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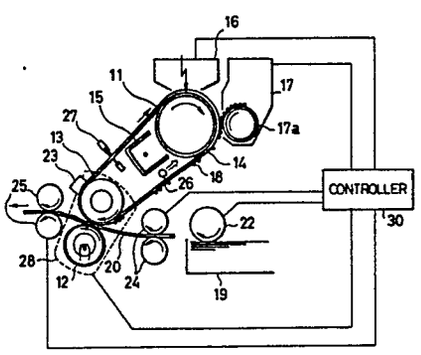
(54) Electrophotography apparatus with toner image bearing film.

(57) An electrophotography apparatus comprises a photosensitive member, such as a photosensitive drum, a transfer section, and a toner image bearing film passing by the photosensitive member, and through the transfer section. A charging device uniformly charges the photosensitive member. An exposure device exposes the photosensitive member to a light image thereby to form a latent image. A developing device is disposed facing the toner image bearing film passing by the photosensitive member, for causing toner to be attracted toward the photosensitive member, thereby forming a toner image on the toner image bearing film. A paper feed mechanism means feeds a recording paper through the transfer section, at which the toner image is transferred from the toner image bearing film to the recording paper. A fixing device fixes the toner image on the recording paper.

FIG.2



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ELECTROPHOTOGRAPHY APPARATUS WITH TONER IMAGE BEARING FILM

BACKGROUND OF THE INVENTION

This invention concerns electrophotography apparatus for forming images in a photocopier, a laser-beam printer and the like.

Electrophotography of the Carlson's system has been widely employed for forming images in photocopying and printing. Electrophotography uses a drum having a photosensitive surface which passes a charging section where the photosensitive surface is uniformly charged, an exposure section where the photosensitive surface is exposed to light image or pattern of light which correspond to the original (source document) or the print data to form an electrostatic latent image consisting of charged areas and discharged areas, a developing section where toner is attracted to the charged areas of the latent image so that a developed, toner image is created, a transfer section where the toner image is transferred to a recording paper which is brought into contact with the photosensitive drum, and a cleaning section which removes any residual toner on the photosensitive surface. The toner image that has been transferred to the recording paper is fixed by application of heat, for example, and the recording paper is then discharged from the apparatus.

Examples of conventional electrophotography arrangements are shown in U. S. Patent No. 2,297,691, and "Fundamentals and Applications of Electrophotography," page 28, and pages 303 to 304, Edited by The Society of Electrophotography of Japan, Published by Corona K. K., June 15, 1988.

A problem associated with the prior system is that because various devices must be disposed on the periphery of the photosensitive drum, the drum must have a sufficient diameter, and the cost of the drum is high, and the overall apparatus is bulky.

Another problem is that the transfer of the toner image to the recording paper is not complete and there is a considerable amount of toner remaining on the photosensitive drum after the transfer. This residual toner must be removed by a cleaning device, and must be collected and then disposed. When the collected toner is disposed, the toner may be scattered in and out of the apparatus, and the operator's clothing or body may be soiled.

A scheme been proposed to reduce the amount of toner residue after the transfer (U.S. Patent No. 3,591,276 or Japanese Patent Application Kokai Publication No. 41679/1971). According to this method, a toner image is first transferred to a transfer blanket, and is then transferred to a recording paper. If this method is employed the transfer efficiency is increased, there is still some residual toner and a cleaning device is therefore still required.

Another scheme has been proposed to eliminate the cleaning device and the need for disposing the toner in Japanese Patent Application Kokai Publication No. 42669/1986. This scheme is shown in Fig. 1, and is briefly described below.

As a photosensitive drum 3 rotates in the direction A, its photosensitive surface is first uniformly charged by a charge roller 4, which is electrically connected to an electrically conducting shaft 4A to a power supply 5, and is then exposed by an exposure device 6, and is then developed by a developing device 7. The developed image is then transferred to a recording paper 10 by means of a transfer device 9.

The photosensitive drum 3 with residual toner 8 rotates to the charge roller 4, which is rotating in the direction B. The toner is wiped off by the charge roller 4, and adheres to its circumference, and is then turned around the charge roller 4 to the surface of the photosensitive drum 3 and is again attached to the photosensitive drum 3. The toner that is attached to the photosensitive drum 3 has been discharged because it has once been removed from the photosensitive drum 3 by the charge roller 4. When this toner reaches the developing device 7, the toner is absorbed by the developing device 7.

An advantage of this configuration is that the developing device 7 functions also as a cleaning means, and no cleaning device is required around the photosensitive drum, and it is therefore unnecessary to recover the toner 8 which has been removed from the photosensitive drum 3. The residual toner is automatically re-used for developing so that toner usage efficiency is increased.

However, when the amount of toner which remains on the photosensitive drum 3 after the transfer may so so large that its effect on the exposure process is not negligible, because shadows of the toner particles are cast on the photosensitive drum 3 during the exposure.

SUMMARY OF THE INVENTION

An object of the invention is to eliminate the necessity for a cleaning section.

Another object of the invention is to eliminate the need for disposal of residual toner which may be present after transfer of the toner to a recording paper, and hence avoid scattering of toner inside or

around the device, and soiling of the operator's body and clothing.

A further object of the invention is to reduce the number of processes around the photosensitive member, and thereby to reduce the size and cost of the apparatus.

A still further object of the invention is to eliminate the adverse effect of the residual toner on the exposure process.

Electrophotography apparatus according to the invention comprises:
a photosensitive member;
a transfer device;
a toner image bearing film passing by the photosensitive member and through the transfer section;
a charging device for uniformly charging a photosensitive member;
an exposure device for exposing the photosensitive member to a light image;
a developing device provided facing the toner image bearing film passing by the photosensitive member for causing toner to be attracted toward the photosensitive member, and thereby forming a toner image on the toner image bearing film which is passing around the photosensitive member; and
a paper feed means for feeding a recording paper through the transfer device;
the transfer device transferring the toner image on the toner image bearing film to the recording paper.

The photosensitive member may be in the form of a drum or in the form of a belt.

The exposure device may be provided to face the photosensitive member through the toner image bearing film. In this case, the toner image bearing film should be transparent to the wavelengths of light used by the exposure device. The exposure device may alternatively be provided to face the photosensitive member directly, i.e., without interposition of the toner image bearing film.

The toner image bearing film may be an endless film, or alternatively be a two-ended film (a film having ends in the direction of feed). In the latter case, a supply roller and a take-up roller should be provided.

The transfer device may comprise a heating roller and a pressure roller which are pressed against each other, so as to function also as a fixing device for fixing the toner image on the recording paper.

