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(54) **SHEET CUTTING DEVICE AND IMAGE FORMING APPARATUS**

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

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(57) **ABSTRACT**

A sheet cutting device including first and second rotating blades that mesh with each other at inner and outer positions in an axial direction and that cut a sheet, and a restoring unit. When a positional relationship between the inner and outer positions of the first and second rotating blades in the axial direction is reversed, the restoring unit releases the first and second rotating blades from each other and moves at least one of the first and second rotating blades in the axial direction to restore the positional relationship between the inner and outer positions to an original state.

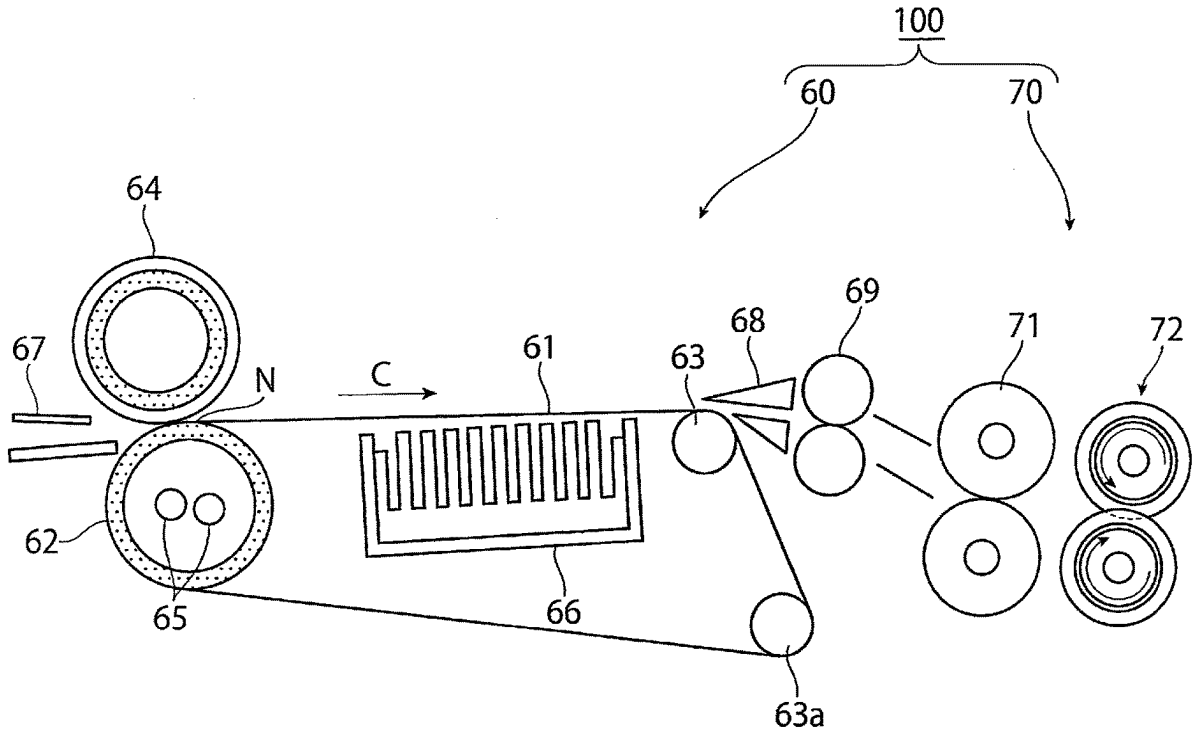
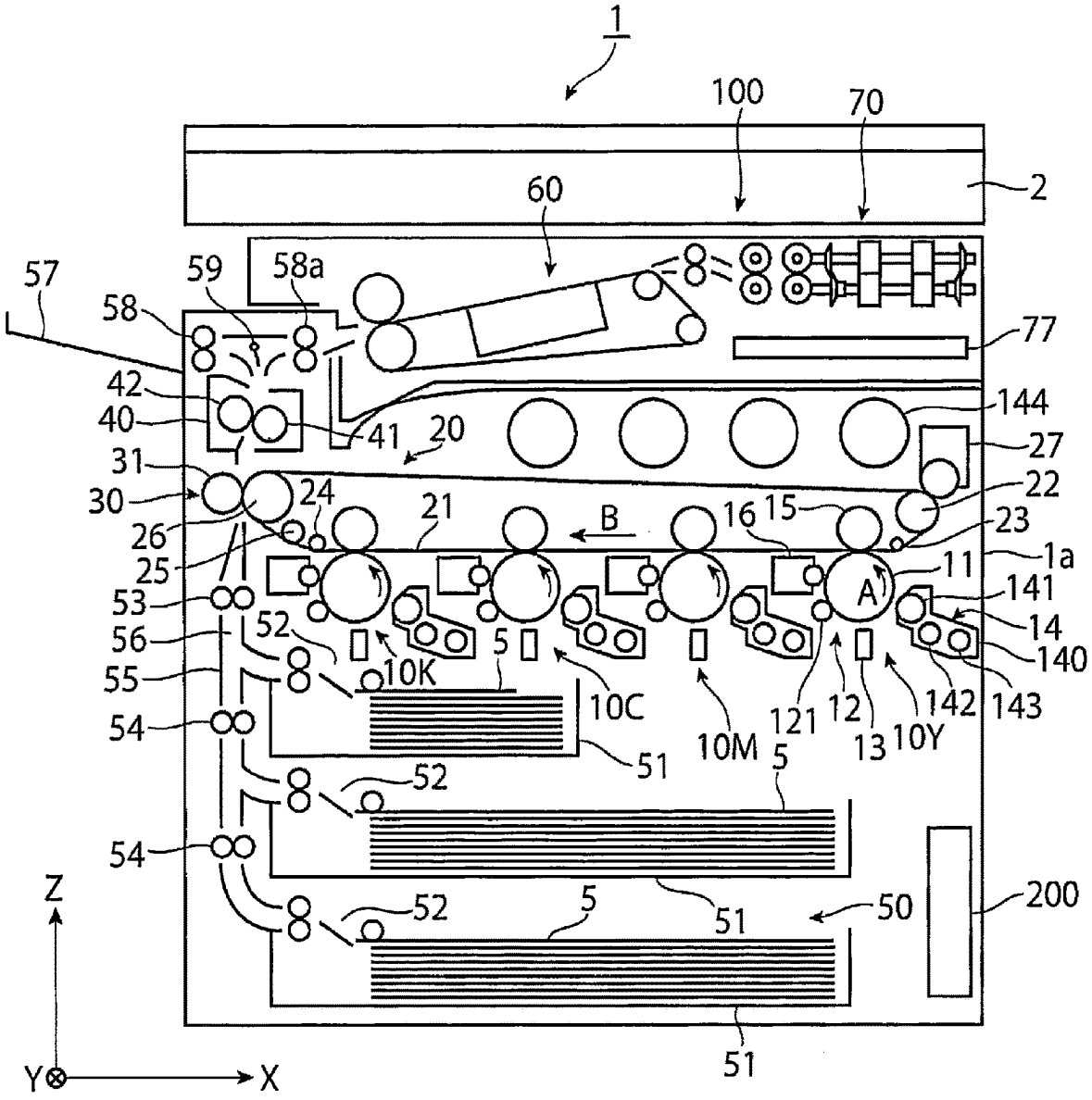


FIG. 1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10K
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10C
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FIG. 2

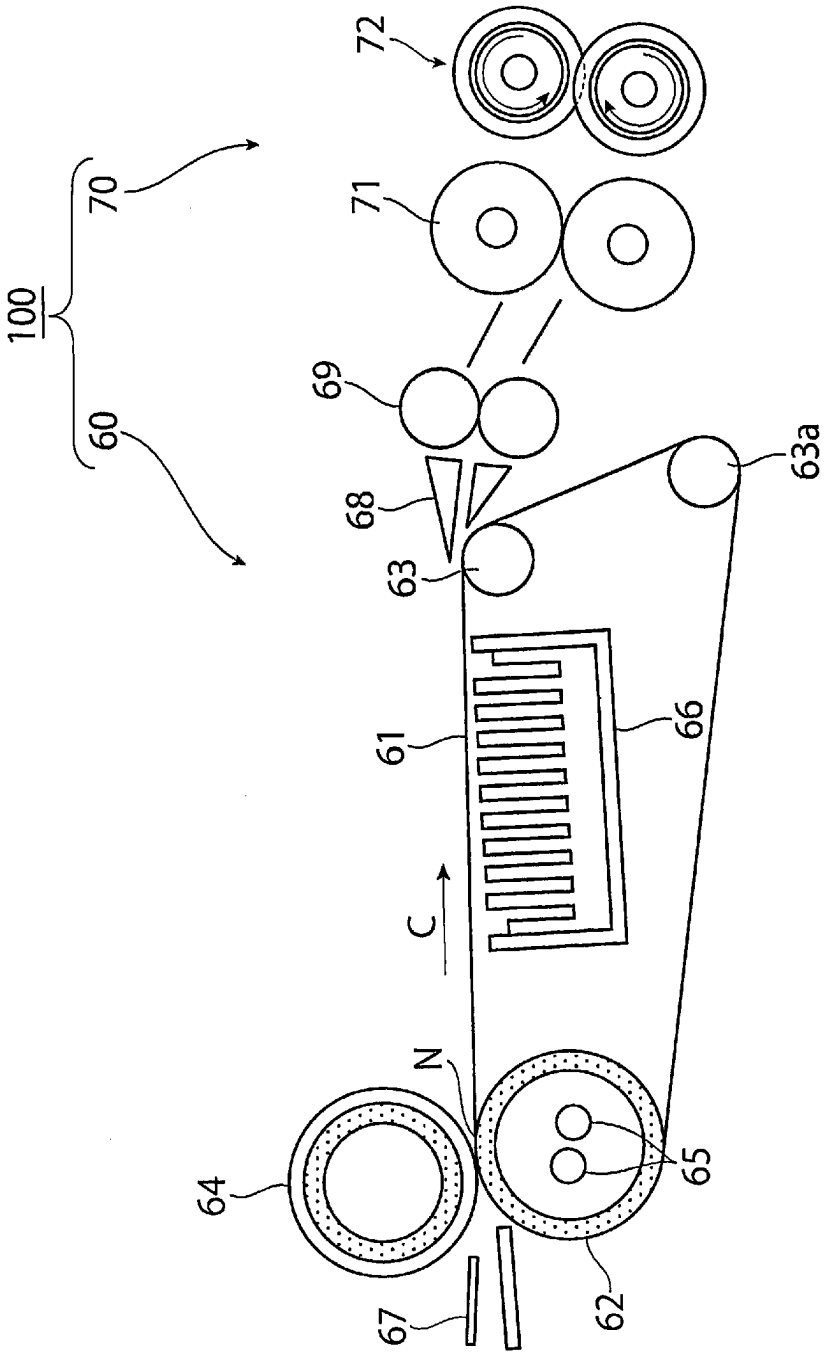

FIG. 3

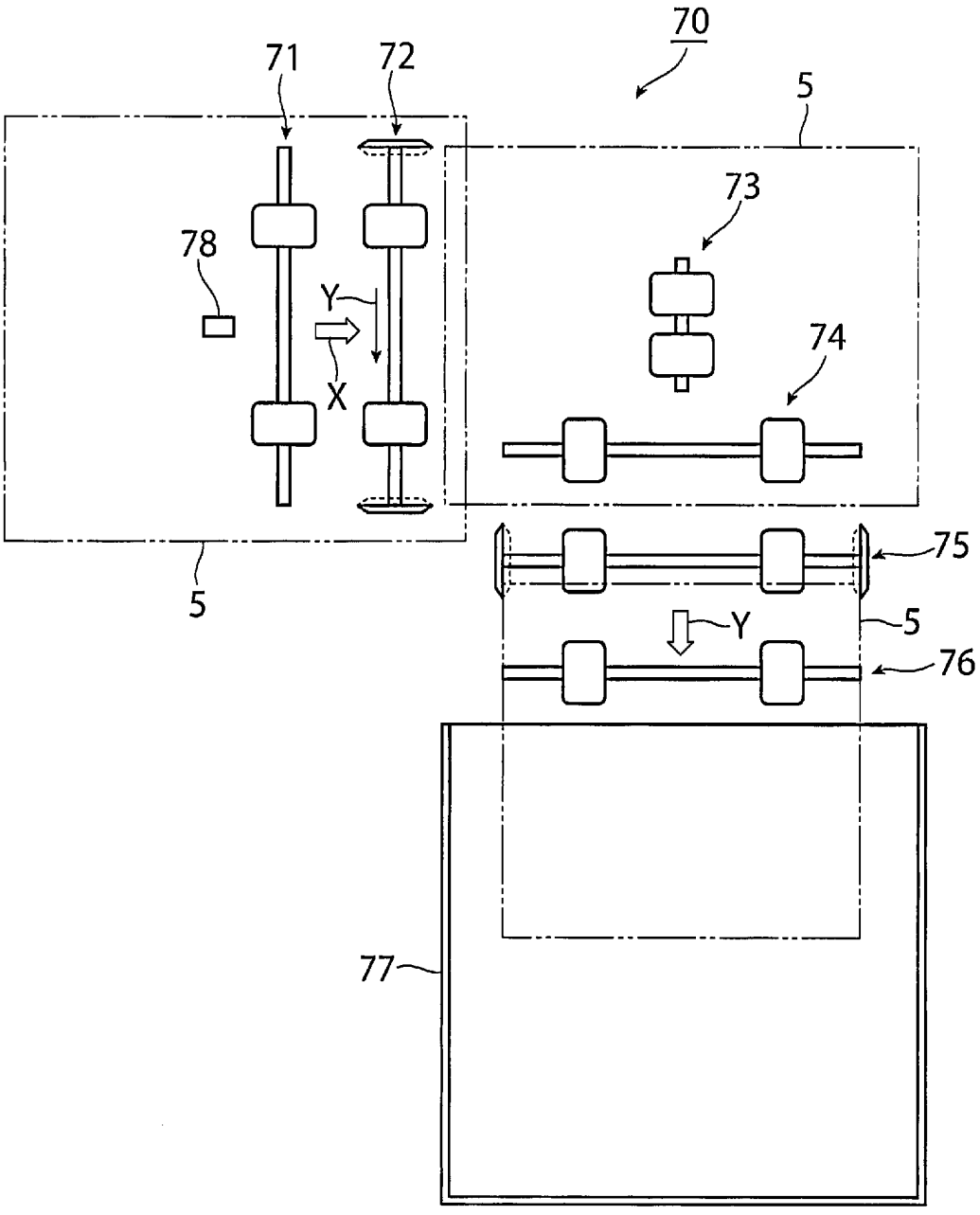

FIG. 4A

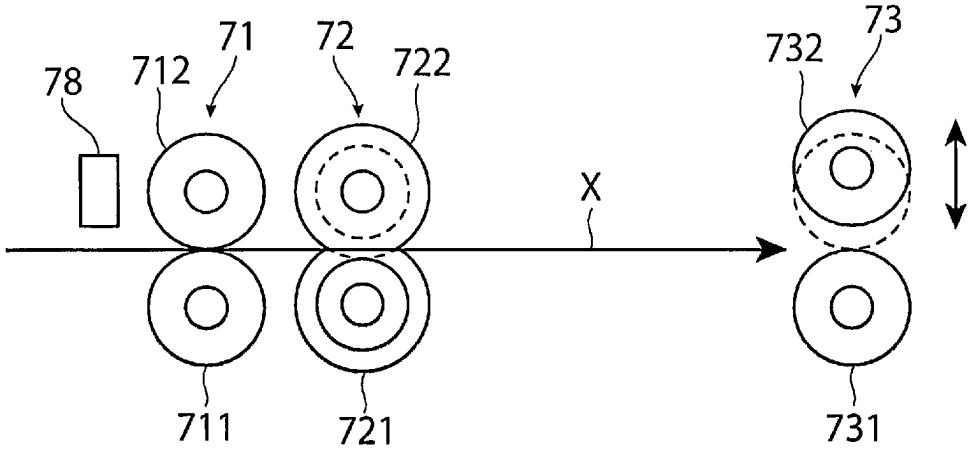
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FIG. 4B

