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[54] **INTERMITTENT GRIT REMOVAL
PROCESS**

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[58] Field of Search 96/1; 117/17.5; 355/15;
118/637; 15/1.5

[56] **References Cited**

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[57] **ABSTRACT**

In an electrostatographic reproduction process involving cascade-type development, an improvement is provided allowing intermittent removal of grit generated in the developer. The improvement comprises intermittently bypassing the normal reproduction cycle and interposing a grit-removal cycle wherein a charge is imposed upon the electrostatographic imaging surface relatively opposite in polarity to the charge of the accumulated grit in the developer; the developer is then cascaded over the charged imaging surface and the grit is preferentially attracted thereto and separated from the developer system.

6 Claims, 1 Drawing Figure

INTERMITTENT GRIT REMOVAL PROCESS

This invention relates to electrostatography. More particularly, this invention relates to improvements in electrostatographic processes whereby grit can be removed from the developer thereby reducing unsightly deposition in non-charged background areas.

In a typical electrostatographic process, for example, as disclosed in Carlson U.S. Pat. No. 2,297,691, issued Oct. 6, 1942, an electrostatographic imaging surface comprising a layer of photoconductive insulating material on an electrically conductive backing is given a uniform electrostatic charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the surface in image configuration and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged finely divided material, such as an electroscopic powder, that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed electrostatographic powder image is usually transferred to a transfer support surface, for example paper, to which it may be affixed by any suitable means.

The cascade method of latent image development has found extensive commercial acceptance and generally consists of gravitationally flowing across the electrostatographic surface a two component developer material consisting of an electroscopic marking powder termed "toner" and a granular material called "carrier" which consists preferably of spherical particles devoid of so-called "grit" which includes fine chips, powder, filaments and dust which may freely reside in the carrier mixture or adhere tenaciously to the surface of individual carrier beads.

Illustrative examples of such two component developer materials are disclosed in Walkup et al. U.S. Pat. No. 2,638,416, Walkup U.S. Pat. No. 2,618,551, Wise U.S. Pat. No. 2,618,552 and Copley U.S. Pat. No. 2,659,670. Generally carrier particles are much larger relative to the toner particles, toner particles generally having an average particle diameter between about 1 and 40 microns; whereas the carrier particles, for example, may have an average particle diameter from about 50 to 700 microns.

As indicated in the aforementioned patents, conventionally the carrier particles act as vehicles to carry toner to latent image areas and serve to triboelectrically charge toner so that toner may be pulled off of the carrier particles to image areas but not to background areas. Carrier beads also pick up toner particles which might tend to adhere to uncharged or background areas.

The accumulation of grit in the developer is to be avoided since grit can be deposited on the electrostatographic surface and remain thereon after development and be carried on said surface through subsequent image transfer and cleaning steps. Grit on the surface during the image transfer step prevents intimate contact of said surface with the transfer support surface in the region of the grit thus causing incomplete image transfer in that region. Also, pressure is often required during this transfer step and this pressure may cause grit to scar, dent or otherwise degrade the relatively delicate electrostatographic surface.

In automatic recyclable electrostatographic copying machines, the electrostatographic surface is generally cleaned after the transfer step to ready the surface for a new imaging cycle. In the cleaning step where any remaining toner is removed from the surface to ready it for reuse, especially where web belts in skidding contact with said surface are employed as the cleaning means, grit on the electrostatographic surface, being ground against it, may cause serious damage to said surface which ordinarily should be very smooth to produce quality prints.

In addition, it is found that grit which adheres to the surface of both round and irregular carrier beads, can cause unsightly deposition in non-charged background areas of the elec-

trostatographic imaging surface. To require remedial measures such as tapping or air pressure to remove grit from the imaging surface after the development step would add greatly to the complexity of electrostatographic apparatus. This problem will become even more acute as developers with greater longevity are obtained. The very nature of the developer system is grinding action; consequently, a certain amount of grit will always be produced in any system employed. No method, however, has heretofore been found which satisfactorily removes grit from the bead surface.

