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[54] **METHOD FOR TEMPERATURE STABILIZING PHOTORECEPTORS**

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[51] **Int. Cl.** **G03g 17/00**

[58] **Field of Search** ..... 96/1.5, 1 R

[56] **References Cited**

UNITED STATES PATENTS

2,803,542	8/1957	Ullrich	96/1.5
3,312,548	4/1967	Straughan	96/1.5

OTHER PUBLICATIONS

Journal of the Optical Society of America Vol. 42, No. 4 pp. 221–225 April 1952.

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[57] **ABSTRACT**

Improved development, stability endowed by better charging level, image resolution and a lower dark discharge rate are obtainable in selenium-arsenic containing photoreceptor utilizing a cascade or a magnetic brush development system and exposed to the aging effects of an environment associated with high voltage electrical discharge by raising and maintaining the temperature of the photoreceptor at a point within the range of about 10 percent –30 percent above controlled ambient conditions.

6 Claims, No Drawings

METHOD FOR TEMPERATURE STABILIZING PHOTORECEPTORS

BACKGROUND

The formation and development of images on the imaging surfaces of photoconductive materials by electrostatic means is well-known (Carlson, U.S. Pat. No. 2,297,691). The best known of the commercial process, more commonly known as xerography, utilizes a latent electrostatic image on the surface of an imaging layer. This is done by uniformly electrostatically charging the surface in the dark, and then exposing the charged surface to a light and shadow image. The light-struck areas of the imaging layer are thus made substantially more charge-conductive and the electrostatic charge is selectively dissipated in such areas. After light exposure, the latent electrostatic image remaining on the imaging surface (ex. a positive electrostatic image) is made visible by contacting with finely divided colored or black electroscopic material, known in the art as "toner." Toner is principally attracted to those areas on the image bearing surface which retain the original electrostatic charge and thereby form a visible positive image.

In structure, the conventional xerographic plate normally has a photoconductive insulating layer overlaying a conductive base or substrate, and frequently an interface or charge blocking layer between the two.

The photoconductive layer can comprise a number of materials known in the art. For example, selenium-containing photoconductive material such as vitreous selenium, or selenium modified with varying amounts of arsenic are found very useful for modern xerographic copying purposes. Generally speaking, such photoconductive layers have a specific resistivity greater than about 10^{10} ohm-cm (preferably 10^{13} ohm-cm) in the absence of illumination. In addition, resistivity should drop at least several orders of magnitude in the presence of an activating energy source such as light. As a practical matter, a photoconductor layer should support an electrical potential of at least about 100 volts in the absence of light or other actinic radiation, and may usefully vary in thickness from about 10 to 200 microns.

In addition to the above, photoconductive layers normally exhibit some reduction in potential or voltage leak, even in the absence of an activating light. This phenomenon, known as "dark decay," will vary somewhat depending upon the potential employed, the method of xerographic development, and the amount of exposure to ozone or impurities such as organic or inorganic breakdown products or general atmospheric contaminants.

The general problem is well recognized and has been controlled to some extent by incorporation of an interface or barrier layer such as a very thin dielectric film or layer between the substrate and the photoconductive insulating layer and by various cleaning techniques. U.S. Pat. No. 2,901,348 to Dessauer et al relates to the use of a layer of aluminum oxide as a barrier layer.

With the advent of the newer more sensitive and versatile inorganic photoconductors comprising selenium-arsenic alloys (ref. U.S. Pat. Nos. 2,822,300; 2,803,542; 3,312,548), however, there is noted an increased sensitivity to impurities resulting in premature fatigue of the photoconductor layer. This is evidenced by variations in charging level, irregular localized high dark discharge and also loss in image resolution due to lateral charge migration.

In attempting to rectify the above problems, however, it is necessary to keep in mind that any modifications in the photoconductive layer must allow sufficient conductivity to permit photodischarge of a substantial portion of the applied charge. The above criteria is particularly important in attempting to utilize xerographic processes in modern high speed automatic copiers.