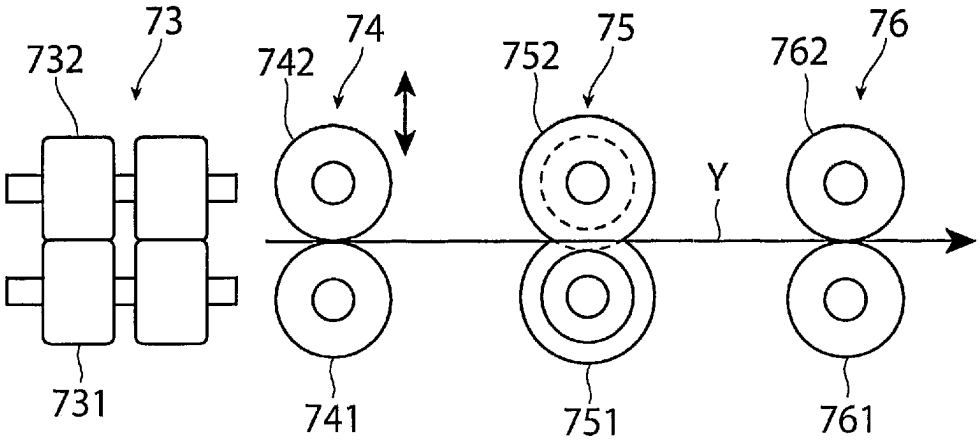
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FIG. 5B

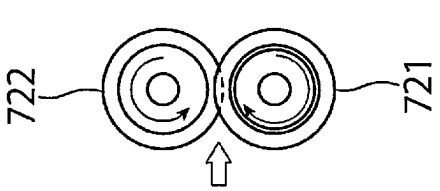

FIG. 5A

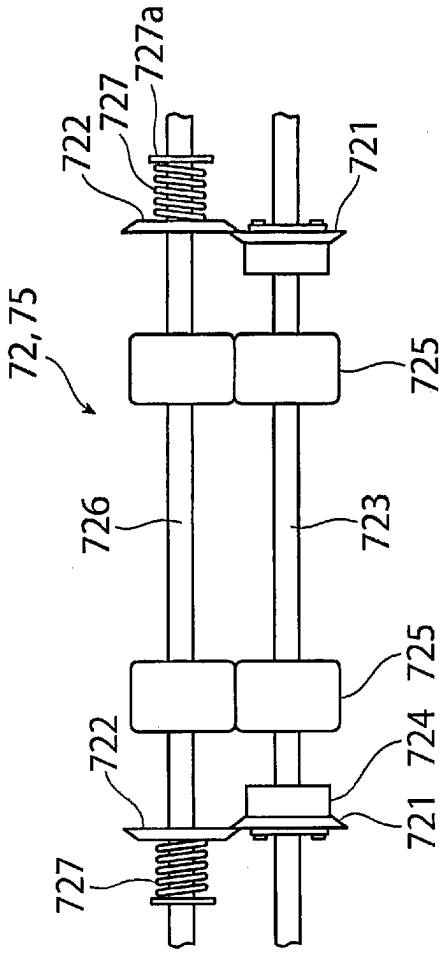

FIG. 6

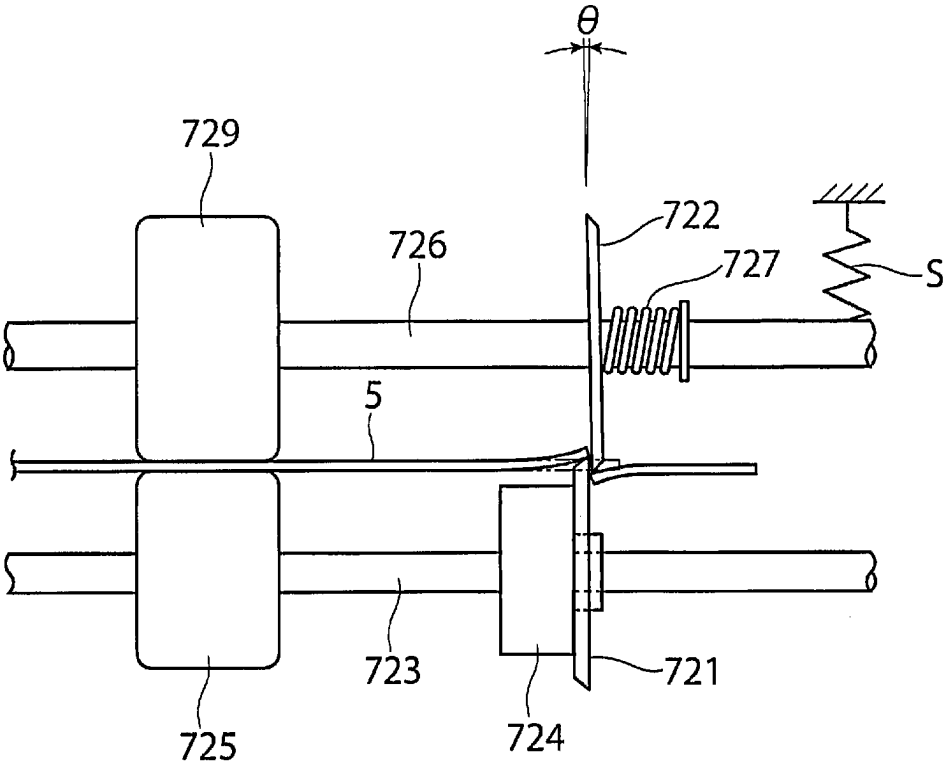

FIG. 7

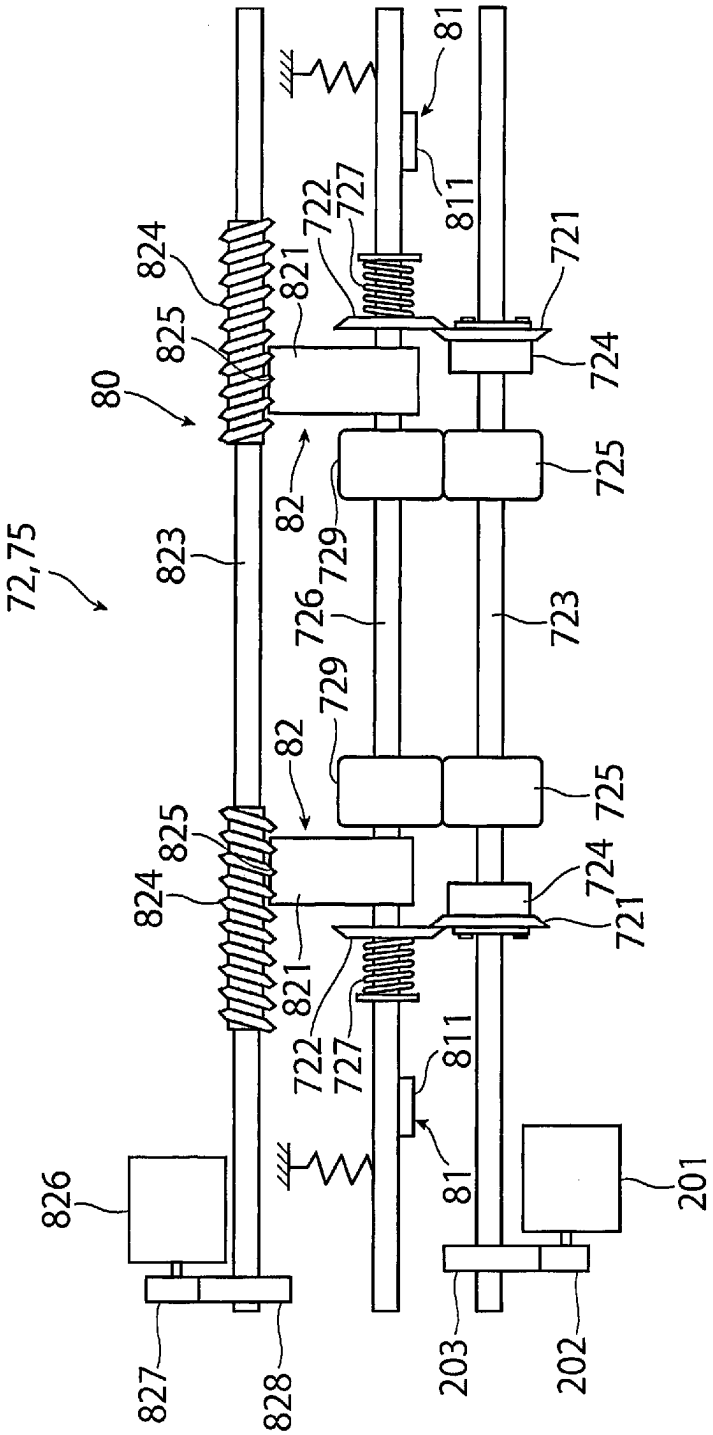
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FIG. 8A