The toner may be a heat fixing toner or a pressure fixing toner.

The transfer device may be provided to face the photosensitive member through the toner image bearing film being passed around the photosensitive member. In this case it is preferable that the exposure device be provided to face the photosensitive member without interposition of the toner image bearing film, and the developing device be so designed as to collect any residual toner on the toner image bearing film and re-uses it for development.

Some of the advantages derived from the configuration of the invention are set forth below:

Because the number of processes which are carried out by the photosensitive member is reduced, the size and cost of the apparatus can be reduced. When the photosensitive member is a photosensitive drum, the diameter of the photosensitive drum can be reduced, and the size and the cost of the photosensitive drum, and hence the size and cost of the apparatus can be reduced.

Because the developing device and the cleaning device are not provided in contact with the photosensitive member, wear of the photosensitive member can be reduced. Moreover, for the same reason, a photosensitive member having a weaker wear resistance can be used. This means that a photosensitive member with a positive type organic photosensitive body can be used.

Further, as there is no need for a means to separate the recording medium from the photosensitive member, the device can be simplified, and the problem of paper jamming during the separation is eliminated. If moreover the separation was performed by use of a separating film, the printing cannot be conducted over the entire surface. In contrast, in the invention, such a separating film need not be used, so the recording paper can be printed all over its surface.

When toner image formed on the toner image bearing film is transferred to the recording paper by means of heat and pressure, disturbance of the image is better suppressed than in the case of electrostatic transfer.

Further, by integrating the transfer section and the fixing section as illustrated, the toner image transferred to the recording paper is simultaneously fixed, so the handling of the recording paper is facilitated. Particularly, the transfer and fixing can be made on a downwardly facing surface of the recording paper. That is, a face-down mechanism can be employed.

When heat and pressure are used for the transfer process, sheets of recording paper do not stick to each other due to the effect of residual static electricity after being ejected from the apparatus. Further, the image can be transferred to rough paper such as bond paper, and an electrically conducting toner which is easy to develop in the developing process may be used.

In conventional electrophotography, the transfer efficiency was of the order of 70% and the toner usage efficiency was low. In the invention, the

transfer efficiency can be increased to of nearly a 100%.

Moreover, as a cleaning step for removing residual toner powder from the photosensitive member can be omitted, the apparatus can be made even more compact, and its cost can be reduced.

Furthermore, as the cleaning step can be eliminated, scattering of toner inside and outside the apparatus can be reduced.

In addition, since there is no need to dispose of toner after cleaning, soil of the operator or his clothing with toner can be avoided, and maintenance work can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an example of prior-art electrophotography apparatus.

Fig. 2 is a schematic drawing of the electrophotography apparatus of Embodiment 1.

Fig. 3 shows the charging process.

Fig. 4 shows the exposure process.

Fig. 5 shows the development process.

Fig. 6 shows the transfer and fixing process.

Fig. 7 is a schematic structural drawing of the electrophotography apparatus of Embodiment 2.

Fig. 8 shows the exposure process in Embodiment 2.

Fig. 9 shows the transfer and fixing process in Embodiment 2.

Fig. 10 is a schematic drawing of the eletrophotography apparatus of Embodiment 3 this invention.

Fig. 11 shows the transfer process in Embodiment 3.

Fig. 12 shows the fixing process in Embodiment 3.

Fig. 13 shows transfer process which occurs when the photosensitive drum and the toner image bearing film are separating.

Fig. 14 shows the transfer process which occurs when the photosensitive drum and the toner image bearing film have separated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

An embodiment of this invention will now be described with reference to Fig. 2 to Fig. 6.

Fig. 2 is a schematic drawing of the electrophotography apparatus of Embodiment 1.

The illustrated image forming apparatus comprises a photosensitive member in the form of a photosensitive drum 11 rotatably mounted on a frame, not shown. The photosensitive drum 11 has a photosensitive layer on an electrically conducting support. Suitable materials for the photosensitive layer are selenium photosensitive material, an organic photosensitive material, zinc oxide and amorphous silicon.

The image forming apparatus also comprises a heating roller 12 and a pressure roller 13 which are pressed against each other by a means not shown. The heating roller 12 may be of a hollow metal member enclosing a halogen lamp, or one having a heat-emitting body on a metal surface. The surface of the pressure roller 13 is covered with silicone rubber, which has heat stability as well as elasticity.

An endless toner image bearing belt or film 14 is passed around the photosensitive drum 11 and the pressure roller 13. More particularly, the toner image bearing film 14 is in contact, on a first or inner surface thereof, with the peripheral surface of the photosensitive drum 11 over a portion of the photosensitive drum arc, and as the photosensitive drum 11 rotates, the toner image bearing film 14 moves together with the photosensitive drum 11. Where the toner image bearing film 14 passes around the pressure roller 13, it passes between the heating roller 12 and the pressure roller 13. The location where the heating roller 12 confronts the pressure roller 13 forms a transfer and fixing section 28.

The elasticity of the silicone rubber layer of the pressure roller 13, the diameter of the pressure roller 13 and the pressing force between the pressure roller 13 and the heating roller 12 are so designed as to provide just enough nip width.

As the photosensitive drum 11 rotates its surface sequentially passes various processing sections or devices, namely a charging or electrifying device 15, an exposure device 16, a developing device 17, and a discharge lamp 26. A difference to be noted is that some of the processing devices, i.e. , the exposure device 16 and the developing device 17, are provided to face the photosensitive drum, not directly, but through the toner image bearing film 14. Between the location where the electrifying device 15 confronts the photosensitive drum 11 and the location where the exposing device confronts the photosensitive drum 11, the toner image bearing film 14 is brought into contact with the photosensitive drum 11. Between the location where the developing device 17 confronts the photosensitive drum 11 and the location where the discharging lamp 26 confronts the photosensitive drum 11, the toner image bearing film 14 is separated from the photosensitive drum 11.

The electrifying device 15 is a corona discharge device for providing an electrostatic charge

uniformly over the photosensitive surface of the photosensitive drum 11. The electrifying device 15 may alternatively be formed of a brush discharge device.

The exposure device 16 exposes the photosensitive drum 11 through the toner image bearing film to a light image or radiation pattern to form an electrostatic latent image on the photosensitive surface of the photosensitive drum 11. The areas or dots of the photosensitive surface which have been irradiated by light is discharged, while the areas or dots of the photosensitive drum which have not been irradiated is kept charged. This does not mean that each area can assume either of the two distinct states: charged and discharged: there can be intermediate states and each area is discharged to the degree which is dependent on the density of the corresponding area of the light image. However, the following description will be made assuming that the latent image consists of charged areas and discharged areas, for simplicity of explanation and illustration.

