



US 20050133980A1

(19) **United States**(12) **Patent Application Publication****Koga**(10) **Pub. No.: US 2005/0133980 A1**(43) **Pub. Date:****Jun. 23, 2005**(54) **SHEET FEEDING APPARATUS AND IMAGE FORMING APPARATUS**(75) Inventor: **Hiroto Koga, Abiko-shi (JP)**

Correspondence Address:

**FITZPATRICK CELLA HARPER & SCINTO
30 ROCKEFELLER PLAZA
NEW YORK, NY 10112 (US)**(73) Assignee: **CANON KABUSHIKI KAISHA,
TOKYO (JP)**(21) Appl. No.: **11/000,989**(22) Filed: **Dec. 2, 2004**(30) **Foreign Application Priority Data**

Dec. 5, 2003 (JP) 2003-407026

Publication Classification(51) **Int. Cl.⁷ B65H 1/08; B65H 3/14**(52) **U.S. Cl. 271/97**(57) **ABSTRACT**

A middle plate for piling a sheet bundle is provided elevatably. A duct opened to the side surface of the upper part of the sheet stack supported on the middle plate. A vacuuming belt for vacuuming and feeding the uppermost sheet of the sheet stack supported on the middle plate is provided. A first height detecting means for detecting the uppermost part of the sheet stack supported on the middle plate reaching a first position and a second height detecting means for detecting the uppermost part of the sheet stack supported on the middle plate reaching a second position higher than the first position are provided. At the time the uppermost surface of the sheet stack supported on the middle plate is detected by the first height detecting means, the controller stops the middle plate and commands the air blowing operation from the duct opening, and then at the time the uppermost surface of the sheet bundle is detected by the second height detecting means according to the middle plate raising operation, it commands the vacuuming and feeding operation of the uppermost sheet by the vacuuming belt.

