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(54) Electrophotographic apparatus for performing image exposure and development simultaneously

Elektrophotographischer Apparat für die gleichzeitige Durchführung der bildmassigen Beleuchtung und der Entwicklung

Appareil électrophotographique pour éffectuer l'exposition d'image et le développement en simultané

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an image forming apparatus of what is called electrophotographic type for forming an electrostatic latent image on a photosensitive body and developing the resultant electrostatic latent image with toner.

Related Background Art

[0002] As means for obtaining a hard copy such as a copying machine, a computer, and so on, image forming apparatus utilizing the electrophotographic method have been widely used. A typical image forming apparatus has a photosensitive body and devices for image formation arranged around the photosensitive body. More specifically, around the photosensitive body, there are provided a charger device, an exposure device, a developer device, a transfer device, a cleaning device, and so on. This image forming apparatus of electrophotographic method carries out image forming process comprising steps of charging the photosensitive body with electricity, exposing the photosensitive body to light in order to form an electrostatic latent image on the photosensitive body, developing the resultant electrostatic latent image by applying toner to it to obtain a toner image, transfer the developed toner image onto a transfer medium, and subsequently fixing the transferred toner image on the transfer medium to finally obtain a print image.

[0003] Compared with print images obtained from other means for obtaining hard copies such as those of thermal transfer type, of ink jet type, of impact printing type, or the like, the print image obtained as described above has higher resolution and stronger contrast, that is, as a whole, high quality.

[0004] However, as described before, the image forming process by the electrophotographic method requires many devices. So, the apparatus therefor tends to be of a large size and complicated. It is not easy to miniaturize and simplify the apparatus.

[0005] In order to solve said problem, some methods have been proposed in which, while using the same electrophotographic method, the apparatus carries out all the processes such as electrification, exposure development, and so on substantially at the same time and at the same position (such combined processes will be referred to "simplified process"). Among said methods, typical ones are disclosed, for example, in Japanese Laid-Open Patent Appln. Nos. 58-153957, 62-209470 and so on. In general, in these methods, either conductive toner or conductive carriers, and insulating toner are used, and the image forming process comprises steps of (1) cleaning the residual toner which was not transferred at previous image forming process; (2) contact electrification; (3) image exposure from the back surface of the photosensitive body; and (4) contact development. The series of steps are performed in a developing nip between the photosensitive body and a magnetic brush roller which corresponds to an exposure position on the back surface of the photosensitive body and which is in contact with the outer surface of the photosensitive body.

[0006] More specifically, as shown in Fig. 2, a magnetic brush provided upstream in the developing nip N between a developer sleeve 22 and a photosensitive body 1 scrapes the residual toner which was not transferred (hereinafter referred to as "transfer residual toner") to clean the photosensitive body 1. As the toner employed here is magnetic toner T and a fixed magnet 23 is arranged inside the developer sleeve 22, magnetic force can improve the cleaning effect.

[0007] Then, the surface of the photosensitive body 1 is brushed by a conductive magnetic brush (of conductive toner or conductive carriers) to apply the surface of the photosensitive body 1 with electricity. As the electrification is carried out by trapping electric charge in impurity levels on the surface of the photosensitive body 1, charger member(s) having very small resistance and a long period of electrification are required to carry out electrification sufficiently. Therefore, material which sufficiently holds electricity near its surface is needed. As said material, amorphous silicon-(hereinafter referred to as "a-Si"), selenium, and so on are preferably used.

[0008] The above-mentioned cleaning operation and electrification are performed at the same time in a cleaning-electrification region Nc, which is in the developing nip N and upstream with respect to a back surface exposure position A (described later). Incidentally, the potential of the charged photosensitive body 1 brushed with the magnetic brush is substantially equal to the applied voltage or less.

[0009] Next, the back surface of the photosensitive body 1 is exposed to light. A light source (exposure means) 3 having an LED array 31 illuminate the predetermined position (back surface exposure position) in the developing nip N formed by- developer between the developer sleeve 22 and the photosensitive body 1. Thus, a latent image is formed on the exposed photosensitive body 1. The latent image is developed in a development region N_D, which is downstream with respect to the back surface exposure position A, in the developing nip N. When conductive toner is used, the electric charge electrostatically induced by the latent image formed on the photosensitive body 1 is applied via a triboelectric brush to the toner at the tip of the triboelectric brush. The latent image is developed with toner separated from the triboelectric brush by Coulomb force acting between said electric charge and the electric charge of the latent image.

[0010] Otherwise, when two-component developer consisting of magnetic conductive carriers C and insulating toner T is used in the same apparatus, the triboelectric brush of the conductive carriers serves, as neighboring electrodes. Accordingly, sufficient electrical field for development can be obtained even if the voltage applied between the photosensitive body 1 and the developer sleeve 22 is small. Thus, development with insulating toner can be carried out by applying low voltage.

[0011] Since it is difficult to transfer toner image in the electric field obtained when conductive toner is employed, development with two-component developer including insulating toner is generally preferred.

[0012] However, in the image forming process in prior art described above, some problems arise because a plurality of processes are carried out in the developing nip N between the photosensitive body and the developer sleeve.

[0013] First, in the contact electrification with the conductive magnetic brush, electric charge is supplied to the surface of the photosensitive body, as described above. So, the material used for the photosensitive body 1 should have a level on the surface in which electric charge can be trapped. In this case, it is difficult to use an organic photo-semiconductor (OPC) which has been preferably used though such semiconductor has no toxicity and can have functions separately.

[0014] Fig. 3A shows a case in which the OPC photosensitive body 1 was electrified with conductive particles having volume resistivity of $10^4\ \Omega \cdot$ cm. In this case, when voltage of -60V was used for electrification, the photosensitive body 1 could be charged only with voltage of -40V. Before electric charge converged to -40V, the photosensitive body 1 in the apparatus shown in Fig. 2 had to make five rotations. Cleaning operation is also influenced. In this process, as described above, cleaning operation is performed in the cleaning-electrification region Nc upstream in the developing nip N between the photosensitive body 1 and the developer sleeve 22. Actually, the cleaning operation and electrification are performed at the same time.

