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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.

In one aspect, the invention provides an electrophotographic process using an electrophotographic member having an insulating layer on a photoconductive layer, said process comprising applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge so that, in areas of the image in which the photoconductive layer is activated, the magnitude of the charge on the member is reduced more than in the other areas of the image, where 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.

In another aspect, the invention provides an electrophotographic apparatus comprising an electrophotographic member having an insulating layer on a photoconductive layer; a primary charging device arranged for applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge simultaneously with the image exposure, to form an electrostatic image on the plate.

It is preferable, after termination of the image exposure and application of the secondary charge, to expose the member to radiation to activate the photoconductive layer overall in order to increase the electrostatic potential difference between the areas of the electrostatic image.

In one preferred embodiment, the electrophotographic member includes a conductive layer upon which the photoconductive layer is located, and the insulating layer is on the photoconductive layer. The primary charge is positive or negative according to whether the photoconductive layer is N-type or P-type and the member is such that the charges bound in the region of the interface between the insulating and photoconductive layers are injected from the conductive base.

In an alternative preferred embodiment, the electrophotographic member comprises two insulating layers between which the photoconductive layer is located. A positive and a negative primary charge are applied to the surfaces of the first and second insulating layers respectively and the member is such that this results in the formation of layers of negative and positive charge bound in the regions of the interfaces between the photoconductive layer and the first and second insulating layers respectively.

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

Figure 1 illustrates an electrophotographic plate useful in the invention,

Figures 2 to 4 illustrate the formation of an electrostatic image on the plate of Figure 1, in accordance with an embodiment of the invention,

Figure 5 is a graph of the surface potential of the plate during the steps illustrated in Figures 2 to 4,

Figures 6 and 7 illustrate the development and transfer of the image formed on the plate by the process described with reference to Figures 2 to 5,

Figures 8 to 11 illustrate a process of forming an electrostatic image in accordance with an alternative embodiment of the invention, utilising an alternative form of plate,

Figure 12 illustrates a modification of the process illustrated in Figures 8 to 11,

Figures 13 to 15 and 16 to 18 respectively illustrate two preferred methods of transferring the developed image from the electrophotographic plate to a transfer member,

Figure 19 is a graph illustrating the effect of varying one of the parameters of the plate,

Figures 20 to 22 illustrate three modified forms of plate which can be used in the invention,

Figures 23 and 24, 25 and 26 and 27 and 28 illustrate respectively three further forms of plate which may be used in the invention, and

Figure 29, Figure 30 and Figures 31 and 32 respectively illustrate three forms of apparatus in accordance with the invention.

The electrophotographic plate A shown in Figure 1 of the drawings comprises a conductive base 1, an N-type photoconductive layer 2 and a translucent insulating layer 3. The photoconductive layer 2 is adhered to the insulating layer 3 and to the conductive base 1.

The first step in the process of using the plate is illustrated in Figure 2. This comprises the application to the surface of the insulating layer 3 of a positive charge using a corona discharge device 5 energised from a high voltage D.C. source 4, the negative terminal of which is grounded. The conductive base 1 is also grounded and the plate A is such that, upon the application of the positive charge to the surface of the insulating layer 3, negative charges are injected from the conductive base 1 and form a layer of negative charges bound in the region of the interface between the photoconductive and insulating layers 2 and 3.

The second step in the process is illustrated in Figure 3. It comprises the exposure of the plate to an image to be copied,

which is diagrammatically illustrated at 8 and comprises light and dark portions 6 and 7 respectively, and the simultaneous application to the surface of the insulating layer 3 of an A.C. corona discharge using a corona discharge device 10, which is optically open, so as not to interrupt the image exposure, and which is energised from a high voltage A.C. source 9. The effect of the A.C. corona discharge in the light areas of the image is to at least partially cancel some of the charge which was applied to the plate during the first step of the process, since, in the light areas, the photoconductive layer 2 conducts, so releasing the negative charges which had been bound in the region of the interface between the layers 2 and 3. In the dark areas of the image, however, the negative charge in the region of the interface between the layers 2 and 3 remains bound there and because of the electric field associated with these negative charges, much of the positive charges which were applied to the surface of the insulating layer 3 during the first step remain on the surface of the insulating layer 3 despite the application of the A.C. corona discharge. Figure 3 does illustrate that some of the positive charges on the surface of the insulating layer 3 in the dark areas of the image are removed, as only three plus signs are shown in each dark area, whereas five minus signs are shown; but the amount of charge removed in the dark areas is shown in Figure 3 to be much less than that removed in the light areas, in which there is only a single plus sign and a single minus sign.

The second step in the process thus results in the formation of an electrostatic image on the plate A. The contrast, i.e. the electrostatic potential difference between the light and dark areas of this image is, however, to some extent adversely affected by the negative electric field associated with the extra negative charges which have remained bound in the region of the interface between the layers 2 and 3 in the dark areas of the image, these extra charges being indicated by the greater number of minus signs than plus signs in the dark areas. In order to remove these extra charges, the plate A is exposed overall to uniform light as shown in Figure 4, so rendering the whole area of the photoconductive layer 2 conductive and permitting the extra negative charges, i.e. those which do not have corresponding positive charges on the surface of the insulating layer 3 to leak to ground. Thus the electrostatic potential difference at the surface of the insulating layer 3 between the light and dark areas of the image is increased.

Figure 5 is a graph of the surface potential of the plate against time during the process steps so far described. The curve

V_p illustrates the rise in potential of the surface of the insulating layer 3 during the application of the primary positive charge and the curves V_L and V_D respectively illustrate the surface potential in the light and dark areas of the image during the image exposure and A.C. corona discharge. It will be noted that, although less positive charge is removed from the surface of the insulating layer 3 during the second step, the potential of the dark areas of the plate is less than that of the light areas at the termination of this step and this is due to the presence at the interface between the layers 2 and 3 of the extra negative charges referred to above. Figure 5 shows that, after the overall exposure of the whole surface to light, which results in the removal of the extra negative charges, the potential in the dark areas of the image increases to a value higher than that in the light areas, the curves V_{DL} and V_{LL} indicating respectively the potential in the dark and light areas during the overall exposure.