Accordingly, it is an object of the present invention to provide a process for removing grit from the developer system.

It is another object of this invention to provide means for reducing background deposits on electrostatographic imaging surfaces.

It is a still further object to provide means for reducing the occurrence of grit on electrostatographic imaging surfaces thereby reducing potential damage to said surfaces.

These as well as other objects are accomplished by the present invention where in a process for electrostatographic reproduction comprising the following reproduction cycle: (i.e.

- a. electrostatically charging an electrostatographic surface;
 - b. imaging said surface to impart a latent electrostatic image thereto; and
 - c. developing said latent image by cascading developer comprising toner electrostatically clinging to carrier particles across said imaged surface;
- the improvement is provided which comprises separating accumulated grit from the developer by intermittently bypassing said reproduction cycle and interposing a grit removal cycle comprising:
- i. electrostatically charging the electrostatographic surface with a charge relatively opposite to that of the accumulated grit in the developer;
 - ii. cascading developer across said charged surface whereby grit is preferentially attracted to said surface and separated from the developer, said developer being recycled for further use in the process; and
 - iii. discarding the collected grit.

For a better understanding of the invention, reference is made to the following detailed description of the invention to be read in connection with the accompanying drawing, wherein:

The FIGURE illustrates schematically a typical electrostatographic apparatus adapted to be employed in accordance with the invention.

As shown schematically in the FIGURE, the automatic electrostatographic reproducing apparatus generally comprises an electrophotographic plate 20 including a photoconductive layer or light-receiving surface on a conductive backing and formed in the shape of a drum, which is mounted on a shaft journaled in a frame to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of electrostatographic processing stations during the reproduction cycle.

For the purpose of the present disclosure, the several electrostatographic processing stations in the path of movement of the drum surface generally involved in the conventional electrostatographic reproduction cycle may be described functionally as follows.

A charging station, at which a uniform electrostatic charge is deposited on the photoconductive layer of the electrophotographic drum;

An exposure station, at which a light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the drum charge in the exposed areas thereof and thereby form a latent electrostatic image of the copy to be reproduced;

A developing station, at which an electrostatographic developing material including toner particles having an electrostatic charge opposite to that of the electrostatic latent image is cascaded over the drum surface, whereby the toner

particles adhere to the electrostatic latent image to form an electrostatographic powder image in the configuration of the copy being reproduced;

A transfer station, at which the electrostatographic powder image is electrostatically transferred from the drum surface to a transfer material or support surface; and

A drum cleaning and discharge station at which the drum surface is brushed to remove residual toner particles remaining thereon after image transfer and at which the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The charging station is preferably located as indicated by reference character A. As shown, the charging arrangement includes a corona charging device 21 which includes a corona discharge array of one or more corona discharge electrodes that extend transversely across the drum surface and are energized from a high potential source and are substantially enclosed within a shielding member.

Next subsequent thereto in the path of motion of the electrophotographic drum is an exposure station B. An optical scanning or projection system is provided to project a flowing image onto the surface of the electrophotographic drum from a stationary original.

The optical scanning or projection assembly comprises a stationary copyboard which consists of a transparent curved platen member 22 such as, for example, a glass plate or the like, positioned on the exterior of the cabinet, which is adapted to support a document to be reproduced, the document being uniformly illuminated and arranged in light projecting relation to the moving light receiving surface of the electrophotographic drum. Uniform lighting is provided by banks of lamps LMPS arranged on opposite sides of the copyboard. Scanning of the document on the stationary copyboard is accomplished by means of a mirror assembly which is oscillated relative to the copyboard in timed relation to the movement of the electrophotographic drum.

The mirror assembly, which includes an object mirror 23, is mounted below the copyholder to reflect an image of the document through a lens 24 onto an image mirror 25 which, in turn, reflects the image onto the electrophotographic drum through a slot in a fixed light shield 26 positioned adjacent to the drum surface.

