

March 8, 1960

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2,927,554

CASCADE DEVELOPING APPARATUS

Filed Sept. 23, 1957

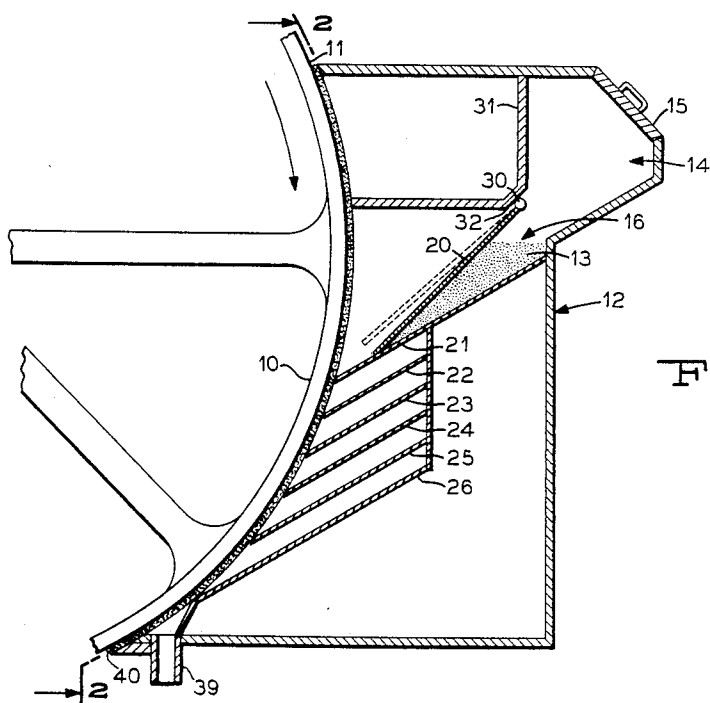


FIG. 1.

FIG. 3.

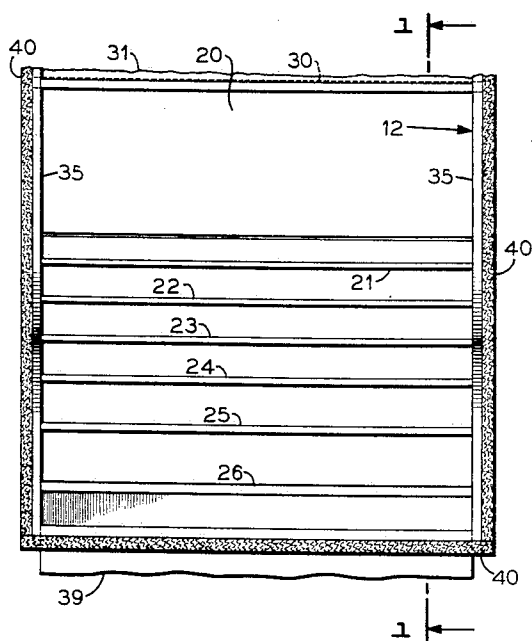
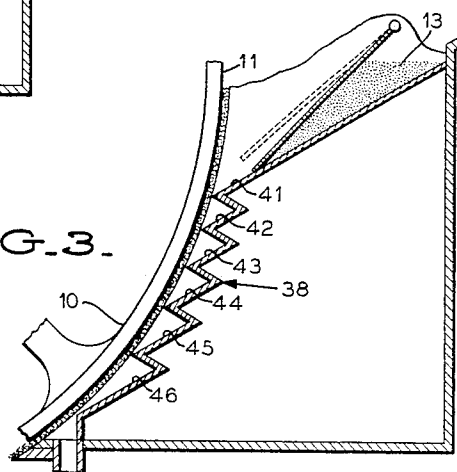


FIG. 2.

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CASCADE DEVELOPING APPARATUS

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Application September 23, 1957, Serial No. 685,742

5 Claims. (Cl. 118—637)

This invention relates generally to an image developing apparatus and in particular to a developing apparatus for electrostatic images formed on a xerographic drum.

In xerographic machines utilizing a rotatable drum such as shown in the application to I. M. Hix et al., Serial No. 419,392, filed March 29, 1954, now Patent No. 2,859,673, there are many pieces of equipment which must necessarily be mounted in the upper part of the machine. It has therefore been found desirable to place the developing apparatus in the lower section of the machine on the underside of the xerographic drum since its location is not critical.