The toner image bearing film 14 must be transparent to the wavelengths of the light used for the exposure. The exposure device 16 may be a combination of a light source such as a laser or an LED array and an optical imaging system, and in this case, the light image is produced by electrical signals representing the image. Such electrical signals are supplied from a controller 30 which performs the overall control of the apparatus. The exposure device 16 may alternatively be a combination of an illuminating device illuminating an original document and an optical imaging system for directing the light reflected at the surface of the original to the photosensitive surface of the photosensitive drum 11.

The developing device 17 is installed facing the outer surface of the toner image bearing film 14 which is moving in intimate contact with the photosensitive drum 11, as described above. The developing device is provided with a developing agent support 17a, to which toner 18 is attached. The toner 18 is transported so as to develop the electrostatic latent image on the outer surface of the toner image bearing film 14. The developing device may be a tow-component magnetic brush developer, a one-component magnetic brush developer, or a one-component non-magnetic brush developer.

The discharge lamp 26 is provided so as to face the part of the photosensitive drum 11 which has just separated from the toner image bearing film 14 after developing. The function of the discharge lamp 26 is to irradiate the photosensitive drum through its entire width to dissipate all the charges on it thereby making it ready for next operation.

As described earlier, the toner image bearing film 14 passes around the photosensitive drum 11, and through the transfer and fixing section which is formed at the location where the pressure roller 13 and the heating roller 12 are juxtaposed. The film 14 also passes a cleaning device 23 and then a discharge brush 27.

The cleaning device 23 is provided in apposition to the pressure roller 13, but after the transfer and fixing section. The function of the cleaning device 23 is to remove any residual toner from the toner image bearing film 14 after transfer of the toner image to a recording paper 20 to be described later.

The discharge brush 27 is provided in contact with the toner image bearing film 14. The function of the discharge brush 27 is to remove any residual electrostatic charge from the toner image bearing film 14 after the transfer.

The paper feed system for the recording paper 20 is comprised of a paper feed cassette 19, a paper pick-up roller 22, a paper advance roller 24, and a paper eject roller 25. Their operation is controlled by the controller 30.

The photosensitive drum 11 and the heating roller 12 are rotated at a constant peripheral speed in the direction shown by the arrow in the figure by a drive mechanism not shown. As a result, due to the frictional force of the photosensitive drum 11 and the pressure roller 12, the toner image bearing film 14 is moved in the direction shown by the arrow.

The image-forming process will now be described with reference to Fig. 3 to Fig. 6.

Fig. 3 shows the charging process, Fig. 4 shows the exposure process, Fig. 5 shows the development process, and Fig. 6 shows the transfer and fixing process.

In the electrifying step shown in Fig. 3, the surface of the photosensitive drum 11 is directly charged uniformly by the corona discharge device 15. The figure shows the case where a selenium photosensitive body is used. The photosensitive drum 11 is formed of a photosensitive layer 11a coated on an electrically conductive support 11b. In this case, when a high voltage is applied to the corona discharge device 15, the surface is charged positively.

In the exposure process (Fig. 4), light from the exposure device 16 passes through the toner image bearing film 14 and is irradiated onto the photosensitive drum 11 to form an electrostatic latent image on the photosensitive layer 11a of the photosensitive drum 11. The latent image consists of charged areas which have not been irradiated, and discharged areas which have been irradiated. In the developing step shown in Fig. 5, reversal development is used, and a means 32 of applying

a bias potential is connected across the electrically conducting support 11b of photosensitive drum 11 and the toner support 17a, to apply a bias potential. As a result, the discharged areas of the latent image on the photosensitive drum 11 attract the positively charged toner 18, and the attracted toner 18 is attached to the outer surface of the toner image bearing film 14 directly over the discharged areas. More specifically, electric lines of force are generated between the developer support 17a and the discharged areas of the latent image on the photosensitive drum 11, passing through the toner image bearing film 14. The particles of the toner 18 travel along these electric lines of force and adhere to the outer surface of the toner image bearing film 14, and are kept adhering there by a relatively weak electrostatic force.

Finally, the toner image on the toner image bearing film 14 is moved past the transfer and fixing section where the transfer and fixing step shown in Fig. 6 takes place. In synchronism with the toner image on the toner image bearing film 14, the recording paper 20 is fed to the transfer and fixing section 28. More specifically, the recording paper is the supplied from a paper supply cassette 19, being picked up by a pick-up roller 22, and is advanced by the paper advance roller 24, such that the leading edge of the recording paper (to be precise, the leading edge of the area in which the image is to be reproduced) arrives at the transfer and fixing section 28 simultaneously with and hence comes into contact with the leading edge of the area of the toner image bearing film 14 in which the toner image is formed. The toner image bearing film 14 and the recording paper 20 are moved at the same speed.

The recording paper 20 and the toner image bearing film 14 are held between the pressure roller 13 and the heating roller 12. The toner image on the toner image bearing film 14 is therefore melted by the heat of the heating roller 13, whereupon the pressure causes melted toner 18 to permeate the fibers of the recording paper 20. This transfers and fixes the toner image so as to reproduce an image on the recording paper 20.

The recording paper 20 is thereafter discharged or ejected by means of the eject roller 25, out of the housing of the apparatus, onto a stacker, not shown, for example.

After the transfer onto the recording paper 20 is completed, a small amount of toner 18 may remain on the toner image bearing film 14, however this is wiped off by bringing the cleaning device 23 into pressure-contact with the the toner image bearing film 14 on the heating roller 12. Further, the discharge brush 27 is also arranged in contact with the toner image bearing film 14 to remove static electricity may on the toner image bearing film 14. In this way, the toner image bearing film 14 is cleaned and electrically discharged, and may thus be used again.

After the developing process has been completed, the photosensitive drum 11 separates from the toner image bearing film 14, and is irradiated by the discharge lamp 26 so as to dissipate any residual electrostatic charge on the photosensitive drum 11. The drum then returns to the charging section, and may thus be used again.

In the above-described transfer and fixing process, the toner image bearing film 14 is heated by the heating roller 12 to reach a temperature of about 160 ° C. It must therefore be heat resistant, and must also have insulating properties to a certain extent, and transparency to the wavelengths of the light emitted in the exposure process. From these considerations, the film used may consist of a material such as polyester, polyimide, polyetherimide, polyethersulfone or polyetheretherketone.

