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XEROGRAPHIC DEVELOPER SEAL AND PROCESS

Filed March 1, 1965

3 Sheets-Sheet 2

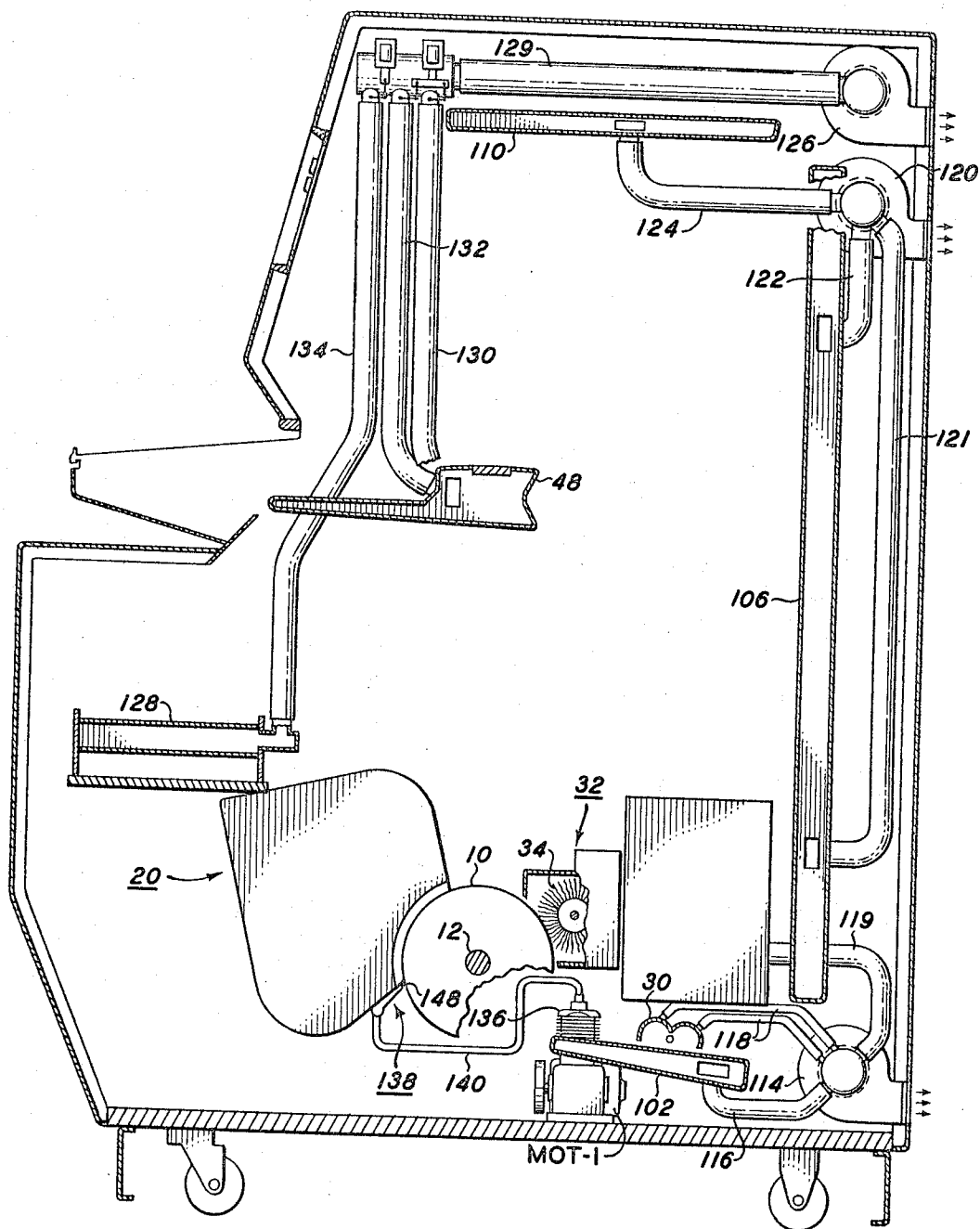


FIG. 2

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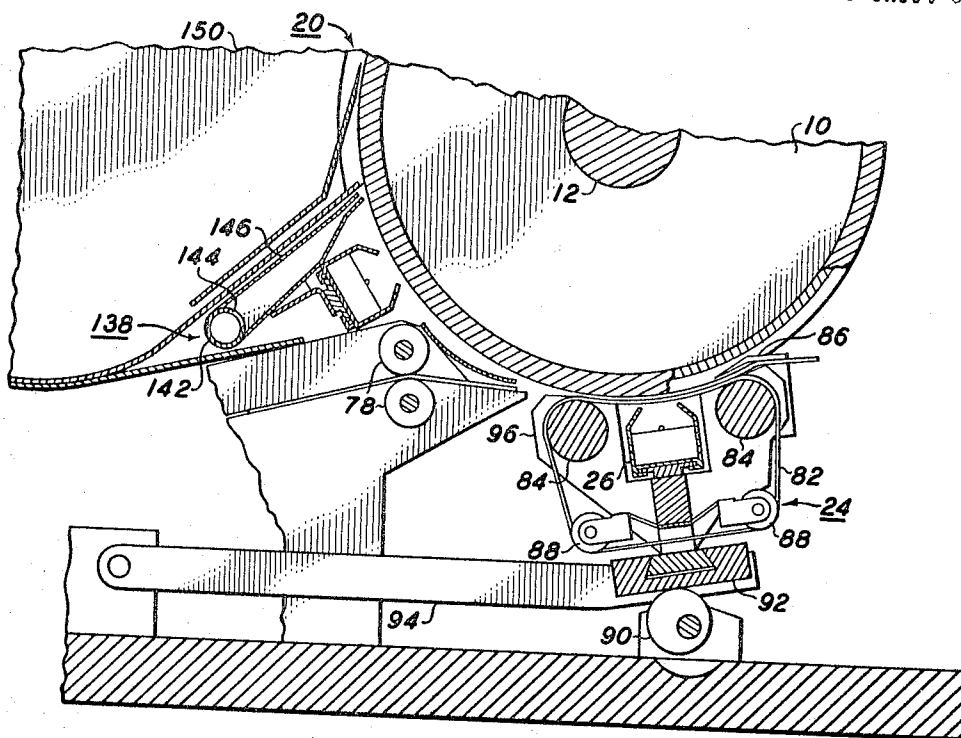


FIG. 3

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XEROGRAPHIC DEVELOPER SEAL AND PROCESS
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4 Claims. (Cl. 95—1.7)

This invention relates to an improved xerographic developing apparatus and process and, in particular, to improvements in cascade development of xerographic images.

In the process of xerography, an electrostatic charge in image configuration of original copy is produced on the surface of a photoconductive drum. This latent electrostatic image on the photoconductive surface is developed with a powder material referred to herein as toner. Toner normally consists of a finely divided pigmented resin attractable by the electrostatic forces to the photoconductive surface. The electrostatic charge on the photoconductive surface holds the toner on the photoconductive surface in image areas, thus, producing a developed powder image of the copy being reproduced.

One form of development system for developing the latent electrostatic image with toner or powder is commonly referred to as cascade developing. Cascade development is a two component system wherein small glass beads are mixed with the toner to act as a carrier for the toner material. The glass beads provide mechanical control of the toner and; when agitated with the toner, it provides a triboelectric charge which holds the toner on the surface of the glass bead. The combination of glass beads or carrier and toner is referred to as developer or developer material. When the