Adjacent to the exposure station is a developing station C in which there is positioned a developer apparatus 30 including a casing or housing having a lower or sump portion for accumulating developer material. A bucket type conveyor is used to carry the developing material to the upper part of the developer housing where it is cascaded over a hopper chute onto the electrophotographic drum to effect development. A toner dispenser 35 is used to accurately meter toner to the developing material as toner particles are consumed during the developing operation.

Positioned next and adjacent to the developing station is the image transfer station D which includes a sheet feeding arrangement adapted to feed sheets of support material, such as paper or the like, successively to the electrophotographic drum in coordination with the presentation of the developed image on the drum surface at the transfer station.

The sheet feeding mechanism includes a sheet feed device 40 adapted by means of vacuum feeders to feed the top sheet of a stack of sheets on a tray 41, to rollers 42 cooperating with the belts of paper transport 44 for advancing the sheet sufficiently to be held by paper transport 44 which, in turn, conveys the sheet to a sheet registration device 45 positioned adjacent to the electrophotographic drum. The sheet registration device arrests and aligns each individual sheet of material and then in timed relation to the movement of the drum, advances the sheet material into contact with the drum in registration with a previously formed electrostatographic powder image on the drum.

The transfer of the electrostatographic powder image from the drum surface to the sheets of support material is effected

by means of a corona transfer device 51 that is located at or immediately after the line of contact between the support material and the rotating drum. In operation, the electrostatic field created by the corona transfer device is effective to tack the support material electrostatically to the drum surface, whereby the support material moves synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract the toner particles comprising the electrostatographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the support material.

Immediately subsequent to the image transfer station, there is positioned a paper pick-off mechanism 52 for removing the sheets of support material from the drum surface. This device, which is of the type disclosed in Rutkus et al., U.S. Pat. No. 3,062,536, includes a plurality of small diameter orifices supplied with pressurized aeriform fluid by a suitable pulsator or other device. The pulsator is adapted to force jets of pressurized aeriform fluid through the outlet orifice into contact with the surface of the drum slightly in advance of the sheet of support material to strip the leading edge of the sheet from the drum surface and to direct it onto an endless conveyor 55 whereby the sheet material is carried to a fixing device 60. At the fixing device, the transferred electrostatographic powder image on the sheet of support material is permanently fixed or fused thereto as by heat. After fusing, the reproduction is discharged from the apparatus at a suitable point for collection externally of the apparatus by means of the conveyor 65. In the embodiment shown, the reproductions are discharged from conveyor 65 into a receiving tray 61.

The next and final station in the device is a drum cleaning station E, having positioned therein a corona pre-clean device 66, a drum cleaning device 70 adapted to remove any powder remaining on the drum after transfer by means of a rotating brush 71, and a discharge lamp LMP-1 adapted to flood the electrophotographic drum with light to cause dissipation of any residual electrical charge remaining on the drum.

To remove residual powder from the drum, there is disposed a cylindrical brush 71 rotatably mounted on an axle and driven by a motor, not shown. For collecting powder particles removed from the drum by the brush, there is provided a dust hood 73 that is formed to encompass approximately two-thirds of the brush area. To ensure thorough cleaning of the brush, a flicking bar 74 is secured to the interior of the dust hood adjacent the edge of the outlet duct 75 of the dust hood and in interfering relation with the ends of the brush bristles whereby dust particles may be dislodged therefrom.

For removing dust particles from the brush and dust hood, an exhaust duct 76 is arranged to cover the outlet of the dust hood, the exhaust duct being connected at its other end to the wall of a filter box 77 attached to the dust hood. A filter bag 78 is secured within the filter box, with the mouth of the filter bag in communication with the exhaust duct. Motor fan unit MOT-6, connected to the filter box, produces a flow of air through the filter box drawing air through the area surrounding the drum and the dust hood, the air entraining powder particles removed from the drum by the brush as the air flows through the dust hood. Powder particles are separated from the air as it flows through the filter bag so that only clean air reaches the motor unit. x

Suitable drive means are provided to drive the drum rotating mirror and sheet feed mechanism at predetermined speeds relative to each other, and to effect operation of the bucket-type conveyor and toner dispenser mechanism and the other operating mechanisms.

