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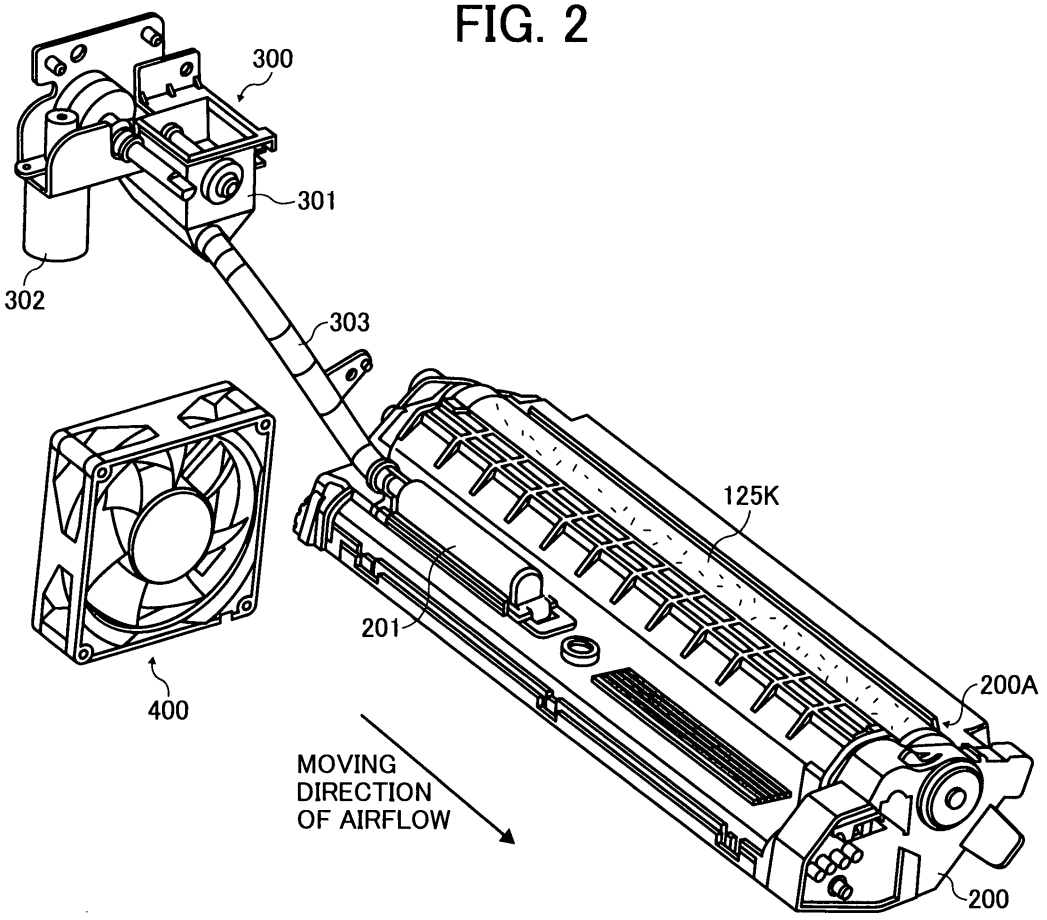
(54) Cooling structure and image forming apparatus

(57) A developing device (126K) develops an image by using black toner, and a toner supply unit (300) supplies black toner to the developing device (126K). A fan (400) cools the developing device (126K) by generating an airflow in a direction that is approximately same as a direction of supply of toner from the toner supply unit (300) to the developing device (126K).

FIG. 2



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present document incorporates by reference the entire contents of Japanese priority document, 2006-042590 filed in Japan on February 20, 2006.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a technology for cooling inside of an image forming apparatus.

2. Description of the Related Art

[0003] In an image forming apparatus such as a copying machine, a printer, a facsimile machine, or a printing press, an electrostatic latent image formed on a latent image carrier is processed into a visible image in a development process, the visible image is electrostatically transferred on a sheet such as a recording paper that is one of recording media, and the transferred visible image is heated and fixed on the recording paper to create a copied material or a recorded material.

[0004] On the other hand, in the image forming apparatus, a process cartridge structure (hereinafter, "process cartridge") is often employed. In the process cartridge, devices that carry out image forming process for each latent image carrier are integrated and arranged in the same case as that of the latent image carrier and the case is provided detachably in the main body of the image forming apparatus.

[0005] A technology for the process cartridge is disclosed in, for example, Japanese Patent Application Laid-Open No. 2004-271703. In the disclosed technology, a photosensitive member that is a member used for an image forming process, a charging device that carries out the image forming process with respect to the photosensitive member, a developing device, a cleaning device, and the like are integrally housed in the cartridge detachable from/to the image forming apparatus.

[0006] In the image forming apparatus, several devices that are used as heat generating sources are installed. Devices that are used as the heat generating sources include the fixing device, electromagnetic devices such as a motor and a crutch, and a microchip used for control. Heat from the heat generating sources causes a rise in atmospheric temperature in the image forming apparatus, which sometimes causes thermal adverse effects on the devices loaded therein.

[0007] For example, toner is used for a developer in the developing device and the toner is sometimes solidified owing to a temperature rise inside the developing device. Accordingly, desired control of supplying the developer cannot sometimes be carried out. Particularly, in recent years, since it is required to downsize the image forming apparatus and speed-up an image processing, a temperature in the device or the process cartridge rises caused by an increased packing density of devices inside the image forming apparatus and an increased stirring speed of the developer inside the developing device.

[0008] Due to a temperature rise in the process cartridge, which accommodates the developing device, abnormal images such as development defect and white lines caused by repeated fusion and solidification of toner as described above are often generated.

[0009] Thus, conventionally, a technology in which heat is exhausted from a target developing device or process cartridge by sending air to the inside of the casing used for the process cartridge and the developing device is disclosed in Japanese Patent Application Laid-Open No. 2005-173226. Furthermore, Japanese Patent Applications Laid-Open Nos. 2004-109868, 2002-278268, and H10-91228 disclose a technology in which an air path is formed inside a layer-thickness control member or a stirring member for a developer provided inside the developing device and cooling is carried out using air flowing in the air path, and a technology in which an air path is formed inside a stirring member provided in a developing device to serve as a cooling unit.

[0010] Moreover, Japanese Patent Application Laid-Open No. 2004-139031 discloses a technology for supplying new toner depending on toner consumption in a developing device. In the disclosed technology, a supply pipe is extended from a toner supply unit, which is provided with a toner tank that stores toner therein, toward a toner intake unit in the developing device, an end of the supply pipe is inserted into the toner intake unit in the developing device, and toner is delivered by airflow. In the developing device in such a structure, it is also needed to suppress deterioration in image quality caused by toner solidification by preventing a temperature rise inside the developing device.

[0011] In the technologies disclosed above, a fan is used as a forced-airflow generating unit, and a space is necessary inside the drum and the process cartridge, through which airflows generated by the fan pass. Moreover, when the developing device is targeted and when toner is scattered by the generated cooling airflow, the inside of the device is sometimes stained. Therefore, an airtight structure for preventing toner from scattering have to be provided, and the apparatus structure needs to be large accordingly.

[0012] Image forming apparatuses are targeted to form not only a monochrome image but also a multicolored image such as a full-color image. Accordingly, the number of developing devices increases corresponding to the number of colors of an image to be formed, more space for setting developing devices in the image forming apparatus is required, and therefore downsizing of the image forming apparatus is difficult.

SUMMARY OF THE INVENTION

[0013] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0014] According to one aspect of the present invention, a cooling structure for cooling a developing structure, the developing structure including a developing unit that develops an image by using toner and a toner supply unit that supplies toner to the developing unit, includes a cooling unit that cools the developing unit by generating an airflow in a direction that is approximately same as a direction of supply of toner from the toner supply unit to the developing unit.

