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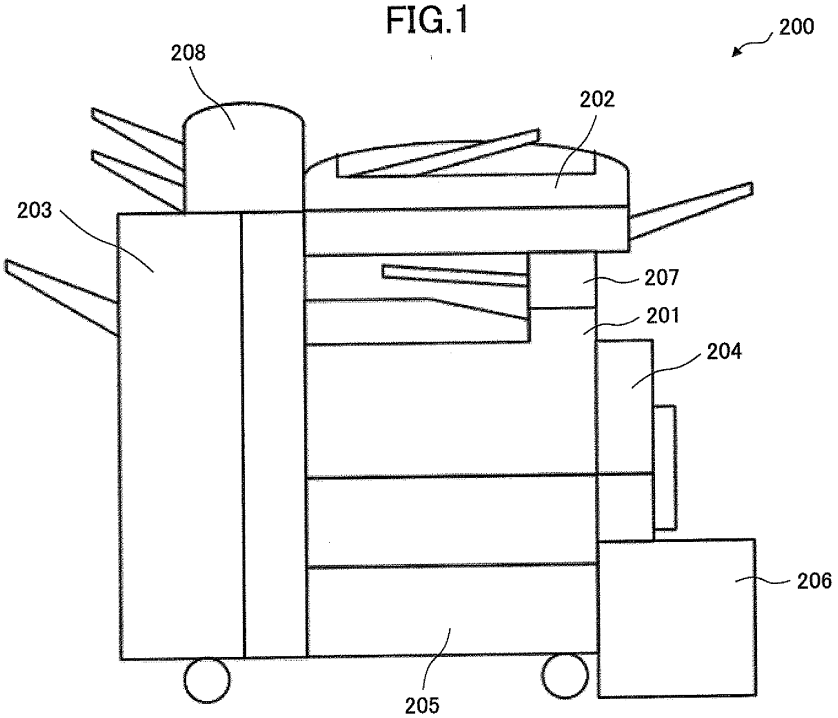
(54) Print medium feeding apparatus with electrode in endless belt

(57) A print medium feeding apparatus includes an endless belt disposed to face stacked media and configured to rotate, the endless belt divided into sections having electrodes, respectively, fixed terminals configured to be in contact with two or more of the electrodes while the two or more of the electrodes are passing through a position facing the media as the electrodes are moved by rotation of the endless belt, a voltage applying unit connected to the fixed terminals and configured to apply voltage to the two or more of the electrodes that are in contact with the fixed terminals, a connection unit configured to make and break a connection between the voltage applying unit and at least one of the fixed terminals, and a switching unit configured to change a state of the connection of the connection unit in response to size of the media.

FIG.1



EP 2 637 065 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The disclosures herein relate to a print medium feeding apparatus, an image forming apparatus, and a print medium feeding system.

2. Description of the Related Art

[0002] An image forming apparatus such as a printer or a copier feeds paper sheets one by one to an image forming unit by separating a paper sheet from a stack of paper sheets stored in a sheet tray, and uses the image forming unit to print an image on the surface of the paper sheet, which is then discharged to outside the apparatus. If multiple paper sheets are fed at a time from the sheet tray, a paper jam may occur along the conveyance path or in the image forming unit, or a print failure may be caused. In order to improve the productivity of the image forming apparatus, there is a need to separate paper sheets one by one from a stack of paper sheets at high speed in a stable manner.

[0003] An electrostatic adherence paper feed technology known in the art (see Japanese Patent Application Publication No. 2010-126317, for example) uses a plurality of electrodes embedded in an insulating paper feed belt, and applies voltage to the electrodes to polarize a paper sheet surface that is placed in contact with the paper feed belt, thereby causing the paper sheet to adhere to the paper feed belt through an electrostatic force to feed the paper sheet.

[0004] The electrostatic adherence paper feed technology may need to apply a large voltage to the electrodes to create sufficient paper sheet adherence when the paper sheet to be fed is larger than the paper feed belt. When the paper feed belt is the same size as the size of the largest sheet among paper sheets to be fed, voltage applied to the entirety of the paper feed belt at the time of feeding a small-sized paper sheet may result in needless consumption of electric power.

[0005] Accordingly, it may be desirable to provide a print medium feeding apparatus that can feed a medium by the use of an appropriate amount of electric power responsive to the size of the medium.

SUMMARY OF THE INVENTION

[0006] It is a general object of at least one embodiment of the present invention to provide a print medium feeding apparatus that substantially obviates one or more problems caused by the limitations and disadvantages of the related art.

[0007] In one embodiment, a print medium feeding apparatus includes an endless belt disposed to face stacked media and configured to rotate, the endless belt divided into sections having electrodes, respectively, fixed terminals configured to be in contact with two or more of the electrodes while the two or more of the electrodes are passing through a position facing the media as the electrodes are moved by rotation of the endless belt, a voltage applying unit connected to the fixed terminals and configured to apply voltage to the two or more of the electrodes that are in contact with the fixed terminals, a connection unit configured to make and break a connection between the voltage applying unit and at least one of the fixed terminals, and a switching unit configured to change a state of the connection of the connection unit in response to size of the media.

[0008] According to at least one embodiment, a print medium feeding apparatus is provided that can feed a medium by use of an appropriate amount of electric power responsive to the size of the medium.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other objects and further features of embodiments will be apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:

Fig. 1 is a drawing illustrating an example of the appearance of an image forming apparatus that is provided with a paper feed apparatus according to a first embodiment;

Fig. 2 is a drawing illustrating an example of the schematic configuration of a paper feed apparatus and a paper feed cassette according to the first embodiment;

Fig. 3 is a drawing illustrating an example of the hardware configuration of the paper feed apparatus according to the first embodiment;

Fig. 4 is a drawing illustrating an example of the configuration of the paper feed apparatus according to the first embodiment;

Figs. 5A and 5B are drawings illustrating an example of the configuration of a paper feed belt of the paper feed apparatus according to the first embodiment;

Fig. 6 is a drawing illustrating an example of another configuration of the paper feed apparatus according to the first embodiment;

Fig. 7 is a drawing illustrating an example of the configuration of the paper feed apparatus according to a second embodiment;

Fig. 8 is a drawing illustrating an example of sections to which voltage is applied in response to the size and basis weight of a paper sheet in the paper feed apparatus according to the second embodiment;

Fig. 9 is a drawing illustrating an example of the configuration of a paper feed belt of the paper feed apparatus according to a third embodiment;

Fig. 10 is a drawing illustrating an example of the appearance of an image forming system according to a

fourth embodiment; and

[0010] Fig. 11 is a drawing illustrating an example of the hardware configuration of the image forming system according to the fourth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] In the following, embodiments will be described by referring to the accompanying drawings. In these drawings, the same elements are referred to by the same references, and repetitive description thereof may be omitted.

[First Embodiment]

<Configuration of Image Forming Apparatus>

[0012] Fig. 1 is a drawing illustrating an example of the appearance of an image forming apparatus 200 that is provided with a paper feed apparatus according to a first embodiment.

[0013] As illustrated in Fig. 1, the image forming apparatus 200 includes an image forming apparatus main section 201, an automatic document feeder (ADF) 202, a finisher 203 having a stapler and a shift tray, a duplex-printing buffer/flipper unit 204, an extended paper feed tray 205, a one-bin discharge tray 207, an insert feeder 208, and so on.

[0014] The image forming apparatus main section 201 includes a scanner unit, an image forming unit, a developer unit, a fuser unit, and a paper feed apparatus, etc., accommodated therein, and prints an image on the surface of a paper sheet fed from the paper feed apparatus.

[0015] The image forming apparatus main section 201 may use an electrophotographic process to print an image on the surface of a paper sheet. The process of forming an image may be a different process such as an inkjet process. Further, it does not matter whether the process is a monochrome process or a full color process.

<Configuration of Paper Feed Apparatus>

[0016] Fig. 2 is a drawing illustrating an example of the schematic configuration of a paper feed apparatus 100 and a paper feed cassette 9 according to the first embodiment.

[0017] As illustrated in Fig. 2, the paper feed apparatus 100 includes a paper feed belt 1, a drive roller 141, a driven roller 142, and a high-voltage power supply 121.

[0018] The paper feed belt 1 is an endless belt having a plurality of electrodes embedded therein that are covered with an insulating layer. The paper feed belt 1 is looped around the drive roller 141 and the driven roller 142.

[0019] The drive roller 141 is rotated by a drive unit (not shown) to rotate the paper feed belt 1. The driven roller 142 is rotated by the paper feed belt 1 that is rotated by the drive roller 141.

[0020] The high-voltage power supply 121 applies voltage to the electrodes in the paper feed belt 1 to polarize the surface of a paper sheet P coming in contact with the paper feed belt 1, thereby causing the paper sheet P to adhere to the paper feed belt 1.

[0021] The paper feed cassette 9 storing paper sheets P includes a sheet-width regulating guide 4, a sheet-rear-end regulating plate 5, a bottom plate 6, a fan 7, an optical sensor 8, a conveyor sensor 10, and a conveyor roller 11.

[0022] The sheet-width regulating guide 4 and the sheet-rear-end regulating plate 5 secure the paper sheets P in their place and also detect the size of the paper sheets P upon the paper sheets P being set.

[0023] The bottom plate 6 elevates to such a height that the top of the stored paper sheets P can be detected by the optical sensor 8, thereby raising the paper sheets P to the position at which paper feeding can be performed by the paper feed apparatus 100.

[0024] The fan 7 blows air into a space over the stacked paper sheets P to flip a sheet, thereby causing the topmost paper sheet P to come in contact with the paper feed belt 1. The paper sheet P may come in contact with the paper feed belt 1 while voltage is applied to the embedded electrodes. When this happens, the surface of the paper sheet P polarizes, and thus adheres to the paper feed belt 1. Rotation of the paper feed belt 1 then causes the paper sheet P to be conveyed to outside the paper feed cassette 9.

[0025] The conveyor sensor 10 detects the paper sheet P that is fed by the paper feed belt 1 to a conveyor path. Upon the conveyor sensor 10 detecting the paper sheet P, the paper feed apparatus 100 deactivates the high-voltage power supply 121 to stop the adherence and conveyance of the paper sheet P.