25 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. 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. A visible image 11 as shown in Figure 6 is formed, in which negatively charged particles are used and they adhere to the plate, therefore, in the dark areas of the image, which are positively charged.

40 The image 11 is then transferred, as shown in Figure 7, 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 12, 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.

50 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 A.C. discharge. The cleaning can be effected by rubbing the plate with an elastic body, for example.

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 applied by A.C. corona discharge.

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), TiO_2 (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

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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:

10 10 g of polyvinyl chloride was added to 90 g of cadmium sulphide activated by copper, and a little amount of thinner was added thereto. The photoconductive mixture obtained was sprayed on aluminium plate whose thickness is about 1 mm, to a thickness of about 100 μ . On the surface of this photoconductive film, a film of Mylar (Trade Mark) whose thickness is about 15 μ was adhered by using an adhesive. A corona discharge of (+)6kv was irradiated on the surface of the Mylar layer and the positive charge was uniformly bound on the surface of the film, and then the image to be copied was irradiated for about 0.1-0.3 seconds by means of a 10 lux tungsten lamp on the above mentioned surface, and at the same time, an alternating current corona discharge of AC 6 kv was applied, and then the whole surface was uniformly illuminated by means of a tungsten lamp for 1 to 2 seconds and a resultant electrostatic image was formed in accordance with the light-and-dark pattern of the original image. This electrostatic image was developed by means of the magnet brush method, and thereby a visible image of remarkably excellent quality having high image density was obtained.

Example 2:

40 20 parts by weight of styrene butadiene copolymer (such as Pliolite (Trade Mark) C.P.R. produced by American Good Year Chemical), 10 parts by weight of chlorinated rubber, 70 parts by weight of Xylene and 45 100 parts by weight of ZnO for electrophotography (produced by American Zinc Co.) were mixed in a ball mill for two hours, and then an alcohol solution containing 0.12 parts of Rose Bengale and 0.1 parts by weight of Fluorescein based on 100 parts by weight of ZnO was added thereto, and the whole mixture was stirred.

The thus obtained mixture was coated on the surface of a polyester film whose thickness is less than 25 μ to a thickness of about 80 μ , and after drying a conductive paint was coated thereon, thus obtaining the photosensitive plate. The surface of the polyester film was charged uniformly by a positive corona discharge (6 kv) and then an AC 7 kv corona discharge and the image at an intensity of about 50 lux sec. were irradiated. The whole surface was thereafter uniformly irradiated with light amount of 100 lux sec. for 1 to 2 seconds to form

an electrostatic image. Using a commercially distributed negative charged toner and by means of the fur brush method, a visible image was developed, and excellent image having no fogginess was produced. Further the surface of the thus obtained visible image was positively charged by a +6kv corona discharge, and by means of a conductive roll copying paper was closely contacted onto the plate, and an excellent transferring effect was obtained.

Example 3:

1 g of finely crushed metallic selenium whose particle diameter was about 10 μ , and 1 g of cadmium sulphide which was activated by copper whose particle diameter was about 10 μ , were mixed with 1 g of clear laquer of the copolymer of vinyl chloride and vinyl acetate, and they were dispersed by means of a little amount of thinner.

The mixture obtained was coated on a 1 mm thick aluminium plate (100 mm $\times$ 100 mm) by means of a spray method, and after drying the same, a 12 μ thick of polyester transparent film was adhered by using an epoxy resin adhesive.

Then a positive 7 kv corona discharge was made on the plate and the secondary charge of 7 kv AC corona discharge and the radiation of the original image was made in a dark place. After the uniform radiation, the image was developed by negative toner with the magnet brush method to obtain a positive image of the original. When -7kv corona discharge was used instead of the +7kv corona discharge, then a negative image of the original was produced.

A further embodiment of the invention will now be described with reference to Figures 8 to 11. In this embodiment, the electrophotographic plate comprises a photoconductive layer 2 sandwiched between and adhered to two insulating layers 3 and 3'. The layer 3 is translucent. The same materials as already described may be used for the photoconductive layer 2 and the insulating layers 3 and 3'.

The first step in the process of using this plate is illustrated in Figure 8 and it comprises placing the plate on to a grounded conductive base 18 and applying a positive charge to the surface of the insulating layer 3 using a corona discharge device 20 energised from a high voltage source 19.

The positive charge on the surface of the insulating layer 3 induces the application of a negative charge on the surface of the insulating layer 3', which is in contact with the conductive base 18, this negative charge flowing to the surface of the insulating layer 3' through the conductive base 18. The plate is such that, upon the application of these charges to the surfaces of the insulating layers 3, 3', layers of negative and positive charges are formed respectively in the region

of the interfaces between the photoconductive layer 2 and the insulating layers 3 and 3'. Preferably, to facilitate the formation of these charge layers, the first step of the process is carried out with the plate exposed overall to light, so that the photoconductive layer 2 conducts. The device 20 is optically open so that, as it is moved across the plate, the exposure to light is not interrupted.

10 The second step in the process involves the exposure of the plate by means of the translucent insulating layer 3 to an image to be copied, comprising light and dark areas *a* and *b* respectively, and the simultaneous application to the surface of the insulating layer 3 of AC corona discharge. This is illustrated in Figure 9, but the means for applying the corona discharge is not shown. In the light areas of the image, AC corona discharge is able to remove to a substantial extent the charges applied to the surfaces of the insulating layers 3 and 3', since the photoconductive layer 2 is conductive in these areas and the negative and positive charges in the respective interface regions at these areas can move to cancel one another out. In the dark areas, however, the negative and positive charges remain bound in the interface regions respectively, since the photoconductive layer is non-conductive in these areas. Thus, although the effect of the AC corona discharge in the dark areas is to tend to remove the charges on the surfaces of the insulating layers 3 and 3', less charge can be removed than in the light areas because the electric fields associated with the bound charges in the interface regions tend to retain the charges on the respective surfaces of the insulating layers 3 and 3'. Hence, the result of this step is the formation of an electrostatic image on the plate. Since, however, the AC corona discharge has removed some of the charges on the surface of the insulating layers 3 and 3', the contrast of the electrostatic image i.e. the electrostatic potential difference between the light and dark areas is to some extent adversely affected by the electric fields associated with the extra charges remaining bound in the respective interface regions, i.e. those negative charges in the region of the interface between the layers 2 and 3 whose corresponding positive charges on the surface of the insulating layer 3 have been removed by the A.C. corona discharge. To dissipate these extra charges, and therefore increase the electrostatic potential difference between the light and dark areas of the image, the plate is exposed overall to light as illustrated in Figure 10, thus rendering the whole of the photoconductive layer 2 conductive and enabling the extra negative and positive charges in the interface regions between the photoconductive layer 2 and

the insulating layers 3 and 3' respectively to move towards one another and cancel one another out.

