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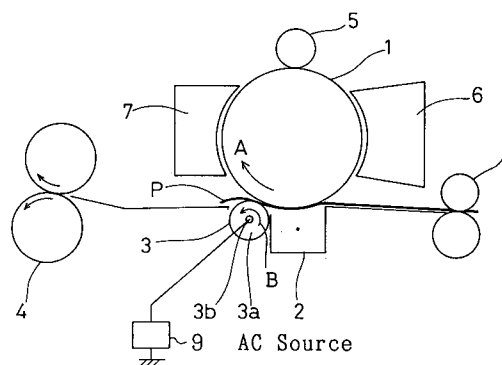
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D-80538 München (DE)(54) **Transfer sheet separator in an image forming apparatus.**

(57) A conductive separating roller (3) is arranged to be in contact with the surface of a transfer sheet (P) electrostatically adhering to the surface of a photoreceptor drum (1). The charge on the transfer sheet (P) is removed by applying an alternating current voltage or a pulse voltage to the separating roller (3). The transfer sheet (P) is separated from the surface of the photoreceptor drum (1) by its dead load and/or its resiliency against being bent.

Fig. 1

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a separator for separating a transfer sheet from a photoreceptor, and more specifically, to a separator for separating an electrostatically adhering transfer sheet for use in an image forming apparatus such as an electrophotographic copying machine, a printer and a facsimile machine.

Description of the Prior Art

In a conventional electrophotographic copying machine, electrostatic transfer is performed to transfer a toner image formed on the surface of a photoreceptor to a transfer sheet. However, the transfer sheet made to electrostatically adhere to the surface of the photoreceptor in the electrostatic transfer remains adhering to the surface of the photoreceptor after the toner image is transferred to the transfer sheet.

To explain the mechanism of the electrostatic adherence of the transfer sheet to the surface of the photoreceptor, electrostatic transfer of negatively charged toner will be described as an example with reference to Fig. 2. As shown in the figure, when positive corona discharge is applied from the back surface of the transfer sheet P (from the upper part of the figure), the surface of the transfer sheet P is charged with positive ions 13 generated by the corona discharge. Then, a negative charge is induced between a photosensitive layer 12 formed on the surface of a photoreceptor drum 1 and a substrate 11 arranged below the layer 12. At this time, the potential of the transfer sheet P is several hundreds to several thousands of volts to the substrate 11. A positive charge applied at the time of main charging remains on the portions of the surface of the photosensitive layer 12 where toner 14 is present. The positive charge decreases the electrostatic force between the transfer sheet P and the photoreceptor drum 1. However, on the portions of the photosensitive layer 12 where no toner is present, since the positive charge is removed at the time of exposure and a negative charge is induced by the corona discharge at the time of transfer, a great electrostatic force works between the photoreceptor drum 1 and the transfer sheet P. Because of this electrostatic force, the transfer sheet P and the surface of the photoreceptor drum 1 are in close contact. The strength of the electric field therebetween is said to be as high as 100kV/cm at the portions where no toner is present. Although this exceeds 30kV/cm which is the withstand voltage of normal air gaps, no discharge occurs since the gap is very small.

Various electrostatic separators (hereinafter sometimes referred to as separators) have been proposed for forcibly separating the transfer sheet electrostatically adhering to the surface of the photoreceptor. Typical ones are a separator employing the AC charge removal separation method and a separator employing the conductor separation method.

According to the charge removal separation method which is generally known, corona discharge is applied from the reverse surface of the transfer sheet by an AC corona charge remover to remove the surface potential of the transfer sheet. After the charge is removed, the transfer sheet is separated from the surface of the photoreceptor by its own dead load and its resiliency against bending generated by its rigidity.

According to the conductor separation method, the transfer sheet is separated from the surface of the photoreceptor by use of a conductive roller. For example, Japanese Laid-open Utility Model Application No. S61-188163 discloses an electrostatic separator employing this method where a conductor to which an earth voltage or a bias voltage is applied is arranged to be close to or in contact with the back surface of the transfer sheet adhering to the surface of the photoreceptor from which the image has been transferred, and by the attractive force between the conductor and the charge of the transfer sheet, the transfer sheet is separated from the surface of the photoreceptor.

However, in the separator employing the AC charge removal separation method, discharge products such as ozone which is harmful to the human body and nitrogen oxides (NOx) which produces a bad effect on the photoreceptor are generated. In the separator of Japanese Laid-open Utility Model Application S61-188163 employing the conductor separation method, when a bias voltage of a polarity reverse to the transfer voltage is applied to the conductor, toner may be reversely transferred onto the surface of the photoreceptor. By simply grounding the conductor, the transfer sheet may not be sufficiently separated from the photoreceptor, since only a weak attractive force is generated.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a separator for separating an electrostatically adhering transfer sheet where the generation of discharge products is reduced and the transfer sheet is surely separated without the toner thereon being reversely transferred to the surface of the photoreceptor.