[0015] The Van der Waals force between the toner and the photosensitive body 1 and Coulomb force both act on the residual toner to be removed which was not transferred. But, Coulomb force more strongly acts on the toner developed in the exposed portions than the toner in the non-exposed portions. Accordingly, when the surface of the photosensitive body 1 is electrified with the conductive magnetic brush, cleaning operation can be performed more effectively. However, if the photosensitive body 1 does not have a good electrification characteristic, it can not be sufficiently charged in the cleaning-electrification region Nc, which causes cleaning failure and a positive ghost image. The positive ghost image may be generated not only by the cleaning failure in which the residual toner used for the previous image forming process is not sufficiently removed, but also by electrification failure caused by said residual toner.

[0016] On the other hand, when the a-Si photosensitive drum 1 coated with the silicon-calcium carbide layer was electrified in the same way, it could be charged with 55V, as shown in Fig. 3B after making only two rotations of electrification. At the same time, in this reverse development system, the surface of the photosensitive drum 1 and toner are homopolar. So, repulsion between them remarkably improved cleaning effect.

[0017] In short, the above-mentioned first problem is that the material used for the photosensitive body 1 can not be selected freely but must be selected from comparatively few that realize the good electrification characteristic.

[0018] Secondly, even if the a-Si photosensitive body 1 is employed, a conductive magnetic brush whose resistance value is $10^3\Omega$ or more can not supply sufficient electric charge, which causes electrification failure. So, it is preferable to use materials for the photosensitive body 1 which have even better electrification characteristics.

[0019] Thirdly, since the a-Si photosensitive body 1 is prepared by deposition and other processes, the transparent substrate used for the photosensitive body 1 should be made of expensive heat resistance material. Accordingly, it is desirable that the photosensitive body 1 should be made of less expensive material such as OPC.

[0020] Patent specification JP-A-63-91667(Seiko Epson) discloses an electrophotographic photosensitive body which is illuminated from one side and developed at toner at the other side. The body comprises a transparent substrate having laminated on it a charge generating layer, a charge transfer layer and a surface layer containing TiO_2 particles. However, the surface layer is stated preferably not to contain a conductive material and to be of high resistance. JP-A-58107554 is similar, and again the photoconductive member has an insulating surface layer.

[0021] EP-A-0464749 discloses an electrophotographic photosensitive member having a protective layer whose resistivity is controlled by dispersing metal oxide particles in that protective layer. However, this photosensitive member is used for a conventional electrophotographic process rather than for the simplified process. Research disclosure No. 10942 of May 1993 is concerned with a multi-layered photoconductive element comprising a conductive support, a photoconductive insulating layer, an opaque optical barrier layer and a high contrast overcoat layer which includes a light-scattering particulate material dispersed in a resinous binder. There is no disclosure that the particles in the overcoat layer should be of conductive material, and there is no disclosure of the use of the photoconductive element in a simplified electrophotographic process.

[0022] The present invention is concerned with an electrophotographic apparatus having the features set out in claim 1 of the accompanying claims. Embodiments of the electrophotographic apparatus permit simultaneous image exposure and image development, and permit the use of a wide variety of materials for the photosensitive body. Embodiments of the apparatus provide images of good quality and with good reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 is a cross-sectional view showing the structure of the photosensitive body and the developing nip of the first embodiment according to the first invention;
Fig. 2 is a schematic cross-sectional view showing the image forming apparatus which carries out simplified image forming process;
Fig. 3A is a graph showing electrification characteristic of a conventional photosensitive body, Fig. 3B is a graph showing electrification characteristic of the photosensitive body of the first embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Embodiments according to the present invention will be described below with reference to the drawings.

〈First Embodiment〉

[0025] In the first embodiment, exposure of the back surface of the photosensitive body, cleaning operation, electrification and development are performed simultaneously ("simplified process") in the apparatus shown in Fig. 2, wherein a negatively chargeable OPC (organic photo conductor) employed here as the photosensitive body further has an electric charge supply layer formed on its surface layer.

[0026] Now, the image forming apparatus used in the first embodiment shown in Figs. 1 and 2 will be briefly described.

[0027] A photosensitive body 1 is a transparent glass cylinder 11 of a diameter of 30 mm on which photosensitive layers are laminated. As the material used for the cylinder 11, not only glass but also transparent resin having good dimensional stability can be employed. Further, polycarbonate, PMMA resin, and so on can be also employed.

[0028] First, the cylinder 11 is coated with ca. 1 µm of conductive base 12 (ITO layer) serving as a transparent conductive layer. On this ITO layer, an ordinary OPC photosensitive layer of functionally separated type is formed, which is prepared by laminating: an unchargeable layer 13 for inhibiting positive electric charge of the conductive base 12 from flowing in (UCL: thickness of 20 µm, volume resistivity of 10^6 Ω • cm); an electric charge generating layer 14 (CGL: thickness of 1 µm, polyvynyl butyral resin binder and diazo pigment); and a p-type electric charge transmitting layer (CTL: thickness of 2 µm, polycarbonate resin binder and hydrazone) 15. On this photosensitive layer, further an electric charge supply layer 16 according to the present invention is laminated.

[0029] The electric charge supply layer 16 used in this embodiment was prepared by uniformly dispersing 70 wt% of SnO_2 serving as conductive particles 17 (conductive fillers) in phosphazene resin serving as the binder. The thickness of the layer was 10 µm. Antimony was doped in SnO_2 employed here to make the particles conductive. Otherwise, indium may be doped in this ITO layer.

[0030] By dispersing the conductive particle 17 on the surface of the photosensitive body 1, the photosensitive body 1 can be utilized as a group of micro condensers. More specifically, the conductive base 12 and the conductive particles 17 serves as plate electrodes, while the electric charge transmitting layer 15 functions as dielectric substance. The plate electrodes are charged with electricity when the surface of the photosensitive body 1 is brushed by the conductive brush.

