US 20120025449A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2012/0025449 A1**

(43) **Pub. Date: Feb. 2, 2012**

Yanagi et al.

(54) **SHEET FEEDING APPARATUS AND IMAGE FORMING APPARATUS**

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(21) Appl. No.: **13/182,553**

(22) Filed: **Jul. 14, 2011**

(30) **Foreign Application Priority Data**

Aug. 2, 2010 (JP) 2010-173729

Publication Classification

(51) **Int. Cl.**
B65H 9/00 (2006.01)
B65H 3/06 (2006.01)

(52) **U.S. Cl.** **271/109**; 271/234

(57) **ABSTRACT**

The present invention provides a sheet feeding apparatus and an image forming apparatus which can suppress generation of sheet skew feeding by a simple configuration and a pair of side edge regulating portions **30***r* and **30***l* is provided opposite each other in a sheet storage portion in order to regulate positions of side edges in a width direction orthogonal to a sheet feeding direction of the stored sheet S. At least one of the side regulating plates **30***r* and **30***l* can be moved in the width direction, and abutting portions **301***r* and **301***l* are provided opposite each other on inner wall surfaces of the side regulating plates **30***r* and **30***l* to abut on side edges of the sheet S.

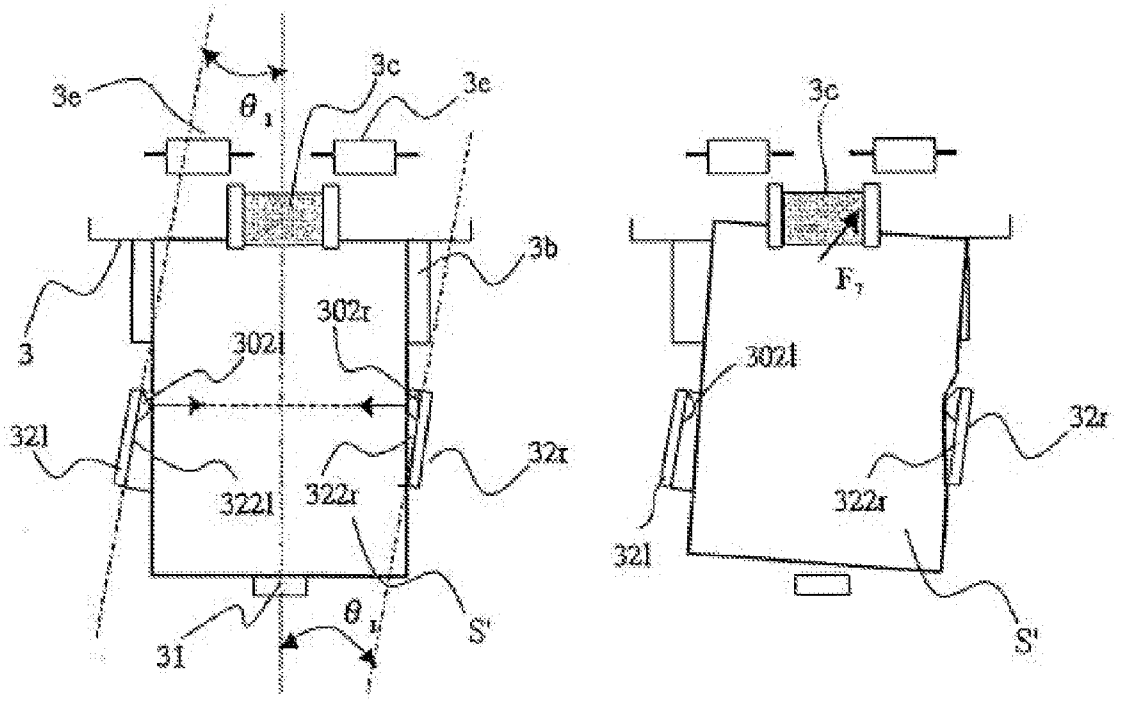


FIG. 1

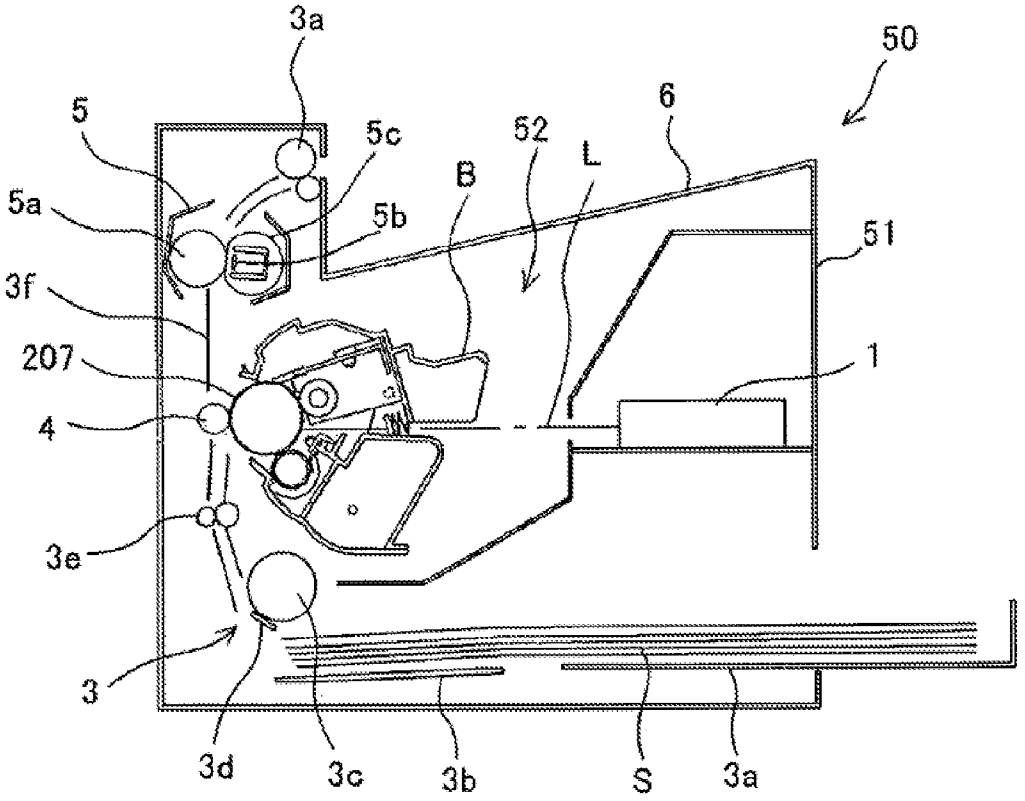


FIG. 2

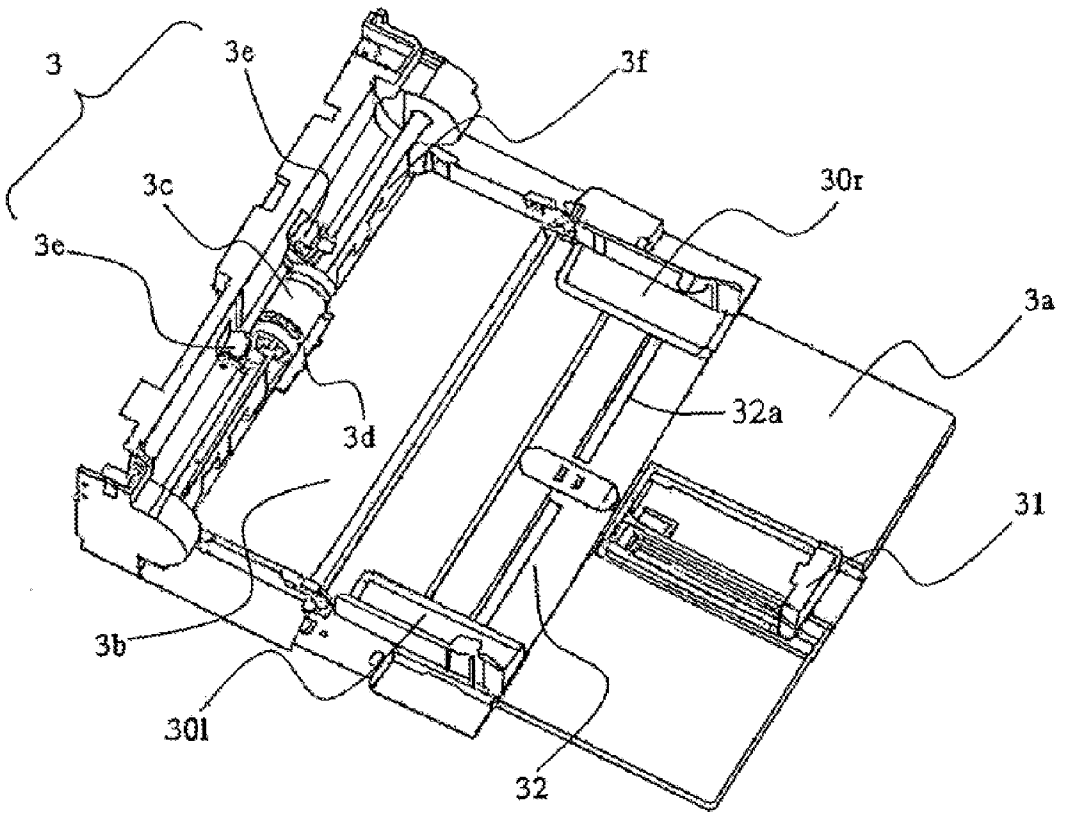


FIG. 3

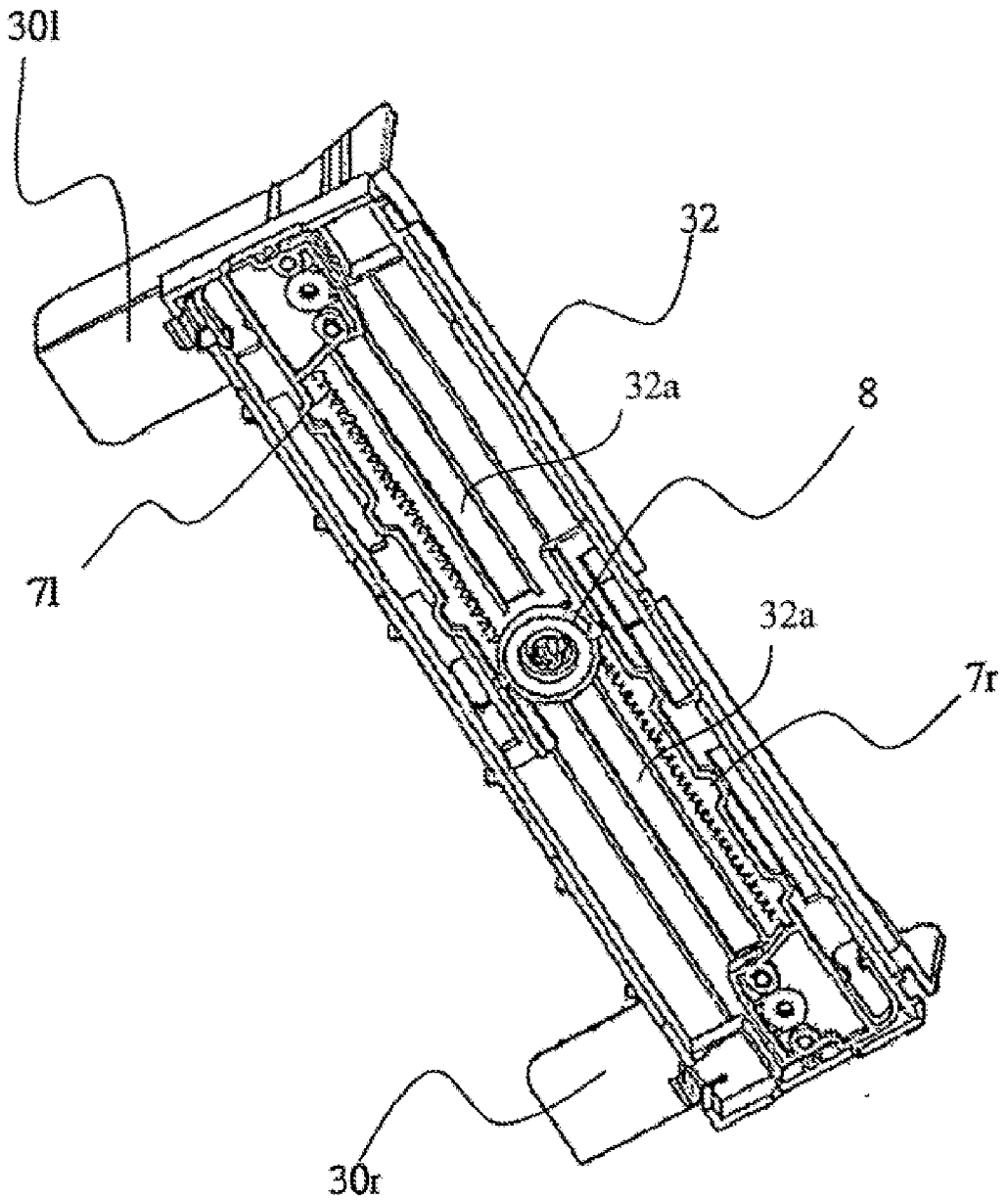


FIG. 4A

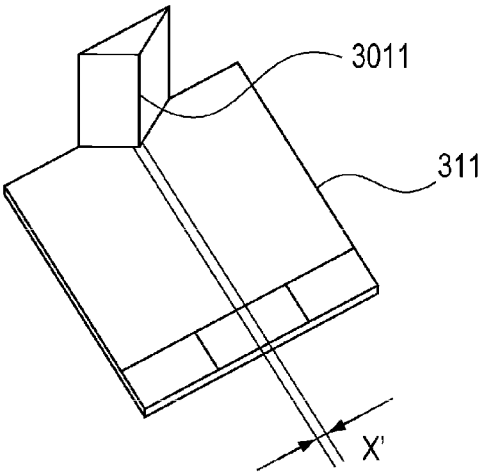


FIG. 4B

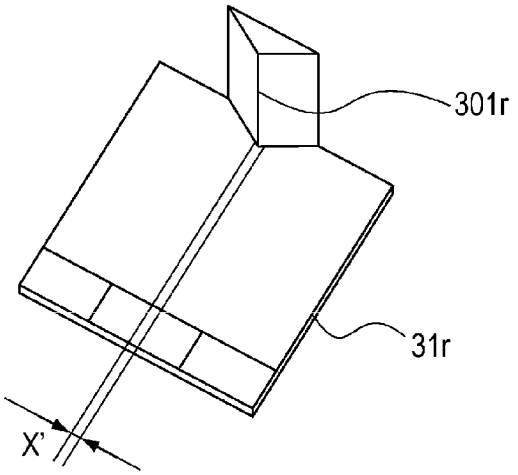


FIG. 4C

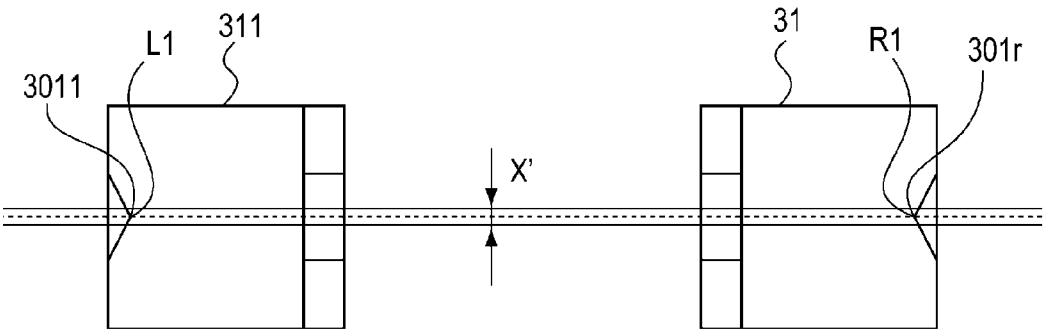


