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PATENT SPECIFICATION
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COMPLETE SPECIFICATION

Electrophotography

We, CANON CAMERA COMPANY INCORPORATED, a corporation organised under the laws of Japan, of 312 Shimomaruko-cho, Ohta-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to electrophotography.

An electrophotographic process according to the invention uses an electrophotographic member having a conductive layer, an N-type or P-type photoconductive layer on the conductive layer, and an insulating layer on the photoconductive layer, the conductive layer and/or the insulating layer being translucent for exposing the member, said process comprising applying to the surface of the insulating layer a positive or negative primary charge according to whether the photoconductive layer is N-type or P-type to cause charges of opposite polarity to be injected from the conductive layer into the photoconductive layer and bound in the region of the interface between the insulating and photoconductive layers, and exposing the member to an image while simultaneously applying to the surface of the insulating layer a secondary charge of opposite polarity to the primary charge so that, in areas of the image in which the photoconductive layer is activated, the polarity of the charges on the member is reversed, whereas, in the other areas of the image, at least some of the charges bound in the region of said interface so remain, thus forming an electrostatic image on the surface of the insulating layer.

The process preferably includes the additional step after termination of the image exposure and application of the secondary

charge of activating the photoconductive layer overall whereby any charges accumulated on the conductive base in said other areas of the image during the application of the secondary charge at least partially cancel said charges which had remained bound in the region of said interface, to increase the electrostatic potential difference between the different areas of the electrostatic image.

Electrophotographic apparatus according to the invention comprises an electrophotographic member having a conductive layer, an N-type or P-type photoconductive layer on the conductive layer, and an insulating layer on the photoconductive layer, the conductive layer and/or the insulating layer being translucent for exposing the plate; a primary charging device arranged for applying to the surface of the insulating layer a positive or negative primary charge according to whether the photoconductive layer is N-type or P-type, the member being such that, upon application of the primary charge, charges of opposite polarity are injected into the photoconductive layer from the conductive layer and bound in the region of the interface between the photoconductive layer and the insulating layer; an optical system for exposing the member to an image subsequent to the application of the primary charge, and a secondary charging device arranged for applying to the surface of the insulating layer a charge of polarity opposite to that of the primary charge simultaneously with the image exposure, to form an electrostatic image on the plate.

It is also preferable in the apparatus to include means for carrying out the additional step referred to above.

The invention is described further with reference to the accompanying drawings in which:

Figure 1 shows an electrophotographic

[Price 4s. 6d.]

Price 5s. 0d. Price 25p

*At photo
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ification*

plate according to the invention.

Figures 2 to 6 illustrate the steps of an electrophotographic process according to the invention, using the plate shown in Figure

1, Figures 7 and 8 respectively illustrate diagrammatically the electrophotographic charge patterns and the surface potentials obtained on the plate under various process conditions.

Figure 9 illustrates the different surface potentials obtained on the plate by varying one of the parameters of the plate.

Figure 10 illustrates a modified plate.

Figure 11 illustrates apparatus according to the invention, and

Figures 12 and 13 are respectively longitudinal section and plan views of apparatus according to another embodiment of the invention.

Referring to Figures 1 to 6, an electrophotographic plate A comprises a conductive base 1, an N-type photoconductive layer 2 coated on the base 1 and a translucent insulating layer 3 adhered to the layer 2. The plate is such that, upon application of a positive charge to the surface of the insulating layer 3, as illustrated in Figure 2, negative charges are injected from the conductive base 1 and bound in the region of the interface between the layers 2 and 3.

This application of a positive charge to the surface of the insulating layer 3 is the first step in the electrophotographic process illustrated in Figures 2 to 6 and it is carried out, as shown in Figure 2, by means of a corona discharge device 5 energised by a high voltage source 4.

The second step in the process is illustrated in Figure 3 and comprises the exposure of the plate A to an image 8 and the simultaneous application to the surface of the insulating layer 3 of a negative charge by means of a corona discharge device 10 energised by a high voltage source 9. The corona discharge device 10 is optically open as at 10a as illustrated in Figure 3, in order that the light from the image 8 can pass through it to the plate A.

