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(72) Inventors:
• **Naruoka, Yoshihiko**
Tokyo 105-8001 (JP)
• **Asari, Yukio**
Tokyo 105-8001 (JP)

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(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(71) Applicant: **Kabushiki Kaisha Toshiba**
Minato-ku,
Tokyo 105-8001 (JP)

(54) **Sheet processing device**

(57) A posture control device (1) has a posture detecting section (12), an upstream conveying section (14), a posture control section (16), and a downstream conveying section (18) along a conveying path (10) for mail items. The distance from a nip of the upstream conveying section (14) and a nip of the posture control section (16) (D-E distance) is designed to be substantially as long as

the longest one of the mail items to be processed by the device which has the greatest length along a conveying direction. The distance from the nip of the posture control section (16) and a nip of the downstream conveying section (18) (E-F distance) is designed to be slightly longer the shortest one of the mail items to be processed by the device which has the shortest length along the conveying direction.

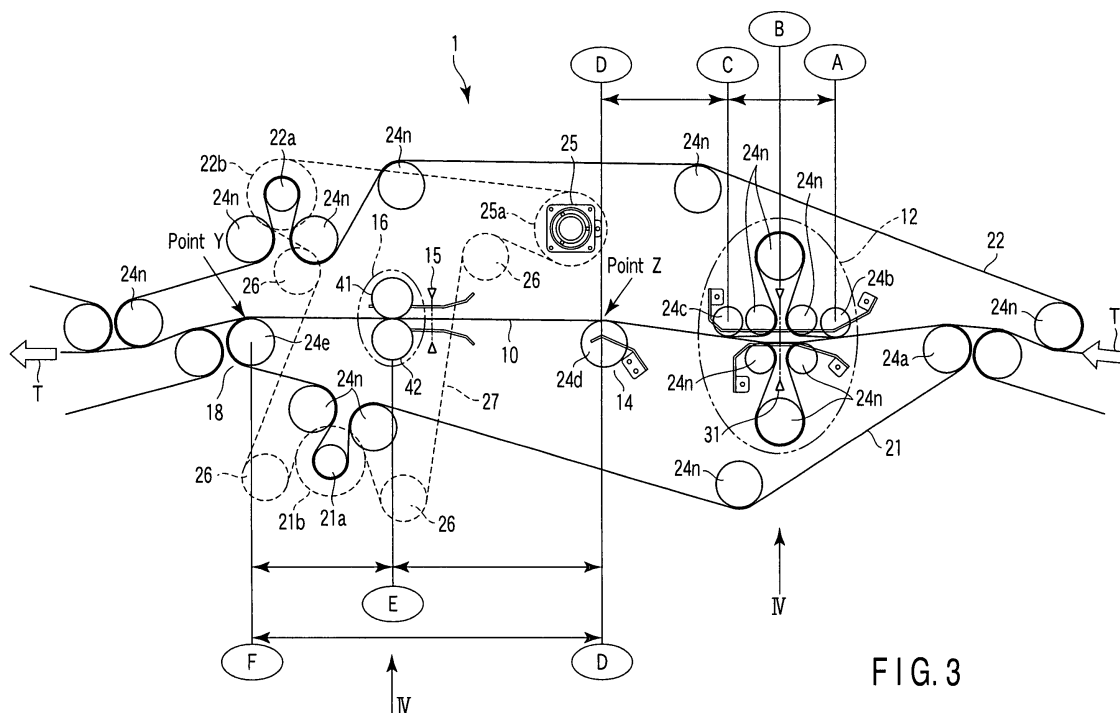


FIG. 3

Description

[0001] The present invention relates to a sheet processing device that controls the posture of sheets being conveyed at a high speed.

[0002] As a sheet processing device that controls the posture of sheets being conveyed, a device is conventionally known which corrects the skew of sheets conveyed while being nipped between belts (see, for example, Jpn. Pat. Appln. KOKAI Publication No. 2005-255406). This device has a taper roller shaped like a truncated cone and which rotates in contact with a sheet being conveyed and a driven roller that rotates while nipping the sheet between the driven roller and the taper roller. The device corrects the skew of the sheet by moving the driven roller in an axial direction to change a position where the driven roller is pressed against the taper roller to change a speed at which the sheet is fed through the nip between the two rollers.

[0003] However, the device conveys the sheet basically by using plural pairs of belts extending along a conveying direction on the opposite sides of a conveying path. Thus, for example, in an area outside the nip of the roller pair, located on the opposite sides of the conveying path, the sheet is restrained under a weak force. The posture of the sheet is thus likely to be disturbed. That is, with this device, even though the above-described taper roller is used to correct the skew of the sheet, the posture of the sheet stands a good chance of being disturbed in an area in which the sheet is conveyed only by the belt pair.

[0004] An object of the present invention is to provide a sheet processing device that can accurately and reliably control the posture of sheets such that the sheets assumes a desired posture even when the sheets are conveyed at a relatively high speed.

[0005] To accomplish this object, a sheet processing device according to the present invention comprising conveying belts positioned opposite each other across a conveying path and each extending so as to travel in a conveying direction, a posture control section which receives, at a nip, a sheet conveyed via the conveying path and which rotates while nipping and restraining the sheet to variably control a conveying posture of the sheet while applying a conveying force to the sheet, a downstream conveying section located downstream of the posture control section in a conveying direction to receive, at a nip, the sheet conveyed from the posture control section via the conveying path, the downstream conveying section rotating while nipping and restraining the sheet to apply a conveying force to the sheet, wherein a distance between the nip of the posture control section and the nip of the downstream conveying section is designed to be longer than a shortest one of sheets to be processed by the sheet processing device which has a shortest length along the conveying direction and to be equal to or shorter than a longest one of the sheets to be processed by the sheet processing device which has a great-

est length along the conveying direction.

[0006] The present invention avoids delivering the shortest sheet the conveying posture of which is being controlled such that the shortest sheet is nipped and restrained by the nip of the posture control section, to the nip of the downstream conveying section. This prevents the downstream conveying section from applying a conveying force to the shortest sheet the posture of which is being controlled. This in turn enables the posture of the shortest sheet to be accurately controlled and prevents an undesired stress from being applied to the shortest sheet. The shortest sheet is thus prevented from being stained, damaged, or jammed.

[0007] Furthermore, even when a sheet longer than the shortest sheet, for example, the longest sheet, is processed, the conveying posture of the sheet can be reliably and accurately controlled. That is, provided that the posture control section exhibits fixed processing capabilities, before the longest sheet is delivered to the downstream conveying section, the control of the posture of the longest sheet has been completed. This prevents the downstream conveying section from applying an undesired force to the longest sheet. The conveying posture of the longest sheet can thus be reliably and accurately controlled.

[0008] Moreover, since the distance between the nips is designed to be equal to or shorter than the longest sheet, the distance between the nips is prevented from being longer than required. The longest sheet the posture control of which has been completed can thus be subjected to delivery conveyance between the nips. Furthermore, the distance between the nips over which the shortest sheet remains free can be minimized. This makes it possible to substantially prevent the possible disturbance of the posture of the sheet subjected to the posture control.

[0009] The sheet processing device according to the present invention further has an upstream conveying section located upstream of the posture control section in the conveying direction to receive, at a nip, the sheet conveyed via the conveying path, the upstream conveying section rotating while nipping and restraining the sheet to apply a conveying force to the sheet. A distance between the nip of the upstream conveying section and the nip of the posture control section is designed to be longer than the longest sheet.

[0010] That is, according to the present invention, for the sheets of all the lengths, before the sheet is received at the nip of the posture control section, the sheet has been released from the nip of the upstream conveying section. This prevents the upstream conveying section from applying an undesired stress to the sheet the posture of which is being controlled. This in turn makes it possible to accurately control the posture of all the sheets and to prevent the sheet from being stained, damaged, or jammed.

[0011] The invention can be more fully understood from the following detailed description when taken in con-

junction with the accompanying drawings, in which:

FIG. 1 is a perspective view showing the appearance of a mail processing apparatus in which a posture control device is incorporated according to an embodiment of the present invention;

FIG. 2 is a block diagram of the configuration of the mail processing apparatus in FIG. 1;

FIG. 3 is a plan view schematically showing the structure of the posture control device incorporated in the mail processing apparatus in FIG. 3;

FIG. 4 is a partly enlarged view showing the structure of an essential part of the posture control device in FIG. 3;

FIG. 5 is a diagram illustrating another example of arrangement of optical sensors in a posture detecting section incorporated in the device control device in FIG. 3;

FIG. 6 is a schematic diagram of an essential part of the posture control device in FIG. 3, illustrating the layout of components of the posture control device;

FIG. 7 is a schematic diagram illustrating an example in which a plurality of posture control units are arranged along a conveying path;

FIG. 8 is a schematic diagram illustrating an example in which a plurality of posture control sections are arranged in one unit;

FIG. 9 is a schematic diagram showing another configuration layout of the posture control device; and

FIG. 10 is a schematic diagram showing yet another configuration layout of the posture control device.

