IMAGE BEARING MEMBER AND DRIVING MECHANISM THEREFOR

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an image bearing member usable with an electrophotography or another image forming process, and a driving mechanism for the image bearing member. This invention also relates to an image forming apparatus using the image bearing member and/or the driving mechanism.

Also, the present invention relates to a process unit which contains as a unit an image bearing member such as a photosensitive drum or belt or an insulating drum or belt and at least one of processing means actable on the image bearing member to form repeatingly an image on the photosensitive member, such as a charger, a developing device, a transfer charger, a cleaning device or the like, the process unit being detachably mountable into a main assembly of the image forming apparatus. Further, the present invention relates to an image forming apparatus such as an electrophotographic copying machine or recording machine using the process cartridge.

An electrophotographic copying machine or printer using such a process unit or cartridge is known as disclosed in U.S. Patents Nos. 3,985,436; 4,286,861; 4,470,689; 4,551,000; 4,575,221; and 4,591,258. The structures of the known process cartridge will be

briefly explained in conjunction with Figures 9 and 10.

Figure 9 is a perspective view illustrating the connecting portion between the cartridge and the main assembly of the image forming apparatus.

Figure 10 is a sectional view illustrating the connecting portion between the cartridge and the main assembly of the apparatus. Within a cartridge housing 7a, there are contained a developing device, a cleaning device and other means (process means) together with a photosensitive drum 4. The detailed explanation is omitted in this respect, since they are known.

At that side of the cartridge housing which is engaged with the main assembly, there are exposed externally a cartridge shaft 5a into which a part of the photosensitive drum 4a is reformed, and a drive transmission gear 6a fixedly mounted on the shaft 5a. A part of the gear 6a is formed into ribs 6c for receiving a driving pin 3b of the main assembly. On the other hand, the photosensitive drum 4a is supported in the housing 7a with the cartridge supporting portion 6b rotatably supported in the housing 7a.

The main assembly is provided with a drum driving gear 3a which is rotatably supported in a bearing 2a fixed to a frame 1b. The driving gear 3a is driven by an unshown driving means and is provided with the driving pin 3b which is movable in the leftward and

rightward directions in this Figure and which is normally biased toward the cartridge.

When the cartridge is inserted in the direction indicated by an arrow to mount the cartridge in place in the apparatus, the cartridge shaft 5a is engaged with the bearing 2a of the main assembly, whereby the cartridge is correctly positioned with respect to the main assembly. Then, the drum driving gear 3a rotates, the driving pin 3b driven with the gear 3a is brought into engagement with a rib 6c of the cartridge, and the further rotation of the gear 3a rotates the photosensitive drum 4a.

The described structure is effective to reduce the size of the cartridge. However, in the case where the diameter of the photosensitive drum is reduced, or where the length of the drum is increased in comparison with the diameter of the photosensitive drum, undesirably biased force is exerted to the photosensitive drum since then the position where the drum 4a is supported and the position where the driving force is transmitted to the drum are apart in the direction of the rotational axis thereof. This results in vibration of the photosensitive drum 4a or obstructions to a smooth rotation of the photosensitive drum 4a.

SUMMARY OF THE INVENTION

According to the present invention an image bearing member which is detachably mountable into an image forming apparatus comprises:

a) positioning portion at one of its ends which is detachably engageable by a shaft carried by the image forming apparatus, the positioning portion and shaft being constructed so that when the image bearing member is mounted into the image forming apparatus the shaft accurately locates and positions the image bearing member in relation to other elements of the image forming apparatus;

b) a driving force receiving portion for receiving a driving force for rotating the image bearing member; and

c) the positioning portion and the driving force receiving portion overlapping radially.

According to one aspect of the invention the positioning portion is inset with respect to the said end of the image bearing member so that the overall length of the image bearing member is reduced.