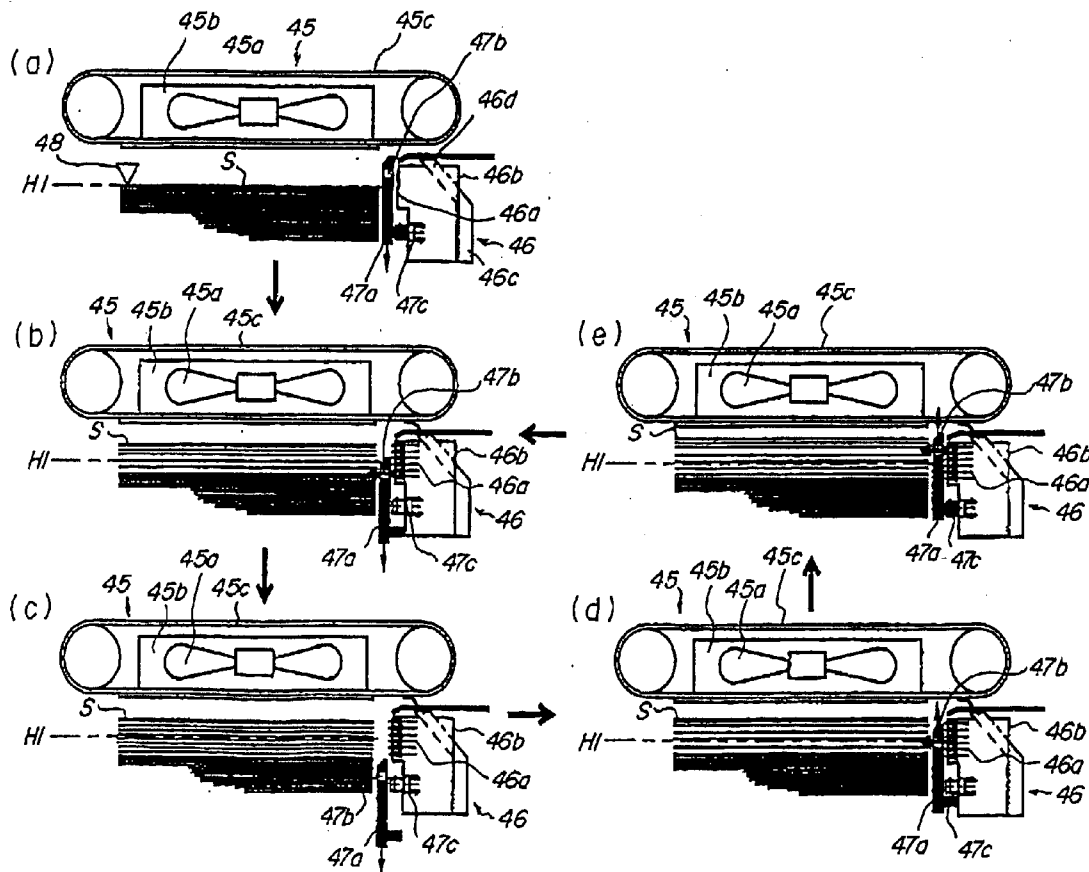


FIG. 1

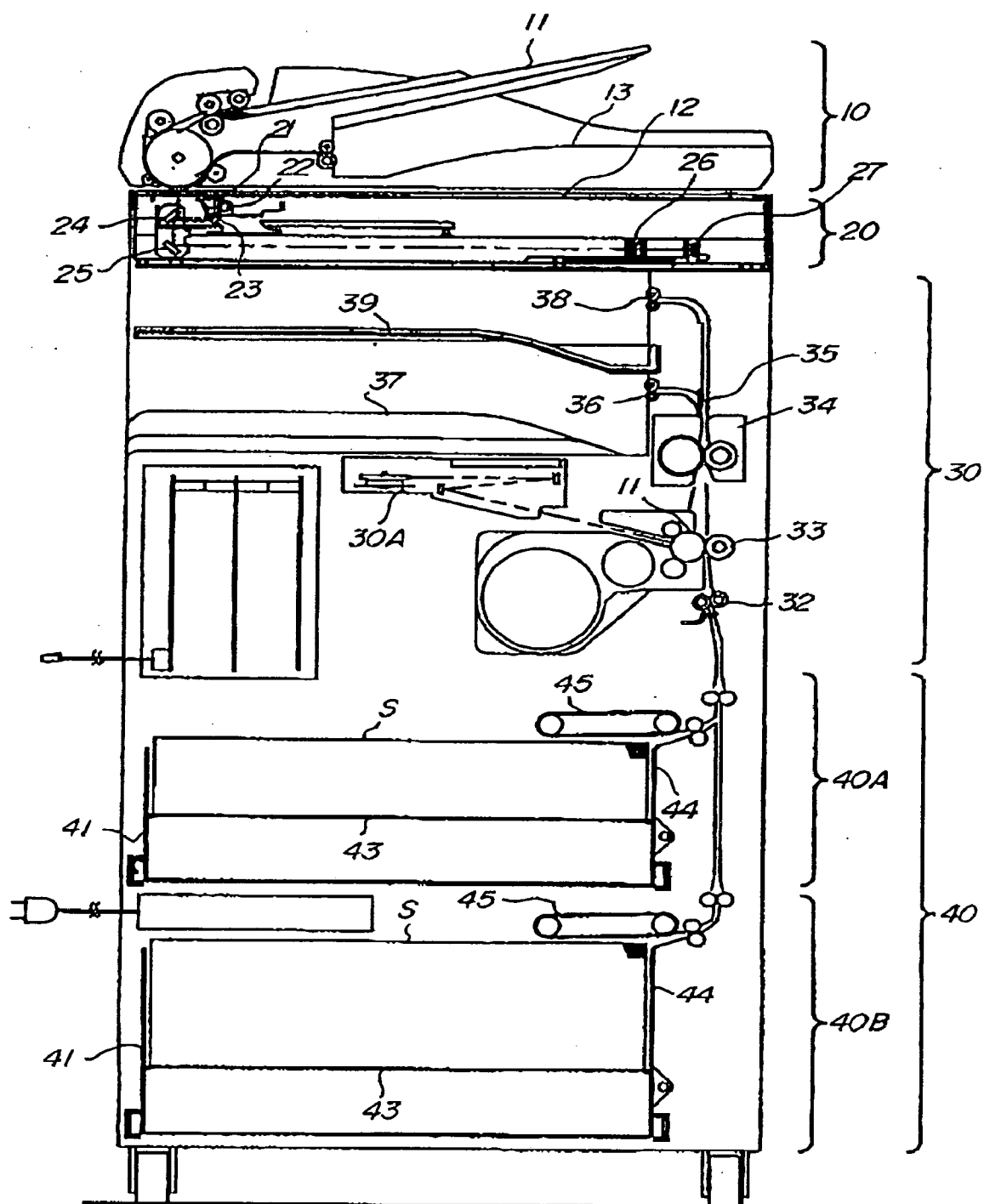


FIG. 2

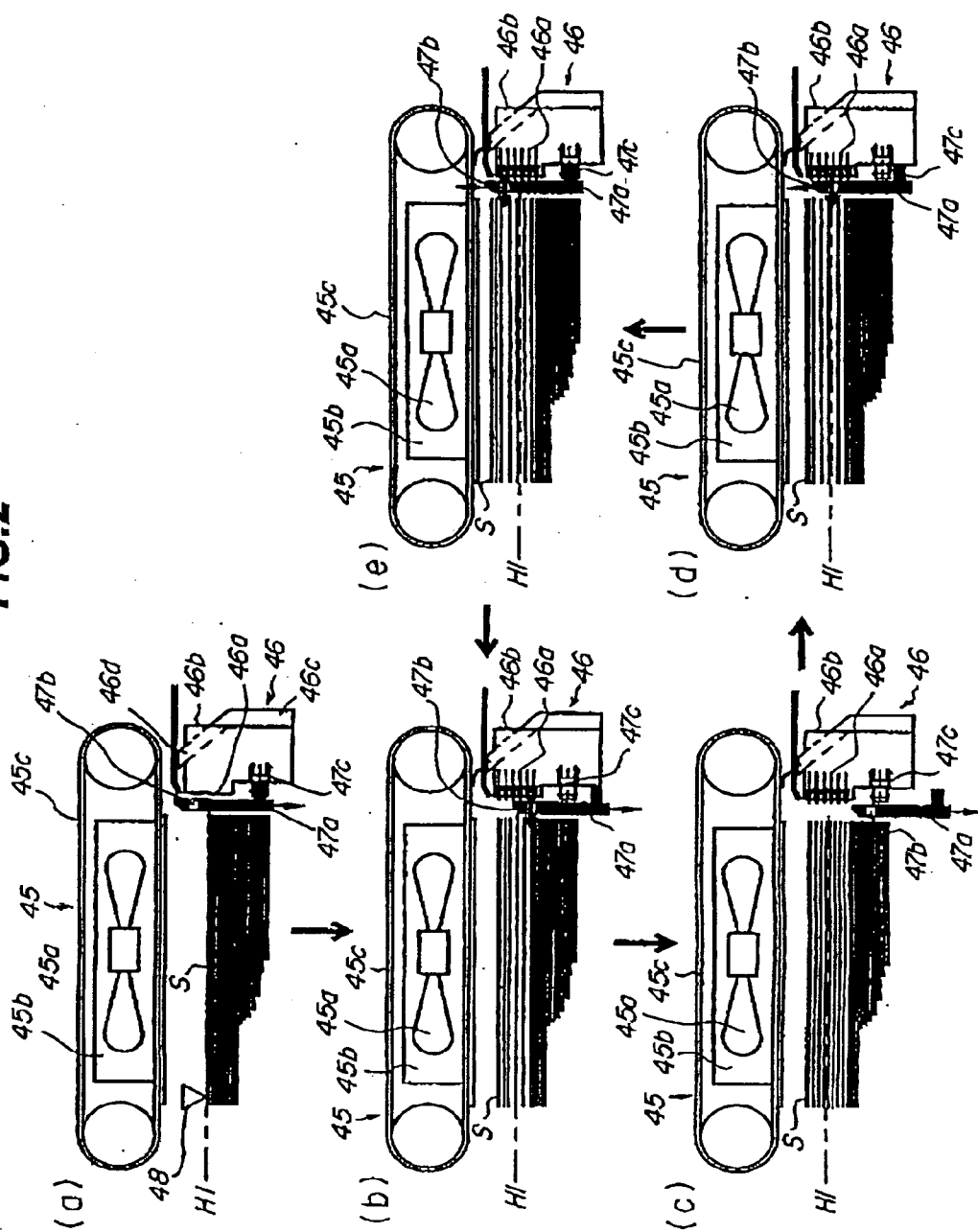


FIG. 3

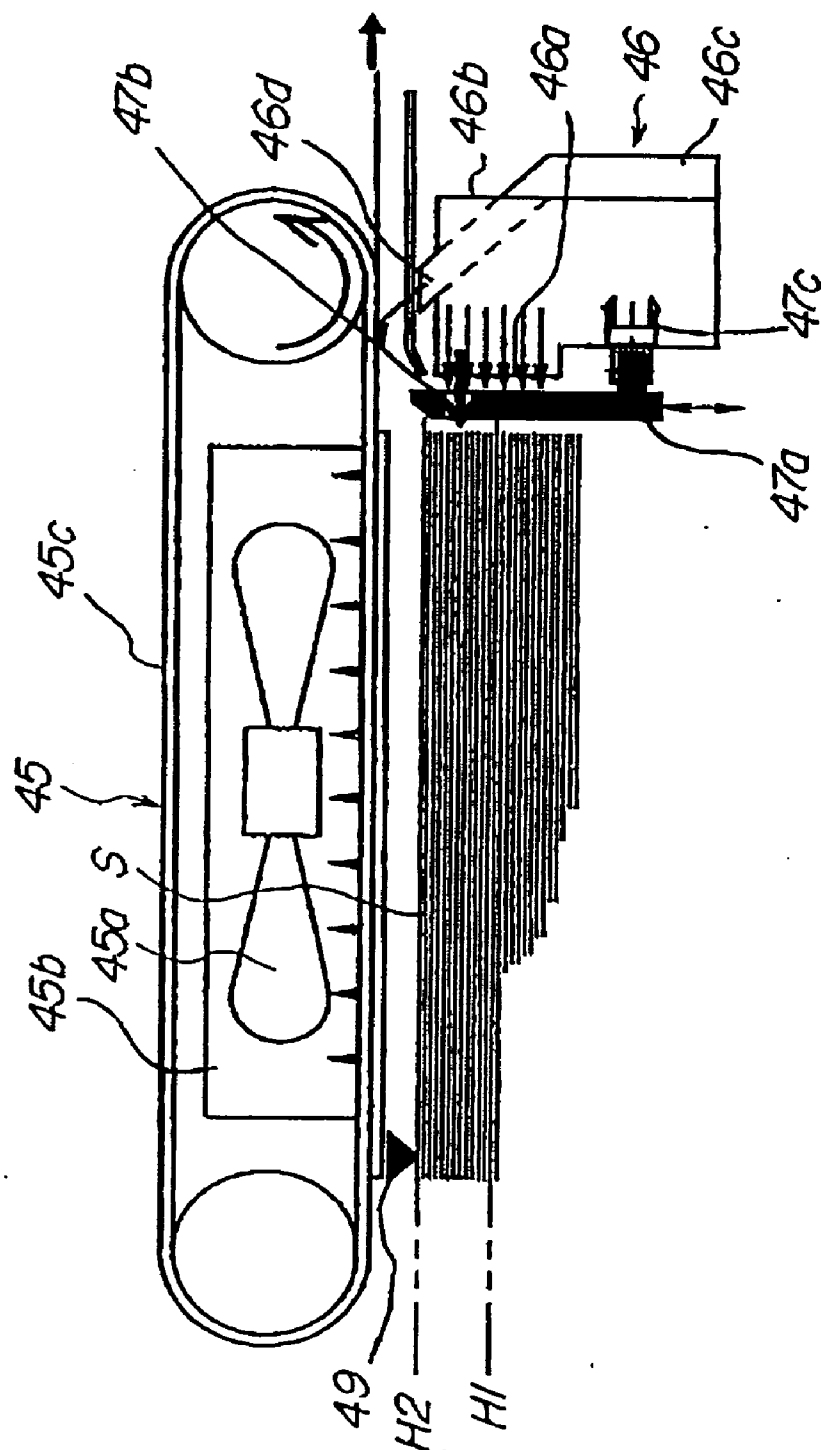


FIG. 4

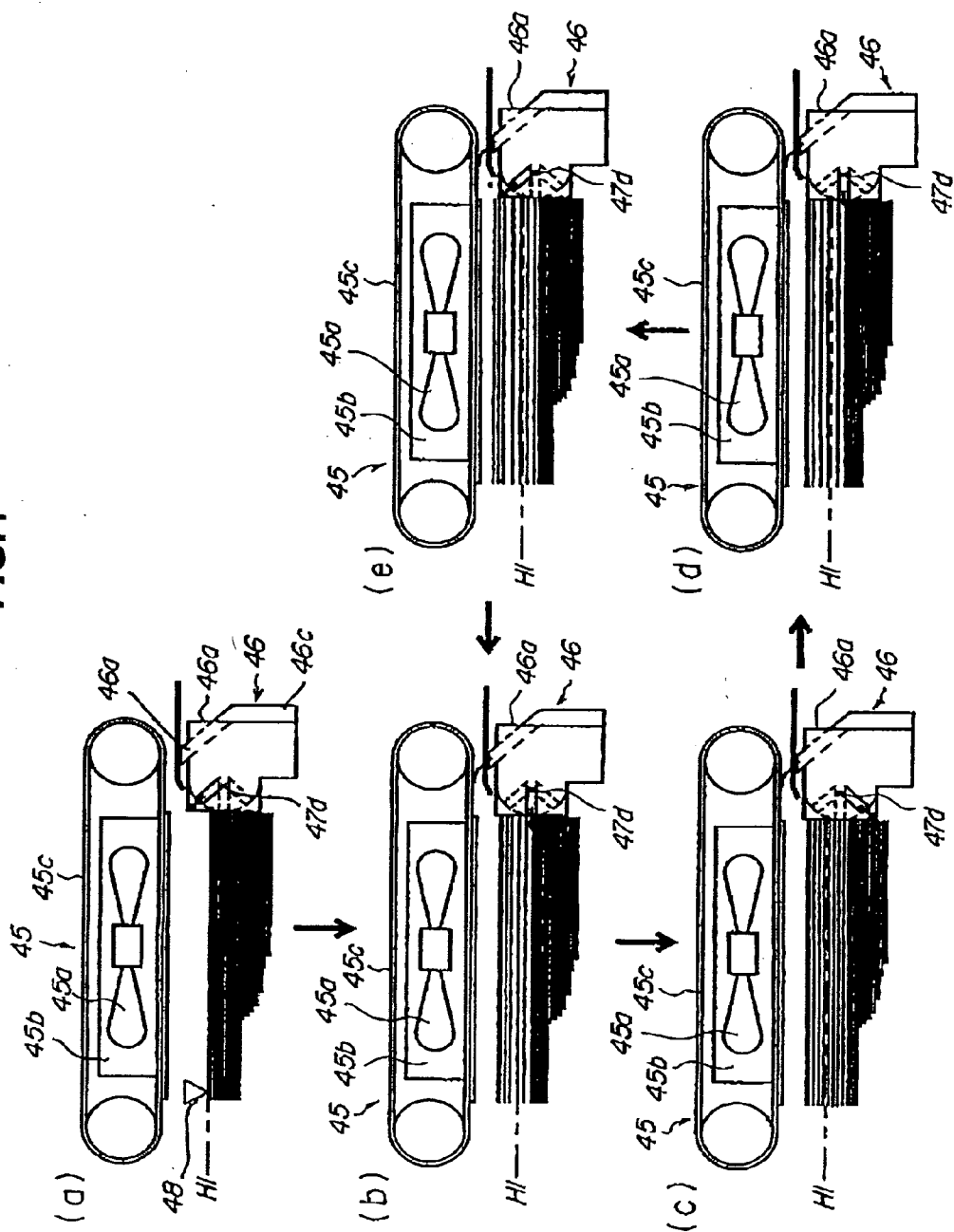


FIG. 5

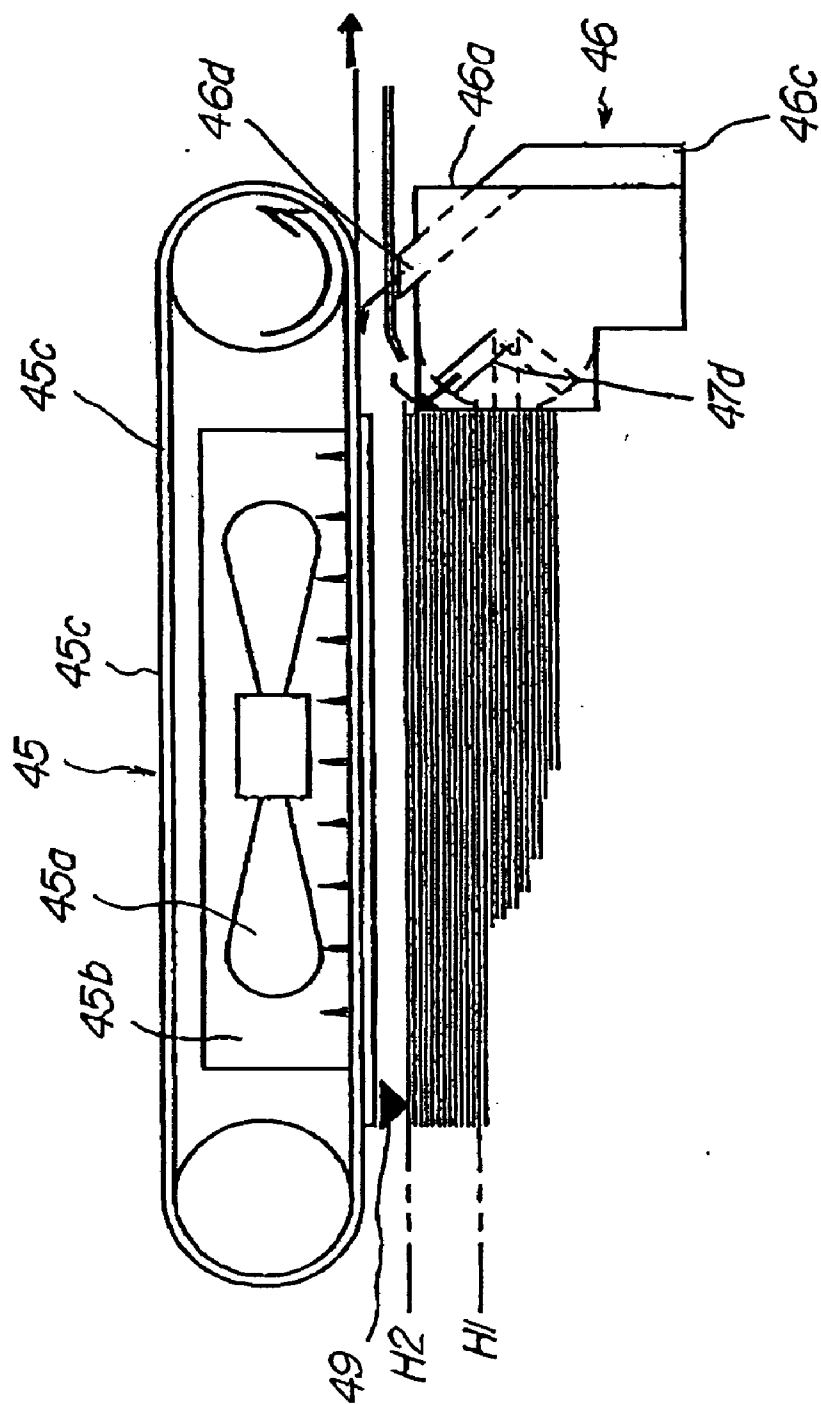


FIG. 6

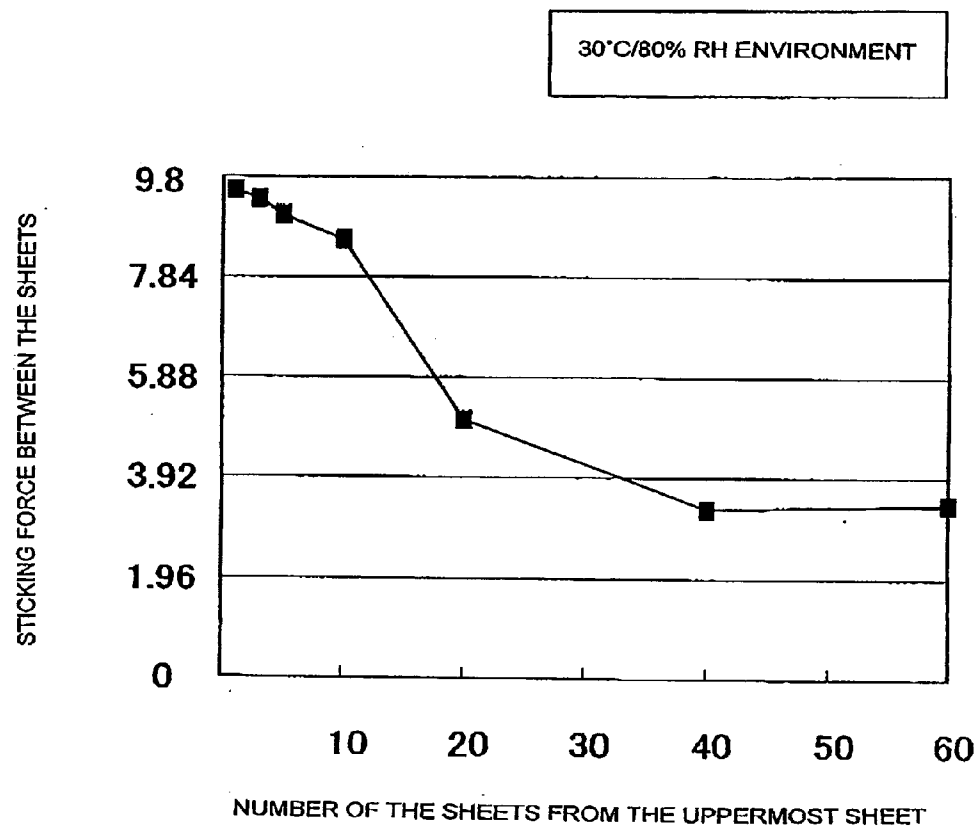


FIG.7

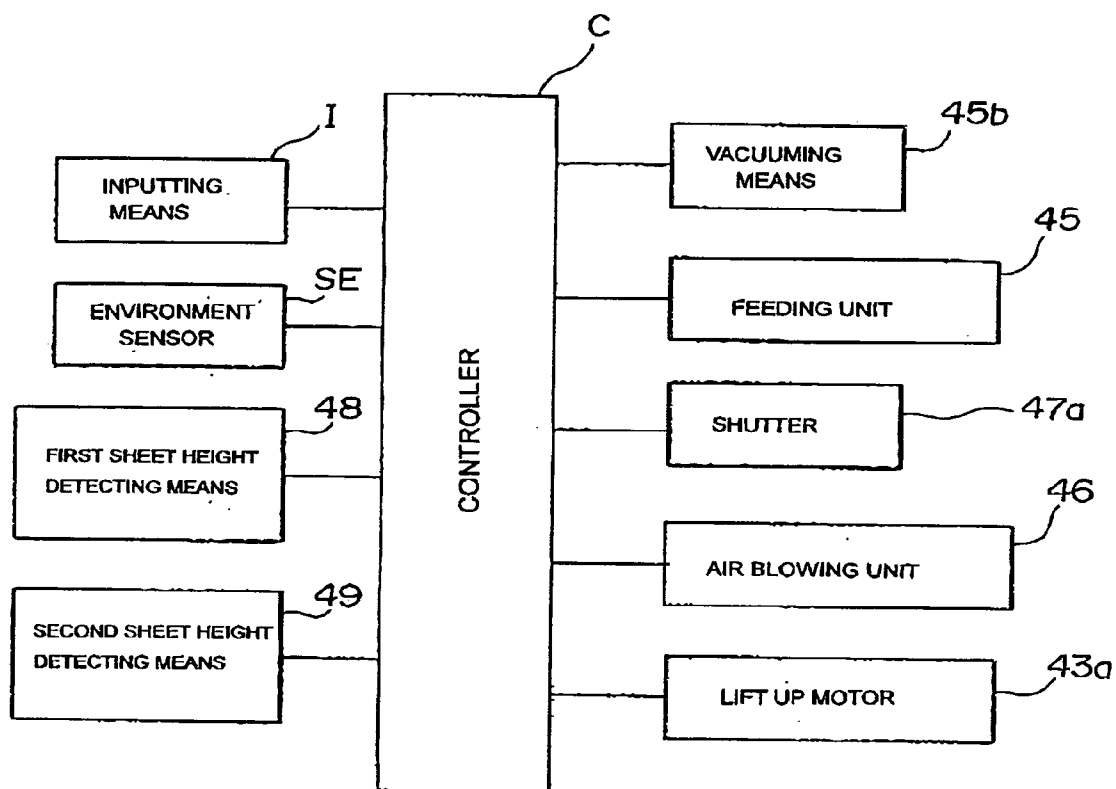
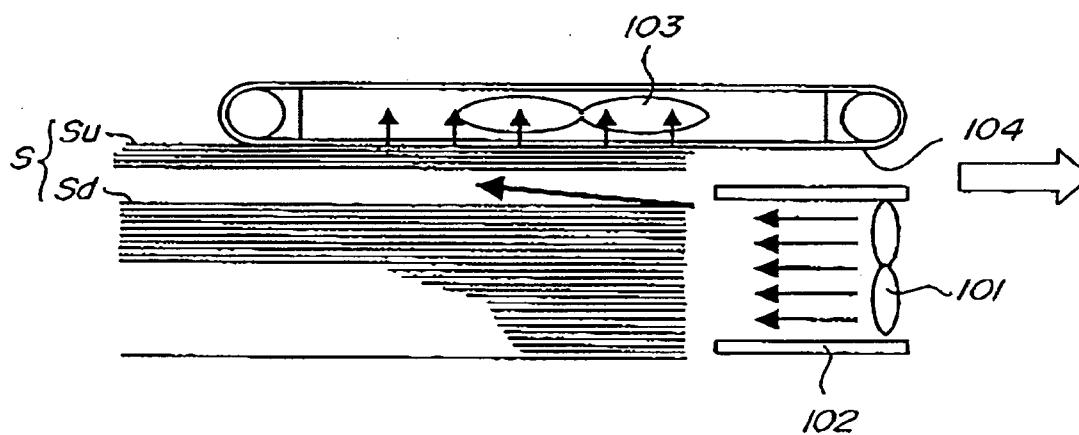


FIG. 8



SHEET FEEDING APPARATUS AND IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a sheet feeding apparatus for separating and feeding the uppermost sheet of a sheet stack, in particular, it relates to a sheet feeding apparatus to be used for an image forming apparatus such as a copying machine, a printer and a facsimile equipment.

[0003] 2. Description of the Related Art

[0004] Conventionally, according to the image forming apparatus such as a copying machine and a printer, cut sheet to be fed continuously have been limited to in general good quality paper or plain paper designated by the copying machine manufacturer. Since the sheets have a low surface smoothness and a low air permeability, air can easily be introduced between the sheets. Therefore, sticking of the sheets and generation of superimposition can hardly be generated at the time of taking out the sheets one by one from the stacked sheets.