[0026] The conveyor roller 11 conveys the paper sheet P to the image forming unit or the like situated at the next stage as the paper sheet P is fed from the paper feed cassette 9 by the paper feed belt 1 of the paper feed apparatus 100.

[0027] Fig. 3 is a drawing illustrating an example of the hardware configuration of the paper feed apparatus 100 according to the first embodiment.

[0028] As illustrated in Fig. 3, the paper feed apparatus 100 includes, in addition to the paper feed belt 1, the high-voltage power supply 121, and so on, a CPU (Central Processing Unit) 171, an HDD (Hard Disk Drive) 172, a ROM (Read Only Memory) 173, a RAM (Random Access Memory) 174, a network interface unit 175, a recording medium interface unit 176, etc., which are connected to each other through a bus B.

[0029] The CPU 171 is a computing unit that performs control operations, arithmetic operations, and data processing by executing programs stored in the ROM 173 and the RAM 174. The CPU 171 performs overall control of the apparatus by executing programs, and also serves as a switchover unit to select the electrodes of

the paper feed belt 1 to which the high-voltage power supply 121 applies voltage.

[0030] The HDD 172 is a nonvolatile storage device to store various programs and data. The stored programs and data include an OS (Operating System) and application programs providing various functions.

[0031] The ROM 173 is a nonvolatile semiconductor memory (storage device) that can retain stored data even when the power is switched off. The RAM 174 is a volatile semiconductor memory (storage device) that temporarily stores programs and data.

[0032] The network interface unit 175 is an interface with peripheral devices having a communication function that are connected through a network such as a LAN (Local Area Network) or WAN (Wide Area Network), which is implemented by use of wired and/or wireless data transmission lines.

[0033] The recording medium interface unit 176 is an interface with a computer-readable recording medium 177 such as a CD-ROM, a flexible disk (FD), a CD-R, a DVD (Digital Versatile Disk), or the like, which is connected through a data transmission line such as a USB (Universal Serial Bus).

[0034] A predetermined program is stored in the recording medium 177. The program stored in the recording medium 177 is installed in the paper feed apparatus 100 via the recording medium interface unit 176. The installed program is ready to be executed by the CPU 171.

[0035] The CPU 171, the HDD 172, the ROM 173, the RAM 174 and the like may be shared with one or more other units such as the image forming apparatus main section 201.

[0036] Fig. 4 is a drawing illustrating an example of the configuration of the paper feed apparatus 100 according to the first embodiment.

[0037] As illustrated in Fig. 4, the paper feed apparatus 100 includes, in addition to the paper feed belt 1, the drive roller 141 and the driven roller 142, the high-voltage power supply 121, a control unit 122, etc. The paper feed apparatus 100 feeds a paper sheet taken from the paper feed cassette 9.

[0038] The paper feed belt 1 is looped around the drive roller 141 and the driven roller 142. The paper feed belt 1 is rotated in a clockwise direction by the drive roller 141 that rotates in the direction indicated by an arrow. The distance between the drive roller 141 and the driven roller 142 is equivalent to the longitudinal length of an A3 paper sheet. The distance between the drive roller 141 and the driven roller 142 may be adaptively set in response to the size of the paper sheet P that is to be fed.

[0039] Further, the paper feed belt 1 has four sections A through D arranged in the rotational direction thereof. The four sections A through D have four electrodes 101 through 104, respectively, embedded therein.

[0040] Figs. 5A and 5B are drawings illustrating an example of the configuration of the paper feed belt 1 of the paper feed apparatus 100 according to the first embodiment. Fig. 5A is a plan view of the section A and part of the section B of the paper feed belt 1 viewed from the inner side of the paper feed belt 1. Fig. 5B is a schematic view of the cross-section taken along the line a-a' illustrated in Fig. 5A.

[0041] As illustrated in Fig. 5A, sections A and B of the paper feed belt 1 have a pair of comb-shaped electrodes 101a and 101b and a pair of comb-shaped electrodes 102a and 102b, respectively, which are arranged such that the teeth of one electrode extend in the direction perpendicular to the rotational direction of the paper feed belt 1 into the spaces between the teeth of the other electrode. The same also applies in the case of the remaining sections C and D.

[0042] It may be noted that the electrode 101 refers to the pair of electrodes 101a and 101b, and the same applies with respect to each of the remaining electrodes 102 through 104. As illustrated in Fig. 5A and Fig. 5B, the electrode 101 is covered with an insulating layer 190, except for areas corresponding to openings 111a and 111b of the insulating layer 190 that are situated near the side ends of the paper feed belt 1. The same also applies in the case of the remaining electrodes 102 through 104. The side ends of electrode 101 near the side ends of the paper feed belt 1 are exposed through the openings 111a and 111b, respectively, toward the inner side of the paper feed belt 1. The same also applies in the case of the remaining electrodes 102 through 104. The side ends of each of the electrodes 101 through 104 exposed through the openings receive a voltage applied thereto. In the section in which voltage is applied to the electrode, the surface of the paper feed belt 1 is made to exert an adhering force to attract a paper sheet P. Because the electrodes 101 through 104 are covered with the insulating layer, no electric charge moves between the electrodes. Voltage control may be performed such that different voltages are applied to the electrodes 101 through 104.

[0043] On the inner side of the paper feed belt 1, as illustrated in Fig. 4, roller-shaped, rotatable fixed terminals 131 through 134 are disposed that are in contact with the side ends of the electrodes 101 through 104 exposed through the openings. The fixed terminal 131 disposed at the position facing the paper feed cassette 9 (not shown) is directly connected to the high-voltage power supply 121. The fixed terminal 132 is connected through a relay 151 to the high-voltage power supply 121. The fixed terminals 133 and 134 are connected to ground. Alternative arrangement may be such that the fixed terminals 133 and 134 are not connected to ground. Since these terminals may be charged to an uncertain potential by paper dusts and friction at the time of feeding paper sheets P, however, the provision of a ground connection may be preferable. The fixed terminals 131 are arranged at such intervals that one electrode arranged in one section of the paper feed belt 1 does not come in contact with two fixed terminals simultaneously.

[0044] The relay 151 is a connecting unit situated be-

tween the high-voltage power supply 121 and the fixed terminal 132. The relay 151 is controlled by the control unit 122 that serves as a switchover unit for changing the state of connection of the relay 151, thereby connecting the fixed terminal 132 either to the high-voltage power supply 121 or to ground.

[0045] The high-voltage power supply 121 applies voltage to those electrodes among the electrodes 101 through 104 that are in contact with either the fixed terminal 131 or the fixed terminal 132 at the time of feeding a paper sheet P, thereby polarizing the surface of the paper sheet P coming in contact with the area of the paper feed belt 1 to which the voltage is applied, and thus causing the paper sheet P to adhere to the paper feed belt 1. One of the two comb-shaped electrodes included in each of the electrodes 101 through 104 may receive a positive polarity voltage, and the other may receive a negative polarity voltage. Alternatively, one of the two comb-shaped electrodes may be connected to ground.

[0046] The control unit 122 serves as a switchover unit for changing the state of connection of the relay 151 based on information indicative of the size of the paper sheet P, thereby connecting the fixed terminal 132 either to the high-voltage power supply 121 or to ground. The control unit 122 obtains the information indicative of the size of the paper sheet P from information entered by a user or from the results of detections made by the sheet-width regulating guide 4 and the sheet-rear-end regulating plate 5 of the paper feed cassette 9.

<Operation of Paper Feed Apparatus during Feed Operation>

[0047] A description will be given of operations performed by the paper feed apparatus 100 of the first embodiment when feeding a paper sheet P from the paper feed cassette 9. The paper sheets P are stored in the paper feed cassette 9, such that they are placed against the inner wall thereof positioned on the same side as the section D.

[0048] At the time of feeding a paper sheet P, the control unit 122 obtains information indicative of the size of the paper sheet P from information entered by a user or from the results of detections made by the sheet-width regulating guide 4 and the sheet-rear-end regulating plate 5 of the paper feed cassette 9.

[0049] The paper sheet P stored in the paper feed cassette 9 may be A3 portrait. In this case, the control unit 122 controls the state of connection of the relay 151 to connect the fixed terminal 132 to the high-voltage power supply 121. In this state, the high-voltage power supply 121 supplies voltage. When the paper feed belt 1 is in such a position as illustrated in Fig. 4, the voltage is applied to the electrode 104 of the section D being in contact with the fixed terminal 131 and to the electrode 103 of the section C being in contact with the fixed terminal 132. As the paper feed belt 1 rotates, different electrodes successively come in contact with the fixed terminals 131 and 132. Despite this, the two sections of the paper feed belt 1 that face the paper feed cassette 9 always have the electrodes thereof receiving the voltage, thereby exerting an adhering force to attract the paper sheet P.

[0050] The paper sheet P stored in the paper feed cassette 9 may be A4 landscape. In this case, the control unit 132 controls the state of connection of the relay 151 to connect the fixed terminal 132 to ground. In this state, the high-voltage power supply 121 supplies voltage. When the paper feed belt 1 is in such a position as illustrated in Fig. 4, voltage is applied only to the electrode 104 of the section D being in contact with the fixed terminal 131. As the paper feed belt 1 rotates, different electrodes successively come in contact with the fixed terminal 131. Despite this, the section of the paper feed belt 1 that faces the paper feed cassette 9 always has the electrode thereof receiving the voltage, thereby exerting an adhering force to attract the paper sheet P.

[0051] In this manner, control is performed based on the information indicative of the size of a paper sheet P, such that the fixed terminal 132 is connected to the high-voltage power supply 121 when feeding a large-size paper sheet P, and is not connected to the high-voltage power supply 121 when feeding a small-size paper sheet P. Through such control, the large-size paper sheet can be reliably fed, and, also, needless consumption of electric power is avoided by applying voltage to the electrode (s) of the fewest necessary section(s) when feeding the small-size paper sheet P.

[0052] Further, as illustrated in Fig. 6, a remaining charge removing power supply 123 may be provided and connected to the fixed terminals 133 and 134. The remaining charge removing power supply 123 applies the voltage for removing remaining charge to an electrode that comes in contact with the fixed terminals 133 and 134 after this electrode receives the voltage of the high-voltage power supply 121 while being in contact with the fixed terminal 131 and disconnects from the fixed terminal 131 as the paper feed belt 1 rotates. An effective method to remove remaining charge is to apply an alternating voltage to the electrode while making the amplitude of the alternating voltage smaller and smaller. The remaining charge removing power supply 123 may thus be preferably an alternating current power supply and a pulse-voltage power supply capable of applying voltages of opposite polarities, and may preferably apply the voltage to the electrode until the amplitude of the voltage reaches 0 V.