According to a further aspect of the invention the shaft is adapted when in its locating position within the printing member itself to engage an electrically conductive member carried by the image bearing member to thereby provide a means for supplying electrical power to the image bearing member and other elements of the image forming apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 are sectional views of a part of a process cartridge and a part of the main assembly, using an image bearing member according to an embodiment of the present invention.

Figures 3, 4 and 5 are partly broken perspective views illustrating the connection between the cartridge and the main assembly.

Figures 6 and 7 are perspective views of the cartridge according to the embodiment of the present invention.

Figure 8 is a sectional view of an electrophotographic copying machine using the cartridge according to an embodiment of the present invention.

Figure 9 is a perspective view of a conventional cartridge.

Figure 10 is a sectional view illustrating a connection between the conventional cartridge and a main assembly of the image forming apparatus.

Figure 11 is a sectional view of a part of a cartridge and a part of the main assembly according to another embodiment of the present invention.

Figure 12 is a partial perspective view of the cartridge of Figure 11.

Figure 13 is a sectional view of a part of a cartridge and a main assembly, according to a further embodiment of the present invention.

Figure 14 is a sectional view of a part of a cartridge and a part of a main assembly according to a further embodiment of the present invention.

Figure 15 is a perspective view of an example of an image bearing member in the form of a combination of a belt and supporting rollers.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 1, 2, 3 and 4, structures of an image bearing member, a process cartridge and the main assembly, according to an embodiment of the present invention, will be described.

The process cartridge comprises a photosensitive drum or cylinder 1, a flange 2 and a cartridge housing 3 containing the photosensitive drum 1. The flange 2 is fixedly mounted to the photosensitive drum 1 adjacent a longitudinal end of the photosensitive drum 1 and is provided with a gear portion 2b for driving an internal mechanism in the

process cartridge, an engaging portion for rotationl engagement with the cartridge housing 3 and a positioning portion 2f for receiving a driving shaft 4 of the main assembly. The positioning portion 2f is formed at the center of the flange 2. The flange 2 is made of resin material such as polyacetal resin polycarbonate resin. The cartridge housing 3 has a drum supporting portion 3a for receiving the engaging portion 2c of the flange 2. In this embodiment, the photosensitive drum 1 is formed by an aluminum cylinder having a diameter of 30 mm. When the positioning portion 2f receives the shaft 4, the process cartridge and the photosensitive drum 1 are correctly positioned relative to the main assembly. The shaft 4 is rotatably supported on a side plate 7 of the main assembly by a spring receiving and bearing member 5 and a bearing 6. And shaft is driven by a chain-sprocket mechanism 8. A drive transmission element 10 for transmitting the driving force of the driving shaft 4 to the drum 1 is mounted on the driving shaft 4 for longitudinal sliding movement only, that is, the drive transmission element 10 is slidable in the longitudinal direction but not rotatable with respect to the shaft 4. The drive transmission element is normally urged by a coil spring 12 toward the drum 1. The driving transmission element 10 is provided with one or more projections 10a which are engageable with a receiving

portion or portions 2d formed in the flange 2, as best seen in Figures 3 and 4. By this engagement, the drum 1 is rotationally driven. To an inside of the drum, a conductive plate is strongly fixed. The conductive plate 13 is of steel, copper, stainless steel or phosphor bronze. When the cartridge is mounted into the main assembly in place, the driving shaft 4 which is also conductive is contacted to a spring portion 13a into which a part of the conductive plate 13 is formed, so that the electrical connection is established therebetween.

When the cartridge is mounted into the main assembly, a free end of the driving shaft 4 which also functions as a positioning member is inserted into the positioning portion 2f of the flange 2 so that the rotational center of the photosensitive drum 1 is aligned with the driving shaft 4 of the main assembly. Then, the cartridge is further pushed into the main assembly, and the projected portion 10a of the drive transmitting element 10 is brought into the drive receiving portion 2d of the flange 2, by which the engagement between the driving shaft 4 and the drum 1 is completed. It is possible that the projected portion 10a and the receiving portion 2d are not aligned. In that case, the free end of the projection 10a is engaged to the surface 2e, and the drive transmission element is pushed leftwardly as seen in

Figures 1 and 2. When, however, the driving shaft 4 rotates, they are sooner or later brought into alignment, and then, the drive transmission element 10 is pushed toward the process cartridge by the action of the coil spring 12, so that they are engaged properly. In this state, the photosensitive drum is rotatable by the driving force from the main assembly with the photosensitive drum being electrically grounded. This engaged state is shown in Figure 2. In Figure 3, the process cartridge and the main assembly are shown in the state of being engaged in a perspective view.