[0012] An embodiment of the present invention will be described below with reference to the drawings. FIG. 1 shows a perspective view of the appearance of a mail processing apparatus 100 in which a posture control device 1 (described below) according to the embodiment of the present invention is incorporated. FIG. 2 shows a block diagram of the configuration of the mail processing apparatus 100. The mail processing apparatus 100 has a loading and supplying section 2, a preprocess section 3, an excluding and accumulating section 4, a reading and recognizing section 5, a printing section 6, and a sorting and accumulating section 7. The posture control device 1, functioning as a sheet processing device according to the present invention, is included in the preprocess section 3.

[0013] The mail processing apparatus 100 operates as described below.

[0014] First, an operator manually sets a plurality of mail items in the loading and supplying section 2, which carries one of the mail items onto a conveying path 10. In the present embodiment, mail items P are conveyed in an upright position via the conveying path 10. In this case, mail items determined by the preprocess section 3 to contain foreign matter or to have an irregular size are excluded and carried to the excluding and accumu-

lating section 4. At this time, in the preprocess section 3, the posture control device 1, described below, is actuated to control the posture of all the mail items conveyed via the conveying path 10 such that the mail items assume a desired posture (in the present embodiment, the posture in which the mail item is not skewed or shifted).

[0015] Subsequently, those of the mail items carried onto the conveying path 10 which can be processed are passed through the reading and recognizing section 5 such that a barcode pre-applied to each of the mail items is read from the mail item. Thus, sorting information such as a postal code and an address which are described on a surface of the mail item is recognized. Then, on the basis of the sorting information acquired by the reading and recognizing section 5, a barcode in a special format is printed on the mail item via the printing section 6. The mail item is then subjected to a verify read operation.

[0016] Moreover, on the basis of the sorting information on the mail item, a sorting destination is assigned to the mail item. The mail item is then assigned to and accumulated in an appropriate stacker in the sorting and accumulating section 7.

[0017] As described above, the posture control device 1 controls the conveying posture of the mail item P such that the mail item P stands straight immediately after the mail item P is carried onto the conveying path 10. This enables the reading and recognizing section 5 to reliably read the barcode and the sorting information. The rate of recognition of the mail item P can thus be increased.

[0018] The conveying path 10 extends from the loading and supplying section 2 through the preprocess section 3, the reading and recognizing section 5, and the printing section 6 to the sorting and accumulating section 7. The mail item conveyed along the conveying path 10, extending downstream of the posture control device 1, to the sorting and accumulating section 7 is basically subjected to delivery conveyance so as to be nipped and restrained by a nip of rollers or a nip of belts in order to prevent the conveying posture of the mail item from being varied. The delivery conveyance means that the mail item conveyed while being nipped and restrained by the upstream nip is delivered to the downstream nip, the mail item is positively conveyed so as to be nipped and restrained by at least one of the nips in order to prevent the mail item from being free between the nips. That is, for the delivery conveyance, the nips may be basically arranged such that the distance between the adjacent nips is shorter than the shortest one P_{min} (shortest sheet) of the mail items to be processed by the device which has the shortest length along the conveying direction.

[0019] The posture control device 1, incorporated in the preprocess section 3, will be described below in detail. FIG. 3 shows a plan view of the posture control device 1 as viewed from above. FIG. 4 shows a partly enlarged view of the configuration of an essential part of the posture control device 1. In FIG. 4, a conveying belt 21 located frontward in the direction of arrow IV in FIG. 3 is removed so as to allow the structure to be easily seen.

[0020] The posture control device 1 has a posture detecting section 12 (detecting section), an upstream conveying section 14, a posture control section 16, and a downstream conveying section 18 arranged along the conveying path 10 in this order from an upstream side in a direction in which the mail item P (sheet) is conveyed (the direction of arrow T). A base plate 11 (see Figure 4) is located below the conveying path 10. A slot 11a (see FIG. 6) is formed in the base plate 11 near the posture control section 16 in order to avoid interfering with the mail item P.

[0021] Conveying belts 21 and 22 are provided on the respective sides of the conveying path 10, extending though the posture control device 1, and extends so as to be travelable along the conveying direction T. The conveying belts 21 and 22 are wound around a plurality of pulleys 24a, 24b, 24c, 24d, 24e, and 24n and extend endlessly. The conveying belts 21 and 22 are arranged opposite each other so as to sandwich the conveying path 10 between the belts 21 and 22. In other words, the conveying path 10 is defined by the two conveying belts 21 and 22. That is, the mail item P fed into the posture control device 1 via the conveying path 10 is conveyed along the conveying path 10 while being nipped between the paired conveying belts 21 and 22 under a weak conveying force.

[0022] The two conveying belts 21 and 22 travel synchronously along the conveying direction T at the same speed by means of one motor 25. That is, the conveying belts 21 and 22 are wound around driving shafts 21a and 22a at an angle of at least 180 degrees; the driving shafts 21a and 22a transmit the driving force of the motor 25 to the conveying belts 21 and 22, respectively. The driving force of the motor 25 is transmitted to the conveying belts 21 and 22 via an endless driving belt 27 placed around driving pulleys 21b and 22b attached to the driving shafts 21a and 22a, a motor pulley 25a for the motor 25, and a plurality of other pulleys 26.

[0023] It is assumed that the mail item P is conveyed only by the paired conveying belts 21 and 22. Then, when the mail item P is conveyed at a high speed of about 6 to 7 m/s, if the mail item P is thin and light or is bent, the conveying posture of the mail item is likely to be disturbed by wind pressure caused by the traveling of the mail item. Thus, nips are normally provided at a plurality of points along the conveying path 10; the nips can apply a conveying force to the mail item P while nipping and restraining the mail item P under a relatively strong clamp force.

[0024] That is, the distance between the nips is designed to be slightly shorter than the shortest one Pmin (shortest sheet) of the mail items P to be processed by the device 1. The term "nip" as used herein refers to a point where a relatively strong conveying force can be applied to the mail item P, such as a point where rollers are pressed against and contact with each other via the conveying path 10 or a point where the two conveying belts 21 and 22 are overlappingly wound around one pulley.

[0025] In the present embodiment, the following areas function as nips capable of nipping and restraining the mail item P to apply a sufficient conveying force to the mail item P: an area in which the two conveying belts 21 and 22 are overlappingly wound around the pulley 24a, located most upstream along the conveying direction and included in the pulleys around which the conveying belt 21, located forward in the direction of arrow IV in FIG. 3, is wound (this area is hereinafter referred to as the nip of the pulley 24a), an area in which the two conveying belts 21 and 22 are overlappingly wound around the pulley 24b, located downstream of and close to the pulley 24a and included in the pulleys around which the conveying belt 22, located inward in the direction of arrow IV, is wound (this area is hereinafter referred to as the nip of the pulley 24b), an area in which the two conveying belts 21 and 22 are overlappingly wound around the downstream pulley 24c (this area is hereinafter referred to as the nip of the pulley 24c), an area in which the two conveying belts 21 and 22 are overlappingly wound around the pulley 24d of the upstream conveying section 14 (point Z), an area in which a driving roller 41 and a driven roller 42 of the posture control section 16 described below are pressed against and contacted with each other away from the conveying belts 21 and 22 via the conveying path 10 (this area is hereinafter referred to as the nip of the posture control section 16), and an area in which the two conveying belts 21 and 22 are overlappingly wound around the pulley 24e of the downstream conveying section 18 (point Y).

[0026] The posture detecting section 12 has a plurality of optical sensors 31 of a type in which a light receiving element receives light beams emitted by a light emitting element. The plurality of optical sensors 31 are arranged such that the light beams cross the conveying path 10. As shown in FIG. 4, the optical sensors 31 are also juxtaposed in the vertical direction of FIG. 4, which is orthogonal to the conveying direction T. To be exact, the plurality of optical sensors 31 are positioned and arranged such that the light beams from the optical sensors 31 pass through positions on the conveying path 10 arranged at equal intervals in the vertical direction. When the mail item P is conveyed via the conveying path 10, the light beams from the optical sensors are blocked by the mail item P to detect the skew or shift amount of the mail item P, that is, the conveying posture.

[0027] The posture detecting section 12 of the type in which the optical sensors 31 are juxtaposed in the vertical direction is a well-known technique. Thus, the detailed description of a posture detecting method is omitted. Alternatively, to increase the accuracy of posture detection, two rows of a plurality of optical sensors 32 may be staggeringly arranged to improve detecting resolution, for example, as shown in FIG. 5. Moreover, the optical sensors 31 need to be arranged in an area in which the mail item P is nipped between the conveying belts 21 and 22. Thus, in the present embodiment, the positions where the conveying belts 21 and 22 travel are bent as shown in FIG.

3 so that the conveying belts 21 and 22 travel outside the light emitting elements and light receiving elements of the optical sensors 31.

[0028] As shown in FIG. 6, the posture control section 16 has paired rollers which receive, at the nip (the nip of the posture control section 16), the mail item P conveyed via the conveying path 10 and which rotate while nipping and restraining the mail item to apply a conveying force to the mail item P, that is, the driving roller 41 and the driven roller 42. As shown in FIG. 4, the driving roller 41 is divided into an upper driving roller 41U and a lower driving roller 41L which can be drivingly controlled independently. Although not shown in FIG. 4, the driven roller 42 is also divided into an upper driven roller 42U and a lower driven roller 42L.