[0031] As for the condition of dispersion of SnO_2 in the electric charge supply layer 16, excessive SnO_2 may disturb the latent image electric charge after exposure be cause the surface resistance of the electric charge supply layer 16 to becomes too small, which occurs especially in high temperature and high humidity environment. On the other hand, if too little SnO_2 is dispersed, SnO_2 particles are not exposed outward on the surface of the electric charge supply layer 16. Thus, sufficient electric charge is not supplied and partial electrification failure occurs. In this case, a solid white image (non-exposed portions) obtained in the reverse development system suffers from defects such as sandy black spots, overall fogging, and so on. In order to prevent such defects, the amount of dispersed SnO_2 in the electric charge supply layer 16 is preferably within a range of 2 to 100 wt%.

[0032] Next, the developer device 2 shown in Fig. 2 will be described.

[0033] The developer device 2 comprises a developer container 21 for containing developer D, a rotary developer sleeve 22 of a diameter of 30 mm and a fixed magnet 23 arranged inside the developer sleeve 22, while the photosensitive body 1 is rotated in the direction of the arrow R1 (counter clockwise) in Fig. 2, the developer sleeve 22 is rotated in the direction of the arrow R2 (clockwise in Fig. 2) at a circumferential speed six times as high as that of the photosensitive body 1. Therefore, in the developing nip N between the photosensitive body 1 and the developer sleeve 22, the surface of the photosensitive body 1 and that of the developer sleeve 22 move in the same direction, while the surface of the developer sleeve 22 moves six times as fast as that of the photosensitive body 1. In this embodiment, the circumferential speed of the photosensitive body 1, which determines the speed of the image forming process, is set to be 50 mm/sec. Therefore, the circumferential speed of the developer sleeve 22 is 300 mm/sec.

[0034] The cylindrically formed fixed magnet 23 has eight poles at regular intervals around the its axis, as shown in Fig. 2. The peak position of each magnet is arranged to be on the line drawn from the center of the photosensitive drum 1 to the center of the developer sleeve 22. The value of magnetic induction at the peak position on the surface of the developer sleeve 22 is designed to be 800 0,08 Tesla (Gauss).

[0035] As shown in Fig. 1, the developer D is a mixture of the components; magnetic conductive carriers C (hereinafter also referred to as simply "carriers") and magnetic insulating toner T (also referred to as simply "toner"). The magnetic conductive carriers C contribute to cleaning of the residual toner on the photosensitive body 1 which was not transferred, electrification of the surface of the photosensitive body 1 and transmission of the toner. The grain diameter of the carriers C is 25 μm and the value of volume resistivity is 10^3 Ω • cm. The carriers are resin carriers prepared by dispersing magnetite, and for the sake of increasing conductivity, carbon black in polyester. The toner T is a negative toner, whose grain diameter is 7 μm and whose volume resistivity is 10^{14} Ω • cm. The toner T and the carriers C are mixed at a T/D rate of 15% (the weight percentage of the toner T in the total weight of the developer D). The mixture is contained in the developer container 21. The resultant developer shows, as a whole, resistance of 1 x 10^4 Ω.

[0036] In the developer container 21, the developer sleeve 22 is faced with a metal blade 24 for regulating the thickness of the developer D on the developer sleeve 22 to be about 1 mm. The clearance between the developer sleeve 22 and the photosensitive body 1 is determined to be 0.5 mm by means of contact rollers (not shown) provided in the end portions of the developer sleeve 22 and the photosensitive body 1. In this way, the developing nip N formed by the developer D between the photosensitive body 1 and the developer sleeve 22 which are rotated at respective predetermined speeds is determined to be about 7 mm.

[0037] Voltage of -60V is applied to the developer sleeve 22 and through it to the photosensitive body 1, to perform reverse development with negative toner.

[0038] An exposure means 3 having an LED array 31 is arranged inside the cylindrical photosensitive body 1 to illuminate the back surface of the photosensitive body 1 at the position of the developing nip N. More specifically, the back surface, exposure position A is 2 mm upstream from the downstream edge of the developing nip N. That is, the overall length of 7 mm of the developing nip N is divided by the back surface exposure position A into 5 mm of cleaning-electrification region Nc upstream with respect to the direction of rotation of the photosensitive body 1 (indicated by the arrow R1); and 2 mm of downstream development region N_D. If the back surface exposure position A is arranged too upstream (with too narrow cleaning-electrification region Nc), the latent image formed by exposure is charged again by the conductive carriers C and the contrast of the latent image decreases. In this case, the density of the resultant image can not be sufficient. On the other hand, if the back surface exposure position A is arranged too downstream, development must be carried out in the too small development region N_D, which also causes insufficient image density.

[0039] An example of image forming process using the above-mentioned apparatus will be described.

[0040] Upstream in the developing nip N formed by the photosensitive body 1 and the developer sleeve 22, the residual toner on the photosensitive body 1 used in the previous image forming operation is scrapped by the magnetic brush which is rotated by the developer sleeve 22 at high speed. At the same time, the conductive carriers C come into contact with the photosensitive body 1 to supply electric charge to the conductive particles 17 in the electric charge supply layer 16 of the photosensitive body 1. Thus the photosensitive body 1 is charged with electricity. In this embodiment, when voltage of -60V was applied to the developer sleeve 22, the photosensitive body 1 got potential of -55V. As electrification and cleaning operation are performed at the same time, repulsion is generated between the toner T and the charged surface of the photosensitive body 1, which further improves cleaning effect.

[0041] The back surface of the photosensitive body 1 is illuminated at the back surface exposure position A by the LED array 31 to reduce the potential of the exposed portions to -5V. After exposure, contact development in the electric field is carried out in the developing nip N. In this embodiment, as the potential in the non-exposed portions is -55V and the potential in the exposed portions is -5V. In other words, 50V of development contrast can be obtained. Since the tip of the triboelectric brush of the conductive carriers C is very close to the photosensitive body 1, the developing electric field acting on the toner T is strong enough to increase the image density. Actually, a density of about 1.3 as the reflection density was obtained, that is, an image of high density and high resolution was obtained.

[0042] Thus developed toner image is transferred onto the transfer medium P by the transfer roller 5 shown in Fig. 2. The transfer roller 5 employed in this embodiment had resistance of 5 x 10^8 Ω transfer voltage (applied bias) was +500V. The toner which is not transferred in the transfer position will be scraped upstream in the developing nip N during the next image forming operation, and will not damage to the image forming process. Subsequently, the transferred toner image is fixed on the transfer medium P by a fixing roller 6, and then the transfer medium P is ejected out of the apparatus.

