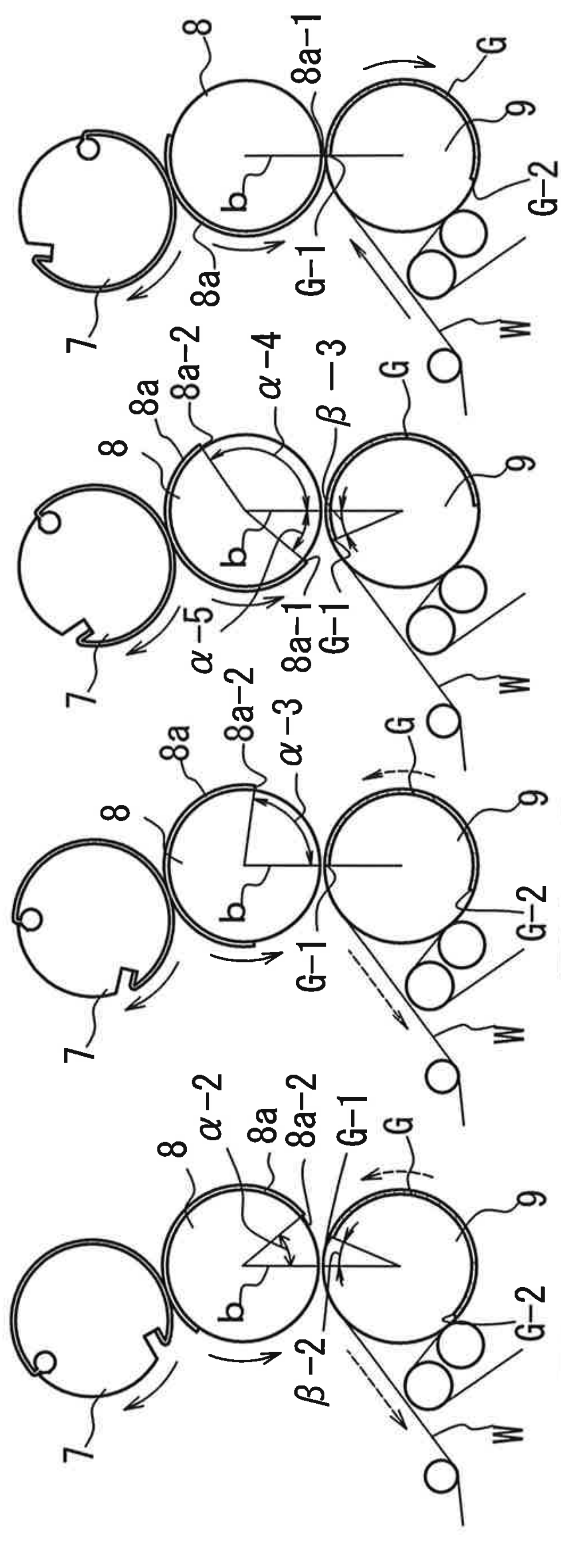


FIG. 7A

FIG. 7B

FIG. 7C

FIG. 7D

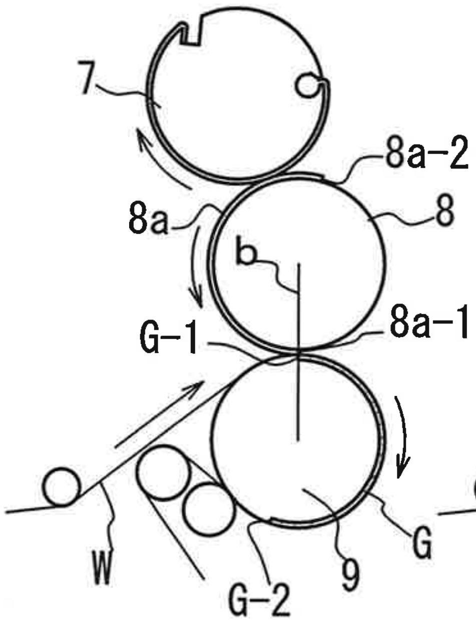


FIG. 8A

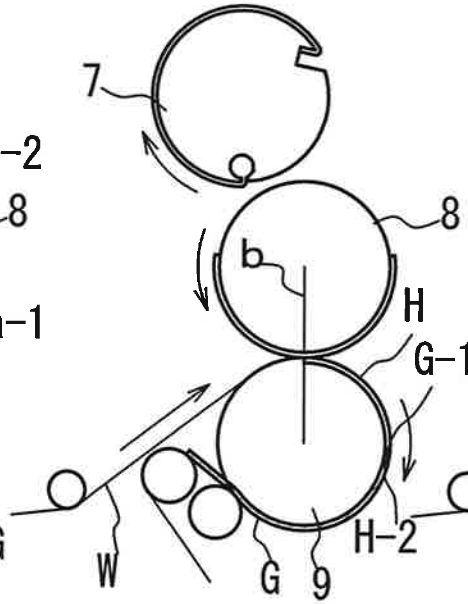


FIG. 8B