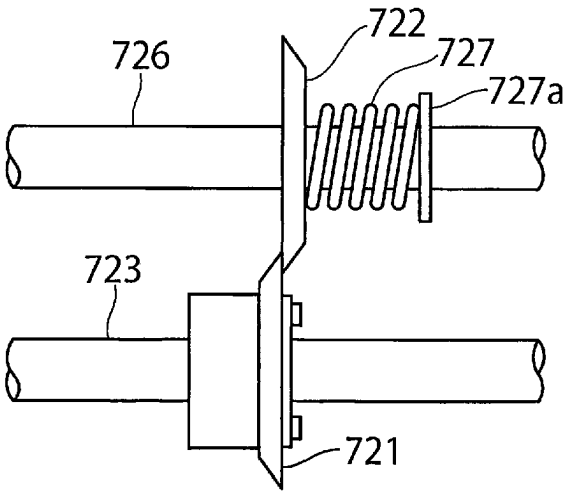

FIG. 8B

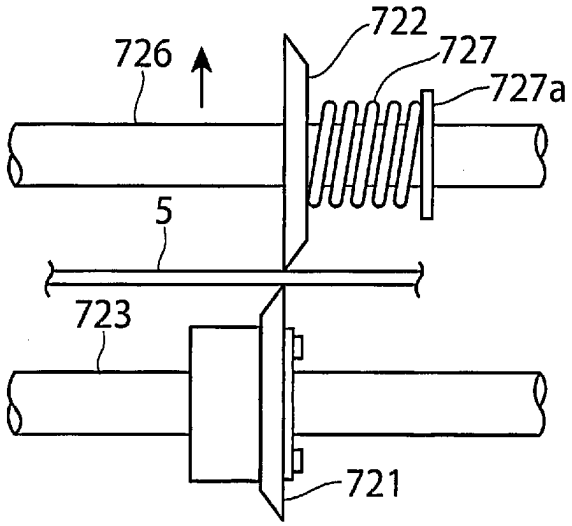

FIG. 8C

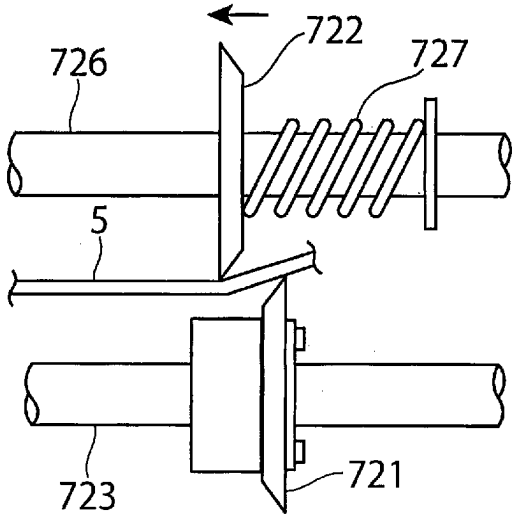

FIG. 9

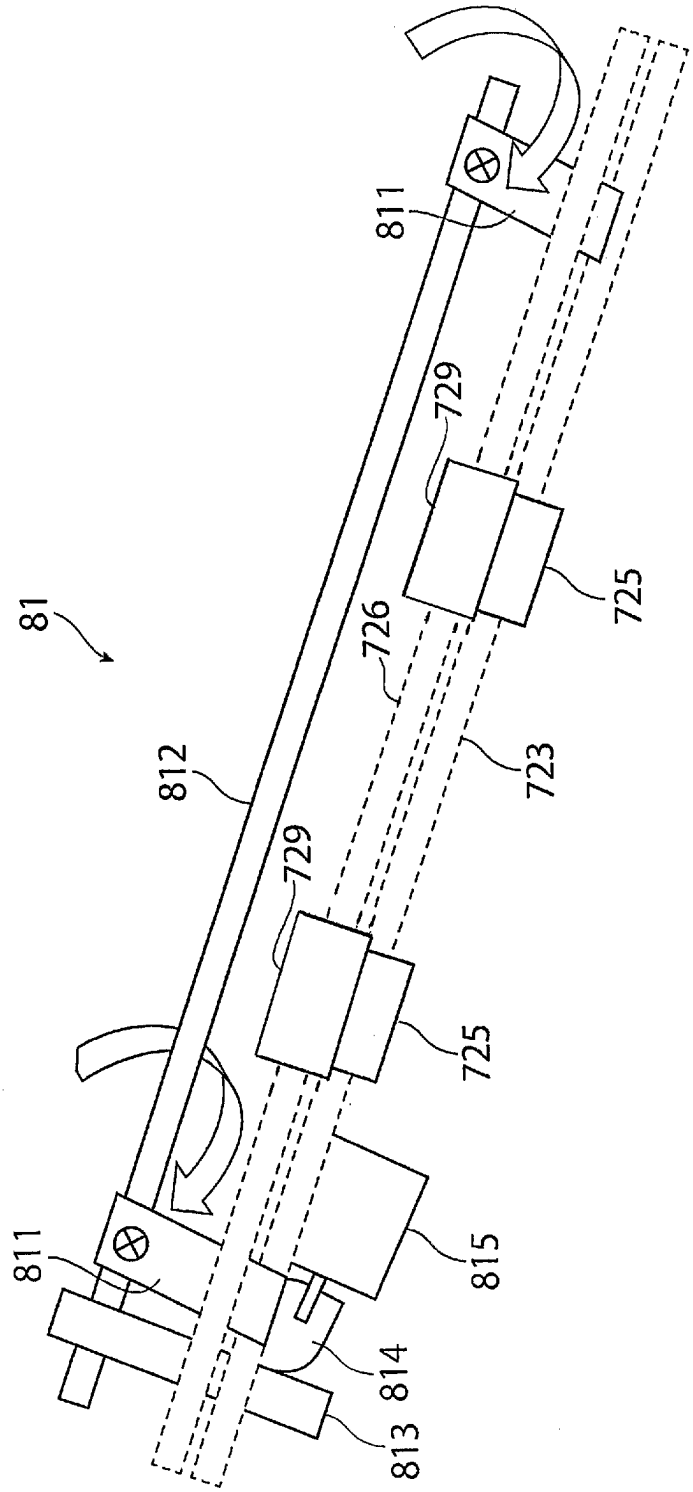

FIG. 10A

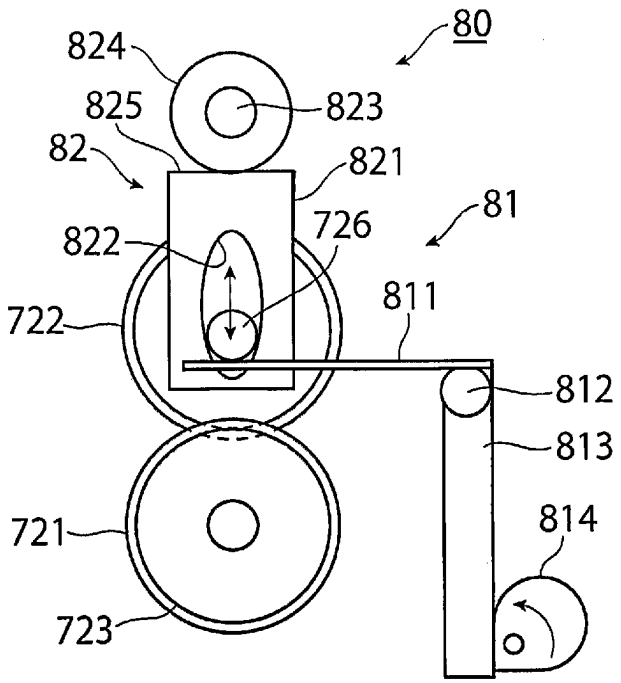

FIG. 10B

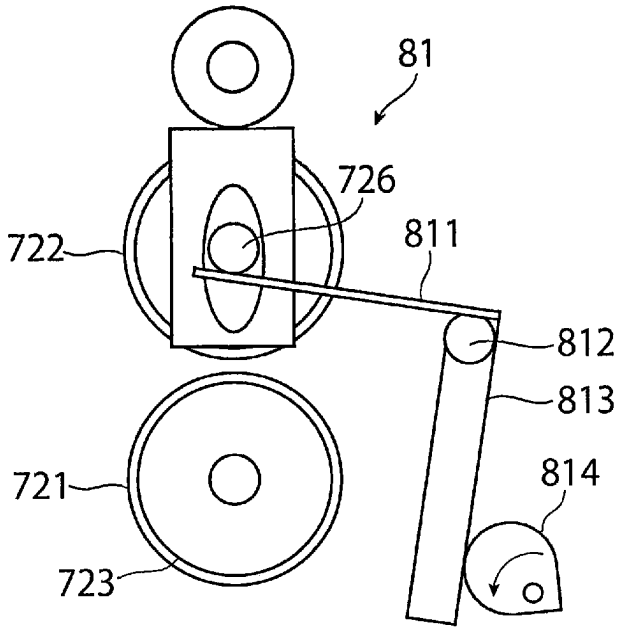

FIG. 11

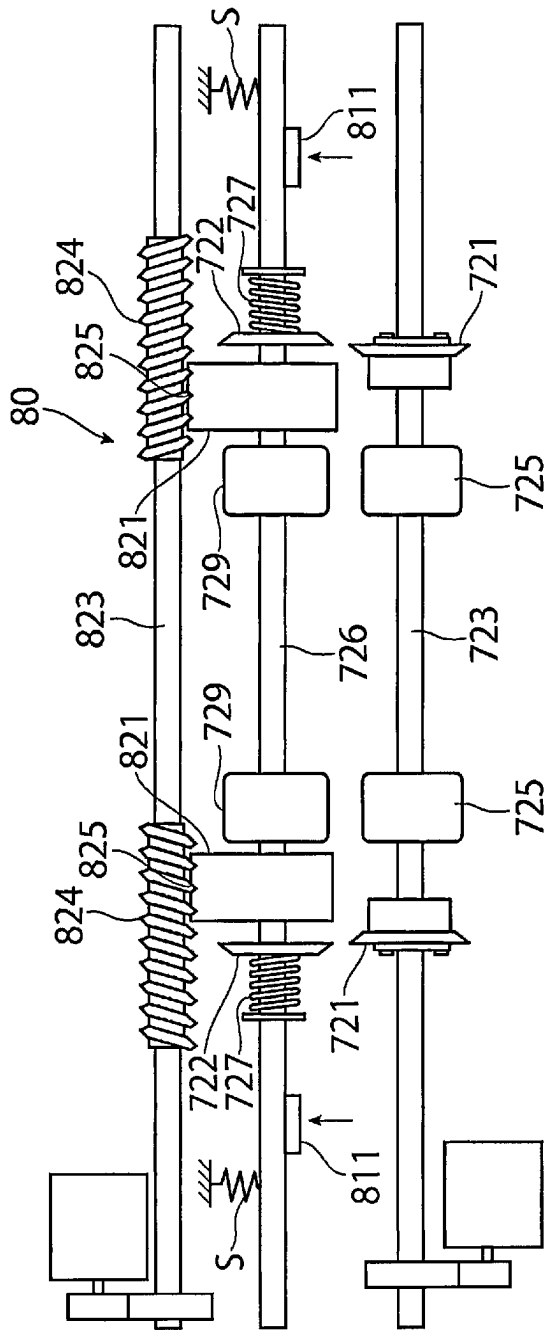
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FIG. 12

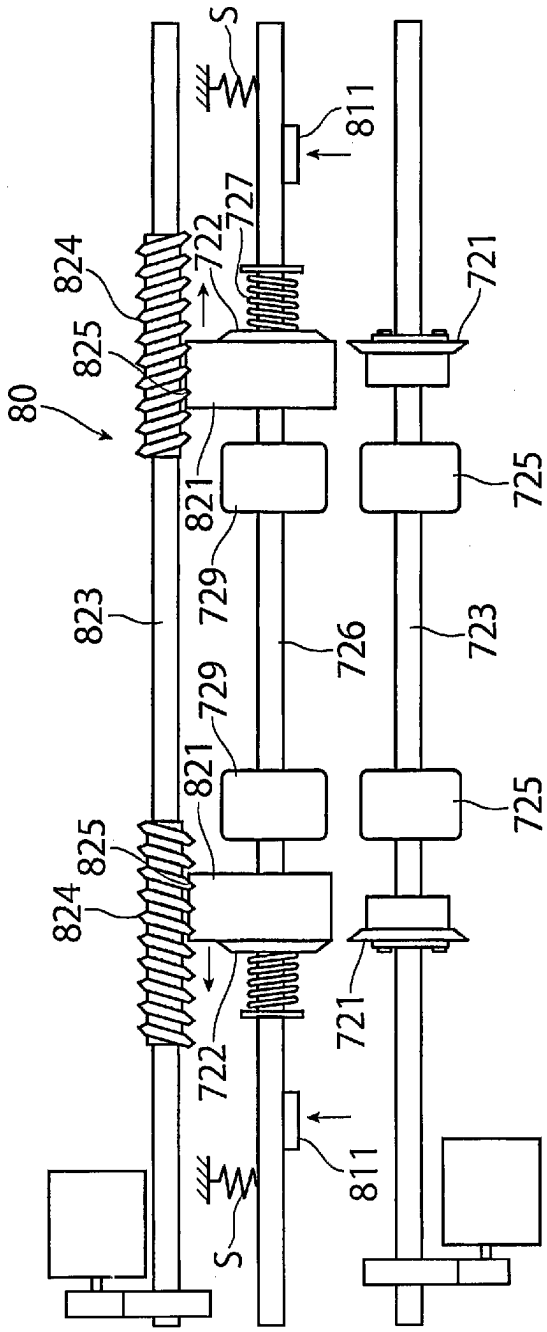
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FIG. 13A

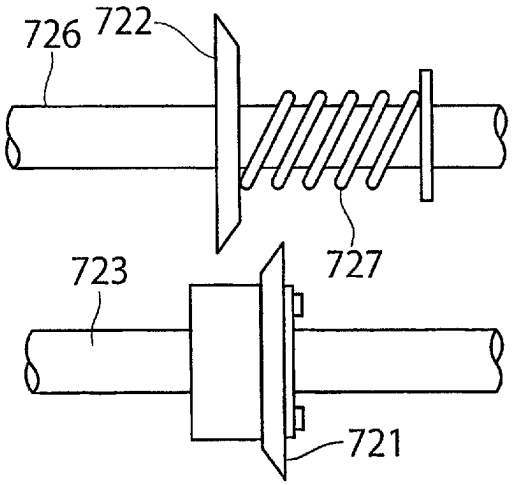

FIG. 13B

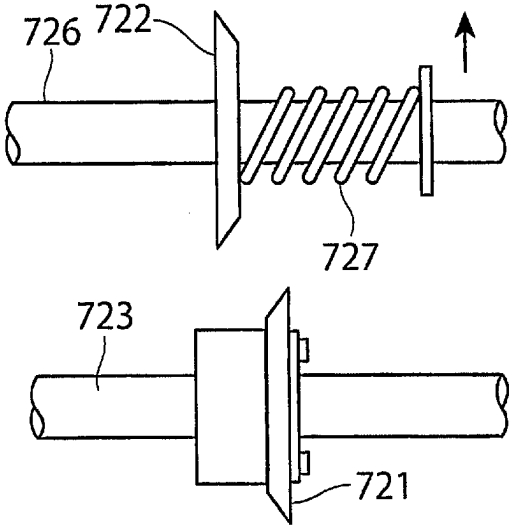

FIG. 13C

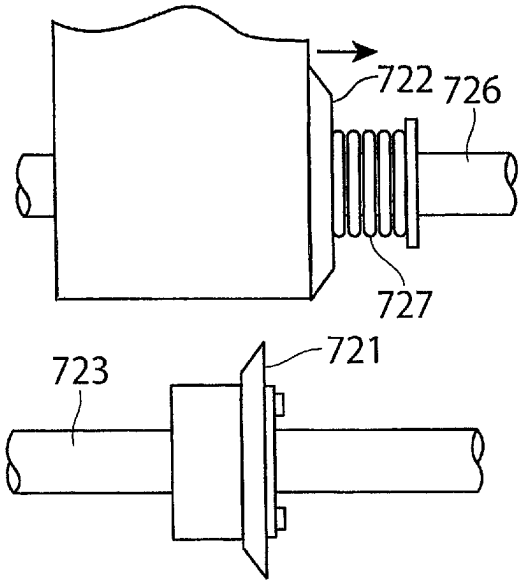

FIG. 14D

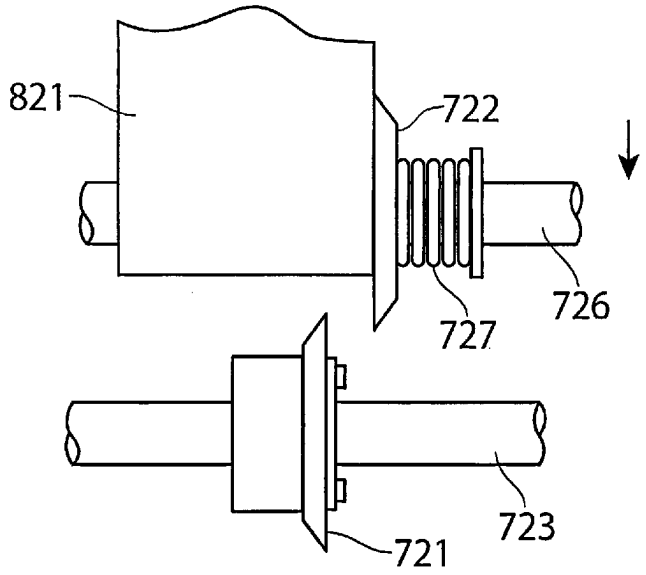

FIG. 14E

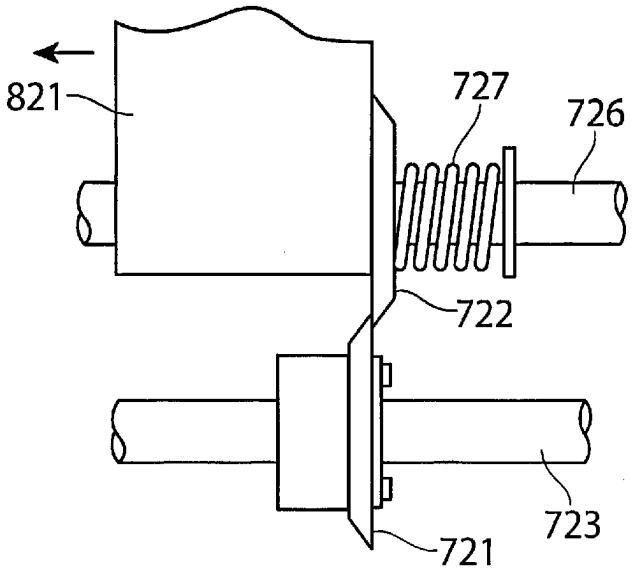

FIG. 15

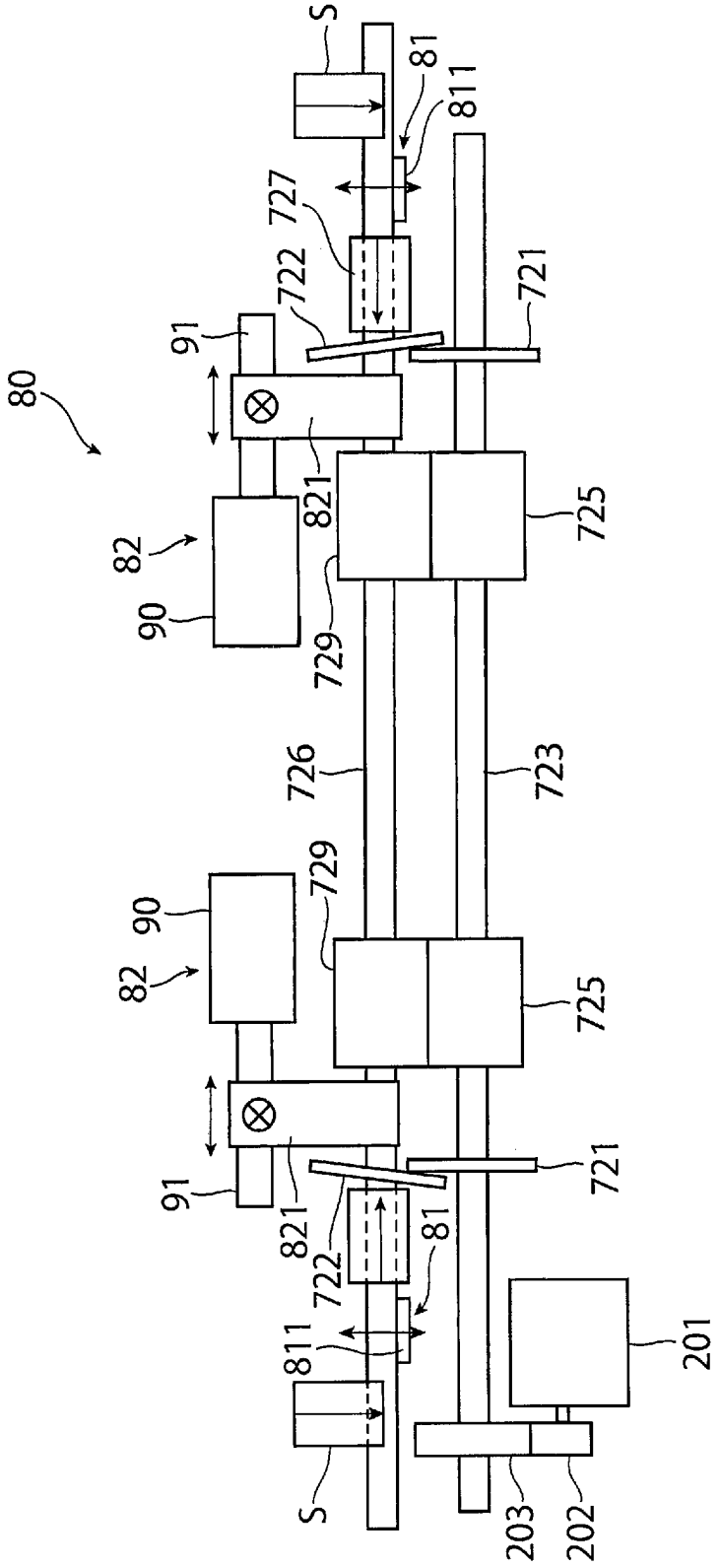
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FIG. 16