[0015] According to another aspect of the present invention, an image forming apparatus includes a developing structure that includes a developing unit that develops an image by using toner; and a toner supply unit that supplies toner to the developing unit; and a cooling unit that cools the developing unit by generating an airflow in a direction that is approximately same as a direction of supply of toner from the toner supply unit to the developing unit.

[0016] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a side view of an image forming apparatus with a cooling structure according to an embodiment of the present invention;

Fig. 2 is a perspective view of an arrangement of a process cartridge, a toner supply unit, and a fan used for the cooling structure;

Fig. 3 is a side view of the arrangement shown in Fig. 2;

Fig. 4 is a side view of the process cartridge and the fan accommodated in the image forming apparatus;

Figs. 5A to 5D are diagrams of an attaching unit of a supply path in the process cartridge and the toner supply unit shown in Fig. 2;

Fig. 6 is a block diagram of a control unit used for the cooling structure;

Fig. 7 is a flowchart of an operation performed by the control unit; and

Fig. 8 is a plan view of another example of the cooling structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Exemplary embodiments of the present invention are described in detail below with reference to the accompanying drawings.

[0019] Fig. 1 is a side view of an image forming apparatus 120 with a sheet delivery device according to an embodiment of the present invention. The image forming apparatus 120 is a tandem type color printer and is capable of forming monochrome or full-color images. The image forming apparatus 120 can be a copying machine, a facsimile machine, a printing press, or the like.

[0020] The image forming apparatus 120 includes image forming devices 121Y, 121C, 121M, and 121K, a transfer device 122, a manual feed tray 123, a feeding-out roller 123A, a paper feed cassette 124A, a paper feeder 124, resist rollers 133, and a fixing device 110. Each of the image forming devices 121Y, 121C, 121M, and 121K, forms a monochrome image for each of colors according to a document image. The transfer device 122 is disposed opposite to each of the image forming devices 121Y, 121C, 121M, and 121K. The manual feed tray 123 and the feeding-out roller 123A serve as a sheet feeding unit that feeds a recording sheet to a transfer area between the image forming devices 121Y, 121C, 121M, and 121K and the transfer device 122 that are arranged opposite to each other. The paper feed cassette 124A is provided in the paper feeder 124. The resist rollers 133 feed the recording sheet delivered from the manual feed tray 123 or the paper feed cassette 124A in accordance with timing of image formation by the image forming devices 121Y, 121C, 121M, and 121K. The fixing device 110 carries out fixation of an image on the recording sheet that is a sheet medium after the sheet medium is transferred to the transfer area.

[0021] The fixing device 110 uses a heat-roller fixing method in which a toner image on the recording sheet is fixed through a melting-softening processing and a permeation processing. By the fixing process, the toner image is fixed on the recording sheet by the action of heat and pressure using a heat roller 110A and a pressure roller 110B that sandwich a delivery path for the recording sheet and are able to come in contact with each other.

[0022] In the transfer device 122, a belt (hereinafter, "transfer belt") 122A that is wound around a plurality of rollers is used as a transfer body, transfer bias units 122Y, 122C, 122M, and 122K that apply transfer bias are arranged in positions opposite to photosensitive drums in the image forming devices 121Y, 121C, 121M, and 121K, and toner images formed by the respective image forming devices 121Y, 121C, 121M, and 121K are sequentially superimposed and transferred on the recording sheet by allowing transfer bias with a polarity opposite to the toner to act.

[0023] In the transfer device 122, a secondary transfer-bias unit 122F is arranged in the delivery path of a recording sheet. The secondary transfer-bias unit 122F transfers the toner images sequentially superimposed and transferred on the transfer belt 122A, on a recording sheet all at once.

[0024] For the image forming apparatus 120, any or-

dinary paper commonly used for copying and the like, over head projector (OHP) sheets, 90K paper such as a card and a postcard, a cardboard whose basis weight is equal to or heavier than ca. 100 g/m^2, and so-called special sheets with thermal capacity larger than a paper such as an envelop can be used as the recording sheet.

[0025] The image forming devices 121Y, 121C, 121M, and 121K carry out development of colors, yellow, cyan, magenta, and black, respectively. Although toner colors used in the respective image forming devices 121Y, 121C, 121M, and 121K are different, the structures thereof are the same. Therefore, the structure of the image forming device 121K is explained on behalf of the image forming devices 121Y, 121C, and 121M.

[0026] The image forming device 121K includes a photosensitive drum 125K as an electrostatic-latent image carrier, a charging device 127K, a developing device 126K, and a cleaning device 128K that are sequentially disposed along the rotation direction of the photosensitive drum 125K. Furthermore, the image forming device 121K is configured so that an electrostatic latent image based on image information corresponding to a color obtained through a color-separation by a writing light 129K from a writing device 129 is formed between the charging device 127K and the developing device 126K. The electrostatic-latent image carrier can be in a belt shape other than in a drum shape. These devices arranged in the periphery of the photosensitive drum for image formation, in other words, devices for image formation are accommodated in a process cartridge 200 that is constructed in a unit structure provided with a case shown in Fig. 2.

[0027] In the image forming apparatus 120, the transfer device 122 is arranged obliquely, and therefore space occupied by the transfer device 122 in the horizontal direction can be made small.

[0028] Next, image formation is explained focusing on the image forming device 121K that forms an image using black toner. Note that the other image forming devices 121M, 121C, and 121Y that respectively include photosensitive drums 125M, 125C, and 125Y and developing devices 126M, 126C, and 126Y form images similarly.

[0029] At the time of image formation, the photosensitive drum 125K is rotatably driven by a main motor (not shown) and discharged by alternating current (AC) bias (direct current (DC) component is zero) applied to the charging device 127K, and the surface potential thereof is set to a standard potential of approximately -50 volts.

[0030] The photosensitive drum 125K is charged uniformly to a potential approximately equal to DC component by being applied with DC bias superimposed with AC bias by the charging device 127K, and the surface potential thereof is charged to between ca. -500 volts and -700 volts (target charge potential is determined by a process control unit).

[0031] When the photosensitive drum 125K is uniformly charged, a writing step is carried out. An image subjected to writing is written to form an electrostatic latent image using the writing device 129 based on digital image information from a controller unit (not shown). In other words, in the writing device 129, laser light emitted from a laser light source based on emission signals for laser diode that has been converted into binary for every color corresponding to the digital image information is irradiated on the respective photosensitive drums, in this case on the photosensitive drum 125K, via a cylinder lens (not shown), a polygon motor 129A, an fθ lens 129B, first to third mirrors, and a wide toroidal lens (WTL). Thereafter, the surface potential of the irradiated portion of the surface of the photosensitive drum becomes ca. -50 volts, and an electrostatic latent image corresponding to the image information is formed.

[0032] The electrostatic latent image formed on the photosensitive drum 125K is processed into a visible image by the developing device 126K using color toner that has a complementary color relation to a color that has been obtained through color-separation. At a developing step, toner (Q/M: -20 μC/g to -30 μC/g) is developed exclusively on the image portion whose potential is decreased by the irradiation of writing light by applying DC of between -300 volts and -500 volts superimposed with AC bias to a developing sleeve, and a toner image corresponding to the image information is formed.

[0033] The toner image of each color processed into a visible image at the developing step is transferred on a recording sheet fed out by the resist rollers 133 with a resist timing set. The recording sheet is applied with attachment bias by a sheet-attachment bias unit composed of rollers, before the recording sheet reaches the transfer belt 122A and is electrostatically attached to the transfer belt 122A.

[0034] The transfer belt 122A is electrostatically transferred with the toner images from the photosensitive drums by applying bias whose polarity is opposite to that of the toner by the transfer bias units 122Y, 122C, 122M, and 122K attached to the transfer device 122 in the positions opposite to the photosensitive drums in the image forming devices, and the toner images superimposed and transferred are collectively transferred onto the recording sheet by the secondary transfer bias unit 122F.