[0005] However, recently, according to the variation of the recording media, in addition to the thick papers, the OHP papers, the tracing papers, or the like, from the demand for the colors from the market, image formation on the sheets having a smooth surface such as art papers, coat papers, with a coating process applied on the sheet surface for providing the whiteness and the glossiness has been more and more required. However, since the OHP papers, the tracing papers, the art papers, the coat papers, or the like have a high smoothness and a high air permeability, particularly in the case of piling the above-mentioned sheets in a high humidity environment, the sheets stick with each other. In the case the sheets stick with each other, a problem is involved in that superimposition and feeding error are generated frequently according to the friction separation method commonly used in the conventional image forming apparatus such as a copying machine and a printer.

[0006] On the other hand, those of the air feeding method of separating and feeding one by one from the upper sheet by a vacuuming device and a feeding belt disposed above while separating a sheet bundle by blowing the air from the side surface of a sheet stack supported and stored in an image forming apparatus at the same time have been adopted in the printing industry and a part of the copying machines, or the like. According to the air feeding method, compared with the friction separation method, there are advantages such as (1) a wide setting latitude of the feeding conditions with respect to various sheets of different materials, (2) capability of high speed feeding, (3) a high durability, and (4) a low running cost.

[0007] A number of proposals have been given for the air feeding. For example, a paper feeding apparatus disclosed for example in the official gazette of the Japanese Patent Application Laid Open (JP-A) No. 62-249835 can be presented. According to the paper feeding apparatus, a method of blowing the air in the direction parallel to the sheet upper surface by an air blowing device onto the sheet top end side surface supported on a paper feeding stand and at the same time having the vacuuming cylinder opened above the sheets in a negative pressure by a negative pressure generating

device for vacuuming is proposed. According to the paper feeding apparatus, the sheets are separated by lifting the uppermost sheets from the sheets stacked on the paper feeding stand by the vacuuming function from the opening and blowing the air from the air blowing device into the gap formed between the uppermost sheet and the next sheet.