[0053] The fixed terminals 132, 133 and 134 are connected either to the remaining charge removing power supply 123 or to ground through relays 151 through 154 whose connection states are controlled by the control unit 122.

[0054] In the paper feed apparatus 100, charge may remain in an electrode to which the high-voltage power supply 121 applies high voltage in order to feed a heavy basis weight paper sheet P, for example. In such a case, the control unit 122 connects the remaining charge re-

moving power supply 123 to the fixed terminal to which the high-voltage power supply 121 does not supply voltage, so that an alternating voltage as described above is applied to each electrode to remove remaining charge.

[0055] Voltage applied by the high-voltage power supply 121 to an electrode may be small when feeding a light basis weight paper sheet P. In this case, remaining charge may not be in existence. The control unit 122 thus controls the connection state of the relays 151 through 154 such that the fixed terminals not connected to the high-voltage power supply 121 are connected to ground.

[0056] As described above, the remaining charge removing power supply 123 is provided to remove charge remaining in each electrode. This arrangement prevents the paper feed belt 1 from exerting a needless adhering force, thereby ensuring a reliable feeding operation of the paper feed apparatus 100.

[0057] As described heretofore, the paper feed apparatus 100 of the first embodiment uses the control unit 122, which changes the state of connection of the relay 151 in response to information indicative of the size of a paper sheet P to change the sections to which the high-voltage power supply 121 applies voltage, thereby attracting and feeding the paper sheet P by use of proper electric power responsive to the size of the paper sheet P. Compared to the case in which the paper sheet P is conveyed by applying voltage to all the electrodes embedded in the paper feed belt 1, for example, power consumption is reduced to a half when conveying an A3 portrait paper sheet P, and power consumption is reduced to a quarter when conveying an A4 landscape paper sheet P. Further, the high-voltage power supply 121 may be powered off while feeding is not performed during an interval between paper sheets, which achieves further reduction in power consumption. Moreover, the provision of the remaining charge removing power supply 123 makes it possible to feed a paper sheet P in a more reliable manner.

[0058] The description of the first embodiment has been given with respect to an example in which the paper feed belt 1 is divided into the four sections A through D in a rotational direction. This is not a limiting example, and the number of divided sections may be two or more. The number of sections may be increased to properly cope with an increased variety of paper sheet sizes, and voltage is applied in response to the size of a paper sheet P to feed the paper sheet P by use of proper electric power while reducing needless power consumption.

[Second Embodiment]

[0059] In the following, a second embodiment will be described with reference to the accompanying drawings. A description will be omitted of the same elements as those of the embodiment already described.

<Configuration of Paper Feed Apparatus>

[0060] The paper feed apparatus 100 of the second embodiment differs from that of the first embodiment in that the paper feed belt 1 is divided into sections in a direction perpendicular to the rotational direction.

[0061] Fig. 7 is a drawing illustrating an example of the configuration of the paper feed apparatus 100 according to the second embodiment.

[0062] As illustrated in Fig. 7, the paper feed belt 1 is divided into sections A through C in a direction perpendicular to the rotational direction. The sections A through C have a pair of comb-shaped electrodes 101a and 101b, a pair of comb-shaped electrodes 105a and 105b, and a pair of comb-shaped electrodes 106a and 106b, respectively, which are arranged such that the teeth of one electrode of a given pair extend in the direction perpendicular to the rotational direction of the paper feed belt 1 into the spaces between the teeth of the other electrode of the given pair. Electrodes 101a and 101b are collectively referred to as an electrode 101. This also applies to other electrodes.

[0063] The paper feed belt 1 has a width (i.e., the span in the direction perpendicular to the rotational direction) equal to the longitudinal length of an A3 size paper sheet. The divided sections A through C are provided such that their widths satisfy the following relationships: a ratio of the width of the section A to the width of the section B = $1:(2^{0.5} - 1)$, and a ratio of the combined width of the sections A and B to the width of the section C = $1:(2^{0.5} - 1)$. The widths and numbers of divided sections may be set differently as appropriate.

[0064] The electrodes 101, 105 and 106 provided in the respective sections A through C are covered with the insulating layer 190. The side ends of the electrodes 101, 105 and 106 opposite to each other in the direction perpendicular to the rotational direction are exposed through openings 111a and 111b, 112a and 112b, and 113a and 113b, respectively.

[0065] Fixed terminals that come in contact with the side ends of the electrodes 101, 105 and 106 through the openings in the sections A through C are provided on the inner side of the paper feed belt 1. These fixed terminals are connected either to high-voltage power supply 121a or 121b or to ground through relays 155a, 155b, 156a and 156b whose connection states are controlled by the control unit 122.

[0066] The high-voltage power supply 121a is connected to the electrodes 101a, 105a and 106a through fixed terminals. The high-voltage power supply 121b is connected to the electrodes 101b, 105b and 106b through fixed terminals. The high-voltage power supplies 121a and 121b produce voltages of opposite polarities, respectively.

[0067] The control unit 122 changes the state of connection of the relays 155a, 155b, 156a and 156b situated between the fixed terminals and the high-voltage power supplies 121a and 121b based on information indicative

of the size of a paper sheet P fed by the paper feed apparatus 100.

<Operation of Paper Feed Apparatus during Feed Operation>

[0068] The paper sheets P are stored in the paper feed cassette 9 facing the paper feed belt 1, such that they are placed against the top right corner of the paper feed cassette 9 (wherein the term "top right" is defined with respect to the positional arrangements illustrated in Fig. 7). A description will be given of an operation of feeding a paper sheet P in the paper feed apparatus 100.

[0069] At the time of feeding a paper sheet P, the control unit 122 obtains information indicative of the size of the paper sheet P from information entered by a user or from the results of detections made by the sheet-width regulating guide 4 and the sheet-rear-end regulating plate 5 of the paper feed cassette 9.

[0070] The paper sheet P stored in the paper feed cassette 9 may be A5 portrait. In this case, the control unit 122 controls the relays 155a, 155b, 156a and 156b to connect the electrode 105 of the section B and the electrode 106 of the section C to ground. The high-voltage power supply 121 applies voltage only to the electrode 101 of the section A of the paper feed belt 1, so that the paper feed belt 1 attracts and conveys the A5 portrait sheet P by use of only the section A.

[0071] When an A4 portrait paper sheet P is to be conveyed, the control unit 122 controls the relays 156a and 156b to connect the electrode 105 of the section B to the high-voltage power supply 121, and controls the relays 155a and 155b to connect the electrode 106 of the section C to ground. The high-voltage power supply 121 applies voltage to the electrode 101 of the section A and to the electrode 105 of the section B, so that the paper feed belt 1 attracts and conveys the A4 portrait sheet P by use of the section A and the section B.

[0072] When an A3 portrait paper sheet P is to be conveyed, the control unit 122 controls the state of connection of the relays to connect the electrode 105 of the section B and the electrode 106 of the section C to the high-voltage power supply 121. In this case, the paper feed belt 1 attracts and conveys the A3 portrait sheet P by use of all the sections A, B and C.

[0073] Moreover, the control unit 122 may change the sections to which to apply voltage in response to the size and basis weight of a paper sheet P to be fed, based on information indicative of a sheet type entered by a user.

[0074] Fig. 8 is a drawing illustrating an example of sections to which voltage is applied in response to the size and basis weight of a paper sheet in the paper feed apparatus 100 according to the second embodiment.

[0075] As illustrated in Fig. 8, in the case of the A5-size paper sheet P, the control unit 122 controls the states of connection of the relays 155a, 155b, 156a and 156b in such a manner as to apply voltage to the electrode of the section A regardless of the basis weight. In the case of the A4-size paper sheet P, the control unit 122 controls the states of connection of the relays 155a, 155b, 156a and 156b in such a manner as to apply voltage to the electrodes in all the sections A through C regardless of the basis weight.

[0076] In the case of a B5-size paper sheet P being conveyed, the control unit 122 controls the states of connection of the relays 155a, 155b, 156a and 156b in such a manner as to apply voltage to the electrodes of the sections A and B for a heavy basis weight sheet and to apply voltage to the electrode of only the section A for a light basis weight sheet. In the case of the B4-size paper sheet P being conveyed, the control unit 122 controls the states of connection of the relays 155a, 155b, 156a and 156b in such a manner as to apply voltage to the electrodes in all the sections A through C for a heavy basis weight sheet and to apply voltage to the electrodes of only the sections A and B for a light basis weight sheet.

[0077] In this manner, the sections to which voltage is applied are changed in response to the size and basis weight of paper sheets P, so that the paper sheets P are properly conveyed and fed with proper power consumption even when the paper sheets P having the same size have different weights due to difference in paper type.

[0078] As described heretofore, the paper feed apparatus 100 of the second embodiment uses the control unit 122, which changes the states of connection of the relays 155a, 155b, 156a and 156b in response to the size and basis weight of a paper sheet P to be fed wherein the size is measured in the direction perpendicular to the rotational direction of the paper feed belt 1, thereby to change the sections to which the high-voltage power supply 121 applies voltage. Accordingly, the paper sheet P is attracted and fed by using a proper amount of electric power for the size and basis weight of the paper sheet P. Compared to the case in which the paper sheet P is conveyed by applying voltage to all the electrodes embedded in the paper feed belt 1, for example, power consumption is reduced to three tenths when feeding an A5 portrait paper sheet P, and power consumption is reduced to a half when feeding an A3 portrait paper sheet P. Further, the high-voltage power supply 121 may be powered off while feeding is not performed during an interval between paper sheets, which achieves further reduction in power consumption.

[0079] The description of the second embodiment has been given with respect to an example in which the paper feed belt 1 is divided into the three sections A through C in the direction perpendicular to the rotational direction. This is not a limiting example, and the number of divided sections may be two or more. The number of sections may be increased to properly cope with an increased variety of paper sheet sizes and types, and voltage is applied in response to the size of a paper sheet P to feed the paper sheet P by use of proper electric power.

