

"ELECTROPHOTOGRAPHIC APPARATUS"

The present invention relates to an electrophotographic apparatus, e.g. for use in copying machines, facsimile machines or optical printers.

Xerography is one of the most important processes used in conventional electrophotographic processes. Xerography consists of six basic steps as follows: a first step in which a photosensitive member is charged with electricity; a second step in which the photosensitive member is exposed by irradiation with light to form an electrostatic latent image thereon; a third step in which toner particles are attached to the electrostatic latent image on the photosensitive member to develop this image; a fourth step in which the developed image is transferred to a record paper by utilizing an electric field; a fifth step in which the image transferred to the record paper is fixed; and a sixth step in which the photosensitive member is cleaned of the toner remaining thereon. In a known xerography apparatus, devices for respectively carrying out the first to fourth and sixth steps are separately disposed along a drum- or sheet-shaped photosensitive member having a relatively large diameter, and a device for carrying out the fifth step is

disposed in the path for transporting the recording paper
(see e.g., "ELECTROPHOTOGRAPHY", written by R.M. Schaffert,
published by THE FOCAL PRESS LIMITED (LONDON AND NEWYORK)).

There is another type of conventional xerography
5 apparatus designed to reduce the number of steps and shorten
the time required for printing, e.g., one disclosed in
Japanese Laid-Open Patent Specification No. 77848/1981.
This type of xerography apparatus includes a photosensitive
member having a photoconductive layer formed on a transparent
10 electrode layer, an electrode provided opposite to this
photosensitive member, a power supply for applying a voltage
between the said opposite electrode and the transparent
electrode layer, and an exposure device which produces
a light image from the side of the photosensitive member
15 which is closer to the transparent electrode layer. A toner
ribbon, which is charged in advance, and record paper are
interposed between the photosensitive member and the said
opposite electrode in such a manner that they are laid one
upon the other and the toner ribbon is in contact with the
20 photoconductive layer. In these circumstances, production
of a light image by the exposure device is effected. The
toner which has been fused in a pattern corresponding to the
light image by the irradiation is transferred to the record
paper, thereby forming an image on the paper.

In the above-described known xerography processes, the primary charging step and the cleaning step are indispensable; therefore, the number of steps is relatively large. In apparatus for carrying out the above-described processes, various devices for carrying out respective steps are disposed separately from each other. For this reason, the apparatus is complicated, and the overall size thereof is relatively large; it is difficult to reduce the thickness or width of the apparatus and obtain a compact system.

In addition, the developing device has a complicated mechanism and, in the developing step, the toner comes in contact with and rubs against the surface of the photosensitive member at high speed, which has an adverse effect on the lifetime of the photosensitive member.

The prior art disclosed in the above-mentioned Japanese Laid Open Patent Specification No. 77848/1981 further suffers from the following problem. Since the toner ribbon overlies the record paper so that the toner ribbon is in contact with the whole surface of the paper, when the toner is fused at a position irradiated with light and is transferred to the record paper, the toner may adhere to peripheral portions around the transferred image, thus easily causing a so-called "ghost" to occur.

It is therefore an object of the present invention to provide an electrophotographic apparatus which enables the number of steps in the process to be reduced by a large margin.

5 According, therefore, to the present invention, there is provided an electrophotographic apparatus comprising a pair of toner reservoirs for holding toner; a pair of electrode plates which are respectively disposed at outlets of said toner reservoirs so as to face each other, the
10 electrode plates being arranged to charge the toner delivered from said outlets and being arranged to deliver a substantially uniform layer of said toner; a photosensitive member which is disposed beneath the electrode plates and which comprises in succession a transparent substrate; a transparent electrode,
15 and a photoconductive layer, said photosensitive member being arranged to be reciprocated so that said toner in said toner reservoirs, after being charged by said electrode plates, is supplied in a substantially uniform thickness onto a surface region of said photoconductive layer
20 of said photosensitive member by virtue of the reciprocating movement of said photosensitive member; light irradiating means for applying light from the side of said transparent substrate of said photosensitive member; the light irradiating means irradiating a portion of said photoconductive
25 layer at said surface region with light so as to reduce the



electrical resistance of said portion; means for subjecting the toner on the said portion, by way of the transparent electrode and the said portion, to an electrical charge of a polarity opposite to its original charge; and means
5 for supporting a record medium opposite to the photoconductive layer so that in operation the toner on the said portion is transferred onto the record medium.

