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(54) **SHEET DISCHARGING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SHEET DISCHARGING DEVICE**

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(57) **ABSTRACT**

In a sheet discharging unit including a pair of sheet discharge rollers which discharges a sheet P, the outer diameter of a sheet discharge drive roller included in the pair of sheet discharge rollers is set so that the outer diameter of a straight portion which is a central portion in the width direction perpendicular to the discharging direction of the sheet P is larger than the outer diameters of both end portions in the width direction. Further, in the sheet discharging unit, the pair of sheet discharge rollers respectively include metal shafts extending in the width direction and elastic layers respectively wound around the metal shafts and continuously formed to be longer in the width direction than the width of a sheet P with a passable maximum size. Further, at least one elastic layer of the pair of sheet discharge rollers is formed of a foamed material.

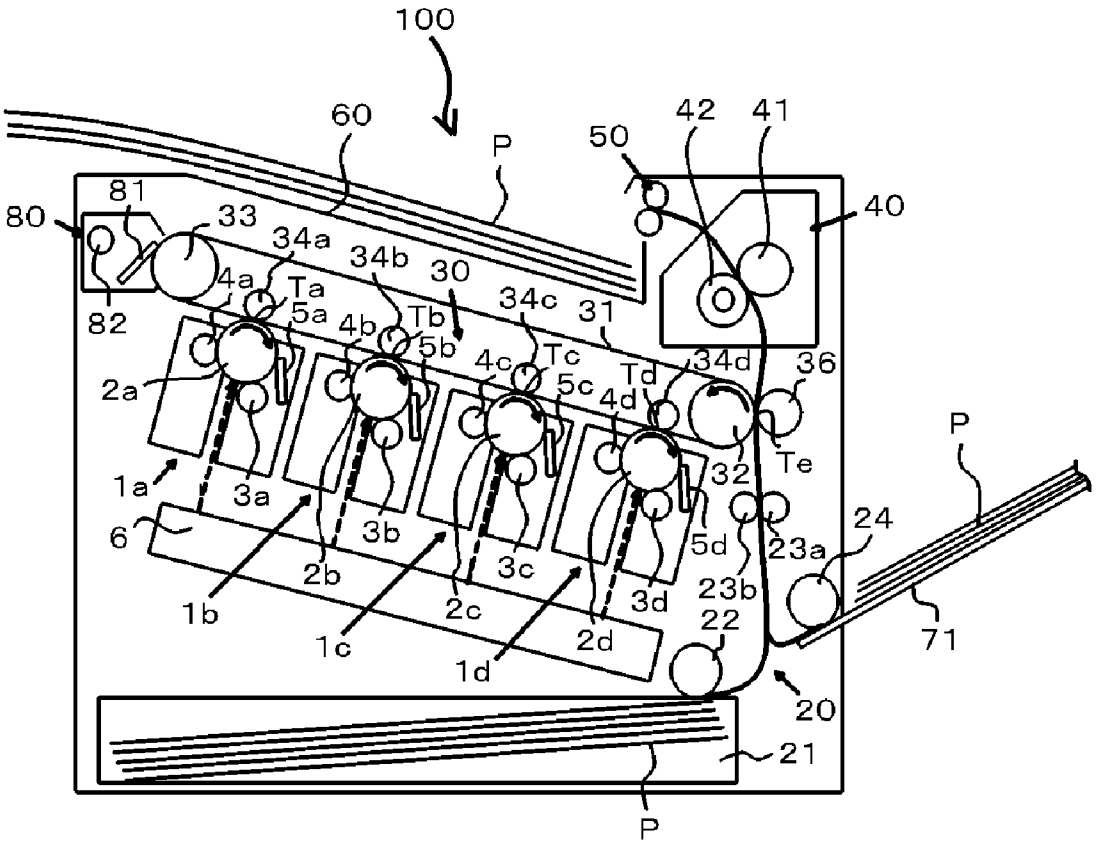


FIG. 1

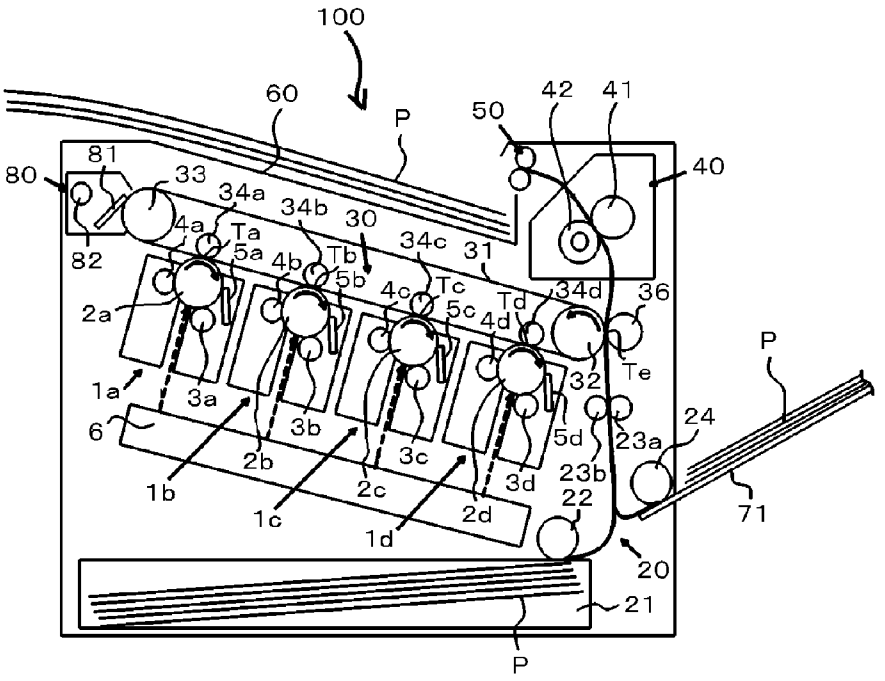
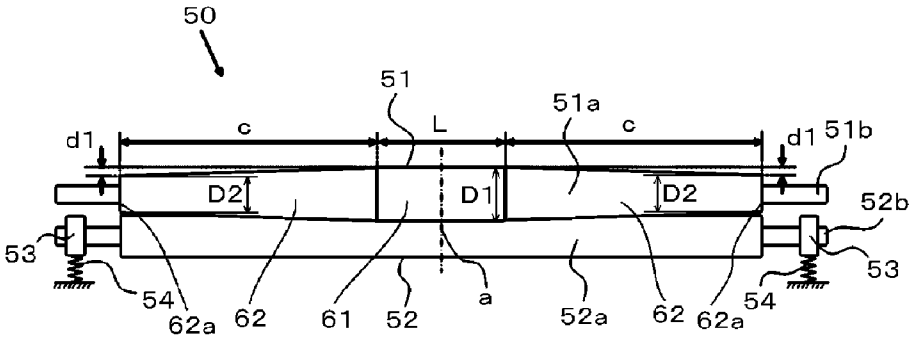