[0043] Also the OPC photosensitive body 1 is advantageous compared with the a-Si photosensitive body with respect to the manufacturing cost, manufacture condition required, and so on, and can realize an inexpensive, simply-constructed image forming apparatus.

〈Second Embodiment〉

[0044] In this embodiment, a colored (including black) electric charge supply layer 16 is formed on the photosensitive layer to prevent deterioration of the photosensitive body 1 caused by external light. More specifically, colored material (black with carbon black, or white with titanium oxide) is used as the conductive particles 17 dispersed in the electric charge supply layer 16, wherein the conductive particles 17 contribute not only electric charge supply but also shield from light.

[0045] In general, a photo-semiconductor has photo memory effect or is irreversibly deteriorated after a long period of exposure to light, or when illuminated with strong light. Therefore, for example, a drum shutter is provided to protect the photosensitive body 1 from external light. But the drum shutter can not protect the photosensitive body 1 when the apparatus is opened at the time of, for example, maintenance check. Also during the image forming operation, stray light generated inside the apparatus (such as the light from the exposure device and pre-exposure device, the glow of a halogen heater, light emitted from the LEDs on the electric substrate, etc.) sometimes disturbs the image.

[0046] Such problems are all caused by the fact that the outer surface of the photosensitive body is exposed to light in the conventional image forming apparatus. In other words, they are caused because the light for image exposure and the stray light can not be distinguished. However, in case the back surface of the photosensitive body 1 is exposed to perform image exposure, as in the present invention, the light for image exposure always comes from the back side, while all the other light such as external light and stray light come from outer side. Therefore, a shield means provided on the outer surface of the photosensitive body 1 can remove such harmful light.

[0047] Therefore, in this embodiment, the conductive particles 17 dispersed in the electric charge supply layer 16 as in the First Embodiment has not only an electric charge support function, but also a light shielding function to prevent the photo-semiconductor from being deteriorated by external light and stray light.

[0048] The conductive particles 17 having both the electric charge support function and the light shielding function includes: black substance such as conductive carbon (carbon black, kechene black, acetylene black) and titanium oxide; white substance making the surface white to reflect external light such as titanium dioxide (treated with antimony-doped stannic oxide to control conductivity); and conductive, light-reflecting or light-absorbing metal particles, or the oxides thereof.

[0049] In this embodiment, titanium dioxide was used in the experiment. The same apparatus as in the First Embodiment was used. The only difference is the electric charge supply layer 16 of the photosensitive body 1, which was prepared by dispersing 120 wt% of titanium dioxide in polypropylene resin binder. The amount of dispersion differs from that of the First Embodiment, because titanium dioxide has specific volume resistivity higher than stannic oxide used in the First Embodiment. In order to prevent electrification failure and disturbed images, the amount of dispersed titanium dioxide is preferably within a range of 5 to 250 wt%. Though polypropylene resin is used as the binder in this embodiment, any material which forms good coating and is a good insulator (whole resistance does not preferably vary when absorbing moisture) may be used. In order to improve the light-shielding function, however, preferably the resin has its own color.

[0050] The photosensitive body 1 was coated with said disperse system by dipping, and the electric charge supply layer 16 of a thickness of 5 µm was formed. The resultant photosensitive body 1 appeared white. Thus light in the ordinary working condition can be sufficiently reflected and can not deteriorate the photosensitive layer beneath the electric charge supply layer 16.

[0051] As described above, in this embodiment, the photosensitive body 1 is coated with the electric charge supply layer 16 in which light-shielding conductive particles are dispersed. Accordingly, the image forming apparatus can be easily operated.

[0052] Incidentally, the present embodiment is effective especially when it is applied to an image forming apparatus carrying a detachable photosensitive body cartridge in which light-shielding shutter for the photosensitive body must be provided.

〈Third Embodiment〉

[0053] In this embodiment, the electric charge generating layer (CGL) 14 and the electric charge transmitting layer (CTL) 15 of the photosensitive body 1 of the First Embodiment are laminated in reverse sequence, wherein a positively chargeable photosensitive body 1 with p-type photo-semiconductor is prepared.

[0054] In the simplified process according to the present invention, the potential in the non-exposure portions and development voltage differs little from each other, wherein fogging generated in the non-image portions is a big problem. For example, in the First Embodiment, the potential in the non-exposure portions is -55V, while the developer sleeve 22 is charge with -60V. Thus, even the non-image forming portions have potential difference of 5V for development. Especially, when the triboelectricity of the toner is high development of the non-image forming portion is promoted and fogging becomes remarkable. In fact, fogging becomes more troublesome in the low temperture/low humidity environment where toner is highly charged. In such an environment, a 5V of potential difference is enough to carry out development because of high triboelectricity of the toner as well as of strong attraction between the toner and the photosensitive body 1. Therefore, to perform the simplified process properly, low triboelectricity should be always realized regardless of environmental conditions.

[0055] The toner used in the present invention is pulverized toner, which is a mixture of resin, magnetite, electrification control agent and lubricant. As most of the typical resins used for toner such as polyester resin, styvene acrylic resin and so on tend to be negatively chargeable, and they can be easily charged with excessive negative electricity even if electrification control agent suppress the triboelectricity. Accordingly, in order to obtain stable toner with low triboelectricity, it is preferable to employ positively chargeable toner. However, when the organic photo-semiconductor (OPC) is employed in order to obtain high withstand voltage, there is no n-type OPC which can be practically used with respect to stability. Thus, positively chargeable OPC can not be used for the photosensitive body.

[0056] In order to prepare a positively chargeable photosensitive body by using a p-type photo-semiconductor, an ordinary photosensitive body of functionally separated type may be prepared, wherein the CGL layer 14 and the CTL layer 15 are laminated in reverse sequence. However, as the CGL layer is easily scraped, a protection layer should be formed in the prior art. But, according to the present invention, as the electric charge supply layer 16 also serves as the protection layer, a protect layer does not have to be newly provided. Thus, the positively chargeable photosensitive body 1 can be easily prepared.