In accordance with the present invention, grit which accumulates on the developer during the normal electrostatographic reproduction process can be removed by intermittently bypassing the reproduction cycle and interposing the cleaning cycle of the present invention. It has been found that the grit which is obtained primarily by abrasion within the developer system as it cascades over the electrostatographic imaging surface, includes fine chips, powder, filaments, and

dust derived primarily from the carrier which exhibit essentially the same charge as that of the carrier. Accordingly, by imposing an electrostatic charge on the electrostatographic imaging surface relatively opposite to that of the accumulated grit in the developer, a charge differential is created which enables the grit to be selectively removed from the developer system.

The grit removal cycle of the present invention can be employed with any electrostatographic imaging surface, including any suitable photoconductive surface. Well-known photoconductive materials include vitreous selenium, selenium alloys, organic or inorganic photoconductors imbedded in a nonphotoconductive matrix, organic or inorganic photoconductors imbedded in a photoconductive matrix, or the like. Representative patents in which photoconductive materials are disclosed include U.S. Pat. No. 2,803,542 to Ullrich, U.S. Pat. No. 2,970,906 to Bixby, U.S. Pat. No. 3,121,006 to Middleton, U.S. Pat. No. 3,121,007 to Middleton, and U.S. Pat. No. 3,151,982 to Corrsin. Reusable photoreceptor surfaces comprising vitreous selenium, selenium alloys or selenium mixtures are preferred because their faster photographic response allows higher machine speeds to be obtained.

The photoconductive insulating material may be employed alone or dispersed in a high electrical resistance binder. Typical photoconductive insulating materials which may be used without a binder include: vitreous selenium, sulfur, anthracene, and mixtures thereof. Typical photoconductive materials which may be employed in an insulating binder include: sulfur, vitreous selenium, amorphous alpha monoclinic selenium, zinc sulfide, zinc oxide, zinc cadmium sulfide, zinc magnesium oxide, cadmium selenide, zinc silicate, calcium-strontium sulfide, cadmium sulfide, mercuric iodide, mercuric oxide, mercuric sulfide, indium trisulfide, gallium triselenide, arsenic disulfide, arsenic trisulfide, arsenic triselenide, antimony trisulfide, cadmium sulfoselenide, doped calcogenides of zinc and cadmium (O, S, Se, Te aluminum oxide, bismuth oxide, molybdenum oxide, lead oxide, molybdenum iodide, molybdenum selenide, molybdenum sulfide, molybdenum telluride, aluminum iodide, aluminum selenide, aluminum sulfide, aluminum telluride, bismuth iodide, bismuth selenide, bismuth sulfide, bismuth telluride, cadmium telluride, mercuric selenide, mercuric telluride, lead iodide, lead selenide, lead sulfide, lead telluride, cadmium arsenide, lead chromate, gallium sulfide, gallium telluride, indium sulfide, indium selenide, indium telluride, red lead (Pb₃O₄), triphenyl amine, 2,4-bis(4,4'-diethylaminophenyl)-1,3,4-oxadiazole, N-isopropylcarbazole triphenylpyrrole, 4,5-diphenylimidazolidinone, 4,5-diphenylimidazolidinethione, 4,5-bis(4'-amino-phenyl)imidazolidinone, 1,5-cyanonaphthalene, 1,4-dicyanonaphthalene, aminophthalodinitrile, nitrophthalidinitrile, 1,2,5,6-tetraazacyclooctatetraene (2,4,6,8), 3,4-di(4'-methoxy-phenyl)-7,8-diphenyl-1,2,6,6-tetraazacyclooctatetraene (2,4,6,8), 3,4-di(4'-phenoxy-phenyl)-7,8-diphenyl-1,2,5,6-tetraazacyclooctatetraene (2,4,6,8), 3,4,7,8-tetramethoxy-tetramethoxy-1,2,5,6-tetraazacyclooctatetraene (2,4,6,8), 2-mercapto-benzthiazole, 2-phenyl-4-alpha-naphthylidene-oxazolone, 2-phenyl-4-diphenylidene-oxazolone, 2-phenyl-4-p-methoxybenzylidene oxazolone, 6-hydroxy-2-phenyl-3-(p-dimethylaminophenyl)-benzofurane, 6-hydroxy-2,3-di(p-methoxyphenyl)-benzofurane, 2, 3,5,6-tetra-(p-methoxyphenyl)-furo-(3,2')-benzofurane, 4-dimethylaminobenzylidene-benzhydrazide, 4-dimethylaminobenzylideneisonicotinic acid hydrazide, furfurylidene-(2)-4'-dimethylamino-benzhydrazide, 5-benzilidene-amino-acenaphthene, 3-benzylidene-amino-carbazole, (4-N,N-dimethyl amino-benzylidene)-p-N,N-dimethylaminoaniline, (2-nitro-benzylidene)-p-bromoaniline, N,N-dimethyl-N'-(2-nitro-4-cyano-benzylidene)-p-phenylenediamine, 2,4-diphenyl-quinazoline, 2-(4'-amino-phenyl)-4-phenyl-quinazoline, 2-phenyl-4-(4'-dimethylaminophenyl)-7-methoxyquinazoline, 1,3-diphenyl-tetrahydroimidazole, 1,3-di(4'-chlorophenyl)-tetrahydroimidazole, 1,3-diphenyl-2-(4'-dimethyl amino