[0035] The recording sheet passed through the transfer step for each color is allowed to self-strip from the transfer belt 122A at a roller on the driving side of a transfer belt unit (shown by the reference symbol 122A1 in Fig. 1) and delivered toward the fixing device 110. The recording sheet then passes through a fixing nip formed by the fixing belt and the pressure roller to make the toner image be fixed on the recording sheet and is delivered to a paper delivery tray 132.

[0036] In the image forming apparatus 120 shown in Fig. 1, image formation not only on one side of the recording sheet to be delivered after fixation but also on two sides thereof can be carried out. At the time of two-side image formation, the recording sheet is delivered to a reverse circulation path RP after the image is fixed on one side and fed out toward the resist rollers 133 by feeding-out rollers RP1 that are positioned at an end of the

reverse circulation path RP and that serves for feeding out the recording sheet from the manual feed tray 123. Switching of delivery paths for a recording sheet at the time of image formation from one side to two sides is carried out by a delivery-path switching claw RP2 arranged in the rear of the fixing device 110.

[0037] The delivery-path switching claw RP2 is provided in a delivering unit used as a sheet delivering device described later and switches the delivery paths according to sheet delivery modes.

[0038] Each physical property such as the charge potential is not limited to the values described above, and it is a matter of course that these values can be changed according to colors, darkness, and the like. Furthermore, in Fig. 1, the reference symbols T1 to T4 represent supply tanks of toner used for the developing devices. The supply tank is in a bottle shape that extends from the front side to the rear side in the figure and has a structure in which toner is supplied from the rear side in the figure to the developing device.

[0039] In the image forming apparatus 120, the transfer belt 122A used for the transfer device 122 is also obliquely stretched to make the length in the height direction small as described above.

[0040] The image forming devices 121Y, 121C, 121M, and 121K used for the image forming apparatus 120 are housed in respective metal process cartridges that is detachable by sliding the developing devices used for a processing of making an electrostatic latent image into a visible image, from the rear side to the front side in Fig. 1 with respect to the inside of the main body of the image forming apparatus 120. Furthermore, the image forming devices 121Y, 121C, 121M, and 121K are supplied with new toner from the toner tanks T1 to T4, respectively.

[0041] Fig. 2 represents the process cartridge 200 that houses the developing device and a toner supply unit 300 for supplying toner from the toner tanks T1 to T4. In Fig. 2, the process cartridge 200 provided with the photosensitive drum 125K for which a development process is carried out by the developing device 126K that supplies black toner, is shown as an example of the image forming devices. The lower right side of Fig. 3 corresponds to the front side of Fig. 1, and the upper left side of Fig. 3 corresponds to the rear side of Fig. 1.

[0042] As shown in Fig. 2, the developing device 126K is housed in the metal process cartridge 200 and disposed in the inside thereof so as to be adjacent to the photosensitive drum 125K whose part of the peripheral surface is exposed from an opening 200A formed on the process cartridge 200.

[0043] A supplying unit 201 to which toner is supplied from the toner supply unit 300 is provided to a portion of the process cartridge 200 and is composed of the connecting unit 201 (hereinafter, the supplying unit is named as the connecting unit 201) jutting outwardly from the surface of the process cartridge 200. The connecting unit 201 is a portion that communicates with a stirring and mixing unit inside the developing device 126K and is inserted with an end of a supply member (pipe) 303 extended from the toner supply unit 300 described later. Furthermore, engagement with the supply member 303 is released by pulling out the process cartridge 200 together with the connecting unit 201 to the lower right side in Fig. 2. Thus, maintenance of the process cartridge 200 can be performed.

[0044] The toner supply unit 300 is a mechanism to which toner is supplied from the toner tank (any member shown by the reference symbols T1 to T4 in Fig. 1) and is provided with a hopper 301 disposed adjacently to the toner tank. A stirring member (not shown) is provided inside the hopper 301, and the stirring member is rotatably driven by a driving motor 302 attached to the hopper 301 and transfers (supplies) toner toward the supply member 303.

[0045] In the embodiment, a structure for cooling the developing device 126K that is provided with a structure of receiving toner supply from the toner supply unit 300 and that is housed in the process cartridge 200 is provided. The structure is explained below.

[0046] Near the process cartridge 200, a fan 400 as an airflow generating unit is disposed in the longitudinal direction of the process cartridge 200, that is, along the axis direction of a developing sleeve 126K1 in the developing device 126K, on the upstream side in the transfer (supply) direction of toner from the toner supply unit 300, and on the side of the toner supply unit 300.

[0047] The fan 400 is separated from the process cartridge 200 and attached to a supporting unit (not shown) provided in a position communicable to the outside of the image forming apparatus 120. The airflow generation direction shown by the reference symbol F in Fig. 3, that is, an airflow direction is set to approximately the same direction as the toner transfer (supply) direction shown by the reference symbol F1 in Fig. 3.

[0048] It is facilitated that toner transferred from the supply member 303, which is extended from the toner supply unit 300 and inserted into the connecting unit 201 of the developing device 126K, to the developing device 126K is pushed to the side of the developing device 126K because the airflow direction of the fan 400 is set to approximately the same as the toner transfer (supply) direction. Accordingly, little toner leaks from the connecting unit 201 to the outside to scatter. That is, the connecting unit 201 and the end of the supply member 303 have a dimensional relation in which a fitting width corresponding to an allowance at the time of insertion and withdrawal is created so that the withdrawal and the insertion of the supply member 303 can easily be carried out. In this case, a slight gap is sometimes produced, and toner sometimes leaks from the gap to the outside to scatter. However, in the structure of the embodiment, toner is facilitated to flow toward the inside of the developing device 126K along the direction of airflow generated by the fan 400 without leaking to the outside.

[0049] On the other hand, as shown in Fig. 4, the process cartridge 200 is disposed and fixed in an inserting

and detaching unit 500 provided inside the image forming apparatus 120. In the inserting and detaching unit 500 provided on the side of the image forming apparatus 120, the fan 400 is supported by a supporting unit 500A included in the inserting and detaching unit 500 on the side of the image forming apparatus 120.

[0050] In the inserting and detaching unit 500, a partition member 600 is provided adjacently to the space in which the process cartridge 200 is disposed. An electrical component (board) 700 attached with a power device that is one of the electrical components to be heat generating sources, and a driving circuit driven by the power device(shown by the reference symbol 700A in Fig. 4) is disposed in the space partitioned by the partition member 600.

[0051] The space partitioned by the partition member 600 is positioned in the airflow direction of the fan 400, in other words, in the direction orthogonal to the airflow moving direction, and the process cartridge 200 and the electrical component 700 are arranged adjacently in the direction orthogonal to the airflow.

[0052] In the embodiment, cooling by the fan 400 is carried out for such a positional arrangement of respective devices. As shown in Fig. 4, the airflow from the fan 400 is diverted by the partition member 600 extended in the length that can cover approximately the whole area from the position near the air blowout portion of the fan 400 to the longitudinal direction of the process cartridge 200 and the electrical component 700, and is allowed to flow through each space.

[0053] For the partition member 600 described above, a heat radiating member made of metal and a heat shielding member such as heat insulating resin are used. When a heat radiating member is used, it functions as a heat sink. When a heat shielding member is used, it functions to shield heat conduction to adjacent devices.

[0054] The air blowout portion of the fan 400 faces both spaces partitioned by the partition member 600. The airflow generated by the fan 400 flows along the longitudinal direction of the process cartridge 200 that is the same direction as the transfer (supply) direction of toner and the direction of the loaded electrical component 700 as shown by the reference characters FA and FB in Fig. 4, respectively, and each device is cooled by contact with the airflow.

[0055] In the structure, the moving direction of airflow by the fan 400 is the same as the transfer (supply) direction of toner from the toner supply unit 300, and therefore, in addition to carrying out cooling, toner scattering can be prevented by pushing toner transferred in the connecting unit 201 on the side of the developing device 126K into the inside of the developing device 126K.