To achieve the above-mentioned object, according to the present invention, in a separator for separating a transfer sheet electrostatically adher-

ing to the surface of a moving photoreceptor from the surface of the photoreceptor, a conductor the surface of which moves in a direction corresponding to the movement direction of the surface of the photoreceptor is provided to be close to or in contact with the transfer sheet, and the charge on the transfer sheet is removed by applying an alternating current voltage or a pulse voltage to the conductor. The transfer sheet is separated from the surface of the photoreceptor by its dead load and/or its resiliency against bending generated by its rigidity.

The conductor may be roller-shaped or belt-shaped. When a roller-shaped conductor is used, preferably, the roller is made of conductive rubber, and is rotated at a speed substantially equal to the movement speed of the surface of the photoreceptor. When a belt-shaped roller is used, it is also preferable to rotate it at a speed substantially equal to the movement speed of the surface of the photoreceptor.

According to the above-described features, since the charge on the transfer sheet is removed when an alternating current voltage or a pulse voltage is applied to the conductor provided to be close to or in contact with the surface of the transfer sheet, the attractive force working between the photoreceptor and the transfer sheet decreases, so that the resiliency of the transfer sheet against bending due to its rigidity and/or the dead load of the transfer sheet becomes greater than the attractive force to overcome it. As a result, the transfer sheet is separated from the surface of the photoreceptor.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of this invention will become clear from the following description, taken in conjunction with the preferred embodiments with reference to the accompanied drawings in which:

Fig. 1 is a front view schematically showing an electrophotographic copying machine provided with a separator according to an embodiment of the present invention; and

Fig. 2 schematically shows the mechanism of electrostatic transfer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described with reference to the drawing. Fig. 1 schematically shows a separator embodying the present invention which is used in an electrophotographic copying machine.

In the figure, a photoreceptor drum 1 comprises a tube made of a metal such as aluminum on which a photosensitive layer made of amorphous silicon (a-Si) or other photosensitive material is formed. The photoreceptor drum 1 is arranged substantially horizontally in the copying machine, and is rotated clockwise (i.e. in the direction of arrow A) by a driving system (not shown) provided in the copying machine. The direction of rotation of the photoreceptor drum 1 is set to correspond to the conveying direction of a transfer sheet P like the counter-clockwise (arrow B) rotation of a subsequently-described separating roller 3.

Around the surface of the photoreceptor drum 1, a charging means 5, a developing means 6, a transfer charger 2 and a charge-removing and cleaning means 7 are arranged in this order in the direction of rotation of the photoreceptor drum 1. Between the charging means 5 and the developing means 6, the photoreceptor drum 1 is exposed to a laser beam irradiated from the exposure means (not shown).

In an electrophotographic copying machine provided with the above-described arrangement, first, the photosensitive layer on the surface of the photoreceptor drum 1 is charged through corona discharge by the charging means 5. The exposure means irradiates the laser beam in accordance with an image read out from an original (not shown) to the charged surface of the photoreceptor drum 1, thereby forming an electrostatic latent image. The electrostatic latent image is transformed into a toner image by being toner-developed by the developing means 6. The transfer sheet P is conveyed between the photoreceptor drum 1 and the transfer charger 2 by a pair of resist rollers 8 in accordance with the rotation (arrow A) of the photoreceptor drum 1 at a speed equal to the peripheral speed of the surface of the photoreceptor drum 1.

While the transfer sheet P thus conveyed is in contact with the surface of the photoreceptor drum 1, charged toner adhering to the surface of the photoreceptor drum 1 is electrostatically transferred onto the surface of the transfer sheet P by the transfer charger 2. The transfer sheet P to which the toner image has been transferred is separated from the surface of the photoreceptor drum 1 by the separating roller 3 rotating in the direction of arrow B at a peripheral speed equal to that of the surface of the photoreceptor drum 1. Then, the transfer sheet P is heated and pressurized while passing between the rollers at a fixing means 4 to fix the toner image to the surface of the transfer sheet P. On the other hand, after the transfer, the residual toner and charge on the surface of the photoreceptor drum 1 are removed by the charge-removing and cleaning means 7. The photorecep-

tor drum 1 is ready for the next charging when it makes one revolution after the last charging.

The separating roller 3 is arranged in the downstream side of the transfer charger 2 so as to be close to or in contact with the back surface of the transfer sheet P, and rotates in a direction corresponding to the movement direction of the surface of the photoreceptor drum 1.

