

[54] **ELECTROPHOTOGRAPHIC COPY
PROCESS AND ELEMENT PRODUCED
IN SAME**

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19, 1966, abandoned.

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[51] Int. Cl. G03g 13/00

[58] Field of Search.....250/65 ZE; 96/1.5

[56] **References Cited**

UNITED STATES PATENTS

2,956,878 10/1960 Michiels 250/65

3,037,861	6/1962	Hoegl	250/65
3,308,444	3/1967	Ting	250/65
3,317,315	5/1967	Nicoll	250/65

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[57] ABSTRACT

An electrostatic copy process in which the electrostatic charge is applied to a film of a polyester resin and in which charge differential for development of a latent electrostatic image is achieved by exposure to intense ultraviolet radiations.

11 Claims, 4 Drawing Figures

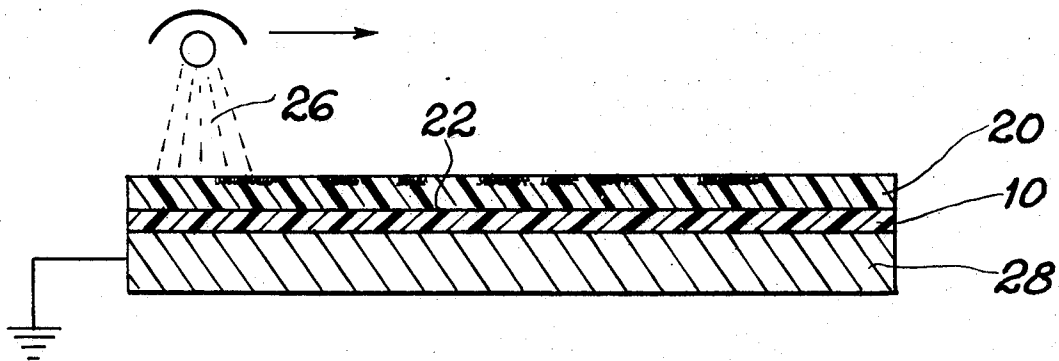


FIG. 1

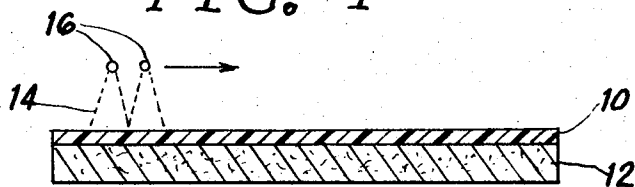


FIG. 2

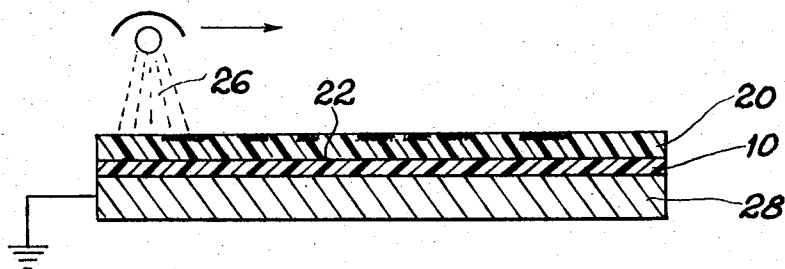


FIG. 3

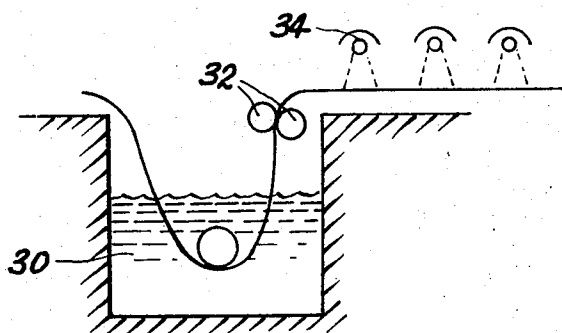
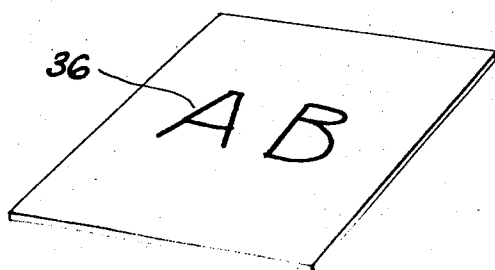


FIG. 4



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ELECTROPHOTOGRAPHIC COPY PROCESS AND ELEMENT PRODUCED IN SAME

This is a continuation-in-part of my copending application Ser. No. 551,404, filed May 19, 1966, now abandoned and entitled "Electrophotographic Copy Process and Element Produced in Same."