In the above embodiment, from the consideration of transfer efficiency in the transfer and fixing process, a film of Teflon (polytetrafluoroethylene) -coated polyimide is used. The transfer efficiency is then approximately 100%, there is less load on the cleaning device 23, and the life thereof can be extended. Further, from consideration of the electric lines of force generated in the developing process, it is desirable that the thickness of the toner image bearing film 14 be no greater than 200 μ m; while from considerations of tensile strength and ease of handling, it is desirable that its thickness be no less than 10 μ m.

In the above embodiment, the toner 18 is a heat fixing toner, but a pressure fixing toner may be used instead. An example of pressure fixing toner is a microcapsule pressure fixing toner, which can be fixed with a minute pressure. In this case, the heating roller 12 may be omitted.

Further, in the exposure process, the photosensitive drum 11 is exposed through the toner image bearing film 14 to form the electrostatic latent image. As an alternative, the photosensitive drum 11 may be exposed directly, i .e., without interposition of the toner image bearing film 14, and the toner image bearing film 14 may be brought into intimate contact with the photosensitive drum 11 between the exposure section and the the development section. In this case, the toner image bearing film 14 need not have a transparency to the wavelengths of the emitted light used in the exposure means 16.

In the embodiment described, a photosensitive drum 11 with a selenium photosensitive body is used. As an alternative, a photosensitive drum with a less expensive, organic photosensitive body may be used. There are two types of organic photosensitive body. In one type, a charge generating layer

and a charge transport layer are successively formed on an electrically conductive support. This type has a good wear resistance, but is charged negatively at the electrifying process, which is a disadvantage because a relatively complicated scorotron discharge device need to be used for the uniform charging, and because greater amount of ozone is produced. In the other type, a charge transport layer and a charge generation layer are successively formed on an electrically conductive support (it should be noted that the sequence of the layers are reversed). This type is charged positively so that a relatively simple corotron charging device can be used for the uniform charging and the generation of ozone is reduced. A shortcoming of this latter type is a relatively poor wear resistance. But in the present invention, the photosensitive drum is not subject to friction with the developing device and the cleaning device, so the the photosensitive drum needs not have a high wear resistance as in the past. Accordingly, it is possible to use the photosensitive drum with a positive type organic photosensitive body.

Instead of the photosensitive drum 11, a photosensitive belt may be used. In this case, the toner image bearing film 14 is is made to pass by the photosensitive belt over a certain length, and the developing device is provided facing the toner image bearing film passing 14 by the photosensitive belt.

In the above embodiment, the transfer and fixing are carried out simultaneously, but they may be carried out separately: the toner image on the toner image bearing film may be transferred onto the recording paper first, and thereafter the toner image be fixed, at a location separate from the location of the transfer.

The positions of the heating roller 12 and the pressure roller 13 may be interchanged such that the toner image bearing film 14 is passed around the heating roller 12, rather than the pressure roller 13.

The recording paper 20 as used in the above embodiment may be replaced by any other form of recording medium.

With configuration described above, when the transfer process and the fixing process can be combined into one, the device can be made more compact, and the cost can be reduced. Moreover, as the toner image transferred to the recording paper is simultaneously fixed, the handling of the recording paper is facilitated. It should be noted that if the transfer section and the fixing section are separate, the toner image that has just been transferred but not been fixed is attached to the recording paper with a weak electrostatic force and is subject to disturbance.

Furthermore, perturbation of the image which occurred in the conventional electrostatic transfer process can be prevented.

In addition, the process of cleaning of the powder toner remaining on the photosensitive drum can be omitted so that the size of the apparatus can be reduced, and the cost can be reduced. Also, as the process of cleaning can be omitted, the scattering of the toner inside and outside of the apparatus can be reduced.

Moreover, as the transfer is not effected electrostatically, the conductive toner can be utilized.

Embodiment 2

Another embodiment of the invention will now be described with reference to Fig. 7 to Fig. 9.

In these figures, reference numerals identical to those in Fig. 2 to Fig. 6 denote identical or similar devices or elements so their description is omitted.

Fig. 7 is a schematic structural drawing of the electrophotography apparatus of Embodiment 2.

Embodiment 2 differs from Embodiment 1, in that a two-ended toner image bearing film 102 (having ends in the feed direction) is used in place of the endless toner image bearing film 14 in Embodiment 1.

The photosensitive drum 11 in this embodiment comprises a positive charge type organic photosensitive body comprising a charge transport layer and charge generating layer, which are formed successively on an electrically conducting support.

The toner image bearing film 14 of this embodiment is formed of polyester film, in view of its advantage in cost. From the viewpoints of tensile strength and ease of handling, it is desirable that the thickness of the film is no less than 5 μ m and no more than 100 μ m.

The exposure device 16 of this embodiment is disposed to face the photosensitive drum 11 directly, i .e., without interposition of the toner image bearing film 102.

The toner image bearing film 102 is supplied from a supply roller 103, is passed around a free roller 114, around the photosensitive drum 11, and around the heating roller 12, in the direction shown by the arrow in the figure, and is then wound on a take-up roller 104.

Further, a tension mechanism not shown in the figure is provided on the free roller 104 to give a suitable tension to the toner image bearing film 102.

A controller similar to the controller 30 in Fig. 2 is provided but it is omitted from illustration.

The operation of the electrophotography apparatus having the above construction will now be described.

The photosensitive drum 11 and the heating roller 12 are rotated at a constant peripheral speed in the direction shown by the arrow in the figure by a drive means not shown. Due to friction between the toner image bearing film 102 and the photosensitive drum 11 and the contact pressure between the heating roller 12 and the pressure roller 13, the toner image bearing film 102 moves at the same speed as the peripheral speed of the photosensitive drum 11 and the heating roller 12.

The operations at the charging section, the exposure section, the development section and the transfer and fixing section are identical to those described with reference to Fig. 3 to Fig. 6, except that the photosensitive drum 11 is directly exposed as shown in Fig. 8, and the heating of the toner image bearing film 102 is made directly as shown in Fig. 9, i.e., not through the recording paper 20.

After the transfer of the toner image to the recording paper 20, a small amount of toner may remain on the toner image bearing film 102, and the toner image bearing film 102 is recovered by the take-up roller 104 with this residual toner still adhering to it. The residual toner recovered by the take-up roller 104 however has been melted in the transfer and fixing process, and fixed on the toner image bearing film. There is therefore no scattering of toner inside or outside the device, or over the operator.