Preferably, said photosensitive member constitutes a portion of the bottom of both of said toner reservoirs
10 so that said photosensitive member and both of said toner reservoirs are reciprocated together.

Preferably, also, said photosensitive member is of planar shape.

In the electrophotographic apparatus according to the
15 present invention, at the same time as the portion of the photosensitive member is irradiated with light, the toner on the irradiated portion may be transferred directly to the record medium by means of coulomb force or by the force of the electric field. Accordingly, an electrostatic
20 latent image forming step, a developing step and a transfer step, which have heretofore been carried out separately from each other, can be executed in one intensive step. In addition, it becomes unnecessary to carry out steps of charging and cleaning the photosensitive member which
25 are conventionally required.

The photosensitive member may be rigid, e.g. it may have a flat plate shape or a drum shape. Alternatively, it may be flexible and may be constituted by an endless member.

5 The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 shows the principle of operation of the electrophotographic apparatus according to the present invention; and

10 Figure 2 is a sectional view of an embodiment of an electrophotographic apparatus according to the present invention.

Terms such as "upper" and "lower" as used in the description below, are to be understood to refer to
15 directions as seen in the accompanying drawings.

The principle of operation of the electrophotographic apparatus according to the present invention will first be described with reference to Figure 1.

A photosensitive member 1 consists of three
20 successive layers, namely a transparent support 1a made of a glass or plastics material; a transparent electrode 1b formed on the upper surface of the transparent support 1a; and a photoconductive layer 1c formed on the upper surface of the transparent electrode 1b. A record medium
25 2, such as an ordinary paper, is transported past the

photosensitive member 1, as indicated by arrow 6, a slight gap being provided between the opposing surfaces of the record medium 2 and the photoconductive layer lc. A charged toner 4 (the toner 4 being charged positive, in this example) is substantially uniformly attached to virtually the whole upper surface of the photoconductive layer lc. A charging device 3, such as a corona-charging device, which constitutes a toner transfer means, is disposed at the upper side of the record medium 2. When a light beam 5, such as a laser beam, is applied to the photosensitive member 1 from the lower side thereof, that is, from the side of the transparent support la, there is a decrease in the electrical resistance of the portion of the photoconductive layer lc which has been irradiated by the light beam 5. If the transparent electrode lb is reverse-biased by means of a power supply E, charges which are opposite in polarity to the charges in the toner 4 are injected into the toner 4 which covers the irradiated portion of the photoconductive layer lc. In consequence, those toner particles that have been subjected to charges of the said opposite polarity are transferred to the record medium 2 by means of the coulomb force acting between the toner 4 and the charging device 3 or by the force of the electric field produced by the charging device 3. In other words, the toner 4 covering the exposed portion of the photoconductive layer lc is directly transferred to the record medium 2 without pre-charging of the photosensitive member 1.

Figure 2 shows an embodiment of an electrophotographic apparatus according to the present invention.

In this embodiment, a photosensitive member 31 has a flat plate-like configuration and consists of three layers, that is, a transparent support 31a, a transparent electrode 31b and a photoconductive layer 31c arranged in a manner similar to that of Figure 1. The photosensitive member 31 is buried in the centre of the bottom portion of a support member 38 which also serves as a toner casing. A pair of electrode plates (doctor blades) 36a and 36b are provided above the photosensitive member 31 with a predetermined gap provided therebetween. The electrode plates 36a and 36b are respectively secured at predetermined positions by electrode support members 37a and 37b and connected to a power supply E_1 . A toner 34 is accommodated in a pair of toner reservoirs 39a and 39b defined between the support member 38 and the electrode support members 37a, 37b. The distal end of each of the electrode plates 36a and 36b is disposed so that a predetermined gap is provided between the same and the photoconductive layer 31c, thereby also carrying out a toner layer thickness adjusting function. A record medium 32 is provided so as to be transported from the left to the right (as viewed in Figure 2) while facing the photosensitive member 31. A charging

device 33, which constitutes a toner transfer means, is disposed above, i.e. at the rear of, the record medium 32. A relatively high voltage is applied to the electrode plates 36a, 36b through the power supply E_1 for the purpose of charging the toner 34. The transparent electrode 31b is connected to a power supply E_2 for the purpose of injecting charges into the toner 34 which are opposite in polarity to the charges which have already been injected therein by pre-charging.