The separating roller 3 includes a body 3a (volume electrical resistivity $\rho_v = 10^6$ to $10^7 \Omega \cdot \text{cm}$) made principally of conductive rubber and a rotational axis 3b made of a metal. The surface of the separating roller 3 is formed by the conductive body 3a. The body 3a is fixed around the rotational axis 3b so as to form a long-axis roller shape. The body 3a may be made of a conductive resin material such as polystyrene and urethane resin in which carbon or an alkali metal is mixed or of a conductive rubber material. To the rotational axis 3b, an alternating current (AC) voltage or a pulse voltage is applied through a contact terminal (not shown) at the time of separation.

According to the arrangement of the present invention, when an AC voltage or a pulse voltage is applied to the conductive separating roller 3 which is arranged to be close to or in contact with the back surface of the transfer sheet P, the charge on the transfer sheet P is removed, and the attractive force between the photoreceptor drum 1 and the transfer sheet P is decreased. Therefore, the resiliency of the transfer sheet P generated by being bent against its rigidity and/or the dead load of the sheet P overcome the attractive force. As a result, the transfer sheet P is separated from the surface of the photoreceptor drum 1.

Though the separation of the transfer sheet P from the surface of the photoreceptor drum 1 according to the present invention is like an electrostatic separation, it is not made by the attractive force of the separating roller 3 to the transfer sheet P. It is mainly caused by the fact that the elastic energy (resiliency), which was generated and stored when the transfer sheet P was attracted and bent against its rigidity by the surface of the photoreceptor drum 1, exceeds the electrostatic energy between the photoreceptor drum 1 and the transfer sheet P. This is based on a principle similar to that of the conventionally-known method using the AC corona charge remover.

In this embodiment, since the conductor separation method is employed without using the AC corona charge remover, the necessary current and voltage are reduced. As a result, the generation of the discharge products such as ozone which is harmful to the human body and NOx which produces a bad effect on the photoreceptor is reduced. Moreover, by applying an AC voltage or a pulse voltage to the separating roller 3, the transfer

sheet P is surely separated without the toner on the transfer sheet P being reversely transferred to the surface of the photoreceptor drum 1.

Further, since the separating roller 3 is rotated at a peripheral speed equal to that of the surface of the photoreceptor drum 1 in a direction corresponding to the direction of rotation of the drum 1, it is possible to arrange the separating roller 3 close to the surface of the photoreceptor drum 1. Since the transfer efficiency increases consequently, the necessary current and voltage are reduced. As a result, the generation of the discharge products such as ozone and NOx can be further reduced.

Instead of the roller-shaped conductor, a belt-shaped conductor may be used. By moving the surface of the belt-shaped conductor at a speed equal to the movement speed of the surface of the photoreceptor drum 1, the same advantages are obtained.

As described above, according to the present invention, the transfer sheet is surely separated without the toner thereon is reversely transferred to the surface of the photoreceptor, and further, the generation of the discharge products (ozone, NOx) is largely reduced.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described.

Claims

1. A transfer sheet separator for separating a transfer sheet (P) electrostatically adhering to a moving surface of a photoreceptor (1) from the surface of the photoreceptor (1), said transfer sheet separator comprising:
alternating current voltage supplying means (9); and
a conductor (3) to which an alternating current voltage is applied by the alternating current voltage supplying means (9) to remove a charge on the transfer sheet (P) adhering to the surface of the photoreceptor (1), said conductor (3) being arranged to be close to a back surface of the transfer sheet (P) adhering to the surface of the photoreceptor (1), a surface of said conductor (3) moving in a direction corresponding to a movement direction of the surface of the photoreceptor (1).
2. A transfer sheet separator according to claim 1, wherein said alternating current voltage applied to the conductor (3) is a pulse voltage.

3. A transfer sheet separator according to claim 1, wherein said conductor (3) is arranged to be in contact with the transfer sheet (P) at a back surface of a portion adhering to the surface of the photoreceptor (1). 5
4. A transfer sheet separator according to claim 1, wherein the transfer sheet (P) the charge of which has been removed by the conductor (3) is separated from the surface of the photoreceptor (1) by a dead load of the transfer sheet (P) and a resiliency of the transfer sheet (P) against a bending generated by a rigidity of the transfer sheet (P). 10 15
5. A transfer sheet separator according to claim 1, wherein said photoreceptor (1) is formed on a surface of a rotary drum and wherein said conductor (3) is formed to be roller-shaped. 20
6. A transfer sheet separator for separating from a moving surface of a photoreceptor (1) a transfer sheet (P) electrostatically adhering to the surface of the photoreceptor (1) and to which an image has been transferred by a transfer means (2), wherein a conductor (3) a surface of which moves in a direction corresponding to a movement direction of the surface of the photoreceptor (1) is provided in a downstream side of the transfer means (2) so as to be close to the transfer sheet (P), and a charge on the transfer sheet (P) is removed by applying an alternating current voltage to the conductor (3), and the transfer sheet (P) is separated from the surface of the photoreceptor (1) by a dead load of the transfer sheet (P) and a resiliency of the transfer sheet (P) against a bending generated by a rigidity of the transfer sheet (P). 25 30 35 40
7. A transfer sheet separator according to claim 6, wherein said conductor (3) is arranged to be in contact with a back surface of the transfer sheet (P) adhering to the surface of the photoreceptor (1). 45