developer material is cascaded over the surface of a xerographic plate containing an electrostatic latent image thereon, the toner, which is adhering to the carrier by triboelectric forces, is attracted away from the carrier by the stronger electrostatic charges and is held on the surface of the xerographic plate. In conventional cascade development systems, the carrier continues to cascade across the surface of the xerographic plate back into a hopper or supply bin wherein it is again agitated with toner material and recascaded over the surface of the xerographic plate.

In the reproduction of semi-micro images, such as, for example, images which are reduced in size from 2½ to 3 times their original size prior to reproduction, it is necessary to use a carrier bead which is considerably smaller than the carrier bead normally used in cascade developing. The carrier beads used in semi-micro reproduction work are so small that the force of gravity which carries the bead across the surface of the xerographic plate and back into the developer bin, is in some instances less than the attractive forces from the electrostatic charge on the plate surface. Thus, some of the glass beads tend to adhere to the surface of the plate interfering with the development process and the transfer of the powder image to support material surfaces. In automatic xerographic machines wherein the xerographic plate is in the form of a rotating drum, the carrier beads which adhere to the surface of the xerographic plate are carried out of the development system and into the mechanical apparatus of the machine. These carrier beads cannot be scraped from the surface of the xerographic drum without either upsetting the powder image loosely held thereon or damaging the photoconductive surface of the drum.

