March 26, 1968 L. F. W. LAWES ET AL 3,374,768

DEVELOPING APPARATUS FOR ELECTROPHOTOGRAPHY

Filed July 26, 1965 2 Sheets-Sheet 1

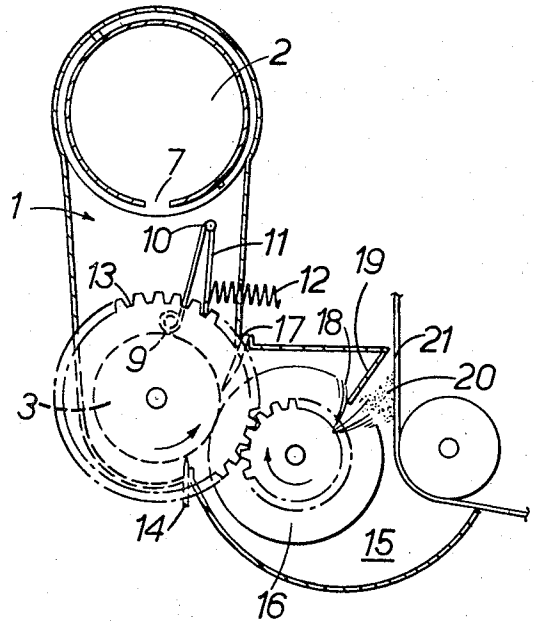



FIG. 1.

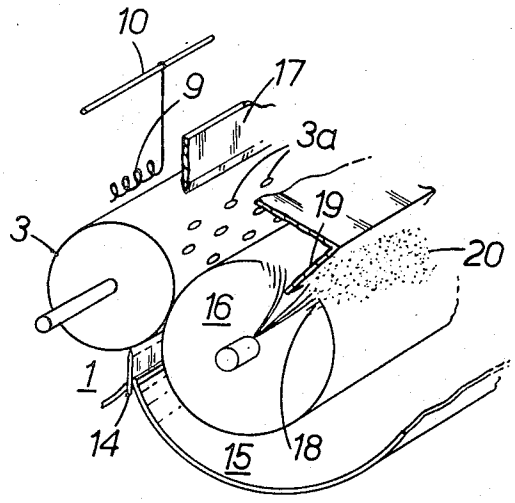



FIG. 2.

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March 26, 1968 L. F. W. LAWES ET AL 3,374,768

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Filed July 26, 1965 2 Sheets-Sheet 2

FIG. 3.

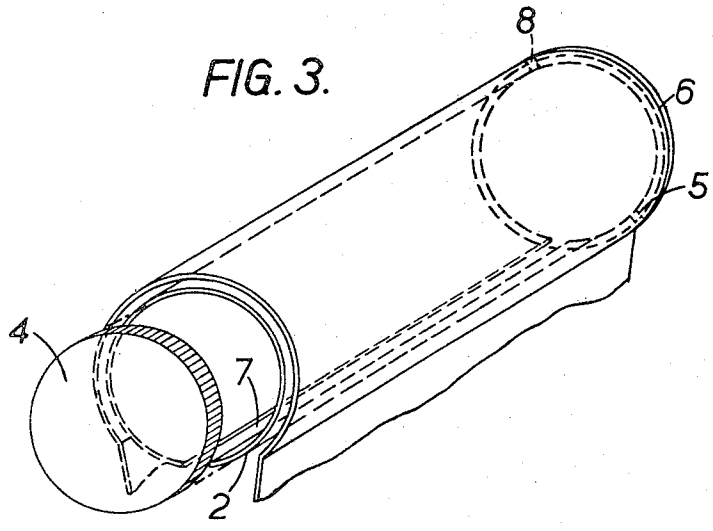
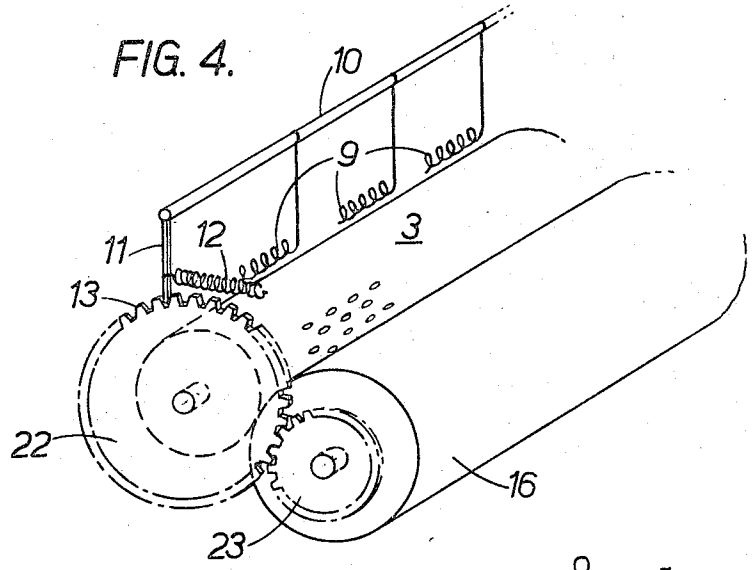