phenyl-tetrahydroimidazole, 1,3-di(p-tolyl)-2-(quinol-2-yl)-tetrahydroimidazole, 3-(4'-dimethylamino phenyl)-5-(4'-methoxyphenyl)-6-phenyl-1,2,4-triazine, 3-pyridyl-(4'-dimethylaminophenyl)-6-phenyl-1,2,4-triazine, 3-(4'-aminophenyl)-5,6-diphenyl-1,2,4-triazine, 2,5-bis[4-aminophenyl-(1')]-3,4-triazole, 2,5-bis[4'-N-ethyl-N-acetylamino-phenyl-(1')]-1,3,4-triazole, 1,5-diphenyl-3-methylpyrazoline, 1,3,4,5-tetraphenylpyrazoline, 1-phenyl-3-(p-methoxystyryl)-5-(p-methoxyphenyl)-pyrazoline, 2-(4'-dimethylamino phenyl)-benzoxazole, 2-(4'-methoxyphenyl)-benzthiazole, 2,5-bis-[p-aminophenyl-(1)]-1,3,4-oxadiazole, 4,5-diphenyl-imidazolone, 3-aminocarbazole, and mixtures thereof.

Any suitable high resistance binder may be employed to suspend the photoconductive material. A film-forming binder material having a relatively high dielectric constant and high dielectric strength is preferred. Typical film-forming materials include: polyolefins such as polyethylene, polypropylene and chlorinated polyethylene; vinyl and vinylidene resins such as polystyrene, polyvinyl pyrrolidone, acrylic polymers, polyvinyl acetate, polyvinyl butyral, and polyvinyl chloride; fluorocarbons such as polytetrafluoroethylene and polychlorotrifluoroethylene; styrene-butadiene, heterochain thermoplastics such as polyamides, polyesters, and polycarbonates; phenolic resins such as phenol-formaldehyde and resorcinol-formaldehyde; melamineformaldehyde resins such as methylol melamine resins, dimethyl trimethylol melamine resins, and trimethylol melamine resins; silicone resins; epoxy resins; and mixtures thereof. Any suitable additives such as emulsifiers, wetting agents, pH regulators, brightening agents and stabilizers may be admixed with the film-forming binder.