[0057] The experiment was made as follows. The same apparatus used in the First Embodiment was used. Only the photosensitive body and the toner were charged.

[0058] The photosensitive body used here was prepared in the same manner as the First Embodiment except that the CTL layer 15 and the CGL layer 14 were laminated in reverse sequence. The negative toner used in the First Embodiment was replaced by a positive toner in this embodiment. The positive toner comprises 100 volume units of styrene acrylic resin, 50 volume units magnetite, 10 volume units of polypropyrene as the lubricant and powder of copy blue kreaded and crushed to obtain a diameter of 7 μm as the electrification control agent. As an additive agent silica is added.

[0059] Images were formed with the photosensitive body and the toner prepared as described above, and compared with the images obtained from the negatively chargeable photosensitive body and the negative toner used in the First Embodiment. The image obtained as in the First Embodiment in normal, low temperature/ low humidity environment was first stable with triboelectricity of about -10 μC/g and showed just negligible amount of fogging, 1% in the non-image forming portions. After making idle rotations for ten minutes in low temperture/low humidity environment, the image obtained according to the First Embodiment showed triboelectricity of as large as -18 μC/g, and the amount of fogging on the transfer medium reached 4%.

[0060] On the other hand, the images obtained according to this embodiment with the positively chargeable photosensitive body in combination with the positive toner were stable with triboelectricity of about +10 μC/g and showed the amount of fogging, 1%. These values did not change even after a long period of operation.

[0061] According to the present invention described above, even the p-type organic photo-semiconductor can be used for the positively chargeable photosensitive body simply by forming the electric charge supply layer on the surface of the photosensitive body, for the electric charge supply layer also serves as surface protection layer. It is possible to reduce the amount of troublesome fogging in the non-image forming portions, which is caused by excessively charged toner in the conventional simplified process, by using the positively chargeable photosensitive body according to the present invention in combination with the positive toner.

[0062] As described above, the present invention has the following effects.

[0063] According to the present invention, an image of good quality can be obtained with the image forming apparatus which carries out what is called "simplified process" (in which cleaning, electrification and development are all performed in the developing nip, and the back surface of the photosensitive body is illuminated for image exposure), even if photosensitive material which does not have sufficient electric charge support capacity and thus has not been used in the simplified process is employed. This effect can be obtained by providing the electric charge supply layer on the surface of the photosensitive body. In particular, the organic photo-semiconductor which is widely used because of the facility of handling and designing can also be used in the simplified process.

[0064] Further, by using the photosensitive body having the good electrification characteristic, not only the surface of the photosensitive layer can be electrified with the magnetic brush, but also cleaning effect can be improved, which greatly contributes to the simplified back surface exposure process in which cleaning operation and electrification are performed at the same time. In addition, by using colored particles as the conductive particles used for the electric charge supply layer, the electric charge supply layer can not only improve the electric charge support capacity of the photosensitive body but have a light-shielding effect. Thus, the photosensitive layer can be easily protected from harmful external light. It should be noted that ITO refers to a conductive tin oxide e.g. Indium tin oxide.

[0065] Preferably the electric charge supply layer has a surface energy of 5×10^{-3} Nm^{-1} to $3\times10^{-2} Nm^{-1}$, more preferably $1\times10^{-2}Nm^{-1}$ to $3\times10^{-2}Nm^{-1}$, as described in our concurrently filed application EP-A-606004.

Claims

1. An electrophotographic apparatus comprising:

an electrophotographic photosensitive member including a translucent substrate (11) carrying, with increasing distance from the substrate, a conductive layer (12), a photosensitive layer of an organic photoconductive material and an electrical charge supply layer (16) having conductive powder dispersed in an insulating binder;
exposure means (3) for exposing the photosensitive member to a light image from one side of the translucent substrate (11); and
developing means located to the other side of the substrate (11) at a position corresponding to an exposure position of the photosensitive member (1) by the exposure means (3), said developing means being for formation of a magnetic brush of conductive developer which is contactable with the charge supply layer (16) adjacent to said exposure position and for supplying electric charge to the charge receiving layer (16) via said magnetic brush upstream of the exposure position with reference to a direction of movement of the photosensitive member, characterised by the exposure position of the photosensitive member (1) being located downstream of a centre position in an area where the magnetic brush contacts the photosensitive member.

2. The apparatus of claim 1, wherein the translucent substrate (11) has a cylindrical shape and said exposure means (3) is arranged inside the substrate (11).

3. The apparatus of claim 1 or 2, wherein the conductive layer (12)is of indium tin oxide.

4. The apparatus of claim 3, wherein the photosensitive member carries, between the conductive layer (12) and the photosensitive layer a non-chargeable layer (13) for inhibiting flow of electrical charge from the conductive layer (12).

5. The apparatus of claim 4, wherein the photosensitive layer comprises, laminated in either sequence, a charge generating layer (14) containing the organic photoconductor material and a charged transmitting layer (15).

6. The apparatus of any preceding claim, wherein the conductive particles of the charge supply layer (16) are coloured particles dispersed in the binder for shielding the photosensitive member from light.

7. The apparatus of any preceding claim, further comprising a two-component toner comprising conductive carrier particles and insulating toner particles.

8. A method of forming an electrophotographic image which comprises exposing to light the electrophotographic photosensitive member of an apparatus according to any of claims 1 to 7 and developing the resulting image with toner.