[Third Embodiment]

[0080] In the following, a third embodiment will be described with reference to the accompanying drawings. A description will be omitted of the same elements as those of the embodiments already described.

[0081] The paper feed apparatus 100 of the third embodiment differs from that of the first embodiment and the second embodiment in that the paper feed belt 1 is divided into sections in the rotational direction as well as in the direction perpendicular to the rotational direction.

[0082] The paper feed belt 1 of the third embodiment is divided into four areas in the rotational direction and further divided into three sections in the direction perpendicular to the rotational direction. In total, twelve sections A1, B1, C1, ..., A4, B4, and C4 are created.

[0083] Fig. 9 is a drawing illustrating an example of the configuration of the paper feed belt 1 used by the paper feed apparatus 100 of the third embodiment. Fig. 9 is a plan view of the paper feed belt 1 as viewed from the inner side of the loop to show the areas A1, B1, C1, A2, B2, and C2 of the paper feed belt 1.

[0084] As illustrated in Fig. 9, the paper feed belt 1 has in each of the divided sections a pair of comb-shaped electrodes, which are arranged such that the teeth of one electrode extend in the direction perpendicular to the rotational direction into the spaces between the teeth of the other electrode.

[0085] The electrodes provided in the respective sections are partially covered with the insulating layer 190, and are exposed toward the inner side of the paper feed belt 1 through openings that are formed at side ends of the electrodes opposite to each other in the direction perpendicular to the rotational direction.

[0086] Fixed terminals are disposed on the inner side of the paper feed belt 1 to come in contact with the side ends of the electrodes at the position facing the paper sheets P stored in the paper feed cassette 9. Each of the fixed terminals is connected either to the high-voltage power supply or to ground through relays whose state of connection is changed by the control unit.

[0087] The control unit changes the state of connection of the relays situated between the high-voltage power supply and the fixed terminals in response to the size of or the size and basis weight of the paper sheet P to be fed by the paper feed apparatus 100, thereby changing the electrodes to which the high-voltage power supply applies voltage at the time of feeding the paper sheet P.

[0088] In this manner, electrodes are provided in the sections into which the paper feed belt 1 is divided in the rotational direction as well as in the direction perpendicular to the rotational direction, and the electrodes to which voltage is applied are selected in response to the size, basis weight, and/or the like of the paper sheet P. This arrangement can feed paper sheets P of various sizes and types by use of proper electric power while reducing needless power consumption.

[Fourth Embodiment]

[0089] In the following, a fourth embodiment will be described with reference to the accompanying drawings. A description will be omitted of the same elements as those of the embodiments already described.

[0090] Fig. 10 is a drawing illustrating an example of the configuration of an image forming system 400 according to the fourth embodiment.

[0091] The image forming system 400 of the fourth embodiment is a production printing system in which an image forming apparatus 200 is provided with peripheral units having functions such as feeding, folding, stapling, cutting, etc., which may be combined at the time of use according to need. The image forming system 400 of the fourth embodiment includes a large volume paper feed unit 211, an inserter 212, a folding unit 213, a finisher 214 for stapling and punching, a cutter 215, and an information processing apparatus 300, which are connected to the image forming apparatus 200.

[0092] Fig. 11 is a drawing illustrating an example of the hardware configuration of the image forming system 400 according to the fourth embodiment.

[0093] The information processing apparatus 300 includes a network interface unit 301, a ROM 302, a RAM 303, a CPU 304, an HDD 305, and an interface unit 306, which are connected to each other through a bus B1. The information processing apparatus 300 is connected to the image forming apparatus 200 through a dedicated line 210.

[0094] The CPU 300 of the information processing apparatus 300 is a computing unit that performs control operations, arithmetic operations, and data processing by executing programs stored in the ROM 302 and the RAM 303. Further, the CPU 304 performs overall control of the apparatus by executing programs, and also serves as a control unit of a paper feed unit 403 of the image forming apparatus 200.

[0095] The HDD 305 is a nonvolatile storage device to store various programs and data. The stored programs and data include an OS (Operating System) and application programs providing various functions.

[0096] The ROM 302 is a nonvolatile semiconductor memory (storage device) that can retain stored data even when the power is switched off. The RAM 303 is a volatile semiconductor memory (storage device) that temporarily stores programs and data.

[0097] The network interface unit 301 is an interface with peripheral devices such as PCs 501 through 503 having a communication function that are connected through a network 500 such as a LAN or WAN, which is implemented by use of wired and/or wireless data transmission lines.

[0098] The interface unit 306 is used to connect the information processing apparatus 300 to the image forming apparatus 200, and is connected to an interface unit 403 of the image forming apparatus 200 through the dedicated line 210.

[0099] The image forming apparatus 200 connected to the information processing apparatus 300 through the dedicated line 210 includes a printing unit 401, a display unit 402, a paper feed unit 403, an interface unit 404, an operation unit 405, and a miscellaneous interface unit 406, which are connected to each other through a bus B2.

[0100] The printing unit 401 includes a photosensitive unit, a fuser unit, etc., and forms an image on the surface of a paper sheet P based on image data.

[0101] The display unit 402 and the operation unit 405 are formed of key switches (i.e., hard keys) and an LCD (liquid crystal display) that has a touch panel function (inclusive of software keys implemented by graphical user interface). The display unit 402 and the operation unit 405 are a display and input apparatus serving as a user interface that is used to exploit the functions of the image forming apparatus 200. Using the display unit 402 and the operation unit 405, a user may enter information indicative of the size or the like of the paper sheet P to be printed.

[0102] The paper feed unit 403 is the paper feed apparatus 100 of the first embodiment, and feeds a paper sheet P stored in a paper feed cassette to the printing unit 401.

[0103] The interface unit 404 is used for connection to the information processing apparatus 300, and is connected to the interface unit 306 of the information processing apparatus 300 through the dedicated line 210.

[0104] The image forming system 400 having the configuration described above uses the CPU 304 of the information processing apparatus 300 to control the state of connection of relays situated between the electrodes of the paper feed belt 1 and the high-voltage power supply in the paper feed unit 403 of the image forming apparatus 200. This arrangement serves to feed a paper sheet P by use of optimal conditions for applying voltage.

[0105] It is preferable to connect the image forming apparatus 200 to the information processing apparatus 300 through the dedicated line 210 since such a connection allows the paper feed unit 403 of the image forming apparatus 200 to be controlled at high speed. As long as the control of the paper feed unit 403 is performed at high speed, the connection may be provided by use of a network or the like.

[0106] The paper feed unit 403 of the image forming apparatus 200 may be the paper feed apparatus 100 of the second or third embodiment. Regardless of the configuration used, a paper sheet P can be fed under proper electric power conditions without consuming needless electric power in response to the size, basis weight, and/or the like of the paper sheet P.

[0107] The function of the CPU 304 of the information processing apparatus 300 to serve as a control unit to control the paper feed unit 403 of the image forming apparatus 200 may be provided in the image forming apparatus 200, or may be provided in the PC 501 or the like connected through a network or the like.

[0108] Although the present invention has been described heretofore by referring to one or more embodiments, the present invention is not limited to such embodiments. Various variations and modifications may be made without departing from the scope of the present invention.

Claims

1. A print medium feeding apparatus, comprising:

an endless belt disposed to face stacked media and configured to rotate, the endless belt divided into sections having electrodes, respectively;
fixed terminals configured to be in contact with two or more of the electrodes while the two or more of the electrodes are passing through a position facing the media as the electrodes are moved by rotation of the endless belt;
a voltage applying unit connected to the fixed terminals and configured to apply voltage to the two or more of the electrodes that are in contact with the fixed terminals;
a connection unit configured to make and break a connection between the voltage applying unit and at least one of the fixed terminals; and
a switching unit configured to change a state of the connection of the connection unit in response to size of the media.

2. The print medium feeding apparatus as claimed in claim 1, wherein the sections of the endless belt are formed by dividing the endless belt in a rotational direction thereof.

3. The print medium feeding apparatus as claimed in claim 1 or 2, wherein the sections of the endless belt are formed by dividing the endless belt in a direction perpendicular to a rotational direction thereof.

4. The print medium feeding apparatus as claimed in any one of claims 1 to 3, wherein the switching unit is configured to change the state of the connection of the connection unit in response to basis weight of the media.

5. The print medium feeding apparatus as claimed in any one of claims 1 to 4, further comprising a remaining charge removing unit configured to apply alternating voltage to the electrodes to which the voltage applying unit has applied the voltage.

6. The print medium feeding apparatus as claimed in any one of claims 1 to 5, further comprising a ground unit configured to connect, to a ground, one or more electrodes among the electrodes of the endless belt, which one or more electrodes are not receiving the

voltage applied by the voltage applying unit.

7. The print medium feeding apparatus as claimed in any one of claims 1 to 6, wherein each of the electrodes is a pair of comb-shaped electrodes, which are arranged such that teeth of one of the comb-shaped electrodes extend in a direction perpendicular to a rotational direction of the endless belt into spaces between teeth of another of the comb-shaped electrodes.