In Figure 4, the relation between the driving shaft 4 with the transmission element 10 and the flange 2 with the positioning portion 2f and the drive receiving portion 2d, in a perspective view under the condition that they are being engaged.

In Figure 5, the electrical contact between the shaft 4 and the conductive plate 13 is illustrated in a perspective view. As will be understood, the conductive plate 13 has a projection 13b by which it is securedly fixed to the inside surface of the drum 1.

Referring to Figure 6, the gear portion 2b is meshed with a gear 14 for transmitting the driving force to rotate a developing sleeve of a developing device 14 which is contained in the cartridge as a unit and also is meshed with a gear 15a for transmitting a driving force to rotate a screw which serves to

forcedly convey the toner collected by a cleaning device 15 also contained in the cartridge as a unit.

Since the driving force is transmitted to those means from the flange 2 through the gear portion 2b, the load resulting from the required drive transmissions, tends to cause and increase an eccentricity of the flange 2 with respect to the drive shaft 4.

However, as in this embodiment of the present invention, at least a part of the positioning portion 2f of the flange 2 where the shaft 4 and the flange 2 are engaged, is radially overlapped with at least a part of the drive receiving portion 2d of the flange 2 where the driving projection 10a is engaged with the flange 2. Because of this positional relation, even if a force or forces are exerted to the drive receiving portion 2d which is away from the rotational center, it is possible to stably drive and rotate the photosensitive drum 1.

Further, in this embodiment the flange 2 is provided with the gear portion 2b for driving other means, and at least a part of the gear portion 2b is radially overlapped with at least a portion of the positioning portion 2f. Here, "radially overlapped" means that they are overlapped when seen from the rotational axis in a direction perpendicular to the rotational axis.

Because of this positional relation between

the gear portion 2b and the positioning portion 2f, the possible eccentricity of the gear portion 2b and/or the photosensitive drum 1 is minimized even when the gear portion 2b receives an eccentric high load.

In another aspect of the present embodiment, the drive transmitting action from the main assembly to the process cartridge is carried out within the range of the length, that is, width of the photosensitive drum 1. For this reason, the photosensitive drum partly exposed from the cartridge housing 3 does not have a central shaft projected out of the photosensitive drum for the purpose of positioning, as contrasted to the conventional process cartridge. Additionally, the flange having a relatively complicated configuration to receive the driving force is not exposed very much. Therefore, the positioning portion or the drive receiving portion which is an important part of the process cartridge from the standpoint of the driving connection with the main assembly is not damaged or deformed even when the process cartridge is handled without care.

From a further aspect of the drive transmitting mechanism according to this embodiment, the resin flange 2 which functions to receive the driving force to the drum 1, extends from the housing 3 thereinto by a distance l, as shown in Figure 2. Further, when the cartridge is mounted into the main assembly, the shaft

4 extends into the housing to such an extent that it extends into the imaging area L of the drum 1.

Because of this arrangement, that region of the photosensitive drum 1 which is effective for the image formation is partly used as the region for the drive transmitting mechanism and/or the electrical contact establishing region, whereby the total length of the photosensitive drum assembly is reduced as compared with the conventional ones. As a result, the size of the photosensitive drum and/or the process cartridge can be reduced, and also, the protection of the drive transmitting mechanism is assured.

Figure 8 illustrates an electrophotographic copying apparatus usable with the process cartridge according to the embodiment described above.