In the above embodiment, after the transfer of the toner image to the recording paper 20, the toner image bearing film 102 is recovered by the take-up roller 104. As an alternative, a cleaning device may be provided being pressed against the toner image bearing film 102 passing around heating roller 12 so that residual toner fixed on the toner image bearing film 102 can be completely wiped off. In this case, the toner image bearing film 102 that is recovered on the take-up roller 104 may then be relocated on the side of supply roller 103 and may be used again.

Further, in order to increase the transfer efficiency of the transfer and fixing section, the toner image bearing film 102 is preferably Teflon-coated. The load on the cleaning device is then lessened and the lifetime of the cleaning device is extended. Toner wiped off by the cleaning device has been melted in the fixing process, and fixed on the cleaning device. Even if toner powder is used, therefore, toner will not be scattered inside and outside the device or over the operator when the cleaning device is recovered and replaced.

With the configuration described above, any residual toner on the toner image bearing film after the transfer process has been melted, so the toner will not be scattered inside and outside of the apparatus. Moreover, since the image bearing film is wound on the take-up roller, scattering of the toner is further reduced, or is essentially eliminated, and there is therefore no need for the cleaning section.

As scattering of toner inside the device is reduced, soiling of the operator's body or clothing, and of the area around the device, can be prevented.

As the toner image bearing film is not repeatedly made into contact with the photosensitive drum as in the case of an endless film, heat transmitted to the toner image bearing film in the fixing process is not transmitted to the photosensitive drum. The adverse effect of heat on the photosensitive drum is thereby avoided, and a stable reproduction is obtained.

Embodiment 3

Another embodiment of the invention will now be described with reference to Fig. 10 to Fig. 14. In these drawings, reference numerals identical to those in Fig. 2 to Fig. 9 denote identical or similar devices or elements and their description is omitted.

Fig. 10 is a schematic drawing of the electrophotography apparatus in Embodiment 3.

This Embodiment 3 is similar to Embodiment 1 but the transfer of toner image is made from the toner image bearing film 11 being passed around the photosensitive drum 11 to a recording paper 20, and there is a fixing section 212 separate from a transfer section 211.

The toner image bearing film 14 of this embodiment is passed around the photosensitive drum 11, and a free roller 203 and a tension roller 204. As the toner image bearing film 14 is moved around the photosensitive drum 11, the free roller 203 and the tension roller 204, the outer surface of the toner image bearing film 14 passes a developing device 207, and the transfer section 211.

A recording paper 20, which is supplied by a feeding means similar to that of Embodiment 1 and Embodiment 2, is passed through the transfer section 211, and then the fixing section 212.

The exposure device 16 of this embodiment is disposed facing the photosensitive drum 11 directly, as in Embodiment 2. The exposure device 16 of the illustrated example comprises a combination of an LED array and a Selfoc lens (commercial name).

The developing device 207 functions not only as a developing means, but also as a cleaning means, as described above. In the developing device 207, toner 209 is attached on a toner support 208, transported in the direction shown by the arrow in the figure, and is attracted to the discharged areas of the latent image on the photosen-

sitive drum 11, and is thereby attached on the outer surface of those parts of the toner image bearing film 14 which are placed on the discharged areas of the latent image on the photosensitive drum 11. By this attachment of the toner, the toner image is developed.

The transfer device 210 is provided facing the toner image bearing film 14 being passed around the photosensitive drum 11. The transfer device 210 transfers the toner image on the toner image bearing film 14 to the recording paper 20, which is supplied in synchronization with the toner image on the toner image bearing film 14, and pressed against the toner image bearing film 14, by a means not shown.

The transfer device 210 may comprise a corona charge device as illustrated, or, alternatively, an electrostatic transfer device such as an electrically conducting roller, or a transfer device which transfers by means of adhesion.

The toner image transferred to the recording paper 20 is fixed in the fixing section 112. The fixing section may comprise a heat roller fixing device comprising a heating roller 213 and a pressure roller 214 pressed against the heating roller 213, as shown in the figure, or, alternatively, a pressure fixing device.

The photosensitive drum 11 is rotated in the direction shown by the arrow in the figure at a constant peripheral speed by a drive means not shown in the figure, whereupon the toner image bearing film 14 rotates in the direction shown by the arrow due to friction with the photosensitive drum 11. The toner image bearing film 14 is given a suitable tension by the tension roller 204 which is provided with a tension mechanism not shown in the figure so that it moves at the same speed as the photosensitive drum 11.

A controller similar to the controller 30 in Fig. 2 is also provided, but it is omitted from illustration.

The charging process, the exposure process and the development process are respectively similar to those described with reference to Fig. 3, Fig. 8, and Fig. 5. The transfer process and the fixing process are shown in Fig. 11 and Fig. 12, respectively.

In the transfer process shown in Fig. 11, the recording paper 20 is supplied by a paper feed means not shown in the figure to be superimposed on the toner image bearing film 14 at the location where the toner image bearing film 14 and the photosensitive drum 11 are in intimate contact. By this superimposition, the first surface of the recording paper 20 is brought into contact with the outer surface of the toner image bearing film 14 on which the toner image has been formed. The second surface of the recording paper 20 is uniformly charged by the transfer device 210 to a polarity opposite to the polarity of the toner image. In the example illustrated in Fig. 11, the toner image has a positive polarity, and the transfer device 210 charges the second surface of the recording paper 20 with a negative polarity. As a result, the toner image on the toner image bearing film 14 is transferred electrostatically to the recording paper 20 (Fig. 11).

The recording paper 20 to which the toner image has been transferred is then fed to the fixing device 112, and heated and pressed so that the transferred toner image is fixed, as shown in Fig. 12. In this process, the heat of heating roller 214 melts the toner 209 via the recording paper 20, and the melted toner 209 permeates the fibers of the recording paper 20 due to the action of the pressure.

After the transfer, a small amount of toner 216 may remain on the toner image bearing film 14. When this is transported back to the developing device 207, however, the residual toner is collected by the developing device 207 and re-used for developing. Thus, developing and cleaning of residual toner take place simultaneously, and there is therefore no need for a cleaning device on the photosensitive drum.

Consideration is now given on the position where the transfer of the toner image takes place.

As shown in Fig. 11, it is essential that the transfer to the recording paper 20 takes place at a point where latent image support 11 and the toner image bearing film 14 are in contact. If the transfer to the recording paper 20 of the toner image formed on the toner image bearing film 14 takes place at the point where the photosensitive drum 11 and the toner image bearing film 14 are separating as shown in Fig. 13, or after they have separated as shown in Fig. 14, the quality of the transferred toner image is poor. The reason is considered that when the toner image bearing film 14 and the photosensitive drum 11 are separating, gaseous discharge occurs across the toner image bearing film 14 and the photosensitive drum 11 that are separating, and hence the toner image formed on the toner image bearing film 14 is disturbed.