The image to which the plate A is exposed is composed of light and dark areas. In the light areas, the photoconductive layer 2 is activated to become conductive and the effect of the negative charge applied by the device 10 is to reverse the polarity of the charge in these areas on the surface of the insulating layer 3 and in the region of the interface between the layers 2 and 3. In the dark areas, however, the negative charge in the region of the interface between the layers 2 and 3 remains bound there, since the photoconductive layer 2 does not become conductive. Therefore, the effect of the negative charge applied by the device 10 in the dark areas is to only partially

remove the positive charge previously applied by the device 5 and to accumulate a positive charge at the conductive base 1.

This therefore results in an electrostatic image being formed on the surface of the insulating layer 3.

The contrast of this image is increased by the further step illustrated in Figure 4, of exposing the plate A overall to light, so rendering the entire area of the photoconductive layer 2 conductive and enabling the positive charges accumulated on the conductive base 1 in the dark areas of the image to cancel some of the negative charges which had remained bound at the interface between layers 2 and 3 during the step illustrated in Figure 3. These cancelled negative charges would, if allowed to remain as shown in Figure 3, reduce the potential difference between the light and dark areas of the image and therefore the image contrast, due to the negative electric field associated with them.

The image can now be developed by applying charged coloured particles to the surface of the insulator 3, for example by any of the well-known methods such as the cascade method, the magnetic brush method or the powder cloud method and a visible image 11 as shown in Figure 5 is formed. Alternatively, the image can be developed using a liquid developer such as halogenated hydrocarbons, dimethylpolysiloxane or highly insulating oils with pigments or dyes dispersed in them.

The image 11 is then transferred, as shown in Figure 6, to a transfer sheet 13 such as of paper. This can be carried out using an external bias voltage produced by the corona discharge device 10, as more fully described in U.S. Patent No. 2,637,651, or by using a transfer sheet whose capacity is sufficiently large that transfer of the image is achieved without requiring an external electric field, as more fully described in Japanese Patent Publication 12183/67. The transferred image can then be fixed on to the transfer sheet for example by infra-red heating.

To re-use the plate A, it is cleaned to remove the remaining particles from the surface of the insulating layer 3. This is facilitated if the charge on the surface of the insulating layer 3 is first of all removed, for example by subjecting the plate to an AC discharge.

As described, the plate A utilises an N-type photoconductive layer 2 and has the characteristic that, when the primary positive charge is applied, as illustrated in Figure 2, negative charges are injected from the conductive base 1 and bound in the region of the interface between the layers 2 and 3. The invention also envisages that a plate utilising a P-type photoconductive layer can be used, in which case the primary

charge applied to the surface of the insulating layer would be negative and the plate would have the characteristic that positive charges would be injected from the conductive base to be bound in the region of the interface between the photoconductive and insulating layers. Thus, the photoconductive layer can comprise P-type or N-type material. It would also be possible to utilise a mixture of the two types of material, but the polarity of the primary charge would still be chosen according to whether the mixture is predominantly of N-type or P-type photoconductivity, the essential thing being that charges of opposite polarity to the primary charge are injected from the base and bound at the aforesaid interface region. In all cases, the secondary charge, applied simultaneously with the image exposure, is of opposite polarity to the primary charge.

The aforesaid injection characteristics can be obtained with various photoconductive materials, such as CdS (cadmium sulphide), CdSe (cadmium selenide), ZnO (zinc oxide), metallic Se (selenium), amorphous Se (selenium), TiO₂ (titanium dioxide), SeTe (selenium telluride), PbO (lead oxide) and S (sulphur), or organic photoconductors such as anthracene or carbazole or certain mixtures of them. Particularly suitable materials are CdS or CdSe, since high sensitivity for example of over ASA 100 can be achieved with these. Metallic Se, of low resistivity, is also particularly suitable. A further example of a photoconductive material which may give excellent results is one utilising ZnO doped with lithium. With some of these materials, it is necessary to mix them with binder chosen to obtain the injection characteristic. Some examples of binders useful with some of the above mentioned photoconductive materials are to be found in the specific examples which are described below.

