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XEROGRAPHIC DEVELOPING APPARATUS

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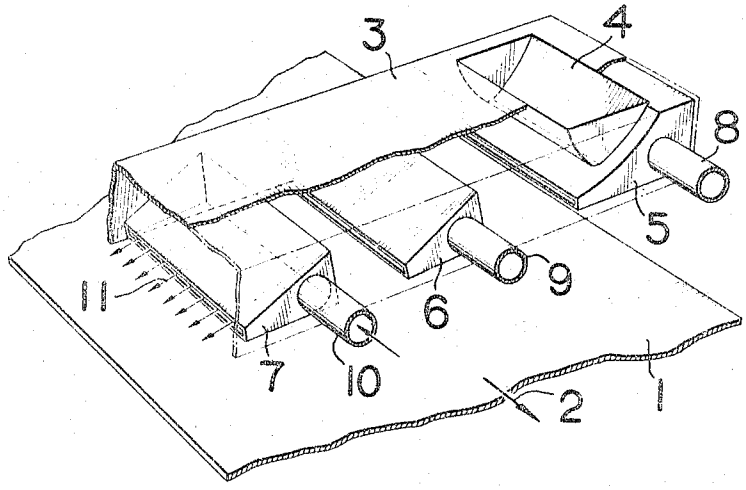

FIG. 1

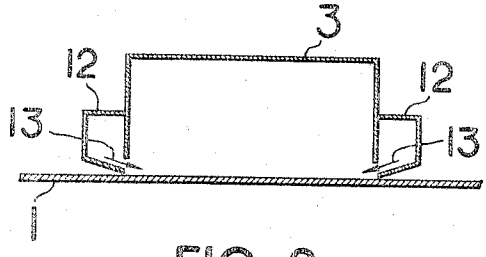

FIG. 2

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XEROGRAPHIC DEVELOPING APPARATUS

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4 Claims. (Cl. 118—637)

ABSTRACT OF THE DISCLOSURE

A xerographic developing apparatus including a hopper supplying developer to a latent image bearing material in a cascade fashion, with at least one gas jet nozzle positioned above the material and below the hopper. The gas stream flowing from the nozzle thereby rolls the developer over the image surface of the material and allows toner in the developer to transfer to the latent image.

The present invention relates to a xerographic developing apparatus wherein feeding of a developer is performed by a gas flow.

It is well known that one of the best developing process adopted in the xerography is a cascade developing process. In a limited sense of the cascade developing process, however, it is necessary to incline the sensitive surface with a certain gradient relative to the horizontal plane so that the force of gravity may cause developer to flow along the sensitive surface.

So that any developer commonly used at present may flow smoothly on the sensitive surface, an inclination thereof in an angle of more than twenty degrees is required, the degree of the inclination depends on the shape and size of the developer as used. In other words the inclination less than twenty degrees disturbs the free flowing of developer and consequently satisfactory development cannot be obtained.

In order to carry out the cascade developing process on a substantially horizontal plane some external force rather than the force of gravity is required. For instance, carrier in developer is made of magnetic material, then the magnetic force is used for flowing the developer.

The essential feature of the present invention resides in that the feeding of developer to the sensitive material is performed by means of the force due to the gas or gases flow.

The present invention will be better understood in the following description made with reference to the drawings, wherein:

FIG. 1 is a perspective view of the embodiment according to the present invention with one part thereof broken down, showing the principle of the present invention; and

FIG. 2 is a sectional view of the embodiment as shown in FIG. 1.

Referring to FIG. 1, **1** indicates the xerographic sensitive material, this material with the sensitive surface upsided travelling in the direction indicated by arrow **2**. A duct **3**, which has an opening only at the bottom is installed perpendicular to the travelling direction of the sensitive material **1**. Narrow gaps are left between the side walls of the duct **3** and the surface of the sensitive material so that the movement of the sensitive material may not be disturbed. In the duct **3** there are provided a hopper for supplying developer **4** and gas jet nozzles **5**, **6** and **7**. Developer is supplied from the hopper **4** onto the surface of the sensitive material **1**. The hopper may be shaped so as to give developer the initial tangential velocity. Developer, in general, cannot continue flowing against friction and therefore, it stops after flowing a

certain distance. Being supplied at a constant pressure from gas supplying tubes **8**, **9** and **10** to gas jet nozzles **5**, **6** and **7**, gas flows in the direction perpendicular to the travelling direction of the sensitive material **1**, thereby causing developer to continue flowing smoothly on the sensitive material so that satisfactory developing may be performed.