With the developing apparatus placed on the underside of the xerographic drum, cascade type developing apparatus of the type shown in the patent to R. M. Schaffert, Patent No. 2,576,047, cannot be used since the developing process depends on gravity alone in dispensing developing powder to the face of the drum. As shown clearly in this patent, the developing process is one wherein the developing powder is directed from a container to strike the xerographic drum and any latent image carried thereon. The contact of the toner powder with the latent image which is electrostatically charged attracts the toner powder to visibly define the image carried on the drum.

For use below the horizontal center line of the xerographic drum, other types of developing apparatus, mechanically operable, have been used. Of particular interest with respect to the present invention is a developing apparatus of the type shown in Patent No. 2,357,809 which uses a powder cloud developing process. This process is one wherein electroscopic toner is mechanically agitated to form a cloud of toner particles in immediate proximity to the xerographic drum wherein the toner particles are attracted to any electrostatic image carried thereon.

Without discussion of the relative merits of the different types of developing apparatus, since they all perform satisfactorily, it is desirable that a gravity type developing apparatus be available for use below the horizontal center line of a xerographic drum.

It is therefore an object of this invention to provide a new and improved gravity type developing apparatus.

It is a further object of this invention to provide a developing apparatus utilizing both cascade and powder cloud principles.

It is another and further object of this invention to provide a gravity type developing apparatus for use below the horizontal center line of a drum on which an image to be developed is carried.

Another object of this invention is to provide a developing apparatus of the gravity type for use below the center line of a drum on which an image to be developed is carried utilizing both cascade and powder cloud principles.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of

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examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a vertical sectional view of a portion of a xerographic drum and a developer apparatus incorporating the invention along the line 1—1 of Fig. 2.

Fig. 2 is a fragmentary front elevation of the developer apparatus along the line 2—2 of Fig. 1.

Fig. 3 is a vertical sectional view of an alternate construction of the developer apparatus shown in Fig. 1.

A xerographic drum 10 of a suitable conducting material with a photoconductive material 11 fixed thereto, e.g., amorphous selenium, rotates in a clockwise direction, Fig. 1. A given area of drum surface is charged to a certain potential and then discharged selectively to form a charged image area. This charged image is to be transferred, for example, to a paper sheet, not shown, which contacts the drum. In order to be able to transfer an image represented by an electrostatically charged area from the drum coating 11 to a paper sheet as a visible image, a developing process must be utilized to render the charged area definitive visually and capable of being transferred. The developing unit 12 performs this function. The developing unit is described in conjunction with a photoconductive surface on the drum but it is apparent that any process whereby an electrostatic image is formed on a dielectric surface could use such a unit.

A developing powder 13 consisting of an electroscopic toner material and a carrier are placed in a hopper 14 by any desired means. In this application, to simplify matters, the hopper 14 is shown as a container with a lid 15 in which developer powder is manually placed as needed. In a more sophisticated approach, an apparatus such as shown in the patent to Dunn, Patent No. 2,779,306, would be utilized to obviate manual filling of the hopper.

While the developing powder is not per se part of the present invention, an understanding of its physical characteristics are desirable in understanding the present invention. The carrier particles consist of glass beads (for example) for imparting a triboelectric charge to the toner powder of opposite polarity to the image so that it will be attracted to the electrostatically charged image on the xerographic drum. The toner powder particles are extremely small (e.g., 2 to 20 microns in diameter) while the carrier particles are (for example) 30 mesh. The carrier particles are therefore extremely large with relation to the toner particles and by their nature have a much greater weight than the toner particles. When intimately mixed, the toner powder particles will coat the carrier particles since they are displaced from one another in the triboelectric series and carry an opposite charge. While the toner powder particles are attracted to the carrier particles they will be pulled away from the carrier particles by the more oppositely charged image area on the xerographic drum or be separated by impact, air resistance, etc.

Considering the apparatus of the present invention, Fig. 1, the carrier material 13 will be dispensed to the surface of the drum 10 from a compartment 16 formed between a fixed baffle plate 21 and a movable baffle plate 20. The movable baffle plate 20 is hinged at 30 to a supporting structure 31 secured to the inner surface of the unit 12 and limited in angular movement by the abutment 32 formed on said supporting structure. The gravitational force of the developing powder 13 contained in the compartment 16 and hopper 14 is sufficient to move the baffle plate 20 to the dotted line position shown and allow developing powder to be metered in accordance with the opening formed between baffle plates 20 and 21. Since the movement of developing powder

will to some extent be determined by the amount contained in hopper 14, a supply device as shown in Dunn, 2,729,306, would be helpful in maintaining a constant weight of developing material in the hopper 14.