8. An image forming apparatus, comprising the print medium feeding apparatus claimed in any one of claims 1 to 7.

9. A system, comprising:

a print medium feeding apparatus configured to feed a medium; and
an information processing apparatus,

wherein the print medium feeding apparatus includes:

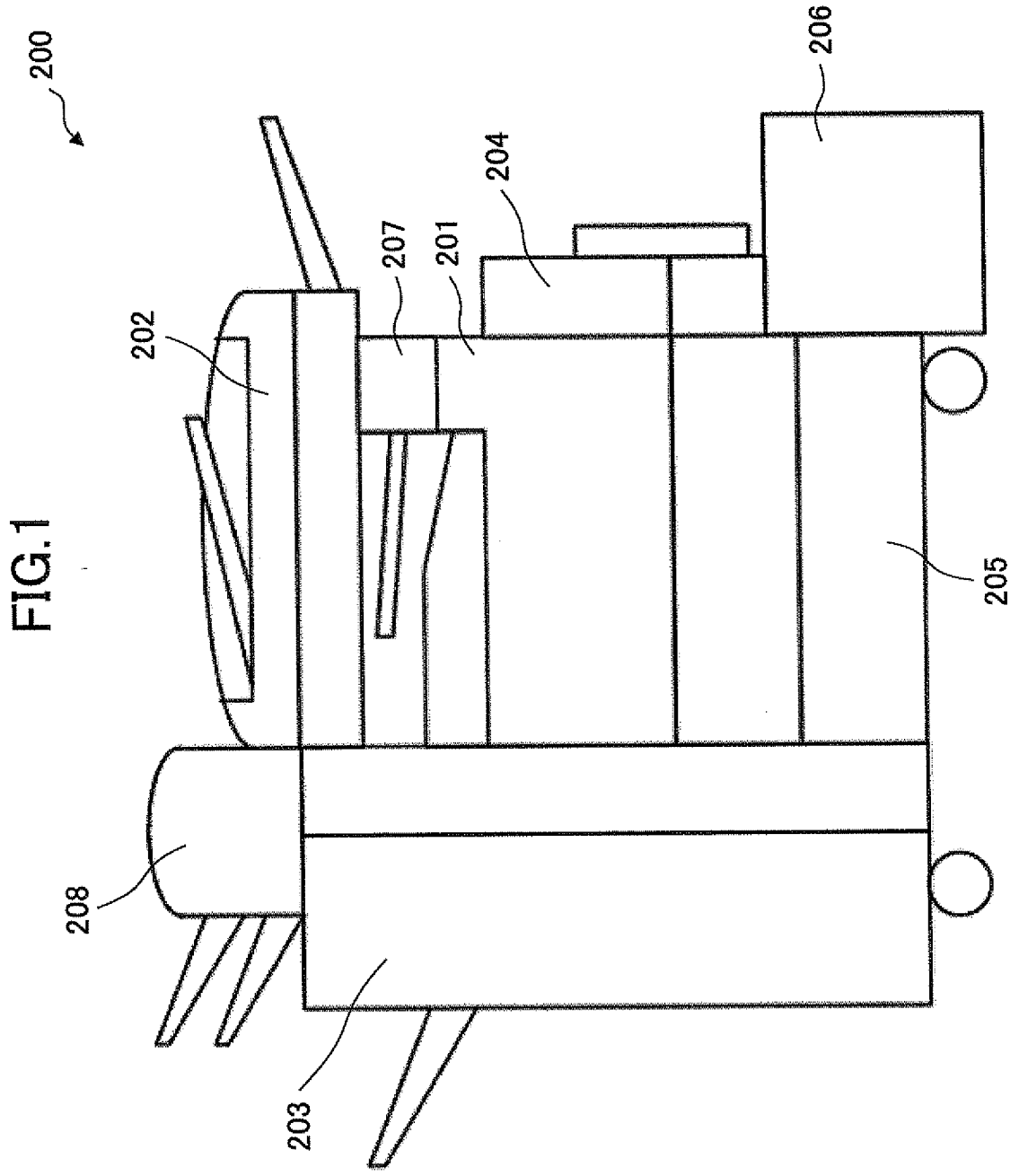
an endless belt disposed to face stacked media and configured to rotate, the endless belt divided into sections having electrodes, respectively;
fixed terminals configured to be in contact with two or more of the electrodes while the two or more of the electrodes are passing through a position facing the media as the electrodes are moved by rotation of the endless belt;
a voltage applying unit connected to the fixed terminals and configured to apply voltage to the two or more of the electrodes that are in contact with the fixed terminals; and
a connection unit configured to make and break a connection between the voltage applying unit and at least one of the fixed terminals,

wherein the information processing apparatus includes a switching unit configured to change a state of the connection of the connection unit in response to size of the media.

10. A method of feeding a medium, comprising:

rotating an endless belt disposed to face stacked media, the endless belt divided into sections having electrodes, respectively;
applying voltage to one or more of the electrodes while the one or more of the electrodes are passing through a position facing the media as the electrodes are moved by rotation of the endless belt,
wherein a number of the electrodes to which the voltage is applied is changed in response to size of the media.