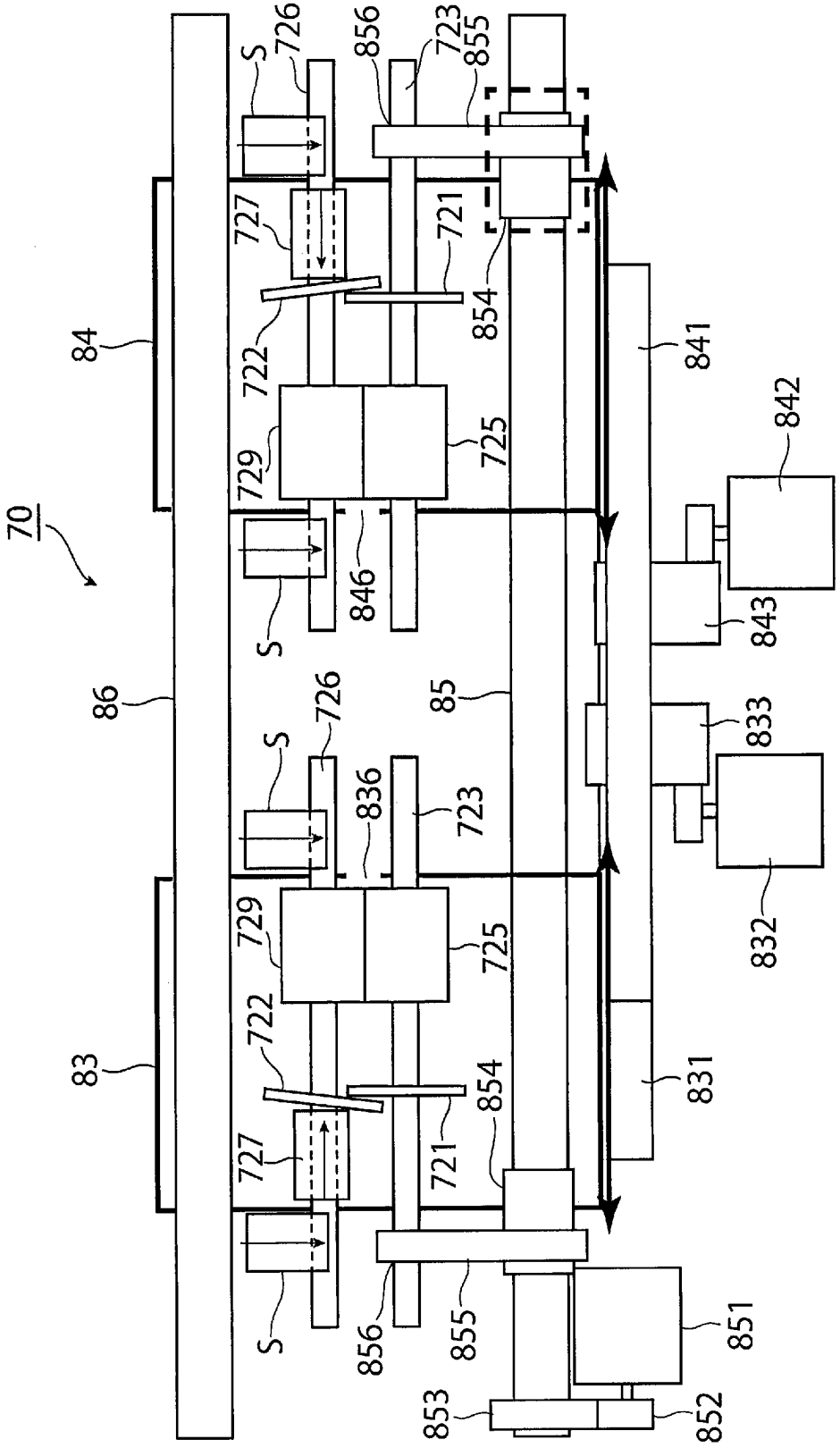
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FIG. 17

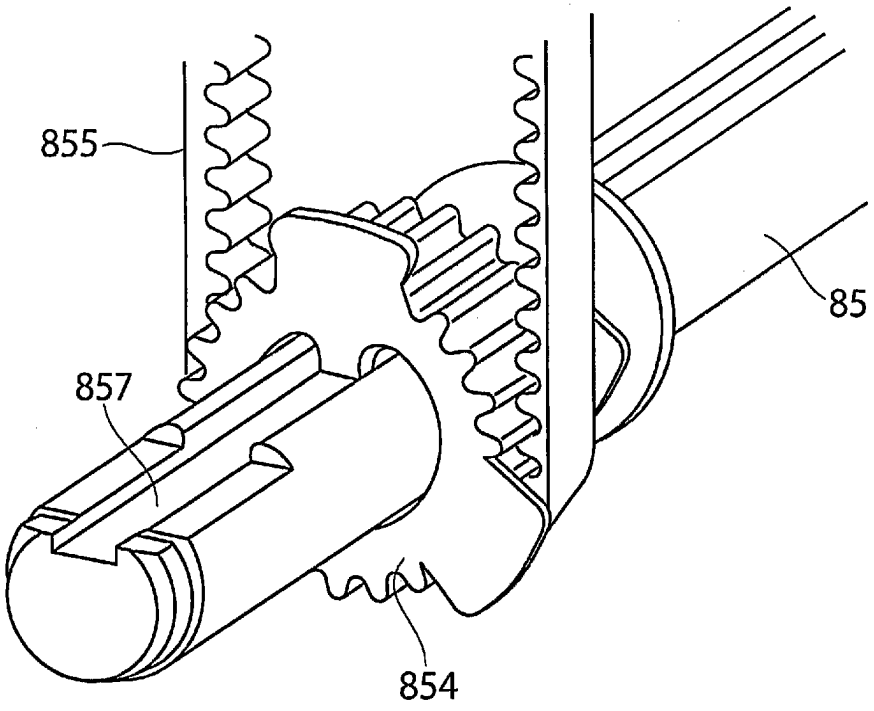


FIG. 18

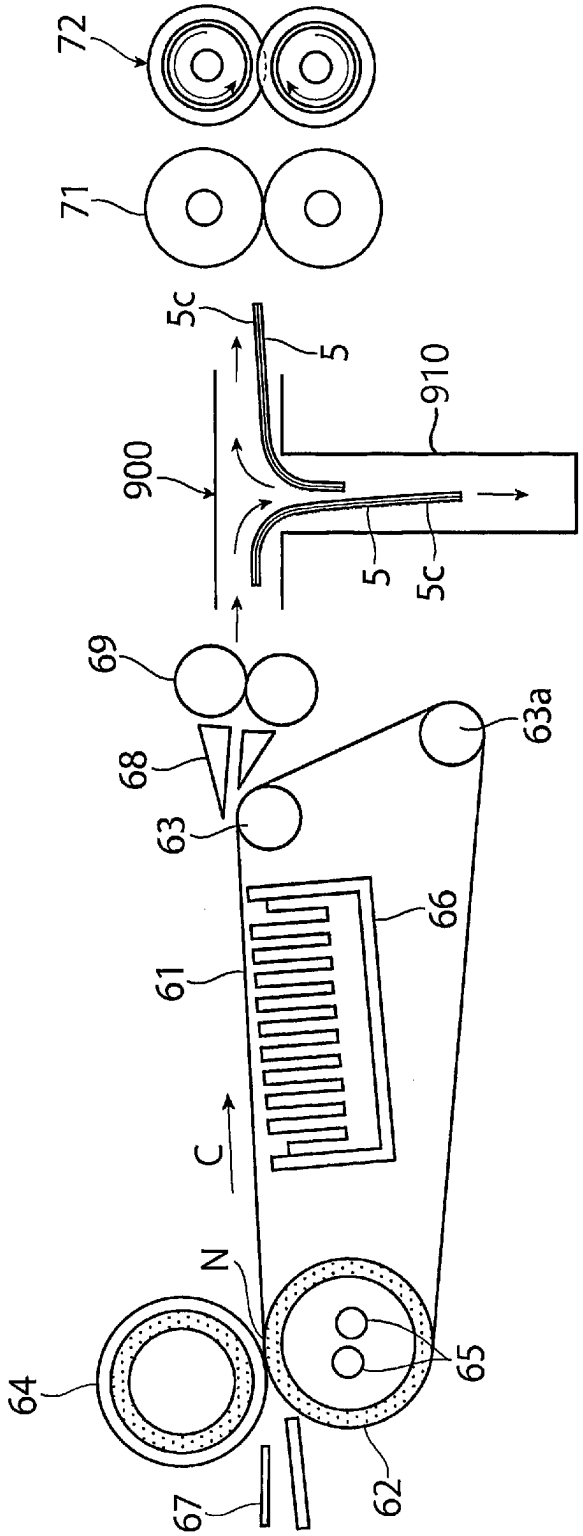


FIG. 19A

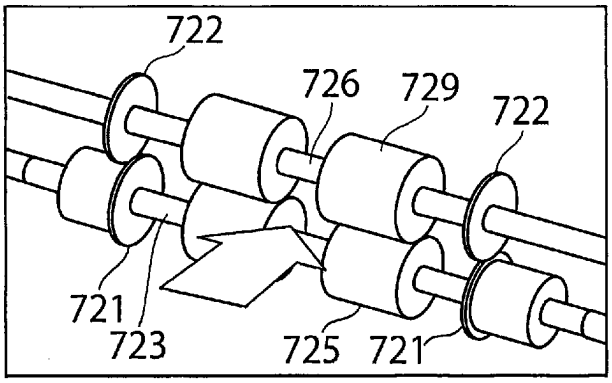


FIG. 19B

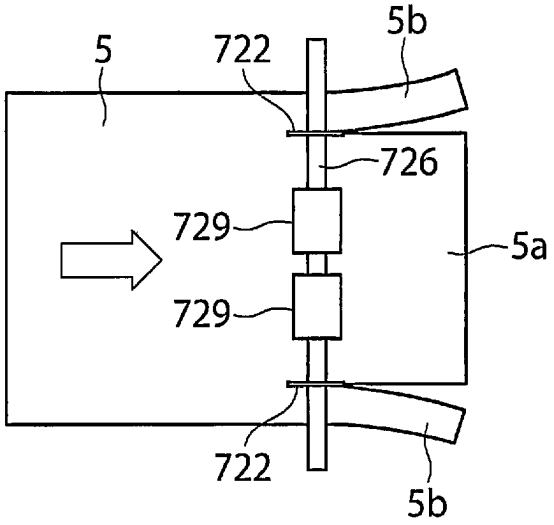


FIG. 19C

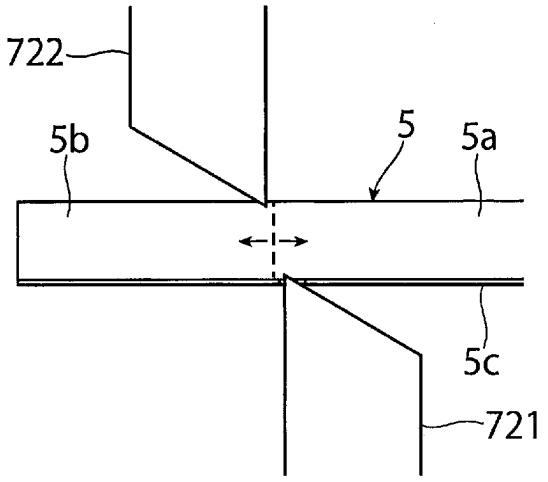


FIG. 20A

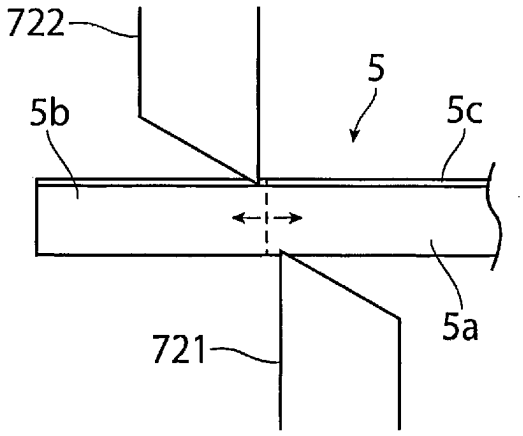


FIG. 20B

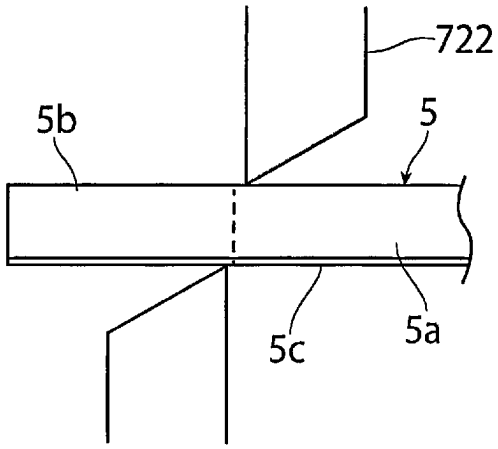


FIG. 21A

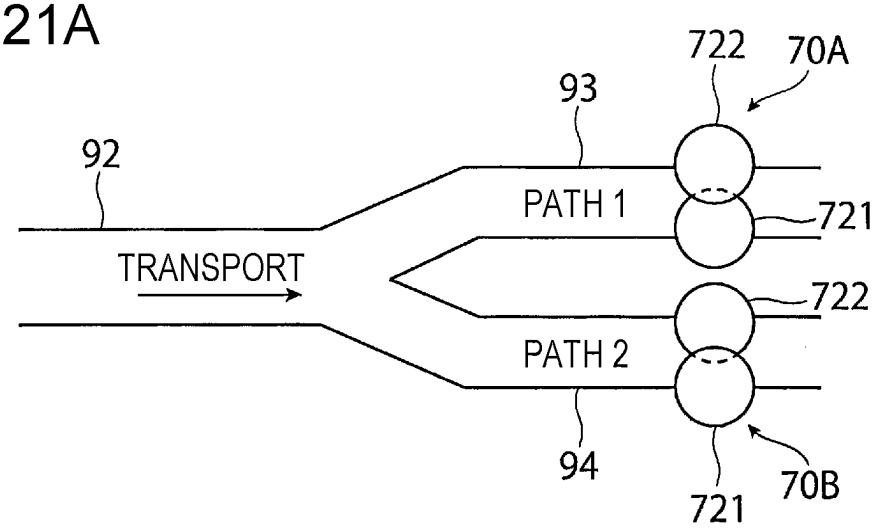


FIG. 21B

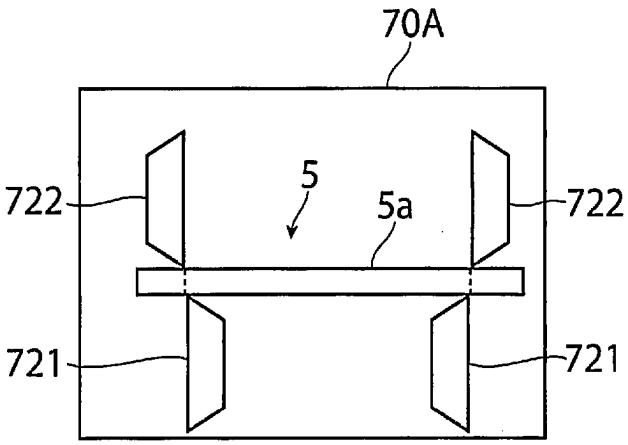
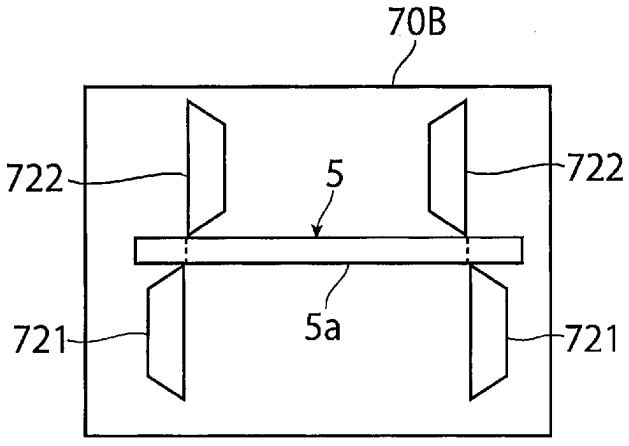


FIG. 21C



SHEET CUTTING DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2024-021655 filed Feb. 16, 2024.

BACKGROUND

(i) Technical Field

[0002] The present disclosure relates to a sheet cutting device and an image forming apparatus.

(ii) Related Art

[0003] Japanese Unexamined Patent Application Publication No. 2005-262408, for example, describes a technology related to a sheet cutting device according to the related art.

[0004] According to Japanese Unexamined Patent Application Publication No. 2005-262408, a first round blade and a second round blade overlap and rotate in mesh with each other. A sheet is placed between the first round blade and the second round blade and moved relative to the first round blade and the second round blade so that the sheet is cut in the moving direction.

SUMMARY

[0005] Aspects of non-limiting embodiments of the present disclosure relate to a technology for enabling first and second rotating blades that have been unmeshed to return to the original state without the need for manual intervention by, for example, a customer engineer.

[0006] Aspects of certain non-limiting embodiments of the present disclosure address the above advantages and/or other advantages not described above. However, aspects of the non-limiting embodiments are not required to address the advantages described above, and aspects of the non-limiting embodiments of the present disclosure may not address advantages described above.