The image can now be developed and transferred as described with reference to Figures 6 and 7. It may be noted that, if a positively charged toner is used, the particles thereof adhere to the plate most strongly in the light areas of the image, so producing an optically negative image of the original. If a negatively charged toner is used, an optically positive image of the original results.

Although the conductive base 18 has been described as separate from the plate, it could, as an alternative, be formed as a part of the plate.

Further, instead of using the grounded conductive base 18 for applying the primary and secondary charges to the surface of the insulating layer 3', it would be possible to use a corona discharge device. In this case, there would be two corona discharge devices as illustrated in Figure 12, which shows the first step in the process, one of the devices 15 being optically open so as not to interrupt the exposure of the plate and being energised from the positive terminal of a high voltage D.C. source 14 and the other device 16 being energised from the negative terminal of the source 14 and arranged to apply a negative charge to the surface of the insulating layer 3'.

In the embodiments described with reference to Figures 8 to 12, the primary DC charge can be of either polarity.

Advantageously, the insulating layers 3 and 3' would be the same as one another, so that, by appropriately positioning the plate, the image can be formed on either layer and can be positive or negative image as required. In this way, the life of the plate can be enhanced, since the wear which occurs to the surface on which the image is formed, as from cleaning, would then be shared between the surfaces of the two insulating layers 3 and 3'.

Also, the material of the insulating layers may be humidity resistant, in which case it is possible to avoid the deterioration of the photoconductive material due to absorption of humidity since the photoconductive material is covered on each side with the insulating material. Numerical examples of constructions of the plate and the process of use are as follows:

Example 4:

In the Example 2, instead of a backing of conductive paint, a polyester film (25 μ) was adhered as a translucent insulating layer by means of an epoxy polymer adhesive.

Both sides of the above mentioned photosensitive plate were then charged, one positively and the other negatively by means of a double corona discharge. A light image

was irradiated for about 1 second by means of about 50 lux tungsten light source, and at the same time the above mentioned double corona discharge was carried out, this time both at AC 7.5 kv. Thereafter by means of the above mentioned tungsten light source, the whole surface was uniformly exposed. A cascade method was employed to develop the latent image and a positive image was produced on one of the sides, and a negative image on the other side.

A preferred method of transferring the image developed on the plate to a transfer material, such as a sheet of paper, will now be described with reference to Figures 13 to 18.

Figure 13 shows the plate A as having formed on it an electrostatic image constituted by positive charges on the surface of the insulating layer 3. The image has been developed by a toner 27 composed of negatively charged particles which therefore adhere to the plate in the dark areas of the image which are projected on to the plate. As shown in Figure 14, the first step in the process of transfer comprises applying to the surface of the insulating layer 3 and to the toner on it, further positive charge by means of a corona discharge device 22 energised by a high voltage source 21. It will be noted that, as with the first step in the process of forming the electrostatic image, negative charges are injected from the conductive base 1, which is grounded, and from a further charge layer in the region of the interface between the photoconductive layer 2 and the insulating layer 3. The effect of the corona discharge upon the toner is to change the polarity of the charge thereof in the outer layers as is illustrated in Figure 14. Hence the outer layers of the toner are now positively charged and, by virtue of the electric fields associated with the positive charges which form the electrostatic image on the insulating layer 3, the attraction of the outer layers of the toner to the plate 3 is reduced.

As shown in Figure 15, these outer layers of toner 27 then can be easily transferred to a sheet of paper 23 by laying the paper over the plate, applying a bias potential to the paper, and then peeling the paper off. It will be seen from Figure 15 that the positively charged particles in the outer layers of the toner 27 induce a negative charge 28 in the paper 23, which induced charge assists in the transfer.

In carrying out this process of transfer, it is preferable to use a toner of high resistivity, preferably of over 10^{12} ohms cms.

Figure 16 illustrates a plate in which the electrostatic image is composed of negative charges in the light areas of the image and positive charges in the dark areas. A nega-

tively charged toner 27' is used to develop the image and the particles thereof thus adhere to the plate in the dark areas of the image.

As shown in Figure 17, negative charge is applied to the surface of the insulating layer 3 and to the toner 27' on it by means of a corona discharge device 25 energised from a high voltage source 24. The negative charges applied to the toner 27' by the corona discharge neutralise to some extent the positive charges of the electrostatic image. This is shown by the fact that, in Figure 17, there are fewer plus signs beneath the toner than in Figure 16. It will be appreciated that, in some circumstances, the positive charges of the electrostatic image might be completely neutralised. To facilitate this neutralisation, the toner 27' is preferably of low resistivity, preferably less than 10^{12} ohms cms. Thus, the result of this step is to reduce the attraction between the toner and the plate.

As shown in Figure 18, a sheet of paper 26 can be laid over the plate and the toner easily transferred to the paper by applying a bias potential to the paper.

One way to apply the bias potential to the transfer sheet is to connect the sheet electrically to the conductive layer 1, as by grounding each.

Although Figs. 13 to 18 illustrate a plate having a conductive base 1, these methods of transfer of the developed image can also be utilised where the plate has the two insulating layers 3 and 3'.