The copying apparatus 19 comprises a photosensitive drum 1 having a conductive base drum of aluminum coated with a photoconductive layer, which is rotatable in the direction indicated by an arrow. Around the drum 1, there are provided, in the direction of the rotation, a corona discharger 16, an array 17 of short-focus optical elements, a developing device 14, a transfer corona discharger 18 and a cleaning device 15. In this apparatus, the photosensitive drum 1, the discharger 16, the developing device 14 and the cleaning device 14 are contained in the housing 3 as a unit to constitute a process cartridge. The housing 3

is guided and supported by a guide rail 20 fixed to the main assembly of the electrophotographic copying apparatus. The process cartridge is detachably mountable into the main assembly.

The developing device 14 includes at an upper position a hopper 14a for containing developer, and also includes at a lower position a developing roller 14b which is effective to supply the developer to the photosensitive drum 2. The developer, in this embodiment, may be one component developer containing magnetic toner particles or two component developer containing toner particles and magnetic carrier particles. The developing roller 14b may be in the form of a rotatable magnetic roller having magnetic pole or poles in the surface thereof or may be a combination of a magnetic roller and a non-magnetic sleeve enclosing it. The cleaning device 15 may be in the form of a cleaning blade or a fur brush.

In operation, the surface of the photosensitive drum 1 is uniformly electrically charged by the corona discharger 16 to a predetermined polarity. On the other hand, an original to be copied is placed on an original carrige which is reciprocable in this embodiment and which is located at an upper part of the main assembly is illuminated by a lamp 22, and the light reflected by the original is projected onto the photosensitive drum 1 through the array 17 of the

optical elements. By this exposure of the photosensitive drum 1 to the reflected image light, an electrostatic latent image is formed on the photosensitive drum. The thus formed latent image is developed by the developing device 14, and the developed image is transferred to a transfer material by the transfer corona discharger 18. The transfer material is manually loaded into a transfer material feeding cassette 23, from which the transfer material is fed out one by one with the aid of the transfer rollers 24 and timing roller 25 to between the photosensitive drum 1 and the transfer discharger 18. The transfer material having received the image from the photosensitive drum 1 is transported through a passage 26 to the image fixing device 27 where the transferred image is fixed. Then, the transfer material is discharged onto a tray 30 by a discharging roller couple 29.

In the foregoing embodiment, the shaft 4 has been described as functioning as a driving shaft as well as a positioning shaft. However, as the positioning shaft, it is not innevitable for the shaft 4 is rotatable.

Figure 11 illustrates another embodiment of the present invention, wherein like reference numerals have been used to describe the corresponding elements. In this embodiment, the positioning portion 2f of the

resin flange 2 receives a positioning shaft 31 which is fixedly mounted to a side plate or frame of the main assembly. In this Figure, the process cartridge is shown as having been mounted into the main assembly. In this state, the gear portion 2b of the flange 2 is meshed with a drum driving gear 32 of the main assembly, so that the rotation of the drum driving gear 32 drives the flange 2, and therefore, the photosensitive drum 1. It is possible that the gear portion 2b of the flange 2 is further meshed with other gears for driving another processing means within the process cartridge, as shown in Figure 6.

Figure 12 illustrates the meshing engagement between the gear portion 2b of the flange 2 and the drum driving gear 32. The driving gear 32 is supported together with an additional gear 33 on a gear supporting plate 34. The supporting plate 34 is pivotably supported on a pin 35. By this structure, the driving gear 32 is capable of assuming a first position wherein it is meshed with the gear portion 2b and a second portion wherein it is away therefrom, in association with mounting an demounting of the process cartridge with respect to the main assembly.

It is understood that, in this embodiment, the positioning portion 2f where the positioning shaft 31 is engaged with the flange 2 is at least partly overlapped radially with the drum gear portion 2b where

the drum gear portion 2b is externally driven, or the driving force is transmitted to a driving gear to another processing means in the cartridge.