Suitable materials for the insulating layer are fluoroethylene resin, polycarbonate resin, polyethylene resin, cellulose acetate resin, and polyester resin.

The material of the insulating layer should be chosen to be highly resistant to abrasion and to have a high electrical resistance in order that the layer can support electrostatic charge. A particularly suitable material is fluoroethylene resin, since this has the characteristic that the developer particles do not tend to adhere to it and therefore this insulating material is easy to clean.

Examples of suitable material for the conductive base are tin, copper, aluminium, damp paper or aluminium foil adhered to a paper backing, this latter being both economical and capable of being wound upon a drum.

Specific examples of constructions of the

plate and the process of use are as follows:

Example 1

10g of clear acrylic lacquer was added to 90g of cadmium sulphide activated by copper, and a little amount of thinner was added to the above obtained mixture, and the whole mixture was made into paint form and coated on an aluminium plate to a thickness of about 1 mm, by means of a spray. Then a film of transparent fluoroethylene resin, the thickness thereof being about 15 μ , was adhered on the above obtained photoconductive coated surface and the photosensitive plate was prepared. A corona discharge of +6KV was made on the resin film of the photosensitive plate and the positive charge was applied uniformly over the surface of the plate, and then the original image was irradiated on the charged fluoroethylene resin coated film surface by using a tungsten lamp of about 10 lux for about 0.1 to 0.3 seconds, and at the same time negative corona discharge of -6KV was irradiated thereon. An electrostatic image was formed on the fluoroethylene resin coated film; and thereafter, the whole surface of the said coated film was exposed uniformly for 1 to 2 seconds by means of 10 lux tungsten lamp to form an electrostatic image in accordance with the light-and-dark patterns of the original image; this image was developed by means of a magnet brush method, and it is possible to obtain a visible image of high image density and remarkably excellent quality without fogging.

Example 2

A mixture of zinc oxide, silicon resin, and toluene in the weight ratio 2:1:3, were mixed within a ball mill for about three hours. An alcoholic solution of 0.15% Rose Bengale was added to the above prepared mixture so as to have the weight % of Rose Bengale equal to 0.05% by weight of zinc oxide. The thus obtained mixture was coated on an aluminium plate to a thickness of about 60 μ when dried, and a 25 μ thick polyester film was adhered thereon by using an epoxy resin. A latent electrostatic image was formed in the same manner as in Example 1, but in this case it was necessary to use about 100 lux/second exposure.

Example 3

20 parts by weight of styrene butadiene copolymer (such as Pliolite (Registered Trade Mark)—C.P.R. made by American Good Year Chemical Co.) 10 parts by weight of chlorinated rubber and 70 parts of xylene were mixed with 100 parts of ZnO (American Zinc Co.) within a ball mill for about 4 hours. Then an alcohol solution containing 0.1 parts by weight of bromophenol blue, 0.1 parts by weight of Rose Bengale, 0.1 parts by weight of fluoroscein was added to 100 parts by weight of the

ZnO mixture. The whole mixture was sufficiently stirred, and was coated to a 50 μ thickness on a 25 μ thick polyester film and dried, and a conductive paint was backed thereon. An electrostatic image and the visible image were formed in accordance with Example 1.

Referring to Figures 7 and 8, the effect of varying magnitudes of the primary and secondary charges is illustrated. In Figure 7 the number of plus and minus signs marked on the sketches is indicative of the amount of charge on the plate. Thus in Figure 7-1a a small primary charge is applied, followed in Figure 7-2a1 by a small secondary charge, simultaneously with the image exposure and the resultant electrostatic image is shown in Figure 7-3a1 after the overall exposure to light. Figure 7-2a2 and 7-3a2 illustrate respectively the condition of the plate when a high secondary charge follows the low primary charge of Figure 7-1a and the final electrostatic image. Figures 7-1b, 7-2b and 7-3b illustrate the situation when a medium primary charge is followed by low and high secondary charges respectively. Figures 7-1c, 7-2c and 7-3c illustrate the situation when a high primary charge is followed by low and high secondary charges respectively.