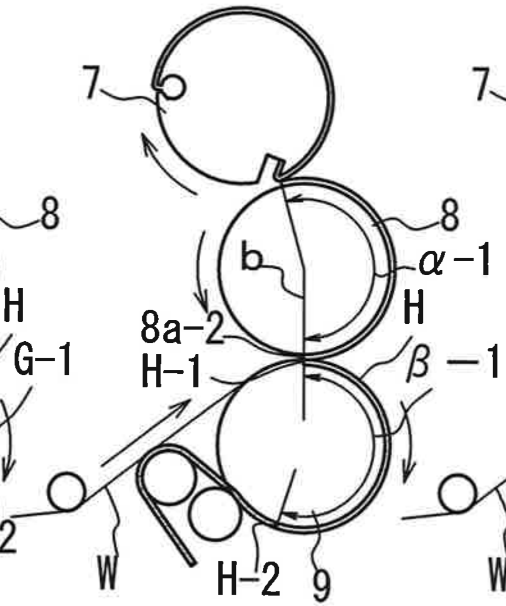


FIG. 8C

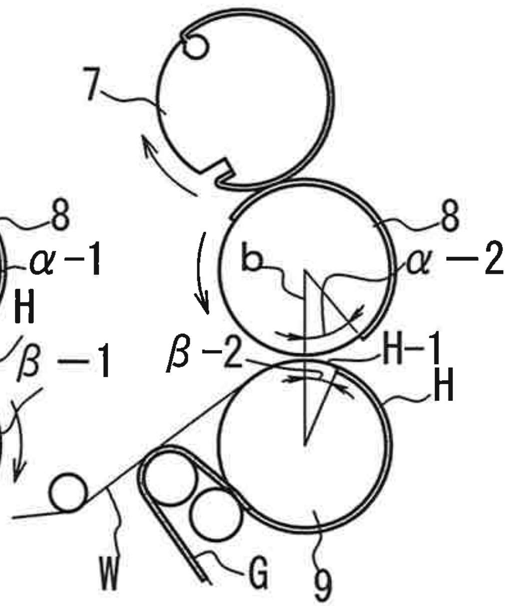
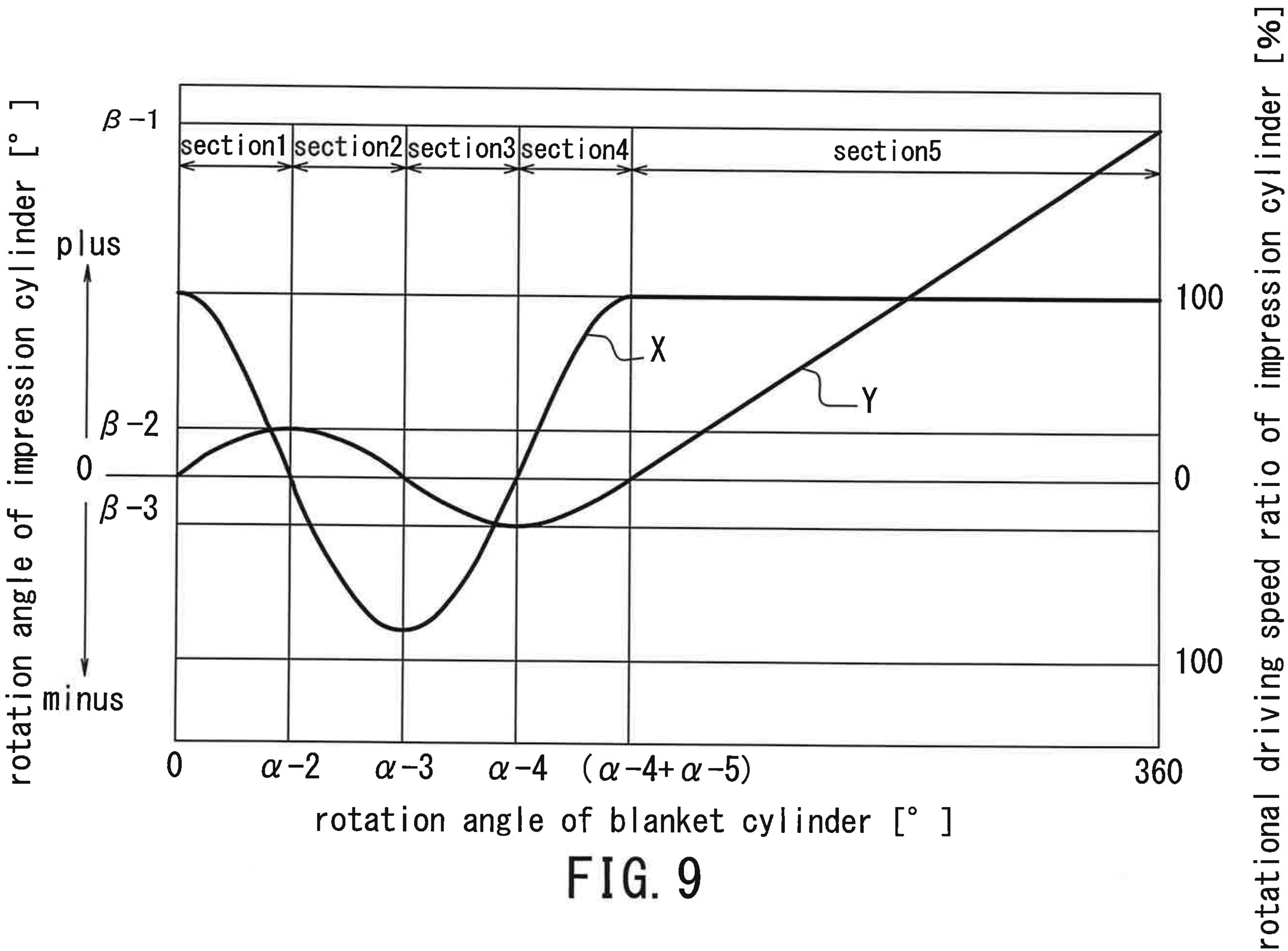
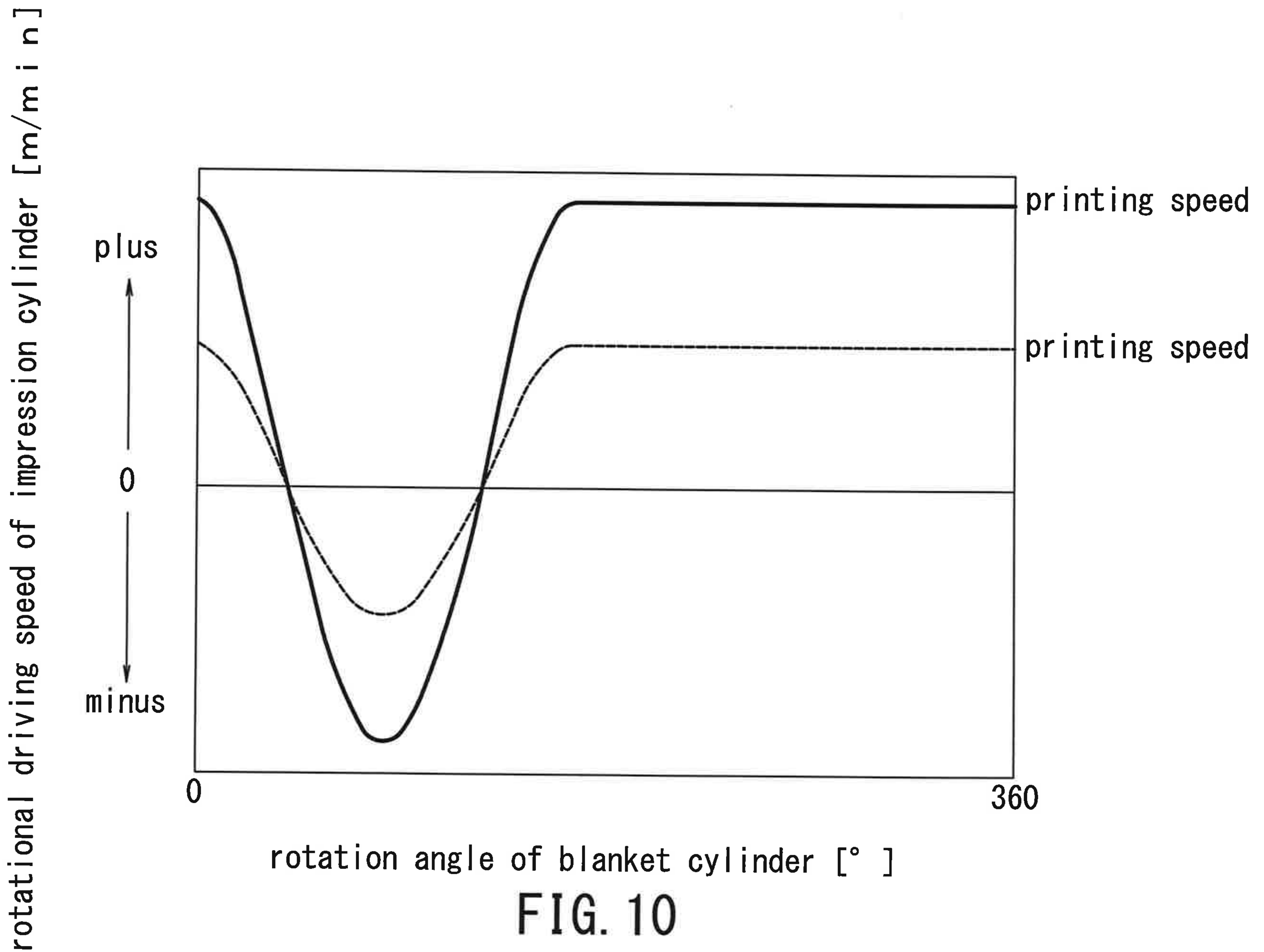