FIG. 5A

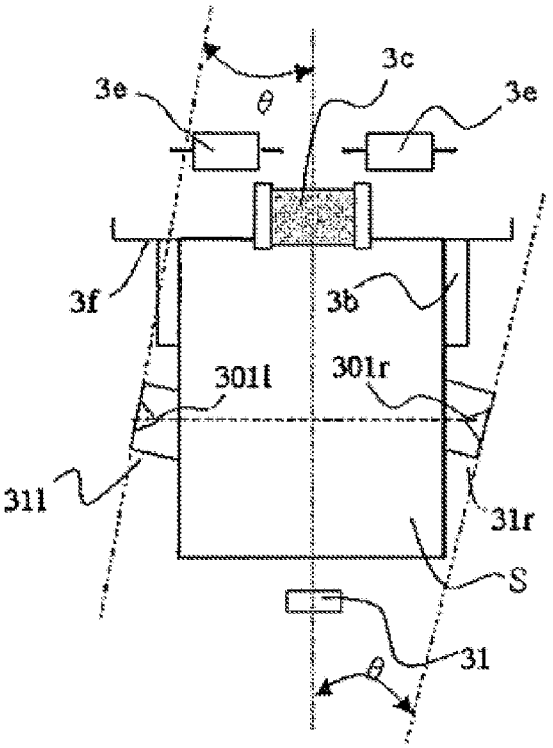

3e
θ
3c
3e
3f
3b
3011
301r
311
31r
S
31
θ

FIG. 5B

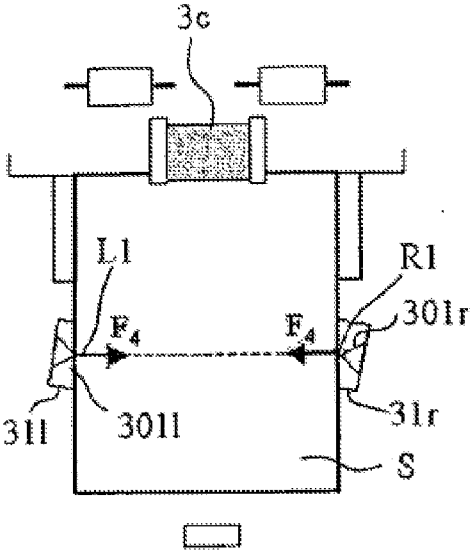

3c
L1
R1
F4
F4
301r
311
3011
31r
S

FIG. 6

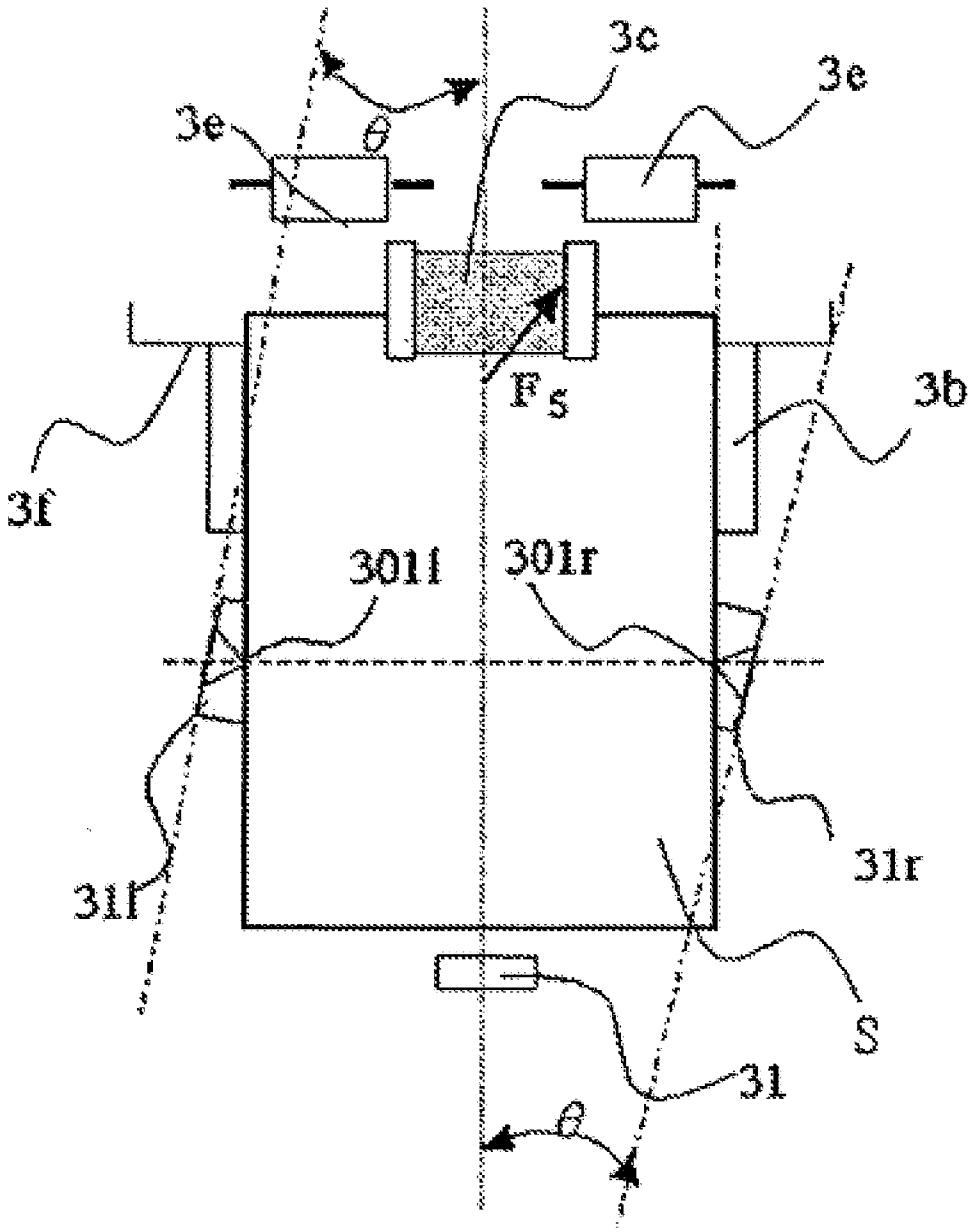


FIG. 7

LENGTH X' (mm) OF SHEET ABUTTING PORTION OF SIDE REGULATING PLATE	DETERMINATION OF TOLERANCE GOOD (WITHIN TOLERANCE) NO GOOD (OUT OF TOLERANCE)
5	GOOD
10	GOOD
20	GOOD
30	GOOD
40	NO GOOD
50	NO GOOD
60	NO GOOD
100	NO GOOD

FIG. 8A

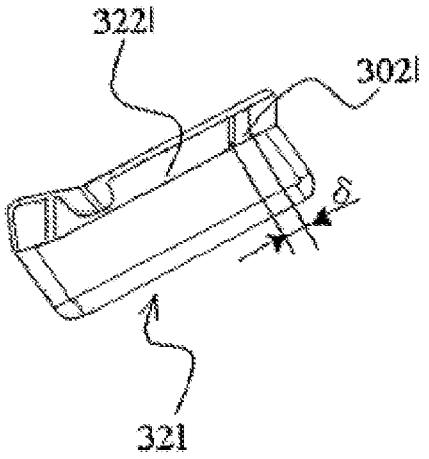


FIG. 8B

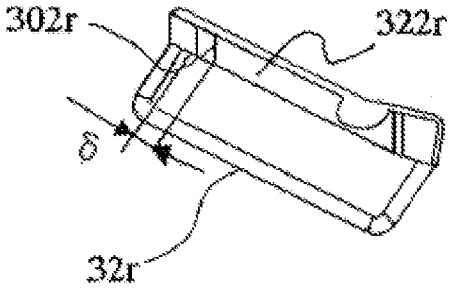


FIG. 8C

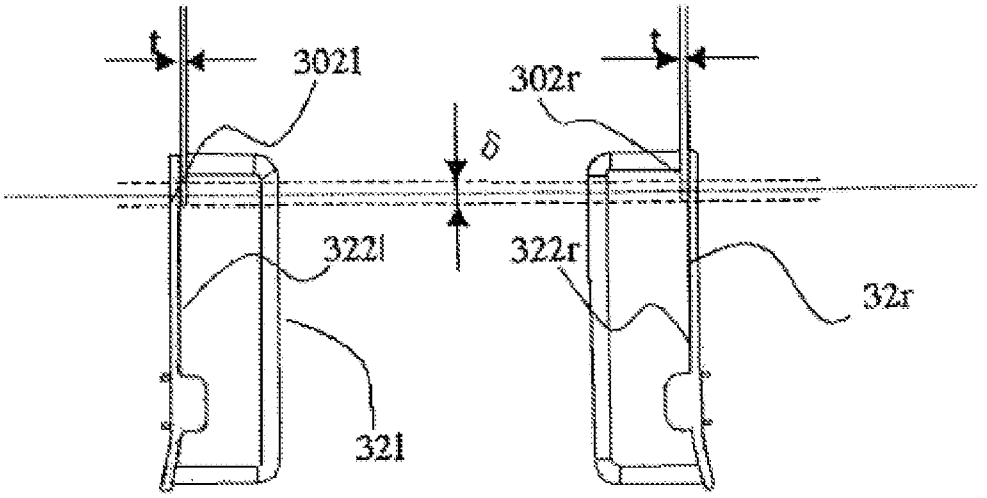


FIG. 9A

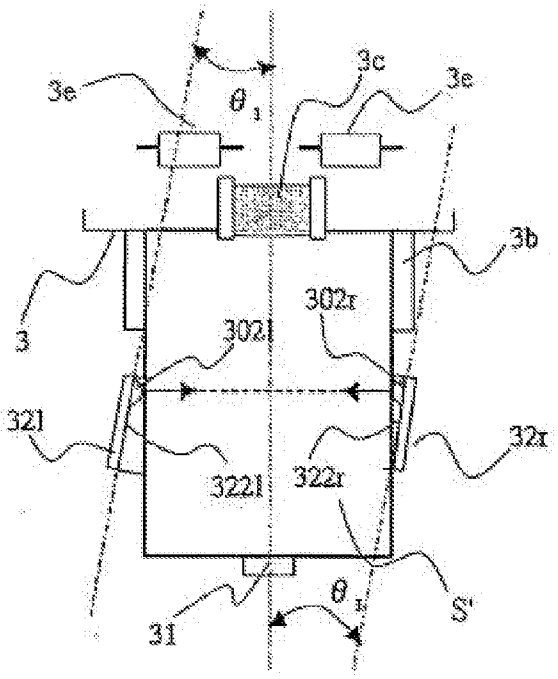

3e
θ_1
3c
3e
3b
3
302l
302r
321
3221
322r
32r
31
θ_2
S'

FIG. 9B

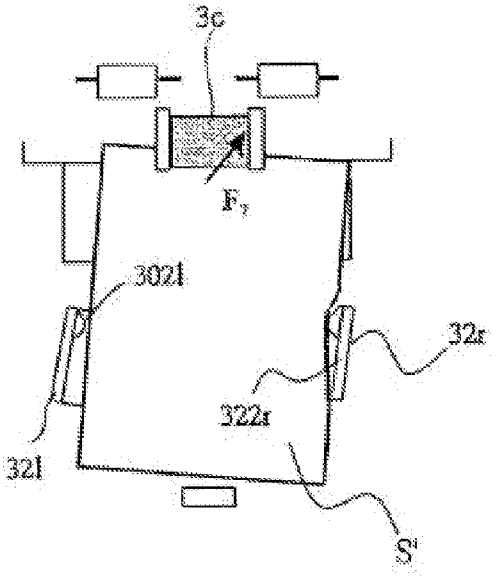

3c
F_1
302l
32r
322r
321
S'