[0029] The driven rollers 42U and 42L may be pinch-contacted with the driving rollers 41U and 41L, arranged opposite each other across the conveying path 10. However, in the present embodiment, the rollers are each composed of two coaxially arranged rubber layers 421 and 422 having different hardnesses as shown in FIG. 6. A rotating shaft of the driving roller 41 and a rotating shaft of the driven roller 42 are fixedly arranged on the conveying path 10. Thus, when the mail item P passes through the nip between the rollers, an inner layer 421 in the driven roller 42 which has a lower hardness is elastically deformed to slightly deform the driven roller 42 away from the conveying path 10. The driven roller 24 can thus be prevented from jumping up from the conveying path 10. This makes it possible to absorb a difference in thickness among the mail items P and to apply a sufficient force to all the mail items P.

[0030] Referring back to FIG. 4, the upper and lower driving rollers 41U and 41L, into which the driving roller is divided, are connected to a servo motor 44 via a coupling 43. However, by independently rotating the upper driving roller 41U and the lower driving roller 41L at a desired speed, it is possible to adjust the skew or shift of the mail item P being conveyed along the conveying path 10, to a desired value. The posture control method in the posture control section 16 is also a well-known technique. The detailed description of the posture control method is omitted.

[0031] In actuality, before the mail item P the conveying position of which has been detected by the posture detecting section 12 reaches the posture control section 16, an appropriate rotation speed for the upper and lower driving rolls 41U and 41L has been calculated on the basis of a detection result from the posture detecting section 12. When the mail item P enters the nip of the posture control section 16, the upper and lower driving rollers 41 (and the upper and lower driven rollers 42) are being rotated at the control speed.

[0032] In other words, the distance between the position detecting section 12 and the posture control section 16 is designed to be equal to the distance corresponding to the time required to calculate the posture of the mail item P, that is, the skew or shift amount of the mail item

P and the time required to control the rotation speed of the rollers 41 and 42 of the posture control section 16 to a target value. A timing sensor 15 (FIG. 3) located upstream of the posture control section 16 in the conveying direction is provided to acquire timing at which the mail item P, a target of posture control, reaches the posture control section 16.

[0033] As described above, when the paired conveying belts 21 and 22 are used to convey the mail item P, the nips basically need to be arranged at a distance shorter than the shortest mail item P_{min} so as not to disturb the conveying posture of the mail item P. For example, the distance between the nip (point A) of the pulley 24b of the posture detecting section 12 and the nip (point C) of the pulley 24c of the postured detecting section 12 is shorter than the shortest mail item P_{min}. The distance between point C and point Z (point D) is also shorter than the shortest mail item P_{min}.

[0034] In particular, setting the distance between points A and C shorter than the shortest mail item P_{min} makes it possible to prevent a possible variation in the conveying posture of the mail item P the posture of which is being detected. Setting the distance between points C and D shorter than the shortest mail item P_{min} makes it possible to maintain the conveying posture of the mail item P the posture of which has been detected. The mail item P kept in the detected position can then be fed into the posture control section 16.

[0035] However, the positions of the nips nipping and restraining the mail item P which positions precede and succeed the posture control section 16, that is, the positions of points Z and Y in FIG. 3, cannot be determined on the basis of the delivery conveyance of the mail item P as in the case of the other nips. That is, when the mail item P nipped and restrained by the nip between the driving roller 41 and driven roller 42 of the posture control section 16 is simultaneously nipped by the nip of the upstream conveying section 14 or the nip of the downstream conveying section 18, twisting stress may be applied to the mail item the posture of which is being controlled. This prevents the correct posture control and may cause the mail item P to be stained, damaged, or jammed.

[0036] Thus, in the present embodiment, the position of the nip (that is, a point F) of the downstream conveying section 18 is determined such that the distance between the nip (point E) of the posture control section 16 and the nip (point F or Y) of the downstream conveying section 18 is longer than the shortest mail item P_{min} and equal to or shorter than the longest one P_{max} (longest sheet) of the mail items P to be processed by the posture control device 1 which has the greatest length along the conveying direction. This makes it possible to prevent the mail items P the posture control of which has not been completed from being disadvantageously nipped and restrained by the nip of the downstream conveying section 18. The conveying posture can thus be accurately controlled and substantially prevented from being disturbed after the posture control.

[0037] That is, by setting the distance between E and F greater than the length of the shortest mail item Pmin along the conveying direction, it is possible to prevent the delivery, to the nip of the downstream conveying section 18, of the conveying-direction leading end of the shortest mail item Pmin the conveying posture of which is being controlled such that the mail item Pmin is nipped and restrained by the nip of the posture control section 16. Thus, the downstream conveying section 18 does not apply a conveying force to the shortest mail item Pmin the posture of which is being controlled. This prevents the possible situation in which an undesired stress is applied to the shortest mail item Pmin to disturb the conveying posture or to cause the mail item Pmin to be stained, damaged, or jammed.

[0038] In the present embodiment, the processing speed (throughput) of the posture control section 16 required for the posture control of one mail item P is set to the smallest value at which the posture control of the shortest mail item Pmin can be completed after the arrival of the conveying-direction leading end of the shortest mail item Pmin at the nip of the posture control section 16 and before the exit of the conveying-direction trailing end of the shortest mail item Pmin from the nip. That is, the processing speed is set such that the posture control is started when the conveying-direction leading end of the shortest mail item Pmin reaches the nip of the posture control section 16 and is completed when the conveying-direction trailing end of the shortest mail item Pmin leaves the nip. Although an increase in the time required for the posture control enables an increase in the accuracy of the posture control, the increased control time reduces the throughput. Thus, in the present embodiment, a speed at which the mail item P is conveyed is set to a desired value, and the processing speed of the posture control section 16 is set to allow the posture of the shortest mail item Pmin to be controlled.

[0039] Thus, even if a mail item longer than the shortest mail item Pmin, for example, the longest mail item Pmax, is to be processed, the posture control section 16 completes the posture control of the longest mail item Pmax in the relatively short time required for the posture control of the shortest mail item Pmin. That is, before the conveying-direction leading end of the longest mail item Pmax is delivered to the nip of the downstream conveying section 18, the posture control of the longest mail item Pmax by the posture control section 16 has been completed.

[0040] That is, as described above, setting the distance between points E and F longer than the shortest mail item Pmin prevents at least the conveying-direction leading end of the mail item P the posture of which is being controlled such that the mail item P is nipped and restrained by the nip of the posture control section 16, from reaching the nip of the downstream conveying section 18 regardless of the length of the mail item P. This in turn prevents the downstream conveying section 18 applying an undesired stress to the mail item P the pos-

ture of which is being controlled. The posture of the mail items of all the lengths can be accurately controlled, preventing possible staining, damaging, or jamming.

[0041] However, setting the distance between points E and F longer than required causes the shortest mail item Pmin the posture control of which has been completed to remain free over a relatively long distance in such a manner that the shortest mail item Pmin is not nipped or restrained by any nip, until the conveying-direction leading end of the shortest mail item Pmin is delivered to the nip of the downstream conveying section 18. In this case, while the shortest mail item Pmin is free, the conveying posture of the shortest mail item Pmin stands a good chance of being disturbed. Thus, it is desirable to avoid setting the distance between points E and F longer than required.

[0042] That is, the distance between points E and F is desirably set slightly greater than the conveying-direction length of the shortest mail item Pmin. However, by setting the distance between the nips at least equal to or shorter than the length of the longest mail item Pmax along the conveying direction, it is possible to prevent the longest mail item Pmax from being away from the nip and free. In other words, setting the distance between points E and F longer than the longest mail item Pmax is no meaning. Increasing the inter-nip distance above this value simply increases the possibility of disturbing the conveying posture.

[0043] In the present embodiment, the position of the nip (that is, point D) is determined such that the distance between the nip (point D or Z) of the upstream conveying section 14 and the nip (point E) of the posture control section 16 is at least greater than the length of the longest mail item Pmax along the conveying direction.

[0044] In the present embodiment, as described above, the speed of the driving roller 41 and driven roller 42 of the posture control section 16 is controlled to the target value after the posture detecting section 12 detects the posture of the mail item P being conveyed via the conveying path 10 and before the mail item P reaches the posture control section 16. Thus, the posture control of the mail item P is started when the conveying-direction leading end of the mail item P enters the nip of the posture control section 16.

[0045] Thus, to prevent the upstream conveying section 14 from applying an undesired stress to the mail item P the posture of which is being controlled by the posture control section 16, it is necessary that the conveying-direction trailing end of the mail item leave the nip of the upstream conveying section 14 before the conveying-direction leading end of the mail item P reaches the nip of the posture control section 16. Thus, in the present embodiment, the distance between points D and E is designed to be longer than the longest mail item Pmax.

[0046] However, setting the distance between points D and E longer than the longest mail item Pmax causes the shortest mail item Pmin to remain free between points D and E over a relatively long distance in such a manner

that the shortest mail item P_{min} is restrained by any nip. The increased length of the conveying section in which the mail item is free may cause the conveying posture to be distributed. This is not preferable. Thus, in the present embodiment, the distance between points D and E is designed to be substantially the same as the minimum required distance, that is, the length of the longest mail item P_{max} .