The six graphs shown in Figure 8 correspond to the six processes illustrated in Figure 7 and each is a plot of surface potential against time, each graph showing the surface potential both in the light and in the dark areas of the image. The sections of the horizontal axis designated P, S and E represent respectively the time of application of the primary and secondary charges and the time of the final overall exposure. The legend SC indicating the distance between the final part of the curve of the surface potential of the dark areas of the image from that of the light areas of the image represents the image contrast which is obtained.

It will be apparent from a study of Figures 7 and 8 that increasing the primary and secondary charges increases the contrast of the electrostatic image. However, it has been found that increase of the secondary charge beyond a certain point causes the contrast to decrease.

It will also be noted that with the different degrees of primary and secondary charge, the resulting electrostatic image is of different types of charge pattern. For example, in Figures 7-3a2 and 7-3b2, the electrostatic image is composed wholly of negative charges, the density of which is different in the light and dark areas of the image, whereas, in Figures 7-3b1, 7-3c1 and 7-3c2 the light areas of the image are composed of negative charges, whereas the dark areas are composed of positive charges. This may

also be observed by considering the corresponding graphs of Figure 8.

Figure 9 is a graph of the surface potential of a plate against time and includes several plots which are drawn for several plates respectively which differ from one another by the thickness of the insulating layer 3. As seen from Figure 9, the different thicknesses of insulating layer produce different surface potentials in the dark area of the image, the reference V_{DL} indicating the potential in the dark areas of the image and the reference V_{LL} indicating the potential in the light areas of the image and each of the several curves V_{DL} being marked with the thickness of the insulating layer used.

As seen, the thinner the insulating layer 3, the greater the image contrast obtained, i.e. the greater the difference between the potential V_{LL} and the potential V_{DL} after the final overall exposure of the plate. It is preferable that the thickness of the insulating layer be less than 50 μ to obtain a clear image. However, the thickness of the insulating layer should preferably not be less than 10 μ since, with thicknesses less than this, it is difficult to produce a layer which is free from pin holes and which is of uniform thickness. Also, such thin layers are likely to suffer from dielectric breakdown and this is aggravated where pin holes are present. Furthermore, subjecting the insulating layer to corona discharge tends to cause the surface of the layer to be burned as a result of which such thin layers deteriorate rapidly and cannot be used repetitively for a long period of time. The result of these various deficiencies of very thin insulating layers is the production of images which are foggy.

It has also been found that the thickness of the photoconductive layer should preferably be within a range of 50 to 200 μ . With such a photoconductive layer and with an insulating layer of less than 50 μ , it has been found possible to obtain a surface potential difference between the light and dark areas of the image of greater than 500 volts. This potential difference represents an excellent image contrast.

The modified plate illustrated in Figure 10 will now be described. It has been found that the resolving power of the plate is increased the finer the particles of the photoconductor used, although a photoconductor with coarser particles tends to be more sensitive. Many photoconductive materials contain when produced normally particles of different sizes. It has been found that, if the materials are graded to remove the coarser particles, say above 12 μ , a better image can be produced than if ungraded photoconductor is used, or than if a photoconductor containing only coarse particles is used. However, discarding the coarse particles is uneconomical.

In the plate illustrated in Figure 10, the photoconductive layer 2 is formed as two sub layers 2' and 2". The sub layer 2' is composed of coarse particles of photoconductor and is adjacent the conductive layer 1. The sub layer 2" is composed of fine particles of photoconductor and is adjacent the insulating layer 3. It has been found that images can be obtained with this plate which are as good as obtained if only fine particles are used. Hence, with this plate, it is not necessary to discard the coarse particles in order to obtain good images and, therefore, photoconductive material which contains both fine and coarse particles can be used economically.

Some photoconductive materials which are available already consist substantially of fine particles, whereas others consist substantially of coarse particles. Examples of materials which can be obtained consisting substantially of fine particles are cadmium oxide, zinc sulphide, selenium compounds and zinc oxide, of which the latter can easily be obtained with particles of average diameter less than 1 μ . Examples of materials which can be obtained consisting substantially of coarse particles are cadmium sulphide, or cadmium selenide activated by copper. If the sub layer 2' of the plate illustrated in Figure 10 is made of a material consisting substantially of coarse particles and the layer 2" is made of a different material consisting substantially of fine particles, it has been found that an excellent image can be obtained, since the coarse particles enhance the sensitivity of the plate, whereas the fine particles enhance the resolving power. To further enhance the sensitivity, dyes can be included in the material of which the layer 2" is made.