Figure 19 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. This graph can be obtained when the photoconductive layer comprises a cadmium selenide or cadmium sulphide mixture with a vinyl resin binder in the ratio 1/2 to 1/10 by weight.

As seen from Figure 19, 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 50μ to obtain a clear image. However, the thickness of the insulating layer should preferably not be less than 10μ 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 when 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 plates illustrated in Figures 20 to 22 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, 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 Figures 20 and 21, the photoconductive layer 2 is formed as two sub layers 2' and 2''. The sub layer 2' is composed of coarse particles, e.g. above several μ . The sub layer 2'' which is adjacent the insulating layer 3 upon which the electrostatic image is to be formed is composed of fine particles of photoconductor, e.g. less than several μ . 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 are available consisting substantially of fine particles, whereas others are available consisting substantially of coarse particles. Examples of materials which are available consisting substantially of fine particles are cadmium oxide, zinc sulphide, selenium 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 20 or 21 is made of a material consisting substantially of coarse particles and the layer 2'' is made of the same or 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 overall thickness of the photoconductive layer is 10-100 μ , the sub layer 2' is of cadmium sulphide and the sub layer 2'' is of zinc oxide and is 5 to 20 μ thick.

In Figure 22, the photoconductor is formed with two of the sub layers 2'' comprising fine particles of material, adjacent the respective insulating layers 3' and 3, and the coarse sub layer 2' is between the two sub layers 2''.

A further modified form of plate will now be described.

As indicated previously, it is possible to obtain with the process described an electrostatic image of high contrast. The problem arises that, in view of the high contrast, half tones of an original to be copied may not be accurately reproduced on account of the "edge" effect. The modified plates illustrated with reference to Figures 23 to 28 are intended to enable half tones to be reproduced.

Referring to Figure 23, there is formed on the surface of the insulating layer 3 a pattern 4 of opaque and translucent portions 4a and 4b respectively. The pattern is in the form of a series of dots and is such that the light transmitting characteristics of the opaque and translucent portions of the pattern are as shown in Figure 24, in which the vertical axis illustrates the penetration by a light ray of the pattern 24 and the horizontal axis represents the positions of the pattern on which the light rays fall. Figures 23 and 24 are aligned so that the pattern as shown in Figure 23 can be easily related to the graph of Figure 24.

In Figure 25, the pattern is composed of a network of opaque crossing lines 4c with translucent portions 4d between them and the corresponding graph of light penetration is shown in Figure 26. In Figure 27, the pattern 4 is also composed of a network of opaque lines, but in this case, is located on the underside of the insulating layer 3 and is so formed as to give a graph of light penetration as shown in Figure 28.

The pattern 4, whether it be of dot form, network form or other line form, for example, can be formed photographically. One way of producing the pattern would be to coat the insulating layer 3 with a photosensitive resin such as "Kodak Photo Resist" (Registered Trade Mark) or "Oriental Photo Resist" and then form the pattern by photographic printing. The coating of photosensitive resin would preferably be several μ thick.

Although photographic printing is a convenient method of forming the pattern, particularly as it enables the different characteristics illustrated in Figures 24, 26 and 28 to be easily produced, it is to be understood that the pattern may be produced by other means such as other printing methods.

An alternative way of reducing the "edge" effect, instead of using the modified plate illustrated in Figures 23 to 28, would be to carry out twice the exposure and secondary charging step; the first exposure would be to an opaque pattern, e.g. dots or a network, and the second exposure would be to the image.

Several apparatus according to the invention will now be described. The plate embodied in the apparatus can be of any of the forms previously described.

Referring to Figure 29, an electrophotographic plate comprising a conductive base 1t, a photoconductive layer 2t and an insulating layer 3t is formed around the periphery of a drum 12t which rotates in the direction of the arrow. The plate is firstly charged by a D.C. corona discharger 4t and the thus charged insulating layer 3t is irradiated with the original image via a lens 13t through an A.C. discharger 8t which is optically open to define the area of the plate exposed and at the same time subjected to an A.C. corona discharge to form the electrostatic image. Thereafter the whole surface of the insulating layer is exposed to a tungsten lamp 23t to increase the contrast of the image. A toner 14t comprising charged coloured particles, is deposited by a magnetic brush 15t onto the drum to develop the image. Then, a copying material 11t is moved in contact with the image by a transfer roller 16t and by applying a corona discharge of opposite polarity to the charged particles with the aid of a corona discharger 10t the transfer of the charged toner particles to the material 11t is carried out.

The copying material 11t moves across the periphery of a drum 18t having an infra red ray lamp 17t inside thereof, and the transferred image is thus fixed by the heat provided to the surface of the sheet 11t. Finally the sheet 11t is deposited on the receiver 91t.

After having carried out the transfer, any of the charge forming the electrostatic image still remaining on the surface of the insulating layer 3t, is removed by means of an A.C. corona discharger 20t and then at a cleaner 21t, any powder image remaining on the insulating film surface 3t is removed by a rotary brush 22t having soft hairs on the periphery thereof, such as a fur brush. The drum is thus prepared for repeated use.

A microfilm reader printer embodying the invention is shown in Figure 30. Located in a housing 19s is a photosensitive plate 1s wound on the periphery of a rotary drum 12s. An image of a film F illuminated by a lamp 20s is projected along a light path X onto a screen 24s by means of a lens 21s and mirrors 22s and 23s.

When the mirrors 22s and 23s are pivoted to the solid line position shown, the image of the film F is projected along a light path Y on to the photosensitive plate 1s by means of reflecting mirrors 25s and 26s.

A D.C. primary charger 2s, an A.C. corona discharger 13s, a lamp 5s, a developer 14s, a copying material supplying device 15s, a transferring roller 16s, a fixing device 17s, and a cleaning device 18s are arranged in sequence around the drum surface.

The discharger 13s includes shields 13₁ and 13₂ between which it is optically open so that the image can be projected onto the plate 1s.

The developer 14s comprises a belt 27s, provided with scoops 28s, and passing over pulleys 29s and 30s. Plates 31s and 32s guide the toner raised by the scoops 28s. An opening 33s is provided for supplying toner a and a recovery box 34s collects falling toner.