[0047] The expression "substantially the same length" as used herein involves a distance slightly shorter than the longest mail item P_{max} and a distance slightly greater than the longest mail item P_{max} . For example, when the distance between points D and E is set slightly shorter than the longest P_{max} , the trailing end of the longest mail item P_{max} has not left the nip of the upstream conveying section 14 at the moment when the leading end of the longest mail item is nipped by the nip of the posture control section 16. However, immediately after the posture control section 16 starts the posture control, the trailing end of the longest mail item P_{max} leaves the nip of the upstream conveying section 14. This prevents a stress sufficient to cause staining, damaging, or jamming from acting on the longest mail item P_{max} .

[0048] In other words, no problem occurs when a stress insufficient to cause the staining, damaging, or jamming of the longest mail item P_{max} acts on the longest mail item P_{max} the posture of which is being controlled. Accordingly, the distance between points D and E can be set shorter than the longest mail item P_{max} so that the resulting distance is within an allowable range. Thus, reducing the distance between points D and E as much as possible enables a reduction in the distance over which the shortest mail item P_{min} remains free during the conveyance. The factors disturbing the posture of the shortest mail item can thus be reduced.

[0049] As described above, according to the present embodiment, for the mail items P of all the lengths the posture control of which has been started, the present embodiment can prevent the upstream conveying section 14 from applying an undesired stress to the mail item. This makes it possible to prevent upstream conveying section 14 from affecting the posture control of the mail item P, thus preventing the mail item P from being stained, damaged, or jammed. Furthermore, the distance over which the shortest mail item P_{min} remains free during the conveyance can be reduced, enabling reliable and accurate posture control.

[0050] For the above-described reasons, it is optimum to design the distance between points D and E to be substantially as long as the length of the longest mail item P_{max} along the conveying direction. However, the length of the free conveying section between points D and E in which the mail item P is not nipped or restrained by the nip varies depending on the allowable amount of the disturbance of the posture for the mail item being conveyed through this section.

[0051] That is, if the allowable amount is present for the disturbance of the conveying posture of the mail item

P fed into the posture control section 16 after the posture of the mail item P has been detected by the posture detecting section 12, the length between points D and E can be correspondingly increased. However, it is difficult to quantify the behavior of the mail item P in the free conveying section because of uncertainties such as the surface condition of the mail item P, the surface condition of the conveying belts 21 and 22, process speed, that is, the speed at which the mail item P is conveyed, and bending of the mail item P.

[0052] From another standpoint, in the present embodiment, the distance from the posture detecting section 12 to the upstream conveying section 14 is designed to be short but still enough to perform the delivery conveyance on the mail item P the posture of which has been detected, without changing the conveying posture. Specifically, the distance between the most downstream restrain position in the posture detecting section 12, that is, the nip (point C) of the pulley 24c, and the nip (point D) of the upstream conveying section 14 is shorter than the shortest mail item P_{min} . This allows the mail item P the posture of which has been detected to be fed into the upstream conveying section 14 without changing the posture of the mail item P. The possible disturbance of the conveying posture can thus be more reliably prevented.

[0053] On the other hand, as described above, in the present embodiment, the B-E distance between the posture detecting section 12 and the posture control section 16 is designed to be the minimum required distance corresponding to the time required to calculate the amount by which the posture control section 16 needs to control the posture of the mail item P and the time required to control the speed of the driving roller 41 to the target value. This prevents the distance between points B and E from increasing indefinitely. That is, if the distance between points B and E is increased to allow for the time for the control, an additional nip capable of applying a conveying force to the mail item P is appropriately provided between the posture detecting section 12 and the upstream conveying section 14.

[0054] That is, the D-E distance between the upstream conveying section 14 and the posture control section 16 is prevented from being longer than the conveying-direction length of the longest mail item P_{max} . In other words, if the distance between points D and E is excessively longer than the longest mail item P_{max} , the posture of the mail item stands a better chance of being changed between points D and E, that is, in the belt nipping section with a weak conveying force.

Thus, as described above, the distance between points D and E is desirably substantially equivalent to the length of the longest mail item P_{max} .

[0055] As described above, the present embodiment appropriately sets the positions of the nips arranged upstream and downstream, respectively, of the posture control section 16. This makes it possible to prevent an undesired stress from being applied to the mail item P the posture of which is being controlled, allowing the pos-

ture control operation to be stably performed. Furthermore, the mail item P can be prevented from being stained, damaged, or jammed during the posture control, allowing the conveying posture of the mail item P to be reliably and accurately controlled.

[0056] Another embodiment of the present invention will be described below with reference to FIGS. 7 and 8. Components of this embodiment which function similarly to those of the above-described embodiment are denoted by the same reference numerals and will not be described in detail.

[0057] In the description of the above embodiment, the posture control section 16 is provided at only one point in the middle of the conveying path 10 to perform one control operation such that the mail item P assumes the desired posture. However, for example, as shown in FIG. 7, a plurality of the posture control sections 16 are juxtaposed along the conveying path 10 so as to perform the respective control operations on the conveying posture of the mail item P. This makes it possible to deal with any posture control while conveying the mail item P at a high speed to increase the throughput.

[0058] In this case, posture control units 50 may each be composed of the upstream conveying section 14, the posture control section 16, and the downstream conveying section 18. These components may be arranged such that the mail item P is subjected to the delivery conveyance between the adjacent units 50.

Specifically, each of the following distances is set slightly shorter than the conveying-direction length of the shortest mail item P_{min}: the distance between the nip of the downstream conveying section 18 of a conveying-direction upstream unit 50a and the nip of the upstream conveying section 14 of a conveying-direction downstream unit 50b and the distance between the nip of the downstream conveying section 18 of the unit 50b and the nip of the upstream conveying section 14 of a further conveying-direction downstream unit 50c.

[0059] Alternatively, as shown in FIG. 8, a plurality of posture control sections 16a and 16b may be arranged in one posture control unit 60. In this case, the following distances may be designed as is the case with the above-described embodiment: the distance between the nip of the upstream conveying section 14 and the nip of the conveying-direction upstream position control section 16a (D-E1 distance) and the distance between the nip of the conveying-direction downstream conveying section 16b and the nip of the downstream conveying section 18 (E2-F distance). Furthermore, the following distance may be designed to be slightly greater than the length of the longest mail item P_{max} along the conveying direction: the distance between the nip of the upstream posture control section 16a located adjacent to the above-described posture control unit 60 in the conveying direction and the nip of the downstream control section 16b located adjacent to the above-described posture control unit 60 in the conveying direction (E1-E2 distance).

[0060] In each of the embodiments shown in FIGS. 7

and 8, the number of posture control sections 16 can be optionally set and varied depending on the operational status of the position control device 1.

[0061] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein.

[0062] Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

[0063] For example, in the description of the above embodiments, the posture control device 10 is incorporated in the mail processing apparatus 100. However, the present invention is not limited to this. For example, the present invention may be applied as a posture control device for a bill processing apparatus that processes bills.

[0064] Furthermore, the above-described embodiment focuses on the position of the upstream conveying section 14 located upstream of and closest to the posture control section 16 in the conveying direction the position of the downstream conveying section 18 located downstream of and closest to the posture control section 16 in the conveying direction.

However, the present invention is also applicable to a layout in which other pulleys or conveying belts are present on the conveying path 10 between the nip of the posture control section 16 and the nip (point Y) of the downstream conveying section 18 as shown in FIG. 9 or a layout in which other pulleys or conveying belts are present on the conveying path 10 between the nip (point Z) of the upstream conveying section 14 and the nip of the posture control section 16 as shown in FIG. 10.

[0065] That is, in this case, for example, in the layout shown in FIG. 9, conveying belts 73 and 74 are independently wound around pulleys 71 and 72 arranged between the nip of the posture control section 16 and the nip of the downstream conveying section 18. In this area, a strong conveying force is not applied to the mail item P being conveyed along the conveying path 10. That is, in this layout, the nip located downstream of and closest to the posture control section 16 in the conveying direction is an area (point Y) in which two conveying belts 75 and 76 are overlappingly wound in the downstream conveying section 18.

[0066] Also in the layout shown in FIG. 10, the nip located downstream of and closest to the posture control section 16 is an area (point Y) in which two conveying belts 81 and 82 are overlappingly wound around one pulley 83. Another nearby pulley 84 and a conveying belt 85 do not function so as to apply a sufficient conveying force to the mail item P being conveyed.

[0067] Furthermore, in this layout, the nip located upstream of and closest to the posture control section 16 is an area (point Z) in which two conveying belts 86 and 87 are overlappingly wound around one pulley 88. Other

pulleys 89 around which the conveying belts 86 and 87 are wound do not function so as to form a nip.

[0068] That is, regardless of whatever layout is adopted, the effects of the present invention can be enjoyed by setting the appropriate distance between the nip of the posture control section 16 and a nip standing a chance of to apply an undesired stress to the mail item P the posture of which is being controlled by the posture control section 16.