It is therefore the primary object of this invention to improve xerographic developing apparatus by sweeping the xerographic surface without disrupting the powder image thereon.

It is also an object of this invention to improve cascade

development systems to permit the use of carrier particles so small that the force of gravity is insufficient to separate the carrier particle from the xerographic surface.

It is also an object of this invention to improve xerographic cascade development systems by sweeping a current of air over the xerographic surface with an intensity sufficient to separate carrier beads from the xerographic surface without disrupting the powder image thereon.

These and other objects of this invention are attained by means of an air knife positioned adjacent to the xerographic drum at the point where the xerographic drum emerges from the development system and a source of air which is directed by the air knife against the surface of the xerographic drum at the outlet of the development system to thereby deflect carrier beads off the surface of the drum back into the development system.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic side view of a xerographic apparatus utilizing the present invention;

FIG. 2 is a pneumatic system of the xerographic machine shown in FIG. 1;

FIG. 3 is an enlarged detailed view of the xerographic drum development system and air knife shown in FIG. 1.

The present invention is suitable for use in automatic xerographic machines of the type disclosed in copending application Ser. No. 436,168, filed Mar. 1, 1965, in the name of Thomas H. Galster, Allen M. Hitchcock and Gordon P. Taillie. A schematic representation of the functions of that machine are shown here in FIG. 1.

As seen in FIG. 1, a rotatable xerographic drum 10 is mounted for rotation on a shaft 12. The drum rotates about the shaft 12 in the direction indicated by the arrow and passes a charging station generally indicated as 14 wherein a corotron 16, connected to a suitable power source not shown, places a uniform electrostatic charge on the surface of the xerographic drum. The drum rotates past an exposure station 18 wherein light images of copy to be reproduced discharge the electrostatic charge on the drum surface and produces a latent electrostatic image of the copy being reproduced on the drum surface. The drum then rotates past a developer station, generally indicated as 20, wherein a developer mechanism, described in detail below, develops the latent electrostatic image into a powder image. After the electrostatic image is developed, a pretransfer corotron 22 places an electrostatic charge on the surface of the drum to loosen the powder image for transfer purposes. The drum then rotates past a transfer station 24 wherein the powder image is transferred to a suitable support material surface by means of a transfer corotron 26 which places a suitable electrostatic charge on the back surface of the support material to attract the powder from the xerographic drum to the support material. The support material is then transported past a fusing station 28 wherein the support material and the powder image thereon are exposed to rays from a flash fuser 30 which heats the powder causing it to coalesce and bond to the surface of the support material. The xerographic drum rotates past a cleaning station 32 wherein residual toner material remaining on the surface of the drum is cleaned therefrom by means of a rotating brush 34.

In the apparatus shown either images of original copy reduced to 2½ to 3 times its size may be reproduced on data processing cards or previously reduced images on data processing cards may be reproduced onto other data processing cards. Documents which are to be reduced and copied on data processing cards are placed on a document

tray 36. The tray 36 is mounted on a pair of rollers 38 on a track 40. With the document to be reproduced on the tray 36, the tray is moved forward towards a scanning station 42. With the tray 36 in the forward position, the document is picked up by a belt conveyor 44 and a feed roller 46 in a manner described in detail in the above-cited compending application Ser. No. 436,168. The document is held on conveyor 44 by means of a vacuum produced in a manifold 48 which produces a suction through a series of openings in the manifold and corresponding perforations in the surface of the belts in the conveyor 44. The conveyor 44 carries the documents past the scanning station 42 wherein a pair of lamps LMP-1 illuminate incremental areas of the surface of the document. The illuminated areas of the document are reflected by a mirror 50 through a reducing lens 52 to the surface of the xerographic drum at exposure station 18. The movement of the conveyor 44 is synchronized with the movement of the drum 12 so that the image is placed on the drum surface with the proper size reduction. The conveyor 44 then carries the document around a main drive roller 54 by means of a series of resilient rollers 56 rotatably mounted and in surface contact with the belts of the conveyor 44 as they extend around the roller 54. When the document emerges from the bands 56, it is again held on the belts of the conveyor 44 by means of a vacuum produced in manifold 48. The document is carried forward beyond the end of the manifold 48 where, with the suction released, it tends to drop away from the conveyor 44 and is deflected downward by a plate 60 into a receiving tray 62.