As a specific example, good results can be obtained where the sub layer 2' is of cadmium sulphide and is 10 to 100 μ thick and the sub layer 2" is of zinc oxide and is 5 to 20 μ thick.

A specific example is as follows:

Example 4:

20 g of CdS, in a vinyl chloride-vinyl acetate copolymerised resin, and 50 g of varnish (containing 20% of resin component), and 56 g of thinner were mixed, and the mixture obtained was coated on an aluminium plate to a thickness of 50 to 100 μ when dried. 50 g of ZnO and 50 g of a silicon resin varnish (containing 50% of resin component), 15 cc of 0.1% Rose Bengale ethanol solution and 100 cc of thinner were mixed up by using a porcelain ball mill for two hours, and a pink liquid paint was obtained. The paint was spray coated on to the above prepared CdS film to a thickness of several μ when dried. Last of all, a polyethylene terephthalate resin film (the Trade Mark thereof being Mylar) of 12 μ was adhered on

to the ZnO layer by using adhesive to produce a photosensitive plate.

A voltage of +6KV was applied to the side of a movable electrode at a light place, and between the electrode and the aluminium plate corona discharge was carried out to charge the plate in the positive; and then at a dark place, a microfilm was enlarged about 8 times by means of an enlarger which had a 150 W tungsten filament lamp, and the image was projected on to the photosensitive plate at F 5.6 of the enlarging lens; and while the exposure was being carried out through a movable electrode which has a protecting wall which can pass light, a corona discharge of -6 KV was carried out. The exposure and charging lasted for about 2 seconds on average against the respective portions of the photosensitive plate. Then an overall exposure was made for about 2 seconds by a tungsten lamp of 100 W placed at the distance of 50 cm from the plate; and then a toner having a negative electrostatic charge was used, and cascade development was carried out by using glass beads as carriers, and as a result the clear positive image enlarged from the original copy of the microfilm was obtained.

Figure 11 shows an apparatus embodying the invention. The electrophotographic plate is in the form of a drum 12t having coated on its periphery a conductive base 1t, a photoconductive film 2t and an insulating film 3t, in this order. This drum 12t is rotated in the direction shown by the arrow in the drawing.

The photosensitive plate 4t is subjected to a primary charging by a corona discharge device 4t. The original image to be copied is projected by a lens 13t on to the surface of the charged insulating layer 3t, through the secondary charger 8t, which is optically open for the purpose of defining the area of the plate exposed, and which at the same time charges the surface in the opposite polarity to the primary charge to form an electrostatic image on the surface of insulating film 3t. The whole surface of the insulating film is then uniformly exposed by a tungsten lamp 23t to form an electrostatic image in accordance with the light-and-dark pattern of the original image. This electrostatic image is developed by means of a developer 14t mainly composed of charged colour particles which are applied by a magnet brush 15t and a visible powder image is formed. This visible powder image is transferred to a transfer material 11t by applying a corona discharge of opposite polarity to the charged particles using the corona discharger 10t for attracting the particles to the transfer material 11t which is moved in contact with the visible powder image by a roller 16t. The transfer material 11t is then moved along the periphery of a drum

18t which is heated by an infra-red lamp 17t therewithin, to fix the transferred image to the material surface. Finally the copy is deposited on the receiver 19t.

5 After the completion of the transfer of the image, the charge remaining on the insulating coated film surface 3t is removed by an alternating current discharger 20t. The plate is then cleaned with a rotary brush 22t having soft bristles such as fur on the periphery thereof to remove any powder image remaining on the insulating coated surface 3t.

15 In the embodiments so far described, the insulating layer of the electrophotographic plate has been translucent and the image exposure and final overall exposure of the plate has been carried out on the translucent insulating layer. If the conductive layer 1

20 were made translucent, the image exposure and overall final exposure could be carried out on that, but the charging will still be applied to the insulating layer.