Claims

1. A sheet processing device comprising:

conveying belts (21, 22) positioned opposite each other across a conveying path (10) and each extending so as to travel in a conveying direction;

a posture control section (16) which receives, at a nip, a sheet conveyed via the conveying path and which rotates while nipping and restraining the sheet to variably control a conveying posture of the sheet while applying a conveying force to the sheet;

a downstream conveying section (18) located downstream of the posture control section in a conveying direction to receive, at a nip, the sheet conveyed from the posture control section via the conveying path, the downstream conveying section (18) rotating while nipping and restraining the sheet to apply a conveying force to the sheet,

characterized in that a distance between the nip of the posture control section and the nip of the downstream conveying section is designed to be longer than a shortest one of sheets to be processed by the sheet processing device which has a shortest length along the conveying direction and to be equal to or shorter than a longest one of the sheets to be processed by the sheet processing device which has a greatest length along the conveying direction.

2. The sheet processing device according to claim 1, **characterized in that** the posture control section (16) performs posture control on the sheet of any of the lengths in the same amount of time as that required for the posture control of the shortest sheet.

3. The sheet processing device according to claim 2, **characterized in that** the distance between the nip of the posture control section (16) and the nip of the downstream conveying section (18) is designed to be slightly longer than the shortest sheet.

4. The sheet processing device according to claim 1, **characterized in that** the posture control section

(16) is capable of completing posture control while the shortest sheet is passing through the nip.

5. The sheet processing device according to claim 4, **characterized in that** the distance between the nip of the posture control section (16) and the nip of the downstream conveying section (18) is designed to be slightly longer than the shortest sheet.

6. The sheet processing device according to claim 1, further comprising:

an upstream conveying section (14) located upstream of the posture control section (16) in the conveying direction to receive, at a nip, the sheet conveyed via the conveying path (10), the upstream conveying section rotating while nipping and restraining the sheet to apply a conveying force to the sheet,

characterized in that a distance between the nip of the upstream conveying section and the nip of the posture control section is designed to be longer than the longest sheet.

7. The sheet processing device according to claim 6, **characterized in that** the distance between the nip of the upstream conveying section (14) and the nip of the posture control section (16) is designed to be substantially as long as the length of the longest sheet along the conveying direction.

8. The sheet processing device according to claim 7, further comprising:

a detecting section (12) located upstream of the upstream conveying section (14) in the conveying direction to detect the conveying posture of the sheet conveyed via the conveying path (10),

characterized in that a distance between the detecting section and the nip of the upstream conveying section is designed to be short but still enough to allow the shortest sheet the posture of which has been detected by the detecting section to be nipped and restrained by the nip of the upstream conveying section before the posture of the shortest sheet changes.

9. The sheet processing device according to claim 7, further comprising:

a second upstream conveying section (14) located downstream of the downstream conveying section in the conveying direction to receive, at a nip, the sheet conveyed via the conveying path, the second upstream conveying section (14) rotating while nipping and restraining the

sheet to apply a conveying force to the sheet;
 a second posture control section (16) located
 downstream of the second upstream conveying
 section in the conveying direction to receive, at
 a nip, the sheet conveyed via the conveying
 path, the second posture control section (16) ro- 5
 tating while nipping and restraining the sheet to
 variably control a conveying posture of the sheet
 while applying a conveying force to the sheet;
 and 10
 a second downstream conveying section (18)
 located downstream of the second posture con-
 trol section in the conveying direction to receive,
 at a nip, the sheet conveyed via the conveying
 path, the second downstream conveying section 15
 (18) rotating while nipping and restraining the
 sheet to apply a conveying force to the sheet;

characterized in that a distance between the nip
 of the second upstream conveying section and the 20
 nip of the second posture control section is designed
 to be substantially as long as the length of the longest
 sheet along the conveying direction,
 a distance between the nip of the second posture
 control section and the nip of the second down- 25
 stream conveying section is designed to be greater
 than the length of the shortest sheet along the con-
 veying direction and to be equal to or shorter than
 the length of the longest sheet along the conveying
 direction, and 30
 a distance between the nip of the downstream con-
 veying section and the nip of the second upstream
 conveying section is designed to be shorter than the
 length of the shortest sheet along the conveying di-
 rection, 35

10. The sheet processing device according to claim 1,
 further comprising:

a second posture control section (16a) located 40
 upstream of the posture control section (16b) in
 the conveying direction to receive, at a nip, the
 sheet conveyed via the conveying path, the sec-
 ond posture control section (16a) rotating while 45
 nipping and restraining the sheet to variably con-
 trol a conveying posture of the sheet while ap-
 plying a conveying force to the sheet; and
 the upstream conveying section (14) located up-
 stream of the second posture control section in
 the conveying direction to receive, at a nip, the 50
 sheet conveyed via the conveying path, the up-
 stream conveying section (14) rotating while nip-
 ping and restraining the sheet to apply a con-
 veying force to the sheet; 55

characterized in that a distance between the nip
 of the upstream conveying section and the nip of the
 second posture control section is designed to be sub-

stantially as long as the length of the longest sheet
 along the conveying direction, and
 a distance between the nip of the second posture
 control section and the nip of the posture control sec-
 tion is designed to be slightly greater than the length
 of the longest sheet along the conveying direction.