This invention relates to the electrophotographic copy process and more particularly to the art of electrostatic printing and elements employed in the practice of same.

In the Carlson patents No. 2,297,691 and No. 2,357,809, description is made of an electrostatic copy process in which a photoconductive layer is given an overall electrostatic charge, while being protected from light. Thereafter the charged layer is exposed to an optical light image of the subject matter to be reproduced. The layer becomes conductive in the areas struck by light to enable dissipation of the electrostatic charge while the charge remains in the unexposed areas to define a latent electrostatic image. The latter is visibly developed by a dry powder developer which is thereafter transferred from the layer to a copy sheet where it is fixed to produce visible copy.

More recently, copy sheets have been produced with photoconductive coating of special zinc oxides in a suitable binder in which the coating is applied to a backing of paper or other suitable conductive backing material whereby the overall electrostatic charge is retained by the photoconductive coating until exposed to light in the non-imaged areas to dissipate the charge in the exposed areas. This leaves a latent electrostatic image that can be visually developed by conventional powder of liquid developers and fixed to produce visible copy directly on the coated sheet.

To the present, the electrostatic process for copy reproduction has been limited to photoconductive coatings such as the selenium metal layers of the Carlson patents, or the special zinc oxide coatings of the Greig patent No. 3,052,540.

Much to my surprise, I have found that the electrostatic copy process can be practiced with thin films of tough and highly plastic material which do not embody the photoconductive characteristics believed to be essential for the electrostatic copy process. It has been found, for example, that a clear film of a polyester polymer resin, such as Mylar, preferably when disposed but not essentially disposed on a conductive support or a conductive coating as a backing on the film such as a thin metallized coating on the backside of the film, will retain an overall electrostatic charge when exposed to a corona spray of positive or negative charge. Unlike a photoconductor whose high dielectric strength is drastically reduced upon exposure to visible light, the dielectric strength of the polyester film is not appreciably changed upon exposure to visible light. While the mechanism is not yet understood, it is believed that exposure to ultra-violet induces photolytic bond rupture with the consequent formation of free radicals or an increase in electron mobility sufficient to enable dissipation of the electrostatic charge in the areas exposed to ultra-violet to provide sufficient differential in the charge levels between the exposed and unexposed areas of the film whereby toner particles for visual development will be attracted by the one in preference to the other.

The unique characteristics described are not capable of development with any and all films of plastic material. The concept appears to be limited to plastic films having the combination of characteristics consisting of high dielectric and insulating properties and which is capable of being discharged by exposure to ultra-violet light which includes the ultra-violet component in visible light. The invention can be practiced with plastic films that exhibit these characteristics, such as films formed of polyester resins, such as Mylar, marketed as a plastic film by E. I. du Pont de Nemours & Company, and polyimides, such as Kapton. The desired characteristics for use in the practice of this invention are not present in such plastic films as are formed of polyvinyl chloride, cellulose acetate, polyethylene, polyamides or polytetrafluoroethylene. Films having a thickness within the range of 0.25 to 2 mils are preferred, although films of lesser or greater thickness can be employed.

It has been found that, in the practice of this invention with plastic films of the type described, it is not necessary to effect dissipation of the entire charge in the exposed or non-imaged areas of the film. It is sufficient, for visual development, if sufficient of the charge is dissipated to provide for a differential between the level of charge in the imageable areas as compared to the charge remaining in the non-imageable areas. The degree of difference will vary depending somewhat upon the charge level or absolute voltage that is applied. For example, when the polyester (Mylar) film is originally given an overall electrostatic charge to 500-1000 volts, visual development of the image can be achieved when the charge in the exposed or non-imaged areas is reduced to less than 200 volts. When the surface is charged to less than 500 volts, such as to 300-400 volts, it is sufficient when the imaged portion is reduced to 0-50 volts. On the other hand, if the film is originally charged at over 1000 volts, then a voltage drop in the order of 10-20 percent or more in the exposed portion will provide a differential sufficient for good image development. Thus, in general, it may be said that at original voltages of 1000 or more, a voltage drop of 10-20 percent in the imaged areas would be sufficient; at between 500 and 1000 volts, a voltage drop of 50 percent would be sufficient; and at original voltages of less than 500, a voltage drop of almost 100 percent is indicated. It is preferred to position the film on a conductive support during exposure, but the use of such conductive support is not essential.