In the description of the principle of the present invention, for convenience, it is supposed that developer flows in the direction perpendicular to the travelling direction of the sensitive material. This orientation, in case of developing long and broad sensitive material, is advantageous from the economical point of view.

It is not always necessary to maintain the flow of developer transverse to the travelling direction of the sensitive material. Of course, the flowing direction of developer may be selected within the range from right angles to parallel to the travelling direction of the sensitive material, if required in designing.

If the developer departs from the enclosure of the duct **3**, the developer will not be influenced by the gas blown off from the nozzles **5**, **6** and **7**, so it can not continue to flow and is taken off with the sensitive material, so resulting in irregularity in development. In order to obtain regular development it is desirable that the gas flow has no irregular component therein. It is also desirable to give the gas flow the component cancelling the component in the travelling direction of the sensitive material. As a method for maintaining the regularity in the gas flow, as commonly known in the wind tunnel and the like, it is supposed that guide blades are provided within the duct and the nozzle.

As a method for cancelling the travelling component of the sensitive material it is supposed that the nozzles and the guide blades are arranged with a slight gradient in the opposite direction to the travelling direction of the sensitive material.

According to the above methods, however, it is supposed that the particles of developer collide with each other, resulting in the irregular flow of developer and the flow of developer partially departs from the enclosure of the duct **3**.

Therefore, it is desirable that gas jet nozzles **12** are provided on the side walls of the duct **3**. Then, the air blowing in the direction indicated by arrow **13** prevents the departure of developer from the interior of the duct.

According to the xerographic developing process of the present invention developer can flow smoothly and in the case the gas flow which wind pressure does not cause carrier and toner to separate from each other is applied the outcome of development is similar to that obtained according to the so-called cascade developing process.

In the case the stronger gas flow is applied, toner will separate from carrier to suspend in the gas flow, resulting in the development similar to that obtained according to the so-called powder cloud developing process. Both of them, accordingly, fall within the scope of the present invention.

What is claimed is:

1. A xerographic developing apparatus comprising a hopper which is adapted to supply a developer consisting of a toner and a carrier to a latent image bearing material in a cascade fashion, and at least one gas jet nozzle positioned above said material and below said hopper, thereby allowing the gas stream flowing from said nozzle to roll the developer over the image surface of said material and allowing the toner to transfer to the latent image.

2. An apparatus for developing a xerographic sensitive material bearing a latent image, said apparatus comprising means to advance said material along a fixed path, hopper means disposed above said path and adapted to

supply a developer consisting of a toner and a carrier to said material in a cascade fashion, and at least one gas jet nozzle positioned above said path and below said hopper and adapted to emit a gas stream toward said material to roll the developer over the image surface of said material and to allow the toner to transfer to the latent image.

3. The apparatus of claim 2, wherein said nozzles are positioned so that said gas stream flows therefrom in a direction at right angles to the direction of advancement of said material.

4. The apparatus of claim 3, further comprising a pair of additional nozzles disposed adjacent the ends of said hopper means above said path, one of said additional nozzles adapted to emit a gas stream towards said material in the same direction as the direction of advancement thereof, and the other of said additional nozzles adapted to emit a gas stream towards said material in an opposite direction to the direction of advancement thereof.

References Cited

UNITED STATES PATENTS

2,872,338	2/1959	Landrigan et al.	118—637 X
2,932,278	4/1960	Sims	118—637
3,114,482	12/1963	Dunaway	118—636 X
3,124,483	3/1964	Rheinfrank	118—637
3,277,493	10/1966	Fyler.	

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