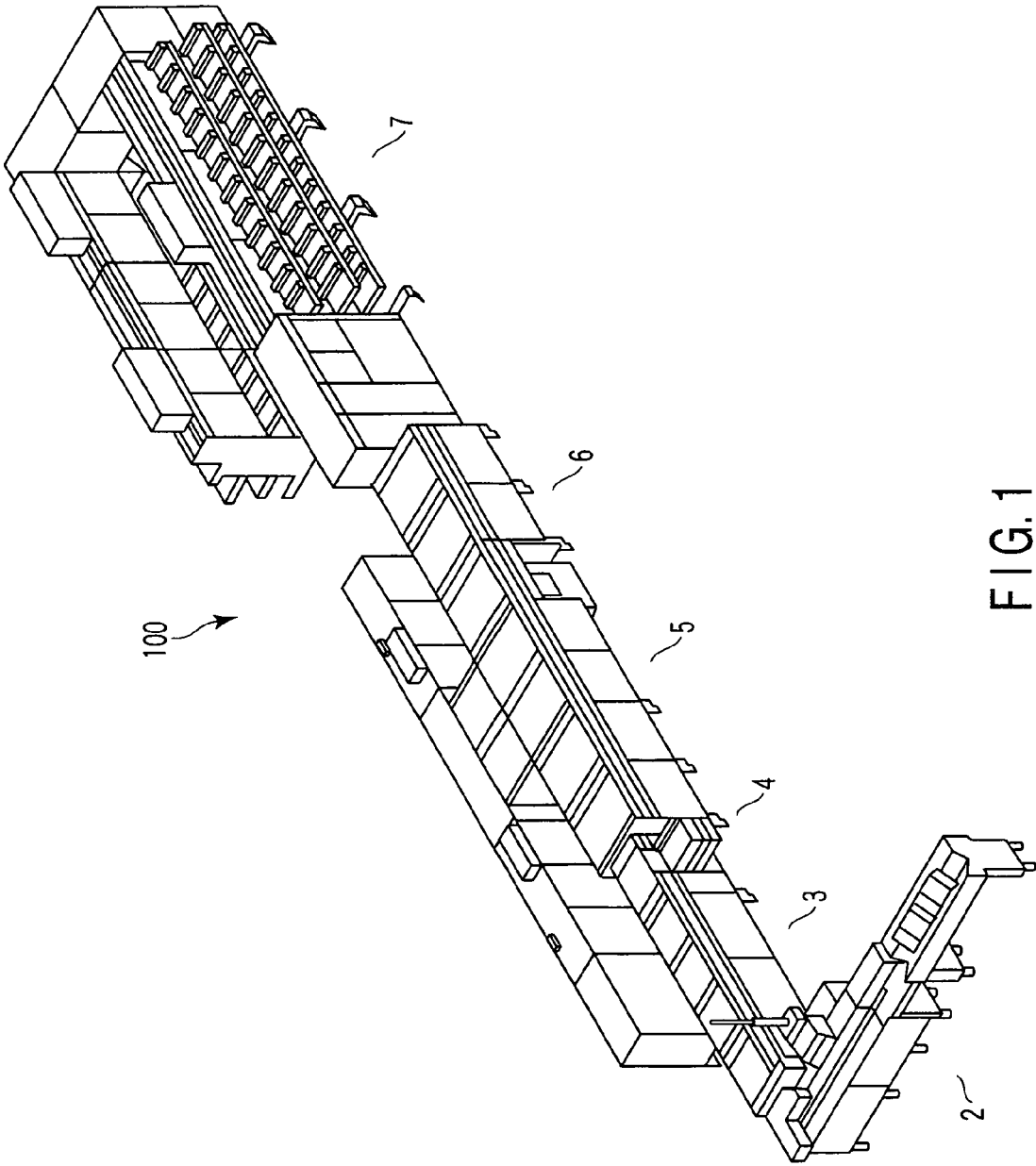


FIG. 1

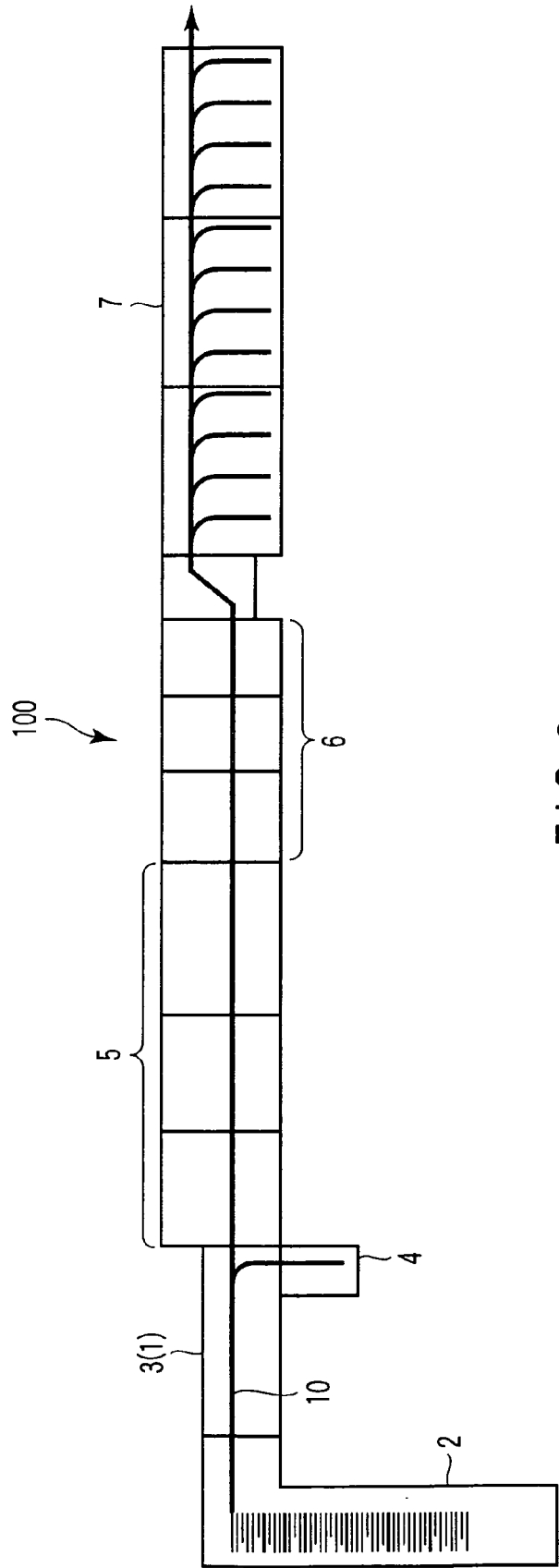


FIG. 2

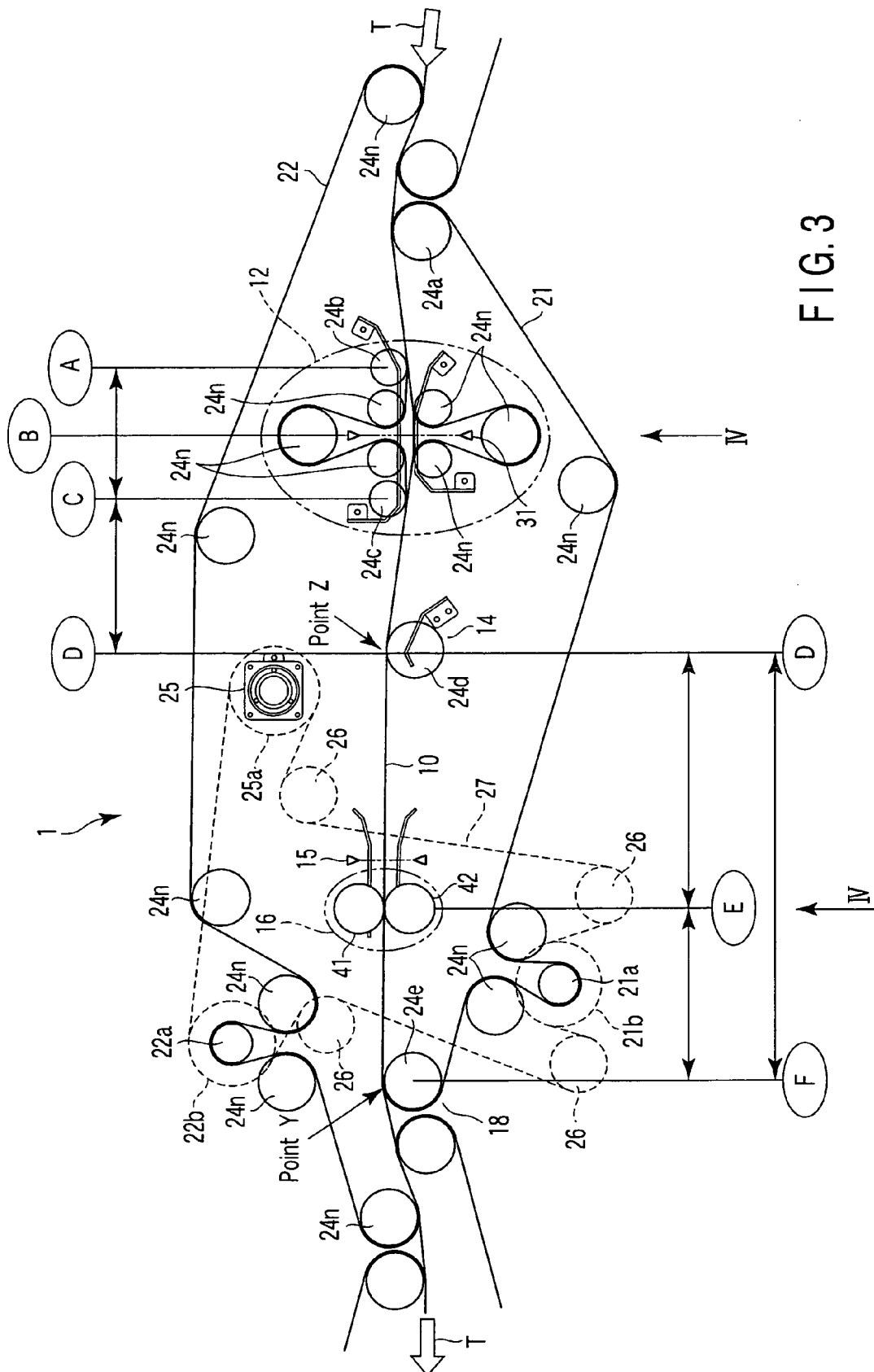


FIG. 3

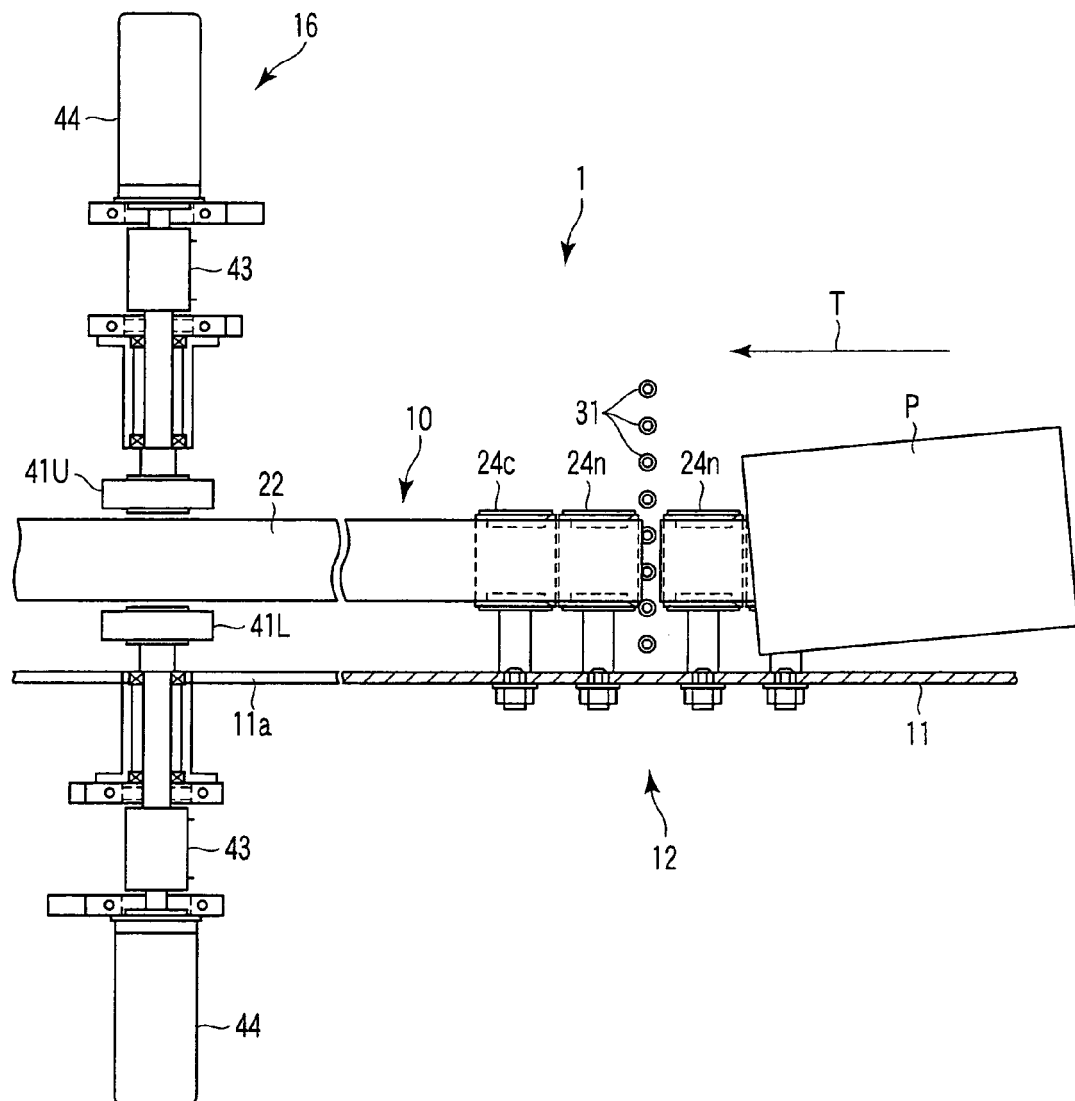