FIG. 8D



β-1
section1
section2
section3
section4
section5
plus
β-2
0
β-3
minus
X
Y
100
0
100
0
α-2
α-3
α-4
(α-4+α-5)
360
rotation angle of impression cylinder [°]
rotation angle of blanket cylinder [°]
rotational driving speed ratio of impression cylinder [%]

FIG. 9



rotational driving speed of impression cylinder [m/m i n]
plus
0
minus
printing speed
printing speed
0
360
rotation angle of blanket cylinder [°]

FIG. 10

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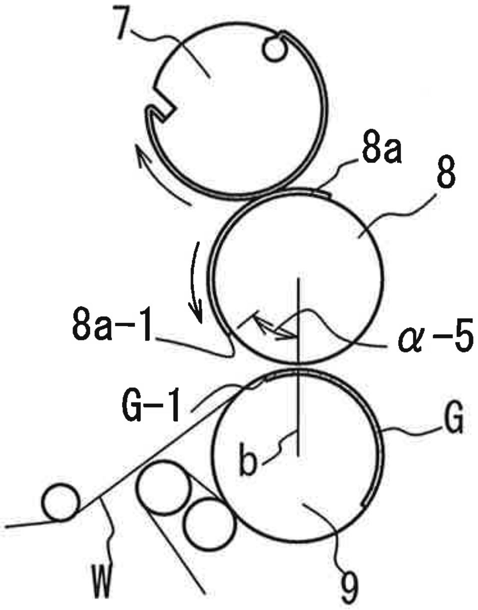

FIG. 11

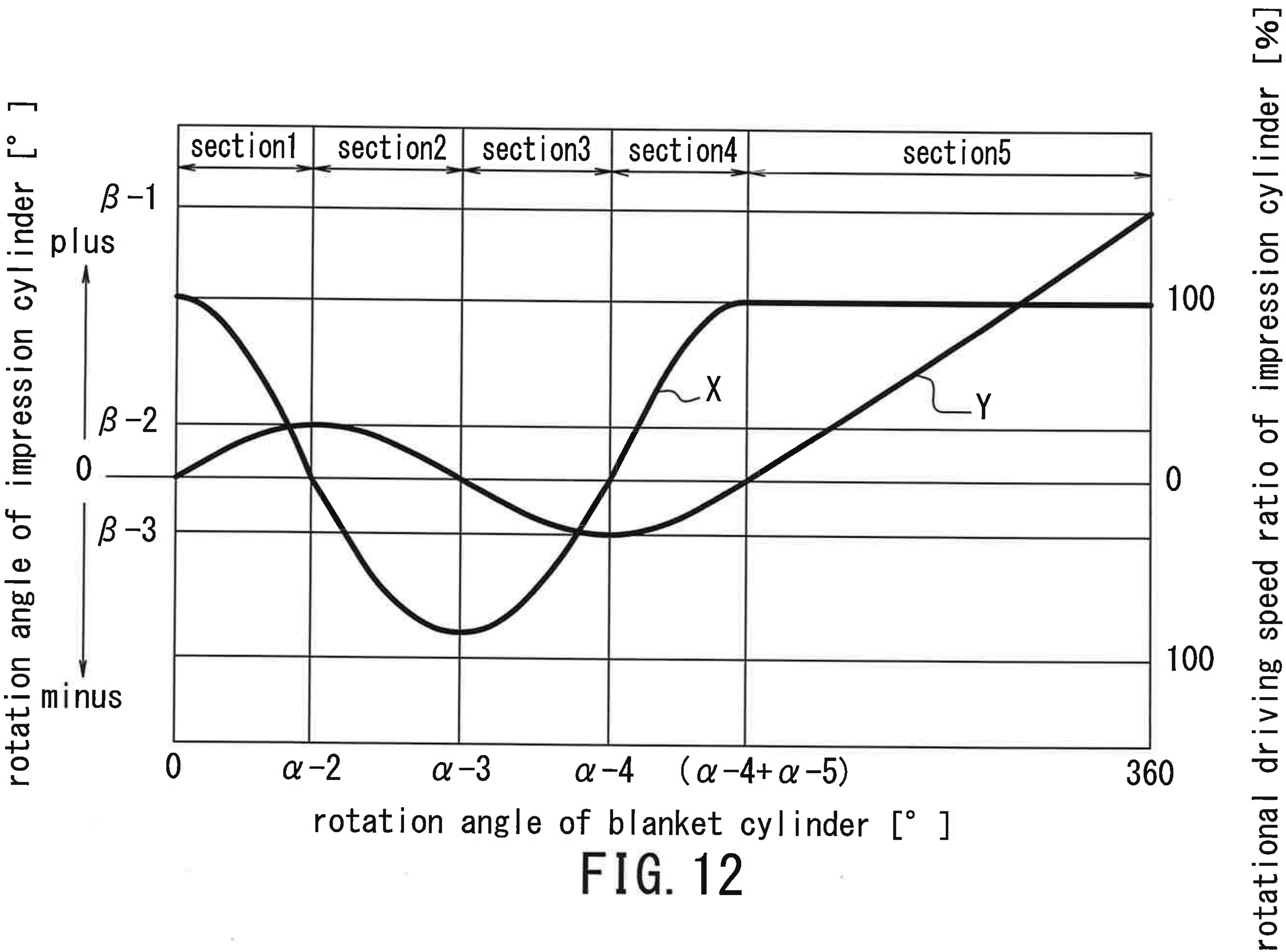
section1
section2
section3
section4
section5
rotation angle of impression cylinder [°]
plus
minus
β-1
β-2
0
β-3
X
Y
100
0
100
rotational driving speed ratio of impression cylinder [%]
0
α-2
α-3
α-4
(α-4+α-5)
360
rotation angle of blanket cylinder [°]

FIG. 12

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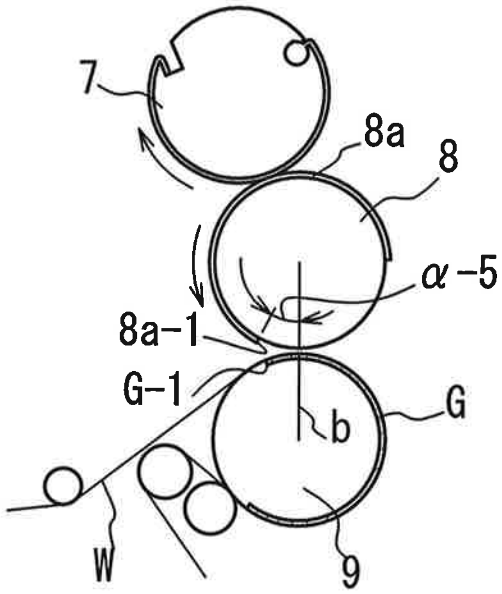