25 If the plate is made with an opaque insulating layer and translucent conductive layer, the process could be carried out with the insulating layer exposed to ambient light. An apparatus embodying such a plate is illustrated in Figures 12 and 13.

30 In Figures 12 and 13 an original copy 12b placed on a glass plate 11b is illuminated by a lamp 13b. A positive image of 12b is projected onto a photosensitive plate B having its opaque insulating layer uppermost, by means of an optical system 18b

35 which contains mirrors 14b, 15b, 16b and a lens 17b. The optical system 18b is moved from right to left at a uniform speed by means of a reversible motor M, and a chain 40 20b along a rail 19b to project the whole length of the image of the original copy 12b on to the photosensitive plate B. The lamp 21b for the final uniform exposure is provided at the reflecting optical system 18b.

45 A corona discharge device 23b, 23ab and 23bb for the primary and secondary charges respectively, is also provided with means so that it can move right to left on two rails 22b provided on the frame 26b in parallel with the photosensitive plate B. On a part of the charger 23b a magnet 24b is provided, and by means of the attraction of a magnet 25b attached to the reflecting optical system 18b, the charger 23b is transferred

55 in the same direction as the optical system 18b.

60 The electrostatic latent image is formed on the photosensitivity plate B by means of a single scanning of the reflecting optical system 18b in the direction as shown by an arrow in Figure 19, and then the respective operations of developing the image, transferring the developed image, and cleaning, are carried out manually from the out-

65 side of the frame 26b.

Thus the whole process for producing the electrostatic image can be carried out in lit surroundings.

The term "translucent" is used herein in a broad sense and therefore also includes 70 materials which are fully or semi-transparent.

The electrophotographic member is independently claimed in our copending application No. 15109/69 (Serial No. 1165407). 75

WHAT WE CLAIM IS:—

1. An electrophotographic process using an electrophotographic member having a conductive layer, an N-type or P-type photoconductive layer, and an insulating layer 80 on the photoconductive layer, the conductive layer and/or the insulating layer being translucent for exposing the member, said process comprising applying to the surface of the insulating layer a positive or 85 negative primary charge according to whether the photoconductive layer is N-type or P-type to cause charges of opposite polarity to be injected from the conductive layer into the photoconductive layer and bound 90 in the region of the interface between the insulating and photoconductive layers, and exposing the member to an image while simultaneously applying to the surface of the insulating layer a secondary charge of 95 opposite polarity to the primary charge so that, in areas of the image in which the photoconductive layer is activated, the polarity of the charges on the member is reversed, whereas, in the other areas of the 100 image, at least some of the charges bound in the region of said interface so remain, thus forming an electrostatic image on the surface of the insulating layer.

2. A process according to claim 1, including the additional step after termination 105 of the image exposure and application of the secondary charge of activating the photoconductive layer overall whereby any charges accumulated on the conductive base 110 in said other areas of the image during the application of the secondary charge at least partially cancel said charges which had remained bound in the region of said interface, to increase the electrostatic potential 115 difference between the different areas of the electrostatic image.

3. A process according to claim 1 or 2 wherein the primary and secondary charges 120 are applied by corona discharge.

4. A process according to claim 1, 2 or 3, wherein the thickness of the insulating layer is from 10 to 50 μ .

5. A process according to claim 1, 2 or 3 wherein the insulating layer comprises 125 fluoroethylene resin or polyester resin.

6. A process according to claim 1, 2 or 3 wherein the photoconductive layer comprises a mixture of CdS and binder.

7. A process according to claim 6, where- 130

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18r which is heated by an infra-red lamp 17r therewithin, to fix the transferred image to the material surface. Finally the copy is deposited on the receiver 19r.

- 5 After the completion of the transfer of the image, the charge remaining on the insulating coated film surface 3r is removed by an alternating current discharger 20r. The plate is then cleaned with a rotary brush 22r having soft bristles such as fur on the periphery thereof to remove any powder image remaining on the insulating coated surface 3r.