Another surprising and unique feature of this invention resides in the sensitivity of the charged film to intensive radiation of ultra-violet while remaining substantially insensitive to ambient light or to room light of say 120 foot candles, even when exposed for as much as one-half hour. Thus, unlike the photoconductors of the type employed in previous electrostatic copy processes of the type heretofore described, the charged film and even the film after exposure need not be protected from ambient or room light. The exposure can be made by projection but best results are secured when the negative or positive transparency, bearing the image, is arranged in close contact with the charged surface of the film and when the radiations of ultra-violet are directed through the transparency onto the charged film with an illumination or exposure of from 1-30 seconds.

As the source for radiations, use can be made of an ultra-violet arc bulb of high-pressure mercury-vapor arc in quartz, such as marketed by the Hanovia Lamp Division of Engelhard Hanovia, Inc. of Newark, New Jersey, under the name "Inspectolite." The lamp issues sufficient long-wave ultra-violet radiations within a preferred range of 3600–3700 Å.U. Ultra-violet radiations within the ultra-violet range of 3000 to 4000 can be used effectively as long as the energy of ultra-violet light striking the charged film is within the range of 400–1400 microjoules/cm².

The corona charge applied to the surface of the film can be either positive or negative for visual development of the image with toner particles of the opposite charge applied either from a dry powdered developer as described in the aforementioned Carlson patents, or as described in other U. S. Pats., such as No. 2,618,552 and No. 2,753,308, or a liquid developer, such as described in U. S. Pat. Nos. 2,907,674, 2,899,335, 2,890,911, 3,135,095, or 3,155,546.

Having described the basic concepts of the invention, illustration will now be made of the practice thereof, reference being made to the accompanying drawing, in which

FIG. 1 is a schematic sectional elevational view showing the arrangement of elements during charging of the film;

FIG. 2 is a sectional elevational view showing the arrangement of elements during development of the latent electrostatic image;

FIG. 3 is a schematic elevational view showing visual development of the film with a liquid developer followed by fixing the image for heat fusion; and

FIG. 4 is a plan view partially in section of the imaged film.

With reference now to the drawing, a film 10 of polyester (Mylar) or metalized Mylar, having a thickness of about 1 mil, is positioned on a base 12 or support and a corona spray 14 is applied from conductive wires 16 operating at 6000–8000 volts. The charged wires 16 extend across the film and are transported lengthwise of the film, as indicated by the arrow in FIG. 1, to provide an overall charge onto the film.

A positive transparency 20 is positioned over the charged surface 22 of the film 10 and a UV lamp 24 is transported about 5 inches over the assembly to direct ultra-violet radiations 26 of 400–1400 microjoules/cm² through the transparency and onto the underlying charged surface. In the illustrated modification, the charged film is supported on a conductive metal plate 28 which is grounded but such support is not necessary. Charge is dissipated from the surface portions of the film struck by the ultra-violet radiations by an amount to provide at least a differential of 600 volts with the charge remaining on the surface of the film in the unexposed areas.

The resulting film will contain areas differing in the amount of charge with less charge down to no charge at all in the exposed, non-imaged portions of the film and with electrostatic charge of higher voltage in the unexposed portions thereby to define an imageable latent electrostatic image. Exposure is made by a UV lamp transported over the assembly at a rate to provide for exposure of about 5 seconds. It will be understood that all or only part of the charge may be dissipated in the portions that are struck by ultra-violet.

The film 10 with the latent electrostatic image is removed from the support 28 and passed through a conventional liquid developer 30 of the types previously described and which contains a suspension of toner particles having a charge opposite the charge applied to the film surface. During immersion in the liquid developer, toner particles will be attracted to the charged latent electrostatic image for visual development thereof while the discharged, non-imaged portions will remain free of toner particles.