FIG. 4

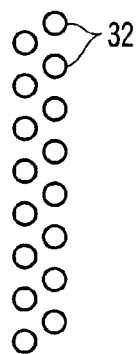


FIG. 5

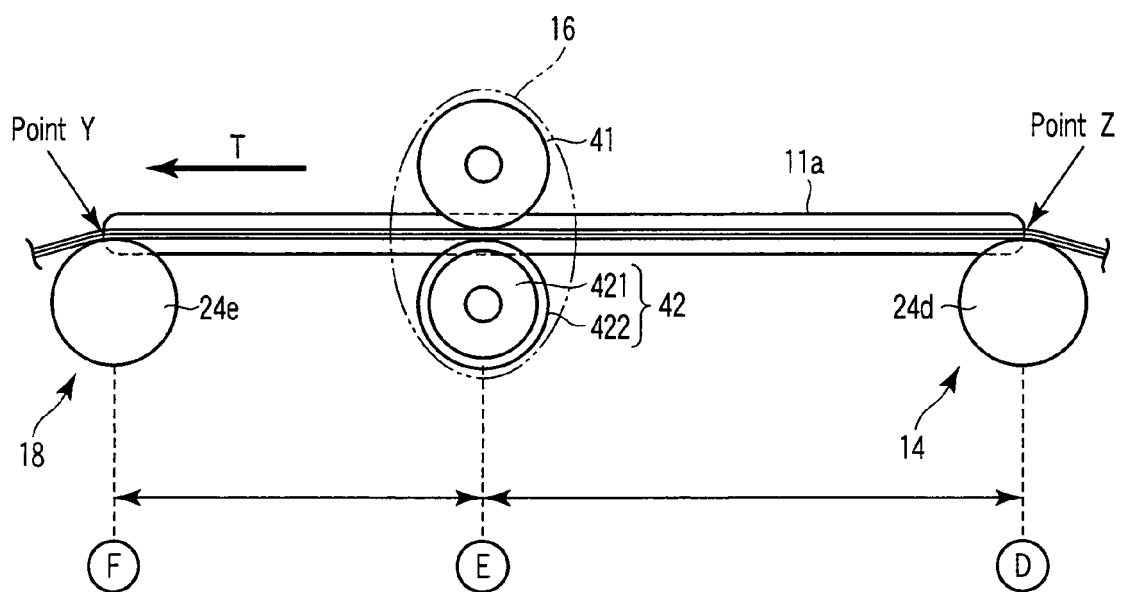


FIG. 6

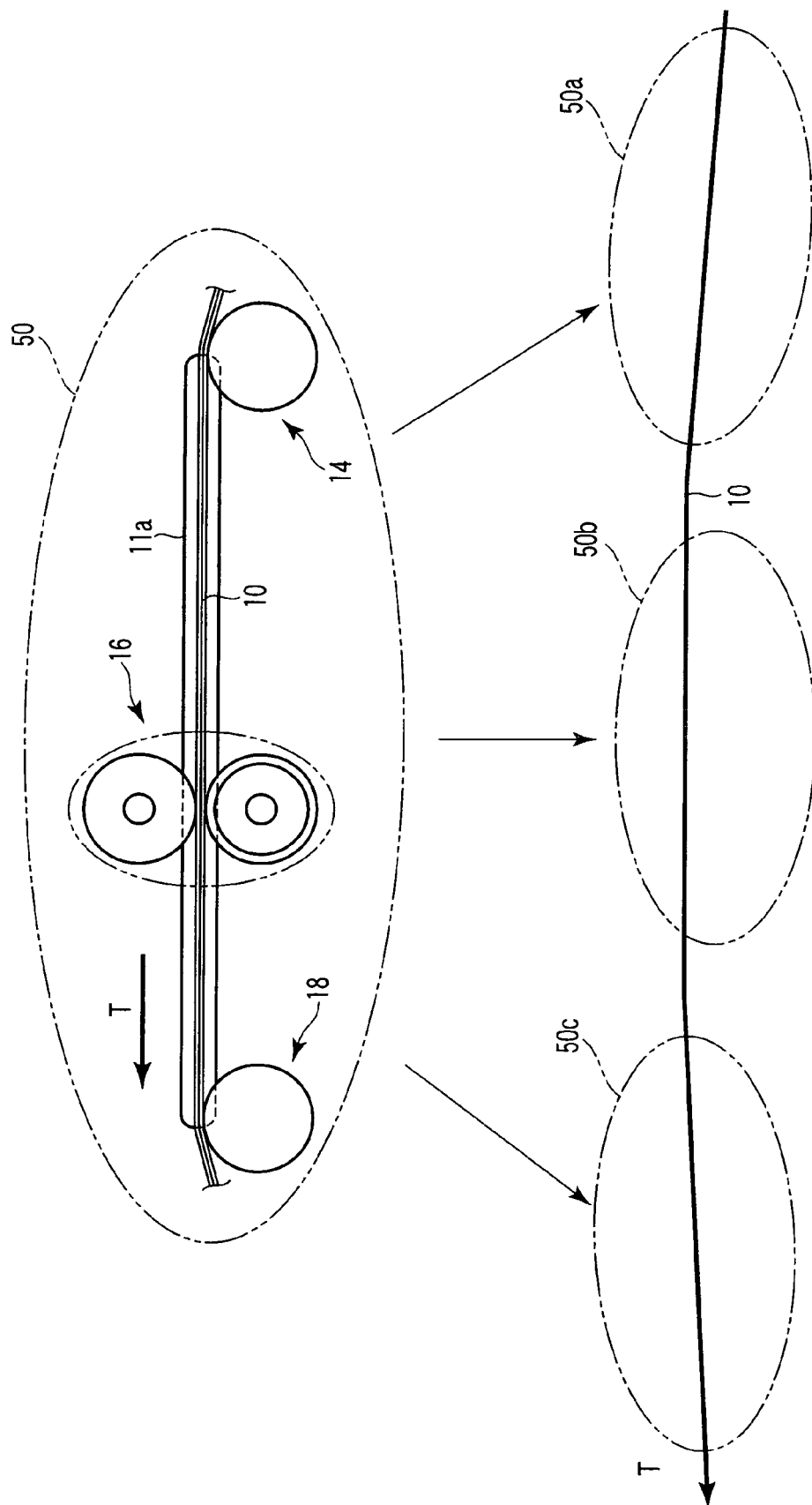


FIG. 7

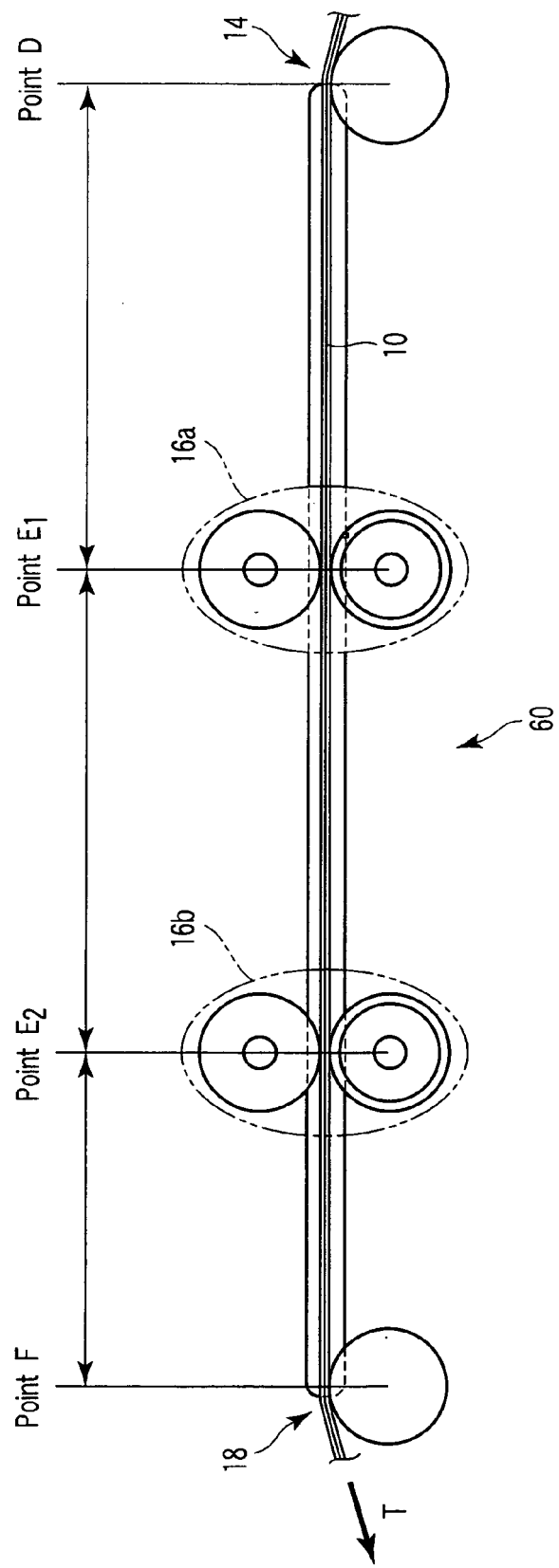