FIG. 13

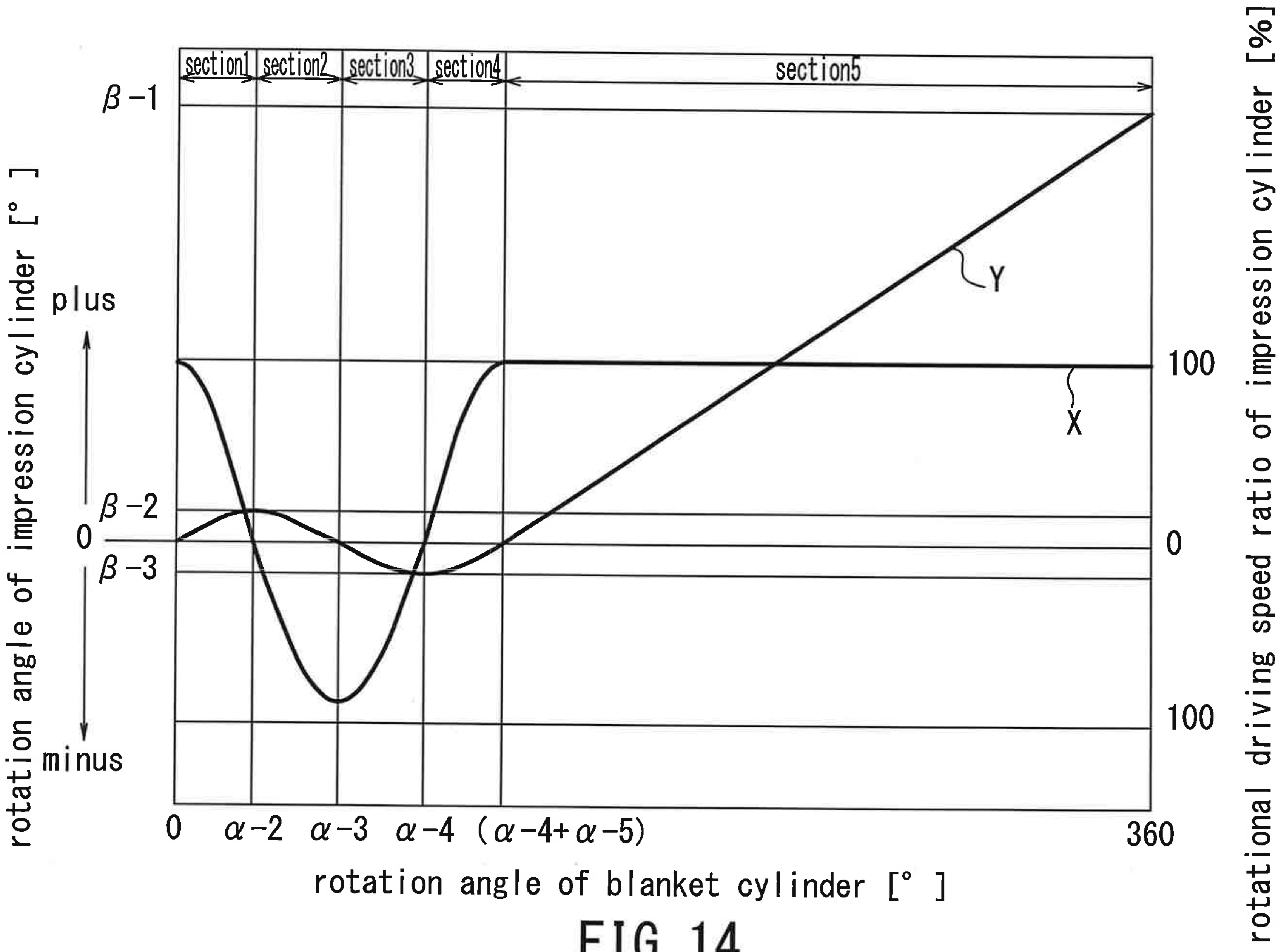
section1
section2
section3
section4
section5
β-1
plus
β-2
0
β-3
minus
rotation angle of impression cylinder [°]
Y
X
100
0
100
rotational driving speed ratio of impression cylinder [%]
0
α-2
α-3
α-4
(α-4+α-5)
360
rotation angle of blanket cylinder [°]

FIG. 14

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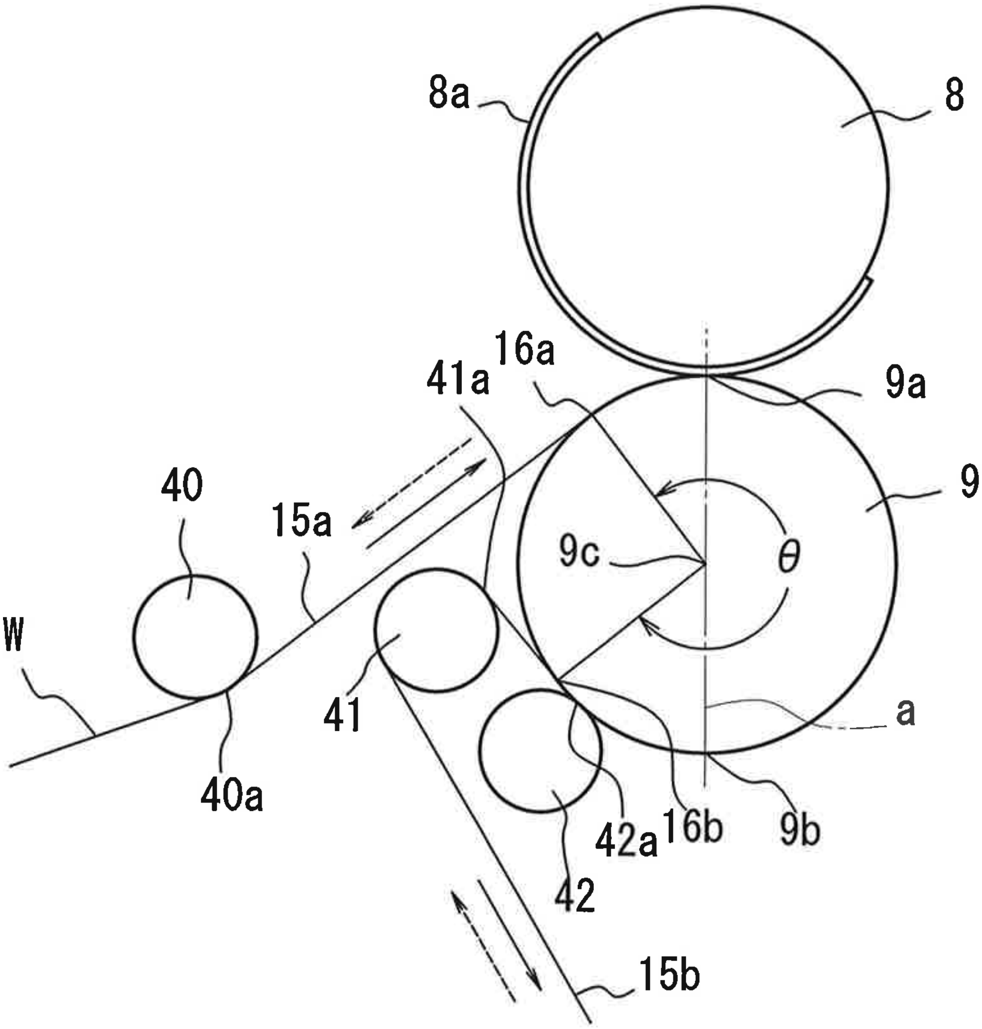