FIG. 10A

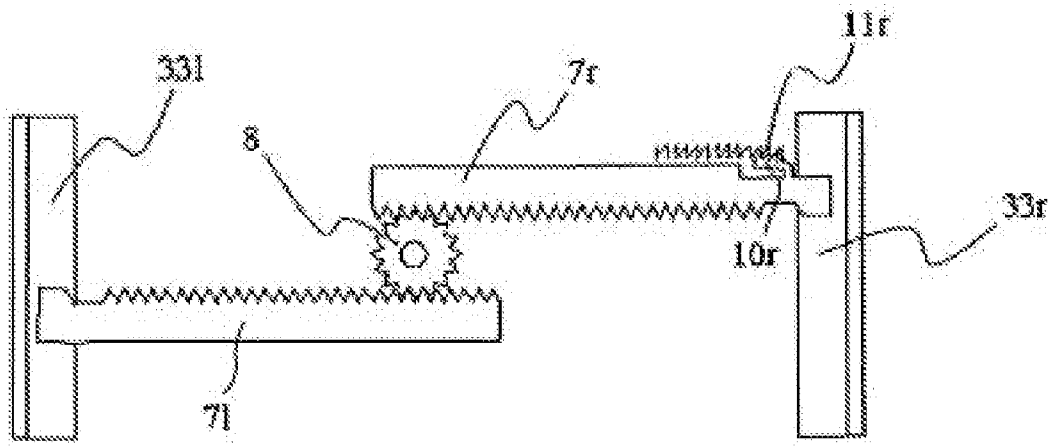


FIG. 10B

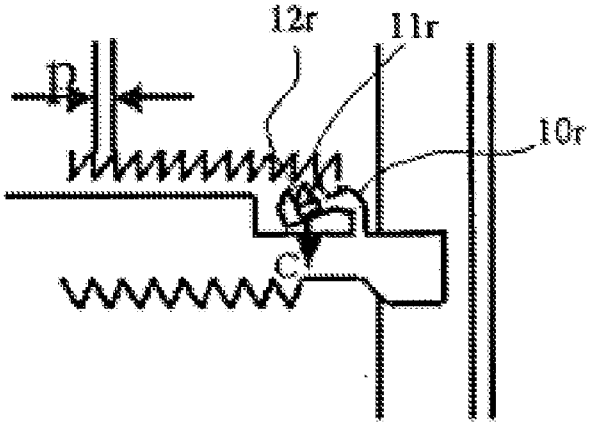


FIG. 11

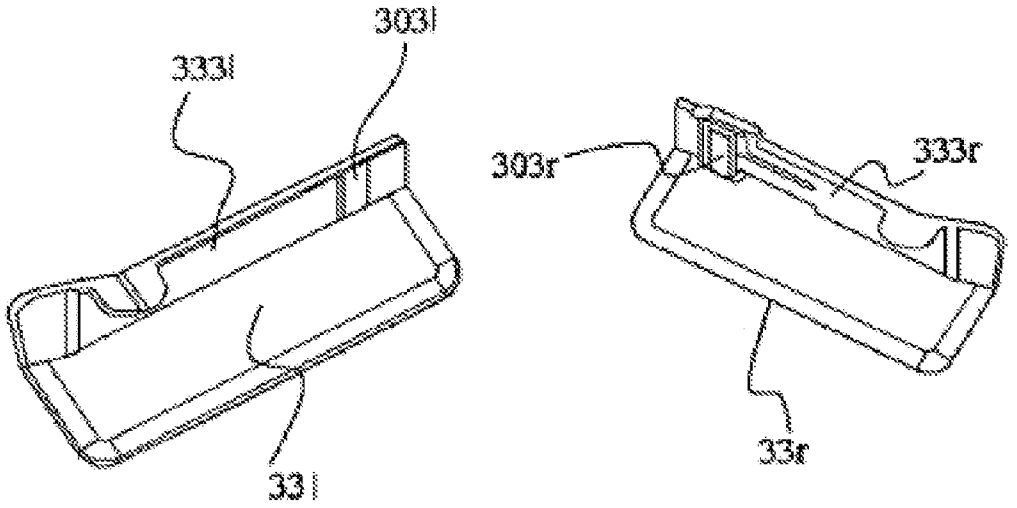


FIG. 12A
PRIOR ART

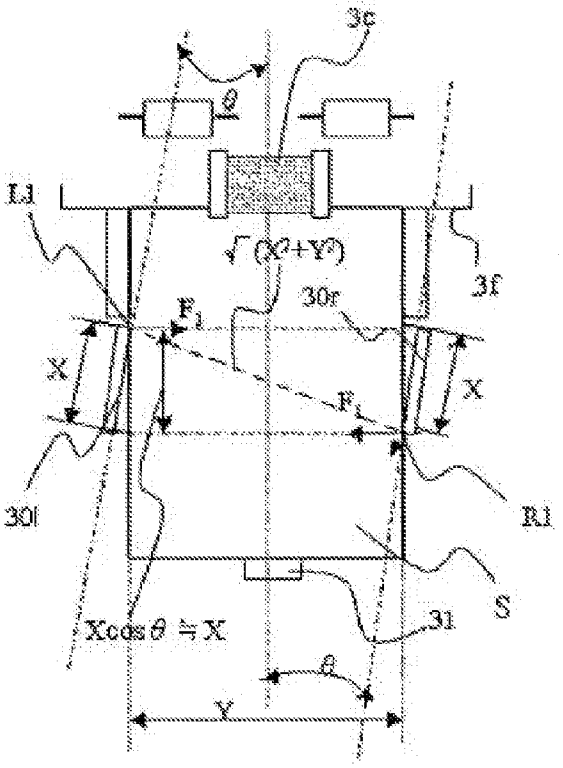


FIG. 12B
PRIOR ART

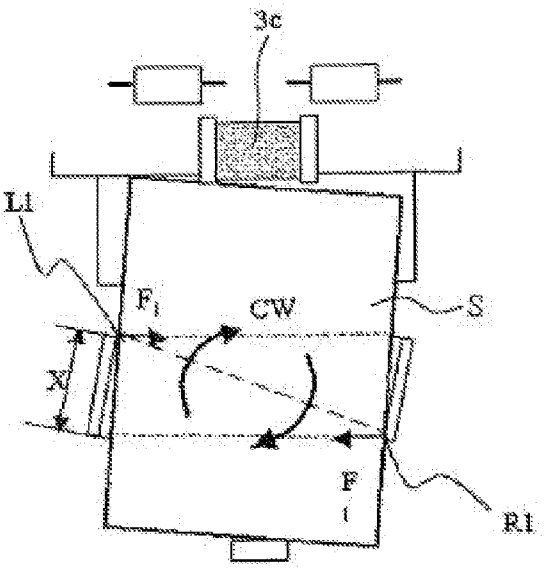
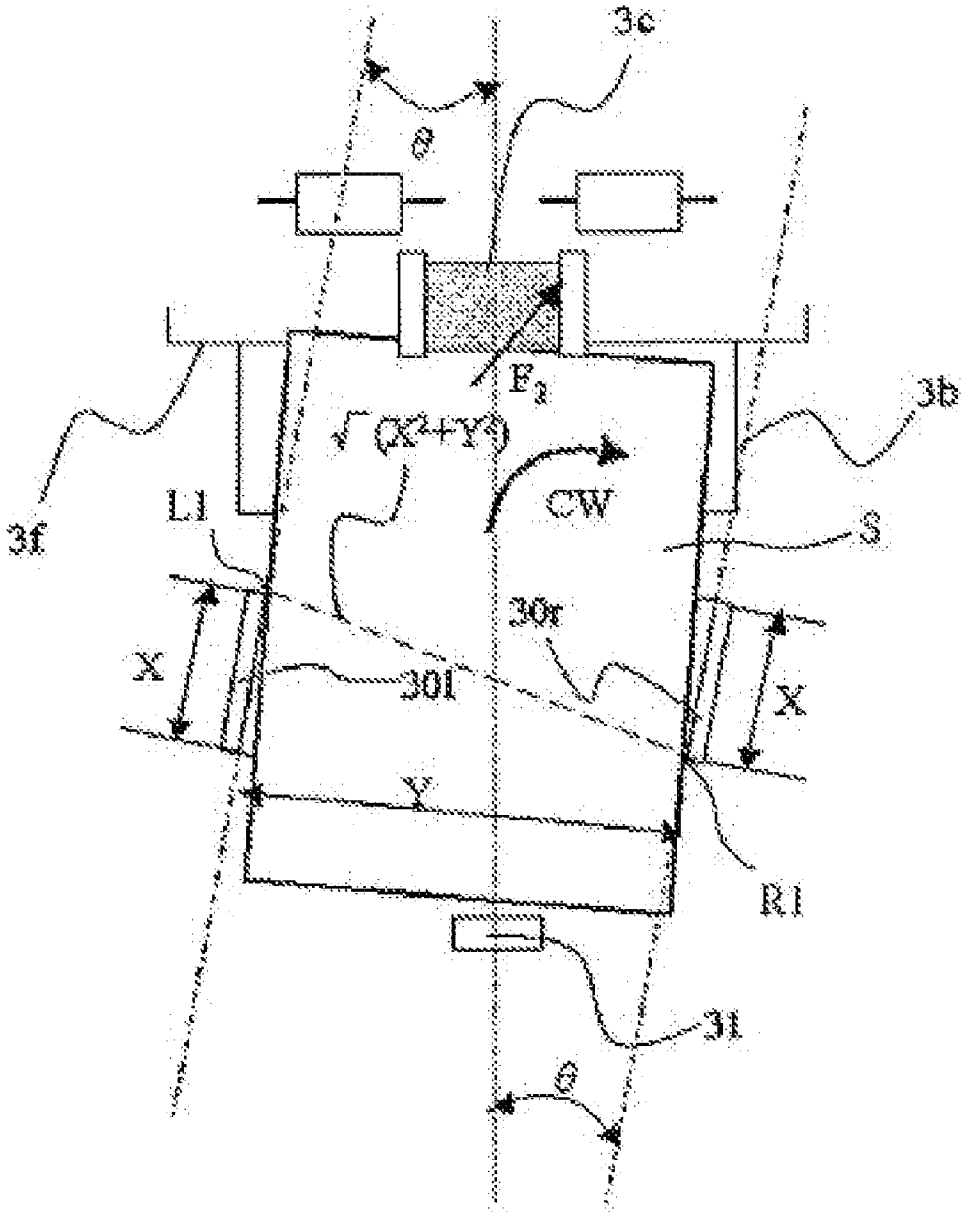