[0008] However, as mentioned above, since the sheets of the OHP papers, the tracing papers, the art papers, the coat papers, or the like have a high smoothness and a high air permeability, particularly in the case the sheets are stacked in a high humidity environment, the sheets stick with each other. Here, in the case the air feeding method is adopted, since the air blown from the side surface of the sheet bundle is a constant flow, the sheet bundle in the upper part may be lifted on the sheet bundle in the lower part out of the sheet bundle at the interface of the sheets with a relatively weak sticking force. Therefore, the sheet bundle in the upper part lifted on the sheet bundle in the lower part cannot have the air introduction between the sheets (gaps) in the sheet bundle so that it has been extremely difficult to certainly separate the uppermost sheet one by one.

[0009] FIG. 7 is an explanatory diagram for the conventional air feeding method. According to the air feeding method shown in FIG. 7, the uppermost sheet is vacuumed by a vacuuming belt 104 by the vacuuming static pressure of a vacuuming fan 103 disposed above while blowing the air from a blowing fan 101 via duct 102 to the upper part side surface of a sheet stack S disposed at a predetermined position (a position capable of feeding the uppermost surface of the sheet bundle) so as to be fed by driving the vacuuming belt 104. However, according to the conventional configuration, since the blowing air for separating the sheet bundle is blown to the sheet bundle at the predetermined position simultaneously with the vacuuming operation by the vacuuming fan, and furthermore, the above-mentioned blowing air is a constant flow as shown in FIG. 7, the air introduced between several to several tens of the sheets stuck with each other relatively weakly from the upper part of the sheet bundle S so that the upper part sheet bundle Su with respect to the sheets with the air introduction is lifted above the lower part sheet bundle Sd, and thus it is difficult to certainly separate the uppermost sheet one by one.

SUMMARY OF THE INVENTION

[0010] The present invention has been achieved in view of the above-mentioned problems, and an object thereof is to provide a sheet feeding apparatus capable of certainly releasing sticking of the sheets in a simple configuration for preventing generation of the feeding error or the superimposition in the air feeding method, which is superior in terms of the compatibility to the sheet materials, the high speed feeding, the high durability, or the like. Furthermore, it is to improve the miniaturization of the apparatus, reduction of the product cost and the running cost, and the reliability.

[0011] In order to achieve the above-mentioned object, the present invention provides a sheet feeding apparatus comprising:

[0012] A sheet supporting means for moving the uppermost surface of a sheet stack to a predetermined position,

- [0013] An air blowing means having a duct for blowing the air from a direction substantially perpendicular to the side surface of the uppermost part of the sheet stack supported on the above-mentioned sheet supporting means, and
- [0014] A sheet feeding means for vacuuming and feeding the uppermost sheet supported on the above-mentioned sheet supporting means by vacuuming the air,
- [0015] Wherein the above-mentioned air blowing means blows the air to the uppermost part of the sheet stack supported on the above-mentioned sheet supporting means at a first position which the uppermost sheet of the sheet stack is faced to an opening of the above-mentioned air blowing means, and the above-mentioned uppermost sheet is vacuumed and fed by the above-mentioned sheet feeding means at a second position above the above-mentioned first position.
- [0016] Moreover, the present invention provides a sheet feeding apparatus comprising:
- [0017] A middle plate provided elevatably which supports sheet stack,
- [0018] A duct opened to the side surface of a upper part of the sheet stack supported on the above-mentioned middle plate, and said duct blows from a opening of the duct to the said surface of a upper part of the sheet stack,
- [0019] A vacuuming belt for vacuuming and feeding a uppermost sheet of the sheet stack supported on the above-mentioned middle plate by vacuuming the air,
- [0020] A first height detecting means for detecting the uppermost part of the sheet stack supported on the above-mentioned middle plate reaching a first position,
- [0021] A second height detecting means for detecting the uppermost sheet of the sheet stack supported on the above-mentioned middle plate reaching a second position higher than the above-mentioned first position,
- [0022] And a controller for commanding the execution of the air blowing operation of the above-mentioned duct when the uppermost surface of the sheet stack supported on the above-mentioned middle plate is detected by the above-mentioned first height detecting means, and commanding the execution of the feeding operation of the above-mentioned vacuuming belt when the uppermost surface of the sheet bundle raised by the elevation of the middle plate is detected by the above-mentioned second height detecting means.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0023] FIG. 1 is a schematic cross sectional view of a copying machine comprising a sheet feeding apparatus according to an embodiment of the present invention.
- [0024] FIG. 2 is a schematic cross sectional view of a sheet feeding apparatus according to a first embodiment.

[0025] FIG. 3 is a schematic cross sectional view of the sheet feeding apparatus according to the first embodiment.

[0026] FIG. 4 is a schematic cross sectional view of a sheet feeding apparatus according to a second embodiment.

[0027] FIG. 5 is a schematic cross sectional view of the sheet feeding apparatus according to the second embodiment.

[0028] FIG. 6 is a graph for explaining the sticking force between the sheets in the case of coat papers under a high humidity environment.

[0029] FIG. 7 is a block diagram of the embodiment.

[0030] FIG. 8 is a schematic cross sectional view for explaining the conventional air feeding configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0031] Hereinafter, with reference to the drawings, preferable embodiments of the present invention will be explained in detail. However, the size of the component parts, the material, the shape, the relative arrangement thereof, or the like disclosed in the following embodiments can optionally be changed according to the configuration and the various conditions of an apparatus with the present invention applied, and thus the scope of the present invention is not limited thereby.

[0032] (Entire Configuration)

[0033] FIG. 1 is a cross sectional view showing the principal part configuration of an embodiment of a copying machine as an image forming apparatus comprising a sheet feeding apparatus according to the present invention.

[0034] As shown in FIG. 1, the copying machine comprises an image reader 20 as an image reading part for reading a document image, a printer 30 as an image forming part for recording the image on a sheet, and a sheet feeding part 40 capable of separating and feeding the sheet one by one. The sheet feeding part 40 comprises paper decks 40A, 40B as a sheet feeding device having a common sheet feeding mechanism. The paper deck 40

[0035] A can store 1,000 sheets and the paper deck 401B can store 1,500 sheets, and the paper decks 40A, 40B have the same configuration. The sheet feeding part 40 will be explained later in detail.

[0036] A document feeding device 10 is mounted in the image reader 20. The document feeding device 10 feeds a document with the image surface set upward on a document tray 11 one by one from the top page in the leftward direction in the figure via a curved path on a platen glass 12 from the left side to the rightward direction through a flow reading position, and then discharges the same onto an outside discharging tray 13. At the time the document passes the flow reading position on the platen glass 12 from the left side to the right side, the document image is read out by a scanner unit 21 supported at a position corresponding to the flow reading position. The reading method is a method in general called the document flow reading. Specifically, at the time the document passes by the flow reading position, the document reading surface is irradiated by the light beam of a lamp 22 of the scanner unit 21 so that the light beam reflected from the document is guided to a lens 26 via mirror

23, 24, 25. The light beam passes through the lens **26** is focused onto an imaging surface of an image sensor **27**.

[0037] Accordingly, by feeding the document from the left side to the right side so that it passes by the flow reading position, a document reading scan with the direction perpendicular to the document feeding direction provided as the main scanning direction and the feeding direction provided as the sub scanning direction is executed. That is, by feeding the document in the sub scanning direction while reading the document image per each line in the main scanning direction by the image sensor **27** at the time of having the document pass by the flow reading position, the entire document image is read out so that the image optically read out is converted to an image data by the image sensor **27** so as to be outputted. The image data outputted from the image sensor **27** are inputted to an exposure control part **30A** of the printer **30** as a video signal after applying a predetermined process at an unshown image signal control part.

[0038] It is also possible to read out the document by scanning with the scanner unit **21** from the left side to the right side in a state with the document fed onto the platen glass **12** by the document feeding device **10** so as to be stopped at a predetermined position. The reading method is a method so called the document fixed reading.

[0039] In the case of reading the document without using the document feeding device **10**, first, the document feeding device **10** is opened and closed by a user for placing the document onto the platen glass **12**. Then, the document is read out by scanning with the scanner unit **21** from the left side to the right side. That is, at the time of reading out the document without using the document feeding device **10**, the document fixing reading is executed.

[0040] The exposure control part **30A** of the printer **30** modulates and outputs a laser beam based on the inputted video signal so that the laser beam is directed onto a photosensitive drum **31** while being scanned by a polygon mirror. An electrostatic latent image is formed on the photosensitive drum **31** according to the scanned laser beam. Here, the exposure control part **30A** outputs a laser beam so as to form a correct image (an image, which is not a mirror image) at the time of the document fixing reading.