FIG. 4.




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# DEVELOPING APPARATUS FOR ELECTROPHOTOGRAPHY

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## ABSTRACT OF THE DISCLOSURE

Developing apparatus for electrostatography includes a powder storage hopper opening to a metering roller having therein a plurality of recesses of predetermined shape, size and volume which are spaced axially and circumferentially from each other. A doctor blade scrapes excess powder off the metering roller, and a plurality of brush bristles are moved into contact with said metering roller and, at their point of contact with the metering roller, move in the same direction as the metering roller so as to pick up powder out of the recesses. A flick edge against and past which the bristles are moved discharges the powder from the bristles to form a powder cloud which will come into contact with the photoconducting surface of the apparatus.

This invention relates to an apparatus for developing latent electrostatographic images on a photoconductive surface. In an electrophotographic process a latent image formed on a photoconductive surface is developed by the application of a suitable developer, so that the latent image is rendered effective, but not necessarily visible. Among methods by which this may be done are those generally known as cascade development, magnetic-brush development, and liquid development. Powder cloud development is also a well known technique, which has been used for many years.

It is an object of this invention to provide a device for discharging powder to a discharge zone at a predetermined controlled rate.

According to the present invention apparatus for use in developing electrostatographic images formed on a photoconductive surface, comprises a powder storage hopper adapted to discharge developer powder on to the surface of a metering roller, which surface is provided with regularly arranged recesses of predetermined shape, size and volume, hereinafter called dimples, a doctor blade bearing against the surface of said metering roller and adapted to wipe said surface whereby only that powder in the dimples is carried past the doctor blade, and an endless transfer system adapted to pick up powder from the dimples at a location beyond the doctor blade and to discharge the picked up powder to a discharge zone.

A photoconductive surface having a latent electrophotographic image, may be presented in the discharge zone to receive the discharged powder. Alternatively a particulate carrier may be passed through the discharge



zone to receive a loading of powder, predetermined according to the rate of discharge of powder and of movement of the carrier through the zone.

The endless transfer system may present a surface of brush bristles adapted to remove developer powder from the dimples of the metering roller, and means may be provided adapted to discharge developer powder from the brush bristles as a cloud close to the image bearing photoconductive surface, if such is present in the discharge zone.

The endless transfer system may comprise a roller whose surface is covered with brush bristles.

The means for discharging developer powder may comprise a flick edge against and past which the bristles are moved whereby they are flexed and subsequently released in such a manner that powder adhering to the bristles is flicked off to form a powder cloud.

An embodiment of the invention, for applying powder to a photoconductive surface, is now described with reference to the accompanying drawings, in which:

FIG. 1 is a section of a general arrangement of the apparatus,

FIG. 2 is a schematic view of the powder conveyance and clouding system,

FIG. 3 is a schematic view showing powder agitating means, and

FIG. 4 shows a refilling apparatus.