FIG. 13
PRIOR ART



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 and an image forming apparatus, particularly to a configuration of a side edge regulating portion that regulates a side edge position of a sheet stored in a sheet storage portion detachably attached to an apparatus main body.

[0003] 2. Description of the Related Art

[0004] Currently, in an image forming apparatus such as a copying machine, a printer, and a facsimile machine, one in which a sheet is fed from a sheet feeding apparatus to an image forming portion to form an image becomes widespread. In the sheet feeding apparatus, generally a sheet cassette which is the sheet storage portion is detachably attached to an apparatus main body, and the sheet stored in the sheet cassette is automatically fed to the image forming portion.

[0005] In some sheet cassette used in the sheet feeding apparatus, for example, a sheet stacking portion which is pressed against a sheet feeding roller while stacking the sheet thereon is provided in a lifting and lowering manner. In the sheet cassette provided with the sheet stacking portion, a tailing end regulating member is slidably provided. The tailing end regulating member regulates a position of a tailing end in a sheet feeding direction (hereinafter referred to as a tailing end) of the sheet which is stacked on and stored in the sheet stacking portion such that sheets having different sizes can be stored in the sheet cassette. A pair of side edge regulating portions is slidably provided to regulate a side edge position in a direction (hereinafter referred to as a width direction) orthogonal to the sheet feeding direction in delivering the sheet.

[0006] In the sheet cassette, the tailing end of the sheet is regulated by the tailing end regulating member while the side edges of the sheet is regulated by the pair of side edge regulating portions, whereby a leading end position of the sheet is always regulated in a predetermined position. Therefore, when the sheet cassette is accommodated in the apparatus main body, the sheet can stably be fed irrespective of the sheet size.

[0007] Since the side edge regulating portion is configured to be slid according to the sheet size, an attachment allowance exists due to the configuration, and the side edge regulating portion may be inclined with respect to the sheet feeding direction. Even if the side edge regulating portion is not inclined, slight irregularity may exist in the side edge regulating portion due to a manufacturing tolerance.

[0008] When the side edge regulating portion is inclined, or when the slight irregularity exists in the side edge regulating portion, the sheet may be inclined with respect to the sheet feeding direction when the side edge regulating portion abuts on the side edge of the sheet after the sheet is stored in the sheet cassette. The phenomenon will be described with reference to FIGS. **12**A and **12**B. Side regulating plates **30***r* and **30***l* which are the side edge regulating portions has the attachment allowances because the side regulating plates **30***r* and **30***l* are configured to be able to be moved in the width direction. In the side regulating plates **30***r* and **30***l*, the slight irregularity exists on a regulating surface facing a sheet S when viewed in the whole area in the sheet feeding direction.

[0009] Therefore, as illustrated in FIG. **12**A, the side regulating plates **30***r* and **30***l* have the same inclination of an angle θ with respect to the sheet feeding direction. The case, in which the sheet S is positioned by the side regulating plates **30***r* and **30***l* having the inclinations of the angles θ with respect to the sheet feeding direction and lengths X in the sheet feeding direction after a leading end of the sheet S abuts on an abutting surface **3***f* to stack the sheet S based on the leading end of the sheet S, will be described below.

[0010] Conventionally, the lengths X in the sheet feeding direction of the side regulating plates **30***r* and **30***l* is increased as much as possible (for example, 60 mm or more) because the sheet S is regulated in a distance as long as possible. However, when the side regulating plates **30***r* and **30***l* are inclined with respect to the sheet feeding direction, the sheet S may be inclined by an attaching state or component accuracy if regulated in the long distance.

[0011] For example, as illustrated in FIG. **12**A, when the side regulating plates **30***r* and **30***l* are inclined by the angle θ with respect to the sheet feeding direction, abutting points R**1** and L**1** between the side regulating plates **30***r* and **30***l* and the sheet S are shifted by X cos θ in the sheet feeding direction. The inclination θ generated by the attachment allowances of the side regulating plates **30***r* and **30***l* depends on the configuration. However, generally the inclination θ satisfies $\theta<0.5°$. Therefore, approximation of $X\cos\theta\approx X$ holds with no incident. Assuming that Y is a length in the width direction of the sheet S, a distance connecting the abutting points R**1** and L**1** between the side regulating plates **30***r* and **30***l* and the sheet S by a straight line can be expressed by $\sqrt{(X2+Y2)}$.

[0012] At this point, the sheet S is subjected to forces F**1** at the abutting points R**1** and L**1** between the sheet S and the side regulating plates **30***r* and **30***l*, when the sheet S is positioned such that the side regulating plates **30***r* and **30***l* are moved to abut on the sheet S. When the sheet S is subjected to the forces F**1** at the abutting points R**1** and L**1**, the abutting points R**1** and L**1** become power points and also become fulcrums about which the sheet is rotated. Therefore, rotation moment is generated clockwise in the sheet S as illustrated in FIG. **12**B, magnitude of the rotation moment is proportional to X cos θ and the forces F**1** acting on the abutting points.

[0013] As the lengths X of the side regulating plates **30***r* and **30***l* are increased, and as the forces F**1** of the side regulating plates **30***r* and **30***l* are increased, the rotation moment generated in the sheet S is increased to enhance a possibility that the sheet S is rotated as illustrated in FIG. **12**B. The inclination of the sheet S cannot completely be corrected even if the tailing end regulating plate **31** abuts on the tailing end of the sheet S. Therefore, the positioning of the sheet S is completed while the sheet S may be inclined with respect to the sheet feeding direction. In such cases, skew feeding of the sheet S is generated when the sheet S is fed by a sheet feeding roller **3***c*. As described above, when the sheet is inclined while the settings of the side regulating plates **30***r* and **30***l* are completed, because the sheet is fed while inclined, the skew feeding of the sheet is generated, which possibly leads to degradation of printing accuracy.

[0014] On the other hand, when the side edge regulating portion having the inclination abuts on the sheet, the sheet may not be aligned with the side edge regulating portion. In such cases, a gap is generated between the side edge regulating portion and the side edge of the sheet. At this point, when a force rotating the sheet acts on the sheet due to an unbalance between right and left pressures of the sheet feeding roller, because the sheet is rotated until the side edge abuts on the

side edge regulating portion, possibly the skew feeding is generated depending on the position of the gap.

[0015] The case, in which the sheet S positioned by the side regulating plates **30***r* and **30***l* having the inclinations of the angles θ with respect to the sheet feeding direction is fed by the sheet feeding roller **3***c*, will be described below with reference to FIG. **13**. FIG. illustrates a state immediately after the leading end of the sheet S is fed by the sheet feeding roller **3***c*. In feeding the sheet S, the sheet S is regulated at the two abutting points R**1** and L**1** of the side regulating plates **30***r* and **30***l*. The sheet S may be subjected to a force F**2** illustrated in FIG. **13** depending on a difference between right and left diameters of the sheet feeding roller **3***c*, a pressure balance between the right and left diameters, and alignment of the sheet feeding roller **3***c* with respect to the sheet feeding direction. The clockwise (CW) rotation moment is generated in the sheet S by the force F**2**, and the sheet S is rotated until the gaps between the side edges and the side regulating plates **30***r* and **30***l* are filled.

[0016] At this point, because the gap can be expressed by √(X2+Y2)−Y, a displacement amount is increased with increasing lengths X of the side regulating plates **30***r* and **30***l*, whereby a skew feeding amount is increased. When the side regulating plates **30***r* and **30***l* are inclined with respect to the sheet feeding direction, it is disadvantageously found that the skew feeding amount generated in the sheet S in positioning or feeding the sheet S is increased with increasing lengths X of the side regulating plates **30***r* and **30***l*.