[0041] The electrostatic latent image on the photosensitive drum **31** is visualized as a developing agent image by a developing agent supplied from an unshown developer. Moreover, a sheet is fed selectively from the paper decks **40A, 40B** as the sheet feeding device to be described later at a timing synchronously with the start of the laser beam irradiation so that the sheet is fed between the photosensitive drum **31** and a transfer part **33** by a resist roller pair **32**. The developing agent image formed on the photosensitive drum **31** is transferred onto the sheet fed by the transfer part **33**.

[0042] The sheet with the developing agent image transferred is fed to a fixing part **34** so that the fixing part **34** fixes the developing agent image on the sheet by heating and pressuring the sheet. The sheet passed through the fixing part **34** is discharged onto a first discharging tray **37** via a first discharging roller **36** or onto a second discharging tray **39** via a second discharging roller **38** according to the changeover of a flap **35**.

[0043] Next, the paper decks of the air feeding method as the sheet feeding device according to the present invention

will be explained in detail with reference to the embodiments. Although the numbers of the sheets to be stored in the paper decks differ, since the other configuration is same, the paper deck **40A** will be explained in the following description and the same, numerals are applied to the members having the same function of the paper deck **40B** so as to omit the explanation.

First Embodiment

[0044] **FIGS. 2, 3** are schematic cross sectional view for explaining the operation of the paper deck **40A** of the air feeding method in the first embodiment. The paper deck **40A** has a sheet stack supported and stored on a middle plate **43** provided in a storage bank **41** as a sheet supporting means. The sheet stack **S** supported and stored in the storage bank **41** has the top end part thereof limited by a pre-separation plate **44** and the rear end part and the side end parts limited each by an unshown rear end limiting plate and side limiting plates at a predetermined position.

[0045] A feeding unit **45** as a sheet feeding means for vacuuming and feeding by the air the uppermost sheet of the sheet stack **S** supported on the above-mentioned middle plate **43** is provided above the sheet stack supported and stored on in the storage bank **41**. The feeding unit **45** comprises a vacuuming means **45a** capable of generating a vacuuming static pressure, such as a fan and a vacuuming duct **45b**. Furthermore, a vacuuming belt **45c** comprising a large number of holes, surrounding the vacuuming duct **45b**, is provided rotatably in the sheet feeding direction.

[0046] Moreover, an air blowing unit **46** as an air blowing means, comprising a duct for blowing the air from the direction substantially perpendicular to the side surface of the upper part of the sheet stack **S** supported on the above-mentioned middle plate **43** is provided on the top end side of the sheet stack supported and stored in the storage bank **41**.

[0047] Next, with reference to **FIG. 2**, the configuration and the operation of the air blowing unit **46** provided on the top end side of the sheet stack will be explained in detail. The installation of the air blowing unit **46** is not limited to the sheet bundle top end side, but it can be installed optionally at any sheet bundle side surface. However, according to the experiment of the present inventor, relatively good results are obtained in terms of the separation performance at the time it is installed at the sheet feeding direction top end side. Moreover, in the case in particular the image formation reference position is at the center of the sheet feeding direction and various sheet sizes need to be dealt with, a simpler configuration can be provided compared with the case of installing the air blowing unit on the side limiting plate side, and thus it is advantageous.

[0048] In **FIG. 2**, the air blowing unit **46** as the air blowing means is provided on the sheet bundle top end side. The air blowing unit **46** comprises the blowing duct **46b** having an unshown blowing fan, and a duct opening **46a** interlocked with the blowing fan and opened toward the side surface of the sheet stack supported and stored in the storage bank **41**. Moreover, an air blowing speed varying means for changing the air blowing speed blown out from the above-mentioned air blowing unit **46** is provided between the above-mentioned air blowing unit **46** and the sheet bundle top end side. The air blowing speed varying means according to this

embodiment is a shutter **47a** movable in the substantially perpendicular direction between the sheet bundle side surface and the duct opening **46a**, comprising a slit **47b** having a width substantially smaller than the width of the duct opening **46a** in a part thereof. That is, the shutter **47a** functions as a channel moving means for moving the channel of the air blown out from the duct opening **46a** of the above-mentioned air blowing unit **46** in the substantially perpendicular direction in the vicinity of the sheet bundle side surface. Moreover, a detecting means **47c** for detecting the position at the time the shutter **47a** is at the uppermost part in the moving direction.

[0049] FIG. 7 is a control block diagram of this embodiment.

[0050] To the controller, the material and the size of the sheets to be piled on the paper decks **40A**, **40B** are inputted by an user from an inputting means **I**. Moreover, the temperature, the humidity, or the like inside and outside the storage bank **41** are inputted from an environment sensor **SE**. Furthermore, a detection signal of the upper surface of the sheet bundle **S** is inputted from a first sheet height detecting means **48** and a second sheet height detecting means **49** to be described later. Then, based on the information, the controller **C** carries out the elevation control of the middle plate **43** by a lift up motor **43a** (shown in FIG. 7), the sheet feeding control by the feeding unit **45**, the drive control of the shutter **47a**, the air blowing control of the air blowing unit **46**, or the like.

[0051] Next, the sheet separation feeding operation in the above-mentioned paper deck **40A** will be explained in detail. In the case the sheet bundle is set in the storage bank **41** of the paper deck **40A** and the paper deck **40A** is inserted into the image forming apparatus main body, the middle plate **43** is lifted up by the lift up motor **43a** to a pre-separation height (first height) **H1** set by a first sheet height detecting means **48** (see FIG. 2A) for executing the pre-separation operation to be described below. As shown in FIG. 2A, the pre-separation height as the first position is a position at which the uppermost surface of the sheet stack **S** supported on the middle plate **43** in the storage bank **41** is in the width range in the vertical direction of the above-mentioned blowing duct **46b**. At the pre-separation height **H1** as the first position, first, the unshown blowing fan is operated so as to blow the air from the duct opening **46a** toward the sheet bundle side surface. Here, the shutter **47a** has the drive transmission from an unshown driving source so as to be moved reciprocally in the substantially vertical direction between the sheet bundle side surface and the blowing duct opening **46a**. First, the shutter **47a** is moved downward and the slit **47b** is moved accordingly. Here, at the time the slit **47b** is at the duct opening **46a**, the air blowing speed passing through the slit **47b** is increased by the difference between the slit width and the duct opening width. The air passed through the slit **47b** with the height air blowing speed is blown continuously to the sheet bundle side surface while moving downward (see FIGS. 2B, 2C). At the time the shutter **47a** is reached at the lowermost point in the moving direction shown in FIG. 2C, then it starts the upward movement (see FIG. 2D) so as to move to the uppermost point again in the moving direction while blowing the air continuously to the sheet bundle side surface in the same manner (see FIG. 2C). Since the air with the height air blowing speed blown from the slit **47b** formed in the shutter

47a to the sheet bundle side surface can be blown by a plurality of times toward the sheet bundle upper part by repeating the reciprocal motion of FIGS. 2B to 2E, a certain sheet separation effect can be expected without lifting up of the sheet bundle upper part by the air of the constant flow to be blown out directly as in the case of the conventional duct opening.

[0052] The number of the reciprocal motion and the moving speed of the shutter **47a** in the above-mentioned pre-separation operation can be set optionally by the material and the size of the sheet, and the environmental conditions. Here, the present inventor collected the sticking force data between the sheets as to the coat paper to be stuck easily at a high humidity (temperature 30° C./humidity 80%). Results are shown in FIG. 6. As it is apparent from FIG. 6, the sticking force between the sheets is maximally about 9.8N at the sheet bundle uppermost part and it tends to be lowered gradually toward the lower part. From the results, since the separation ability in the conventional friction separation method is about 0.98N at most, it is apparent that separation cannot be carried out thereby. Moreover, it is apparent that the sheets are lifted up at a part with a relatively weak sticking force between the sheets at about 10 sheets from the uppermost sheets so as to easily generate superimposition at which the sheet surface height is close to the vacuuming belt according to the above-mentioned conventional air feeding method. Accordingly, since the sticking force between the sheets is high at the uppermost part of the sheet bundle, it is effective to execute the vacuuming feeding operation by the feeding unit **45** to be described later after executing the above-mentioned pre-separation operation at the first position (pre-separation height) to have the uppermost surface of the sheet stack **S** in the range in the vertical direction of the blowing duct **46b** before the sheet feeding operation by the vacuuming feeding as in this embodiment.