100
60
P
50
42
41
40
81
80
33
34a
34b
30
34c
31
4a
Ta
5a
4b
Tb
5b
4c
Tc
5c
Td
4d
34d
36
82
2a
Te
32
P
1a
3a
6
3b
5d
23a
24
2b
3c
23b
1b
2c
3d
22
71
1c
2d
1d
20
21
P

FIG. 2


50
51
51a
d1
c
L
c
d1
51b
D2
D1
D2
52b
53
53
54
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62a
62
61
52
a
52a
62
62a

FIG. 3

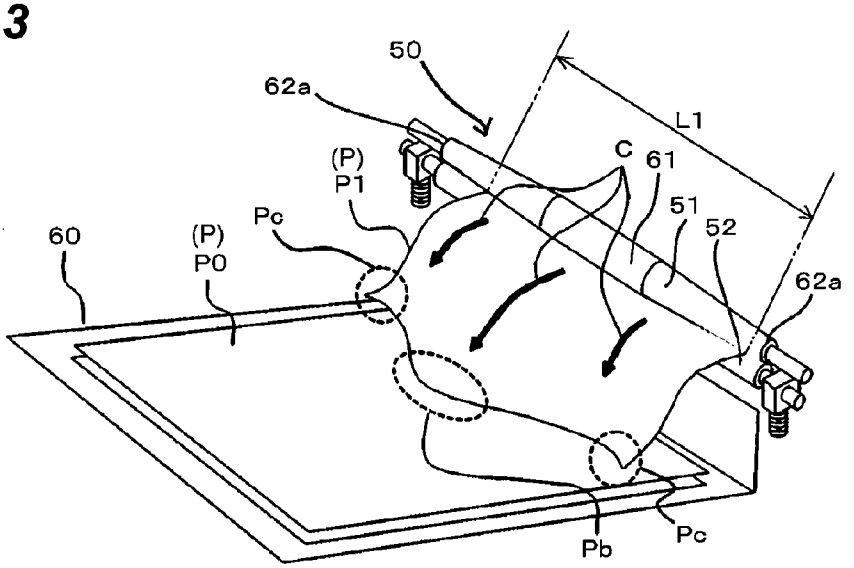

50
62a
L1
C
61
(P)
P1
51
52
Pc
60
(P)
P0
62a
Pb
Pc

FIG. 4

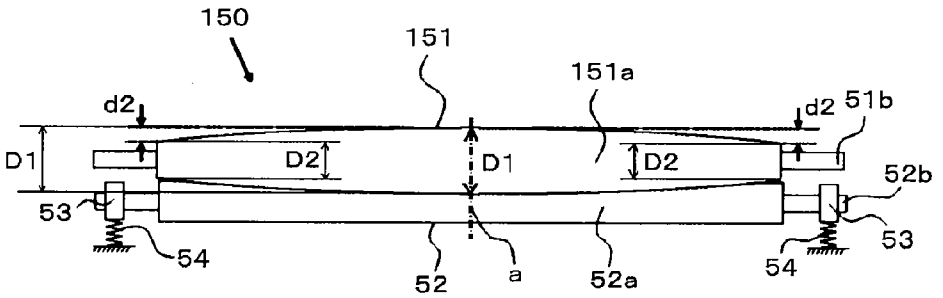

150
151
151a
d2
d2
51b
D1
D2
D1
D2
52b
53
53
54
54
52
a
52a

FIG. 5

PRIOR ART

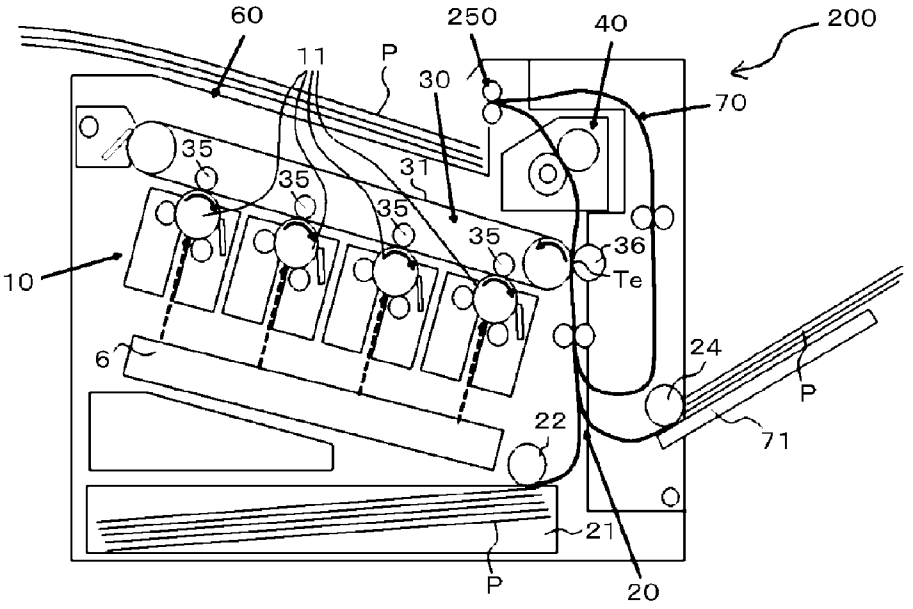


FIG. 6

PRIOR ART

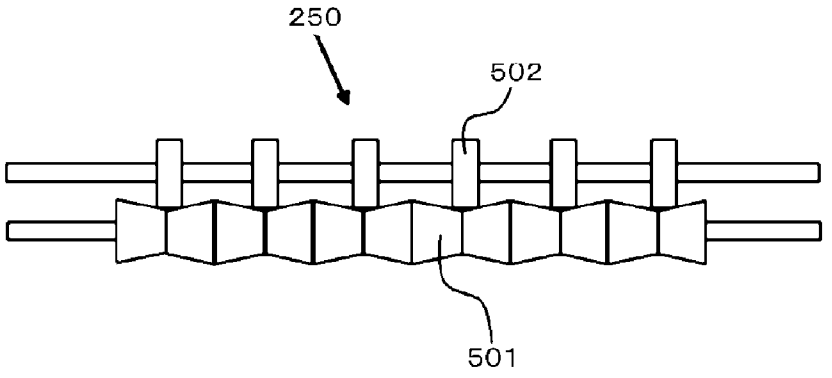
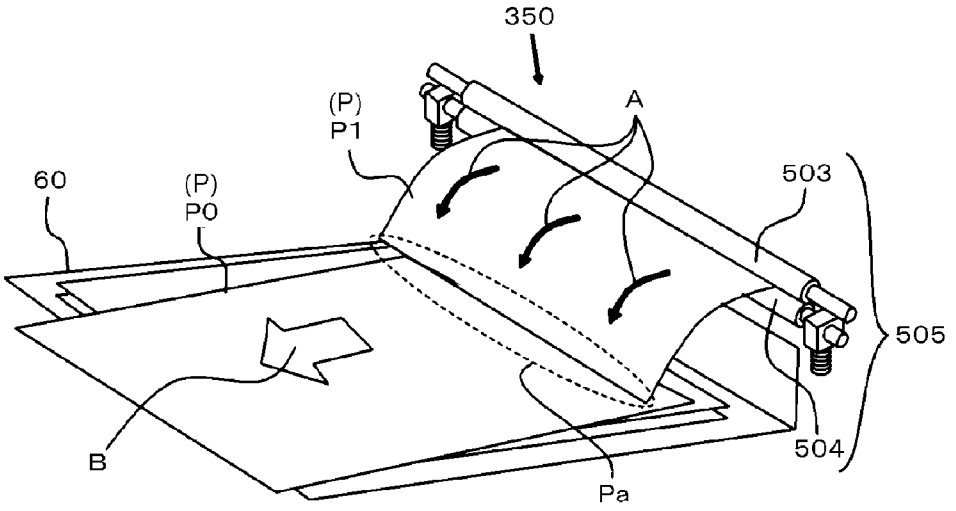


FIG. 7

PRIOR ART



SHEET DISCHARGING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE SHEET DISCHARGING DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a sheet discharging device of an image forming apparatus, which uses an electrostatic recording system and an electrophotographic recording system, and an image forming apparatus including the sheet discharging device.