[0017] There is discussed a sheet feeding apparatus including an angle adjusting portion that adjusts an angle of the side edge regulating portion with respect to the sheet feeding direction (for example, see Japanese Patent Laid-Open No. 2005-263458). When the sheet feeding apparatus includes the angle adjusting portion, a service engineer or a user can simply adjust the sheet feeding apparatus to the desired skew feeding accuracy according to a variation in manufacturing tolerance of the sheet feeding apparatus.

[0018] Recently, the laser beam printer and the copying machine is widely used in not only offices but also home with low cost and miniaturization, and a demand for improvement of usability is increased. In the conventional sheet feeding apparatus and image forming apparatus in which the angle of the side edge regulating portion is adjusted, it takes a significantly long time for not the service person but the individual user to see a sample to adjust the angle of the side edge regulating portion. As a result, productivity of the sheet feeding apparatus is degraded to decrease the usability. That is, it takes a long time to adjust the angle of the side edge regulating portion in order to prevent the skew feeding in positioning or feeding the sheet. An angle adjusting mechanism is also required to complicate a structure.

[0019] The present invention provides a sheet feeding apparatus and an image forming apparatus which can suppress the generation of the sheet skew feeding by a simple configuration.

SUMMARY OF THE INVENTION

[0020] According to an aspect of the invention, a sheet feeding apparatus comprising: a sheet storage portion which stores sheets; a sheet feeding roller which feeds the sheet stored in the sheet storage portion; a pair of side edge regulating portions which is provided opposite each other in the sheet storage portion so as to regulate positions of side edges in a width direction orthogonal to a sheet feeding direction of the stored sheet, and at least one of the pair of side edge regulating portions can be moved in the width direction; and projection portions provided opposite each other on inner wall surfaces of the side edge regulating portions so as to abut on the side edges of the sheet, respectively.

[0021] According to the invention, the projection portion which abuts on each side edge of the sheet is provided on the inner wall surface of the pair of side edge regulating portions, which allows the generation of the sheet skew feeding to be suppressed by the simple configuration.

[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** illustrates a schematic configuration of a printer which is an example of an image forming apparatus provided with a sheet feeding apparatus according to a first embodiment of the invention;

[0024] FIG. **2** is a perspective view of the sheet feeding apparatus;

[0025] FIG. **3** is a perspective view illustrating a movable portion of a side regulating plate provided in the sheet feeding apparatus;

[0026] FIG. **4**A illustrates a configuration of the side regulating plate (left member); FIG. **4**B illustrates a configuration of the side regulating plate (right member); FIG. **4**C is a plan view illustrating the configurations of the side regulating plates;

[0027] FIG. **5**A illustrates a sheet positioning operation performed by the side regulating plates; FIG. **5**B illustrates the sheet positioning operation performed by the side regulating plates;

[0028] FIG. **6** illustrates a state immediately after a sheet positioned by the side regulating plates is fed by a sheet feeding roller;

[0029] FIG. **7** is a table illustrating a determination result of a length of an abutting portion of the side regulating plate to a tolerance of a skew feeding amount;

[0030] FIG. **8**A illustrates a side regulating plate (right member) provided in a sheet tray of a sheet feeding apparatus according to a second embodiment of the invention; FIG. **8**B illustrates a side regulating plate (left member) provided in the sheet tray of the sheet feeding apparatus of the second embodiment; FIG. **8**C is a plan view illustrating the side regulating plates provided in the sheet tray of the sheet feeding apparatus of the second embodiment;

[0031] FIG. **9**A illustrates a sheet positioning operation performed by the side regulating plates; FIG. **9**B illustrates the sheet positioning operation performed by the side regulating plates;

[0032] FIG. **10**A illustrates a configuration of a movable portion of a side regulating plate provided in a sheet tray of a sheet feeding apparatus according to a third embodiment of the invention; FIG. **10**B is an enlarged view illustrating the configuration of the movable portion of the side regulating plate provided in the sheet tray of the sheet feeding apparatus of the third embodiment;

[0033] FIG. **11** is a perspective view of the side regulating plate;

[0034] FIG. **12**A illustrates a sheet positioning operation performed by conventional side regulating plates; FIG. **12**B illustrates the sheet positioning operation performed by conventional side regulating plates; and

[0035] FIG. **13** illustrates a state immediately after a sheet positioned by the conventional side regulating plates is fed by a sheet feeding roller.

DESCRIPTION OF THE EMBODIMENTS

[0036] Hereinafter, exemplary embodiments of the invention will be described in detail with reference to the drawings. FIG. **1** illustrates a schematic configuration of a printer which is an example of an image forming apparatus provided with a sheet feeding apparatus according to a first embodiment of the invention. In a printer **50** of FIG. **1**, an image forming portion **52** is provided in a printer main body **51** which is an apparatus main body, the image forming portion **52** performs image formation by an electrophotographic system, and a sheet feeding apparatus **3** feeds a sheet S to the image forming portion **52**.

[0037] The image forming portion **52** includes a laser exposure device **1**, a photosensitive drum **207** which forms a toner image, and a transfer roller **4** which transfers the toner image formed in the photosensitive drum **207** to the sheet S. A process cartridge B includes the photosensitive drum **207**, a charging roller (not illustrated), and a development portion (not illustrated). The process cartridge B is detachably attached to the printer main body **51**.

[0038] The sheet feeding apparatus **3** includes a sheet feeding roller **3***c*, a sheet tray **3***a* which is a sheet storage portion, and a lift-up plate **3***b*. The lift-up plate **3***b* is provided in the sheet tray **3***a* in a lifting and lowering manner, and presses the sheet S stored in the sheet tray **3***a* against the sheet feeding roller **3***c*. A separation pad **3***d* which presses the sheet feeding roller **3***c* is provided on a downstream side in a sheet feeding direction of the sheet tray **3***a*. In the sheet feeding apparatus **3**, during the image formation, the sheet S is delivered from the sheet tray **3***a* by the sheet feeding roller **3***c*, and the sheet S is separated one by one by the separation pad **3***d* which presses the sheet feeding roller **3***c*.

[0039] An image forming operation in the printer **50** having the above-described configuration will be described below. When the image forming operation is started, the photosensitive drum **207**, which is rotated in an arrow direction while a charging treatment is performed to a surface of the photosensitive drum **207**, is irradiated with a laser beam L emitted from the laser exposure device **1** according to an image signal. A latent image is formed on the photosensitive drum **207** by the laser irradiation according to the image signal. The latent image on the photosensitive drum **207** is developed and visualized as a toner imager by toner supplied by the development portion.

[0040] The lift-up plate **3***b* is lifted in parallel with the toner image forming operation, the sheet S set in the sheet tray **2***a* is delivered by friction with the sheet feeding roller **3***c*, and the sheet S is separated one by one and substantially vertically fed by the separation pad **3***d*. Then the sheet S is conveyed to a transfer portion by a pair of conveying rollers **3***e*.

[0041] In the transfer portion, a voltage having an opposite polarity to the toner image formed on the photosensitive drum **207** is applied to the transfer roller **4**, thereby transferring the visualized toner image on the photosensitive drum **207** to the sheet S. Then the sheet S to which the toner image is transferred is conveyed to a fixing unit **5**, which is disposed in an upper portion of the printer main body, by a conveyance guide **3***f*. The fixing unit **5** includes a driving roller **5***a* and a heater unit **5***c* in which a heater **5***b* is incorporated. In the fixing unit **5**, the transferred toner image is fixed by applying heat and pressure to the passing sheet S. Then the sheet S to which the toner image is fixed is conveyed by a pair of discharge rollers **3***g* and discharged to a discharge portion **6** provided on an upper surface of the printer main body **51**.

[0042] As illustrated in FIG. **2**, a tailing end regulating plate **31** is provided in the sheet tray **3***a* to regulate a tailing end which is an upstream side edge in the sheet feeding direction on the lift-up plate **3***b*. The tailing end regulating plate **31** can slidably be moved along the sheet feeding direction and disposed at a position corresponding to a sheet size. The tailing end regulating plate **31** is pressed against the tailing end of the sheet S, and a leading end of the sheet S abuts on an abutting surface **3***f*, thereby determining the position of the sheet S in the sheet feeding direction based on the leading end of the sheet S.

[0043] The sheet tray **3***a* includes a pair of side regulating plates **30***r* and **30***l*. The side regulating plates **30***r* and **30***l* abut on both side edges in a width direction orthogonal to the sheet feeding direction of the sheet S stacked on the lift-up plate **3***b* and regulate side edge positions of the sheet S. The side regulating plates **30***r* and **30***l* are supported by a side regulating plate guide **32** while being slidable in the width direction. In not only standard-size sheets such as an A4 size and a letter size but also nonstandard-size sheets such as a postcard and an envelope, the side edge positions of the sheet S can be aligned by the side regulating plates **30***r* and **30***l* which are a side edge regulating portion.

[0044] The sheet feeding apparatus of the first embodiment performs a center registration type sheet feed. Therefore, as illustrated in FIG. **3**, the side regulating plates **30***r* and **30***l* include rack members **7***r* and **7***l* which are slid in conjunction with each other, and the rack members **7***r* and **7***l* engage with a pinion **8** which is journaled at a bottom of the side regulating plate guide **32**.