FIG. 8

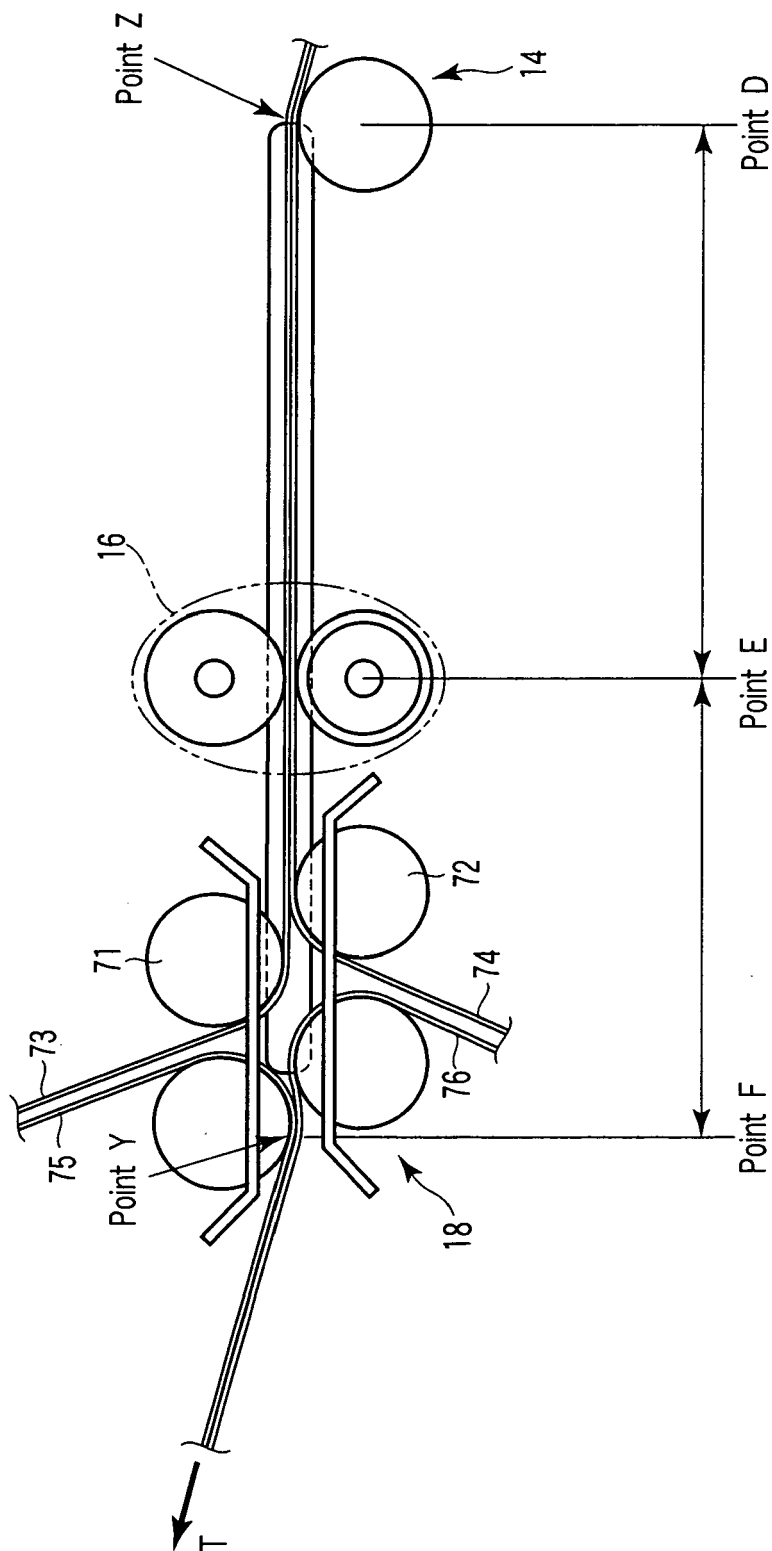


FIG. 9

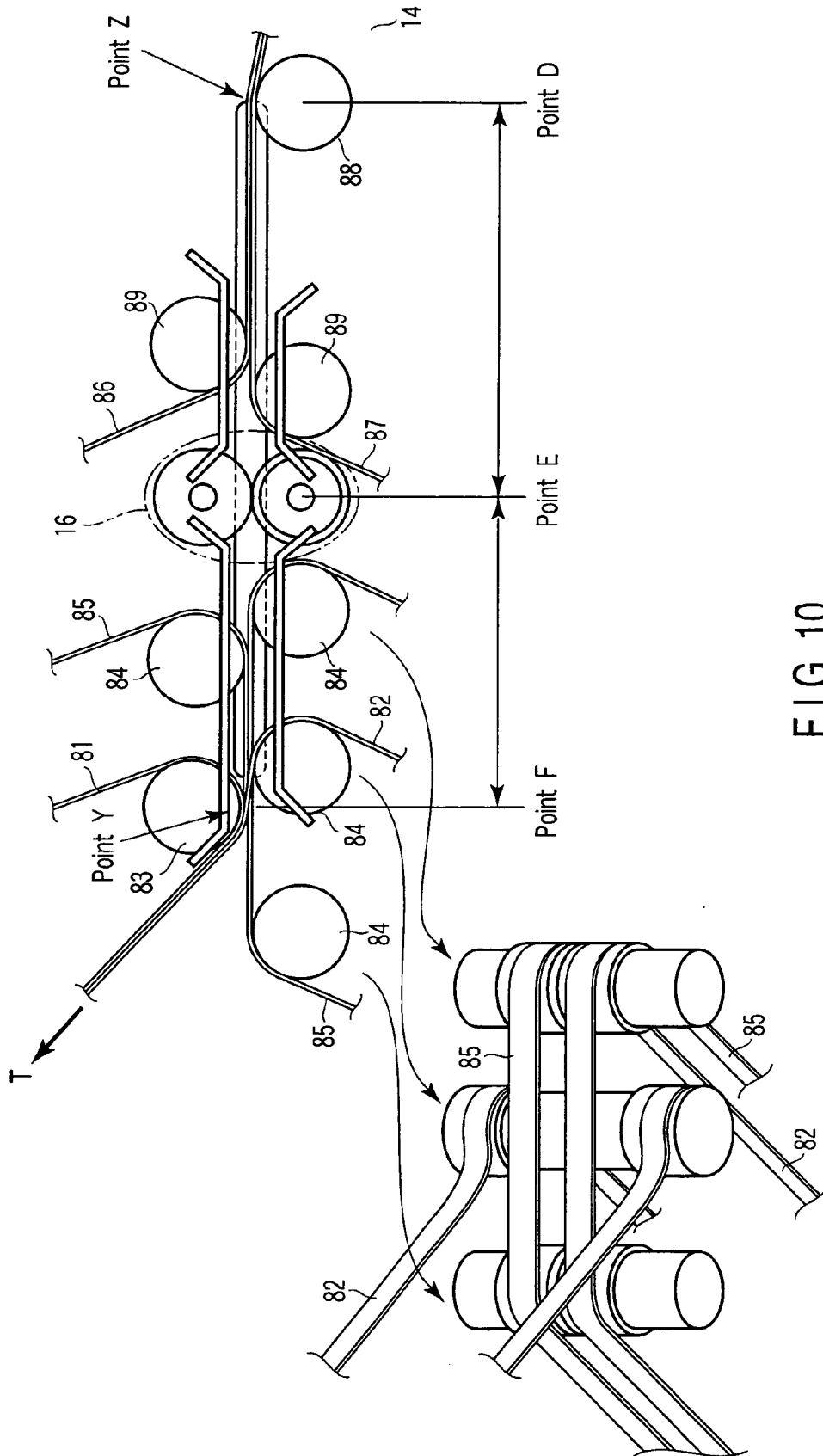


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005255406 A [0002]