In accordance with the present invention the electrostatographic imaging surface is electrostatically charged during the grit removal cycle with a charge relatively opposite to that of the accumulated grit in the developer. For example, in a typical electrostatographic copying operation, toner is generally charged negatively in relation to its positive carrier so that it will be attracted to the positively charged areas of the electrostatographic imaging surface. For example, a selenium plate. If fragments of the carrier as minute chips coated and uncoated with toner come in contact with the photoconductive surface, they will deposit mainly in the background areas (near zero charge). During the cleaning cycle, however, the electrostatographic surface is charged negatively and would therefore have a greater affinity for the positive or mixed polarity agglomerates forming the grit. If, however, a reversal system is employed where the toner is relatively positive in relation to the carrier, a positive charge on the electrostatographic surface would be required in removing the more negatively charged grit.

The grit cleaning cycle of the present invention can be conveniently incorporated in conventional electrostatographic reproduction apparatus. For purposes of illustration only, the grit removal cycle will be described with respect to the type of reproducing apparatus shown in the FIGURE. It should be apparent, however, that such cycle is amenable to any reproduction system involving a cascade type developer.

In one embodiment, the normal reproduction cycle is bypassed and a grit removal cycle is interposed by charging the drum at drum cleaning station E employing the corona preclean device 66, the charge so imposed is allowed to remain on the drum by bypassing the rotating brush 71 and the charging station A and exposure station B. The developer containing the accumulated grit is cascaded across the drum at station C whereby the drum having a charge thereon relatively opposite to the charge of the grit, selectively attracts the grit from the developer. The cleaned developer falls into the developer reservoir and is recycled by way of the bucket type conveyor. The grit, now clinging to the rotating drum, passes disengaged image transfer station D, precleaning station E and is finally brushed off by rotating brush 71 and discarded. If desired, the corona precleaning device 66 can be employed to charge the drum with a charge opposite to that initially im-

posed by the preclean device 66 upon the drum to loosen the grit from the drum thereby allowing the rotating brush 71 to more easily remove the grit. Discharge LMP-1 can also be employed, if desired, to flood the drum with light causing dissipation of any residual electrical charge remaining on the drum after completion of the grit removal cycle. If desired, the grit removal cycle can be continued a plurality of times, i.e., about two to 10, before the reproduction cycle is resumed.

In an alternative and preferred embodiment, the drum is charged at station A with a charge relatively opposite to that of the accumulated grit in the developer. Exposure station B is bypassed. The developer is cascaded over the drum whereby the grit is selectively attracted to the drum. Transfer station D is bypassed. Discharge lamp 67 imposes a charge opposite to the charge initially imposed on the drum thereby facilitating removal of the grit. The grit is then brushed off by the rotating brush 71 and then discarded. LMP-1 then floods the drum with light to cause dissipation of any residual electrical charge remaining on the drum. If desired, the grit removal cycle can be continued a plurality of times, i.e., about two to 10, before the reproduction cycle is resumed.

The above-described cleaning cycle can similarly be employed in processes which do not involve a reusable electrostatographic imaging surface but instead rely upon the use of non-reusable electrostatographic imaging surfaces; such as, for example, zinc oxide or phthalocyanine binder paper. By employing the above cleaning cycle, the grit would be attracted to the paper during the cleaning cycle and the paper together with the attracted grit could be discarded and the normal reproduction cycle resumed. The electrostatographic paper containing a relatively opposite charge to that of the grit can be recycled a plurality of times, i.e., about two to 10 times, during the cleaning cycle prior to being discharged from the copying machine and discarded. In this manner, the paper employed in the cleaning cycle can be most efficiently employed.

The following examples further specifically define, describe and compare the grit removal techniques of the present invention. All parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various embodiments of the intermittent cleaning cycles of the present invention and are not intended to limit the scope or spirit of the invention.