[0056] In the embodiment, the structures shown in Figs. 5A to 5D are used as a structure for preventing toner from scattering in the connecting unit 201.

[0057] Figs. 5A to 5D are diagrams of the connecting unit 201. In Figs. 5A to 5D, various different structures are shown.

[0058] In Figs. 5A to 5D, the connecting unit 201 is a dome-shaped member in a half-column shape whose one end in the longitudinal direction parallel to the moving direction of airflow shown by an arrow is closed. The supply member 303 from the toner supply unit 300 is inserted into and detached from an attachment opening 201A formed at the other end of the connecting unit 201 in the longitudinal direction.

[0059] In the structure shown in Fig. 5A, the attachment opening 201A is in an approximately circle shape large enough to insert the end of the supply member 303, and the end of the supply member 303 is pressed into the attachment opening 201A.

[0060] When the end is inserted into the attachment opening 201A, a slight gap is formed between the attachment opening 201A and the outer peripheral face of the end of the supply member 303 to enhance the workability at the time of withdrawal and insertion. However, if the gap is small and when airflow by the fan 400 enters, the airflow flowing through the gap portion becomes turbulent and toner supposed to be pushed into the inside of the developing device 126K sometimes scatters outside. Thus, in the embodiment, a structure in which scattering caused by toner leakage from the attachment opening 201A does not occur is adopted.

[0061] Fig. 5B is a diagram to represent the connecting unit 201 viewed from the downstream side of the moving direction of airflow shown by an arrow, which is opposite to that shown in Fig. 5A.

[0062] In Fig. 5B, the sectional shape of the connecting unit 201 parallel to the moving direction of airflow generated by the fan 400 is in a taper shape (visible plane dimension L1>L2). Accordingly, toner-flows flown into the inside of the connecting unit 201 is rectified to flows that converge along the sectional shape of the connecting unit 201, and therefore air entering from the gap becomes in conformity with the rectified flows. Thus, turbulent flows disappear, and the problem of external toner scattering caused by the turbulent flows can be solved.

[0063] The structure shown in Fig. 5C is a structure in which for the attachment opening 201A of the connecting unit 201 positioned on the upstream side of the moving direction of airflow, the diameter of the opening end side is enlarged. Even when outside air unexpectedly comes in from the gap depending on the size of the gap, flows that converge near the attachment opening 201A are generated and rectified. Therefore, turbulent flows in the gap are suppressed, and toner scattering caused by turbulent flows can be prevented.

[0064] In the structure shown in Fig. 5D, a scattering prevention member 202 for preventing toner from scattering is attached to the outer peripheral face of the attachment opening 201A of the connecting unit 201. Therefore, toner leaked from the gap between the inner face of the attachment opening 201A and the outer peripheral face of the supply member 303 is prevented from scattering along the airflow direction of the fan 400 (in Fig. 5D, corresponding to the moving direction of airflow

shown by an arrow) toward the center side of the process cartridge, that is, the position in which the photosensitive drum 125K shown in Fig. 2 is exposed to the outside. Accordingly, it is possible to prevent toner from leaking from the attachment opening 201A and scattering to the surface of the photosensitive drum or near the periphery thereof.

[0065] In the embodiment, a thin plate such as Mylar film is used as the scattering prevention member 202. However, a filter capable of adsorbing toner can be used in place of the thin plate.

[0066] In the embodiment, it is possible to rectify the airflow due to the shaping of the structure of the connecting unit 201. Accordingly, it is possible to prevent toner, which is supposed to be pushed into the inside of the developing device 126K by setting direction of airflow using the fan 400, from scattering caused by turbulent flows generated at the connecting unit 201. Therefore, the toner can be prevented from scattering to the development processing units and the inside of the apparatus.

[0067] The time when the process cartridge is exchanged is considered as one of cases in which toner scattering occurs, and therefore toner leaked from the process cartridge at the time of exchange is prevented from scattering inside the image forming apparatus 120. A structure for preventing scattering of the toner is explained below.

[0068] Fig. 6 is a block diagram of a control unit 800 used for carrying out drive control of the fan 400. The control unit 800 uses a microprocessor capable of sequence control for image forming process.

[0069] As members related to the embodiment, a positioning detection sensor 801 that determines a position of the process cartridge 200 is connected to an inputting unit in the control unit 800, and a driving unit 401 of the fan 400 is connected to the output side.

[0070] After the control unit 800 determines that the process cartridge 200 has been removed according to, for example, ON signal from the positioning detection sensor 801 when the process cartridge 200 is removed from the setting position for exchange, the control unit 800 determines the state that the positioning detection sensor 801 is changed again to OFF signal, and determines that the process cartridge 200 has been loaded. The rotation direction of the fan 400 is reversed from the rotation direction for performing an ordinary image formation, for a predetermined time period from the time when the process cartridge 200 is loaded, which is judged based on a signal from the positioning detection sensor 801.

[0071] Fig. 7 is a flowchart of an operation performed by the control unit 800. In Fig. 7, if it is determined that the process cartridge 200 has been exchanged with a new process cartridge by judging an input state of OFF signal of the positioning detection sensor 801, the rotation of the fan 400 is reversed for a predetermined time. The predetermined time in this case is set to approximately from 30 seconds to one minute and corresponds to a time from the time of loading for exchange to a short time elapsed after the load completion.

[0072] Accordingly, even if part of toner leaks and scatters from the process cartridge 200 at the time of loading for exchange, an airflow is generated in the direction opposite to the transfer (supply) direction of toner, and therefore, scattering of the toner to the exposed position of the developing sleeve 126K1 on the side of the process cartridge 200 or to the inside of the image forming apparatus can be prevented.

[0073] After reversing the airflow for the predetermined time, the rotation of the fan 400 is switched to rotation (normal rotation) with which the moving direction of airflow in the same direction as the toner transfer (supply) direction can be obtained.

[0074] In the embodiment, the fan 400 used as an airflow generating unit is controlled for normal and reverse rotation and there are members in the apparatus that toner scattered in the apparatus sometimes adheres to or comes in contact with at the time of reversing rotation. Therefore, attachment of a filter is possible to adsorb the toner scattered at the time of the reverse rotation. For a structure to prevent toner leakage from the attachment opening 201A of the connecting unit 201, it is possible to attach a seal member that has flexibility or elasticity such as sponge to the outer peripheral face of the end on the insertion side of the supply member 303.

[0075] Fig. 8 represents a structure in which the fans 400 as airflow generating units in the image forming apparatus 120 capable of forming a full-color image are provided so that the fans 400 correspond to the process cartridges 200 that are equipped with the developing devices for each color. Note that the reference symbol 120B represents a partition board that thermally shields the integrated setting portion of the process cartridges from, for example, the setting portion for the electrical component board.

[0076] In this case, the fans 400 are attached to one side of a main body case 120A in the image forming apparatus 120 corresponding to the setting positions of the process cartridges 200 and outlets 120A1 are provided on the other side of the main body case 120A. Accordingly, airflows from the fans 400 flow along the longitudinal direction of the process cartridges 200 as shown by the arrows and discharged from the outlets 12CA1 to the outside.

[0077] In this structure, cooling can be carried out for each of the process cartridges 200 individually and the fan 400 can be made small, which is different from a case where an airflow driving source for cooling the entire apparatus is provided. Moreover, when the fan 400 is drive-controlled to be suitable for the condition of temperature rising in each process cartridge, that is, selectively driven, it is possible to prevent an increase in power consumption caused by driving the fan 400 for a process cartridge that is not needed to be cooled. Therefore, it is possible to save energy. When cooling is necessary for temperature management of the entire area of the image forming ap-

paratus 120, it is, of course, possible even for the fan for a process cartridge not in working to be driven.