FIG. 15

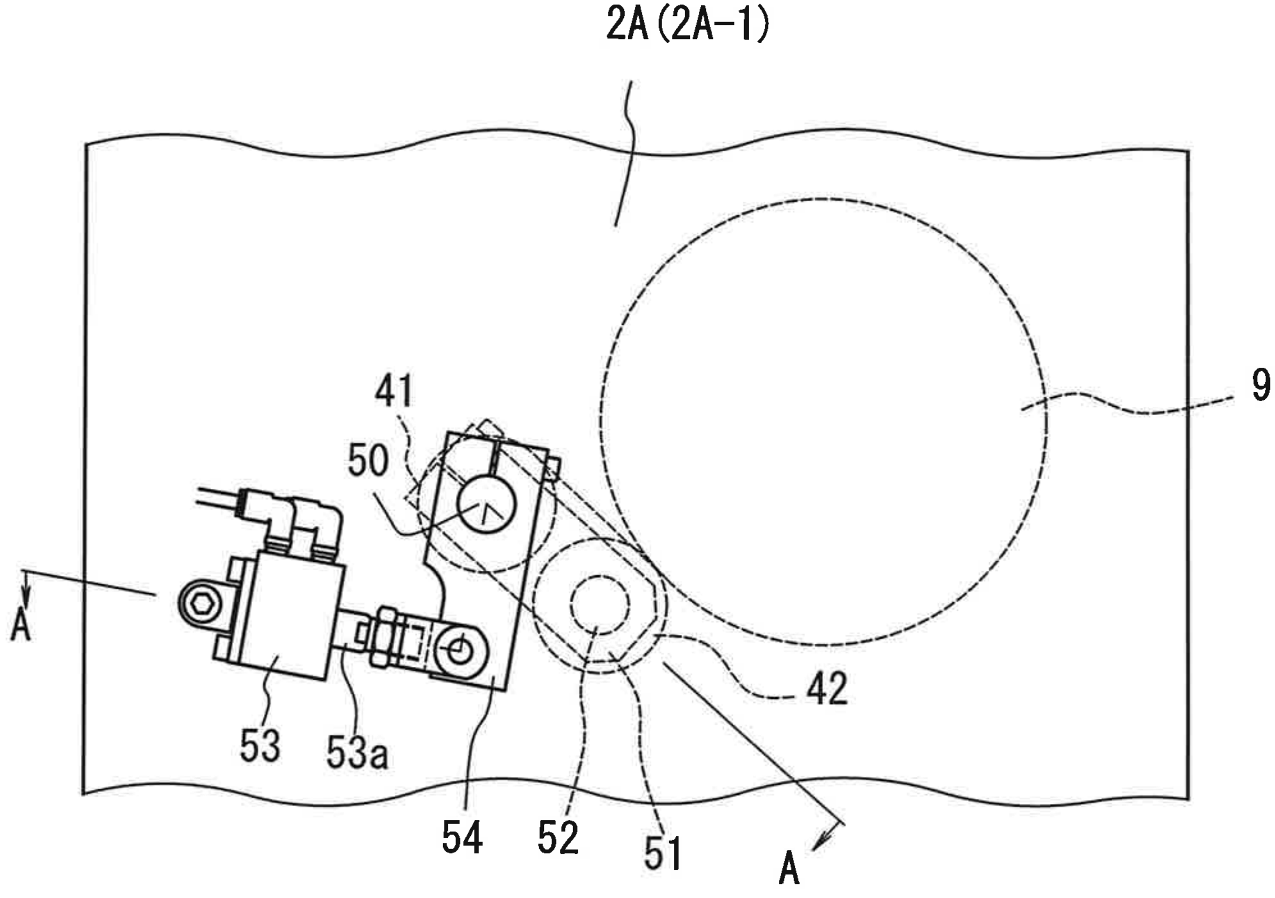

FIG. 16

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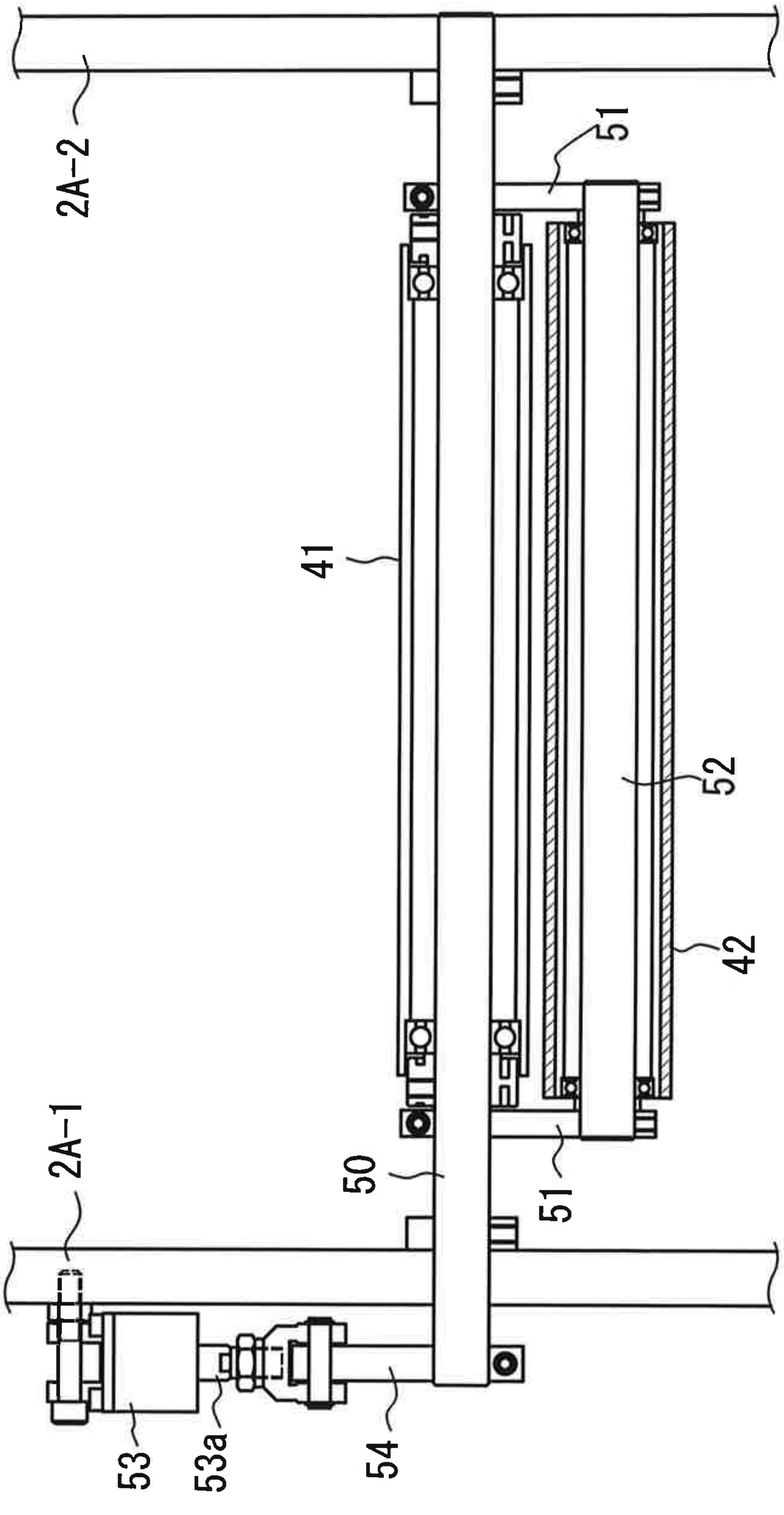