A supply 35s for copying material 11s comprises feed rollers 36s and 37s and a cutter 38s in which, as necessary, the material 11s is cut into predetermined lengths. The end of the material 11s is gripped by a clamp (not shown in detail) on the belt 39s and so is carried thereby until released from the clamp to be guided by a guide 42s between the photosensitive plate 1s and a roller 16s. The powder image is transferred to the sheet which is passed over a drum 45s formed with teeth to grip the sheet and containing a heater 44s to fix the copy. The sheet then passes through a guide 43s, and is ejected from the box 19s via an opening 46s. 47s is a fan for closely contacting the copying paper 11s on to the hot drum 45s.

The cleaning device 18s comprises erasers 48s of rubber or other elastic substance provided radially on a rotary shaft 49s. The erasers 48s directly bear against the photosensitive plate 1s to strongly rub it, and the remaining toner is deposited in a recovery

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In the embodiments so far described, the upper insulating layer (the layer 3 illustrated in the drawings) of the electrophotographic plate has been translucent and the image exposure and final overall exposure of the plate has been carried out on this upper insulating layer. It is to be understood that the conductive layer 1 or the lower insulating layer 3' (and conductive base 18 when used) could be made translucent and the image exposure and overall final exposure could be carried out on that. The image development might still be carried out on the upper insulating layer.

If the plate is made with an opaque upper insulating layer and a translucent lower conductive or insulating layer, the process could be carried out with the upper insulating layer exposed to ambient light. Apparatus embodying such a plate is illustrated in Figures 31 and 32.

In Figures 31 and 32 an original copy 12b placed on a glass plate 11b is illuminated by a lamp 13b. A positive image of 12b is projected on to 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.

A corona discharge device 23b, 23ab and 23bb for applying both the primary and secondary charges, 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 in the same direction as the optical system 18b.

The electrostatic latent image is formed on the photosensitive plate B by means of a single scanning of the reflecting optical system 18b in the direction as shown by an arrow in Figure 31, 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.

Although the apparatus described with reference to Figs. 29-32 embodies means for carrying out certain combinations only of the methods of electrostatic image forma-

tion, development, and developed image transfer described with reference to Figs. 1-28, the apparatus could be modified to carry out any combination of these methods.

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

The plates described are independently claimed in our copending application Nos. 15109/69 (Serial No. 1,165,407) and 17413/69 (1,165,409).

WHAT WE CLAIM IS:

1. An electrophotographic process using an electrophotographic member having an insulating layer on a photoconductive layer, said process comprising applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge so that, in areas of the image in which the photoconductive layer is activated, the magnitude of the charge on the member is reduced more than in the other areas of the image where 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 exposing the member to radiation to activate the photoconductive layer overall to increase the electrostatic potential difference between the different areas of the electrostatic image.

3. Electrophotographic apparatus comprising an electrophotographic member having an insulating layer on a photoconductive layer; a primary charging device arranged for applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge simultaneously with the image exposure, to form an electrostatic image on the plate.

4. Apparatus according to claim 3, including means to expose the member to radiation to activate the photoconductive layer overall, subsequent to the image exposure and the application of said secondary charge.

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In the embodiments so far described, the upper insulating layer (the layer 3 illustrated in the drawings) of the electrophotographic plate has been translucent and the image exposure and final overall exposure of the plate has been carried out on this upper insulating layer. It is to be understood that the conductive layer 1 or the lower insulating layer 3' (and conductive base 18 when used) could be made translucent and the image exposure and overall final exposure could be carried out on that. The image development might still be carried out on the upper insulating layer.

If the plate is made with an opaque upper insulating layer and a translucent lower conductive or insulating layer, the process could be carried out with the upper insulating layer exposed to ambient light. Apparatus embodying such a plate is illustrated in Figures 31 and 32.

In Figures 31 and 32 an original copy 12b placed on a glass plate 11b is illuminated by a lamp 13b. A positive image of 12b is projected on to 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.

A corona discharge device 23b, 23ab and 23bb for applying both the primary and secondary charges, 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 in the same direction as the optical system 18b.

The electrostatic latent image is formed on the photosensitive plate B by means of a single scanning of the reflecting optical system 18b in the direction as shown by an arrow in Figure 31, 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.

Although the apparatus described with reference to Figs. 29-32 embodies means for carrying out certain combinations only of the methods of electrostatic image forma-

tion, development, and developed image transfer described with reference to Figs. 1-28, the apparatus could be modified to carry out any combination of these methods.

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

The plates described are independently claimed in our copending application Nos. 15109/69 (Serial No. 1,165,407) and 17413/69 (1,165,409).

WHAT WE CLAIM IS:

1. An electrophotographic process using an electrophotographic member having an insulating layer on a photoconductive layer, said process comprising applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge so that, in areas of the image in which the photoconductive layer is activated, the magnitude of the charge on the member is reduced more than in the other areas of the image where 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 exposing the member to radiation to activate the photoconductive layer overall to increase the electrostatic potential difference between the different areas of the electrostatic image.

3. Electrophotographic apparatus comprising an electrophotographic member having an insulating layer on a photoconductive layer; a primary charging device arranged for applying to the surface of the insulating layer a D.C. primary charge to cause charges of opposite polarity to be 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 an A.C. secondary charge by corona discharge simultaneously with the image exposure, to form an electrostatic image on the plate.

4. Apparatus according to claim 3, including means to expose the member to radiation to activate the photoconductive layer overall, subsequent to the image exposure and the application of said secondary charge.