[0078] According to an aspect of the present invention, it is possible to prevent toner solidification by cooing the developing device. In addition, since the direction of airflow at the time of cooling is approximately the same as the toner supply direction toward the developing device, toner supplied is pushed into the inside of the developing device, and toner scattering can be prevented.

[0079] According to another aspect of the present invention, it is possible to cool other devices collectively with cooling airflow for the developing device by disposing the electrical component adjacently to the developing device. Therefore, the heat generating sources affecting toner solidification can be cooled collectively.

[0080] According to still another aspect of the present invention, it is possible to block the influence of heat on the developing device by providing the partition member between the developing device and the adjacent electrical component.

[0081] According to still another aspect of the present invention, since the attaching unit for the toner supply path is in a taper shape such that the size thereof becomes gradually smaller from the upstream side to the downstream side of the moving direction of airflow, it is facilitated for the airflow not only to enter the inside of the attaching unit but also to be rectified. Therefore, it is possible to facilitate toner to be pushed into the inside of the developing device and to be prevented from scattering.

[0082] According to still another aspect of the present invention, since a toner scattering prevention member is provided in the attaching unit, toner can be securely prevented from unexpected scattering.

[0083] According to still another aspect of the present invention, since an air blowing unit capable of generating a forced airflow is used as the airflow generating unit, it is possible to push toner for supply toward the developing device and prevent toner from scattering.

[0084] According to still another aspect of the present invention, since a filter is provided in the air blowing unit, it is possible to recover toner scattered in the device at the time of air circulation generated when air is blown.

[0085] According to still another aspect of the present invention, since the developing device is formed of a metal casing, the efficiency of cooling using airflow can be enhanced.

[0086] According to still another aspect of the present invention, it is possible to effectively prevent toner solidification by suppressing heat generation in the device as well as securely prevent toner scattering caused by airflow used at the time of cooling.

[0087] According to still another aspect of the present invention, since recovery of toner scattered at the time of exchanging the developing device is possible by reversing the rotation of the air blowing unit, and therefore, toner scattering at the time of exchange of the developing device can be effectively suppressed.

[0088] Although the invention has been described with respect to a specific embodiment for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. A cooling structure for cooling a developing structure, the developing structure including a developing unit (126K, 126C, 126M, and 126Y) that develops an image by using toner and a toner supply unit (300) that supplies toner to the developing unit, the cooling structure comprising:

   a cooling unit (400) that cools the developing unit (126K, 126C, 126M, and 126Y) by generating an airflow in a direction that is approximately same as a direction of supply of toner from the toner supply unit (300) to the developing unit (126K, 126C, 126M, and 126Y).

2. An image forming apparatus (120) comprising:

   a developing structure that includes

   a developing unit (126K, 126C, 126M, and 126Y) that develops an image by using toner; and
   a toner supply unit (300) that supplies toner to the developing unit; and

   a cooling unit (400) that cools the developing unit (126K, 126C, 126M, and 126Y) by generating an airflow in a direction that is approximately same as a direction of supply of toner from the toner supply unit (300) to the developing unit (126K, 126C, 126M, and 126Y).

3. The image forming apparatus (120) according to claim 2, further comprising an electrical component (700) that is arranged near the developing unit (126K, 126C, 126M, and 126Y) in a path of the airflow and that produces heat, wherein the cooling unit (400) cools the electrical component (700) with the airflow.

4. The image forming apparatus (120) according to claim 3, wherein the electrical component (700) is arranged in a direction orthogonal to the direction of the airflow.

5. The image forming apparatus (120) according to claim 3 or 4, further comprising a partition member (600) arranged between the developing unit (126K,

126C, 126M, and 126Y) and the electrical component (700) for preventing the heat generated in the electrical component (700) from being in contact with the developing unit (126K, 126C, 126M, and 126Y).

6. The image forming apparatus (120) according to claim 5, wherein the partition member (600) is made of a heat radiating material.

7. The image forming apparatus (120) according to claim 5, wherein the partition member (600) is made of a heat shielding material.

8. The image forming apparatus (120) according to any one of claims 2 to 7, wherein

the toner supply unit (300) includes a toner tank (T1 to T4), a toner supply member (303) that supplies toner from the toner tank (T1 to T4) to the developing unit (126K, 126C, 126M, and 126Y), and a connecting unit (201) for connecting the toner supply member (303) to the developing unit (126K, 126C, 126M, and 126Y),
the connecting unit (201) is formed in a taper shape such that a diameter of the connecting unit (201) becomes gradually smaller from an upstream side to an downstream side along the direction of the airflow.

9. The image forming apparatus (120) according to claim 8, further comprising a scattering prevention member (202) that prevents toner from scattering inside the image forming apparatus (120) and that is arranged on the connecting unit (201).

10. The image forming apparatus (120) according to any one of claims 2 to 9, wherein the cooling unit (400) is a fan (400).

11. The image forming apparatus (120) according to claim 10, wherein the fan (400) includes a filter for absorbing scattered toner.

12. The image forming apparatus (120) according to any one of claims 2 to 11, wherein the developing unit (126K, 126C, 126M, and 126Y) is formed of a metal casing.

13. The image forming apparatus (120) according to any one of claims 2 to 12, wherein the developing unit (126K, 126C, 126M, and 126Y) is loaded in a process cartridge (200).

14. The image forming apparatus (120) according to any one of claims 2 to 13, wherein the developing unit (126K, 126C, 126M, and 126Y) is detachably provided in the image forming apparatus (120), and the direction of the airflow is reversed from a previous direction for a predetermined time immediately after the developing unit (126K, 126C, 126M, and 126Y) is exchanged to the developing unit (126K, 126C, 126M, and 126Y) in which toner is charged.