When it is desirable to reproduce images from data processing cards, a series of cards 64 containing xerographic images thereon are stacked in a conventional card feeding hopper 67 and fed onto a card conveyor system which is similar to the conveyor system 44. The card conveyor is not shown, but is a vacuum conveyor which carries the cards past a scanning station similar to the scanning station 42 and deposits the cards into a card receiving hopper. Illuminated portions of the card are deflected upwards into a mirror 66 which directs the images through a lens 68 to a mirror 70 which directs the image onto the surface of the xerographic drum at the exposure station 18.

Images reproduced on the surface of the xerographic drum are transferred to blank data processing cards 72 which are fed from a conventional card feeding hopper 74 to a roller type conveyor system 76. The conveyor 76 consists of a series of rollers 78 which feeds the cards past a rotary card timing device into surface contact with the xerographic drum 10.

The cards 72 are forced into surface contact with the drum 10 by means of a series of bands 82 which are held in surface contact with the drum 10 by means of a pair of rollers 84 and are moved at the same speed as the periphery of the xerographic drum 10. The bands 82 force the card 72 into surface contact with the xerographic drum at the point at which the corotron 26 places an electrostatic charge on the back of the card to transfer the powder image from the drum surface to the card surface. As the card emerges from the bands 82, it is peeled off the surface of the drum by means of a blade 86 which extends into an undercut portion of the xerographic drum, as shown in FIG. 3. The bands 82 are held in tension by a pair of spring loaded rollers 88 and the entire transfer assembly 24 is movable into and out of contact with the drum by means of a cam 90 which may be rotated against a cam follower 92 mounted on a pivot arm 94 and supporting the corotron 26 and frame plates 96 on which the rollers 84 are mounted.

When the card 72 containing a transferred powder image is deflected from the xerographic drum 10 by the blade 86, it is held on a conveyor 98 by the suction produced in a vacuum manifold 102. The conveyor 98 carries the card past the fuser station 28 wherein the powder

image is heated to a point where it coalesces and bonds to the card surface. The card containing the fused image is then transferred to a second conveyor 104 which is also a vacuum conveyor having a vacuum manifold 106. A third vacuum conveyor 108, having a vacuum manifold 110, receives the card from the conveyor 104 and transports it to a card receiving hopper 112 where it is deposited until such time as the machine operator removes it.

FIG. 2 shows the pneumatic system for the entire machine shown in FIG. 1. A first exhaust fan 114 exhausts air from the vacuum manifold 102 through line 116, the fuser 30 through a pair of lines 118 and from the housing of the brush cleaner 34 at the drum cleaning station 32 through line 119. A second fan 120 exhausts air from the manifolds 106 and 110 through hoses 121, 122 and 124. A third fan 126 exhausts air from the manifold 48 in the document conveyor 44 and the manifold 128 located in the card conveyor associated with the card feed hopper 66 through hoses 129, 130, 132 and 134.

A motor MOT-1 drives an air compressor 136 which supplies air under pressure to the air knife, generally indicated as 138, through air line 140. The air knife 138 is seen in section in FIG. 3 and consists of a tubular inlet section 142 which is connected to the air line 140 and has an opening 144 permitting passage of the air to an elongated tapered nozzle 146. The nozzle 146 is tapered from the tubular inlet section 142 down towards the xerographic drum with the smaller end being opened across the width of the drum surface. The small open end 148 is positioned adjacent the surface of the xerographic drum 10 at the point where the surface of the drum emerges from the developer housing 150.

As seen in FIG. 1, the developer housing 150 contains a supply of developer material 152 consisting of toner material and small carrier beads. The developer material 152 is located in the bottom of the housing 150 providing a supply of fresh developer material for continuous bucket conveyor 154. As the xerographic drum 10 rotates, the conveyor 154 rotates its buckets through the developer material 152 in the bottom of the housing and conveys the material to the top of the housing 150 wherein it discharges the developer material down onto a baffle 156. The baffle 156 directs the developer material onto the surface of the xerographic drum where it is cascaded over the drum surface and directed back towards the bottom of the housing 150 by a second baffle 158. During passage over the surface of the xerographic drum, the developer material leaves toner material in the electrostatic image areas, and the carrier material is theoretically directed back towards the sump portion of the housing 150 where it is mixed with additional toner material by the agitation of the conveyor 154. However, because of the size of the carrier particles, the electrostatic charge on the drum surface is sufficient to hold some of the carrier material on the drum, that is, the forces produced by the electrostatic charge on the carrier are greater than the force of gravity on the individual carrier particles, thus, the particles adhere to the drum surface. The baffle 158 and the edge of the developer housing 150 cannot be in contact with the surface of the xerographic drum or else the carrier particles which adhere to the drum surface will lodge between the baffle of the developer housing and scratch the surface of the xerographic drum. Further, the baffle 158 and the developer housing 150 should not in any case touch or disrupt the powder image on the surface of the xerographic drum. Therefore, any of the carrier particles which do adhere to the electrostatic charge on the drum surface tend to rotate out of the developer housing along with the rotation of the drum 10. Particles adhering to the drum outside the development area interfere with effective transfer of the powder image to the support material surface and also tend to become lodged in the moving parts of the overall machine.