[0003] 2. Description of the Related Art

[0004] Recently, an image forming apparatus has reduced in size and realized high performance, and an intermediate transfer type full-color image forming apparatus having the constitution disclosed in U.S. Pat. No. 6,970,665 has been developed. The invention disclosed in U.S. Pat. No. 6,970,665 is described with reference to FIG. **5** of the present application.

[0005] As illustrated in FIG. **5**, an image forming apparatus **200** includes a plurality of image forming portions **10**. The image forming portions **10** form a latent image on photosensitive drums **11**, which are image bearing members, with the use of light, magnetism, and charge to elicit the latent image with a developer such as a toner, and, thus, to obtain a visible image. The image forming apparatus **200** further includes an intermediate transfer unit **30** provided above the image forming portions **10** and a secondary transfer roller **36**. The visible images from the image forming portions **10** are sequentially transferred to the intermediate transfer unit **30**, and the intermediate transfer unit **30** forms an image of a plurality of colors. The secondary transfer roller **36** transfers the image of a plurality of colors on the intermediate transfer unit **30** onto a sheet P. The image forming apparatus **200** further includes a fixing unit **40** for fixing the image of a plurality of colors, transferred onto the sheet P, onto the sheet P and a sheet discharging portion **250** for discharging the sheet P fixed with the image to the outside of the image forming apparatus **200**. Furthermore, a sheet conveyance unit **20** for conveying the sheet P to a secondary transfer portion Te, and a manual paper feed tray **71** and sheet cassette **21** for feeding the sheet P to the sheet conveyance unit **20** are disposed below the secondary transfer roller **36** of the image forming apparatus **200**.

[0006] The intermediate transfer unit **30** includes a rotating endless belt-like intermediate transfer belt **31** stretched between a plurality of rollers, and the intermediate transfer belt **31** is disposed to approach the image forming portions **10**. In the intermediate transfer unit **30**, a primary transfer charging devices **35** are arranged at a position facing the image forming portions **10** so that the intermediate transfer unit **30** is held between the primary transfer charging devices **35** and the image forming portions **10**. The primary transfer charging devices **35** primarily transfers the visible images, formed on the photosensitive drums **11** by an exposure device **6**, onto the intermediate transfer-unit **30**. The visible images primarily transferred from the photosensitive drums **11** are superposed on the intermediate transfer unit **30**. The intermediate transfer unit **30** rotates to thereby convey the visible image to the position of the secondary transfer portion Te where the visible image is secondarily transferred onto the sheet P.

[0007] When the visible image on the intermediate transfer unit **30** arrives at the position of the secondary transfer portion Te, the visible image is secondarily transferred onto the sheet P, selected and conveyed from the manual paper feed tray **71** or a sheet cassette **21**, by the secondary transfer roller **36** and is further fixed by the fixing unit **40**. The sheet P fixed with the image is discharged outside the image forming apparatus **200** by the sheet discharging portion **250**, whereby a full-color image can be obtained. A sheet discharge tray **60** is disposed on the downstream side in the sheet conveyance direction of the sheet discharging portion **250**. The sheet discharge tray **60** can receive therein the sheet P discharged by the sheet discharging portion **250**.

[0008] For the sheet discharging portion **250**, as disclosed in Japanese Patent Application Laid-Open No. 2006-117365, a plurality of rollers **502** with a width smaller than the width of a plurality of concavo-convex rollers **501** are arranged in a row in the width direction perpendicular to the discharging direction of the sheet P. The invention disclosed in Japanese Patent Application Laid-Open No. 2006-117365 is described with reference to FIG. **6**.

[0009] As illustrated in FIG. **6**, the sheet discharging portion **250** includes the plurality of concavo-convex rollers **501**. According to the sheet discharging portion **250**, the sheet P is stiffened, whereby while curl of the sheet P is removed, the sheet P can be discharged while always stabilizing the posture of the sheet P at the time of discharge. The lead end of the sheet P discharged does not push out the sheets P previously stacked in the sheet discharge tray **60**, but the sheet P is discharged in a state that the sheets P are neatly arranged in the sheet discharge tray **60**.

[0010] Meanwhile, for the sheet discharging portion **250**, instead of the concavo-convex rollers **501** of Japanese Patent Application Laid-Open No. 2006-117365 and FIG. **6**, USPub2007/0201892 proposes to use a pair of sheet discharge rollers in which a rubber layer wound around a roller shaft has a length larger than the width of the sheet P. The invention disclosed in the USPub2007/0201892 is described with reference to FIG. **7**.

[0011] As illustrated in FIG. **7**, according to a sheet discharging portion **350**, the total width of elastic layers of a sheet discharge drive roller **503** and a sheet discharge driven roller **504** is evenly in contact with the sheet P, and therefore, heat of the sheet P is uniformly conducted away, whereby uneven brightness of an image can be prevented. Further, since the edge portions of the rollers are not in contact with the sheet P, it is possible to prevent the traces of the rollers from being left on the sheet P.

[0012] However, when the concavo-convex rollers **501** illustrated in FIG. **6** are used, the surfaces of the rollers are nonuniformly in contact with the sheet P. In this case, for the sheet P having passed through the fixing unit **40**, since the portions of the sheet P which are in contact with the roller surfaces and the noncontact portions are different in the amount of heat of the sheet P conducted by the roller surfaces, the cooling conditions of a toner image fixed onto the sheet P results in difference. Therefore, the portions which are in contact with the roller surfaces and the noncontact portions cause the uneven brightness of the image on the sheet P. In particular, when the sheet P with high stiffness, like a heavy paper, is used, the contact surface between the sheet P and the roller surface and the noncontact surface clearly appear, and therefore, the-uneven brightness more notably occurs.

[0013] The plurality of rollers **502** are aligned in the width direction, and the sheet P is stiffened by each edge portion of

the rollers **502**. Therefore, the traces of the rollers are left on the sheet P, softened by the heat when fixed, by the corner portions of the rollers **502**.

[0014] In addition, the sheet discharging portion **350** of U.S. Pat. No. 6,970,665 and FIG. **7** cause the following problem.