[0007] According to an aspect of the present disclosure, there is provided a sheet cutting device including first and second rotating blades that mesh with each other at inner and outer positions in an axial direction and that cut a sheet, and a restoring unit. When a positional relationship between the inner and outer positions of the first and second rotating blades in the axial direction is reversed, the restoring unit releases the first and second rotating blades from each other and moves at least one of the first and second rotating blades in the axial direction to restore the positional relationship between the inner and outer positions to an original state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Exemplary embodiments of the present disclosure will be described in detail based on the following figures, wherein:

[0009] FIG. **1** illustrates the overall structure of an image forming apparatus including a sheet cutting device according to a first exemplary embodiment of the present disclosure;

[0010] FIG. **2** illustrates the structure of a post-processing device of the image forming apparatus according to the first exemplary embodiment of the present disclosure;

[0011] FIG. **3** is a plan view illustrating the structure of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0012] FIGS. **4**A and **4**B are side views illustrating the structure of relevant parts of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0013] FIGS. **5**A and **5**B are a side view and a front view illustrating the structure of a relevant part of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0014] FIG. **6** is an enlarged view illustrating the structure of a relevant part of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0015] FIG. **7** illustrates the structure of a relevant part of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0016] FIGS. **8**A, **8**B, and **8**C illustrate the operation of the sheet cutting device;

[0017] FIG. **9** is a perspective view illustrating the structure of a retracting mechanism;

[0018] FIGS. **10**A and **10**B are side views illustrating the structure of the retracting mechanism;

[0019] FIG. **11** illustrates the operation of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0020] FIG. **12** illustrates the operation the sheet cutting device;

[0021] FIGS. **13**A, **13**B, and **13**C illustrate the operation of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0022] FIGS. **14**D and **14**E illustrate the operation of the sheet cutting device according to the first exemplary embodiment of the present disclosure;

[0023] FIG. **15** illustrates the structure of a sheet cutting device according to a second exemplary embodiment of the present disclosure;

[0024] FIG. **16** illustrates the structure of a sheet cutting device according to a third exemplary embodiment of the present disclosure;

[0025] FIG. **17** illustrates the structure of a relevant part of the sheet cutting device according to the third exemplary embodiment of the present disclosure;

[0026] FIG. **18** illustrates the structure of a sheet cutting device according to a fourth exemplary embodiment of the present disclosure;

[0027] FIGS. **19**A, **19**B, and **19**C illustrate a known operation of the sheet cutting device;

[0028] FIGS. **20**A and **20**B illustrate the structure of a modification of the sheet cutting device according to the fourth exemplary embodiment of the present disclosure; and

[0029] FIGS. **21**A, **21**B, and **21**C illustrate the structure of another modification of the sheet cutting device according to the fourth exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

[0030] Exemplary embodiments for carrying out the present disclosure (hereinafter referred to as "exemplary embodiment") will now be described with reference to the drawings.

First Exemplary Embodiment

[0031] FIG. **1** illustrates an image forming apparatus **1** including a sheet cutting device according to a first exemplary embodiment. In FIG. **1**, X denotes a horizontal direction (width direction) of the image forming apparatus, Y denotes a depth direction of the image forming apparatus, and Z denotes a vertical direction of the image forming apparatus.

Overall Structure of Image Forming Apparatus

[0032] The image forming apparatus **1** according to the first exemplary embodiment is formed as, for example, a color printer. This image forming apparatus **1** includes an apparatus body **1***a* and an image reading device **2** for reading an image of a document (not illustrated) disposed above the apparatus body **1***a*. The image forming apparatus **1** has a function of copying the image of the document read by the image reading device **2**, and also functions as, for example, a color printer for recording image information transmitted from a host computer (not illustrated) or the like or image information stored in a memory, such as ROM, that is removably attachable to the apparatus body **1***a*.

[0033] The image forming apparatus **1** includes plural image forming devices **10**, an intermediate transfer device **20**, a sheet feeding device **50**, and a fixing device **40** disposed in the apparatus body **1***a*. Each image forming device **10** forms a toner image by using toner contained in developer. The intermediate transfer device **20** carries the toner images formed by the image forming devices **10** and transports the toner images to a second transfer position. At the second transfer position, the toner images are transferred onto a recording paper sheet **5**, which is an example of a sheet, in a second transfer process. The sheet feeding device **50** stores recording paper sheets **5** to be supplied to the second transfer position of the intermediate transfer device **20**, and supplies each recording paper sheet **5**. The fixing device **40** fixes the toner images that have been transferred onto the recording paper sheet **5** by the intermediate transfer device **20** in the second transfer process. The image forming devices **10** and the intermediate transfer device **20** constitute an image forming unit that forms an image on the recording paper sheet **5**. The apparatus body **1***a* of the image forming apparatus **1** is formed of, for example, support structural members and an outer covering.

[0034] The image forming devices **10** include four image forming devices **10**Y, **10**M, **10**C, and **10**K for exclusively forming toner images of four colors, which are yellow (Y), magenta (M), cyan (C), and black (K), respectively. The four image forming devices **10** (Y, M, C, and K) are arranged along one line in an inner space of the apparatus body **1***a*.

[0035] As illustrated in FIG. **1**, each of the yellow (Y), magenta (M), cyan (C), and black (K) image forming devices **10** (Y, M, C, and K) includes a rotating photoconductor drum **11** as an example of an image carrier that carries an electrostatic latent image. Devices described below are arranged around the photoconductor drum **11** as examples of toner-image-forming units. These devices include a charging device **12**, an exposure device **13**, a developing device **14**, a first transfer device **15**, and a drum cleaning device **16**. The charging device **12** charges a peripheral surface (image carrying surface) of the photoconductor drum **11** on which an image can be formed to a predetermined potential. The exposure device **13** forms an electrostatic latent image (for the corresponding color) having a potential difference by irradiating the charged peripheral surface of the photoconductor drum **11** with light based on image information (signal). The developing device **14** develops the electrostatic latent image into a toner image by using the toner contained in the developer of the corresponding color (Y, M, C, or K). The first transfer device **15** performs a first transfer process in which the toner image is transferred to the intermediate transfer device **20**. The drum cleaning device **16** cleans the image carrying surface of the photoconductor drum **11** by removing residual toner and other deposits from the image carrying surface after the first transfer process.

[0036] The photoconductor drum **11** is obtained by forming the image carrying surface having a photoconductive layer made of a photosensitive material (photosensitive layer) on a peripheral surface of a hollow or solid cylindrical base material that is grounded. This photoconductor drum **11** is supported so as to be rotatable in the direction of arrow A when power is transmitted thereto from a driving device (not shown).

[0037] The charging device **12** includes a contact charging roller **121** arranged in contact with the photoconductor drum **11**. A cleaning roller (not illustrated) for cleaning the surface of the charging roller **121** is disposed behind the charging roller **121**. A charging voltage is applied to the charging roller **121** of the charging device **12**. In the case where the developing device **14** performs a reversal development, a voltage having the same polarity as the polarity to which the toner supplied from the developing device **14** is charged is supplied as the charging voltage.

[0038] The exposure device **13** irradiates the charged peripheral surface of the photoconductor drum **11** with light corresponding to image information to form the electrostatic latent image. The image information may be, for example, image information of a document read by the image reading device **2**, image information input to the image forming apparatus **1** from an external unit, or image information stored in a memory, such as ROM, that is removably attachable to the apparatus body **1***a*. When a latent image is to be formed, the exposure device **13** receives the image information (signal) of the document read by the image reading device **2** or the image information (signal) input to the image forming apparatus **1** by any method.

[0039] The exposure device **13** is composed of an LED print head that forms an electrostatic latent image by irradiating the photoconductor drum **11** with light corresponding to the image information. The LED print head includes plural light emitting diodes (LEDs) serving as light emitting elements arranged in the axial direction of the photoconductor drum **11**. The exposure device **13** may be configured to perform deflection scanning in which the photoconductor drum **11** is scanned with laser light corresponding to the image information in the axial direction.

[0040] The developing device **14** includes a developing roller **141**, a stirring supply member **142**, a stirring transport member **143**, and a layer-thickness regulating member (not illustrated), which are disposed in a housing **140** having an opening facing the photoconductor drum **11** and a storage chamber for the developer. The developing roller **141** carries the developer and transports the developer to a developing region in which the developing roller **141** faces the photoconductor drum **11**. The stirring supply member **142** is, for example, a screw auger that supplies the developer while stirring the developer so that the developer passes the

developing roller **141**. The stirring transport member **143** is, for example, a screw auger that transports the developer to the stirring supply member **142** while stirring the developer. The layer-thickness regulating member regulates the amount (layer thickness) of the developer carried by the developing roller **141**. A developing voltage is applied between the developing roller **141** of the developing device **14** and the photoconductor drum **11** by a power supply device (not shown). Each of the developers of the four colors is, for example, a two-component developer containing non-magnetic toner and magnetic carrier.

[0041] The first transfer device **15** is a contact transfer device including a first transfer roller that rotates while being in contact with the periphery of the photoconductor drum **11** with the intermediate transfer belt **21** interposed therebetween and to which a first transfer voltage is supplied. The first transfer voltage is a direct-current voltage having a polarity opposite to the polarity to which the toner is charged, and is supplied by the power supply device (not shown).

[0042] The drum cleaning device **16** includes a cleaning plate (not illustrated) and a transport member. The cleaning plate is pressed against the peripheral surface of the photoconductor drum **11** at a predetermined pressure after the first transfer process, and cleans the peripheral surface by removing residual toner and other deposits therefrom. The transport member is, for example, a screw auger that collects the deposits, such as toner, removed by the cleaning plate and transports the collected deposits toward a collection system (not shown).

[0043] As illustrated in FIG. **1**, the intermediate transfer device **20** is disposed above the image forming devices **10** (Y, M, C, and K) in the vertical direction Z. The intermediate transfer device **20** includes the intermediate transfer belt **21**, plural belt support rollers **22** to **26**, a second transfer device **30**, and a belt cleaning device **27**. The intermediate transfer belt **21** rotates in the direction shown by arrow B while passing through first transfer positions, which are positions between the photoconductor drums **11** and the corresponding first transfer devices **15** (first transfer rollers). The belt support rollers **22** to **26** retain the intermediate transfer belt **21** in a desired state and support the intermediate transfer belt **21** in a rotatable manner at the inner surface of the intermediate transfer belt **21**. The second transfer device **30** is disposed so as to oppose the outer peripheral surface (image carrying surface) of a portion of the intermediate transfer belt **21** supported by the belt support roller **26**, and performs a second transfer process in which the toner images on the intermediate transfer belt **21** are transferred onto the recording paper sheet **5**. The belt cleaning device **27** cleans the outer peripheral surface of the intermediate transfer belt **21** by removing residual toner, paper dust, and other deposits from the outer peripheral surface of the intermediate transfer belt **21** after the intermediate transfer belt **21** has passed the second transfer device **30**.

[0044] The intermediate transfer belt **21** may be, for example, an endless belt made of a material obtained by dispersing a resistance adjuster, such as carbon black, into a synthetic resin, such as a polyimide resin or a polyamide resin. The belt support roller **22** serves as a driving roller that is rotationally driven by a driving device (not shown). The belt support rollers **23** and **24** serve as surface positioning rollers that retain the position of the intermediate transfer belt **21**. The belt support roller **25** serves as a tension-applying roller that applies tension to the intermediate transfer belt **21**. The belt support roller **26** serves as a backup roller for the second transfer process.

[0045] Referring to FIG. **1**, the second transfer device **30** is a contact transfer device including a second transfer roller **31** to which a second transfer voltage is applied and that rotates while being in contact with the peripheral surface of the intermediate transfer belt **21** at a second transfer position. The second transfer position is the position of the outer peripheral surface of the portion of the intermediate transfer belt **21** that is supported by the belt support roller **26** of the intermediate transfer device **20**. The second transfer voltage is a direct-current voltage having a polarity that is the same as or opposite to the polarity to which the toner is charged, and is supplied to the second transfer roller **31** or the belt support roller **26** of the intermediate transfer device **20**.

[0046] The belt cleaning device **27** includes a cleaning plate (not illustrated) and a transport member. The cleaning plate is pressed against the peripheral surface of the intermediate transfer belt **21** at a predetermined pressure after the second transfer process, and cleans the peripheral surface by removing residual toner and other deposits therefrom. The transport member is, for example, a screw auger that collects the deposits, such as toner, removed by the cleaning plate and transports the collected deposits toward a collection system (not shown).

[0047] The fixing device **40** includes a roller-shaped or belt-shaped heating rotating body **41** and a roller-shaped or belt-shaped pressing rotating body **42**. The heating rotating body **41** is heated by a heating unit so that the surface temperature thereof is maintained at a predetermined temperature. The pressing rotating body **42** extends substantially in the axial direction of the heating rotating body **41** and is rotated while being pressed against the heating rotating body **41** at a predetermined pressure. A contact portion in which the heating rotating body **41** and the pressing rotating body **42** of the fixing device **40** are in contact with each other serves as a fixing process section in which a predetermined fixing process (heating and pressing) is performed.

[0048] The sheet feeding device **50** is disposed below the yellow (Y), magenta (M), cyan (C), and black (K) image forming devices **10** (Y, M, C, and K) in the vertical direction Z. The sheet feeding device **50** includes one or more paper sheet containers **51** and feeding devices **52**. Each paper sheet container **51** contains the recording paper sheets **5** of the desired size, type, etc., in a stacked manner. Each feeding device **52** feeds the recording paper sheets **5** one at a time from the corresponding paper sheet container **51**. The paper sheet containers **51** are, for example, mounted to be capable of being pulled out of the apparatus body **1***a* at the front side (side the user faces during operation), that is, the near side in FIG. **1**.

[0049] Examples of the recording paper sheets **5** include sheets of plain paper or thin paper and OHP sheets used in, for example, electrophotographic copy machines and printers. To increase the smoothness of the image surfaces after the fixing process, the surfaces of the recording paper sheets **5** may be made as smooth as possible. The recording paper sheets **5** may be, for example, so-called thick sheets having a relatively large basis weight, such as sheets of coated paper obtained by coating the surfaces of plain paper with an image receiving layer made of synthetic resin or the like, or sheets of art paper for printing.

[0050] One or more paper sheet transport roller pairs **53** and **54** and a sheet transport path **56** are provided between the sheet feeding device **50** and the second transfer device **30**. The paper sheet transport roller pairs **53** and **54** transport each recording paper sheet **5** fed from the sheet feeding device **50** to the second transfer position. The sheet transport path **56** includes transport guides **55**. The paper sheet transport roller pair **53** serves as, for example, a pair of registration rollers that adjusts the time when the recording paper sheet **5** is transported. Output rollers **58** are disposed above the fixing device **40** in the vertical direction Z. The output rollers **58** output the recording paper sheet **5** fed from the fixing device **40** after the fixing process to an output tray **57** such that the image surface faces upward. The output tray **57** is disposed outside the apparatus body **1***a* (on the left side of the apparatus body **1***a* in FIG. **1**).

[0051] The image forming apparatus **1** includes a post-processing device **100** disposed above the apparatus body **1***a* and below the image reading device **2**. The post-processing device **100** performs post-processing on the recording paper sheet **5** having the image formed thereon by the image forming apparatus **1**. The post-processing device **100** includes a second fixing device **60** and a sheet cutting device **70**. A switching gate **59** and transport rollers **58***a* are disposed at the upper end of the apparatus body **1***a*. The switching gate **59** switches the transport path of the recording paper sheet **5** between the path for outputting the recording paper sheet **5** to the output tray **57** and the path toward the post-processing device **100** that performs the post-processing. The transport rollers **58***a* transport the recording paper sheet **5** to the post-processing device **100** when the transport path is switched by the switching gate **59**.

[0052] As illustrated in FIG. **2**, the second fixing device **60** includes an endless fixing belt **61**, a heating roller **62**, a separation roller **63**, a walk control roller **63***a*, a pressing roller **64**, halogen lamps **65**, a heat sink **66**, a guide member **67**, a separation guide **68**, and a transport roller pair **69**. The heating roller **62** heats the fixing belt **61**. The pressing roller **64** is pressed against the heating roller **62** with the fixing belt **61** disposed therebetween to form a nip portion N. The halogen lamps **65** are disposed in a hollow section of the heating roller **62** and heat a predetermined region of the nip portion N. The heat sink **66** cools the recording paper sheet **5** that is in close contact with the fixing belt **61**. The guide member **67** guides the recording paper sheet **5** to the nip portion N. The separation guide **68** assists and guides the separation of the recording paper sheet **5** from the fixing belt **61**. The transport roller pair **69** transports the separated recording paper sheet **5** to the sheet cutting device **70**. The heating roller **62** is rotationally driven by a drive source (not illustrated). The fixing belt **61** is rotationally driven in the direction of arrow C in FIG. **2** at a predetermined speed.