In the configuration of Embodiment 3, the developing device 207 serves also as a cleaning means, and no toner is present on the photosensitive drum while residual toner is present on the toner image bearing film, so even if the cleaning device is omitted, there is no shielding effect on the exposure.

Moreover, because the transfer takes place from the toner image bearing film which is passing around the photosensitive drum, degradation of the quality of the toner image can be minimized.

Furthermore, as there is no need to collect and recover the used toner, there is no danger of

scattering of the toner inside and outside of the apparatus, and hence soiling of the operator's body and clothing can be avoided.

In addition, the toner is utilized efficiently, and consumption of the toner is therefore reduced.

This invention is not limited to the above embodiments, various modifications being possible within the spirit of the invention which shall not be excluded from it.

Claims

1. Electrophotography apparatus comprising:
a photosensitive member;
a transfer device;
a toner image bearing film passing by the photosensitive member and through said transfer section;
a charging device for uniformly charging a photosensitive member;
an exposure device for exposing the photosensitive member to a light image;
a developing device provided facing the toner image bearing film passing by the photosensitive member for causing toner to be attracted toward the photosensitive member, and thereby forming a toner image on the toner image bearing film which is passing by the photosensitive member; and
a paper feed means for feeding a recording paper through said transfer device;
said transfer device transferring the toner image on the toner image bearing film to the recording paper.

2. Apparatus according to claim 1, wherein said transfer device functions also as a fixing device for fixing said toner image on said recording paper.

3. Apparatus according to claim 2, wherein said toner is a heat fixing toner, and said transfer device comprises a heating roller and a pressure roller which are pressed against each other thereby to function also as a fixing device for fixing said toner image on said recording paper.

4. Apparatus according to claim 2, wherein said toner is a pressure fixing toner, and said transfer device comprises a first roller and a second roller which are pressed against each other thereby to function also as a fixing device for fixing said toner image on said recording paper.

5. Apparatus according to claim 1, wherein said exposure device is provided to face the photosensitive member through said toner image bearing film, and said toner image bearing film is transparent to the wavelengths of light used by said exposure device.

6. Apparatus according to claim 1, wherein said toner image bearing film is an endless film.

7. Apparatus according to claim 1, wherein said toner image bearing film is a two-ended film, said apparatus further comprising a supply roller from which said toner image bearing film is unwound, and a take-up roller for winding the toner image bearing film that has been passed through said transfer device.

8. Apparatus according to claim 6, wherein said transfer device comprises a heating roller and a pressure roller which are pressed against each other thereby to function also as a fixing device for fixing said toner image on said recording paper.

9. Apparatus according to claim 1, wherein said exposure device is provided to face the photosensitive member without interposition of the toner image bearing film.

10. Apparatus according to claim 1, wherein said transfer device is provided to face the photosensitive member through the toner image bearing film passing by the photosensitive member, said exposure device is provided to face the photosensitive member without interposition of the toner image bearing film, and said developing device collects any residual toner on the toner image bearing film and re-uses it for development.