Therefore, even when an eccentric external force is imparted to the photosensitive drum 1, the flange 2 is most stably supported. Similarly to the foregoing embodiment, the photosensitive drum assembly has less portions projecting out of the cartridge housing 3, and the portions used for the positioning and the drive transmission is protected sufficiently by the housing 3.

In this embodiment, the photosensitive drum assembly is constituted by a metal cylindrical member and a resin flange (for example, polycarbonate resin containing fluorine), and the drum positioning portion and the driving force receiving portion are radially overlapped. For this reason, no significant eccentric force is applied, and therefore, the latitude of selecting the flange material is increased.

In this embodiment, the same thing applies as in the embodiment of Figure 2 with respect to the effective length of the drum 1 for the image formation and with respect to the distance l from the out side of the housing 3 to the end of the flange 2.

In the foregoing embodiments, the photosensitive drum 1 and the flange 2 are separate members integrally connected. However, it is possible that the

photosensitive drum has a integrally molded flange 36.

Figures 13 and 14 illustrate embodiments of this type, wherein like reference numerals have been used to designate the corresponding elements. In Figure 13, the positioning and drive force transmitting mechanisms are similar to the embodiment of Figure 1. The positioning and driving shaft 4 is engaged into a bearing portion 37 (a positioning portion) of the photosensitive drum 39. The gear 38 is fixed to the flange 36 by pressure fitting or bonding.

As will be understood from Figure 13, the positional relations described in Figure 1 embodiment apply to this embodiment.

In Figure 14, the positioning and drive force receiving mechanisms are similar to those of Figure 11 embodiment. The drum 39, however, is similar to Figure 13 embodiment. In that it has a molded integral flange.

In the foregoing embodiment, the image bearing member has been in the form of a photosensitive drum. However, the image bearing member may be an insulating drum when the latent image is formed by a modulated ions or a multi-stylus electrodes.

As for the components constituting the process cartridge, the image bearing drum, the corona discharger, the developing device and the cleaning device have been described as being contained in the housing as a unit. However, it is possible that the

process cartridge contains the image bearing drum and the discharger; the image bearing drum and the cleaning device; or the image bearing drum and the developing device. Further, another means of the main assembly may be contained in the housing to constitute a process cartridge.

As another example using a photosensitive drum or a process cartridge containing a photosensitive drum, there is a printer using a modulated laser beam in place of the light reflected by an original to be copied.

In the foregoing embodiments, the process cartridges have been described. However, the present invention is applicable to the photosensitive drum itself.

When the present invention is applied to the process cartridge, the present invention is also applicable to the developing roller and/or a cleaning roller when they receive a driving force from the main assembly independently from the driving force to the photosensitive drum.

In the foregoing embodiments, the photosensitive member in the form of a drum is directly driven. However, the present invention is applicable to a drum member, a cylindrical member or roller for driving a photosensitive member in the form of a belt trained therearound.

Figure 15 illustrates an example of a photosensitive belt and drums supporting it. In this Figure, an electrophotographic photosensitive belt 40 comprises an electrically conductive base belt 42 of a metal and a photoconductive surface layer 41 thereon. The photosensitive belt 40 is supported around the supporting drums 43, 44 and 45 of a conductive material such as aluminum and stainless steel. At least one of those drums may have the same structure as in Figure 1, Figure 11, Figure 13 or Figure 14, in which case the drum functions as a driving drum, and the other drums function as follower drums. By doing so, the photosensitive belt 40 is capable of being driven. In this case, the driving drum corresponds to the photosensitive drum 1 of the foregoing embodiments, and the positional relations described applies to this case. Similarly to Figure 1 embodiment, an electrically contacting plate can be disposed within a range of the width of the belt. Therefore, by disposing the contacting plate as well as the flange within the effective range of the photosensitive member, the width of the image bearing member can be minimized, allowing efficient utilization of the space.