[0015] As illustrated in FIG. **7**, the sheet discharging portion **350** is constituted of the pair of sheet discharge rollers including the sheet discharge drive roller **503** and the sheet discharge driven roller **504** which have a uniform diameter and are through rollers continued in the width direction of the sheet P. The sheet discharge tray **60** is disposed on the downstream side of the sheet discharging unit **50**.

[0016] As illustrated in FIG. **7**, a pair of sheet discharge roller **505** is a straight pair of roller having a uniform outer diameter over the whole length in the width direction and does not have a function for stiffening the sheet P. Thus, a sheet P**1** is discharged on the sheet discharge tray **60** so that a lead end portion Pa is discharged substantially linearly with respect to the pair of sheet discharge roller **505** and, at the same time, so that the sheet P**1** is discharged in a curled fashion in the sheet discharging direction. At this time, the sheet P**1** is discharged in the direction of the arrow A with respect to the sheet P**0**, which has been discharged and stacked on the sheet discharge tray **60**, so that the entire region of the lead end portion Pa (a dotted line region in FIG. **7**) is pressed against the sheet P**0**. Therefore, the sliding resistance between the sheet P**1** and the sheet P**0** increases, and the sheet P**0** may be pushed out in the direction of the arrow B. In addition, the lead end portion Pa of the sheet P**1** may be caught on the sheet P**0** to be curled on the sheet discharge tray **60** due to a surface property of the sheet P or a minimal burr, which is generated at the end of the sheet P when the sheet P is cut. Thus, the sheet to be discharged subsequently cannot be normally discharged, and the sheet P**1** is highly likely to be pushed outside the sheet discharge tray **60**, or sheet jamming easily occurs, resulting in extreme deterioration of sheet dischargeability.

[0017] In addition, the amount of heat of the sheet P**1** conducted by the pair of sheet discharge roller **505** is different between the front surface and the rear surface of the sheet P**1** due to the difference in material of the pair of sheet discharge roller **505**, whereby shrinkage of the sheet P**1** in the cooling of the sheet P**1** is different between the front surface and the rear surface, and thus, the sheet may be likely to be curled.

[0018] The present invention has been made in view of the above problems, and the present invention provides a sheet discharging device, which can increase the rigidity of a sheet in a sheet discharging direction, stabilize the posture of a discharged sheet, and realize the improvement of loading performance of the discharged sheet.

SUMMARY OF THE INVENTION

[0019] The present invention provides a sheet discharging device comprising a sheet stacking portion on which sheets are staked, and a pair of sheet discharge rollers which nips and discharges a sheet, on which a toner image is fixed by heat, onto the sheet stacking portion in a convex shape in a width direction perpendicular to the discharging direction of the pair of sheet discharge rollers.

[0020] Each of the pair of sheet discharge rollers includes a rotating shaft extending in the width direction and an elastic layer is provided on the rotating shaft and continuously formed to be longer in the width direction than the width of a sheet with a passable maximum size, and at least one elastic layer of the pair of sheet discharge rollers is formed of a foamed material.

[0021] According to the present invention, a pair of sheet discharge rollers has an elastic layer. The sheet is nipped and discharged by the pair of sheet discharge rollers in a convex shape (U-shaped curve) in a width direction, whereby the rigidity of the sheet in the sheet discharging direction increases, the posture of the discharged sheet is stabilized, and the loading performance of the discharged sheet is improved. The sheet and the roller surface are evenly in contact with each other by the elastic layer, at least one elastic layer is formed of a foamed material, of the pair of sheet discharge rollers, and thus, the uneven brightness can be prevented when an image is fixed onto the sheet. Further, since the corner portions of the roller are not in contact with the sheet, the traces of the rollers are prevented from being left on the sheet.

[0022] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is a cross-sectional view illustrating a configuration of an image forming apparatus according to a first embodiment of the present invention;

[0024] FIG. **2** is an enlarged side elevational view illustrating a configuration of a sheet discharging unit as viewed from the downstream side in a conveyance direction of a sheet;

[0025] FIG. **3** is a schematic perspective view illustrating configurations of the sheet discharging unit and a sheet discharge tray;

[0026] FIG. **4** is an enlarged side elevational view illustrating a configuration of a sheet discharging unit, used in an image forming apparatus according to a second embodiment of the present invention, as viewed from the downstream side in a conveyance direction of a sheet;

[0027] FIG. **5** is a cross-sectional view illustrating a configuration of the prior image forming apparatus;

[0028] FIG. **6** is an enlarged side elevational view illustrating a configuration of the prior sheet discharging unit; and

[0029] FIG. **7** is a schematic perspective view illustrating configurations of the prior sheet discharging unit and the prior sheet discharge tray.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

[0030] FIG. **1** is a cross-sectional view illustrating a configuration of an image forming apparatus **100** according to the first embodiment of the present invention. The image forming apparatus **100** is a color image forming apparatus using an electrophotographic image forming process.

[0031] As illustrated in FIG. **1**, the image forming apparatus **100** includes an image forming portion **1***a* for forming a yellow image and an image forming portion **1***b* for forming a magenta image. The image forming apparatus **100** further includes an image forming portion **1***c* for forming a cyan image and an image forming portion **1***d* for forming a black image. The image forming apparatus **100** includes those four image forming portions (image forming unit). Those four image forming portions **1***a*, **1***b*, **1***c*, and **1***d* are arranged in a row at a constant interval. The image forming portions **1***a*, **1***b*, **1***c*, and **1***d* respectively include drum-type electrophoto-

graphic photoreceptor (hereinafter referred to as photosensitive drums) **2***a*, **2***b*, **2***c*, and **2***d* serving as image bearing members forming a visible image. Around the respective photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d*, there are provided chargers **3***a*, **3***b*, **3***c*, and **3***d*, developing devices **4***a*, **4***b*, **4***c*, and **4***d*, drum cleaning devices **5***a*, **5***b*, **5***c*, and **5***d*. An exposure device **6** is provided below the image forming portions **1***a*, **1***b*, **1***c*, and **1***d*. The developing devices **4***a*, **4***b*, **4***c*, and **4***d* respectively contain yellow, magenta, cyan, and black toners.

[0032] Each of the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* is a negatively charged OPC photoreceptor having a photoconductive layer on a drum base body made of aluminum, and is driven and rotated by a drive (not illustrated) in the direction of the arrow (the clockwise direction) at a predetermined process speed. The chargers **3***a*, **3***b*, **3***c*, and **3***d* serving as charging portions uniformly charge the surface of the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* to a predetermined negative electrode potential by a charging bias applied from a charging bias supply (not illustrated). The developing devices **4***a*, **4***b*, **4***c*, and **4***d* cause the toners of the respective colors to adhere to the electrostatic latent images formed on the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* to develop (visualize) the electrostatic latent images as toner images. The developing method performed by the developing devices **4***a*, **4***b*, **4***c*, and **4***d* includes a two-component contact developing method. In this developing method, a developer containing a magnetic carrier mixed with toner particles is conveyed by a magnetic force, and image development is performed in a contact state with the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d*.