Directly below fixed baffle 21 are a series of baffle plates 22—26 forming steps adjacent the periphery of the drum 10 which may vary in number in accordance with the spacing therebetween. The baffle plates 21—26 are formed, Figs. 1 and 2, of flat rectangular sheets secured to the sides 35 of the unit 12. Each baffle plate is angularly inclined to the perpendicular with the free edge adjacent drum 10 being in close proximity (e.g., $\frac{1}{8}$ " to $\frac{5}{32}$ ") to the drum with these front edges of the baffle plates falling on an arc of a circle having approximately the same radius of curvature as the drum 10. An outlet 39 is formed in the lower portion of the developing apparatus to collect the carrier particles and any unused toner powder for reuse. This may conventionally be some sort of catch basin (not shown) which collects the unused developer powder and transmits it to the input of the developing unit.

The periphery of the developing apparatus has secured thereto strips of suitable non-matting soft dense fur 40 (e.g., beaver) to prevent the escape of developing material and yet prevent any wear on the selenium coating 11.

The action of the developing process is thought to consist of two distinct phenomena and to be as follows:

The first phenomenon occurs as the developing powder 13, as it is dispensed from the compartment 16, flows downward on the baffle 21 to contact the drum surface adjacent the free edge of baffle 21. From baffle plate 21 the developing powder 13 falls to the next succeeding lower baffle plate 22. Here the identical process is repeated since this baffle plate is inclined toward the xerographic drum in the same manner as the baffle plate 21. For the succeeding baffle plates 23—26, a similar operation takes place. The net result is that developing powder is brought into contact with the xerographic drum at a plurality of discrete points displaced about the lower quadrant of the xerographic drum.

As a second phenomenon associated with the structure of the present invention, toner powder clouds are formed on each baffle plate 22—26. The developing powder 13, as it is dispensed from the compartment 16, falls from the top baffle plate 21 to the next succeeding lower baffle plate 22. In falling, the air resistance separates some of the toner powder from the carrier material. This toner powder being very fine falls slowly and forms a cloud of toner material which envelopes the surface of the drum. At the baffle plate 22, the carrier particles, being resilient, rebound slightly in an upward direction to increase the turbulence of the powder cloud formed between baffle plates 21 and 22. The inclined baffle plate 22 gives direction to the rebounding and sliding developing material so that this material falls to the next succeeding lower baffle plate 23 where a similar process occurs. Thus, between the series of baffle plates 21—26, a number of powder clouds are generated which cover a predetermined sector of the drum surface.

The developing process therefore consists of:

(1) A cascade of developing powder directed against the drum at each baffle plate.

(2) A toner powder cloud formed between each baffle plate.

The combined result is therefore to provide any desired area of development which in turn provides an extended time of contact between drum 10 and developing powder

13 to allow for complete development of any electrostatic image carried on the drum.

While not shown, it is within the scope of this invention to feed developer powder to each individual baffle plate 21—26, of Fig. 1, by apparatus such as the compartment 16 or a bucket conveyor as described in the above-mentioned Dunn patent.

In the apparatus, as originally constructed, the free edge of the top baffle plate 20 was located approximately 3" below the horizontal center line of the drum. All fixed baffles 21—26 were spaced $\frac{1}{2}$ " apart with the angle between the perpendicular and the top face of the baffles being 30°.

An alternate construction for the developer unit 12 is shown in Figure 3 wherein the baffles 41—46 are formed from a single piece of material 38 supported in the same manner as the baffles of the apparatus shown in Fig. 1.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In combination with an electrostatic printer containing an axially rotatable drum on which an electrostatic image to be developed is formed, a plurality of successively elevated baffles each having a downwardly directing edge immediately adjacent the drum, means for securing said baffles at an acute angle to the perpendicular and with the directing edge of each succeeding lower baffle extending beyond the common edge of all preceding high baffles with each said edge falling below the horizontal center line of the drum, and a developing powder dispensing means for dispensing powder to the uppermost baffle whereby the powder flows downward over each successive baffle to form a cascade of successive discontinuities and thereby direct said powder into intimate contact with said drum at each said baffle whereby incremental areas of any image on said drum are subjected to a developing process at each said baffle.

2. The apparatus of claim 1 in which the locus of the edges of said baffles adjacent the drum has approximately the same radius of curvature as said drum.

3. The apparatus of claim 2 in which said developer powder dispensing means comprises a movable baffle mounted above said uppermost baffle and forming a compartment for the developer with the uppermost baffle, said baffle being movable under the weight of the developer powder to permit the same to fall to the next successive baffle.

4. The apparatus of claim 3 wherein said baffles consist of a series of flat plates.

5. The apparatus of claim 3 wherein said baffles consist of a unitary member formed to present a series of interrupting steps to the stream of developing material.

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