As described above, according to the present invention, the peculiar positional relations described hereinbefore the possible eccentricity, deformation and/or vibration can be minimized even when the driving

load is increased. Additionally, the portion of the image bearing member for receiving the driving force and/or positioning is disposed inside the image bearing member, so that the portion is hardly damaged or deformed externally, together with the advantage of the reduced width of the image bearing member.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

CLAIMS

1. An image bearing member which is detachably mountable into an image forming apparatus comprises:

a) a positioning portion at one of its ends which is detachably engageable by a shaft carried by the image forming apparatus, the positioning portion and shaft being constructed so that when the image bearing member is mounted into the image forming apparatus the shaft accurately locates and positions the image bearing member in relation to other elements of the image forming apparatus;

b) a driving force receiving portion for receiving a driving force for rotating the image bearing member; and

c) the positioning portion and the driving force receiving portion overlapping radially.

2. An image bearing member as claimed in claim 1 in which the positioning portion is inset with respect to the said end of the image bearing member so that the overall length of the image bearing member is reduced.

* C L M S *

3. An image bearing member as claimed in any previous claim in which the shaft is adapted when in its locating position within the positioning member itself to engage an electrically conductive member carried by the image bearing member to thereby provide a means for supplying electrical power to the image bearing member and other elements of the image forming apparatus.

4. An image bearing member as claimed in any previous claim wherein said image bearing member is a photosensitive drum comprising a base drum and an electrophotographic photosensitive layer thereon.

5. An image bearing member according to any preceding claim, wherein said image bearing member comprises an electrophotographic photosensitive belt and a drum supporting it.

6. An image bearing member according to any preceding claim, wherein said positioning portion is a recess substantially concentric with said image bearing member.

* C L M S *

7. An image bearing member according to any preceding claim, wherein said positioning portion extends into a region corresponding to a region of said image bearing member usable for image formation thereon.

8. An image bearing member as claimed in any preceding claim, wherein the driving force receiving portion is substantially concentric with the image bearing member.

9. A process cartridge for an image forming apparatus, comprising, as a unit, an image bearing member as claimed in any preceding claim and at least one process means operable on the image bearing member.

10. A cartridge as claimed in claim 9 when dependent directly or indirectly on claim 3, wherein the image bearing member is in the form of a metal drum having an insulating flange at one end thereof, the positioning portion being provided by the flange, and the electrically conductive member being disposed inside the drum adjacent the flange.

11. A cartridge as claimed in claim 9 or 10, further comprising drive transmitting means for transmitting the driving force to the process means, the drive transmitting means being radially overlapped, at least in part, with the driving force receiving portion and the positioning portion.

12. A cartridge as claimed in claim 11, wherein the driving force receiving portion also functions as the drive transmitting means.

13. A cartridge as claimed in any of claims 9 to 12, wherein the, or one of the, process means is a developing means.

14. A cartridge as claimed in any of claims 9 to 13, wherein the, or one of the, process means is a cleaning means.

15. A cartridge as claimed in any of claims 9 to 14, wherein the, or one of the, process means is a corona discharger.

16. An image forming apparatus comprising an image bearing member as claimed in any of claims 1 to 8 or a process cartridge as claimed in any of claims 9 to

15, detachably mountable into the apparatus, a rotational centre positioning shaft for engaging the positioning portion of the image bearing member when mounted in the apparatus, and means for driving the image bearing member via the driving force receiving portion.

17. An apparatus as claimed in claim 16, wherein the driving means is mounted on the positioning shaft.

18. An apparatus as claimed in claim 16 or 17 when dependent on any of claims 9 to 15, further comprising means for guiding the process cartridge when it is mounted into the apparatus.

19. A cartridge according to claim 10, wherein the driving force receiving portion is inside the insulating flange.

20. An image bearing member or cartridge according to any one of claims 1 to 4, and 19, wherein the drive receiving portion includes a gear.

21. An image bearing member, process cartridge, or image forming apparatus, substantially as described in

the description with reference to Figures 1 to 8 and 11 to 15 of the drawings.

---

* C L M S *