5. An electrophotographic process using 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 D.C. primary charge according to whether the photoconductive layer is N-type or P-type to cause charges of polarity opposite to the primary charge 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 an A.C. secondary charge by corona discharge so that, in areas of the image in which the photoconductive layer is activated, the magnitude of the charge on the member is reduced more than in the other areas of the image where 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.
6. A process according to claim 5, including the additional step after termination of the image exposure and application of the secondary charge of exposing the member to radiation to activate the photoconductive layer overall to increase the electrostatic potential difference between the different areas of the electrostatic image.
7. A process according to claim 5 or 6, wherein the primary charge is applied by corona discharge.
8. A process according to claim 5, 6 or 7, comprising developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to that of the electrostatic image, applying to the surface of the insulating layer with the toner thereon a further D.C. charge of the same polarity as the electrostatic image to reverse the polarity of the outer particles of the toner, and transferring the developed image to a transfer member by placing the member over the surface of the insulating layer with the toner thereon, applying a bias potential to the transfer member to attract the toner particles thereto and removing the transfer member with the developed image thereon.
9. A process according to claim 8, wherein the resistivity of the toner is greater than 10^{12} ohms cms.
10. A process according to claim 5, 6 or 7, comprising developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to the polarity of the electrostatic image, applying to the surface of the insulating layer with the toner thereon a further D.C. charge of polarity opposite to the polarity of the electrostatic image so as to at least partially neutralise the charge forming the electrostatic image, and transferring the developed image to a transfer member by placing the transfer member over the surface of the insulating layer with the toner thereon, applying a bias potential to the transfer member to attract the toner particles thereto and removing the transfer member with the developed image thereon.
11. A process according to claim 10, wherein the resistivity of the toner is less than 10^{12} ohms cms.
12. A process according to claim 5, 6 or 7, wherein the thickness of the insulating layer is from 10 to 50 μ .
13. A process according to claim 5, 6 or 7, wherein the insulating layer comprises fluoroethylene resin or polyester resin.
14. A process according to claim 5, 6 or 7, wherein the photoconductive layer comprises a mixture of CdS and binder.
15. A process according to claim 14, wherein the binder is: a copolymer of vinyl chloride and vinyl acetate; or polyvinyl chloride.
16. A process according to claim 5, 6 or 7, wherein the photoconductive layer comprises a mixture of ZnO and binder.
17. A process according to claim 16, wherein the binder is a copolymer of styrene and butadiene.
18. A process according to claim 5, 6 or 7, wherein the photoconductive layer is SeTe.
19. A process according to claim 5, 6 or 7, 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.
20. A process according to claim 19, wherein the same photoconductive material is used in each of the sub layers.
21. A process according to claim 19, wherein different photoconductive materials are used in the two sub layers.
22. A process according to claim 21, wherein the overall thickness of the photoconductive layer is 10-100 μ and wherein the sub layer adjacent the conductive layer is 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.
23. A process according to claim 5, 6 or 7, wherein the insulating layer is opaque and the conductive layer is translucent for exposing the plate.
24. A process according to claim 5, 6 or 7, wherein the insulating layer is translucent for exposing the plate.





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7, wherein the electrophotographic member has formed thereon an opaque pattern arranged so that the photoconductive layer is exposed to the image via the pattern, to at least reduce the edge effect.
 25. A process according to claim 24, wherein the opaque pattern is on the surface of the insulating layer.
 26. A process according to claim 24, wherein the opaque pattern is located between the insulating layer and the photoconductive layer.
 27. A process according to claim 24, 25 or 26, wherein the opaque pattern is composed of dots.
 28. A process according to claim 24, 25, or 26, wherein the opaque pattern is composed of lines.
 29. A process according to claim 24, 25 or 26, wherein the opaque pattern is composed of a network of crossing lines.
 30. 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 member; a primary charging device arranged for applying to the surface of the insulating layer a positive or negative D.C. 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 polarity opposite to the primary charge 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 an A.C. charge by corona discharge simultaneously with the image exposure, to form an electrostatic image on the plate.
 31. Apparatus according to claim 30, including means to expose the member to radiation to activate the photoconductive layer overall, subsequent to the image exposure and the application of said A.C. charge.
 32. Apparatus according to claim 30 or 31, wherein the member is exposed to the image through the secondary charging device, which is optically open and defines the area of the member exposed.
 33. Apparatus according to claim 30, 31 or 32, further including developing means for applying to the surface of the insulating layer a developer material to render the 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.

34. Apparatus according to claim 33, wherein the developing means comprises a magnetic brush.

35. Apparatus according to claim 33, wherein the developing means is adapted to apply a liquid developer material.

36. Apparatus according to any of claims 30 to 35, including a further device arranged for applying to the member an A.C. charge to discharge the member subsequent to transfer of the visible image.

37. Apparatus according to claim 30, 31 or 32, comprising means for developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to that of the electrostatic image, a further charging device for applying to the surface of the insulating layer with the toner thereon a further D.C. charge of the same polarity as the electrostatic image to reverse the polarity of the outer particles of the toner, and transfer means for the developed image adapted to place a transfer member over the surface of the insulating layer with the toner thereon, to apply a bias potential to the transfer member to attract the toner particles thereto and to remove the transfer member with the developed image thereon.

38. Apparatus according to claim 30, 31 or 32, comprising means for developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to the polarity of the electrostatic image, a further charging device for applying to the surface of the insulating layer with the toner thereon a further D.C. charge of polarity opposite to the polarity of the electrostatic image so as to at least partially neutralise the charge forming the electrostatic image, and transfer means for the developed image adapted to place a transfer member over the surface of the insulating layer with the toner thereon, to apply a bias potential to the transfer member to attract the toner particles thereto and to remove the transfer member with the developed image thereon.

39. Apparatus according to claim 30 or 31, wherein the thickness of the insulating layer is from 10 to 50 μ .

40. Apparatus according to claim 30 or 31, wherein the insulating layer comprises fluoroethylene resin or polyester resin.

41. Apparatus according to claim 30 or 31, wherein the photoconductive layer comprises a mixture of CdS and binder.

42. Apparatus according to claim 41, wherein the binder is a copolymer of vinyl chloride and vinyl acetate; or polyvinyl chloride.