FIG. 1

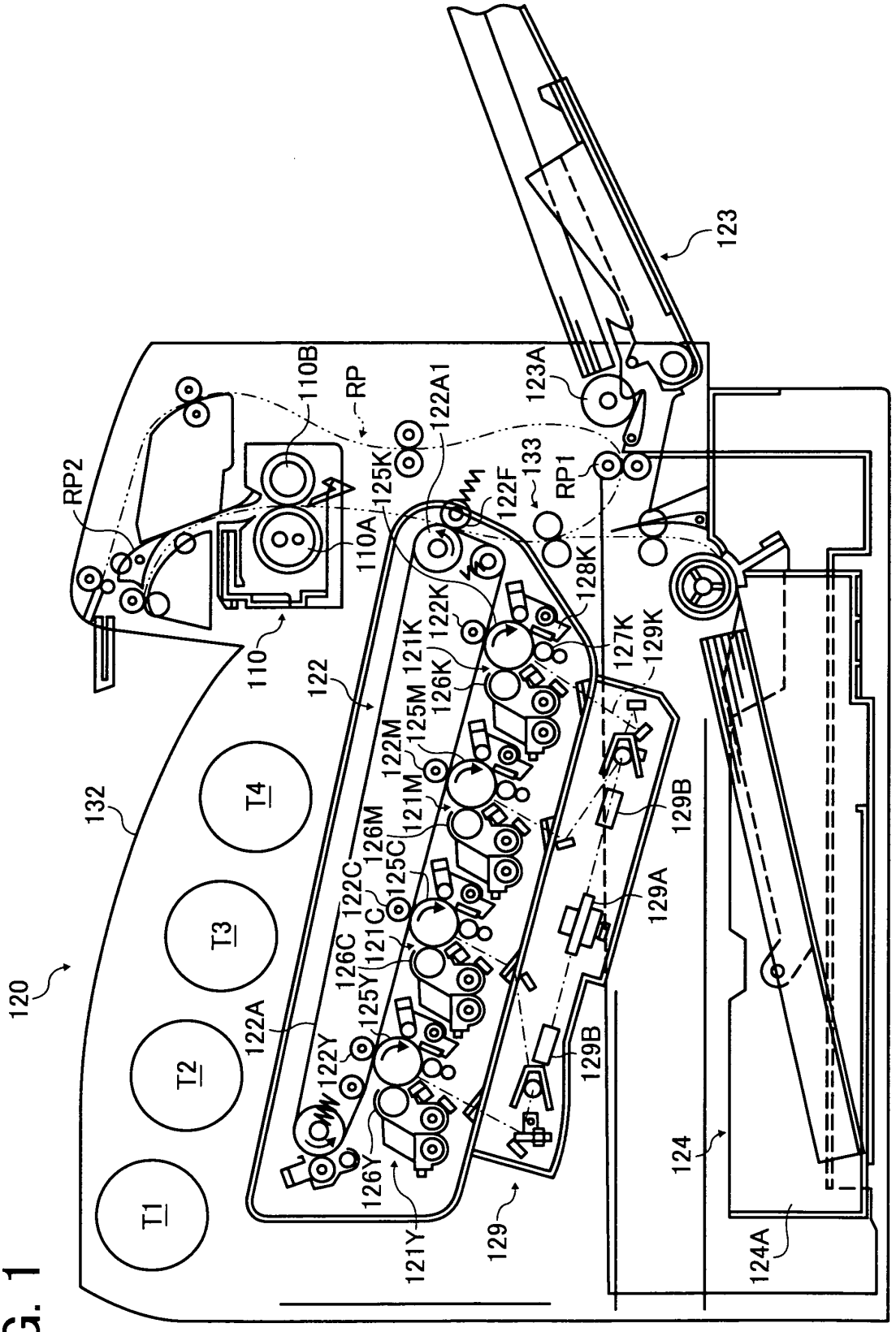

120
132
T1
T2
T3
T4
RP2
110B
RP
122A1
123A
123
125K
122F
133
RP1
110A
128K
110
122
122K
121K
127K
129K
126K
125M
122M
121M
129B
126M
125C
122C
121C
126C
125Y
129A
122A
122Y
126Y
121Y
129
124
124A