[0053] Next, as shown in FIG. 3, after executing the above-mentioned pre-separation operation, the middle plate **43** is lifted up by the lift up motor **43a** such that the uppermost surface of the sheet stack reaches at the feeding sheet surface height (second position) **H2** to be detected by the second sheet height detecting means **49** so as to execute the sheet feeding operation by the feeding unit **45**. As shown in FIG. 3, the feeding sheet surface height **H2** as the second position is a position for operating the above-mentioned feeding unit **45** (the vacuuming means **45b** and the vacuuming belt **45c**) above the first position. By starting the vacuuming operation by the upper vacuuming means **45a** and driving and rotating the vacuuming belt **45c** at the feeding sheet surface height **H2** as the second position, a preferable separation feeding operation can be carried out certainly for each sheet from the uppermost sheet of the sheet bundle after the above-mentioned pre-separation operation. Moreover, the separation duct **46c** interlocked with an unshown separation fan supplies the separation air toward the vacuuming belt **45c** through the duct opening **46d** from the sheet feeding direction downstream side. Although the separation air is effective for vacuuming only the uppermost sheet by the vacuuming belt **45c** and then separating and dropping the following sheets, the configuration without the separation air may be employed as well.

[0054] The timing of the air blowing operation by the above-mentioned air blowing unit **46** to be carried out while reciprocally moving the shutter **47a** having the above-

mentioned slit **47b** is not limited to the pre-separation operation at the first position but also it can be operated while the uppermost surface of the above-mentioned sheet bundle is moved between the above-mentioned first position **H1** and the above-mentioned second position **H2** or it is at the second position **H2**. That is, the air blowing operation can be carried out by the above-mentioned air blowing unit **46** while reciprocally moving the shutter **47a** having the above-mentioned slit **47b** during the sheet feeding operation after the above-mentioned pre-separation operation.

[0055] As heretofore explained, according to this embodiment, since the pre-separation height (first position) **H1** is set in the reciprocal movement range of the slit **47b** of the shutter **47** having a high sheet separation effect (in the range of the vertical direction width of the duct opening **46a**) and the sheet bundle separated sufficiently is moved to the feeding sheet surface height (second position) **H2** above the pre-separation height **H1** for vacuuming and feeding the sheets, even in the case of a bundle of special sheets such as a coat paper of a material different from a plain paper, or the like, that is, a bundle of sheets having a relatively high sticking force between the sheets, the stickiness can be released by certainly introducing the air between the sheets. Thereby, according to the air feeding method superior in terms of the compatibility to the sheet materials, the high speed feeding, the high durability or the like, a sheet feeding apparatus capable of certainly releasing the stickiness between the sheets in a simple configuration and preventing generation of the feeding error and the superimposition can be provided.

[0056] Furthermore, since it has a simple configuration of executing the pre-separation operation by the blowing air of the air blowing unit **46** at the first position **H1** with the uppermost surface of the sheet stack in the vertical direction width range of the duct opening **46a** and the vacuuming feeding operation by the feeding unit **45** at the second position **H2** above the first position **H1**, the sheets can be separated and fed certainly in a simple configuration without the need of additionally providing new parts of the bulkiness of the apparatus, or increasing the parts cost or the running cost so as to improve the reliability.

[0057] Although the case of having the initial position of the shutter **47a** at the uppermost position in the moving direction has been explained above, it is not limited thereto and thus it can be provided at an optional position. Moreover, the vacuuming means **45a** or the unshown blowing fan may be a fan such as a sirocco fan, a compressor, or the like.

[0058] Moreover, in order to further improve the separation effect during continuous feeding according to the conditions such as the environment and the material, it is also possible to provide the control of temporarily stopping the sheet feeding operation even in the case there is a remaining feeding job at the time of a continuous feeding job of a certain number or more sheets, moving the uppermost surface of the sheet stack from the feeding sheet surface height **H2** to the pre-separation height **H1** by lowering the middle plate **43**, and again lifting the same up to the feeding sheet surface height **H2** after executing the pre-separation operation so as to execute the remaining feeding job.

Second Embodiment

[0059] The second embodiment of the present invention will be explained with reference to **FIGS. 4, 5**. As to the

numerals in the figures, the same numerals are applied to the same elements as in the above-mentioned first embodiment, and the explanation is omitted here.

[0060] This embodiment comprises a swing nozzle **47d** capable of rotating the sheet bundle upper side end part in the vertical direction in the blowing duct **46b** provided on the sheet bundle top end side. The swing nozzle **47d** is an air direction varying means for changing the orientation of the air blown out from the air blowing unit **46** such as a blowing fan, which executes the pre-separation operation for the sheet bundle lifted up to the pre-separation height (first position) **H1** as in the first embodiment. The above-mentioned swing nozzle **47d** blows the air to the sheet bundle side surface while changing the orientation thereof from the initial position (upward) shown in **FIG. 4A** to substantially horizontally, downward, substantially horizontally, upward (in the order of **FIGS. 4B** to **4E**). Since the air blowing operation is executed while vertically rotating the swing nozzle **47d**, the air with the air orientation changed continuously can be provided to the sheet bundle, the effect of separating the sheets stuck with each other or the sheets piled slightly displaced with each other by introducing the air is extremely high. The number of the reciprocal operation or the moving speed of the swing nozzle **47d** by the pre-separation operation can be set optionally according to the material and the size of the sheets and the environmental conditions.

[0061] After executing the above-mentioned pre-separation operation, like the above-mentioned first embodiment, as shown in **FIG. 5**, the middle plate **43** is lifted up by the lift up motor **43a** until the feeding sheet surface height (second position) **H2** with the uppermost surface of the sheet stack detected by the second sheet height detecting means **49** so as to execute the sheet feeding operation by the feeding unit **45**. As shown in **FIG. 5**, the feeding sheet surface height **H2** as the second position is a position for operating the above-mentioned feeding unit **45** (vacuuming means **45a** and the vacuuming belt **45c**) above the first position **H1**. At the feeding sheet surface position height **H2** as the second position, the vacuuming means **45a** provided above starts the vacuuming operation and the vacuuming belt **45c** is driven and rotated so as to execute certainly a preferable separation feeding operation for each sheet from the uppermost sheet of the sheet bundle after the above-mentioned pre-separation operation. Moreover, the separation duct **46c** interlocked with an unshown separation fan supplies the separation air from the sheet feeding direction downstream side through the duct opening **46d** toward the vacuuming belt **45c**. Although the separation air is effective for vacuuming only the uppermost sheet by the vacuuming belt **45c** and then separating and dropping the following sheets, the configuration without the separation air may be employed as well.

[0062] The timing of the air blowing operation by the above-mentioned air blowing unit **46** to be carried out while rotating the above-mentioned swing nozzle **47d** is not limited to the pre-separation operation, but also it can be operated while at least the uppermost surface of the above-mentioned sheet bundle is between the above-mentioned first position **H1** and the above-mentioned second position **H2**. That is, the air blowing operation can be carried out by the above-mentioned air blowing unit **46** while rotating the

swing nozzle 47d during the sheet feeding operation after the above-mentioned pre-separation operation.

[0063] As heretofore explained, also according to this embodiment, since the pre-separation height (first position) H1 is set in the duct swing operation range of the swing nozzle 47d having a high sheet separation effect (in the range of the vertical direction width of the duct opening 46a) and the sheet bundle separated sufficiently is moved to the feeding sheet surface height (second position) H2 above the pre-separation height H1 for vacuuming and feeding the sheets, even in the case of a bundle of special sheets such as a coat paper of a material different from a plain paper, or the like, that is, a bundle of sheets having a relatively high sticking force between the sheets, the stickiness can be released by certainly introducing the air between the sheets. Thereby, according to the air feeding method superior in terms of the compatibility to the sheet materials, the high speed feeding, the high durability, or the like, a sheet feeding apparatus capable of certainly releasing the stickiness between the sheets in a simple configuration and preventing generation of the feeding error and the superimposition can be provided.

[0064] Furthermore, since it has a simple configuration of executing the pre-separation operation by the blowing air of the air blowing unit 46 at the first position H1 with the uppermost surface of the sheet stack in the vertical direction width range of the duct opening 46a and the vacuuming feeding operation by the feeding unit 45 at the second position H2 above the first position H1, the sheets can be separated and fed certainly in a simple configuration without the need of additionally providing new parts of the bulkiness of the apparatus, or increasing the parts cost or the running cost so as to improve the reliability.

[0065] Although the case of having the initial position of the swing nozzle 47d at the uppermost position (upward) in the moving direction has been explained above, it is not limited thereto and thus it can be provided at an optional position. Moreover, the vacuuming means 45a or the unshown blowing fan may be a fan such as a sirocco fan, a compressor, or the like.