FIG. 17

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20202011139

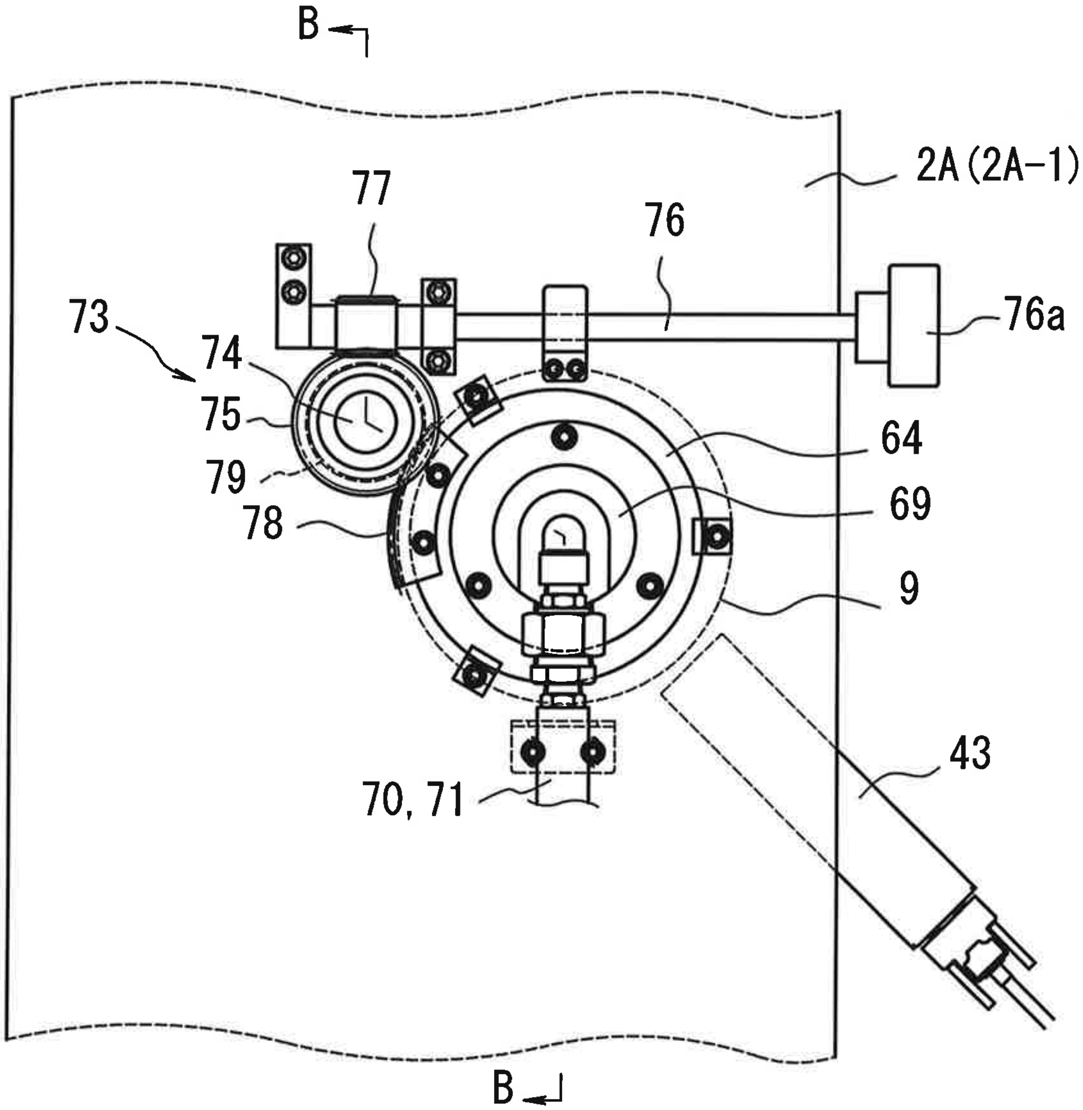
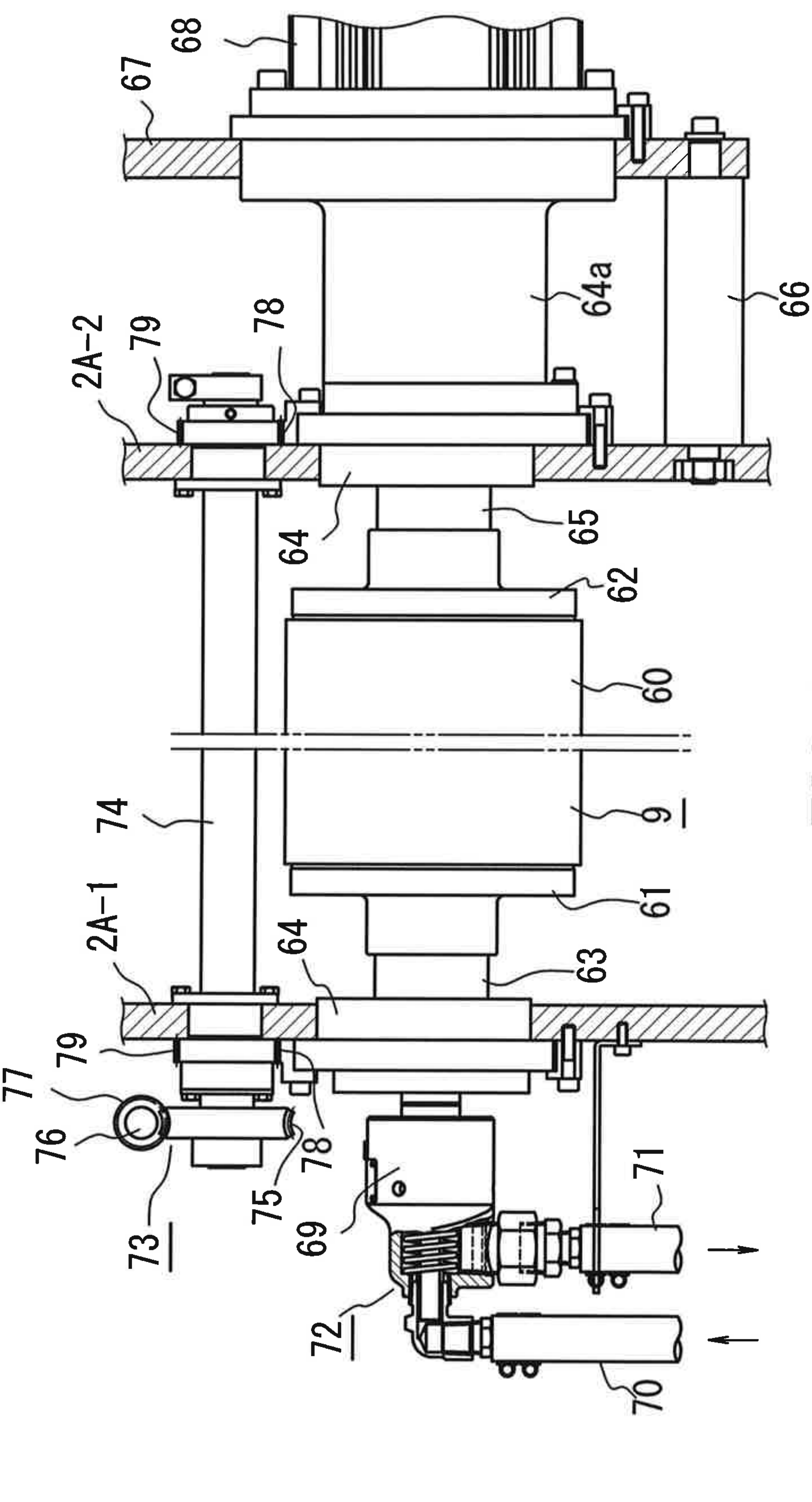