FIG. 2

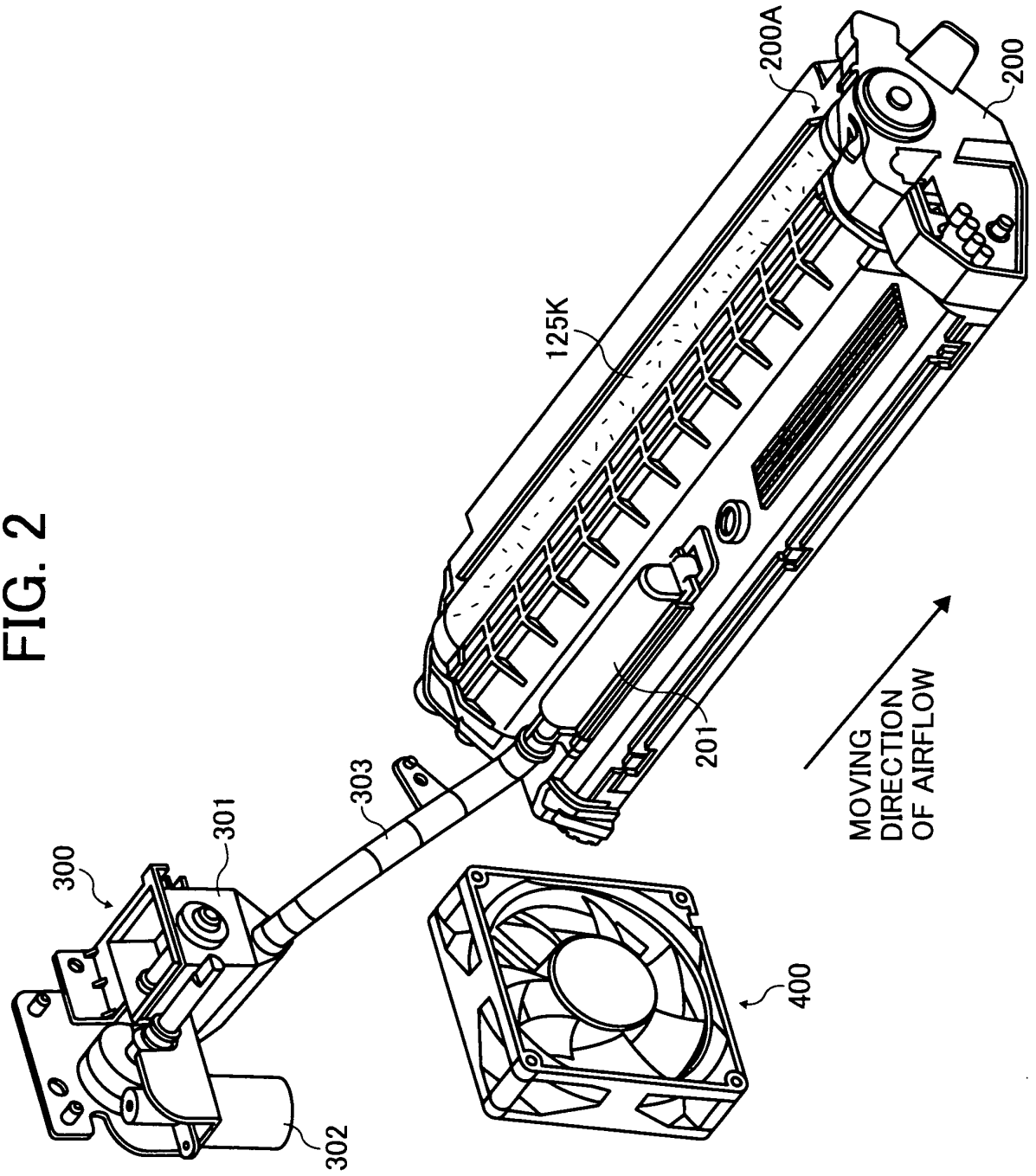

200A
200
125K
201
303
301
300
302
400
MOVING
DIRECTION
OF AIRFLOW

FIG. 3

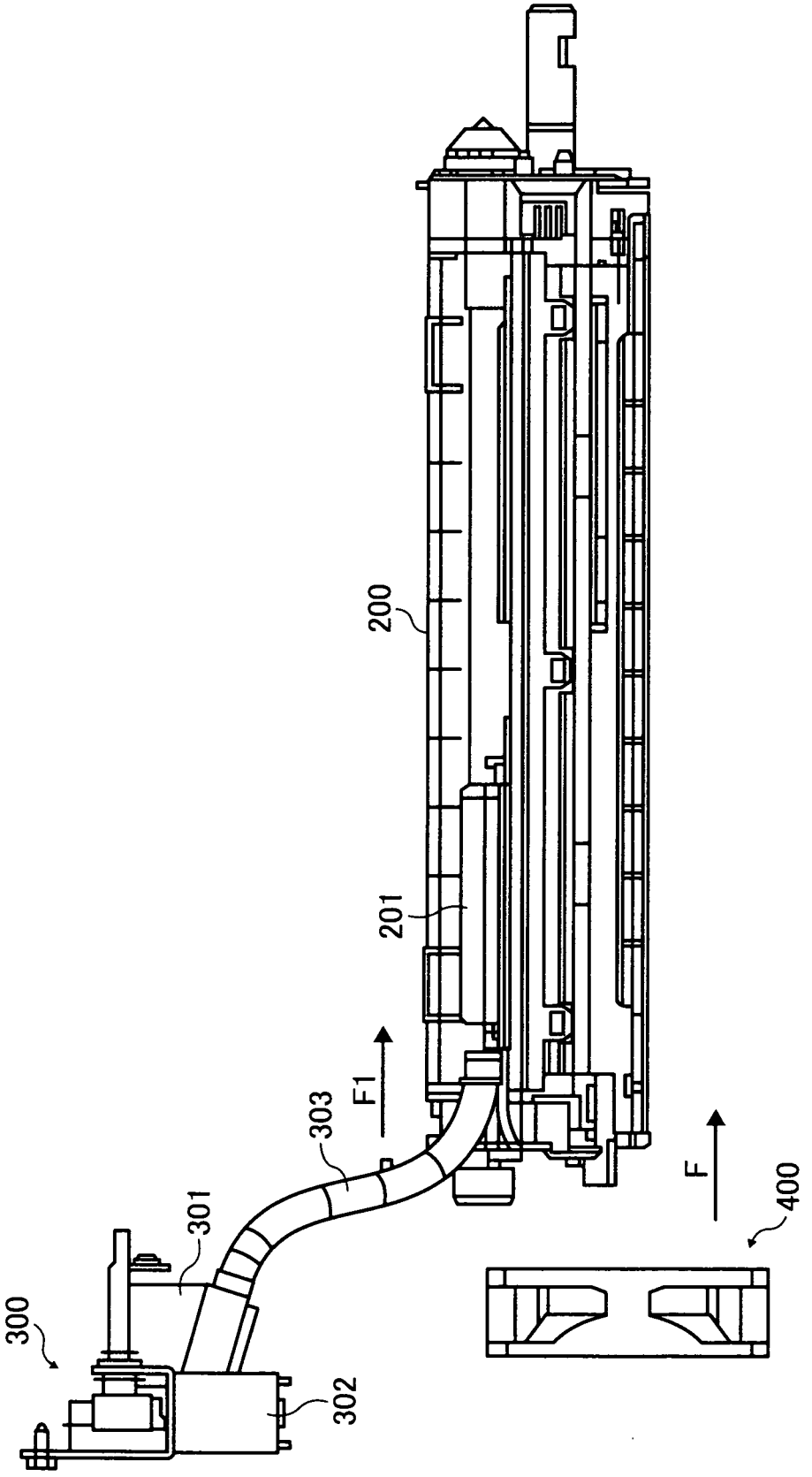


FIG. 4

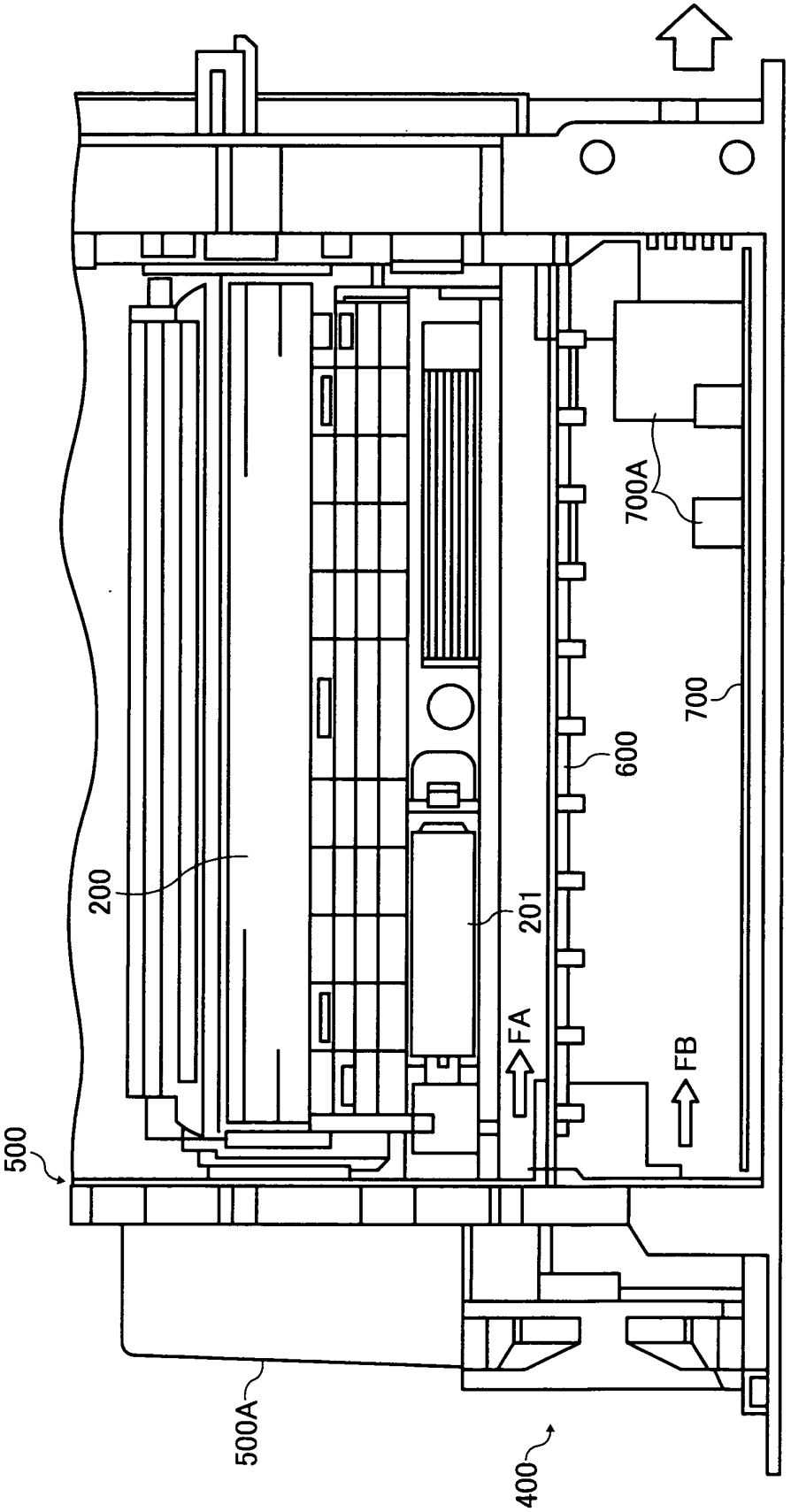


FIG. 5A

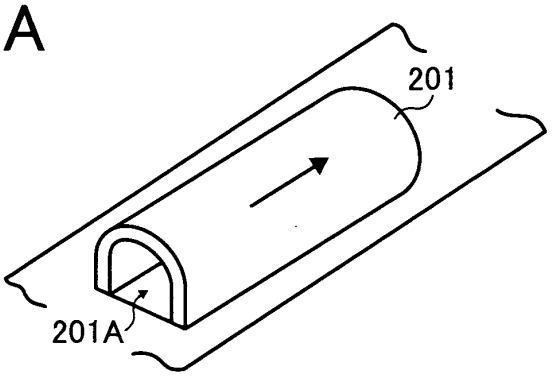


FIG. 5B

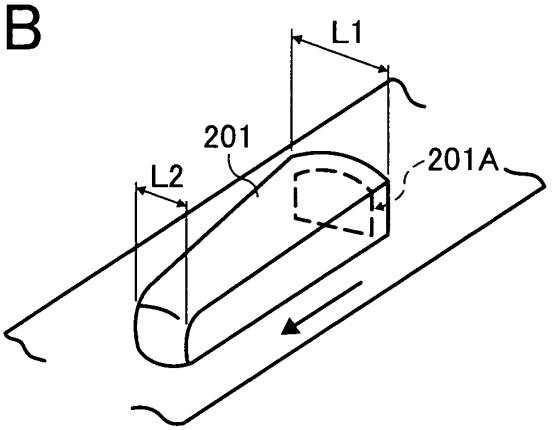


FIG. 5C

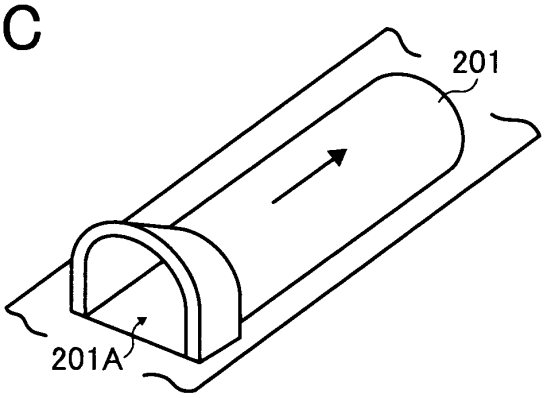


FIG. 5D

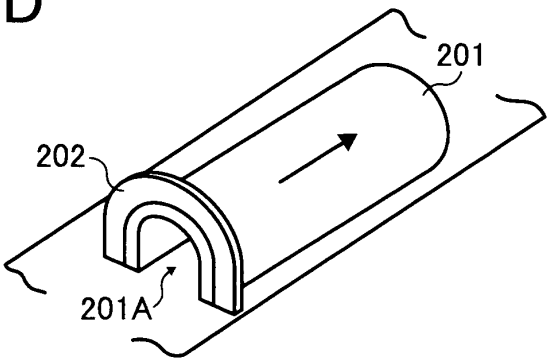


FIG. 6

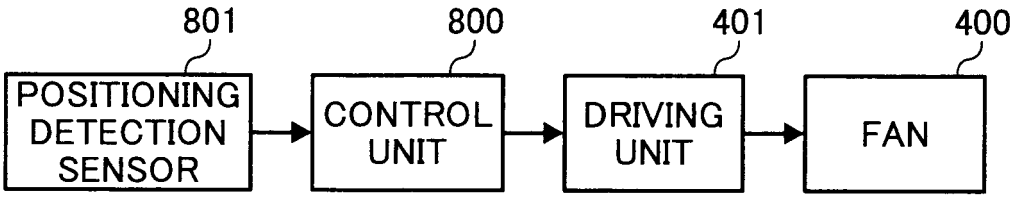

801
800
401
400
POSITIONING DETECTION SENSOR