FIG. 1

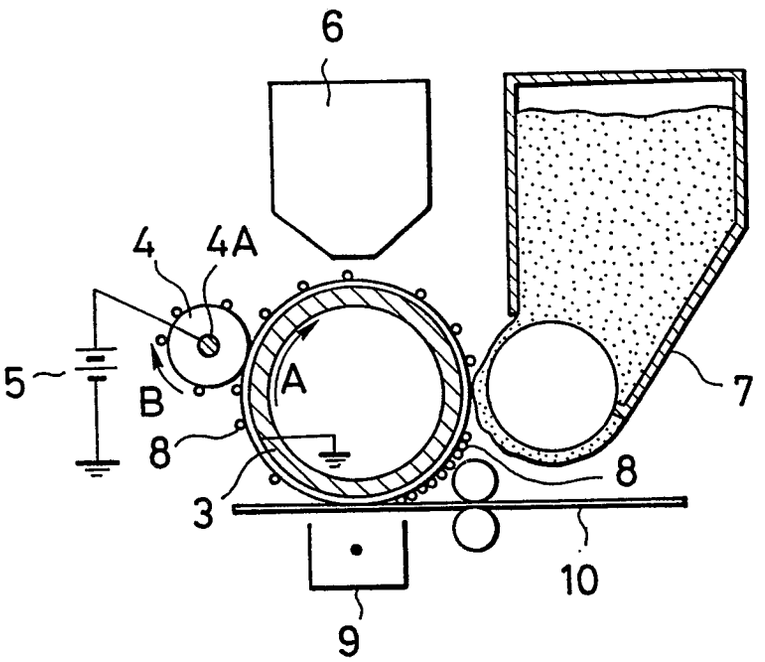

FIG.2

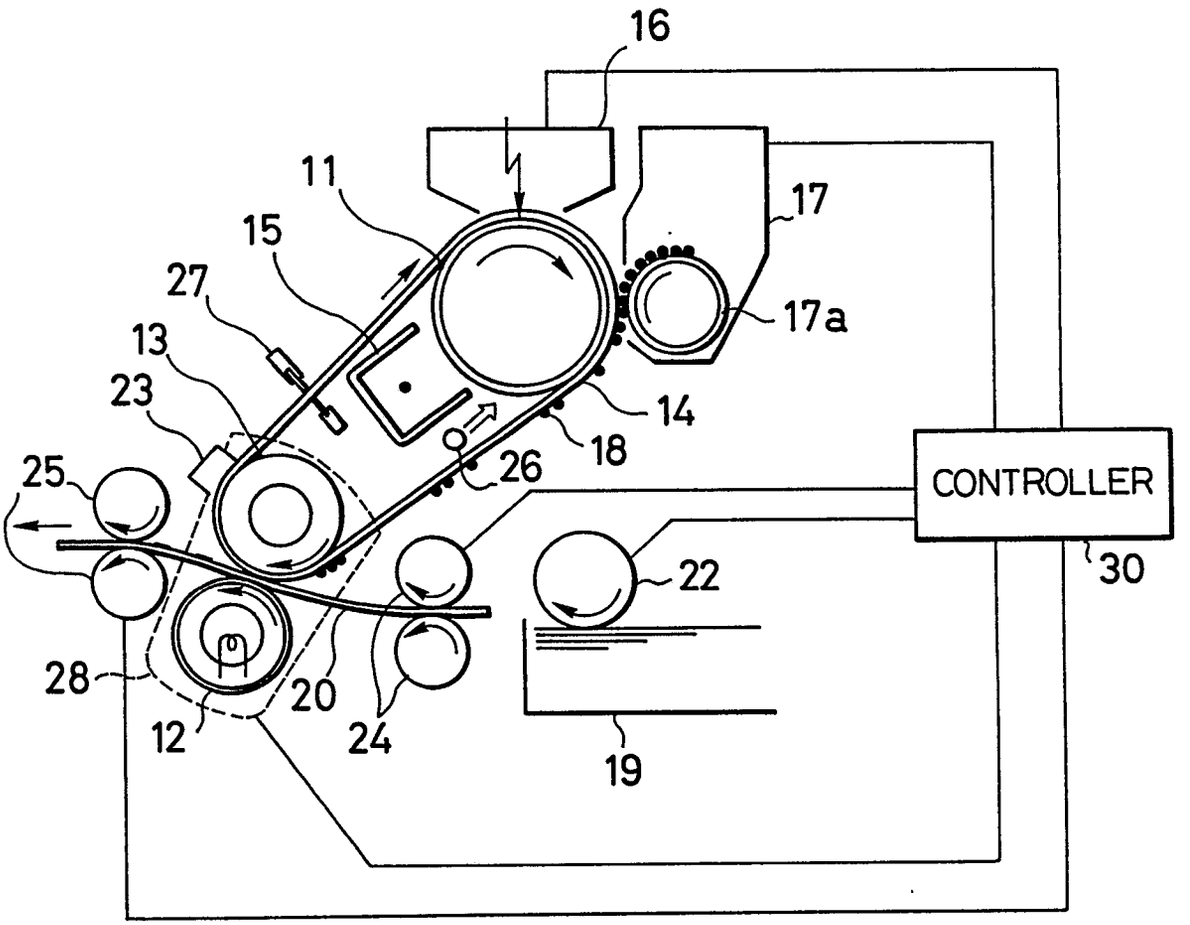

FIG.3

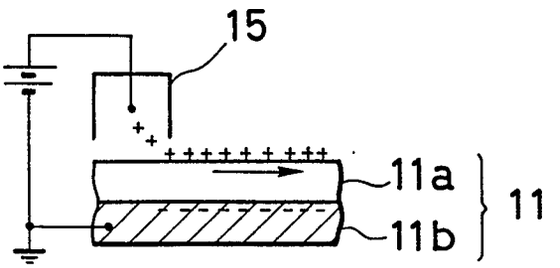

FIG.4

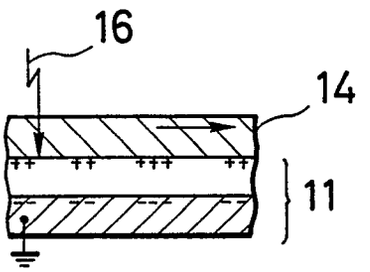

FIG.5

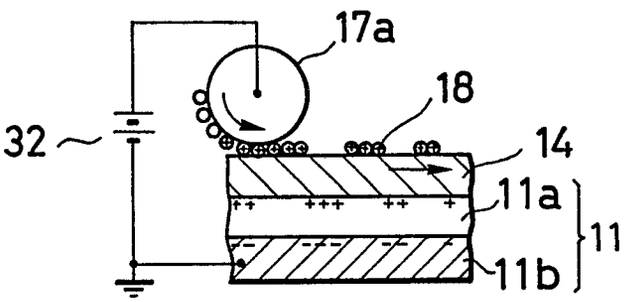

FIG.6

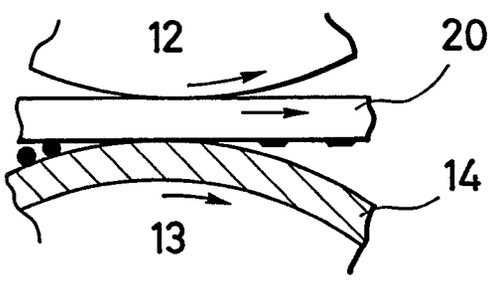

FIG.7

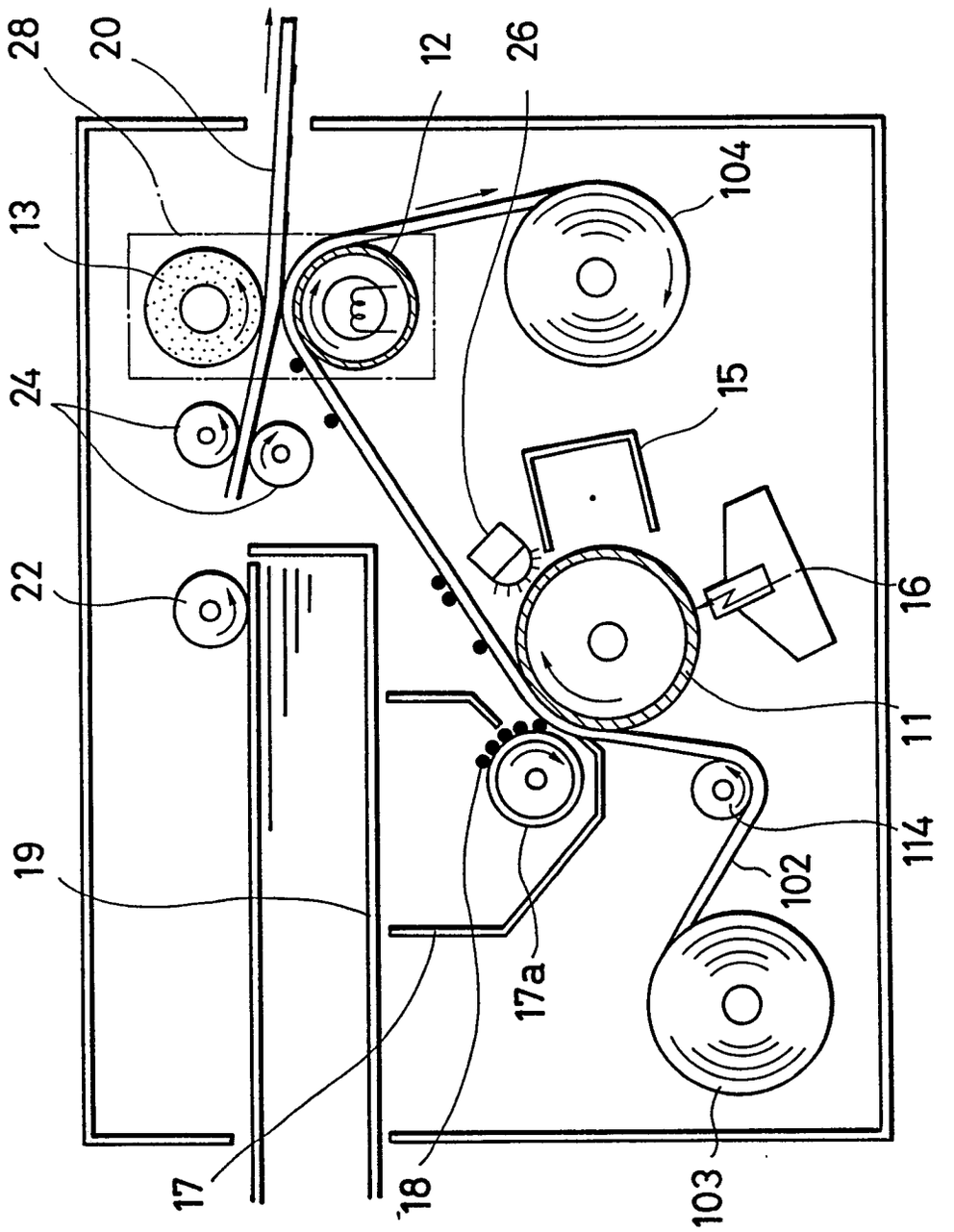