15 In the embodiments so far described, the insulating layer of the electrophotographic plate has been translucent and the image exposure and final overall exposure of the plate has been carried out on the translucent insulating layer. If the conductive layer 1 were made translucent, the image exposure and overall final exposure could be carried out on that, but the charging will still be applied to the insulating layer.

20 If the plate is made with an opaque insulating layer and translucent conductive layer, the process could be carried out with the insulating layer exposed to ambient light. An apparatus embodying such a plate is illustrated in Figures 12 and 13.

30 In Figures 12 and 13 an original copy 12b placed on a glass plate 11b is illuminated by a lamp 13b. A positive image of 12b is projected onto a photosensitive plate B having its opaque insulating layer uppermost, by means of an optical system 18b which contains mirrors 14b, 15b, 16b and a lens 17b. The optical system 18b is moved from right to left at a uniform speed by means of a reversible motor M, and a chain 20b along a rail 19b to project the whole length of the image of the original copy 12b on to the photosensitive plate B. The lamp 21b for the final uniform exposure is provided at the reflecting optical system 18b.

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60 The electrostatic latent image is formed on the photosensitivity plate B by means of a single scanning of the reflecting optical system 18b in the direction as shown by an arrow in Figure 19, and then the respective operations of developing the image, transferring the developed image, and cleaning, are carried out manually from the outside of the frame 26b.

Thus the whole process for producing the electrostatic image can be carried out in lit surroundings.

The term "translucent" is used herein in a broad sense and therefore also includes materials which are fully or semi-transparent.

The electrophotographic member is independently claimed in our copending application No. 15109/69 (Serial No. 1165407).

WHAT WE CLAIM IS:—

1. An electrophotographic process using an electrophotographic member having a conductive layer, an N-type or P-type photoconductive layer, and an insulating layer on the photoconductive layer, the conductive layer and/or the insulating layer being translucent for exposing the member, said process comprising applying to the surface of the insulating layer a positive or negative primary charge according to whether the photoconductive layer is N-type or P-type to cause charges of opposite polarity to be injected from the conductive layer into the photoconductive layer and bound in the region of the interface between the insulating and photoconductive layers, and exposing the member to an image while simultaneously applying to the surface of the insulating layer a secondary charge of opposite polarity to the primary charge so that, in areas of the image in which the photoconductive layer is activated, the polarity of the charges on the member is reversed, whereas, in the other areas of the image, at least some of the charges bound in the region of said interface so remain, thus forming an electrostatic image on the surface of the insulating layer.

2. A process according to claim 1, including the additional step after termination of the image exposure and application of the secondary charge of activating the photoconductive layer overall whereby any charges accumulated on the conductive base in said other areas of the image during the application of the secondary charge at least partially cancel said charges which had remained bound in the region of said interface, to increase the electrostatic potential difference between the different areas of the electrostatic image.

3. A process according to claim 1 or 2 wherein the primary and secondary charges are applied by corona discharge.

4. A process according to claim 1, 2 or 3, wherein the thickness of the insulating layer is from 10 to 50 μ .

5. A process according to claim 1, 2 or 3 wherein the insulating layer comprises fluoroethylene resin or polyester resin.

6. A process according to claim 1, 2 or 3 wherein the photoconductive layer comprises a mixture of CdS and binder.

7. A process according to claim 6, where-



in the binder is: a copolymer of vinyl chloride and vinyl acetate; or is acrylic resin.

8. A process according to claim 1, 2 or 3 wherein the photoconductive layer comprises a mixture of ZnO and binder.

9. A process according to claim 8, wherein the binder is silicone resin or is a mixture of chlorinated rubber and a copolymer of styrene and butadiene.

10. A process according to claim 1, 2 or 3, wherein the photoconductive layer is SeTe.

11. A process according to claim 1, 2 or 3, wherein the photoconductive layer is formed as two sub layers, the sub layer adjacent the conductive layer being composed of coarse particles of photoconductive material, and the sub layer adjacent the insulating layer being composed of fine particles of photoconductive material.