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Fig. 1

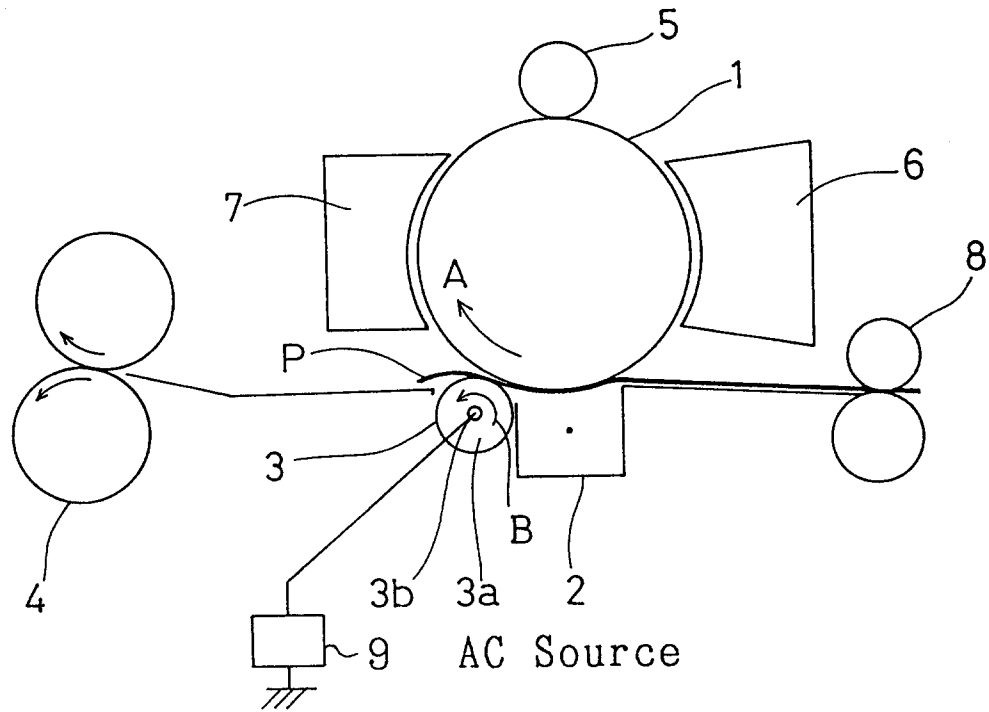
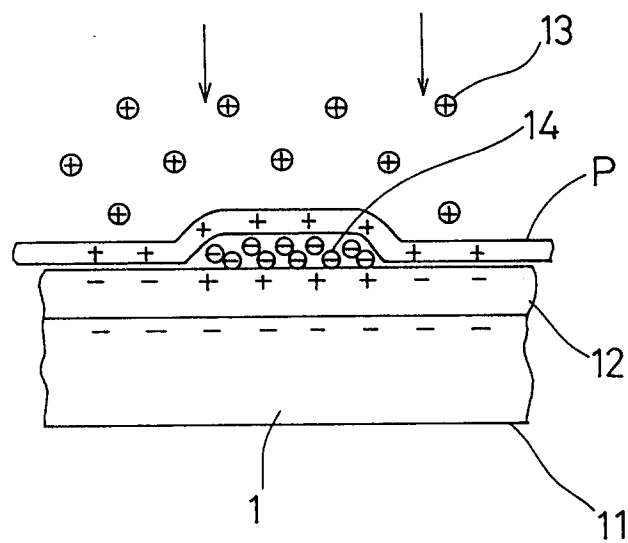


Fig. 2





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 8876

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 16, no. 266 (P-1371) 16 June 1992 & JP-A-04 067 183 (CANON INC) 3 March 1992 * abstract *	1,2	G03G15/00
X	---		
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 82 (P-189) (1227) 6 April 1983 & JP-A-58 010 764 (FUJI XEROX K.K.) 21 January 1983	1,3,4,6,7	
Y	* abstract *	5	

D,Y	JP-U-61 188 163 (...) * figure 2 *	5	

A	PATENT ABSTRACTS OF JAPAN vol. 8, no. 65 (P-263) (1502) 27 March 1984 & JP-A-58 211 774 (RICOH K.K.) 9 December 1983 * abstract *	1,3,6,7	

			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			G03G
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 September 1994	Examiner Cigoj, P
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	