9. The method of claim 8, further comprising the step of transferring the developed image to a recording medium.

Patentansprüche

1. Elektrophotographisches Gerät mit:

einem elektrophotographischen photosensitiven Element mit einem lichtdurchlässigen Substrat (11), das bei einem zunehmenden Abstand von dem Substrat eine leitfähige Lage (12), eine photosensitive Lage aus einem organischen photoleitfähigen Material und eine Lage (16) für ein Zuführen einer elektrischen Aufladung mit in einem Isolationsbinder dispergiertem leitfähigen Pulver trägt;
einer Belichtungseinrichtung (3) zum Belichten des photosensitiven Elementes mit einem Lichtbild von einer Seite des lichtdurchlässigen Substrates (11); und
einer Entwicklungseinrichtung, die sich an der anderen Seite des Substrates (11) an einer Position entsprechend einer Belichtungsposition des photosensitiven Elementes (1) durch die Belichtungseinrichtung (3) befindet, wobei die Entwicklungseinrichtung dem Ausbilden einer magnetischen Bürste eines leitfähigen Entwicklers, der mit der Lage (16) für die Zuführung der Ladung benachbart zu der Belichtungsposition in Kontakt bringbar ist, und einem Zuführen einer elektrischen Aufladung zu der Lage (16) für eine Zuführung der Aufladung über die magnetische Bürste stromaufwärtig von der Belichtungsposition in Bezug auf eine Bewegungsrichtung des photosensitiven Elementes dient,
dadurch gekennzeichnet, dass
die Belichtungsposition des photosensitiven Elementes (1) sich stromabwärtig von einer mittleren Position in einem Bereich befindet, an dem die magnetische Bürste mit dem photosensitiven Element in Kontakt steht.

2. Gerät gemäß Anspruch 1, wobei

das lichtdurchlässige Substrat (11) eine zylindrische Form hat und die Belichtungseinrichtung (3) im Inneren des Substrates (11) angeordnet ist.

3. Gerät gemäß Anspruch 1 oder 2, wobei

die leitfähige Lage (12) aus Indiumzinnoxid besteht.

4. Gerät gemäß Anspruch 3, wobei

das photosensitive Element zwischen der leitfähigen Lage (12) und der photosensitiven Lage eine nicht aufladbare Lage (13) trägt, die ein Fließen einer elektrischen Aufladung von der leitfähigen Lage (12) verhindert.

5. Gerät gemäß Anspruch 4, wobei

die photosensitive Lage eine das organische Photoleitmaterial enthaltende Ladungserzeugungslage (14) und eine Ladungsübertragungslage (15) geschichtet in jeder Abfolge aufweist.

6. Gerät gemäß einem der vorherigen Ansprüche, wobei

die leitfähigen Partikel der Lage (16) für die Zuführung der Aufladung Farbpartikel sind, die in dem Binder dispergiert sind, um das photosensitive Element vor Licht abzuschirmen.

7. Gerät gemäß einem der vorherigen Ansprüche, das des Weiteren einen Toner aus zwei Komponenten aufweist, der leitfähige Trägerpartikel und Isolationstonerpartikel aufweist.

8. Verfahren zum Erzeugen eines elektrophotographischen Bildes mit den Schritten:

Belichten des elektrophotographischen photosensitiven Elementes von einem Gerät gemäß einem der Ansprüche 1 bis 7 mit Licht und Entwickeln des sich ergebenden Bildes mit einem Toner.

9. Verfahren gemäß Anspruch 8, das des Weiteren den folgenden Schritt aufweist:

Übertragen des entwickelten Bildes auf ein Aufzeichnungsmedium.

Revendications

1. Appareil électrophotographique comportant:

un élément photosensible électrophotographique comprenant un substrat translucide (11) portant, à une distance croissante du substrat, une couche conductrice (12), une couche photosensible d'une matière photoconductrice organique et une couche (16) de fourniture de charges électriques ayant une poudre conductrice dispersée dans un liant isolant;
un moyen d'exposition (3) destiné à exposer l'élément photosensible à une image lumineuse arrivant d'un côté du substrat translucide (11); et
un moyen de développement placé sur l'autre côté du substrat (11) dans une position correspondant à une position d'exposition de l'élément photosensible (1) par le moyen (3) d'exposition, ledit moyen de développement étant destiné à la formation d'une brosse magnétique d'un développateur conducteur qui peut entrer en contact avec la couche (16) de fourniture de charge à proximité immédiate de ladite position d'exposition et à la fourniture d'une charge électrique à la couche (16) de réception de charge par l'intermédiaire de ladite brosse magnétique en amont de la position d'exposition en référence à un sens de déplacement de l'élément photosensible, caractérisé en ce que la position d'exposition de l'élément photosensible (1) est située en aval d'une position centrale dans une zone où la brosse magnétique est en contact avec l'élément photosensible.

2. Appareil selon la revendication 1, dans lequel le substrat translucide (11) présente une forme cylindrique et ledit moyen (3) d'exposition est disposé à l'intérieur du substrat (11).

3. Appareil selon la revendication 1 ou 2, dans lequel la couche conductrice (12) est en oxyde d'étain dopé à l'indium.

4. Appareil selon la revendication 3, dans lequel l'élément photosensible porte, entre la couche conductrice (12) et la couche photosensible, une couche (13) ne pouvant pas être chargée, destinée à empêcher l'écoulement d'une charge électrique depuis la couche conductrice (12).

5. Appareil selon la revendication 4, dans lequel la couche photosensible comporte, stratifiées séquentiellement, une couche (14) de génération de charges contenant la matière photoconductrice organique et une couche (15) de transmission de charge.

6. Appareil selon l'une quelconque des revendications précédentes, dans lequel les particules conductrices de la couche (16) fournissant des charges sont des particules colorées dispersées dans le liant pour protéger de la lumière, en faisant écran, l'élément photosensible.

7. Appareil selon l'une quelconque des revendications précédentes, comportant en outre un toner à deux constituants comprenant des particules d'un véhicule conducteur et des particules d'un toner isolant.

8. Procédé de formation d'une image électrophotographique, qui comprend l'exposition à la lumière de l'élément photosensible électrophotographique d'un appareil selon l'une quelconque des revendications 1 à 7 et le développement de l'image résultante avec un toner.

9. Procédé selon la revendication 8, comprenant en outre l'étape de report de l'image développée sur un support d'enregistrement.