A main powder hopper **1** is formed in an outer casing. A refilling cylinder **2** lies along the top of the hopper and a metering roller **3** in the bottom half thereof. The refilling cylinder **2** is adapted to be removed from the hopper **1**, being provided at one end with a knurled knob **4** and at the other end with a retaining stud **5** which engages in a retaining groove **6** in the casing, and can be withdrawn therefrom through a release opening **8**. A slot **7** is formed along the length of the refilling cylinder **2**, and is so arranged that, when the cylinder is in position in the outer casing **1**, the slot is at the bottom of the cylinder. Thus when the cylinder, filled with powder is placed in the casing and turned to bring the slot underneath, powder is discharged into the bottom half of the hopper and over the metering roller **3**.

The surface of the metering roller **3** is provided with shallow depressions or dimples **3***a*, in which powder is picked up as the rollers are rotated. These depressions **3***a* are regularly arranged and of predetermined shape, size and volume. Located immediately above and along the length of the metering roller **3** are a series of coils **9** which are carried by a rod **10** held in bearings at each end, and moved by lever **11**. The free end of lever **11** is biased by a spring **12** so as to bear against the teeth of a gear **13**, mounted on the spindle of the dimpled roller **3**. When the metering roller **3** is rotated, the lever **11** moves in the same manner as the pawl of a ratchet thus imparting an oscillatory motion to the lever **11**, and through the rod **10** to the coils **9**. It will be appreciated that this oscillatory motion can be controlled by varying the size, form and spacing of the coils **9**, the length of the lever **11**, or the spacing of the teeth of the gear **13**. The coils thus oscillate in the bed of powder in which the

metering roller 3 rotates with the result that powder falls into and fills the depressions 3*a*. A doctor blade 14 bears against the roller so as to wipe off all powder adhering to the surface of the metering roller 3 but allowing the powder in the dimples to pass. The surface of the metering roller 3 is treated in such a way as to resist adhesion of the powder, and to facilitate the operation of the doctor blade 14. It has been found that an anodised aluminium surface to the roller is particularly suitable for this purpose. It will be readily appreciated, of course, that the amount of dust which is carried in the metering roller 3 can be varied by altering the number, size and shape of the dimples, as well as by adjusting the speed of rotation of the metering roller and that in this way an extremely accurate control of the feed of powder past the doctor blade can be obtained.

After passing the doctor blade 14, the metering roller 3 rotates into a chamber 15 in which is located a brush roller 16, the fibres on whose surface bear against the roller 3. The powder in the dimples 3*a* is removed by the brush fibres on the surface of the roller 16. After the powder has been removed, the metering roller rotates back into the main powder container 1 past an adjustable straight edge 17, which prevents any powder from the main powder hopper 1 passing into the chamber 15 other than in the manner described. Both the doctor blade 14 and the straight edge 17 are adjustable so that they can be perfectly aligned to the surface of the metering roller 3, and can be adjusted as and when necessary to compensate for any wear that may have taken place.

The brush roller 16 is rotated in the opposite sense to the metering roller 3, so that the surface of the metering roller 3 and the brush bristles at the surface of the endless transfer system roller 16 move in the same direction in the pick-up zone in the chamber 15. After picking up the dust from the dimples the fibres 18 of the brush roller 16 are carried past and against a flick-edge 19. The fibres 18 are thus bent back and then upon disengaging from the flick edge 19 spring forward, and thereby discharge their powder load as a cloud 20. The choice of developer powder depends on the nature of the brush fibres 18 or vice versa. Not only do the fibres affect the formation of the powder cloud and the pick up of the powder from the dimpled roller, but they can also impart a frictional electrostatic charge to the powder in the course of discharge and this may have enhanced beneficial effects if the polarity of this charge, the physical nature of the powder and the polarity of the image to be developed are in correct accord, and conversely if these three factors are not in correct accord, the formation of the image may be adversely affected.

After the powder has been released, it comes into immediate contact with the image bearing surface 21, where the image is developed according to known principles. In the construction illustrated in the accompanying drawings the image bearing surface takes the form of a curved endless belt passing over a roller, but it will be realised, of course, that any form of image bearing surface (e.g. a flat surface, or a photoconductive drum) may be used without affecting the successful operation of the invention.