[0066] Moreover, in order to further improve the separation effect during continuous feeding according to the conditions such as the environment and the material, it is also possible to provide the control of temporarily stopping the sheet feeding operation even in the case there is a remaining feeding job at the time of a continuous feeding job of a certain number or more sheets, moving the uppermost surface of the sheet stack from the feeding sheet surface height H2 to the pre-separation height H1 by lowering the middle plate 43, and again lifting the same up to the feeding sheet surface height H2 after executing the pre-separation operation so as to execute the remaining feeding job.

Other Embodiments

[0067] Although an example of the shutter (channel moving means) 47a having the slit 47b in a part has been explained as the air blowing speed varying means for changing the air blowing speed to be blown out from the air blowing means in the above-mentioned embodiment, it is not limited thereto. For example, one having the air supplied from the air supply source of the blowing air increased or reduced by the on/off changeover, or an air blocking means

capable of blocking or opening the air channel provided inside the blowing duct opening 46a can be adopted as well. In any case, by setting the pre-separation height (first position) H1 in the opening width (in the vertical direction width range) of the blowing duct opening 46a for executing the pre-separation operation thereat, the sheets can be separated certainly at the feeding sheet surface height (second position) H2 above the pre-separation height.

[0068] Moreover, although the cases of providing the positions of the blowing duct 46b and the shutter 47a, the positions of the blowing duct 46b and the swing nozzle 47d at the sheet bundle side surface top end part have been explained in the above-mentioned embodiments, it is not limited thereto, and an optional position at the sheet bundle side surface can be used as well.

[0069] Furthermore, although the configuration of providing the air blowing means only at the sheet bundle side surface top end part has been explained, it is not limited thereto, and as needed, it can be disposed at a plurality of points facing the sheet bundle side surface. Moreover, it is also possible to use in a combination with the air blowing speed varying means or the air pressure varying means explained in the above-mentioned first and second embodiments.

[0070] Moreover, although the example of the sheet feeding apparatus having only the air feeding method has been explained as the sheet feeding mechanism for separating and feeding the sheets, a configuration having another separating means can be adopted as well.

[0071] Furthermore, although the case of a copying machine has been explained as the image forming apparatus in the above-mentioned embodiments, the present invention is not limited thereto, and for example, another image forming apparatus such as a scanner, a printer and a facsimile equipment, another image forming apparatus such as a composite machine combining the functions thereof, an image forming apparatus using a transfer material supporting member for successively superimposing and transferring toner images of various colors onto a transfer material supported by the transfer material supporting member, or an image forming apparatus using an intermediate transfer member, successively superimposing and transferring toner images of various colors onto the intermediate transfer member, and transferring the toner images supported by the intermediate transfer member onto a transfer material collectively may be adopted as well. By adopting the present invention to the sheet feeding apparatus used in the image forming apparatus, the same effect can be obtained.

[0072] Moreover, although the example of the sheet feeding apparatus provided integrally in the image forming apparatus has been explained in the above-mentioned embodiments, the present invention is not limited thereto, and by adopting the present invention to the sheet feeding apparatus, the same effect can be obtained.

[0073] Furthermore, although the example of the sheet feeding apparatus for separating and feeding the sheets of a plain paper, a coat paper, or the like as the recording subject has been explained in the above-mentioned embodiments, the present invention is not limited thereto. For example, by adopting the present invention to the sheet feeding apparatus for feeding the documents (sheets) of a plain paper, an OHP

paper, or the like as the reading subject to an image reading part, the same effect can be obtained.

[0074] Moreover, although the example of the electron photography method has been explained as the recording method in the above-mentioned embodiments, it is not limited thereto. For example, another recording method such as an ink jet method can be used as well.

[0075] This application claims priority from Japanese Patent Application No. 2003-407026 filed Dec. 5, 2003, which is hereby incorporated by reference herein.

1. A sheet feeding apparatus comprising:

sheet supporting means for moving the uppermost surface of a sheet stack to a predetermined position,

air blowing means having a duct for blowing the air from a direction substantially perpendicular to the side surface of the uppermost part of the sheet stack supported on the sheet supporting means, and

sheet feeding means for vacuuming and feeding the uppermost sheet of the sheet stack supported on the sheet supporting means by vacuuming the air,

wherein the air blowing means blows the air to the uppermost part of the sheet stack supported on the sheet supporting means at a first position which the uppermost sheet of the sheet stack is faced to an opening of the all blowing means, and the uppermost sheet is vacuumed and fed by the sheet feeding means at a second position above the first position.

2. The sheet feeding apparatus according to claim 1, wherein the feeding operation is stopped temporarily after the continuous feeding operation of a predetermined number of sheets at the second position for moving the uppermost sheet of the sheet stack to the first position, and after operating the air blowing means for a predetermined time, the uppermost sheet is moved again to the second position for resuming the feeding operation.

3. The sheet feeding apparatus according to claim 1, further comprising an air blowing speed varying means for changing the air blowing speed blown out from the air blowing means.

4. The sheet feeding apparatus according to claim 3, wherein the sheet feeding means is operated for vacuuming and feeding the uppermost sheet after moving from the first position to the second position after operating the air blowing means and the air speed varying means at the first position for a predetermined time.

5. The sheet feeding apparatus according to claim 4, wherein the feeding operation is stopped temporarily after the continuous feeding operation of a predetermined number of sheets at the second position for moving the uppermost sheet of the sheet stack to the first position, and after operating the air blowing means and the air blowing speed varying means for a predetermined time, the uppermost sheet is moved again to the second position for resuming the feeding operation.

6. The sheet feeding apparatus according to claim 3, wherein the air blowing means and the air blowing speed varying means can be operated also at the time the uppermost sheet of the sheet stack supported on the sheet supporting means is between the first position and the second position.

7. The sheet feeding apparatus according to claim 3, wherein the air blowing speed varying means is a channel moving means for moving the air channel blown out from the air blowing means in the substantially vertical direction in the vicinity of the sheet stack side surface.

8. The sheet feeding apparatus according to claim 3, wherein the air blowing speed varying means increases or reduces the air supply from the air supply source of the air blowing means.

9. The sheet feeding apparatus according to claim 3, wherein the air blowing speed varying means is an air blocking means for blocking or opening the air channel from the air blowing means.

10. The sheet feeding apparatus according to claim 1, further comprising an air orientation varying means for changing the air orientation blown out from the air blowing means.

11. The sheet feeding apparatus according to claim 10, wherein the sheet feeding means is operated at the second position above the first position for vacuuming and feeding the uppermost sheet after operating the air blowing means and the air orientation varying means for a predetermined time at the first position.

12. The sheet feeding apparatus according to claim 11, wherein the feeding operation is stopped temporarily after the continuous feeding operation of a predetermined number of sheets at the second position for moving the uppermost sheet of the sheet stack to the first position, and after operating the air blowing means and the air orientation varying means for a predetermined time, the uppermost sheet is moved again to the second position for resuming the feeding operation.

13. A sheet feeding apparatus comprising:

a middle plate provided elevatably which supports sheet stack,

a duct opened to the side surface of a upper part of the sheet stack supported on the middle plate, and said duct blows out the air from a opening of the duct to the side surface of a upper part of the sheet stack,

a vacuuming belt for vacuuming and feeding a uppermost sheet of the sheet stack supported on the middle plate by vacuuming the air,

first height detecting means for detecting the uppermost sheet of the sheet stack supported on the middle plate reaching a first position,

second height detecting means for detecting the uppermost sheet of the sheet stack supported on the middle plate reaching a second position higher than the first position, and

a controller for commanding the execution of the air blowing operation of the duct when the uppermost surface of the sheet stack supported on the middle plate is detected by the first height detecting means, and commanding the execution of the feeding operation of the vacuuming belt when the uppermost surface of the sheet stack raised by the elevation of the middle plate is detected by the second height detecting means.

14. The sheet feeding apparatus according to claim 13, further comprising a shutter having a slit, vertically movably between the duct opening and the sheet stack such that the

shutter is controlled by the controller so as to be moved vertically at the time the air is blown out from the duct opening.

15. The sheet feeding apparatus according to claim 13, further comprising a swing nozzle to be rotated vertically in the duct such that the air is blown out from the swing nozzle at the time the uppermost surface of the sheet stack is detected by the first height detecting means.

16. An image forming apparatus comprising:

an image forming unit for forming an image on a sheet, and

the sheet feeding apparatus according to any of claims 1 to 15, for separating and feeding sheets one by one to the image forming unit.

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