[0033] Primary transfer rollers **34***a*, **34***b*, **34***c*, and **34***d* serving as transfer portions are constituted of an elastic member and abutted against the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* through an endless belt-like intermediate transfer belt **31** in each transfer nip portion. In this embodiment, the primary transfer rollers **34***a*, **34***b*, **34***c*, and **34***d* are used as the transfer portions; however, there may be used a transfer blade which is subjected to high pressure when transferring a toner image to a transfer material and is abutted against the intermediate transfer belt **31**.

[0034] The drum cleaning devices **5***a*, **5***b*, **5***c*, and **5***d* remove and collect a transfer residual toner remaining on the respective surfaces of the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d*.

[0035] In the exposure device **6**, a laser beam modulated in response to a time series electric digital pixel signal of image information is output from a laser outputting portion (not illustrated). The exposure device **6** exposes the surfaces of the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* through, for example, a polygon mirror (not illustrated) rotating at high speed. According to this constitution, electrostatic latent images of the respective colors corresponding to the image information are formed on the surfaces of the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* charged by the chargers **3***a*, **3***b*, **3***c*, and **3***d*.

[0036] The sheet conveyance unit **20** includes a sheet cassette **21**, a cassette conveyance roller **22**, which is a conveying portion, registration rollers **23***a* and **23***b*, which are conveying portions, a manual paper feed tray conveyance roller **24**, and a manual paper feed tray **71**. The sheet conveyance unit **20** selects the sheet P in the sheet cassette **21** or on the manual paper feed tray **71** to convey the selected sheet P, and conveys the sheet P to the secondary transfer portion Te which is a transfer portion. The secondary transfer portion Te transfers the visible image, formed by the image forming portions **1***a*, **1***b*, **1***c*, and **1***d*, to the sheet P.

[0037] In the intermediate transfer unit **30**, the intermediate transfer belt **31** is stretched between a drive roller **32** and a tension roller **33**, and the intermediate transfer belt **31** is driven by the drive roller **32** to be rotated (moved) in the arrow direction (the counterclockwise direction). The intermediate transfer belt **31** is formed of a dielectric resin such as a polycarbonate, a polyethylene terephthalate resin film, or a polyvinylidene fluoride resin film. Further, an intermediate transfer belt cleaning device **80** is provided in a position facing the tension roller **33** through the intermediate transfer belt **31**. The intermediate transfer belt cleaning device **80** includes a cleaning blade **81** formed of an elastic body abutted against the intermediate transfer belt **31** at a predetermined pressure and a conveying screw **82** which conveys residual toner removed from the intermediate transfer belt **31** by the cleaning blade **81**. The residual toner is conveyed to a toner collection vessel (not illustrated) by the conveying screw **82**.

[0038] The fixing unit **40** is provided on the downstream side of the secondary transfer portion Te. The fixing unit **40** is a fixing portion having a fixing roller **42** including a heat source and a pressure roller **41**. The fixing unit **40** fixes the visible image on the sheet P by heat, transferred at the secondary transfer portion Te, to the sheet P. Further, a sheet discharging unit **50** which is a sheet discharging device is provided on the downstream side in the conveyance direction of the sheet P. The sheet discharge tray **60** is disposed on the further downstream side in the sheet passing direction of the sheet discharging unit **50** and above the intermediate transfer unit **30**. The sheet P discharged by the sheet discharging unit **50** is stacked on the sheet discharge tray **60** serving as a sheet stacking portion.

[0039] Next, an image forming operation performed by the image forming apparatus **100** is described. When an image formation starting signal is given, the photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* of the image forming portions **1***a*, **1***b*, **1***c*, and **1***d*, which are driven and rotated at a predetermined process speed, are uniformly negatively charged by the chargers **3***a*, **3***b*, **3***c*, and **3***d*. Then, the exposure device **6** converts an image signal of an output image into an optical signal by means of a laser outputting portion (not illustrated), and the laser beam which is the optical signal obtained by conversion scans and exposes each surface of the charged photosensitive drums **2***a*, **2***b*, **2***c*, and **2***d* to form the electrostatic latent image.

[0040] Subsequently, the electrostatic latent image formed on the photosensitive drum **2***a* is first adhered with yellow toner by the developing device **4***a* to which a developing bias having the same polarity as the charged polarity (negative electrode polarity) of the photosensitive drum **2***a* is applied, and the electrostatic latent image is developed as the toner image. Then, the yellow toner image is transferred onto the intermediate transfer belt **31** at a primary transfer portion Ta by the primary transfer roller **34***a* to which a transfer bias (opposite-polarity (straight polarity) against the toner) is applied.

[0041] The intermediate transfer belt **31** transferred with the yellow toner image is moved to the image forming portion **1***b* by the drive roller **32**. Likewise, a magenta toner image, formed on the photosensitive drum **2***b* by the above same method, is superposed on the yellow toner image on the sheet P, and then transferred at a primary transfer portion Tb constituted of the image forming portion **1***b* and the primary transfer roller **34***b*. Hereinafter, likewise, a cyan toner image and a black toner image, respectively formed on the photosensitive drums **2***c* and **2***d* of the image forming portions **1***c*

and **1***d*, are sequentially superposed on the yellow and magenta toner images superposed and transferred onto the intermediate transfer belt **31**, at primary transfer portions Tc and Td. According to this constitution, a full color toner image is formed on the intermediate transfer belt **31**.

[0042] The sheet P conveyed from the sheet cassette **21** or the manual paper feed tray **71** is conveyed to the secondary transfer portion Te by the registration rollers **23***a* and **23***b* according to the timing when the lead end of the toner image on the intermediate transfer belt **31** is moved to the secondary transfer portion Te. The full color toner image is then transferred onto the sheet p, conveyed to the secondary transfer portion Te, by the secondary transfer roller **36** to which the transfer bias (opposite-polarity (straight polarity) against the toner) is applied.

[0043] The sheet P formed with the full color toner image is conveyed to the fixing unit **40** serving as a fixing portion which is an image heat fixing device. After the full color toner image is heated and pressurized by a fixing nip between the fixing roller **42** and the pressure roller **41** to be thermally fixed onto the surface of the sheet P, the sheet P is discharged into the sheet discharge tray **60**, provided outside the apparatus, by the sheet discharging unit **50**, whereby a series of the image forming operation is terminated.

[0044] FIG. **2** is an enlarged side elevational view illustrating a configuration of the sheet discharging unit **50** as viewed from the downstream side in the conveyance direction of the sheet P. As illustrated in FIG. **2**, the sheet discharging unit **50** which is a sheet discharging device includes a pair of sheet discharge rollers including a sheet discharge drive roller **51** and a sheet discharge driven roller **52**. A sheet discharge drive roller **51** is corresponds to a one sheet discharge roller. A sheet discharge driven roller **52** is corresponds to an other sheet discharge roller. The sheet discharge drive roller **51** transmits a driving force of a drive source (not illustrated). The sheet discharge driven roller **52** faces the sheet discharge drive roller **51** and applies pressure on the sheet discharge drive roller **51** to be biased. The sheet discharging unit **50** discharges the sheet P, which has passed through the fixing unit **40** and, on which a toner image is fixed by heat, outside an image forming apparatus body **100***a* by the rotation of the sheet discharge drive roller **51** and the sheet discharge driven roller **52**.