[0053] The heat sink **66** for performing forced cooling by coming into contact with the fixing belt **61** is provided on the inner surface of the fixing belt **61** at a location between the heating roller **62** and the separation roller **63**. An urging roller (not illustrated) is disposed to face the heat sink **66** with the fixing belt **61** disposed therebetween. The urging roller urges the recording paper sheet **5** against the fixing belt **61** to assist close contact between the transported recording paper sheet **5** and the fixing belt **61**. A tension roller (not illustrated) having a small diameter that applies constant tension to the fixing belt **61** is provided between the heat sink **66** for cooling and the heating roller **62**.

[0054] The second fixing device **60** operates as follows. After the toner image is fixed to the surface of the recording paper sheet **5** by the fixing device **40** of the image forming apparatus **1**, the recording paper sheet **5** is guided by the guide member **67**, as illustrated in FIG. **2**, and enters the nip portion N with the image surface facing the fixing belt **61**. In the nip portion N, the toner forming the toner image on the recording paper sheet **5** is melted by the heat applied by the heating roller **62** heated with the halogen lamps **65** and pressure applied by the pressing roller **64**. Thus, the toner image is embedded in an image-receiving layer of the recording paper sheet **5** that is softened with heat.

[0055] Then, the recording paper sheet **5** is transported while remaining in close contact with the fixing belt **61** after passing through the nip portion N. The recording paper sheet **5** is subjected to forced cooling by the heat sink **66** while being transported, and the smooth surface of the fixing belt **61** is transferred to the image-receiving layer. As a result, the glossiness of the recording paper sheet **5** and the toner image is increased. After that, the recording paper sheet **5** is cooled to a temperature lower than or equal to the melting temperature of the color toners in a region around the separation roller **63**, and then is separated from the fixing belt **61** by the toughness (rigidity) of the recording paper sheet **5** at the separation roller **63**.

[0056] Referring to FIG. **1**, toner cartridges **144** (Y, M, C, and K) filled with developers containing at least the toners to be supplied to the corresponding developing devices **14** (Y, M, C, and K) are arranged to extend in the direction perpendicular to the plane of FIG. **1**.

[0057] Referring to FIG. **1**, a control device **200** performs centralized control of the operation of the image forming apparatus **1** including the post-processing device **100**. The control device **200** includes a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), a bus that connects the CPU, ROM, etc., a communication interface, and an operation panel. All of these components are not illustrated.

Operation of Image Forming Apparatus

[0058] A basic image forming operation performed by the image forming apparatus **1** will now be described.

[0059] An operation for forming a full-color image by combining toner images of four colors (Y, M, C, and K) using the four image forming devices **10** (Y, M, C, and K) will be described.

[0060] Referring to FIG. **1**, when the control device **200** of the image forming apparatus **1** receives command information of a request for an image forming operation (print operation), the four image forming devices **10** (Y, M, C, and K), the intermediate transfer device **20**, the second transfer device **30**, and the fixing device **40** are activated.

[0061] In each of the image forming devices **10** (Y, M, C, and K), the photoconductor drum **11** rotates in the direction of arrow A. Next, the charging device **12** charges the surface of the photoconductor drum **11** to a predetermined potential of a predetermined polarity (negative in the first exemplary embodiment). Subsequently, the exposure device **13** irradiates the charged surface of the photoconductor drum **11** with light emitted on the basis of an image signal obtained by converting the image information input to the image forming apparatus **1** into components of the respective colors (Y, M, C, and K). Thus, an electrostatic latent image of the corre-

sponding color having a predetermined potential difference is formed on the surface of the photoconductor drum **11**.

[0062] Subsequently, the developing devices **14** (Y, M, C, and K) develop the electrostatic latent images of the respective colors formed on the photoconductor drums **11** by supplying toners of the respective colors (Y, M, C, and K), which are charged to a predetermined polarity (negative polarity), from the developing rollers **141** and causing the toners to electrostatically adhere to the photoconductor drums **11**. Thus, the electrostatic latent images of the respective colors formed on the photoconductor drums **11** are developed with the toners of the respective colors and made visible as toner images of the four colors (Y, M, C, and K).

[0063] Subsequently, the toner images of the respective colors formed on the photoconductor drums **11** of the image forming devices **10** (Y, M, C, and K) reach the first transfer positions. The first transfer devices **15** (Y, M, C, and K) perform the first transfer process in which the toner images of the respective colors are successively transferred onto the intermediate transfer belt **21**, which is included in the intermediate transfer device **20** and rotates in the direction of arrow B, in a superposed manner.

[0064] After the first transfer process, the drum cleaning device **16** of each of the image forming devices **10** (Y, M, C, and K) cleans the surface of the corresponding photoconductor drum **11** by scraping off deposits therefrom. Thus, the image forming devices **10** (Y, M, C, and K) are made ready for the next image forming operation.

[0065] Subsequently, the intermediate transfer belt **21** of the intermediate transfer device **20** rotates to carry and transport the toner images that have been transferred thereto in the first transfer process to the second transfer position. The sheet feeding device **50** feeds the recording paper sheet **5** to the sheet transport path **56** in accordance with the image forming operation. The paper sheet transport roller pair **53**, which serves as a pair of registration rollers, feeds the recording paper sheet **5** toward the second transfer position along the sheet transport path **56** at the time corresponding to the transfer time.

[0066] The toner images on the intermediate transfer belt **21** are simultaneously transferred onto the recording paper sheet **5** in the second transfer process by the second transfer roller **31** of the second transfer device **30** at the second transfer position. After the second transfer process, the belt cleaning device **27** of the intermediate transfer device **20** cleans the surface of the intermediate transfer belt **21** by removing residual toner and other deposits therefrom.

[0067] Subsequently, the recording paper sheet **5** to which the toner images have been transferred in the second transfer process is removed from the intermediate transfer belt **21** and the second transfer roller **31** and transported to the fixing device **40**. The fixing device **40** causes the recording paper sheet **5** after the second transfer process to pass through the contact section between the heating rotating body **41** and the pressing rotating body **42** that rotate. The unfixed toner images on the recording paper sheet **5** are fixed to the recording paper sheet **5** by a necessary fixing process (heating and pressing). Lastly, after the fixing process, the recording paper sheet **5** is output to the output tray **57** disposed outside the apparatus body **1***a* by the output rollers **58** when post-processing by the post-processing device **100** is not performed.

[0068] When the recording paper sheet **5** is to be subjected to post-processing, the switching gate **59** transports the recording paper sheet **5** on which the image is formed to the post-processing device **100** through the transport rollers **58***a*. In the post-processing device **100**, the second fixing device **60** performs the above-described process of increasing the glossiness, and the sheet cutting device **70**, which is an example of a sheet cutting unit, performs a process of cutting the recording paper sheet **5** as described below.

[0069] As a result of the above-described operation, the recording paper sheet **5** having a full-color image, which is formed by combining the toner images of the four colors, formed thereon is output.

Structure of Sheet Cutting Device

[0070] As described above, the image forming apparatus **1** includes the post-processing device **100** above the apparatus body **1***a*, as illustrated in FIG. **1**. The post-processing device **100** is attached to the top of the apparatus body **1***a* of the image forming apparatus **1** as an optional device, or is mounted in an upper end section of the apparatus body **1***a* of the image forming apparatus **1** in advance.

[0071] As illustrated in FIG. **3**, the sheet cutting device **70** basically includes a first transport roller pair **71**, a first cutter mechanism **72** that serves as an example of a first cutting unit, a second transport roller pair **73**, a third transport roller pair **74**, a second cutter mechanism **75** that serves as an example of a second cutting unit, and an output roller pair **76**.

[0072] The first transport roller pair **71** transports the recording paper sheet **5** subjected to the process of increasing the glossiness performed by the second fixing device **60** in the X direction, which is an example of a first transport direction. As illustrated in FIG. **4**A, the first transport roller pair **71** is composed of a pair of transport rollers **711** and **712** that nip the recording paper sheet **5** in the vertical direction Z and transport the recording paper sheet **5**.

[0073] The first cutter mechanism **72** cuts both end portions of the recording paper sheet **5** in the Y direction crossing the X direction, which is the first transport direction in which the recording paper sheet **5** is transported by the first transport roller pair **71**. As illustrated in FIG. **5**A, the first cutter mechanism **72** includes two pairs of first and second rotating blades **721** and **722** that mesh with each other in the vertical direction Z at inner and outer positions in the axial direction to cut the recording paper sheet **5**. The first and second rotating blades **721** and **722** are formed as single-edged blades including blade bodies having a circular shape in front view, as illustrated in FIG. **5**B, and including outer peripheral portions with surfaces opposite to the meshing surfaces being sharpened toward the edge (peripheral edge).

[0074] Each pair of the first and second rotating blades **721** and **722** constitutes a pair of cutting blades that rotate in mesh with each other to cut the recording paper sheet **5**. The first cutter mechanism **72** includes the pair of first and second rotating blades **721** and **722** constituting the pair of cutting blades at each end in the axial direction. As a result, the first cutter mechanism **72** constitutes a cutter mechanism in which the pairs of cutting blades composed of the first and second rotating blades **721** and **722** are provided at both ends in the axial direction.

[0075] However, the first cutter mechanism **72** may include only one pair of cutting blades composed of the first and second rotating blades **721** and **722** when, for example,

only one end portion of the recording paper sheet **5** in the direction crossing the transport direction is cut.

[0076] The first cutter mechanism **72** is capable of simultaneously cutting both end portions of the recording paper sheet **5** in the Y direction crossing the transport direction by transporting the recording paper sheet **5** in the X direction, which is the first transport direction. The recording paper sheet **5** cut by the first cutter mechanism **72** is transported with reference to the center in the direction Y crossing the transport direction X. After the recording paper sheet **5** is cut, the width of the recording paper sheet **5** is equal to the interval between the two pairs of cutting blades.

[0077] As illustrated in FIGS. **5**A and **6**, each first rotating blade **721** is fixed to a first rotating shaft **723** with a fixing member **724**. The first rotating blade **721**, which is disposed at a lower position in the vertical direction Z, constitutes an inner blade positioned at an inner position in the axial direction. The fixing member **724** is not necessarily disposed on the inner side of the first rotating blade **721** in the axial direction of the first rotating shaft **723**, and may be disposed on the outer side of the first rotating shaft **723**. As illustrated in FIG. **7**, the first rotating shaft **723** is rotationally driven at a predetermined speed by a drive motor **201**, which is an example of a drive source, through reduction gears **202** and **203**.

[0078] Driving rollers **725** are fixed to the first rotating shaft **723** of the first rotating blades **721**. Each driving roller **725** is one of transport rollers constituting a transport roller pair that nips and transports the recording paper sheet **5**. The driving rollers **725** are disposed on the inner side of the first rotating blades **721** in the axial direction of the first rotating shaft **723** with a predetermined interval therebetween.

[0079] The second rotating blades **722** are disposed outside the first rotating blades **721** in the axial direction, and are attached to a second rotating shaft **726** such that the second rotating blades **722** are movable in the axial direction of the second rotating shaft **726**. Each second rotating blade **722**, which is disposed at an upper position in the vertical direction Z, constitutes an outer blade. Each second rotating blade **722** is disposed in contact with the corresponding first rotating blade **721** without leaving a gap therebetween and is maintained inclined relative to the first rotating blade **721** at a predetermined small angle θ so that the recording paper sheet **5** can be cut.

[0080] Furthermore, as illustrated in FIG. **6**, each second rotating blade **722** is urged inward relative to the second rotating shaft **726** in the axial direction by a coil spring **727**, which is an example of an urging unit, so that the second rotating blade **722** is in contact with the first rotating blade **721**. One end (outer end) **727***a* of the coil spring **727** is fixed to the second rotating shaft **726**. The second rotating blade **722** has an inner surface in contact with a projecting member (not illustrated), for example, so that the second rotating blade **722** rotates while being maintained inclined relative to the first rotating blade **721** by the predetermined small angle θ such that the lower end thereof is slightly farther away from the first rotating blade **721** than the upper end thereof.

[0081] Pinch rollers **729** are provided on the second rotating shaft **726** of the second rotating blades **722**. Each pinch roller **729** is the other one of the transport rollers constituting the transport roller pair that nips and transports the recording paper sheet **5**. The pinch rollers **729** are disposed on the inner side of the second rotating blades **722** in the axial direction of the second rotating shaft **726** with a predetermined interval therebetween such that the pinch rollers **729** face the driving rollers **725**. The second rotating shaft **726** is urged by coil springs S, which are examples of urging units, through bearing members (not illustrated) or the like so that the pinch rollers **729** are in contact with the driving rollers **725**. The second rotating shaft **726** is rotated when the pinch rollers **729** are in contact with the driving rollers **725**. The second rotating shaft **726** extends through long holes in a frame (not illustrated) of the sheet cutting device **70** and is supported such that the second rotating shaft **726** is rotatable and movable in the vertical direction Z.

[0082] As illustrated in FIG. **3**, the second transport roller pair **73** transports the recording paper sheet **5** in the X direction, which is the first transport direction, while preventing rising of the leading end portion of the recording paper sheet **5** after both edges of the recording paper sheet **5** in the Y direction are cut by the first cutter mechanism **72**. As illustrated in FIGS. **4**A and **4**B, the second transport roller pair **73** includes a pair of transport rollers **731** and **732** that nip the recording paper sheet **5** in the vertical direction Z and transport the recording paper sheet **5** in a central region in the Y direction crossing the transport direction X of the recording paper sheet **5**. Of the pair of transport rollers **731** and **732**, the transport roller **732** disposed at an upper position in the vertical direction is retractable upward at a predetermined timing so that the transport roller **732** does not impede the movement of the recording paper sheet **5** when the third transport roller pair **74** transports the recording paper sheet **5** in the Y direction.

[0083] The third transport roller pair **74** transports the recording paper sheet **5** in the Y direction, which is a second transport direction crossing the first transport direction, after both edges of the recording paper sheet **5** in the Y direction are cut by the first cutter mechanism **72**. As illustrated in FIG. **4**B, the third transport roller pair **74** includes a pair of transport rollers **741** and **742** that nip the recording paper sheet **5** in the vertical direction Z and transport the recording paper sheet **5**. The transport roller **742** of the third transport roller pair **74** is retractable upward so that the third transport roller pair **74** does not impede the transport of the recording paper sheet **5** when the first cutter mechanism **72** cuts both end portions of the recording paper sheet **5** in the Y direction.

[0084] The third transport roller pair **74** nips the recording paper sheet **5** and transports the recording paper sheet **5** in the Y direction, which is the second transport direction, after the first cutter mechanism **72** completes cutting both edges of the recording paper sheet **5** in the Y direction.

[0085] As illustrated in FIG. **3**, the second cutter mechanism **75** cuts both end portions of the recording paper sheet **5** in the X direction crossing the Y direction, which is the second transport direction in which the recording paper sheet **5** is transported by the third transport roller pair **74**.

[0086] The structure of the second cutter mechanism **75** is similar to that of the first cutter mechanism **72**. Here, elements of the second cutter mechanism **75** are denoted by the same reference numerals as those of the first cutter mechanism **72** in FIGS. **5**A, **5**B, and **6** and other figures, and description thereof is thus omitted. Similarly to the first cutter mechanism **72**, the second cutter mechanism **75** includes first and second rotating blades **721** and **722**.

[0087] As illustrated in FIG. **3**, the output roller pair **76** outputs the recording paper sheet **5** to an output tray **77** after both edges of the recording paper sheet **5** are cut by the

second cutter mechanism **75** so that recording paper sheet **5** has a predetermined length and width. The output tray **77** is disposed at a position accessible by the user from the front side of the image forming apparatus **1**. As illustrated in FIG. **4**B, the output roller pair **76** includes a pair of transport rollers **761** and **762** that nip the recording paper sheet **5** in the vertical direction Z and transport the recording paper sheet **5**.

[0088] As illustrated in FIGS. **3** and **4**A, a paper sheet sensor **78** that detects the leading end of the recording paper sheet **5** is disposed upstream of the first transport roller pair **71** in the transport direction of the recording paper sheet **5**.