FIG. 18



68
67
2A-2
79
78
64a
66
64
65
62
60
9
74
61
2A-1
64
63
79
77
76
78
75
73
69
71
72
70

FIG. 19

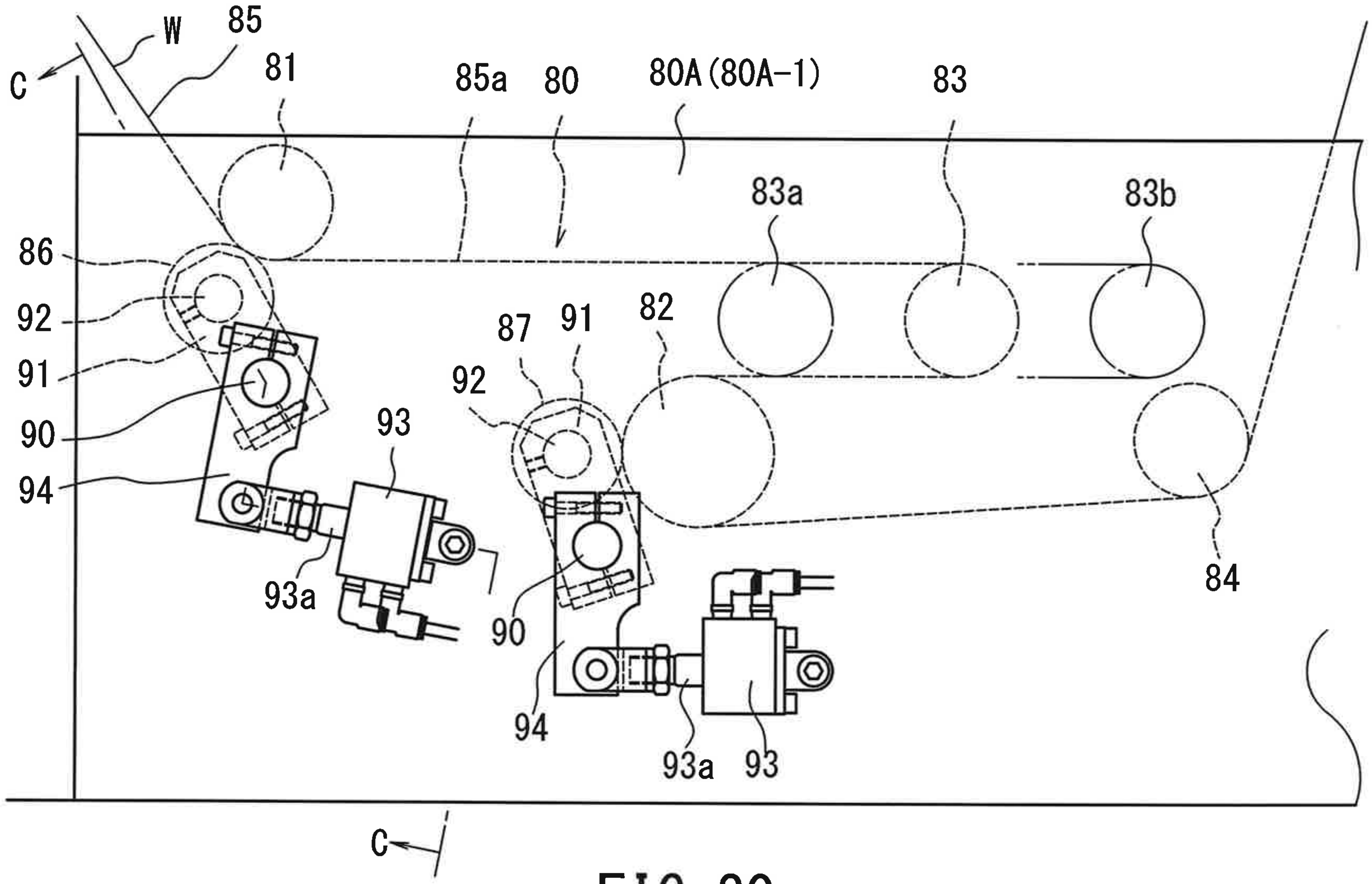

C
W
85
81
85a
80
80A (80A-1)
83
83a
83b
86
92
91
90
94
87
91
82
92
93
93a
90
94
93a
93
84
C