FIG. 1

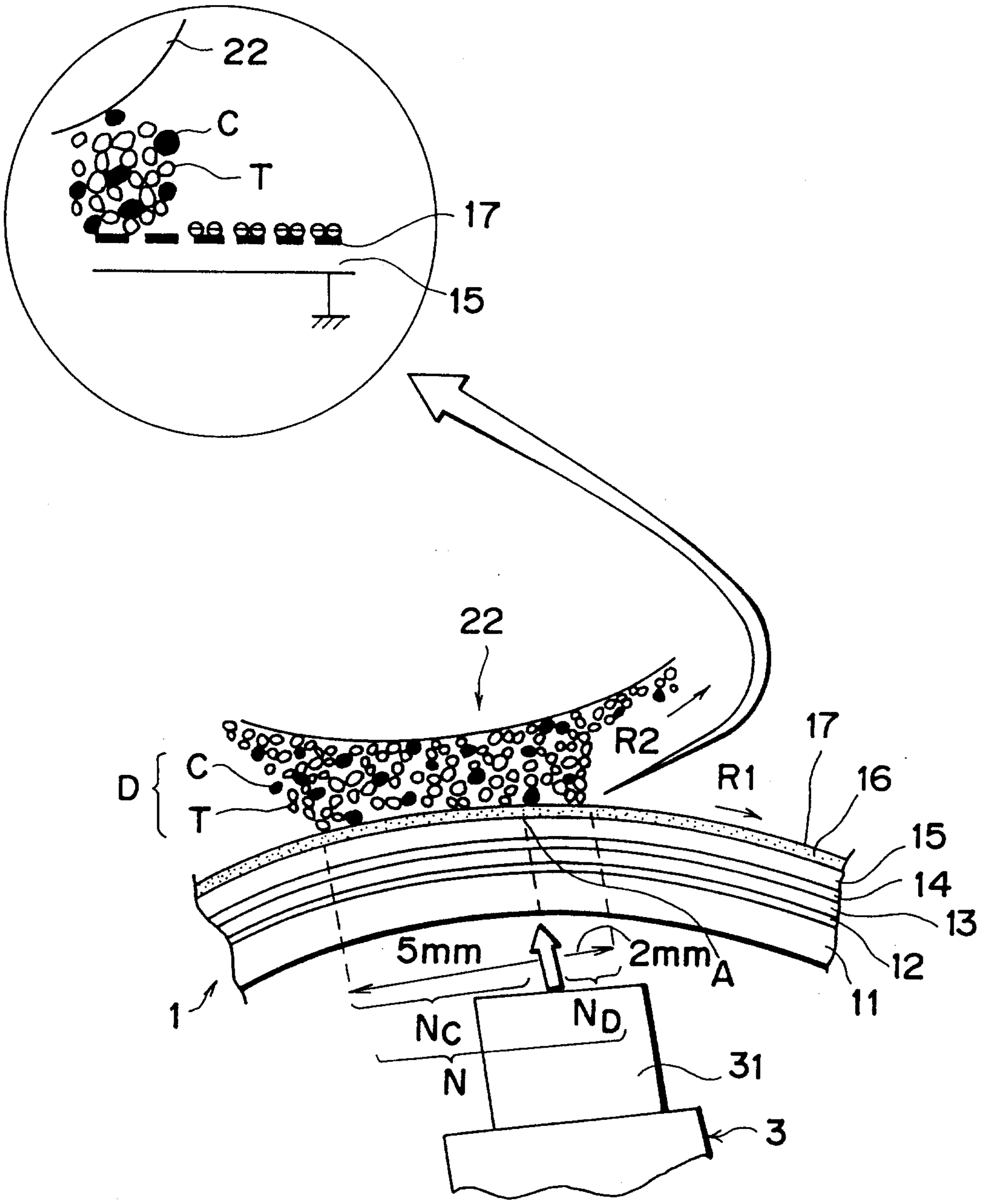


FIG. 2

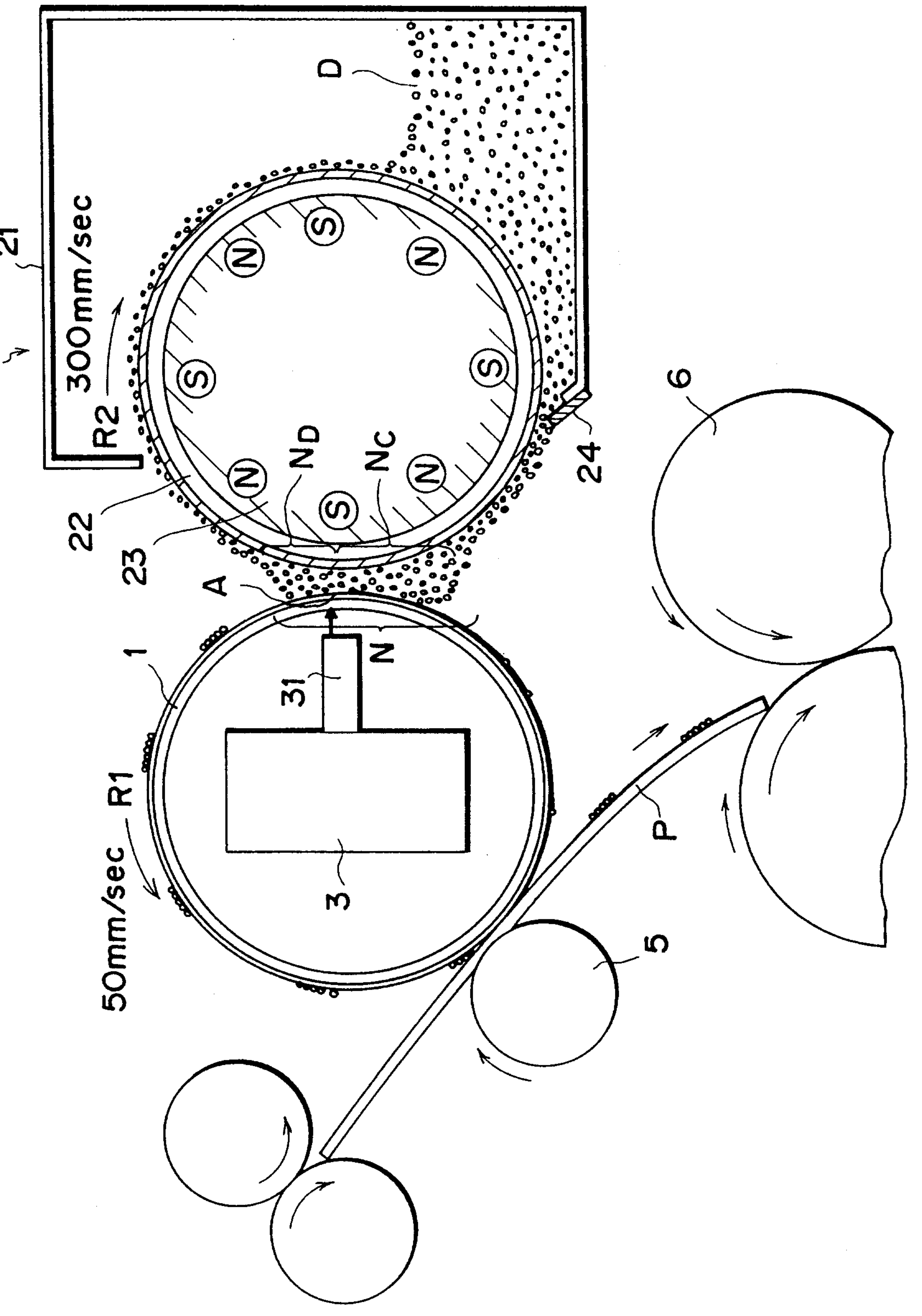


FIG.3A

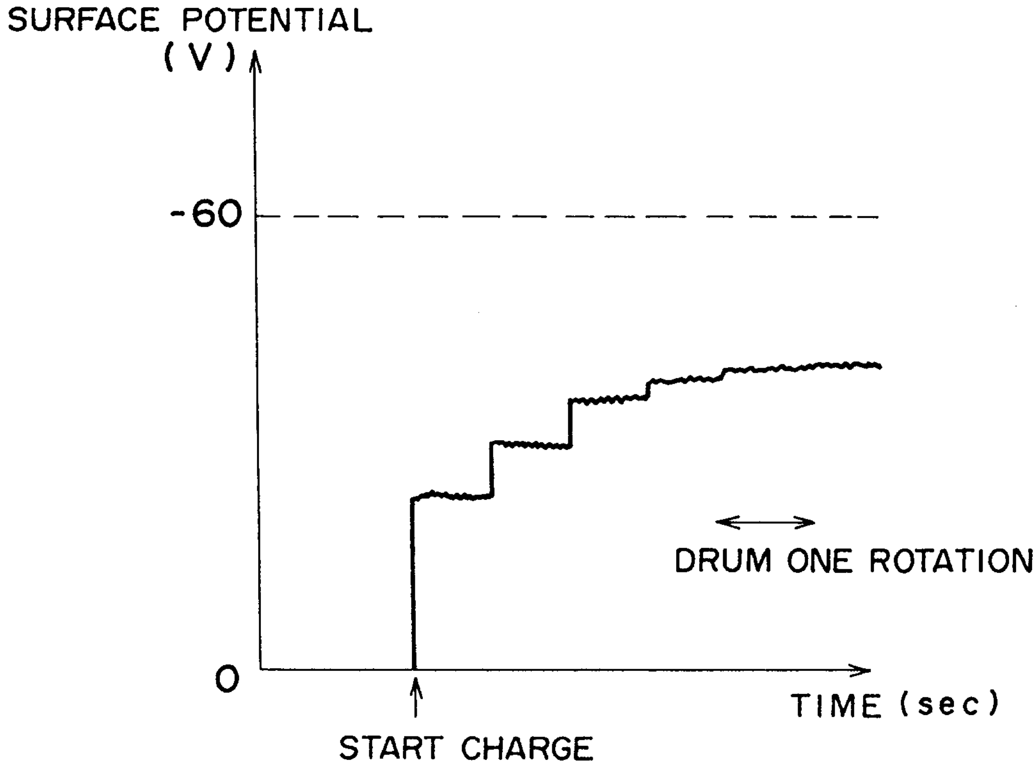