43. Apparatus according to claim 30 or 31, wherein the photoconductive layer comprises a mixture of ZnO and binder.
44. Apparatus according to claim 43, wherein the binder is a copolymer of styrene and butadiene.
45. Apparatus according to claim 30 or 31, wherein the photoconductive layer is SeTe.
46. Apparatus according to claim 30 or 31, 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.
47. Apparatus according to claim 46, is used in each of the sub layers.
48. Apparatus according to claim 46, wherein different photoconductive materials are used in the two sub layers.
49. Apparatus according to claim 48, wherein the overall thickness of the photoconductive layer is 10-100 μ and wherein the sub layer adjacent the conductive layer is 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.
50. Apparatus according to claim 30, wherein the insulating layer is opaque and the conductive layer is translucent for exposing the plate.
51. Apparatus according to claims 31 or 32, wherein the electrophotographic member has formed thereon an opaque pattern arranged so that the photoconductive layer is exposed to the image via the pattern to at least reduce the edge effect.
52. Apparatus according to claim 51, wherein the opaque pattern is on the surface of the insulating layer.
53. Apparatus according to claim 51, wherein the opaque pattern is located between the insulating layer and the photoconductive layer.
54. Apparatus according to claim 51, 52 or 53, wherein the opaque pattern is composed of dots.
55. Apparatus according to claim 51, 52 or 53, wherein the opaque pattern is composed of lines.
56. Apparatus according to claim 51, 52 or 53, wherein the opaque pattern is composed of a network of crossing lines.
57. An electrophotographic process using an electrophotographic member having first and second insulating layers between which a photoconductive layer is located, at least one of the insulating layers being translucent for exposing the member, said process comprising applying to the surfaces of the first and second insulating layers a positive and a negative primary charge respectively whereupon layers of negative and positive charge are formed in the regions of the interfaces between the photoconductive layer and the first and second insulating layers respectively, and thereafter exposing the member to an image while simultaneously applying to the surfaces of the first and second insulating layers an A.C. secondary charge, said secondary charge being applied to at least one of said surfaces by corona discharge so that, in the areas of the image in which the photoconductive layer is activated, the magnitude of the charges on the member is reduced more than in other areas of the image where at least some of the charges of the layers formed in the regions of said interfaces remain bound there, thus forming an electrostatic image on the member.
58. A process according to claim 57, wherein the primary charge is applied while exposing the member to radiation to activate the photoconductive layer overall.
59. A process according to claim 57 or 58, including the additional step after termination of the image exposure and application of the secondary charge of exposing the member to radiation to activate the photoconductive layer overall whereby said charges remaining bound in the regions of said interfaces respectively at least partially cancel one another, to increase the electrostatic potential difference between the different areas of electrostatic image.
60. A process according to claim 57, 58 or 59, wherein the primary charge is applied to at least one of said surfaces by corona discharge.
61. A process according to claim 60, wherein the primary and secondary charges are applied to the other of said surfaces by a conductive base in contact therewith.
62. A process according to claim 57, 58 or 59, comprising developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to that of the electrostatic image, applying to the surface of the insulating layer with the toner thereon a further D.C. charge of the same polarity as the electrostatic image, to reverse the polarity of the outer particles of the toner, and transferring the developed image to a transfer member by placing the member over the surface of the insulating layer with the toner thereon, applying a bias potential to the transfer member to attract the toner particles thereto and removing the transfer member with the developed image thereon.
63. A process according to claim 62, wherein the resistivity of the toner is greater than 10^{12} ohms cms.
64. A process according to claim 57, 58 or 59, comprising developing the electro-





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static image by applying to the surface of the insulating layer a toner composed of particles charges with polarity opposite to the polarity of the electrostatic image, 5 applying to the surface of the insulating layer with the toner thereon a further D.C. charge of polarity opposite to the polarity of the electrostatic image so as to at least partially neutralise the charge forming the electrostatic image, and transferring the de- 10 veloped image to a transfer member by placing the transfer member over the surface of the insulating layer with the toner thereon, applying a bias potential to the 15 transfer member to attract the toner particles thereto and removing the transfer member with the developed image thereon.

65. A process according to claim 64, wherein the resistivity of the toner is less 20 than 10^{12} ohms cms.

66. A process according to claim 57, 58 or 59, wherein the thickness of at least one of the insulating layers is from 10 to 50 μ .

67. A process according to claim 57, 58 25 or 59, wherein the insulating layers comprise fluoroethylene resin or polyester resin.

68. A process according to claim 57, 58 or 59, wherein the photoconductive layer comprises a mixture of CdS and binder.

69. A process according to claim 68, 30 wherein the binder is: a copolymer of vinyl chloride and vinyl acetate; or polyvinyl chloride.

70. A process according to claim 57, 58 35 or 59, wherein the photoconductive layer comprises a mixture of ZnO and binder.

71. A process according to claim 70, wherein the binder is a copolymer of styrene and butadiene.

72. A process according to claim 57, 58 40 or 59, wherein the photoconductive layer is SeTe.

73. A process according to claim 57, 58 45 or 59, wherein the photoconductive layer is formed as two sub layers of which one comprises fine particles of photoconductive material and the other comprises coarse particles of photoconductive material.

74. A process according to claim 57, 58 50 or 59, wherein the photoconductive layer is formed as three sub layers, the two sub layers adjacent the insulating layers comprising fine particles of photoconductive material and the third sub layer comprising 55 coarse particles of photoconductive material.

75. A process according to claim 73 or 74, wherein the same photoconductive material is used in each of the sub layers.

76. A process according to claim 73 or 60 74, wherein different photoconductive materials are used in the sub layers comprising fine and coarse particles respectively.

77. A process according to claim 76, as 65

dependent upon claim 73, wherein the overall thickness of the photoconductive layer is 10-100 μ and wherein the sub layer composed of coarse particles is CdS and binder, and the sub layer composed of fine 70 particles is 5 to 20 μ thick and is ZnO and binder.

78. A process according to claim 57, 58 or 59, wherein one of the insulating layers is opaque and the process is performed 75 with the opaque insulating layer exposed to ambient light.

79. A process according to claim 57, 58 or 59, wherein the electrophotographic member has formed thereon an opaque pat- 80 tern arranged so that the photoconductive layer is exposed to the image via the pattern, to at least reduce the edge effect.