FIG.8

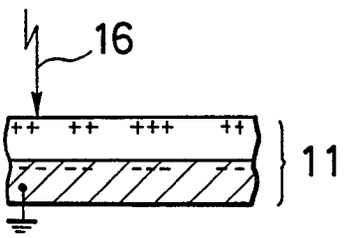

FIG.9

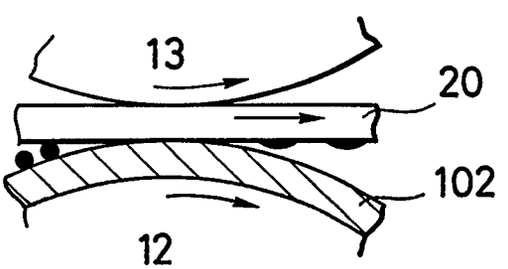

FIG.10

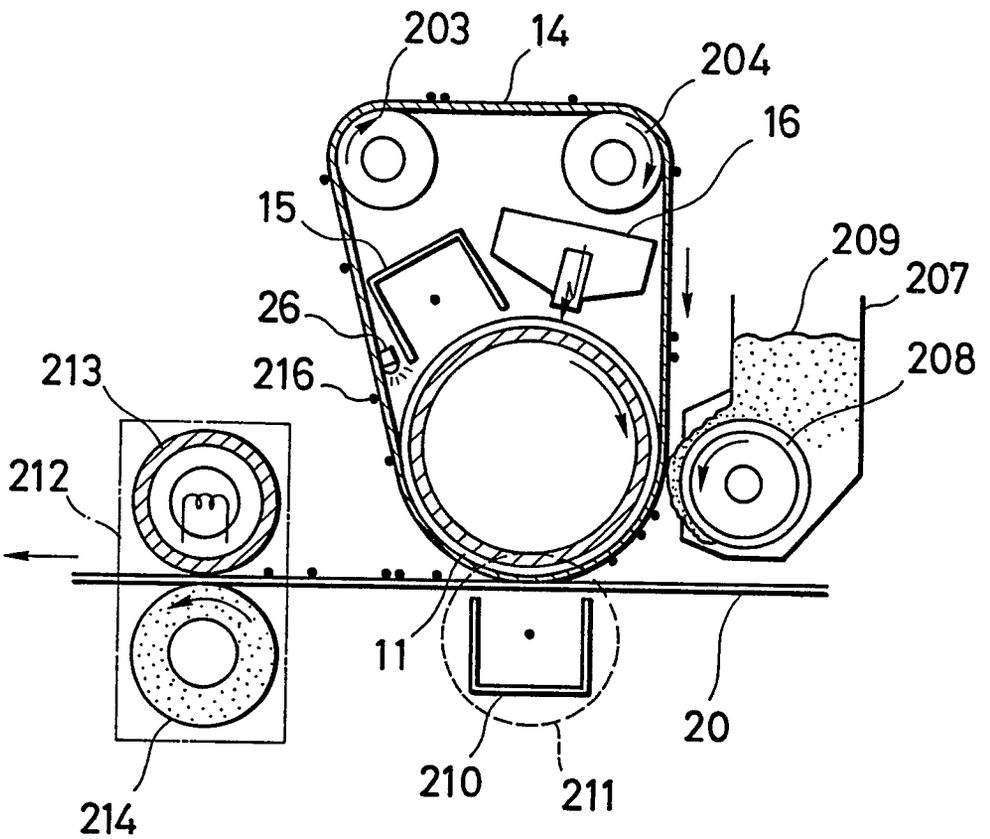

FIG.11

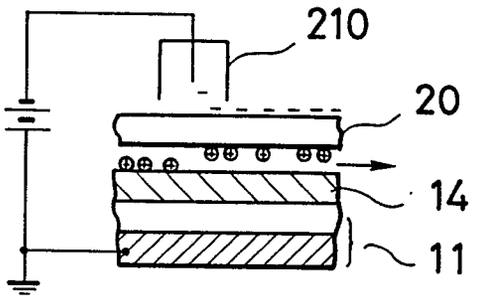

FIG.12

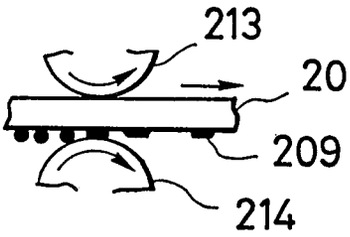

FIG.13

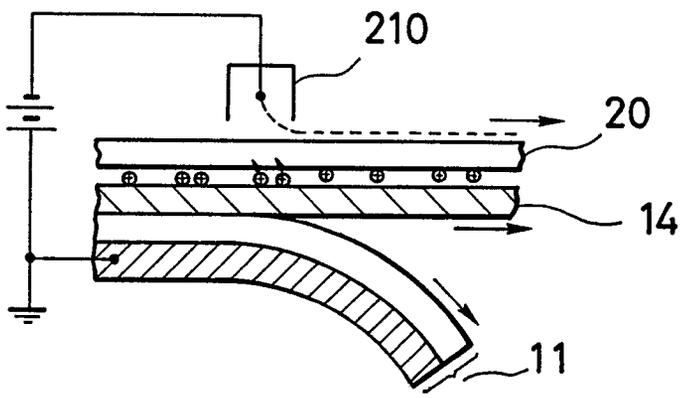

FIG.14