In the following examples, the grit level generated through use of the developer system was determined as follows:

A sample of the developer system being evaluated is removed from the development station of an automatic recyclable electrostatographic copying machine and is charged to a Faraday Cage which has been previously weighed. The loaded Faraday Cage is re-weighed to determine the sample weight. The Cage terminates at opposite ends thereof in 250 micron screens, each about 1 inch in diameter. At one end of the cage, a glass tube about 1 foot in length and about 3 inches in diameter connects one of the 250-micron screens with a 30-micron screen.

A blast of air is sent through the cage causing toner and grit to be separated from the carrier and to pass through the glass tube. The carrier particles are retained in the cage by the 250-micron screen. Suction is applied to the 30-micron screen causing all particles less than 30 microns to pass through. Particles greater than 30 microns in size are considered as grit. The grit particles are retained on the 30-micron screen. The cage is weighed after the air blast to determine the total amount of toner and grit blown off. The 30-micron screen is weighed to determine the amount of grit. The ratio of the grit on the 30-micron screen to the total weight of toner and grit blown off is considered the amount of grit in the sample. The grit level can then be determined by the following relationship:

$$\text{Grit level} = \frac{\text{grit weight}}{\text{total blow-off weight of toner and grit}} \times 100$$

EXAMPLE 1

Control: A developer system comprising 600-micron flint-shot having a 10 percent coating thereon of ethyl cellulose toned to 1 percent with a toner comprising a styrene-n-butyl methacrylate copolymer, polyvinyl butyral and carbon black prepared by the method disclosed in Example I of U.S. Pat. No. 3,079,342 was charged to the development section of a 2400 Xerox copier. The copier was operated in conventional manner for 60,000 copies. The grit level was 1.26 percent after 20,000 copies and increased to 2.8 percent after 60,000 copies.

For purposes of comparison, the copier was modified so that every tenth cycle, the reproduction cycle was bypassed and a grit removal cycle interposed. During the grit removal cycle, the photoconductive selenium drum was charged negatively employing an appropriate corona charging device. The exposure station was bypassed. Developer was allowed to cascade over the drum which selectively attracted the grit thereto. The transfer station was bypassed. A corona charging device then charged the grit-containing drum positively to loosen the attracted grit. The grit was then brushed off and any residual charge on the drum was dissipated. Operating in this manner, a grit level of 1.37 percent was observed after 60,000 copies.

EXAMPLE 2

This example illustrates the applicability of the present invention to electrostatographic processes employing a non-reusable photoreceptor.

A Bruning magnetic brush copier was modified to employ a developer composition comprising toner particles described in Example I and 450-micron steel shot coated with a vinyl chloride copolymer dyed with Luxol Fast Blue dye. A negative charge is imposed on Bruning zinc oxide paper during the reproduction cycle. Operating in this manner, the copier was print tested to 70,000 copies. The grit level at 70,000 copies was double that at 10,000 copies.

For purposes of comparison, the copier was further modified so that every 50th cycle, the reproduction cycle was bypassed and a grit removal cycle interposed. During the grit removal cycle, the zinc oxide paper was charged positively and fed directly to the development section without exposure or imaging. In the development section, the developer composition is contacted with the charged paper to selectively cause deposition of the grit. The paper containing the grit was recycled in this manner a total of five times and was then discharged from the copier and discarded. The copier then resumed the normal reproduction cycle. Operating in this manner, the grit level remained below the 10,000 cycle level up to 70,000 copies.

Although specific materials and conditions were set forth in the above exemplary processes of this invention, these are merely intended as illustrations of the present invention. Various other toners, carrier cores, substituents and processes such as those listed above may be substituted in the examples with similar results.