FIG.1



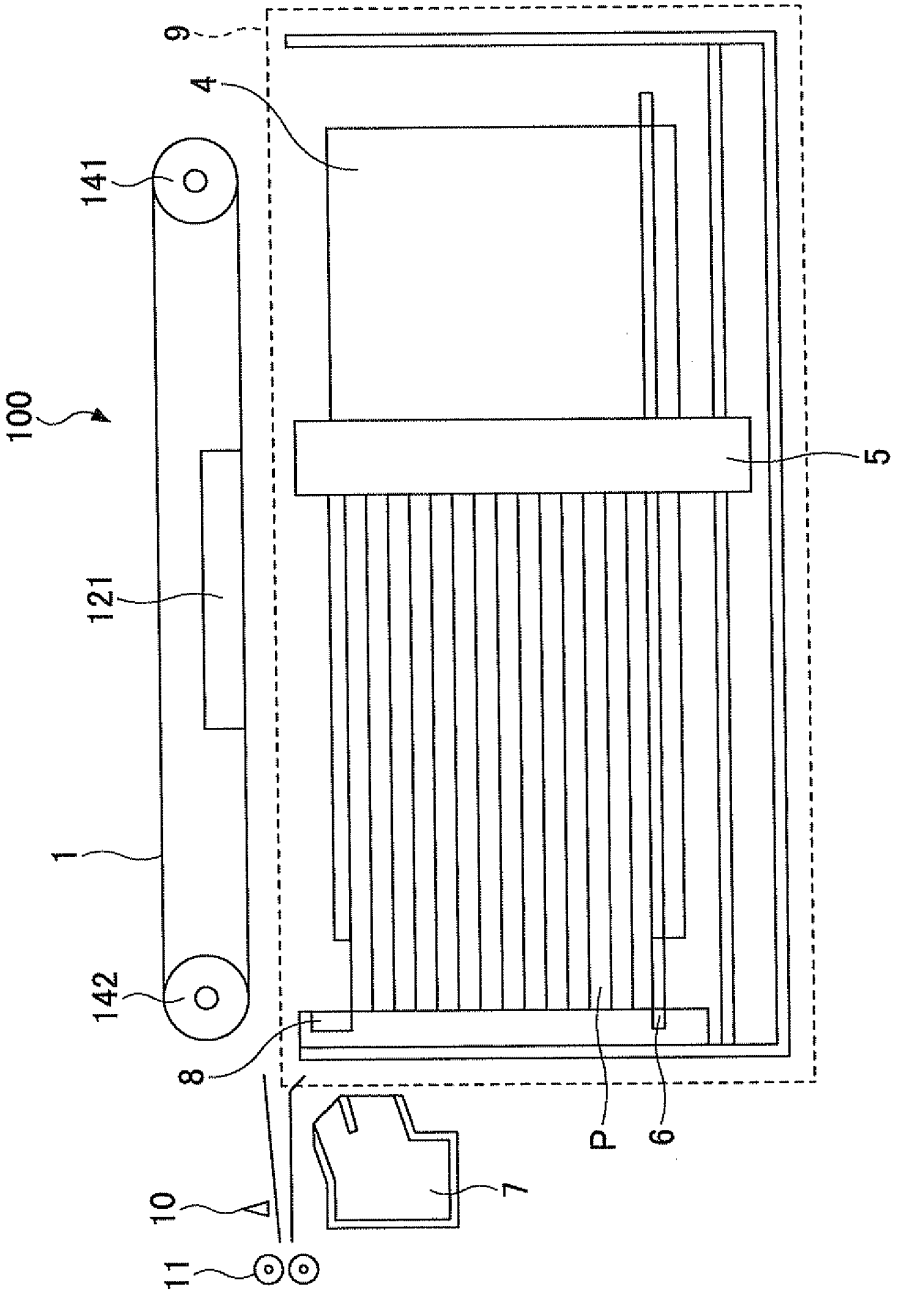


FIG.2

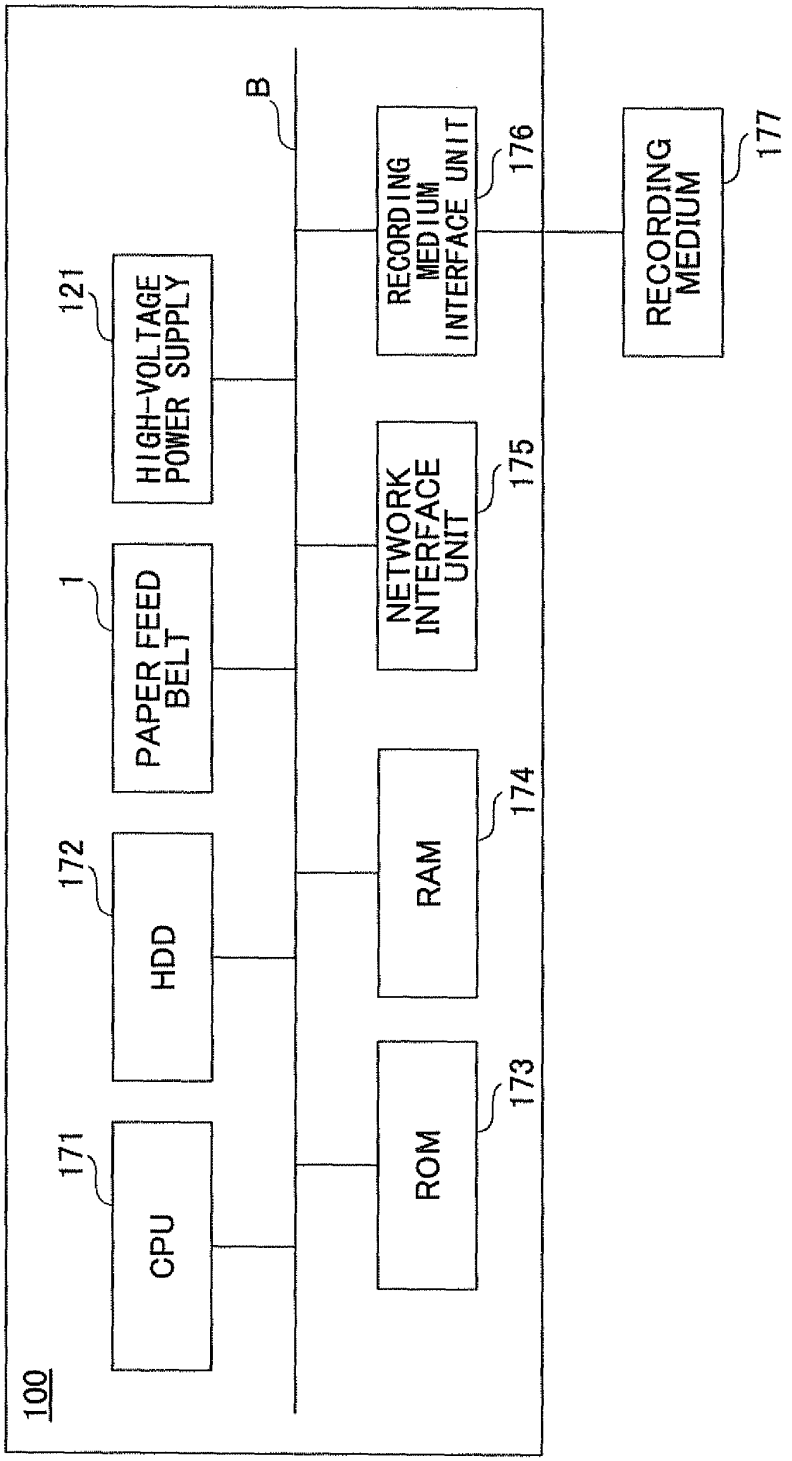

100
CPU
171
HDD
172
PAPER FEED BELT
1
HIGH-VOLTAGE POWER SUPPLY
121
ROM
173
RAM
174
NETWORK INTERFACE UNIT
175
RECORDING MEDIUM INTERFACE UNIT
176
B
RECORDING MEDIUM
177

FIG.3

FIG.4

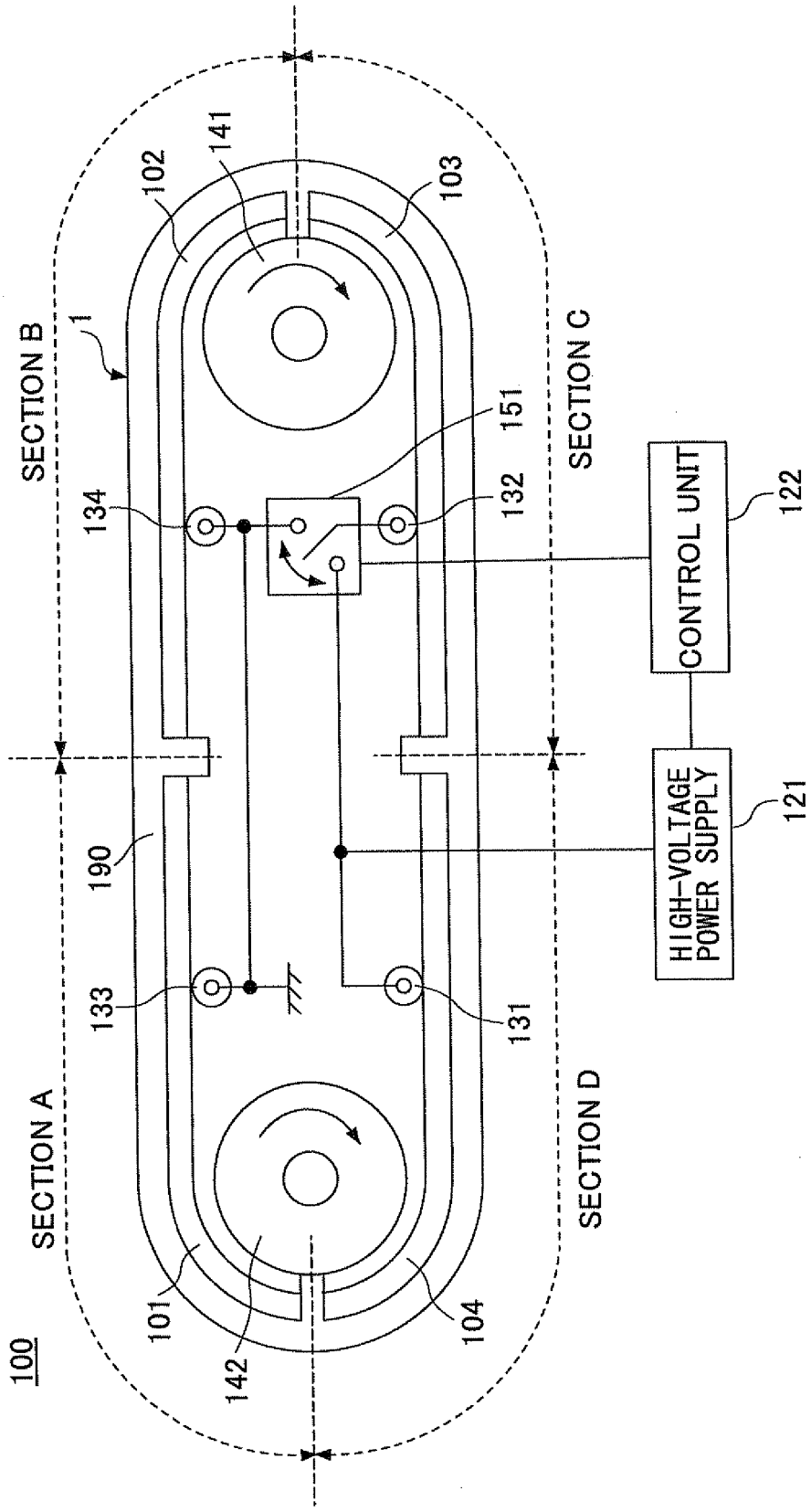

100
1
SECTION A
SECTION B
SECTION C
SECTION D
101
102
103
104
141
142
151
131
132
133
134
190
CONTROL UNIT
122
HIGH-VOLTAGE POWER SUPPLY
121

FIG.5A

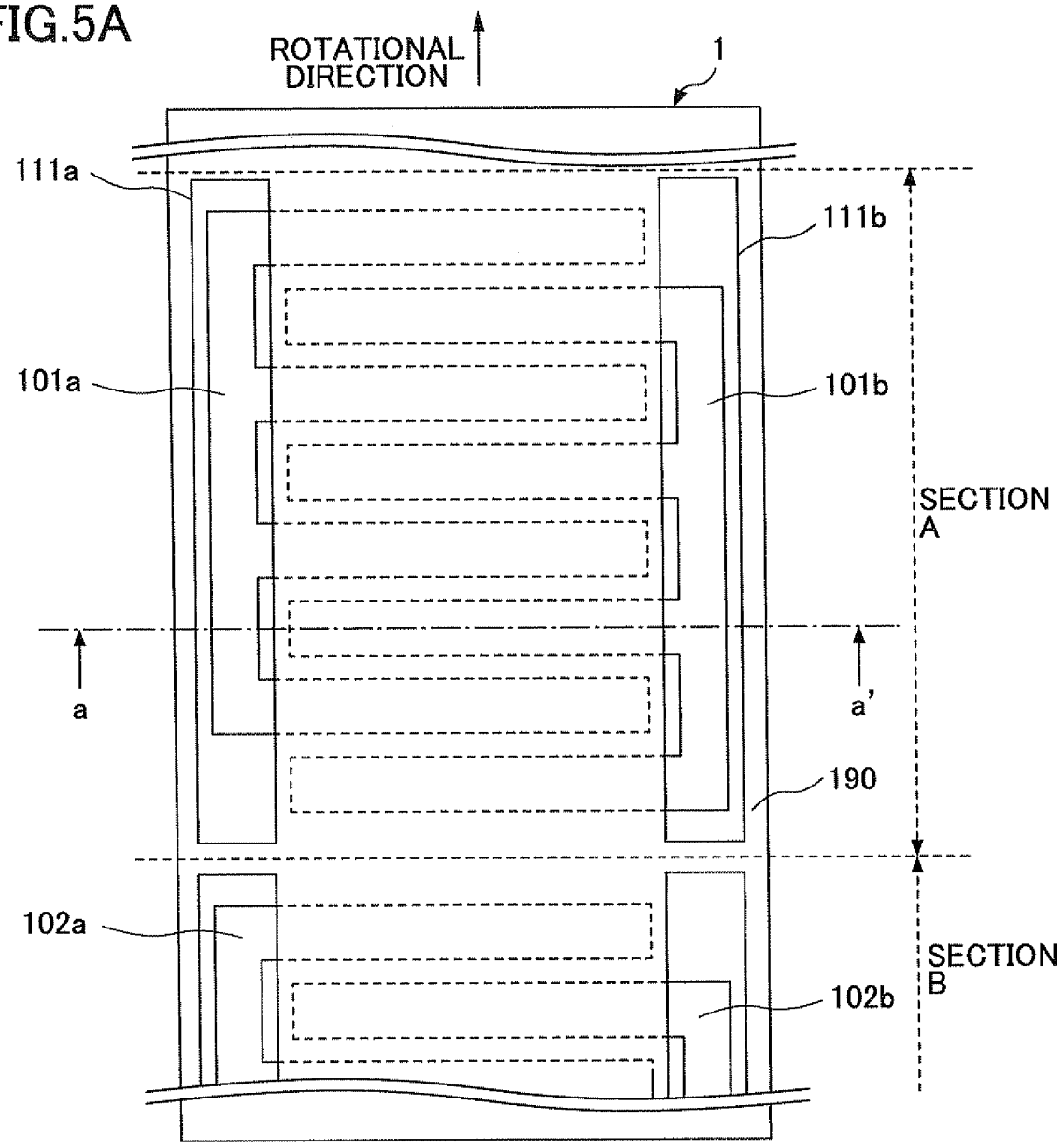
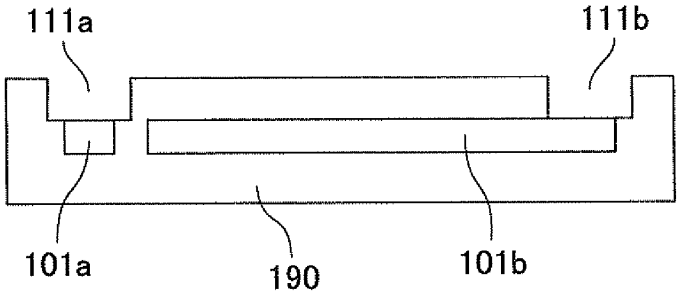
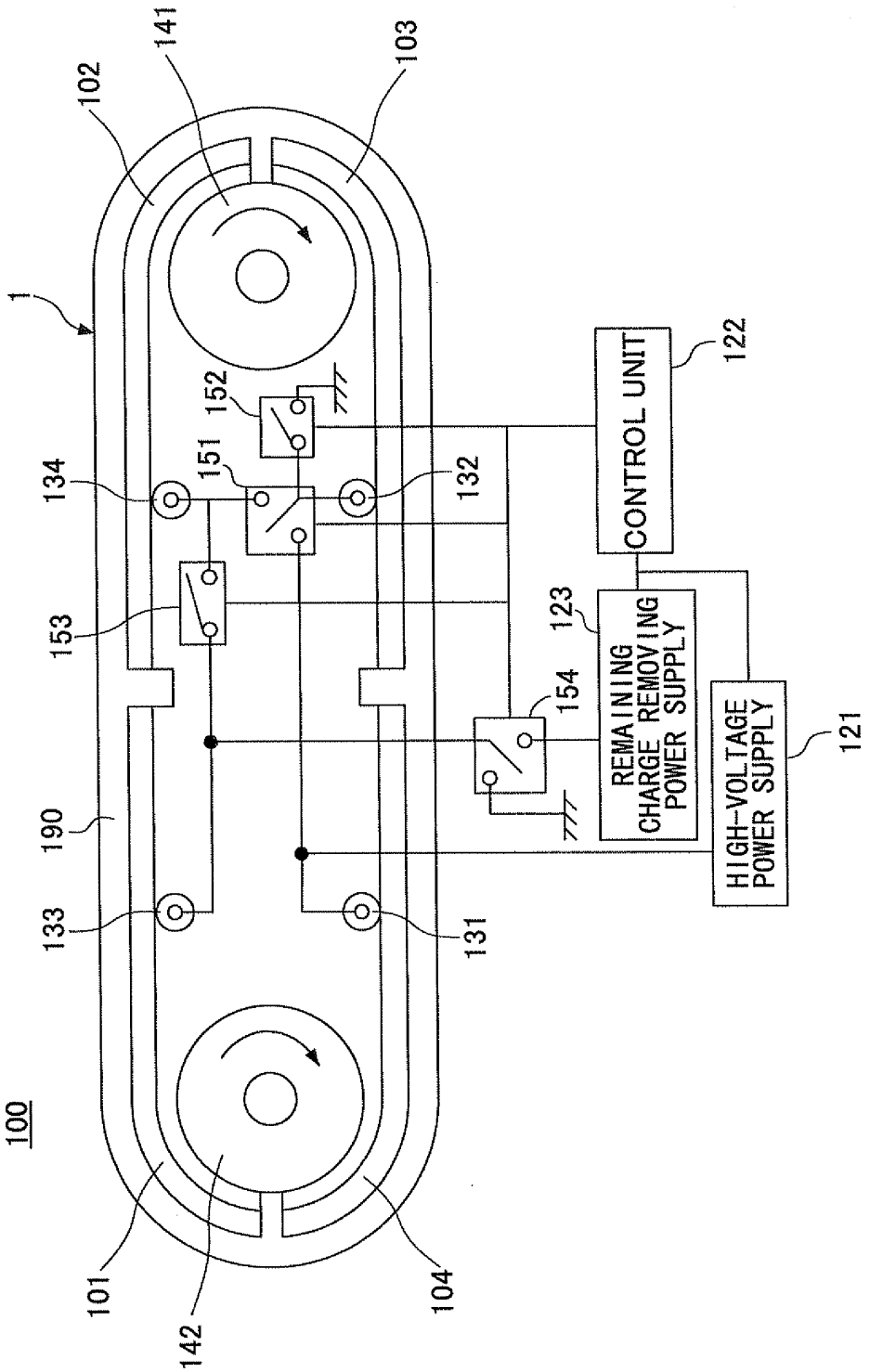