[0089] The control device **200** controls the timing for driving the first to third transport roller pairs **71**, **73**, and **74** and the first and second cutter mechanisms **72** and **75** and the upward retraction based on a detection signal obtained by the paper sheet sensor **78**.

[0090] The sheet cutting device **70** having the above-described structure is normally capable of cutting the recording paper sheet **5** with a thickness and a hardness within predetermined ranges based on, for example, the basis weight and the material. However, there is a possibility that the sheet cutting device **70** will receive the recording paper sheet **5** with a thickness or hardness outside the predetermined allowable range. When the sheet cutting device **70** receives the recording paper sheet **5** with a thickness or hardness outside the allowable range, the first and second rotating blades **721** and **722** cannot perform the cutting process.

[0091] As illustrated in FIGS. **8**A to **8**C, when the sheet cutting device **70** receives the recording paper sheet **5** with a thickness or hardness outside the allowable range, the first and second rotating blades **721** and **722** cannot perform the cutting process. Therefore, the second rotating shaft **726** moves upward against the urging force of the coil springs S, and each second rotating blade **722** also moves upward and onto the recording paper sheet **5**. Then, in the sheet cutting device **70**, since the second rotating blade **722** that serves as a driven blade is urged inward in the axial direction by the coil spring **727**, the second rotating blade **722** moves inward in the axial direction beyond the first rotating blade **721**, and the first and second rotating blades **721** and **722** are unmeshed.

[0092] When the first and second rotating blades **721** and **722** are unmeshed, the sheet cutting device **70** can no longer perform the operation of cutting the recording paper sheet **5**. Therefore, the recording paper sheet **5** that is not cut into the predetermined size is output to the output tray **77**, and the user recognizes that the sheet cutting device **70** is out of order.

[0093] When the sheet cutting device **70** is out of order, the user calls a customer engineer (CE). The customer engineer (CE) manually re-meshes and restores the first and second rotating blades **721** and **722**. Therefore, the sheet cutting device **70** according to the related art cannot be used until the first and second rotating blades **721** and **722** are re-meshed and restored, and has a technical problem in that down time is incurred. The sheet cutting device **70** according to the related also has a technical problem in that the task of re-meshing and restoring the first and second rotating blades **721** and **722** needs to be performed carefully and requires skill because the first and second rotating blades **721** and **722** are sharp and handled manually by the customer engineer (CE).

[0094] The above-described technical problems are not limited to the case in which the recording paper sheet **5** with a thickness or hardness outside the allowable range is supplied. Even when the thickness and hardness of the recording paper sheet **5** are within the allowable ranges, the first and second rotating blades **721** and **722** may become blunt due to wear, for example, after long use of the sheet cutting device **70**. Also in this case, the above-described technical problems occur due to meshing failure of the first and second rotating blades **721** and **722**.

[0095] Accordingly, to enable the unmeshed first and second rotating blades to return to the original state without the need for manual intervention by, for example, the customer engineer, the sheet cutting device according to the first exemplary embodiment includes a restoring unit. When the positional relationship between the inner and outer positions of the first and second rotating blades in the axial direction is reversed, the restoring unit releases the first and second rotating blades from each other and moves at least one of the first and second rotating blades in the axial direction to restore the positional relationship between the inner and outer positions to the original state.

[0096] In the sheet cutting device according to the first exemplary embodiment, the restoring unit includes a releasing unit that releases the first and second rotating blades from each other and a moving unit that moves one of the first and second rotating blades in the axial direction.

[0097] According to the sheet cutting device **70** of the first exemplary embodiment, when the first and second rotating blades **721** and **722** are unmeshed as illustrated in FIG. **8**C, the recording paper sheet **5** cannot be cut and is therefore output from the output tray **77** without being cut to the predetermined size, causing the user to recognize the situation.

[0098] The sheet cutting device **70** may include a size detection unit (not illustrated) that detects the size of the recording paper sheet **5** that has passed the first cutter mechanism **72** and the second cutter mechanism **75**. In this case, the size detection unit may detect the presence of an uncut portion left at one or both ends of the recording paper sheet **5** in the direction crossing the transport direction. This enables automatic detection of meshing failure of the first and second rotating blades **721** and **722** in the first cutter mechanism **72** and/or the second cutter mechanism **75**.

[0099] As illustrated in FIG. **7**, the sheet cutting device **70** according to the first exemplary embodiment includes a restoring mechanism **80** as an example of the restoring unit. When the positional relationship between the inner and outer positions of each pair of the first and second rotating blades **721** and **722** in the axial direction is reversed, the restoring mechanism **80** releases the first and second rotating blades **721** and **722** from each other and moves the second rotating blade **722** as at least one of the first and second rotating blades **721** and **722** in the axial direction to restore the positional relationship between the inner and outer positions to the original state. The restoring mechanism **80** is provided for each of the first and second cutter mechanisms **72** and **75**. The first cutter mechanism **72** will be described herein as an example.

[0100] The restoring mechanism **80** includes a retracting mechanism **81** as an example of the releasing unit and a moving mechanism **82** as an example of the moving unit. The retracting mechanism **81** releases the first and second rotating blades **721** and **722** from each other. The moving

mechanism **82** moves the second rotating blade **722** as at least one of the first and second rotating blades **721** and **722** in the axial direction.

[0101] As illustrated in FIGS. **9**, **10**A, and **10**B, the retracting mechanism **81** includes arm members **811** as examples of swingable operating arms that move the second rotating shaft **726** of the first cutter mechanism **72** upward. The arm members **811** are attached to both end portions of a driving shaft **812** in the axial direction so as to project in a direction crossing the driving shaft **812** in a cantilever manner. A lever member **813** that rotates the driving shaft **812** is provided on one end portion of the driving shaft **812** in the axial direction so as to project in a direction crossing the driving shaft **812** in a cantilever manner. The driving shaft **812** is rotatably attached to a frame (not illustrated) of the sheet cutting device **70**.

[0102] As illustrated in FIGS. **10**A and **10**B, an eccentric cam **814** is maintained in contact with an end portion (lower end portion) of the lever member **813** by an urging force applied by an urging unit, such as a spring (not illustrated), engaged with the driving shaft **812**. The eccentric cam **814** is stopped after being rotationally driven by a drive motor **815** to rotate in a predetermined direction by a predetermined amount.

[0103] In the retracting mechanism **81**, the eccentric cam **814** is rotationally driven by the drive motor **815** to rotate in a predetermined direction by a predetermined amount, so that the lever member **813** attached to the driving shaft **812** is rotationally driven. Accordingly, the driving shaft **812** having the lever member **813** attached to one end portion thereof rotates together with the lever member **813**. When the driving shaft **812** rotates clockwise, the arm members **811** fixed to the driving shaft **812** move upward so that, as illustrated in FIG. **11**, the second rotating shaft **726** of the first cutter mechanism **72** moves upward to release the first rotating blades **721** and the second rotating blades **722** from one another.

[0104] As illustrated in FIGS. **7**, **10**A, and **10**B, the moving mechanism **82** includes moving members **821** that move the second rotating blades **722** in the axial direction of the second rotating shaft **726**. The moving members **821** have long holes **822** through which the second rotating shaft **726** is inserted such that the second rotating shaft **726** is movable in the up-down direction. The moving members **821** are maintained in the illustrated state by a guide member (not illustrated) even when the second rotating shaft **726** is moved in the up-down direction. Rack gears **825** and **825** that constantly mesh with worm gears **824** and **824** attached to a drive shaft **823** are provided at the upper ends of the moving members **821**. The worm gears **824** and **824** are attached to one end portion and the other end portion of the drive shaft **823** in the axial direction such that the directions thereof are opposite to each other. When the drive shaft **823** is rotationally driven in one direction, one of the worm gears **824** and **824** provided on one end portion (left end portion in FIG. **7**) of the drive shaft **823** moves the corresponding one of the rack gears **825** and **825** toward one end (left end in FIG. **7**) in the axial direction, and the worm gear **824** provided on the other end portion (right end portion in FIG. **7**) of the drive shaft **823** moves the corresponding one of the rack gear **825** and **825** toward the other end (right end in FIG. **7**) in the axial direction. As illustrated in FIG. **7**, the drive shaft **823** is rotationally driven by a drive motor **826** disposed at one end thereof in the axial direction through reduction gears **827** and **828**.

[0105] The moving members **821** are capable of being reciprocated in the axial direction of the drive shaft **823** by the rack gears **825** and **825** that mesh with the worm gears **824** and **824** attached to the drive shaft **823** when the drive shaft **823** is rotationally driven by the drive motor **826**.

[0106] As illustrated in FIG. **12**, when the moving members **821** move in the axial direction of the drive shaft **823**, the moving members **821** come into contact with the second rotating blades **722** provided on the second rotating shaft **726** and move the second rotating blades **722** in the axial direction against the urging force applied by the coil springs **727**.

Operation of Sheet Cutting Device

[0107] The sheet cutting device **70** according to the first exemplary embodiment is capable of restoring the unmeshed first and second rotating blades **721** and **722** to the original state, as described below, without the need for manual intervention by, for example, a customer engineer.

[0108] More specifically, in the sheet cutting device **70** according to the first exemplary embodiment, as illustrated in FIGS. **8**A to **8**C, when the recording paper sheet **5** with a thickness or hardness outside the allowable range is supplied or when the first and second rotating blades **721** and **722** become blunt due to wear, for example, the second rotating blade **722** urged by the coil spring **727** may move inward beyond the first rotating blade **721**, and the first and second rotating blades **721** and **722** may be unmeshed.

[0109] In such a case, as illustrated in FIG. **8**C, the sheet cutting device **70** cannot perform the operation of cutting the recording paper sheet **5**. Therefore, the recording paper sheet **5** that is not cut to the predetermined size is output to the output tray **77**, and the user recognizes that the sheet cutting device **70** is out of order.

[0110] When the user recognizes that the sheet cutting device **70** is out of order, the user operates a restore button, for example, provided on an operation panel (not illustrated) of the image forming apparatus **1** to execute a restore operation for the sheet cutting device **70**.

[0111] When the restore button provided on the operation panel is operated, the control device **200** of the image forming apparatus **1** performs the restore operation described below.

[0112] The control device **200** of the image forming apparatus **1** may be configured to automatically detect that the sheet cutting device **70** is out of order and display a message stating, for example, "Sheet cutting device is out of order. Operate restore button on operation panel." on the operation panel (not illustrated) to prompt the user to operate the restore button.

[0113] When the restore button is operated, as illustrated in FIG. **9**, the control device **200** rotationally drives the drive motor **815** of the retracting mechanism **81** to rotate the eccentric cam **814** so that the driving shaft **812** is rotated clockwise by the lever member **813**.

[0114] Accordingly, as illustrated in FIG. **10**B, the arm members **811** provided on the driving shaft **812** rotate to move the second rotating shaft **726** upward. Thus, as illustrated in FIGS. **13**A and **13**B, the arm members **811** release the second rotating blades **722** provided on the second rotating shaft **726** from the first rotating blades **721**.

[0115] Next, as illustrated in FIG. **11**, the control device **200** rotationally drives the drive motor **826** of the moving mechanism **82** to rotate the worm gears **824** and **824** attached to the drive shaft **823**. Thus, the moving members **821** having the rack gears **825** and **825** meshing with the worm gears **824** and **824** move in the axial direction of the second rotating shaft **726**.

[0116] When each second rotating blade **722** reaches a position outside the corresponding first rotating blade **721** in the axial direction of the second rotating shaft **726** as illustrated in FIG. **13**C, the drive motor **826** of the moving mechanism **82** is stopped to stop the second rotating blade **722** at this position.

[0117] After that, as illustrated in FIG. **10**A, the control device **200** rotationally drives the drive motor **815** of the retracting mechanism **81** to rotate the eccentric cam **814** so that the driving shaft **812** is rotated counterclockwise by the lever member **813**. Accordingly, the arm members **811** provided on the driving shaft **812** rotate to move the second rotating shaft **726** downward, as illustrated in FIG. **14**D, so that each second rotating blade **722** provided on the second rotating shaft **726** is moved to a position at which the second rotating blade **722** can mesh with the corresponding first rotating blade **721**.

[0118] Lastly, as illustrated in FIG. **12**, the control device **200** rotationally drives the drive motor **826** of the moving mechanism **82** to rotate the worm gears **824** and **824** attached to the drive shaft **823**. Thus, the moving members **821** having the rack gears **825** and **825** meshing with the worm gears **824** and **824** move in the axial direction of the second rotating shaft **726**.

[0119] As a result, as illustrated in FIG. **14**E, each second rotating blade **722** is restored to the state in which the second rotating blade **722** is in contact with the corresponding first rotating blade **721** by the urging force applied by the coil spring **727**. After that, the moving members **821** move to standby positions that are spaced from the second rotating blades **722** by predetermined distances in the axial direction, and the restore operation is completed.

[0120] When the completion of the restore operation is detected, the control device **200** displays information that the sheet cutting device **70** is usable on the operation panel of the image forming apparatus **1**.

Second Exemplary Embodiment

[0121] FIG. **15** illustrates the structure of a sheet cutting device according to a second exemplary embodiment. The sheet cutting device according to the second exemplary embodiment differs from that of the first exemplary embodiment in the structure of the moving mechanism.

[0122] More specifically, in the sheet cutting device **70** according to the second exemplary embodiment, as illustrated in FIG. **15**, the moving mechanism is not composed of the combinations of the worm gears **824** and **824** and the rack gears **825** and **825**, but is composed of solenoids **90** for moving the second rotating blades **722** in the axial direction.

[0123] Similarly to the first exemplary embodiment, the second rotating shaft **726** of the second rotating blades **722** is provided with the moving members **821** for moving the second rotating blades **722** in the axial direction. The upper ends of the moving members **821** are fixed to movable iron cores **91** of the solenoids **90**. The amounts by which the movable iron cores **91** project may be changed in one or more steps by changing the currents or voltages applied to the solenoids **90**.

[0124] The moving members **821** and the solenoids **90** are arranged to correspond to the second rotating blades **722** disposed at both end portions of the second rotating shaft **726** in the axial direction.

[0125] In the sheet cutting device **70** according to the second exemplary embodiment, the second rotating blade **722** is movable in the axial direction simply by placing the solenoids **90**. Therefore, the size of the restoring mechanism **80** may be reduced.

[0126] The moving mechanism is not limited to those driven by the solenoids **90** and may include, for example, sliders driven by motors or the like and movable in the axial direction of the second rotating shaft **726**.

[0127] Other structures and operations are similar to those of the first exemplary embodiment, and description thereof is thus omitted.

Third Exemplary Embodiment

[0128] FIG. **16** illustrates the structure of a sheet cutting device according to a third exemplary embodiment. According to the sheet cutting device **70** of the third exemplary embodiment, the cutting width of the sheet in the direction crossing the transport direction of the sheet is changeable.

[0129] As illustrated in FIG. **16**, in the sheet cutting device **70** according to the third exemplary embodiment, the first rotating blades **721** provided at both ends in the axial direction are not attached to the same first rotating shaft **723** but are attached to left and right first rotating shafts **723** divided from each other in the axial direction. The second rotating blades **722** provided at both ends in the axial direction are not attached to the same second rotating shaft **726** but are attached to left and right second rotating shafts **726** divided from each other in the axial direction. In this sheet cutting device **70**, the first cutter mechanism **72** and the second cutter mechanism **75** have the same structure.

[0130] The sheet cutting device **70** includes left and right brackets **83** and **84** disposed at both ends in the axial direction. Each of the left and right brackets **83** and **84** is a substantially rectangular-parallelepiped-shaped box having left and right side walls, which support the first and second rotating shafts **723** and **726** in a rotatable manner, and top and bottom walls. The left and right brackets **83** and **84** are attached to two guide shafts **85** and **86** such that the left and right brackets **83** and **84** are movable toward and away from each other. The guide shafts **85** and **86** extend parallel to each other in a horizontal direction at upper and lower positions. The left and right brackets **83** and **84** are attached to the two guide shafts **85** and **86** to maintain the positional accuracy of the first and second rotating blades **721** and **722** disposed in the left and right brackets **83** and **84**. The lower guide shaft **85** also serves as a drive shaft that rotationally drives the first and second rotating blades **721** and **722** disposed in the left and right brackets **83** and **84**. The lower guide shaft **85** is rotationally driven by a drive motor **851** disposed at one end of the lower guide shaft **85** in the axial direction through reduction gears **852** and **853**.