The relative speeds of the two rollers 3 and 16 are controlled by mutually engaging gears 22, 23 respectively fitted on to their spindles, by which means a positive drive need only be applied to one of the two rollers. By varying the ratio of the two gears, the relative speeds of rotation of the rollers 3, 16 can be controlled, and in this way further control of the developing operation can be achieved. It has been found that, in general, a better operation can be obtained if the periphery of the brush-roller is rotated relatively faster than the periphery of the dimpled roller so that there is relative motion at the point of contact of the two rollers; the dimples are thus cleaned out most efficiently.

The apparatus may be modified in several ways. For example the refilling cylinder 2 may be replaced by a longitudinally extending hopper provided with a lid which can be removed for refilling. The metering roller 3 need not be formed with dimples 3*a* on its surface, but may have shallow longitudinal depressions thereon, or even be formed with a slightly roughened matt surface. In this latter case the doctor blade straight edge 14 would have to be carefully adjusted to meter the amount of powder reaching the brush roller 16 and being projected into the cloud 20.

In addition to the purposes already described, apparatus of the general nature disclosed, hereinbefore, are also particularly suitable for the controlled dispensing of toner onto a toner-carrier system as used in cascade development techniques in electrostatography. As is well known to those skilled in the art, the cascade system relies upon a balanced mixture of electroscopic toner and carrier held together triboelectrically, so that the toner is released to form images upon electrostatic latent images. It therefore follows that as the toner component is used up, the carrier needs to be replenished with further equivalent amounts. The present invention is particularly advantageous for effecting such replenishment, since the quantities can be accurately metered, and then distributed in powder cloud form so that it covers the carrier in uniform, particulate fashion, and overcomes any tendency to form co-agulate powder particles. Of course, the arrangement selected will differ from the example herein described in details of construction, but the general principles remain the same.

What is claimed is:

1. Apparatus for use in developing electrostatographic images formed on a photoconducting surface, said apparatus including means for moving a continuous photoconducting surface element past a powder discharge zone, a powder storage hopper to receive a charge of developer powder, a metering roller open to said storage hopper, a plurality of recesses of predetermined shape, size and volume which are regularly spaced axially and circumferentially from each other being provided in the surface of said metering roller, said recesses being staggered with respect to each other axially of said roller, a doctor blade bearing against said surface of said metering roller and adapted to wipe said surface, whereby only that powder in said recesses is carried past said doctor blade, and an endless transfer system presenting a movable surface of brush bristles entrained into contact with said metering roller in a pick-up zone beyond said doctor blade, whereby said brush bristles pick out powder from said recesses in said pick-up zone, said surface of the metering roller and said endless transfer system movable surface moving in the same direction in said pick-up zone, and said brush bristles being adapted to discharge the picked up powder to said discharge zone, said discharge zone being spaced from said pick-up zone.

2. Apparatus according to claim 1 wherein said endless transfer system comprises a roller whose surface is covered with the brush bristles.

3. Apparatus according to claim 2 including means for discharging developer powder from said bristles as a cloud into said discharge zone, said means comprising a flick edge against and past which said bristles are moved, whereby they are flexed and subsequently released in such a manner that powder adhering to said bristles is flicked off to form a powder cloud.

4. Apparatus according to claim 1 wherein said surface of said metering roller is non-adherent to developer powder.

5. Apparatus according to claim 4 wherein said surface of said metering roller is of anodised aluminium.

6. Apparatus according to claim 1 including means to agitate the powder in said powder storage hopper and thereby facilitate collection of said powder in said recesses.

7. Apparatus according to claim 6 including a plurality

of coils lying adjacent said surface of said metering roller parallel to the axis thereof, and means to oscillate said coils toward and away from said metering roller surface.

8. Apparatus according to claim 7 including a pivot rod, arms extending radially therefrom to the ends of which said coils are mounted, an annular ratchet rotatable with said metering roller, and a pawl lever mounted to said pivot rod and biased against said annular ratchet.


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