The developed film is then passed through squeeze rolls 32 for removal of excess liquid developer followed by advancement through a heating zone, such as through a bank of infrared ray lamps 34 for fusion of the toner particles to set the image 36.

Instead of a liquid developer, use can be made of a dry powdered developer in which the toner particles have the desired tribo-electric effect. The powdered developer is cascaded over the surface of the film whereby dry toner particles of opposite charge will be attracted to the latent electrostatic image for visual development. Toner particles are subsequently fixed onto the film by heat from a resistance wire or lamps or by the use of solvent vapors or liquid which operate to soften the resinous binder with the toner particles, but without softening the film. Instead, the toner particles can be transferred from the film onto copy sheets and fixed to produce copy.

While best results are secured in preparation of the latent electrostatic image by exposure to ultra-violet, dissipation of charge, to develop the desired differential, can be achieved with some films by exposure to the longer wave lengths in the lower end of the visible light range and by exposure to still shorter waves such as in the range of X-rays.

Instead of making use of a metallized layer on the surface opposite the exposed surface of the film, the conductive layer can be formed of a conductive resinous coating composition or other conductive material.

It will be apparent from the foregoing that I have provided a new system of materials and method capable of use in the production of copy by simplified electrostatic technique.

It will be understood that changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. An electrostatic copy process comprising the steps of spraying the surface of a thin plastic film with an electrostatic charge whereby an overall electrostatic charge is retained by the film, said film consisting essentially of a plastic material selected from the group consisting of a polyester containing an aromatic group and a polyimide having high dielectric and electrical insulating properties with or without a conductive coating on the backside of the film and in which dissipation of at least a portion of the electrostatic charge occurs in response to exposure to intense ultra-violet radiations, exposing the charged surface of the film to such ultra-violet radiations in a pattern related to the image whereby charge is dissipated at least in part from the exposed portions and retained in the unexposed portions to provide a charge differential between the unex-

posed latent electrostatic image and the exposed portions, contacting the surface of the exposed film with a developing medium containing toner particles have a charge opposite the charge of the latent electrostatic image whereby toner particles are retained on the latent electrostatic image for visual development thereof.

2. The process as claimed in claim 1 in which the ultra-violet radiations are within the range of 3000-4000 A.U.

3. The process as claimed in claim 1 in which the ultra-violet radiations are within the range of 3600-3700 A.U.

4. The process as claimed in claim 1 in which the radiations striking the charged surface are within the range of 400-1400 microjoules/cm².

5. The process as claimed in claim 1 in which the film has a thickness within the range of 0.25 to 2 mils.

6. The process as claimed in claim 1 in which the film is given an overall electrostatic charge in excess of 1000 volts and which only a portion of the charge is removed from exposed areas to provide a reduction of at least 10 percent in the voltage between the exposed portions and the unexposed latest electrostatic imaged portion.

7. The process as claimed in claim 1 in which the exposure of the charged surface to the ultra-violet pattern comprises positioning a transparency containing the image adjacent the charged surface of the film and directing radiations rich in ultra-violet through the

transparency onto the surface of the film.

8. The process as claimed in claim 7 in which the exposure to ultra-violet is for a period of from 1-30 seconds.

9. The process as claimed in claim 1 which includes the step of fixing the toner particles on the imaged surface of the film.

10. The process as claimed in claim 1 in which the film is a polyester film having a metallized layer on the surface opposite the charged surface.

11. A developed film consisting essentially of a plastic material selected from the group consisting of a polyester containing an aromatic group and a polyimide having high dielectric and electrical insulating properties with or without a conductive coating on the back side of the film and in which the film is capable of dissipating at least a portion of the electrostatic charge in response to exposure to intense ultra-violet radiation in the exposed portions of the film corresponding to the imaged portion of an original prepared by the process of claim 1 in which the differential between the exposed portions and the unexposed portions of the film is more than 10 percent when the absolute voltage in the unexposed portions is in excess of 1000 volts, in which the differential is in excess of 50 percent when the absolute voltage is less than 1000 but more than 500 volts and in which the differential is almost 100 percent when the absolute voltage is less than 500 volts.

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