[0045] The sheet discharge drive roller **51** includes a metal shaft **51***b*, which is a rotating shaft, and an elastic layer **51***a* is provided on the metal shaft **51***b*. The elastic layer **51***a* is formed of a resin material such as a foamed rubber material or a foamed elastomer, which is a foamed material, and, for example, urethane, NBR, and EPDM are used therein. In this case, in order to reliably grip and convey the sheet, the hardness of the rubber material is preferably 20 to 60 (when the hardness is measured by Asker C hardness meter). The sheet discharge drive roller **51** is connected to a drive source (not illustrated), and is rotatably constituted as a drive roller. The elastic layer **51***a* is continuously formed in the direction along the metal shaft **51***b*.

[0046] Meanwhile, the sheet discharge driven roller **52** includes a metal shaft **52***b*, which is a rotating shaft, and an elastic layer **52***a* is provided on the metal shaft **52***b*. Like the sheet discharge drive roller **51**, the elastic layer **52***a* of the sheet discharge driven roller **52** is formed of a resin material such as a foamed rubber material or a foamed elastomer, which is a foamed material, and, for example, urethane, NBR, and EPDM are used therein. At least one elastic layer of the sheet discharge drive roller **51** and the sheet discharge driven roller **52** maybe formed of a foamed material, the total amount of heat conducted from the sheet P is reduced and the sheet P is stacked on the sheet discharge tray **60** with flexibility, whereby curling of the discharged sheet P is reduced. Further, it is preferable that the sheet discharge driven roller **52** is formed of the same material as in the sheet discharge drive roller **51** or a material having the same heat conductivity as that of the sheet discharge drive roller **51** to reduce curling of the discharged sheet P. Furthermore, as in the sheet discharge drive roller **51**, in order to reliably grip and convey the sheet, the hardness of the rubber material of the sheet discharge driven roller **52** is preferably 20 to 60 (when the hardness is measured by Asker C hardness meter). The elastic layer **52***a* is continuously formed in the direction along the metal shaft **52***b*. The sheet discharge driven roller **52** includes pressure springs **54** disposed at the both ends of the metal shaft **52***b* through a bearing **53**, and the pressure springs **54** apply a predetermined pressure to the sheet discharge drive roller **51**. The pressure of the pressure spring **54** applied to the sheet discharge drive roller **51** is preferably set to about 0.1 to 1 kg so that the conveying performance for the sheet P can be ensured.

[0047] The elastic layer **51***a* of the sheet discharge drive roller **51** has a substantially symmetrical shape with respect to a center line a of the center in the width direction of the sheet P. The elastic layer **51***a* is constituted of a straight portion **61**, which is a cylindrical portion without a change of the outer diameter, and taper portion **62** having a tapered shape with a taper amount d**1** from the both end portions of the straight portion **61***b* to the both end portions of the elastic layer **51***a*. A region of the center line a is at least referred to as a central portion of the sheet discharge drive roller **51**. A region of the straight portion **61** also corresponds to the central portion of the sheet discharge drive roller **51**. In the elastic layer **52***a* of the sheet discharge drive roller **51**, the outer diameter D**1** of the central portion is set to be larger than the outer diameter D**2** of the both end portions **62***a* which are the both end portions in the width direction.

[0048] When the length L in the axial direction of the straight portion **61** is too long, the effect of the difference between the outer diameter D**1** of the straight portion **61** of the elastic layer **51***a* and the outer diameters D**2** of the both end portions **62***a*: D**1**-D**2** may be reduced. On the other hand, if the length L is too short, a balance of holding the sheet P is likely to be disrupted in the axial direction, thereby leading to skew feeding of the sheet P, or normal discharging may not be able to be performed. Thus, the length L in the axial direction of the straight portion **61** is preferably larger than 0 but equal to or less than ⅓ with respect to the length L**1** (see, FIG. **3**) in the width direction of the sheet P with a passable maximum size. Namely, it is preferable that $0<L\leqq\frac{1}{3}L1$ is established.

[0049] FIG. **3** is a schematic perspective view illustrating the configurations of the sheet discharging unit **50** and the sheet discharge tray **60**. As illustrated in FIG. **3**, the sheet discharge tray **60** is disposed on the downstream side in the passing direction of the sheet P of the sheet discharging unit **50**. In this case, when the sheet P is discharged, the sheet P is conveyed on a center basis regardless of the size of the sheet P.

[0050] According to the sheet discharging unit **50** of the present embodiment, the sheet discharge drive roller **51** has the difference between the outer diameter D**1** of the straight portion **61** and the outer diameters D**2** of the both end portions

62*a*: D**1**-D**2**. Therefore, the circumferential speed of the sheet discharge drive roller **51** is different between the straight portion **61** and the both end portions **62***a*. While the circumferential speed of the straight portion **61** is high, each circumferential speed of the both end portions **62***a* is lower than that of the straight portion **61**. Thus, the sheet discharge speed of the discharged sheet P is different between the central portion Pb and the both end portions Pc. As illustrated by the arrow C in FIG. **3**, the central portion Pb of the lead end portion of the sheet P is discharged at a higher speed than the both end portions Pc of the lead end portion of the sheet P, whereby the central portion Pb of the lead end portion of the sheet P is discharged earlier than the both end portions Pc of the lead end portion of the sheet P. Since the both end portions Pc of the lead end portion of the sheet P are pulled by the central portion Pb of the lead end portion of the sheet P, the both end portions Pc is discharged in a slightly lifted state to follow the shape of the taper portions **62**. Thus, when the sheet P**1** is discharged, the lead end portion of the sheet P**1** can be discharged while only the central portion Pb of the lead end portion of the sheet P**1** is in contact with the sheet P**0** already discharged on the sheet discharge tray **60**.

[0051] As described above, according to the image forming apparatus **100** of the first embodiment, the outer diameters of the elastic layer **51***a* of the sheet discharge drive roller **51** are formed to be substantially symmetrical to each other with the central portion in the width direction of the sheet P as the center, and the outer diameter D**1** of the straight portion **61** is set to be larger than the outer diameters D**2** of the both end portions **62***a*. The elastic layer **51***a* has the smooth taper shapes from the straight portion **61** to the both end portions **62***a*. Thus, the discharge speed of the sheet P is set to be high in the straight portion **61**, but the discharge speeds in the both end portions **62***a* are set to be lower than the discharge speed in the straight portion **61**. Therefore, the sheet P is nipped and discharged by the pair of sheet discharge rollers in a convex shape (U-shaped curve) that the central portion Pb is downward, and the both end portions Pc of the lead end portion of the sheet P are slightly lifted upward in the width direction perpendicular to the discharging direction of the pair of sheet discharge rollers. According to this constitution, the rigidity of the sheet in the sheet discharging direction can be increased, and the contact area between the lead end of the discharged sheet P**1** and the already discharged sheet P**0** can be reduced in size as much as possible. Consequently, it is possible to prevent such a trouble that the discharged sheet P**1** is caught by the already discharged sheet P**0** to push out the sheet P**0**. Further, the sheet jamming is prevented. Furthermore, the dischargeability and the loading performance of the discharged sheet P can be enhanced. In addition, it is possible to prevent, as much as possible, such a phenomenon that the lead end portion of the discharged sheet P is caught to be curled due to the surface property of the sheet P, which has been already discharged on the sheet discharge tray **60**, or a minimal burr, which is generated at the end of the sheet P when the sheet P is cut. The sheet P may be nipped and discharged by the pair of sheet discharge rollers in a reverse convex shape (inverted U-shaped curve) to increase the rigidity of the sheet in the sheet discharging direction.