80. A process according to claim 79, wherein the opaque pattern is on the sur- 85 face of one of the insulating layers.

81. A process according to claim 79, wherein the opaque pattern is located be- 90 tween one of the insulating layers and the photoconductive layer.

82. A process according to claim 79, 80 or 81, wherein the opaque pattern is composed of dots.

83. A process according to claim 79, 80 or 81, wherein the opaque pattern is com- 95 posed of lines.

84. A process according to claim 79, 80 or 81, wherein the opaque pattern is composed of a network of crossing lines.

85. Electrophotographic apparatus com- 100 prising an electrophotographic member having first and second insulating layers between which a photoconductive layer is located, one of the insulating layers being translucent for exposing the member; a pri- 105 mary charging device arranged for applying to the surfaces of the first and second insulating layers a positive and a negative D.C. primary charge respectively, so that layers of negative and positive charge are 110 formed respectively in the region of the interfaces between the photoconductive layer and the first and second insulating layers; an optical system for exposing the member to an image subsequent to the application 115 of the primary charge; and a secondary charging device arranged for applying to the surfaces of the first and second insulating layers an A.C. charge by corona discharge on at least one of said surfaces simulta- 120 neously with the image exposure, to form an electrostatic image on the member.

86. Apparatus according to claim 85, in- 125 cluding means to expose the member to radiation to activate the photoconductive layer overall while said charge is applied by the primary charging device.

87. Apparatus according to claim 85 or 86, including means to expose the member to radiation to activate the photoconductive 130

layer overall subsequent to the image exposure and the application of said A.C. charge.

5 88. Apparatus according to claim 85, 86 or 87, further including developing means for applying to the surface of one of the insulating layers a developer material to render the 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.

10 89. Apparatus according to claim 88, wherein the developing means comprises a magnetic brush.

15 90. Apparatus according to claim 88, wherein the developing means is adapted for applying a liquid developer material.

20 91. Apparatus according to any of claims 85, 86 or 87, wherein the primary and secondary charging devices comprise a corona discharger at one side of the member and a grounded conductive support in contact with the other side of the member.

25 92. Apparatus according to claim 85, 86 or 87, wherein the primary and secondary charging devices comprise a corona discharging device at each side of the member.

30 93. Apparatus according to claim 85, 86 or 87, comprising means for developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to that of the electrostatic image, a further charging device for applying to the surface of the insulating layer with the toner thereon a further D.C. charge of the same polarity as the electrostatic image to reverse the polarity of the outer particles of the toner, and transfer means for the developed image adapted to place a transfer member over the surface of the insulating layer with the toner thereon, to apply a bias potential to the transfer member to attract the toner particles thereto and to remove the transfer member with the developed image thereon.

40 94. Apparatus according to claim 85, 86 or 87, comprising means for developing the electrostatic image by applying to the surface of the insulating layer a toner composed of particles charged with polarity opposite to the polarity of the electrostatic image, a further charging device for applying to the surface of the insulating layer with the toner thereon a further D.C. charge of polarity opposite to the polarity of the electrostatic image so as to at least partially neutralise the charge forming the electrostatic image, and transfer means for the developed image adapted to place a transfer member over the surface of the insulating layer with the toner thereon, to apply a bias potential to the transfer member to attract the toner particles thereto and to

remove the transfer member with the developed image thereon.

95. Apparatus according to claim 85, 86 or 87, wherein the insulating layers composed of the insulating layers is from 10 to 50 μ .

70 96. Apparatus according to claim 85, 86 or 87, wherein the insulating layers comprise fluoroethylene resin or polyester resin.

97. Apparatus according to claim 85, 86 or 87, wherein the photoconductive layer comprises a mixture of CdS and binder.

80 98. Apparatus according to claim 97, wherein the binder is: a copolymer of vinyl chloride and vinyl acetate; or polyvinyl chloride.

99. Apparatus according to claim 85, 86 or 87, wherein the photoconductive layer comprises a mixture of ZnO and binder.

100. Apparatus according to claim 99, wherein the binder is a copolymer of styrene and butadiene.

101. Apparatus according to claim 85, 86 or 87, wherein the photoconductive layer is SeTe.

102. Apparatus according to claim 85, 86 or 87, wherein the photoconductive layer is formed as two sub layers of which one is composed of coarse particles of photoconductive material and the other is composed of fine particles of photoconductive material.

103. Apparatus according to claim 85, 86 or 87, wherein the photoconductive layer is formed as three sub layers, the two sub layers adjacent the insulating layer being composed of fine particles of photoconductive material and the third sub layer being composed of coarse particles of photoconductive material.

104. Apparatus according to claim 102 or 103, wherein the same photoconductive material is used in each of the sub layers.

105. Apparatus according to claim 102 or 103, wherein different photoconductive materials are used in the sub layers composed of fine and coarse particles respectively.

106. Apparatus according to claim 105 as dependent upon claim 102, wherein the overall thickness of the photoconductive layer is 10-100 μ and wherein the sub layer composed of coarse particles is CdS and binder, and the sub layer composed of fine particles is 5 to 20 μ thick and is ZnO and binder.

107. Apparatus according to claim 85, 86 or 87, wherein one of the insulating layers is opaque, the apparatus being adapted to operate with the opaque insulating layer exposed to ambient light.

108. Apparatus according to claims 85, 86 or 87, wherein the electrophotographic member has formed thereon an opaque pattern arranged so that the photoconductive layer is exposed to the image via the pattern, to at least reduce the edge effect.



109. Apparatus according to claim 108, wherein the opaque pattern is on the surface of one of the insulating layers.

110. Apparatus according to claim 108, wherein the opaque pattern is located between one of the insulating layers and the photoconductive layer.

111. Apparatus according to claim 108, 109, 110, wherein the opaque pattern is composed of dots.

112. Apparatus according to claim 108, 109, or 110, wherein the opaque pattern is composed of lines.

113. Apparatus according to claim 108,

109 or 110, wherein the opaque pattern is composed of a network of crossing lines.

114. A process of electrophotography substantially as described with reference to any of the accompanying drawings.

115. Electrophotographic apparatus substantially as described with reference to any of the accompanying drawings.

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