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. In a process for electrostatographic reproduction comprising the following reproduction cycle:

a. forming an electrostatic latent image on an imaging surface; and

b. developing said latent image by cascading developer comprising toner electrostatically clinging to carrier particles across said image surface;

the improvement which comprises separating the accumulated grit derived primarily from the carrier and which exhibits essentially the same charge as that of the carrier, from the developer by intermittently bypassing said reproduction cycle and interposing a grit removal cycle comprising:

- i. electrostatically charging the electrostatographic surface with a charge relatively opposite to that of the accumulated grit in the developer;
 - ii. cascading developer across said charged surface whereby grit is preferentially attracted to said surface and separated from the developer, said developer being recycled for further use in the process; and
 - iii. discarding the collected grit.
2. In a process for electrostatographic reproduction comprising the following reproduction cycle:
- a. depositing an electrostatic charge on the photoconductive layer of an electrostatographic imaging surface;
 - b. forming a latent electrostatic image of the copy to be produced;
 - c. cascading developer having an electrostatic charge opposite to that of the electrostatic latent image over said surface whereby a developed image is formed in the configuration of the copy being reproduced;
 - d. electrostatically transferring said image from said imaging surface to a transfer material or support surface;
 - e. cleaning said imaging surface to remove residual developer particles remaining thereon; and
 - f. discharging any residual electrostatic charge remaining thereon;
- the improvement which comprises separating accumulated grit derived primarily from the carrier and which exhibits essentially the same charge as that of the carrier, from the developer by intermittently bypassing said reproduction cycle and interposing a grit removal cycle comprising:
- i. charging said imaging surface with a charge relatively opposite to that of the accumulated grit;
 - ii. cascading developer across said surface whereby grit is selectively attracted to said surface;
 - iii. charging said surface with a charge opposite to that initially imposed upon said surface to loosen attracted grit thereon;
 - iv. removing the grit from said surface; and
 - v. discharging any residual electrical charge remaining on said surface.
3. Process as defined in claim 2 wherein the grit removal cycle is repeated a plurality of times before the reproduction cycle is resumed.
4. In a process for electrostatographic reproduction comprising the following reproduction cycle:
- a. forming an electrostatic latent image on an electrostatographic imaging surface;

- b. cascading developer across said imaging surface to develop said latent image;
 - c. transferring said developer in image configuration to a support surface; and
 - d. cleaning said imaging surface;
- the improvement is provided comprising separating accumulated grit derived primarily from the carrier and which exhibits essentially the same charge as that of the carrier, from the developer by intermittently interposing a grit removal cycle comprising:
- i. electrostatically charging the electrostatographic surface with a charge relatively opposite to that of the accumulated grit in the developer;
 - ii. bypassing cleaning the electrostatographic surface and forming an image thereon;
 - iii. cascading developer across said charged surface to selectively attract grit thereto from said developer;
 - iv. recycling said developer for reuse in subsequent reproduction cycles; and
 - v. discarding the collected grit.
5. In a process for electrostatographic reproduction comprising the following reproduction cycle:
- a. electrostatically charging a web containing a photoconductive material dispersed in a high electrical resistance binder;
 - b. imaging said web to impart a latent electrostatic image thereto;
 - c. developing said web by cascading developer across said web; and thereafter,
 - d. removing said developed web;
- the improvement is provided which comprises separating accumulated grit derived primarily from the carrier and which exhibits essentially the same charge as that of the carrier, from the developer by intermittently bypassing said reproduction cycle and interposing a grit removal cycle comprising:
- i. electrostatically charging said web with a charge relatively opposite to that of the accumulated grit in the developer;
 - ii. cascading developer across said charged surface whereby grit is preferentially attracted to said surface and separated from the developer, said developer being recycled for further use in the process; and
 - iii. discarding the web containing the attracted grit.
6. Process as defined in claim 5 wherein the grit removal cycle is repeated a plurality of times before the web containing the grit is discarded and the reproduction cycle is resumed.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,655,375 Dated April 11, 1972

Inventor(s) Robert William Madrid

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 62, "x" should be deleted.
Column 5, line 53, "1,2,6,6" should read -- 1,2,5,6 --;
line 56, "tetramethoxy" (in bold print) should be deleted.
Column 6, line 6, "4triazole" should read -- 4-triazole --;
line 26, "formalde-hyde" should read -- formaldehyde --.
Column 8, line 1, "600-micron" should read -- 600 micron --.

Signed and sealed this 8th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patent

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