

# PATENT SPECIFICATION

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## (54) EXCESS DEVELOPER REMOVAL APPARATUS

(71) We, SAVIN CORPORATION, a Delaware corporation, of Columbus and Stevens Avenues, Valhalla, New York 10595, United States of America, 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 The present invention relates to apparatus for removing excess developer liquid from a moving image bearing surface carrying a layer of liquid developer.

15 It is necessary in plain paper electro-photographic copiers to remove most of the layer of liquid developer formed on the photoconductive surface during development, if damp or stained plain paper copies are to be avoided. The removal must be performed without disturbing the delicate developed toner image on the photoconductive surface.

20 The present invention, the scope of which is defined in the appended claims, includes apparatus for removing excess developer liquid from a movable image-bearing surface carrying a layer of liquid developer comprising an elongate barrier member, the barrier means being provided with means 30 which when the barrier member is mounted with the length thereof extending across a portion of said surface provides a substantially unpressurized region adjacent the surface immediately in advance of a portion 35 of said barrier member which is leading with respect to the relative movement of said barrier member and said surface in use; means for so mounting the barrier member with a spacing between the leading portion 40 of said barrier member and said surface which is less than the thickness of said developer layer to intercept said layer; and means for forming an air curtain behind the leading portion of said barrier member 45 in a region adjacent said surface.

In order that the invention may be well understood an embodiment thereof will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a side elevation of an electro-photographic copier, incorporating one embodiment of the apparatus.

FIGURE 2 is a fragmentary view of the apparatus taken along line 2-2 of FIGURE 1, with parts removed;

FIGURE 3 is an enlarged section of the apparatus, taken along line 3-3 of FIGURE 2; and

FIGURE 4 is an enlarged section of the apparatus shown in FIGURE 1 in its inoperative position.

Referring to the drawings, an electro-photographic copier 10 incorporating excess developer liquid removal apparatus includes a drum 12 having a photoconductive surface 14 which is rotated in the direction shown past a plurality of processing stations. More particularly, the drum 12 rotates past a charging station 16 at which a corona charger 18 provides the drum surface 14 with a uniform electrostatic charge, an exposure station 20 at which the surface 14 is exposed to a light image of an original selectively to discharge the surface and form an electrostatic image, a developing station 22 at which a liquid developer is applied to the surface from a developing tank 24 to form a visible toner particle image on the surface 14, and a transfer station 26 at which the developed image is transferred to a sheet 28 of plain paper. Preferably, the copier 10 also includes a cleaning station (not shown) between the transfer station and the charging station 16, at which accumulated toner deposits are removed from the drum surface 14.

The excess developer liquid removal apparatus, indicated generally by the reference numeral 30, is located on the drum 90

periphery immediately following the developing tank 24 in the direction of movement of the drum 12. The apparatus 30 comprises a hollow, elongate generally cylindrical barrier member 32, the ends of which receive stub shafts 34 and 36. Shafts 34 and 36 rotatably support rollers 38 and 40 which are biased against the image bearing drum surface 14 near its lateral edges. Rollers 38 and 40 are formed with a slightly greater diameter than that of the member 32 to provide a spacing between the member 32 and the drum surface 14 which is preferably between 0.001 and 0.002 inch. After passing through the developing station 22, the surface 14 typically carries a film of developer which is about 0.012 inch thick. Thus member 32 acts as a mechanical barrier to the passage of a film of this thickness. While member 32 provides a mechanical barrier to the passage of the relatively thick layer of developer liquid, it is necessary to provide some means for preventing wetting of the trailing portion with respect to the relative movement of the barrier member and the image bearing surface 14, of the member 32 following the point of closest proximity to the surface 14 or edge of the member 32. If this is not done and the trailing portion is wet with developer liquid, large drops of liquid are left on the photoconductive surface 14 as the surface tension film of liquid developer along the trailing portion of the barrier member 32 and the surface 14 is broken loose.

The member 32 is formed with an axially extending exit slit 42 communicating with the hollow interior of member 32. Preferably, the width of the exit slit 42 is five to ten times the gap between the member 32 and the drum surface 14, or about 0.02 inch. Tubing 46 feeds compressed air from a supply 48 to a bore 44 formed in the shaft 36 and leading into the interior of member 32. Preferably, the air supply 48 provides air at a pressure between 5 and 10 inches of water. The member 32 is preferably formed with axially extending grooves 60 and 62 on the outer surface adjacent to the edges of the slit 42 to provide a well-defined region adjacent the surface and to reduce turbulence.

The narrow spacing between the slit 42 and the surface 14 and the slight positive pressure in the region adjacent the surface and behind the leading portion or edge cooperates to form an effective air curtain which breaks the surface tension of the liquid between drum 12 and member 32 to prevent wetting of the trailing portion of member 32. This is accomplished without disturbing the developed image. This arrangement requires only a low volume of air of from about 2 to about 4 cubic feet

per minute. The region of the barrier member 32 adjacent to the surface 4 and immediately in advance of the leading portion remains substantially unpressurized.

A pair of pivot members 50 and 52, arms of which rotatably receive the stub shafts 34 and 36, support barrier member 32 in its operating position. Each of the pivot members 50 and 52 pivots upon a pivot shaft 54 and is suitably biased by means of a spring 56 attached between an arm of the pivot member and a fixed point 58. Springs 56 bias the rollers 38 and 40 against the drum 12 so that the barrier member 32 remains a fixed distance from the drum 12 despite any eccentricity or surface irregularity of the drum 12.