[0052] The sheet discharge drive roller **51** and the sheet discharge driven roller **52** respectively have the elastic layers on the outer circumferential sides, whereby when the sheet P is passed between the sheet discharge drive roller **51** and the sheet discharge driven roller **52** while being pressed therebetween, the straight portion **61** of the sheet discharge drive roller **51** can be elastically depressed according to the thickness of the sheet P. The elastic layer **51***a* can be evenly in contact with the sheet P. According to this constitution, there is no difference in the amount of heat of the toner image on the sheet P conducted by the surfaces of the sheet discharge drive roller **51** and the sheet discharge driven roller **52**, and thus, the occurrence of the uneven brightness of an image can be prevented.

[0053] The elastic layer **51***a* is continued in the direction along the metal shaft **51***b*. The edge portion of the elastic layer **51***a* is not pressed against a softened sheet, and thus, the traces of the rollers are not left on the sheet, whereby the image with fine printing image quality is output.

[0054] The sheet discharge drive roller **51** and the sheet discharge driven roller **52** respectively have the foam elastic layers **51***a* and **52***a*, whereby each heat capacity of the sheet discharge drive roller **51** and the sheet discharge driven roller **52** is set to be reduced, and, thus, the total amount of heat conducted from the sheet P is reduced. The discharged sheet P is not cooled more than necessary, so the discharged sheet P does not become hard. After the sheet P is stacked on the sheet discharge tray **60** with flexibility, the sheet P is stacked on a flat stacking surface of the sheet discharge tray **60** and is cooled, whereby curling of the discharged sheet P is reduced. Furthermore, the amount of heat conducted from the sheet P is uniformed on the front and rear sides of the sheet P, whereby corrugation or curling of the discharged sheet P is reduced.

[0055] The sheet discharge drive roller **51** in which the outer diameter of the straight portion **61** is larger than the outer diameters of the both end portions **62***a* is disposed above the sheet discharge driven roller **52**. Thus, the sheet P is discharged by being pressed from the central position in the width direction of the upper surface of the sheet P. Consequently, when the sheet P passes between the sheet discharge drive roller **51** and the sheet discharge driven roller **52**, the sheet P is likely to be discharged while being curled into a reversed U shape. The central position in the width direction of the discharged sheet P**1** is hardly caught by the already discharged sheet P**0**. On the other hand, if the straight portion **61** and the taper portions **62** are formed in the sheet discharge driven roller **52**, the sheet P may be inconveniently discharged while being curled into a U shape.

[0056] Since the length of the straight portion **61** is equal to or less than ⅓ of the length L**1** in the width direction of the sheet P with a passable maximum size, the gripping force for the sheet P of the sheet discharge drive roller **51** and the sheet discharge driven roller **52** is suitably maintained. When the sheet P with high stiffness, like a heavy paper, is used, the entire region in the width direction of the sheet P can be reliably nipped. Therefore, the uneven brightness can be prevented. If the length of the straight portion **61** is more than ⅓ of the maximum width of the passable sheet P, there hardly occurs a difference in the discharge speed between the straight portion **61** in the width direction of the sheet P and the both end portions **62***a*. When the straight portion **61** is not provided, a balance of holding the sheet P is likely to be disrupted in the axial direction, thereby leading to skew feeding of the sheet P, or normal discharging may not be able to be performed.

[0057] As described above, according to the first embodiment of the present invention, based on a simple constitution, the image forming apparatus **100** can be reduced in size and

cost while maintaining high quality printed image and enhancing the dischargeability of the sheet P.

[0058] It goes without saying that this embodiment is not limited to a developing system and a transferring system used in the image forming apparatus described in this embodiment, but widely effective in a discharge portion of an image forming apparatus.

Second Embodiment

[0059] FIG. **4** is an enlarged side elevational view illustrating a configuration of a sheet discharging unit **150**, used in the image forming apparatus according to the second embodiment of the present invention, as viewed from the downstream side in the conveyance direction of the sheet P. The sheet discharging unit **150** is different from the sheet discharging unit **50** of the first embodiment in the use of a sheet discharge drive roller **151** instead of the sheet discharge drive roller **51**. In the sheet discharging unit **150**, the same components and effects as those in the sheet discharging unit **50** are denoted by the same reference numerals, and the description is suitably omitted. Also in the second embodiment, the image forming apparatus similar to that of the first embodiment can be used, and thus the description of the image forming apparatus is omitted.

[0060] As illustrated in FIG. **4**, the sheet discharging unit **150** is constituted of a sheet discharge drive roller **151** and a sheet discharge driven roller **52**. The sheet discharge drive roller **151** is constituted of a metal shaft **51***b*, which is a rotating shaft, and an elastic layer **151***a* wound around the metal shaft **51***b*. The elastic layer **151***a* has a crown shape with a maximum outer diameter D**1** in the central portion in the width direction of the sheet P. The elastic layer **151***a* is formed of a foam rubber material, which is a foamed material, and, for example, urethane, NBR, and EPDM are used therein. In this case, in order to reliably grip and convey the sheet P, the hardness of the rubber material is preferably 20 to 60 (when the hardness is measured by Asker Chardness meter). The sheet discharge drive roller **151** is connected to a drive source (not illustrated), and is rotatably constituted as a drive roller.

[0061] Meanwhile, the sheet discharge driven roller **52** is constituted of a metal shaft **52***b* and an elastic layer **52***a* wound around the metal shaft **52***b*. As in the sheet discharge drive roller **151**, the elastic layer **52***a* of the sheet discharge driven roller **52** is formed of a foam rubber material, and, for example, urethane, NBR, and EPDM are used therein. Further, it is preferable that the sheet discharge driven roller **52** is formed of the same material as in the sheet discharge drive roller **151** or a material having the same heat conductivity as that of the sheet discharge drive roller **151**. Further, as in the sheet discharge drive roller **151**, the hardness of the rubber material of the sheet discharge driven roller **52** is preferably **20** to **60** (when the hardness is measured by Asker C hardness meter). The sheet discharge driven roller **52** includes pressure springs **54** disposed at the both ends of the metal shaft **52***b* through a bearing **53**, and the pressure springs **54** apply a predetermined pressure to the sheet discharge drive roller **151**. The pressure of the pressure spring **54** applied to the sheet discharge drive roller **151** is preferably set to about 0.1 to 1 kg so that the conveying performance for the sheet P can be ensured.