It is an object of the present invention to improve the effective life of photoreceptors containing selenium photoconductors by slowing down the process of photoconductor fatigue.

It is a further object of the present invention to improve the development stability of selenium-arsenic-type photoconductors when used in combination with available xerographic image development procedures.

THE INVENTION

The above objects are obtained insofar as selenium-arsenic-containing xerographic photoreceptors are concerned by heating and maintaining the temperature of the photoreceptor at about constant temperature at a point within the range of about 10 percent – 30 percent above ambient conditions, and no higher than about 40°C. Preferably, the heating step is effected at a constant temperature within the range of about 28°C.–38°C. and the heating step is utilized for a period both prior to and subsequent to normal charging, developing and image transfer steps. For general purposes, about a 10–30 minute or longer overlapping period is found useful to initially stabilize the photoreceptor and to avoid subsequent condensation deposition of undesired impurities from whatever source onto the photoconductor.

For purposes of the present invention, it is also found that the heating step is best (although not exclusively or solely) carried out with (1) a temperature sensing and switching device. Such a device can be placed in convenient contact with the photoreceptor plate or drum to activate one or more heating means such as an electrical resistance heater and fan for moving warmed air onto the photoreceptor particularly blown across a photoconductor surface. Such arrangement is optionally combined with appropriate air filtering means such as a fiber glass filter. Also useful for this purpose are similarity activated heating coils attached to or near the inner side of the photoreceptor. Such alternate heating means can be conveniently used alone, or on standby, in combination with air circulating means for purposes of the disclosed invention.

The term "selenium-arsenic-containing xerographic photoreceptors" in the described invention is intended to comprise both plate and drum photoreceptors such as coated NESA glass, steel, aluminum or nickel, etc.; the photoreceptor can conveniently contain, for instance, at least one photoconductor layer of the usual thickness comprising a selenium-arsenic alloy containing about 4 percent – 45 percent arsenic by weight and optionally about 0 percent – 0.001 percent by weight of one or more halogen components such as chlorine atoms.

The usual charging and developing steps utilized within the present invention can be carried out with one or more standard corotron charging and detaching devices (ref. U.S. Pat. Nos. 3,566,108; 2,777,957),

light exposure optics system; cleaning means such as a brush, web, or blade-type cleaning device (ref. U.S. Pat. Nos. 3,682,689; 3,634,077; 3,552,850; 3,099,856; 3,186,838); and development means utilizing a cascade or magnetic brush electrostatic developing system (ref. U.S. Pat. Nos. 3,117,884; 3,067,720; 2,874,063).

When utilizing the latter developing system with the present inventive process, it is also found that it is possible to continue to suppress background development of the photoreceptor far beyond the usual period. Such is possible because of the improved stability of photoreceptors treated in accordance with the present invention. This is significant since the development electrode can utilize a bias of up to about 300 volts (preferred 60–100 volts) above the background potential.

When using a metal photoreceptor drum such as an aluminum drum of the "2400" type, it is found convenient to utilize thermisters embedded in the drum since the dimensions of such drums are such that the heat capacity of the drum would give the heating system a thermal time constant favorible for tracking ambient temperature changes, but remaining impervious to short term changes caused by contact with the developer. Generally speaking, it is expected that maximum heat loss through a photoreceptor surface would approximate 35 watt (assuming a 65°F. ambient temperature). In addition, the thermal capacity of the drum requires for instance, heating at about 8 watts for about 1 minute to bring the drum temperature up to 100°F. (37.7°C.).

For most purposes, a heating system having a 50 watt capability will be fully adequate for the above purpose.