It will be appreciated that, in the course of an operating cycle, some wetting of portions of member 32 in and adjacent to the area of the slit 42 occurs. To remove such developer and to prevent buildup of toner deposits in these areas, after each machine use period, the slit area of member 32 is wiped with an elongate spongy pad 64 carried by a supporting member 66 at a location spaced away from the drum surface 14. Preferably, an elongate perforated tubing 68 supplies the spongy pad 64 with developer liquid to keep it wet.

A rotary solenoid 70 mounted on pivot member 50 and coupled to stub shaft 34 is energized during a machine use period to maintain the member 32 in the position shown in FIGURE 3, in which the exit slit 42 is adjacent to the drum surface 14. At the end of a machine use period, solenoid 70 is de-energized to permit the exit slit 42 of the member 32 to rotate counterclockwise past the sponge 64 to the downwardly facing position shown in FIGURE 4. As the exit slit 42 moves past the pad 64, liquid developer is wiped off. At the beginning of the next machine use period, solenoid 70 is again energized to rotate the barrier member clockwise to its operative position with the exit slit 42 adjacent to the drum surface 14.

The described apparatus removes excess liquid toner without disturbing the developed toner image. The apparatus does not create an excess amount of fumes, not does it require bulky auxiliary support systems. Finally, it is mechanically simple.

#### WHAT WE CLAIM IS:

1. Apparatus for removing excess developer liquid from a movable image-bearing surface carrying a layer of liquid developer comprising an elongate barrier member, the barrier member being provided with means which when the barrier member is mounted with the length thereof extending across a portion of said surface provides a substantially unpressurized region adjacent the surface immediately in advance of a portion of

- said barrier member which is leading with respect to the relative movement of said barrier member and said surface in use; means for so mounting the barrier member with a spacing between the leading portion of said barrier member and said surface which is less than the thickness of said developer layer to intercept said layer; and means for forming an air curtain behind the leading portion of said barrier member in a region adjacent said surface.
2. Apparatus as claimed in Claim 1, wherein said air curtain forming means comprises a transverse slit in said barrier member between said leading portion and a trailing portion and means for maintaining the interior of said slit at a pressure greater than atmospheric pressure.
3. Apparatus as claimed in Claim 2, wherein said pressure maintaining means maintains the interior of said slit at a pressure from 5 to 10 inches of water greater than atmospheric pressure.
4. Apparatus as claimed in Claim 2 or 3, wherein said pressure maintaining means supplies the interior of said slit with air at a rate of between 2 and 4 cubic feet per minute.
5. Apparatus as claimed in Claim 2, 3 or 4, wherein the width of said slit is substantially greater than the spacing of said barrier member from said surface.
6. Apparatus as claimed in any one of claims 2 to 5, wherein the width of said slit is 5 to 10 times the spacing of said barrier member from said surface.
7. Apparatus as claimed in any one of claims 2 to 6, wherein the width of said slit is 0.02 inch.
8. Apparatus as claimed in any one of claims 2 to 7, wherein the leading and trailing portions of said barrier member are generally parallel to the image-bearing surface.
9. Apparatus as claimed in any one of claims 2 to 8, in which said barrier member and air curtain forming means comprise a generally cylindrical member having a hollow interior and a said transverse slit extending axially and communicating with said interior, the barrier member having an axially extending groove formed in the outer surface along each side of the slit.
10. Apparatus as claimed in any one of the preceding claims, in which said mounting means comprises a pair of rollers rotatably attached to the barrier member at opposite ends thereof, and means for biasing the rollers against the image-bearing surface.
11. Apparatus as claimed in any one of the preceding claims, in which the spacing between the barrier member and said image-bearing surface is between 0.001 and 0.002 inch.
12. Apparatus as claimed in any one of the preceding claims, further comprising means spaced away from the image-bearing surface for cleaning the portions of said barrier member which in use are adjacent to the image bearing surface, said mounting means comprising means for moving said portions to the cleaning means.
13. Apparatus as claimed in claim 12, in which said cleaning means comprises a spongy pad.
14. Apparatus as claimed in claim 12 or 13, in which the moving means rotates the barrier member about the axis of said rollers.
15. Apparatus for removing excess developer liquid from a moving image-bearing surface carrying a layer of liquid developer of a predetermined thickness comprising a mechanical barrier member extending across said surface and having leading and trailing portions relative to the direction of movement of said surface, said leading and trailing portions being spaced from one another to form a transverse slit; means mounting said member in spaced relationship to said surface with a spacing between said barrier member and said surface which is substantially less than said predetermined thickness, said slit having a width substantially greater than the spacing of said member from said surface; and means for maintaining the interior of said slit at a pressure slightly greater than atmospheric pressure to form a relatively low-pressure air curtain in the region of adjacency of the barrier member and said surface to inhibit wetting of said trailing portion of said barrier member by said developer liquid.
16. Apparatus for removing excess developer liquid from a moving image-bearing surface carrying a layer of liquid developer of a certain thickness comprising an elongate edge; means for mounting said edge with the length thereof extending across the portion of said surface bearing said image with a spacing between said edge and said surface which is less than the thickness of said developer layer to intercept said layer, the region of adjacency of said surface and said edge having no substantial extent in the direction of surface movement; and means for creating a pressurized region immediately behind said edge to form an air curtain in the region of adjacency of said edge and said surface.
17. A copying machine in which a surface bearing a latent electrostatic image is developed by applying liquid developer to the surface at a developing station and is then moved with a relatively thin adhering developer layer to an excess developer removal station comprising apparatus as claimed in any one of the preceding claims.
18. Apparatus for removing excess

developer liquid from a moving image-bearing surface carrying a layer of liquid developer substantially as herein described with referenece to the accompanying 5 drawings.

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