[0062] The elastic layer **151***a* of the sheet discharge drive roller **151** has a substantially symmetrical shape with respect to the center line a of the center in the width direction of the sheet P, and the outer shape is a smooth crown shape with a crown amount d**2**.

[0063] The image forming apparatus of the second embodiment can obtain an effect similar to the case of the first embodiment. The elastic layer **151***a* of the sheet discharge drive roller **151** has a crown shape with the maximum outer diameter D**1** in the central portion in the width direction of the sheet P. Therefore, as an additional effect, the elastic layer **151***a* of the sheet discharge drive roller **151** can be smoothly deformed in accordance with the shape of the sheet P in the width direction of the sheet P.

[0064] Note that the above constitution can be changed as follows. Among the elastic layers **51***a*, **151***a*, and **52***a* of the sheet discharge drive rollers **51** and **151** and the sheet discharge driven roller **52** of the first and second embodiments, a tube-like resin film may be wound around the outer circumference of at least one of the elastic layers **51***a*, **151***a*, and **52***a* disposed on the printed surface side of the sheet. According to this constitution, even if the toner is not completely fusion bonded to the sheet P in the fixing unit **40**, the toner is prevented from being removed by the elastic layers **51***a*, **151***a*, and **52***a*.

[0065] The elastic layers **51***a* and **151***a* of the sheet discharge drive rollers **51** and **151** of the first and second embodiments may be set to have a hardness higher than that of the elastic layer **52***a* of the sheet discharge driven roller **52**. According to this constitution, each hardness of the elastic layers **51***a* and **151***a* of the sheet discharge drive rollers **51** and **151** is higher than the hardness of the elastic layer **52***a* of the sheet discharge driven roller **52**. Thus, it is possible to prevent such a phenomenon that the elastic layers **51***a* and **151***a* of the sheet discharge drive rollers **51** and **151** are gridded by the sheet discharge driven roller **52**. Consequently, the difference between the outer diameter D**1** of the straight portion **61** and the outer diameters D**2** of the both end portions **62***a*: D**1**-D**2**, in the sheet discharge drive rollers **51** and **151** is maintained for a long period of time.

[0066] Further, in the first and second embodiments, the sheet discharging device according to the present invention is incorporated in the image forming apparatus; however, the sheet discharging device maybe a finisher which can be connected from the outside of the image forming apparatus.

[0067] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0068] This application claims the benefit of Japanese Patent Application No. 2008-201811, filed Aug. 5, 2008, No. 2009-162516, filed Jul. 9, 2009 which are hereby incorporated by reference herein in their entirety.

1. A sheet discharging device comprising:

a sheet stacking portion on which sheets are staked; and

a pair of sheet discharge rollers which discharges a sheet, on which a toner image is fixed by heat, onto the sheet stacking portion in a U-shaped curve in a width direction perpendicular to the discharging direction of the pair of sheet discharge rollers, wherein each of the pair of sheet discharge rollers includes a rotating shaft extending in the width direction and an elastic layer is provided on the rotating shaft and continuously formed to be longer in the width direction than the width of a sheet with a

passable maximum size, and at least one elastic layer of the pair of sheet discharge rollers is formed of a foamed material.

2. The sheet discharging device as claimed in claim **1**, wherein the outer diameter of the central portion in the width direction, of one sheet discharge roller of the pair of sheet discharge rollers, is larger than the outer diameters of the both end portions in the width direction.

3. The sheet discharging device as claimed in claim **2**, wherein the one sheet discharge roller is disposed above the other sheet discharge roller of the pair of sheet discharge rollers.

4. The sheet discharging device as claimed in claim **2**, wherein the elastic layer of the one sheet discharge roller has, in the central portion in the width direction, a cylindrical portion without a change of the outer diameter, a length L of the cylindrical portion is 0 L ⅓ L**1** with respect to a length L**1** in the width direction of the sheet with a maximum size that allows the sheet to pass between the pair of sheet discharge rollers, and the elastic layer has taper shape from the both ends in the width direction of the cylindrical portion to the both ends in the width direction of the one sheet discharge roller.

5. The sheet discharging device as claimed in claim **2**, wherein the elastic layer of the one sheet discharge roller has a crown shape with a maximum outer diameter in the central portion in the width direction of the sheet.

6. The sheet discharging device as claimed in claim **2**, wherein the elastic layer of the one sheet discharge roller has a hardness higher than that of the elastic layer of the other sheet discharge roller of the pair of sheet discharge rollers.

7. The sheet discharging device as claimed in claim **1**, wherein a tube-like resin film is wound around the outer circumference of at least one of the elastic layers of the pair of sheet discharge rollers disposed on the printed surface side of the sheet.

8. An image forming apparatus comprising:

an image forming portion which forms a toner image;

a fixing portion which fixes the toner image on a sheet by heat; and

a sheet discharging device which discharges the sheet, having passed through the fixing portion,

wherein the sheet discharging device includes:

a sheet stacking portion on which sheets are staked; and

a pair of sheet discharge rollers which discharges a sheet, on which a toner image is fixed by heat, onto the sheet stacking portion in a U-shaped curve in a width direction perpendicular to the discharging direction of the pair of sheet discharge rollers, wherein each of the pair of sheet discharge rollers includes a rotating shaft extending in the width direction and an elastic layer is provided on the rotating shaft and continuously formed to be longer in the width direction than the width of a sheet with a passable maximum size, and

at least one elastic layer of the pair of sheet discharge rollers is formed of a foamed material.

9. The image forming apparatus as claimed in claim **8**, wherein the outer diameter of the central portion in the width direction, of one sheet discharge roller of the pair of sheet discharge rollers, is larger than the outer diameters of the both end portions in the width direction.

10. The image forming apparatus as claimed in claim **9**, wherein the one sheet discharge roller is disposed above the other sheet discharge roller of the pair of sheet discharge rollers.

11. The image forming apparatus as claimed in claim **9**, wherein the elastic layer of the one sheet discharge roller has, in the central portion in the width direction, a cylindrical portion without a change of the outer diameter, a length L of the cylindrical portion is 0 L ⅓ L**1** with respect to a length L**1** in the width direction of the sheet with a maximum size that allows the sheet to pass between the pair of sheet discharge rollers, and the elastic layer has taper shape from the both ends in the width direction of the cylindrical portion to the both ends in the width direction of the one sheet discharge roller.

12. The image forming apparatus as claimed in claim **9**, wherein the elastic layer of the one sheet discharge roller has a crown shape with a maximum outer diameter in the central portion in the width direction of the sheet.

13. The image forming apparatus as claimed in claim **9**, wherein the elastic layer of the one sheet discharge roller has a hardness higher than that of the elastic layer of the other sheet discharge roller of the pair of sheet discharge rollers.

14. The image forming apparatus as claimed in claim **8**, wherein a tube-like resin film is wound around the outer circumference of at least one of the elastic layers of the pair of sheet discharge rollers disposed on the printed surface side of the sheet.

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