[0131] The left and right brackets **83** and **84** support the left and right first rotating shafts **723** divided from each other in the axial direction and the left and right second rotating shafts **726** divided from each other in the axial direction in a rotatable manner. The first rotating shafts **723** supported by

the left and right brackets **83** and **84** are rotationally driven at the same rotational speed by the lower guide shaft **85** through driving pulleys **854**, driving belts **855**, and driven pulleys **856**. The driving pulleys **854** are attached to the lower guide shaft **85** such that the driving pulleys **854** are movable in the axial direction.

[0132] As illustrated in FIG. **17**, each driving pulley **854** is attached to the lower guide shaft **85** such that the driving pulley **854** is movable in the axial direction along a guide groove **857** and capable of transmitting the rotational driving force. Each driven pulley **856** is movable in the axial direction in response to the movement of the driving pulley **854** and capable of transmitting the rotational driving force.

[0133] Similarly to the first exemplary embodiment, each second rotating shaft **726** on which the second rotating blade **722** is provided has the pinch roller **729** brought into contact with the driving roller **725** by the urging force applied by the coil springs S provided at both ends of the second rotating shaft **726**, and is thereby rotated.

[0134] The left and right brackets **83** and **84** are movable by symmetrical distances in the horizontal direction by long rack gears **831** and **841** provided at the lower ends of the left and right brackets **83** and **84** and pinion gears **833** and **843** rotationally driven by drive motors **832** and **842**.

[0135] Referring to FIG. **16**, in the sheet cutting device **70** according to the third exemplary embodiment, the drive motors **832** and **842** may be rotationally driven to move the left and right brackets **83** and **84** through the pinion gears **833** and **843** and the rack gears **831** and **841**. Thus, the interval between the two pairs of first and second rotating blades **721** and **722** may be changed, and the cutting width of the recording paper sheet **5** may be changed accordingly.

[0136] In the image forming apparatus **1** including the sheet cutting device **70**, the cutting dimension of the recording paper sheet **5** in each of the longitudinal and transverse directions may be input through, for example, the operation panel. Accordingly, the left and right brackets **83** and **84** may be moved so that the distance therebetween is equal to the input dimension, and the recording paper sheet **5** may be cut to desired widths in the longitudinal and transverse directions.

[0137] The opposing walls of the left and right brackets **83** and **84** have openings **836** and **846** for allowing the recording paper sheet **5** to pass therethrough.

[0138] Other structures and operations are similar to those of the first exemplary embodiment, and description thereof is thus omitted.

Fourth Exemplary Embodiment

[0139] FIG. **18** illustrates the structure of a sheet cutting device according to a fourth exemplary embodiment. The sheet cutting device **70** according to the fourth exemplary embodiment is configured to reduce damage to the image formed on the recording paper sheet when the recording paper sheet is cut.

[0140] As illustrated in FIGS. **19**A to **19**C, the sheet cutting device **70** is structured such that when the recording paper sheet **5** is cut, the first and second rotating blades **721** and **722** that rotate come into contact with the front and back surfaces of the recording paper sheet **5**, and both end portions of the recording paper sheet **5** in the direction crossing the transport direction are cut off. At this time, the recording paper sheet **5** is divided into a resultant sheet **5***a* from which both end portions in the direction crossing the transport direction are cut off, and cut-off portions **5***b* that are positioned on both sides of the resultant sheet **5***a* and that are to be discarded.

[0141] It has been confirmed by stress analysis that, when the sheet cutting device **70** cuts the recording paper sheet **5** with the first and second rotating blades **721** and **722** as illustrated in FIG. **19**C, high stress is applied to a portion of the recording paper sheet **5** with which the first and second rotating blades **721** and **722** are in contact. Therefore, when the first or second rotating blade **721** or **722** comes into contact with an image surface **5***c* of the resultant sheet **5***a* of the recording paper sheet **5**, the image surface **5***c* of the recording paper sheet **5** may be damaged by the first or second rotating blade **721** or **722** (first rotating blade **721** in the illustrated example), and marks may be formed on the image. Thus, the image quality may be reduced.

[0142] Instead of using rotating blades with sharp edges for both the first and second rotating blades **721** and **722**, a flat plate-shaped rotating blade having a blunt edge may be used as one of the first and second rotating blades **721** and **722** to reduce the costs without affecting the performance of cutting the recording paper sheet **5**. When the flat plate-shaped rotating blade is positioned to face the image surface **5***c* of the recording paper sheet **5**, the image surface **5***c* of the recording paper sheet **5** is significantly damaged.

[0143] Accordingly, the sheet cutting device **70** of the fourth exemplary embodiment is structured such that, when the recording paper sheet **5** is cut by the first and second rotating blades **721** and **722**, the first or second rotating blade **721** or **722** does not come into contact with the image surface **5***c* of the resultant sheet **5***a* of the recording paper sheet **5**, and the first or second rotating blade **721** or **722** (second rotating blade **722** in the illustrated example) comes into contact with the image surface **5***c* of each cut-off portion **5***b* of the recording paper sheet **5**.

[0144] As illustrated in FIG. **18**, the sheet cutting device **70** according to the fourth exemplary embodiment includes a reversing mechanism **900** disposed downstream of the second fixing device **60** in the transport direction of the recording paper sheet **5**. The reversing mechanism **900** reverses the recording paper sheet **5** that has passed through the second fixing device **60**.

[0145] The reversing mechanism **900** does not directly transport the recording paper sheet **5** that has passed through the second fixing device **60** to the sheet cutting device **70**, but temporarily transports the recording paper sheet **5** to a reversing path **910** provided with reversing rollers (not illustrated). Then, the reversing mechanism **900** reverses the transport direction of the recording paper sheet **5** transported to the reversing path **910** to reverse the front and back sides of the recording paper sheet **5**.

[0146] After the transport direction of the recording paper sheet **5** is reversed at the reversing path **910**, the recording paper sheet **5** is transported to the sheet cutting device **70** with the image surface **5***c* facing upward.

[0147] Referring to FIG. **20**A, the sheet cutting device **70** performs the operation of cutting the recording paper sheet **5** by bringing the second rotating blade **722**, which is an outer blade positioned at an outer position in the axial direction, into contact with the image surface **5***c* of the cut-off portion **5***b* of the recording paper sheet **5** and bringing the first rotating blade **721** into contact with a surface of the resultant sheet **5***a* of the recording paper sheet **5** opposite to the image surface **5***c*.

[0148] The sheet cutting device **70** performs a similar cutting operation at the second cutter mechanism **75**.

[0149] Thus, in the sheet cutting device **70** according to the fourth exemplary embodiment, when the recording paper sheet **5** is cut by the first and second rotating blades **721** and **722**, the image surface of the resultant sheet **5***a* of the recording paper sheet **5** may be reliably prevented from being damaged by the first or second rotating blade **721** or **722**. Thus, the image quality of the recording paper sheet **5** may be increased.

[0150] In the image forming apparatus **1** including the sheet cutting device **70** according to the fourth exemplary embodiment, the post-processing device **100** includes the second fixing device **60** for increasing the glossiness of the recording paper sheet **5**. Therefore, the recording paper sheet **5** is transported toward the sheet cutting device **70** with the image surface **5***c* facing downward.

[0151] Therefore, as illustrated in FIG. **20**B, the sheet cutting device **70** may be structured such that the second rotating blade **722** serves as an inner blade that comes into contact with a surface (upper surface) of the resultant sheet **5***a* at a side opposite to the image surface **5***c* at the lower side of the recording paper sheet **5**, and such that the first rotating blade **721** serves as an outer blade that comes into contact with the image surface of the resultant sheet **5***a* at the lower side of the recording paper sheet **5**. In this case, the reversing mechanism **900** may be omitted.

[0152] FIGS. **21**A, **21**B, and **21**C illustrate the structure of a modification of the sheet cutting device **70** according to the fourth exemplary embodiment.

[0153] The sheet cutting device **70** illustrated in FIGS. **21**A to **21**C includes a transport path **92** along which the recording paper sheet **5** to be subjected to the cutting process is transported and that branches into two paths, which are a first transport path **93** and a second transport path **94**, at an intermediate position. The first transport path **93**, along which the recording paper sheet **5** having the image surface facing upward is transported, is provided with a first sheet cutting device **70**A. As illustrated in FIG. **21**B, the first sheet cutting device **70**A includes first rotating blades **721** that come into contact with a surface (lower surface) of the resultant sheet **5***a* at a side opposite to the image surface at the upper side of the recording paper sheet **5**, and second rotating blades **722** that come into contact with the image surface (upper surface) of the resultant sheet **5***a* at the upper side of the recording paper sheet **5**.

[0154] The second transport path **94**, along which the recording paper sheet **5** having the image surface facing downward is transported, is provided with a second sheet cutting device **70**B. As illustrated in FIG. **21**C, the second sheet cutting device **70**B includes second rotating blades **722** that come into contact with a surface (upper surface) of the resultant sheet **5***a* at a side opposite to the image surface at the lower side of the recording paper sheet **5**, and first rotating blades **721** that come into contact with the image surface (lower surface) of the cut-off portions **5***b* at the lower side of the recording paper sheet **5**.

[0155] In this sheet cutting device **70**, switching between the first and second transport paths **93** and **94** is performed depending on whether the image surface **5***c* is at the upper side of the recording paper sheet **5** or the lower side of the recording paper sheet **5**.

[0156] According to the sheet cutting device **70** illustrated in FIGS. **21**A to **21**C, it is not necessary to reverse the front and back sides of the recording paper sheet **5**. Therefore, the time required for the operation of cutting the recording paper sheet **5** may be reduced.

[0157] Although a full-color image forming apparatus is described in the exemplary embodiments, the image forming apparatus may, of course, be a monochrome image forming apparatus.

[0158] In the above-described exemplary embodiments, the sheet cutting device is mounted in the image forming apparatus as a post-processing device. However, the sheet cutting device may, of course, be provided as an independent post-processing device that is separate from the image forming apparatus.

[0159] The foregoing description of the exemplary embodiments of the present disclosure has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the disclosure and its practical applications, thereby enabling others skilled in the art to understand the disclosure for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the disclosure be defined by the following claims and their equivalents.

APPENDIX

(((1)))

[0160] A sheet cutting device including:

[0161] first and second rotating blades that mesh with each other at inner and outer positions in an axial direction and that cut a sheet; and

[0162] a restoring unit,

[0163] wherein, when a positional relationship between the inner and outer positions of the first and second rotating blades in the axial direction is reversed, the restoring unit releases the first and second rotating blades from each other and moves at least one of the first and second rotating blades in the axial direction to restore the positional relationship between the inner and outer positions to an original state.

(((2)))

[0164] The sheet cutting device according to (((1))),

[0165] wherein the restoring unit includes

[0166] a releasing unit that releases the first and second rotating blades from each other, and

[0167] a moving unit that moves one of the first and second rotating blades in the axial direction.

(((3)))

[0168] The sheet cutting device according to (((2))),

[0169] wherein one of the first and second rotating blades is a fixed rotating blade that is fixed in the axial direction on a rotating shaft, and other of the first and second rotating blades is an urged rotating blade that is movably urged to be in contact with the fixed rotating blade, and

[0170] wherein the moving unit moves the urged rotating blade.

[0171] (((4)))

[0172] The sheet cutting device according to (((3))), wherein the moving unit includes a pushing member that pushes the urged rotating blade in the axial direction.

(((5)))

[0173] The sheet cutting device according to (((4))), wherein the pushing member includes a rack gear that meshes with a rotationally driven pinion gear.

(((6)))

[0174] The sheet cutting device according to (((2))),

[0175] wherein one of the first and second rotating blades is a rotationally driven rotating blade and other of the first and second rotating blades is a rotated rotating blade, and

[0176] wherein the releasing unit moves the rotated rotating blade in a direction crossing the axial direction to release the first and second rotating blades from each other.

(((7)))

[0177] The sheet cutting device according to (((6))), wherein the releasing unit moves a rotating shaft of the rotated rotating blade in the direction crossing the axial direction.

(((8)))

[0178] The sheet cutting device according to (((7))), wherein the releasing unit includes an operating arm and a drive source that rotationally drives the operating arm, the operating arm being capable of swinging the rotating shaft of the rotated rotating blade in the direction crossing the axial direction.

(((9)))

[0179] The sheet cutting device according to (((1))), wherein the first and second rotating blades are provided at each of end portions spaced from each other in the axial direction by a predetermined interval.

[0180] (((10)))

[0181] The sheet cutting device according to (((9))), wherein rotating shafts of the first and second rotating blades are provided with respective transport members that come into contact with each other to transport the sheet.

(((11)))

[0182] An image forming apparatus including:

[0183] an image forming unit that forms an image on a sheet; and

[0184] a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit.

[0185] wherein the sheet cutting device according to one of (((1))) to (((10))) is used as the sheet cutting unit.

What is claimed is:

1. A sheet cutting device comprising:

first and second rotating blades that mesh with each other at inner and outer positions in an axial direction and that cut a sheet; and

a restoring unit,

wherein, when a positional relationship between the inner and outer positions of the first and second rotating blades in the axial direction is reversed, the restoring unit releases the first and second rotating blades from each other and moves at least one of the first and second rotating blades in the axial direction to restore the positional relationship between the inner and outer positions to an original state.

2. The sheet cutting device according to claim **1**,

wherein the restoring unit includes

a releasing unit that releases the first and second rotating blades from each other, and

a moving unit that moves one of the first and second rotating blades in the axial direction.

3. The sheet cutting device according to claim **2**, wherein one of the first and second rotating blades is a fixed rotating blade that is fixed in the axial direction on a rotating shaft, and other of the first and second rotating blades is an urged rotating blade that is movably urged to be in contact with the fixed rotating blade, and

wherein the moving unit moves the urged rotating blade.

4. The sheet cutting device according to claim **3**, wherein the moving unit includes a pushing member that pushes the urged rotating blade in the axial direction.

5. The sheet cutting device according to claim **4**, wherein the pushing member includes a rack gear that meshes with a rotationally driven pinion gear.

6. The sheet cutting device according to claim **2**,

wherein one of the first and second rotating blades is a rotationally driven rotating blade and other of the first and second rotating blades is a rotated rotating blade, and

wherein the releasing unit moves the rotated rotating blade in a direction crossing the axial direction to release the first and second rotating blades from each other.

7. The sheet cutting device according to claim **6**, wherein the releasing unit moves a rotating shaft of the rotated rotating blade in the direction crossing the axial direction.

8. The sheet cutting device according to claim **7**, wherein the releasing unit includes an operating arm and a drive source that rotationally drives the operating arm, the operating arm being capable of swinging the rotating shaft of the rotated rotating blade in the direction crossing the axial direction.

9. The sheet cutting device according to claim **1**, wherein the first and second rotating blades are provided at each of end portions spaced from each other in the axial direction by a predetermined interval.

10. The sheet cutting device according to claim **9**, wherein rotating shafts of the first and second rotating blades are provided with respective transport members that come into contact with each other to transport the sheet.

11. An image forming apparatus comprising:

an image forming unit that forms an image on a sheet; and

a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,

wherein the sheet cutting device according to claim **1** is used as the sheet cutting unit.

12. An image forming apparatus comprising:

an image forming unit that forms an image on a sheet; and

a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,

wherein the sheet cutting device according to claim **2** is used as the sheet cutting unit.

13. An image forming apparatus comprising:

an image forming unit that forms an image on a sheet; and

a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,

wherein the sheet cutting device according to claim **3** is used as the sheet cutting unit.

14. An image forming apparatus comprising:

an image forming unit that forms an image on a sheet; and

a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,

wherein the sheet cutting device according to claim **4** is used as the sheet cutting unit.

15. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **5** is used as the sheet cutting unit.

16. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **6** is used as the sheet cutting unit.

17. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **7** is used as the sheet cutting unit.

18. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **8** is used as the sheet cutting unit.

19. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **9** is used as the sheet cutting unit.

20. An image forming apparatus comprising:
an image forming unit that forms an image on a sheet; and
a sheet cutting unit that cuts the sheet on which the image is formed by the image forming unit,
wherein the sheet cutting device according to claim **10** is used as the sheet cutting unit.

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