The support member 38 is adapted to be able to reciprocate horizontally together with the photosensitive member 31, so that the toner 34 accommodated in the toner reservoirs 39a, 39b is supplied under the electrode plates 36a, 36b by the reciprocating motion of the support member 38. Since a high voltage is applied to the electrode plates 36a, 36b through the power supply E_1 , when the toner 34 comes in contact with the electrode plates 36a, 36b, charges are injected into the toner 34. The charges in the toner 34 induce charges in the surface of the photosensitive member 31 which are opposite in polarity to the charges in the toner 34, thus attracting the toner 34. The toner 34 on the surface of the photosensitive member 31 is formed into a toner layer having a uniform thickness by the motion of the photosensitive member 31 which reciprocates horizontally below the

electrode plates 36a. 36b. When a light beam 35 is applied to the rear surface of the photosensitive member 31 directly below the charging device 33 while the support member 38 is moving from the left to the right, charges of opposite polarity are injected into the toner 34 in a manner similar to that described above and, at the same time, the toner 34 in the irradiated portion is transferred to the record medium 32. Although the toner 34 on the photosensitive member 31 is partially consumed by this transfer, it is compensated for in the following manner. Namely, the toner 34 on the photosensitive member 31 passes under the electrode plate 36b on the right-hand side and enters the toner reservoir 39b and then returns or moves from the right to the left. During this backward movement, when the toner 34 on the photosensitive member 31 passes under the electrode plate 36b so as to be charged, this toner 34 is re-formed into a toner layer having a uniform thickness. In addition, since the photosensitive member 31 also reciprocates together with the support member 38, the position on the photosensitive member 31 which is irradiated with the light beam 35 changes, and this allows the photosensitive member 31 to recover from light fatigue. Accordingly, it is possible to extend the lifetime of the photosensitive member 31.

It should be noted that, although the embodiment described above may employ a corona-charging device alone as a toner transfer means, an opposing roller electrode may, if desired, be employed in place of the corona-charging device.

It is thus possible, in an electrophotographic apparatus of the present invention, to carry out an electrostatic latent image forming step, a developing step and a transfer step in one intensive step, whereas these steps are carried out separately in the known xerography apparatus. Accordingly, the number of steps can be reduced by a large margin. In addition, it is unnecessary to effect primary charging and cleaning of the photosensitive member. Since the toner and the photosensitive member do not come in contact with each other at high speed, there is no frictional adverse effect on the photosensitive member. Further, since the toner on the photosensitive member, other than that on the irradiated portion, is subjected to the force of the repulsion which acts between the same and the record medium, the generation of a "ghost" is suppressed, so that it is possible to effect reproduction with excellent printing quality.



C L A I M S

1. An electrophotographic apparatus comprising:
 a pair of toner reservoirs for holding a toner; a pair
 of electrode plates which are respectively disposed at outlets
 of said toner reservoirs so as to face each other, the electrode
 plates being arranged to charge the toner delivered from said
 outlets and being arranged to deliver a substantially uniform
 layer of said toner; a photosensitive member which is
 disposed beneath the electrode plates and which comprises
 in succession a transparent substrate; a transparent electrode,
 and a photoconductive layer, said photosensitive member being
 arranged to be reciprocated so that said toner in said toner
 reservoirs, after being charged by said electrode plates,
 is supplied in a substantially uniform thickness onto a
 surface region of said photoconductive layer of said
 photosensitive member by virtue of the reciprocating movement
 of said photosensitive member; light irradiating means
 for applying light from the side of said transparent substrate
 of said photosensitive member; the light irradiating means
 irradiating a portion of said photoconductive layer at said
 surface region with light so as to reduce the electrical
 resistance of said portion; means for subjecting the toner



(23)

on the said portion, by way of the transparent electrode and the said portion, to an electrical charge of a polarity opposite to its original charge; and means for supporting a record medium opposite to the photoconductive layer so that in operation the toner on the said portion is transferred onto the record medium.

2. An electrophotographic apparatus according to claim 1, wherein said photosensitive member constitutes a portion of the bottom of both of said toner reservoirs so that said photosensitive member and both of said toner reservoirs are reciprocated together.

3. An electrophotographic apparatus according to claim 1 or 2 wherein said photosensitive member is of planar shape.

4. An electrophotographic apparatus substantially as hereinbefore described with reference to and as shown Figure 2 of in the accompanying drawings.