FIG. 20

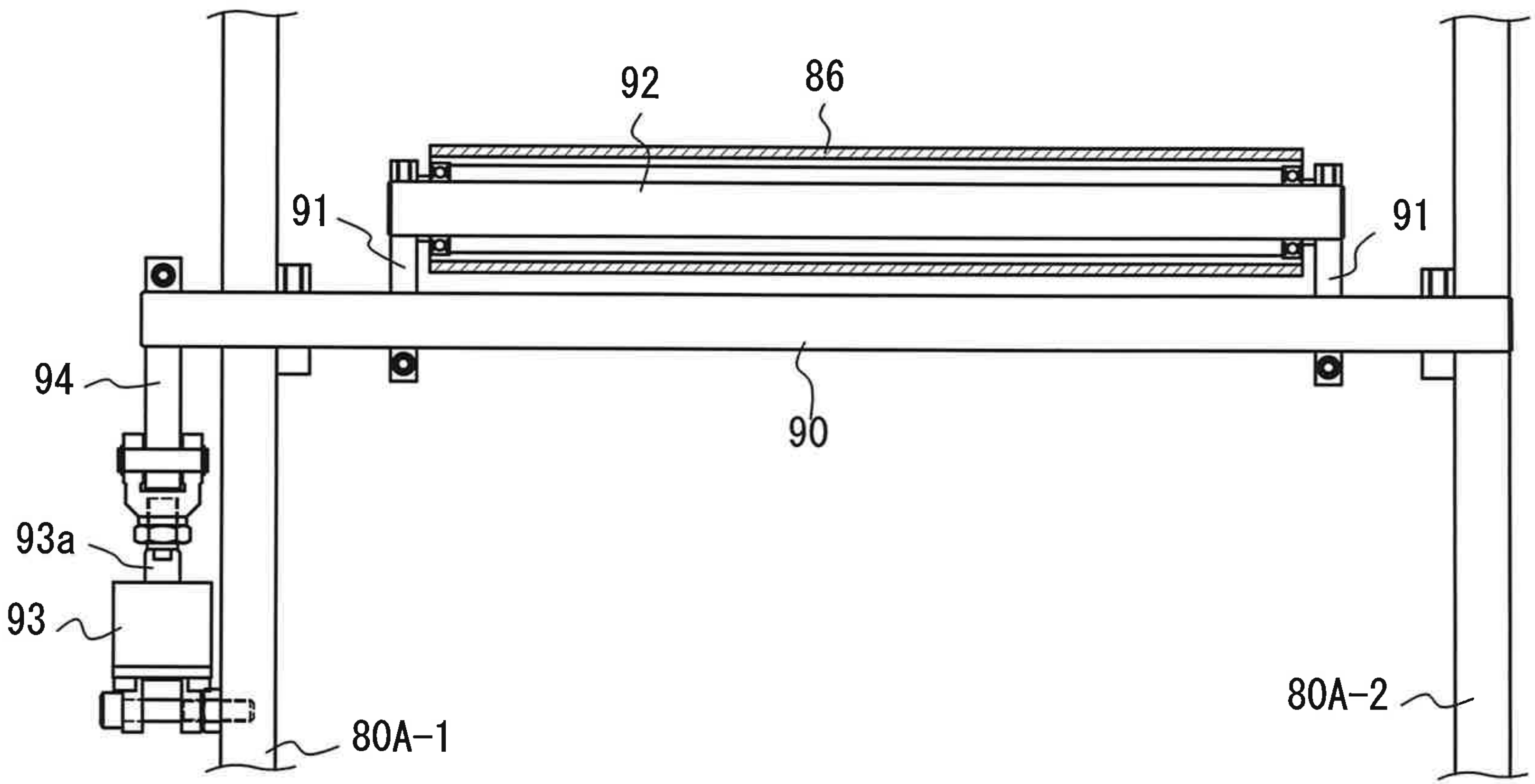


FIG. 21

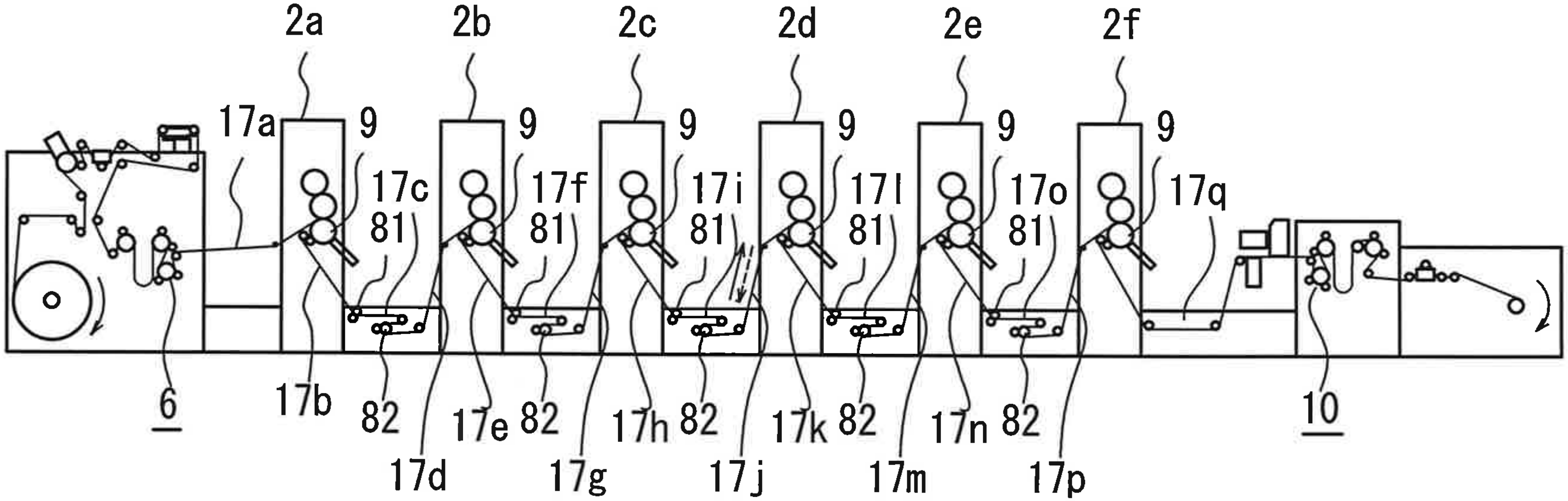

2a
2b
2c
2d
2e
2f
9
17a
17b
17c
17d
17e
17f
17g
17h
17i
17j
17k
17l
17m
17n
17o
17p
17q
81
82
6
10

FIG. 22

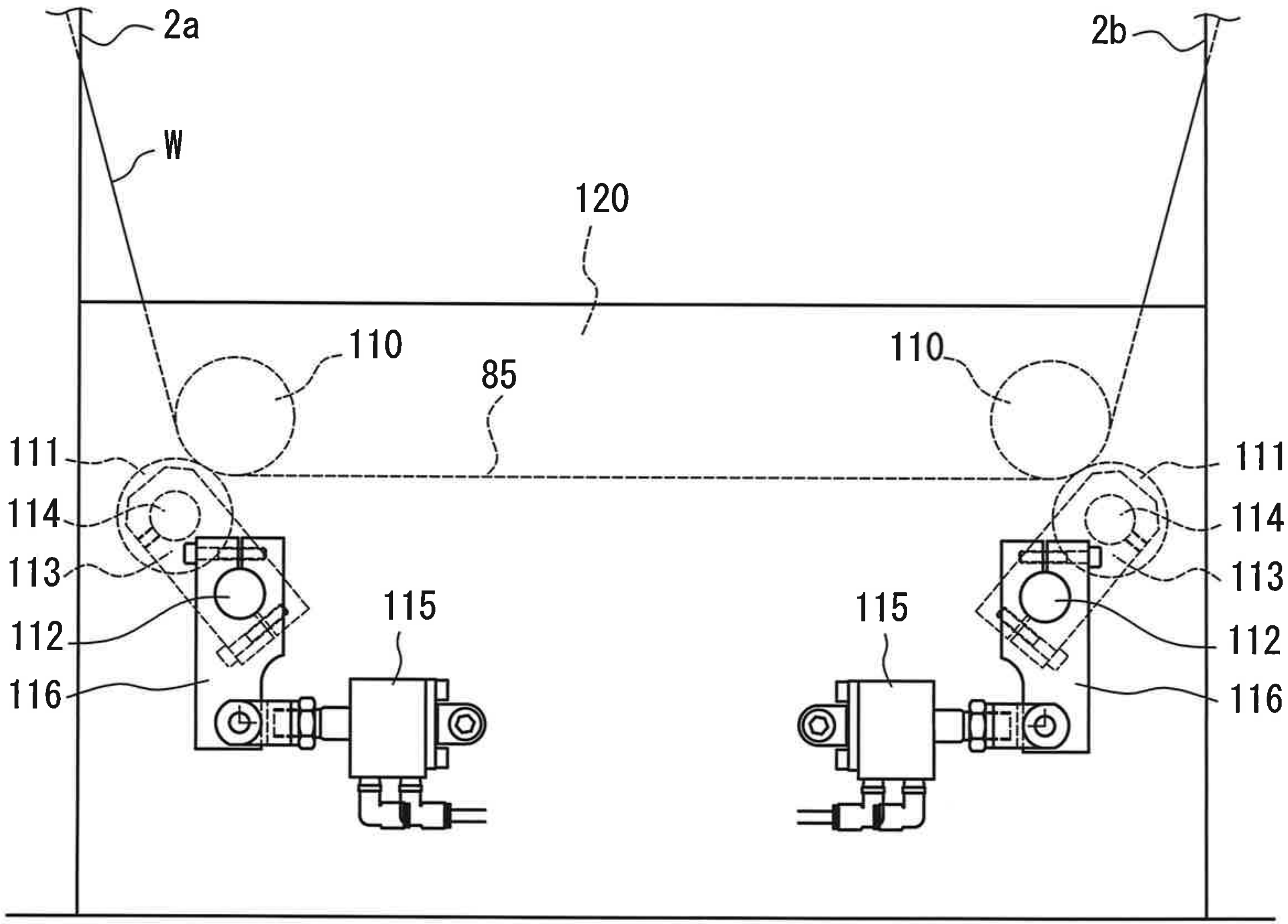

2a
W
2b
120
110
85
110
111
114
113
112
116
115
115
111
114
113
112
116

FIG. 23