CONTROL UNIT
DRIVING UNIT
FAN

FIG. 7

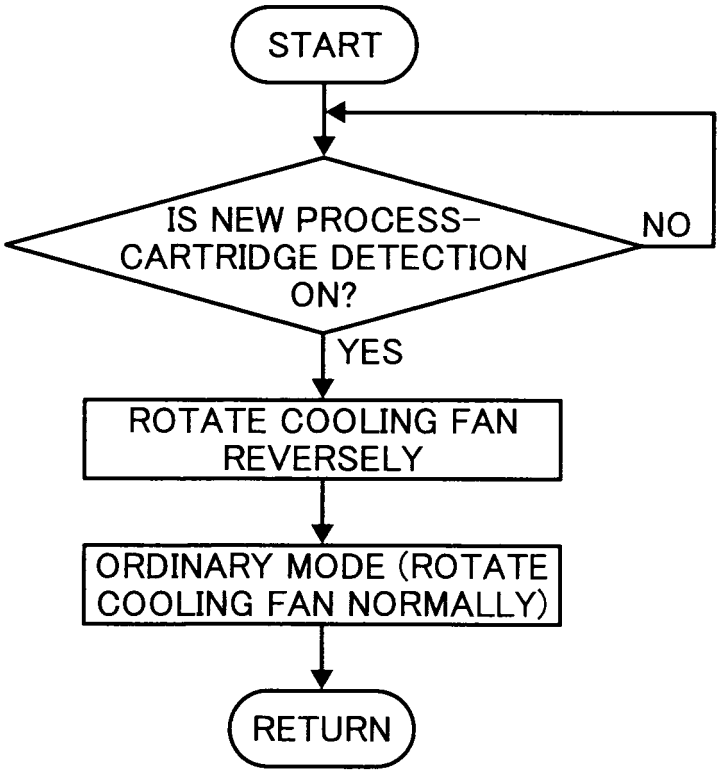
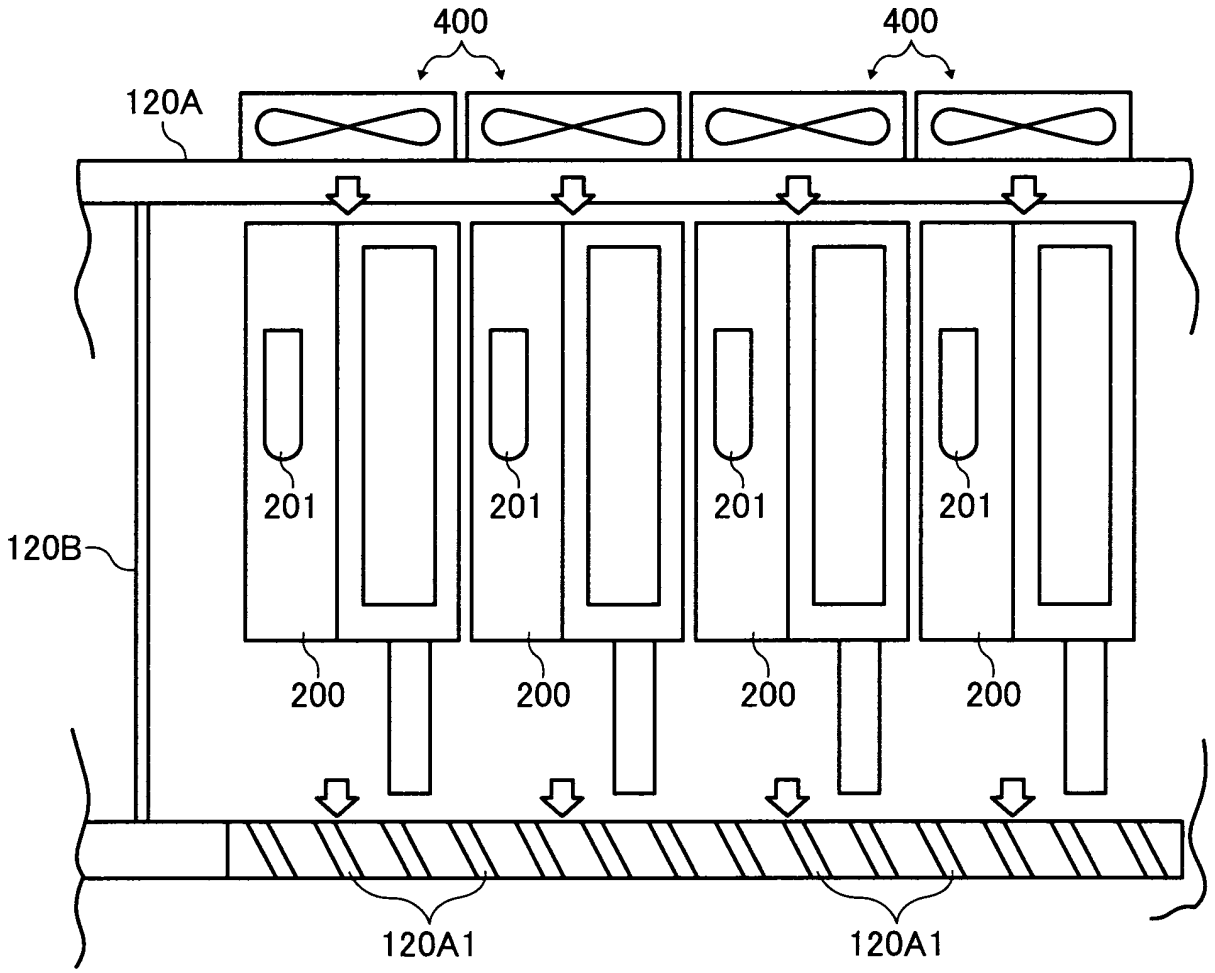

START
IS NEW PROCESS-CARTRIDGE DETECTION ON?
NO
YES
ROTATE COOLING FAN REVERSELY
ORDINARY MODE (ROTATE COOLING FAN NORMALLY)
RETURN

FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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- JP 2004271703 A **[0005]**
- JP 2005173226 A **[0009]**
- JP 2004109868 A **[0009]**
- JP 2002278268 A **[0009]**
- JP H1091228 B **[0009]**
- JP 2004139031 A **[0010]**