[0045] When one of the side regulating plates **30***r* and **30***l* is moved in regulating the side edge positions of the sheet S, the rack members **7***r* and **7***l* are guided by a lateral guide groove **32***a* formed in the width direction of the side regulating plate guide **32**, thereby also moving the other side regulating plate in conjunction with one of the side regulating plates **30***r* and **30***l*. The rack members **7***r* and **7***l* are retained at the moved positions by a frictional force with the side regulating plate guide **32**.

[0046] FIG. **4** illustrates configurations of the side regulating plates **30***r* and **30***l* of the first embodiment. As illustrated in FIGS. **4**A and **4**B, the side regulating plates **30***r* and **30***l* include abutting portions **301***r* and **301***l* on inner wall surfaces thereof, respectively. The abutting portions **301***r* and **301***l* are projection portions whose lengths X' in the sheet feeding direction are short (for example, 5 mm or less). When the abutting portions **301***r* and **301***l* are provided one by one, the side edge of the sheet S and each of the abutting portions **301***r* and **301***l* become a state of a substantial point contact.

[0047] As described above, the rotation moment applied to the sheet S is proportional to the length X in the sheet feeding direction of each of the side regulating plates **30***r* and **30***l*. Therefore, when the side edge of the sheet S and each of the abutting portions **301***r* and **301***l* become the state of the substantial point contact like the first embodiment, because the rotation moment applied to the sheet S is decreased even if the side regulating plates **31***r* and **31***l* are inclined, the sheet S is hardly influenced by the inclinations of the side regulating plates **30***r* and **30***l*.

[0048] As illustrated in FIG. **4**, the pair of abutting portions **301***r* and **301***l* is provided across the sheet S from each other. When the lengths X' in the sheet feeding direction of the abutting portions **301***r* and **301***l* are short (for example, 5 mm or less), directions of forces acting on the sheet S by the abutting portions **301***r* and **301***l* become the substantially same straight line orthogonal to the sheet feeding direction. As a result, deviations in the sheet feeding direction of abutting points between the abutting portions **301***r* and **301***l* and the sheet S are eliminated, and the generation of the rotation moment by the deviations in the sheet feeding direction at abutting points L**1** and R**1** can be prevented when the abutting portions **301***r* and **301***l* abut on the sheet S.

[0049] A positioning operation of the sheet S, which is performed by the side regulating plates **30***r* and **30***l* having the above-described configuration, will be described below with reference to FIG. **5**. FIG. **5**A illustrates a state before the sheet S is positioned, and FIG. **5**B illustrates a state after the sheet S is positioned.

[0050] When the side regulating plates **31***r* and **31***l* are moved from the positions illustrated in FIG. **5**A, the side edges of the sheet S and the abutting portions **301***r* and **301***l* become the state of the substantial point contact as illustrated in FIG. **5**A. Irrespective of an inclination θ with respect to the sheet feeding direction, the abutting portions **301***r* and **301***l* abut on the sheet S at the substantially same position in the sheet feeding direction, namely, with no deviation in the sheet feeding direction. As illustrated in FIG. **5**B, the sheet S does not rotate, because the rotation moment is not generated in the sheet S even if the sheet S is subjected to forces F**4** from the abutting portions **301***r* and **301***l*. Therefore, the sheet S is hardly inclined when the sheet S is positioned.

[0051] FIG. **6** illustrates a state immediately after the leading end of the sheet S is fed by the sheet feeding roller **3***c*. The sheet S is subjected to forces F**5** at the abutting portions **301***r* and **301***l* depending on a difference between right and left diameters of the sheet feeding roller **3***c*, a pressure balance between the right and left diameters, and alignment of the sheet feeding roller **3***c* with respect to the sheet feeding direction. On the other hand, in the first embodiment, the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* abut on the side edges of the sheet S at the same position in the sheet feeding direction to regulate an attitude of the sheet S. Therefore, a gap is eliminated unlike the conventional art, but the sheet S does not rotate. Consequently, in the first embodiment, the skew feeding of the sheet S is not generated during the sheet feed.

[0052] In the first embodiment, until the leading end of the sheet S reaches the pair of conveying rollers **3***e* since the sheet S is fed by the sheet feeding roller **3***c*, the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* are set to positions at which the abutting portions **301***r* and **301***l* can abut on the side edges of the sheet S. Plural pairs of conveying rollers **3***e* constituting the sheet conveying portion are provided in the width direction. In the first embodiment, two pairs of conveying rollers **3***e* are provided, and the two pairs of conveying rollers **3***e* convey the sheet S while nipping the sheet S, thereby stabilizing the attitude of the sheet S. Therefore, the sheet S is regulated by the abutting portions **301***r* and **301***l* such that the attitude of the sheet S does not change until the leading end of the sheet S reaches the pairs of conveying rollers **3***e*, so that the skew feeding of the sheet S can be prevented from the feed to the conveyance.

[0053] In the first embodiment, the lengths X' in the sheet feeding direction of the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* are set to 5 mm or less. However, there is no limitation to the lengths X' in the sheet feeding direction of the abutting portions **301***r* and **301***l*. FIG. **7** illustrates a determination result of the lengths X' of the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* to a tolerance of a skew feeding amount. In the first embodiment, the tolerance of the skew feeding amount is set to 0.5% of a long side (sheet feeding direction) of the sheet S, and 150 letter-size (215.9 mm×279.4 mm) sheets Shaving a basis weight of 75 g/m^2 are stacked. The skew feeding amount is determined when the 150 sheets S are positioned.

[0054] As illustrated in FIG. **7**, the skew feeding amount falls within the tolerance in a range of X' (lengths of the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l*) 30 (mm). Therefore, the effect of the first embodiment is exerted when the length X' of each of the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* is set to the range of X'≦30 (mm). Usually the side regulating plates **31***r* and **31***l* are molded by a synthetic resin. In the side regulating plates **31***r* and **31***l*, a thickness of at least 0.5 mm is required to cause the synthetic resin to flow to details of a mold. Accordingly, the length X' of each of the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* is set to the range of 0.5 (mm)≦X'≦30 (mm).

[0055] As described above, in the first embodiment, the abutting portions **301***r* and **301***l* of the side regulating plates **31***r* and **31***l* abut on the side edges of the sheet S in the state of the substantial point contact and the state in which the deviation in the sheet feeding direction is eliminated. Therefore, when the lengths X' in the sheet feeding direction of the abutting portions **301***r* and **301***l* are short (for example, 5 mm or less), directions of forces acting on the sheet S by the abutting portions **301***r* and **301***l* become the substantially same straight line orthogonal to the sheet feeding direction. As a result, the generation of the sheet skew feeding can be suppressed by the simple configuration.

[0056] When the lengths X' in the sheet feeding direction of the abutting portions **301***r* and **301***l* are 5 mm or more, sometimes the directions of the forces acting on the sheet do not become the substantially same straight. Even in this case, although accuracy is slightly degraded, the generation of the skew feeding of the sheet can be suppressed better than ever before. In the configurations of the side regulating plates **31***r* and **31***l* of the first embodiment, because the regulating portion which regulates the sheet S is restricted compared with the conventional configurations, the size is easily managed on the production.

[0057] A second embodiment of the invention will be described below. FIGS. **8**A to **8**C illustrate a side regulating plate provided in a sheet tray of a sheet feeding apparatus according to a second embodiment of the invention. In FIGS. **8**A to **8**C, the same or equivalent component is designated by the same numeral as that of FIGS. **4**A to **4**C.

[0058] In FIGS. **8**A and **8**B, the numerals **32***r* and **32***l* designate side regulating plates. Similarly to the side regulating plates **31***r* and **31***l* of the first embodiment, the side regulating plates **32***r* and **32***l* include abutting portions **302***r* and **302***l* having lengths δ (≦30 mm) in the sheet feeding direction, respectively. As illustrated in FIG. **8**, the side regulating plates **32***r* and **32***l* include regulating portions **322***r* and **322***l*, respectively. The regulating portions **322***r* and **322***l* are con-

tinuously provided from the abutting portions **302***r* and **302***l* while recessed by t in the width direction from the abutting portions **302***r* and **302***l*.

[0059] The regulating portions **322***r* and **322***l* are continuously provided for the purpose of backup in the case of the thin sheet having the basis weight of about 50 g. The recess width t of each of the regulating portions **322***r* and **322***l* is set such that the abutting portions are in contact with the sheet S even if the side regulating plates **32***r* and **32***l* are most inclined on a manufacturing tolerance. In other words, projection amounts of the abutting portions **302***r* and **302***l* are set such that the abutting portions **302***r* and **302***l* abut on the side edges of the sheet S even if the regulating portions **322***r* and **322***l* are most inclined with respect to the sheet feeding direction. In the second embodiment, the recess width t is set to 5 mm. Similarly to the first embodiment, the abutting portions **302***r* and **302***l* are provided opposite each other as illustrated in FIG. **8**C.