ROTATIONAL DIRECTION
1
111a
111b
101a
101b
SECTION A
a
a'
190
102a
SECTION B
102b

FIG.5B


111a
111b
101a
190
101b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1
101
102
103
104
131
132
133
134
141
142
151
152
153
154
190
CONTROL UNIT
122
REMAINING CHARGE REMOVING POWER SUPPLY
123
HIGH-VOLTAGE POWER SUPPLY
121

FIG.6

FIG.7

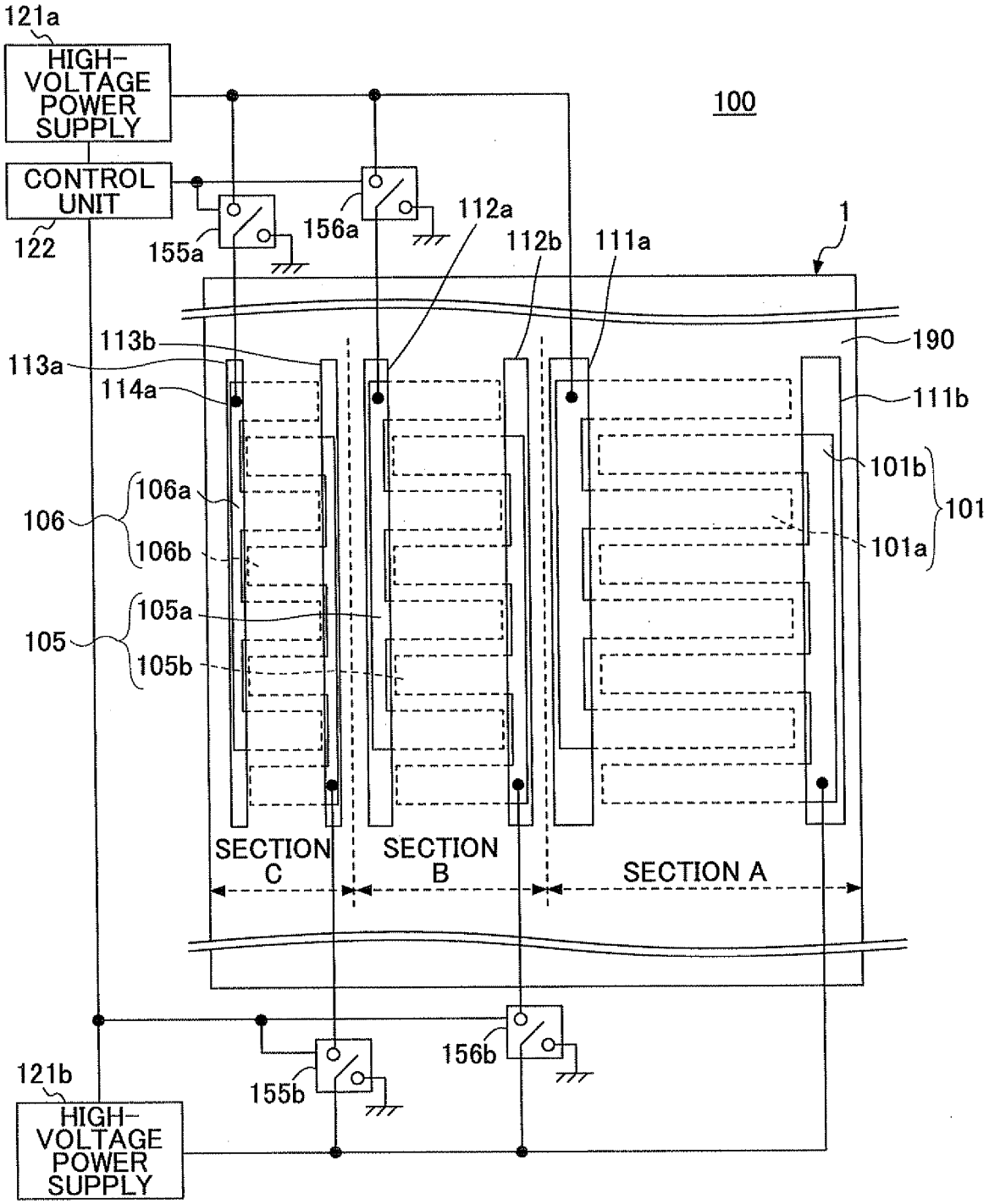

121a
HIGH-VOLTAGE POWER SUPPLY
CONTROL UNIT
122
155a
156a
112a
112b
111a
100
1
113b
113a
114a
190
111b
101b
101
101a
106
106a
106b
105
105a
105b
SECTION C
SECTION B
SECTION A
155b
156b
121b
HIGH-VOLTAGE POWER SUPPLY

FIG.8

SHEET SIZE	BASIS WEIGHT	SECTIONS TO APPLY VOLTAGE
A5	HEAVY	A
	LIGHT	A
B5	HEAVY	A, B
	LIGHT	A
A4	HEAVY	A, B
	LIGHT	A, B
B4	HEAVY	A, B, C
	LIGHT	A, B
A3	HEAVY	A, B, C
	LIGHT	A, B, C