Embodiments of the present invention are further described in the following examples:

EXAMPLE I

Eight xerographic aluminum photoreceptor drums of the "2400" type and identified as T1-8 are coated with Se-As alloy containing 40 percent by weight As by rotating slowly for 20 minutes in a vacuum coater at 5×10^{-4} Torr over a plurality of open electrically heated stainless steel crucibles containing the desired Se-As alloy. The crucibles are maintained at about 380°C. for the desired period and then the coater and its contents permitted to return to ambient conditions.

EXAMPLE II

Sample drums T1-2 of Example I are mounted in the usual manner in two "2400" type xerographic copiers of the type described in FIGS. 1–3 of U.S. Pat. No. 3,301,126 of Osborne et al and copies run off under ambient temperatures varying from about 20°–22°C. After 10,000 copies, the quality of copy and the condition of the drums is noted and reported in Table I (infra).

EXAMPLE III

Drums T3-4 are mounted as in Example II in two substantially identical "2400" type machines with the exception that a magnetic brush developing mode as described in FIGS. 1, 2, and 4 of U.S. Pat. No. 3,608,522 is substituted for the cascade development mode of the machine utilization in Example II. After 10,000 copies at about 20°C.–23°C. ambient conditions, the quality of copy and the condition of the drums is noted and reported in Table I (infra).

EXAMPLE IV

Example II is repeated with drums 5–6 mounted in the machines described in Example II, with the exception that a gentle warmed jet of filtered air at 28°C. is blown across the photoconductor surface at the corotron charging station for 10 minutes before, during and 15 minutes after conclusion of a run of 10,000 copies. The quality of the last 10 copies and condition of the last drum is noted and reported in Table I (infra).

EXAMPLE V

Example III is repeated with drums 7–8 mounted in the machine described in Example III, with the exception that a gentle warmed jet of filtered air at 28°C. is blown across the photoconductor surface at the corotron charging station for 10 minutes before, during and 15 minutes after conclusion of a run of 10,000 copies. The quality of the copies and condition of each drum is noted and reported in Table I (infra).

TABLE I

Drum	Deletions*	Background*	Dark Discharge(%) (3 seconds)
T1	vg	vg	7
T2	vg	g	8
T3	g**	g**	10
T4	p**	g**	12
T5	ex	ex	5
T6	vg	ex	5
T7	vg**	vg**	6
T8	ex**	vg**	7

* ex = excellent (no deletion, no background marks)
vg = very good (less than .5%)
g = good (.5%–2%)
f = fair (2%–5%)
p = poor (5% or more)

** utilizing an 80 v bias on the development electrode above the background potential

EXAMPLE VI

Example V is repeated using similarly coated aluminum drums identified as T9-10 equipped with a combination of insulated resistance heating wires helically arranged and attached on the inside surface of the photoreceptor drum plus a ½ inch fiber glass insulation overcoat, and thermisters embedded in the drum to sense drum temperatures and to activate the heating wires. Both drums are tested at 10,000 copies, at a temperature of about 38°C., T9 being tested with wire heating means alone. The results are found to be closely comparable with results obtained in Examples IV and V, drum T9 demonstrating slightly less deletion than drum T10.

What is claimed is:

1. A method for controlling photoreceptor fatigue effects in selenium-arsenic-containing xerographic photoreceptors evidenced by variations in charging level, poor image resolution and deletions due to high dark discharge rates, the improvement comprising heating and maintaining the photoreceptor at about constant temperature at a point within the range of about 10 percent – 30 percent above ambient conditions and no higher than about 40°C.

2. The method of claim 1 wherein the heating step is effected at a constant temperature within the range of about 28°–38°C.

3. The method of claim 1 wherein the temperature of the photoreceptor is maintained by one or more heating means.

4. The method of claim 3 wherein temperature of the photoreceptor is maintained at least in part by moving warmed air onto the photoreceptor.

5. The method of claim 4 wherein air is prefiltered, heated and blown across a photoconductor surface.

6. The method of claim 1 wherein the heating step is utilized for a period both prior to and subsequent to normal xerographic charging, development and image transfer steps.

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