The air knife 138 is directed at an angle against the drum surface at the point where the surface of the drum

emerges from the developer housing 150. Air under pressure entering the inlet 42 of the air knife 138 is directed by the nozzle 146 towards the open end of the nozzle 148 and against the drum surface at the point where the carrier beads tend to leave the development area. The force of the air from the nozzle 146 is sufficient to separate the carrier particles from the surface of the drum and deflect them back into the developer housing 150. The force of the air does not upset the powder image on the drum or in any way interfere with the effective development and transfer of images.

The carrier beads used in the developer are in the 250-450 micron size range. This size bead will be effectively deflected back into the developer housing by an air stream from the air knife 138 which is traveling at approximately 550 inches per second. With an air knife having an opening $\frac{1}{32}$ inch wide and 5 inches long, the air pressure at the opening is one-half p.s.i. having an air velocity of 550 inches per second, and 3 cubic feet air per minute are passed through the opening into the developer housing. The air enters the developer housing and emerges therefrom through the normal openings in the housing. The developer beads are deposited in the bottom of the housing for reuse in the development process.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth, and this application is intended to cover such modifications or changes as may come within the purpose of the improvements or the scope of the following claims.

What is claimed is:

1. In a xerographic machine of the type utilizing a development system wherein a powder image is developed on a xerographic plate by cascading carrier particles and toner material over the surface of the xerographic plate, apparatus for removing those carrier particles adhering to the surface of the xerographic plate and depositing them into a developer sump comprising in combination
a housing enclosing at least a portion of the xerographic plate,
conveyor means disposed within said housing for cascading carrier particles and toner material across the plate surface,
nozzle means extending across the plate surface and positioned to direct a stream at an angle against the plate surface, toward a narrow opening defined by the lower boundary of said housing and said plate surface,
and means to supply air to the nozzle means under a pressure sufficient to produce a velocity of air which, when directed against the plate and into said narrow opening, will separate those carrier particles held on the plate by electrostatic charge from the plate surface and deposit them into a developer sump formed at the bottom of said housing without disrupting the powder image on the plate surface.

2. In a xerographic machine wherein an electrostatic image is developed on the surface of a rotating drum by cascading carrier particles and toner material located in a developer housing over the surface of the xerographic drum, apparatus for removing those carrier particles adhering to the surface of the xerographic drum and depositing them into a developer sump formed in the bottom of the housing comprising in combination

a xerographic drum journaled for rotational movement, a housing enclosing at least a portion of the xerographic drum,
drive means for rotating said drum,
conveyor means disposed within said housing for cascading carrier particles and toner material across the surface of said xerographic drum,
nozzle means positioned adjacent to the xerographic drum and extending across the drum surface,
the nozzle means having an opening directed at the junction of the drum surface with the lower boundary of the developer housing,
and means to supply air to the nozzle means under pressure so that air passing through the nozzle opening will deflect those carrier particles held on the drum surface by electrostatic charge back into a sump formed in the bottom of the developer housing,
the air supply being sufficient to produce air velocity at the opening that will deflect carrier size particles but will not disrupt toner material being held on the drum by electrostatic charges.

3. The process of reproducing minified images xerographically comprising
exposing a charged photoconductive insulating member to a minified pattern of light and shadow in accordance with the image to be reproduced,
cascading a two-component developer mixture made up of tiny carrier beads and electroscopic toner material across the exposed surface to develop a high quality powder image,
selectively removing carrier beads accidentally sticking to the exposed surface by positioning an air stream on them directed toward a narrow opening defined by the developer supply and the insulating member to deposit them into a developer sump, and transferring the powder image to a support material.
4. The process according to claim 3 wherein the size of the carrier beads ranges from about 250 to about 450 microns.

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