12. A process according to claim 11 wherein the same photoconductive material is used in each of the sub layers.

13. A process according to claim 11 wherein different photoconductive materials are used in the two sub layers.

14. A process according to claim 13, wherein the sub layer adjacent the conductive layer is 10 to 100 μ thick and composed of CdS and binder, and the sub layer adjacent the insulating layer is 5 to 20 μ thick and composed of ZnO and binder.

15. A process according to claim 1, 2 or 3, wherein the insulating layer is opaque and the conductive layer is translucent for exposing the plate.

16. Electrophotographic apparatus comprising an electrophotographic member having a conductive layer, an N-type or P-type photoconductive layer on the conductive layer, and an insulating layer on the photoconductive layer, the conductive layer and/or the insulating layer being translucent for exposing the plate; a primary charging device arranged for applying to the surface of the insulating layer a positive or negative primary charge according to whether the photoconductive layer is N-type or P-type, the member being such that, upon application of the primary charge, charges of opposite polarity are injected into the photoconductive layer from the conductive layer and bound in the region of the interface between the photoconductive layer and the insulating layer; an optical system for exposing the member to an image subsequent to the application of the primary charge; and a secondary charging device arranged for applying to the surface of the insulating layer a charge of polarity opposite to that of the primary charge simultaneously with the image exposure, to form an electrostatic image on the plate.

17. Apparatus according to claim 16, including means to expose the member to

radiation to activate the photoconductive layer overall, subsequent to the image exposure and the application of said charge of opposite polarity.

18. Apparatus according to claim 16 or 17 wherein the member is exposed to the image through the secondary charging device, which is optically open and defines the area of the plate exposed.

19. Apparatus according to claim 16, 17 75 or 18, further including developing means for applying to the surface of the insulating layer a developer material to render the electrostatic image visible, means for transferring the visible image to a transfer material, and a cleaning device for removing from the surface of the insulating layer any remaining developer material.

20. Apparatus according to claim 19, wherein the developing means comprises a magnet.

21. Apparatus according to claim 19, wherein the developing means is adapted to apply a liquid developer material.

22. Apparatus according to any of claims 16 to 21, including an AC charging device arranged for applying to the plate an AC charge to discharge the plate subsequent to transfer of the visible image.

23. Apparatus according to claim 16 or 17 wherein the same charging device is adapted to serve as both the primary and the secondary charging devices.

24. Apparatus according to claim 16 or 17, wherein the thickness of the insulating layer is from 10 to 50 μ .

25. Apparatus according to claim 16 or 17, wherein the insulating layer comprises fluoroethylene resin or polyester resin.

26. Apparatus according to claim 16 or 17, wherein the photoconductive layer comprises a mixture of CdS and binder.

27. Apparatus according to claim 26, wherein the binder is a copolymer of vinyl chloride and vinyl acetate; or is acrylic resin.

28. Apparatus according to claim 16 or 17, wherein the photoconductive layer comprises a mixture of ZnO and binder.

29. Apparatus according to claim 28, wherein the binder is silicon resin or is a mixture of chlorinated rubber and a copolymer of styrene and butadiene.

30. Apparatus according to claim 16 or 17, wherein the photoconductive layer is SeTe.

31. Apparatus according to claim 16 or 17, wherein the photoconductive layer is formed as two sub layers, the sub layer adjacent the conductive layer being composed of coarse particles of photoconductive material, and the sub layer adjacent the insulating layer being composed of fine particles of photoconductive material.

32. Apparatus according to claim 31, 130



wherein the same photoconductive material is used in each of the sub layers.

33. Apparatus according to claim 31, wherein different photoconductive materials are used in the two sub layers.

34. Apparatus according to claim 33, wherein the sub layer adjacent the conductive layer is 10 to 100 μ thick and composed of CdS and binder, and the sub layer adjacent the insulating layer is 5 to 20 μ thick and composed of ZnO and binder.

35. Apparatus according to claim 23, wherein the insulating layer is opaque and the conductive layer is translucent for exposing the plate.

36. A process of electrophotography according to claim 1 and substantially as described in any of the examples or with reference to the accompanying drawings.

34. Electrophotographic apparatus according to claim 16 and substantially as described with reference to the accompanying drawings.

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