[0060] A positioning operation of the sheet S, which is performed by the side regulating plates **32***r* and **32***l* having the above-described configuration, will be described below. FIG. **9**A illustrates a state in which a thin sheet S' is positioned by the side regulating plates **32***r* and **32***l* having maximum inclinations θ1 on the manufacturing tolerance. FIG. **9**B illustrates a state immediately after the thin sheet S' is fed by the sheet feeding roller **3***c* while the difference between the right and left diameters of the thin sheet S', the balance between the right and left diameters, and the alignment with respect to the sheet feeding direction are not adjusted.

[0061] The lengths δ and the widths t of the abutting portions **302***r* and **302***l* are set to the above-described values in positioning the thin sheet S', whereby the abutting portions **302***r* and **302***l* abut on the side edges of the thin sheet S' at the substantially same position as illustrated in FIG. **9**A similarly to the first embodiment. Part of the regulating portion **322***r* also abuts on the thin sheet S'.

[0062] At this point, it is assumed that a force F**7** is applied to the thin sheet S' during a process in which the thin sheet S' is fed by the sheet feeding roller **3***c*. When the side edges of the thin sheet S' are regulated by the abutting portions **302***r* and **302***l* having the lengths δ, the force acting on the side edge per unit length of the thin sheet S' is increased with decreasing length δ. As a result, sometimes the side edges of the thin sheet S abutting on the abutting portions **302***r* and **302***l* are deformed to hardly regulate the rotation of the thin sheet S' depending on the settings of the lengths **6** of the abutting portions **302***r* and **302***l* or a kind of the thin sheet S'. In such cases, the thin sheet S' rotates.

[0063] On the other hand, in the second embodiment, the side edges of the thin sheet S' are regulated by the backup regulating portions **322***r* and **322***l* provided on the upstream side in the sheet feeding direction of the abutting portions **302***r* and **302***l* as illustrated in FIG. **9**B, so that the excess skew feeding can be prevented. Thus, in the second embodiment, the excess skew feeding can be prevented by providing the backup regulating portions **322***r* and **322***l* even if the thin sheet S' is fed.

[0064] A third embodiment of the invention will be described below. FIGS. **10**A and **10**B illustrate a configuration of a movable portion of the side regulating plates provided in the sheet tray **3***a* of a sheet feeding apparatus of the third embodiment. In FIGS. **10**A and **10**B, the same or equivalent component is designated by the same numeral as that of FIG. **3**.

[0065] In FIG. **10**A, a fixing portion **11***r* is provided on the side regulating plate guide **32** (see FIG. **3**) to fix side regulating plates **33***r* and **33***l*, and a rack-shaped tooth is provided in the fixing portion **11***r*. A latching portion **10***r* is provided in a rack member **7***r* of the side regulating plate **33***r*, and a projection which elastically engages with the fixing portion **11***r* is provided in the latching portion **10***r*.

[0066] When the side regulating plates **33***r* and **33***l* are moved in the direction in which the side regulating plates **33***r* and **33***l* come close to each other, the latching portion **10***r* of the side regulating plate **33***r* is pressed against the rack-shaped tooth of the fixing portion **11***r*, and the latching portion **10***r* is subjected to a force in a bending direction by the rack-shaped tooth, whereby the latching portion **10***r* is moved beyond the rack-shaped tooth. Therefore, the side regulating plates **33***r* and **33***l* can be moved in the direction in which the side regulating plates **33***r* and **33***l* come close to each other.

[0067] On the other hand, when the side regulating plates **33***r* and **33***l* are moved in the direction in which the side regulating plates **33***r* and **33***l* are separated from each other, the side regulating plates **33***r* and **33***l* cannot be moved because the latching portion **10***r* of the side regulating plate **33***r* is latched in the rack-shaped tooth of the fixing portion **11***r*. As illustrated in FIG. **11**B, when the side regulating plates **33***r* and **33***l* are moved in the direction in which the side regulating plates **33***r* and **33***l* are separated from each other, a lever **12***r* provided in the latching portion **10***r* is pressed in a direction of an arrow C by a finger to elastically bend the latching portion **10***r*. Therefore, the latching of the latching portion **10***r* in the rack-shaped tooth of the fixing portion **11***r* is released.

[0068] When the fixing portion **11***r* is provided, the positioning is strengthened in the direction in which the side regulating plates **33***r* and **33***l* are opened, namely, the direction in which the side regulating plates **33***r* and **33***l* are separated from each other. On the other hand, as illustrated in FIG. **10**B, the movement in the direction in which the side regulating plates **33***r* and **33***l* are closed, namely, the direction in which the side regulating plates **33***r* and **33***l* come close to each other can be performed on a pitch p of the rack-shaped tooth of the fixing portion **11***r*.

[0069] Therefore, as illustrated in FIG. **11**, one of the sheet regulating portions **303***r* and **303***l* is elastically formed so as to abut on the side edge of the sheet S even if the side regulating plates **33***r* and **33***l* are opened by the pitch p. In the third embodiment, the sheet regulating portion **303***r* is elastically formed. The sheet regulating portion **303***l* is provided across the sheet S from the elastically-formed sheet regulating portion **303***r*.

[0070] As a result, because the sheet regulating portions **303***r* and **303***l* abut on the side edges of the sheet S even if the side regulating plates **33***r* and **33***l* are opened by the pitch p of the rack-shaped tooth, the effect similar to that of the second embodiment can be obtained. As described above, in the configuration of the third embodiment in which the movements in the width directions of the side regulating plates **33***r* and **33***l* are positioned by the rack-shaped tooth, the inexpensive sheet feeding apparatus advantageous to the skew feeding can be provided by the simple configuration.

[0071] 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.

[0072] This application claims the benefit of Japanese Patent Application No. 2010-173729, filed Aug. 2, 2010, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A sheet feeding apparatus comprising:
- a sheet storage portion which stores sheets;
- a sheet feeding roller which feeds the sheet stored in the sheet storage portion;
- a pair of side edge regulating portions which is provided opposite each other in the sheet storage portion so as to regulate positions of side edges in a width direction orthogonal to a sheet feeding direction of the stored sheet, and at least one of the pair of side edge regulating portions can be moved in the width direction; and
- projection portions provided opposite each other on inner wall surfaces of the side edge regulating portions so as to abut on the side edges of the sheet, respectively.

2. The sheet feeding apparatus according to claim **1**, wherein
- a projection amount of the projection portion is set such that the projection portion abuts on each side edge of the sheet even if the pair of side edge regulating portions is most inclined with respect to the sheet feeding direction.

3. The sheet feeding apparatus according to claim **1**, wherein
- a length of the projection portion of the side edge regulating portion is set to a range of 0.5 (mm)≦X'≦30 (mm).

4. The sheet feeding apparatus according to claim **1**, comprising
- a sheet conveying portion which conveys the sheet fed by the sheet feeding roller while nipping the sheet,
- wherein the projection portion is provided at a position at which the projection portion abuts on each side edge of the sheet until the sheet reaches the sheet conveying portion.

5. The sheet feeding apparatus according to claim **4**, wherein
- the plurality of sheet conveying portions is provided in the width direction.

6. The sheet feeding apparatus according to claim **1**, wherein
- a regulating portion is provided on the inner wall surface of the side edge regulating portion and on an upstream side in the sheet feeding direction of the projection portion, the regulating portion abutting on the sheet to regulate inclination of the sheet when the sheet is bent by abutting on the projection portion.

7. The sheet feeding apparatus according to claim **1**, wherein
- at least one of the pair of side edge regulating portions is configured to elastically abut on the side edge of the sheet.

8. An image forming apparatus comprising:
- a sheet feeding apparatus in which a sheet stored in a sheet storage portion is fed by a sheet feeding roller;
- an image forming portion which forms an image in the sheet fed by the sheet feeding apparatus; and
- a pair of side edge regulating portions which is provided opposite each other in the sheet storage portion so as to regulate positions of side edges in a width direction orthogonal to a sheet feeding direction of the stored sheet,
- wherein at least one of the pair of side edge regulating portions can be moved in the width direction, and projection portions are provided opposite each other on inner wall surfaces of the side edge regulating portions so as to abut on the side edges of the sheet, respectively.

9. The image forming apparatus according to claim **8**, wherein
- a projection amount of the projection portion is set such that the projection portion abuts on the side edges of the sheet even if the pair of side edge regulating portions is most inclined with respect to the sheet feeding direction.

10. The image forming apparatus according to claim **8**, wherein
- a length of the projection portion of the side edge regulating portion is set to a range of 0.5 (mm)≦X'≦30 (mm).

11. The image forming apparatus according to claim **8**, comprising
- a sheet conveying portion which conveys the sheet fed by the sheet feeding roller while nipping the sheet,
- wherein the projection portion is provided at a position at which the projection portion abuts on each side edge of the sheet until the sheet reaches the sheet conveying portion.

12. The image forming apparatus according to claim **11**, wherein
- the plurality of sheet conveying portions is provided in the width direction.

13. The image forming apparatus according to claim **8**, wherein
- a regulating portion is provided on the inner wall surface of the side edge regulating portion and on an upstream side in the sheet feeding direction of the projection portion, the regulating portion abutting on the sheet to regulate inclination of the sheet when the sheet is bent by abutting on the projection portion.

14. The image forming apparatus according to claim **8**, wherein
- at least one of the pair of side edge regulating portions is configured to elastically abut on the side edge of the sheet.

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