FIG.9

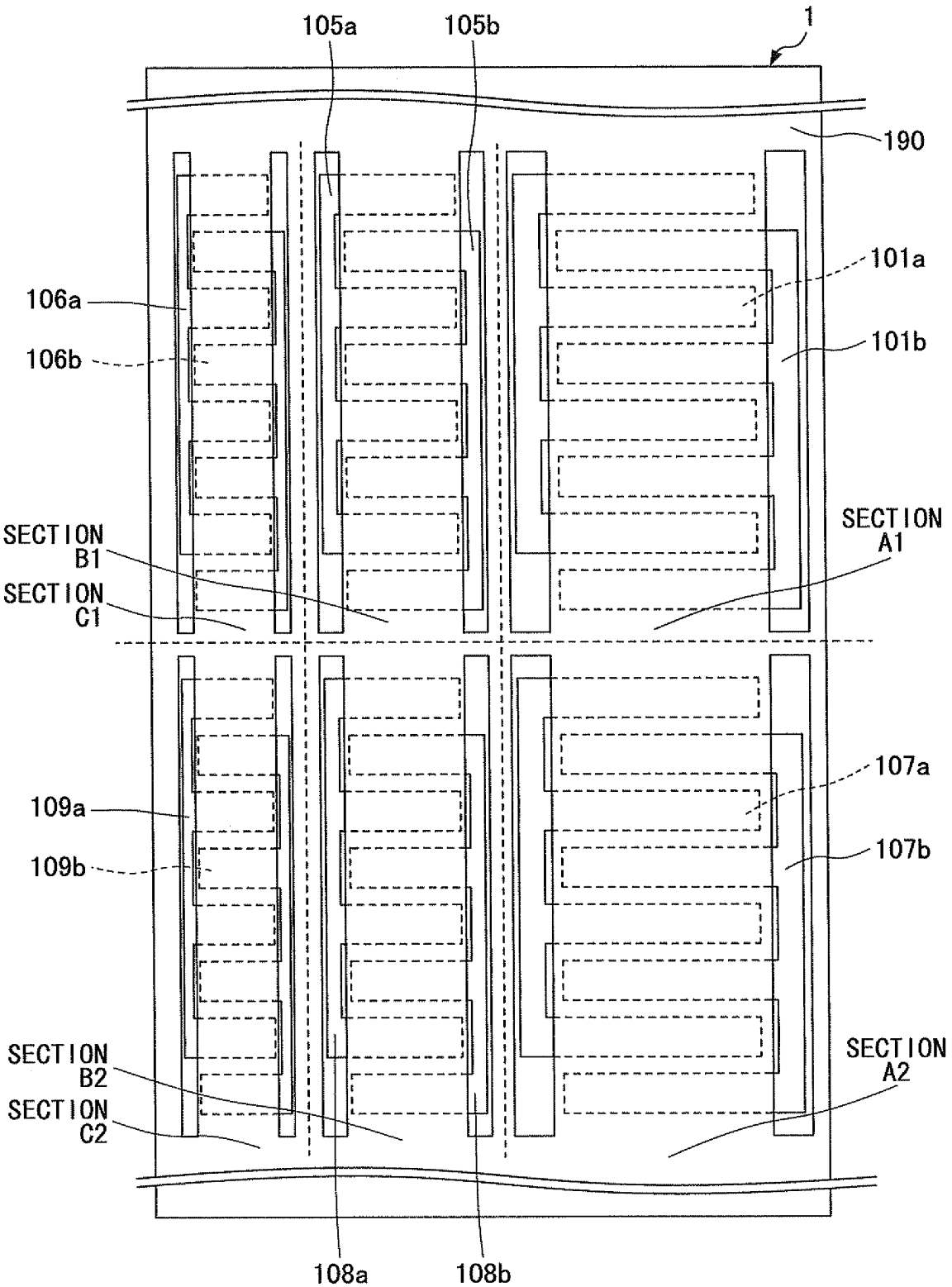

105a
105b
1
190
101a
101b
106a
106b
SECTION B1
SECTION C1
SECTION A1
107a
107b
109a
109b
SECTION B2
SECTION C2
SECTION A2
108a
108b

FIG.10

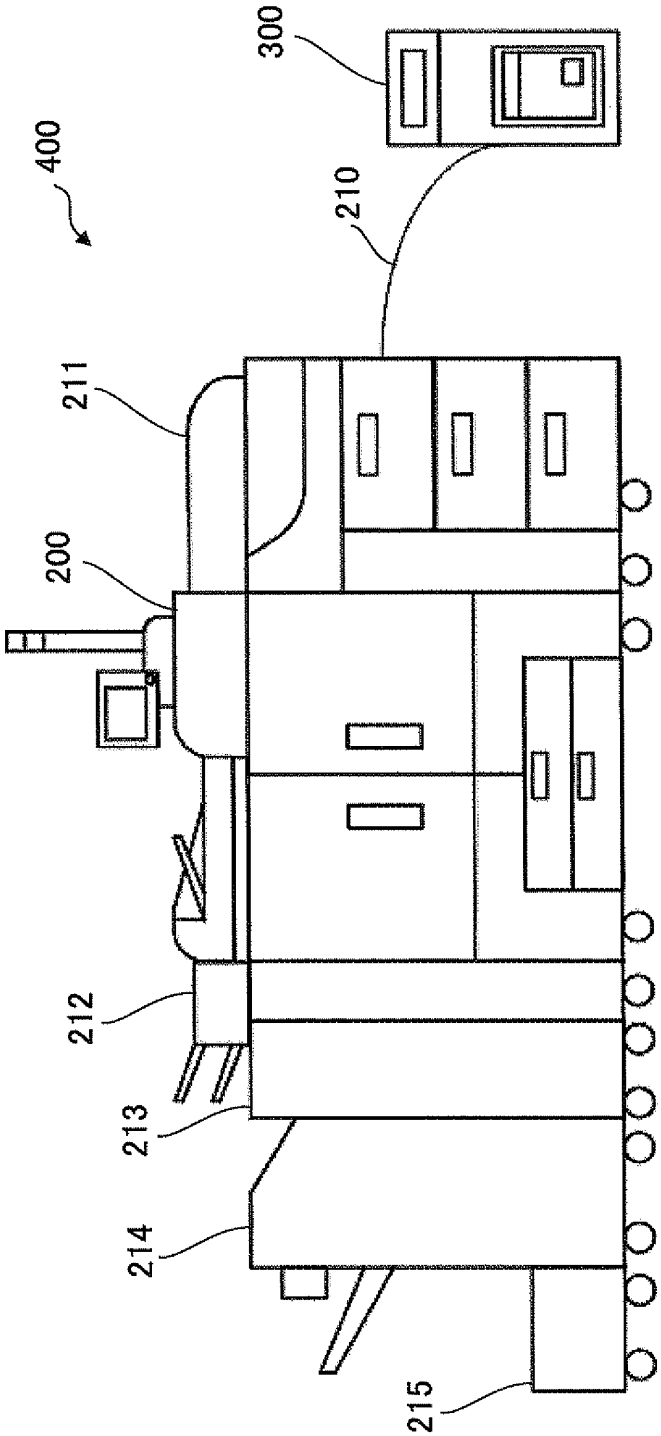
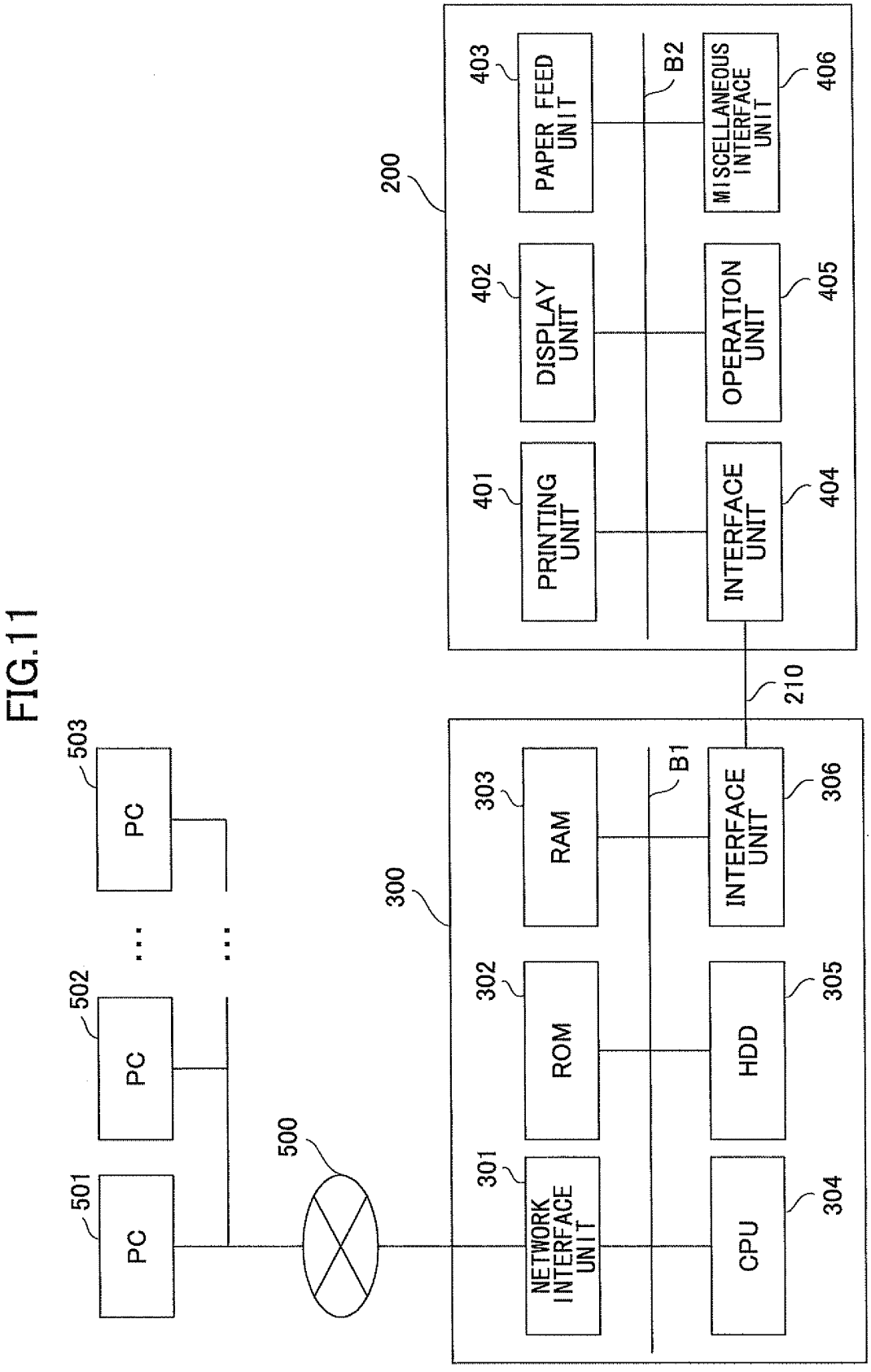


FIG.11


PC
PC
PC
500
NETWORK INTERFACE UNIT
ROM
RAM
CPU
HDD
INTERFACE UNIT
300
210
PRINTING UNIT
DISPLAY UNIT
PAPER FEED UNIT
INTERFACE UNIT
OPERATION UNIT
MISCELLANEOUS INTERFACE UNIT
200
B1
B2
501
502
503
301
302
303
304
305
306
401
402
403
404
405
406

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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