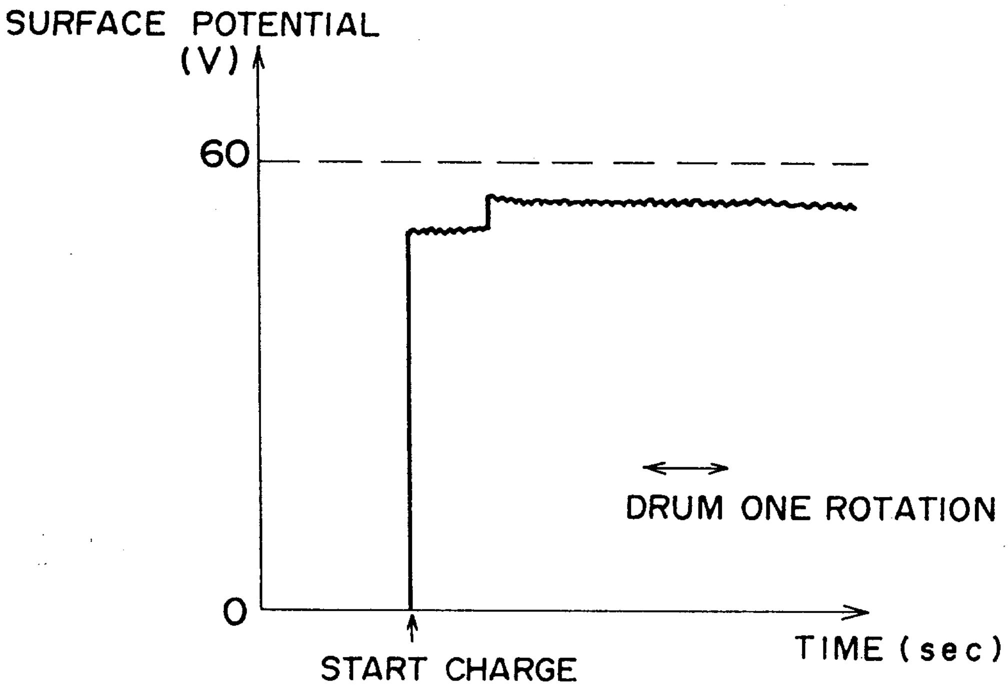

SURFACE POTENTIAL
(V)
-60
0
DRUM ONE ROTATION
TIME (sec)
START CHARGE

FIG.3B


SURFACE POTENTIAL
(V)
60
0
DRUM ONE ROTATION
TIME (sec)
START CHARGE