

Dec. 16, 1969

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3,484,022

SLIT SCANNED ELECTROSTATIC PRINTING

Filed May 8, 1968

2 Sheets-Sheet 2

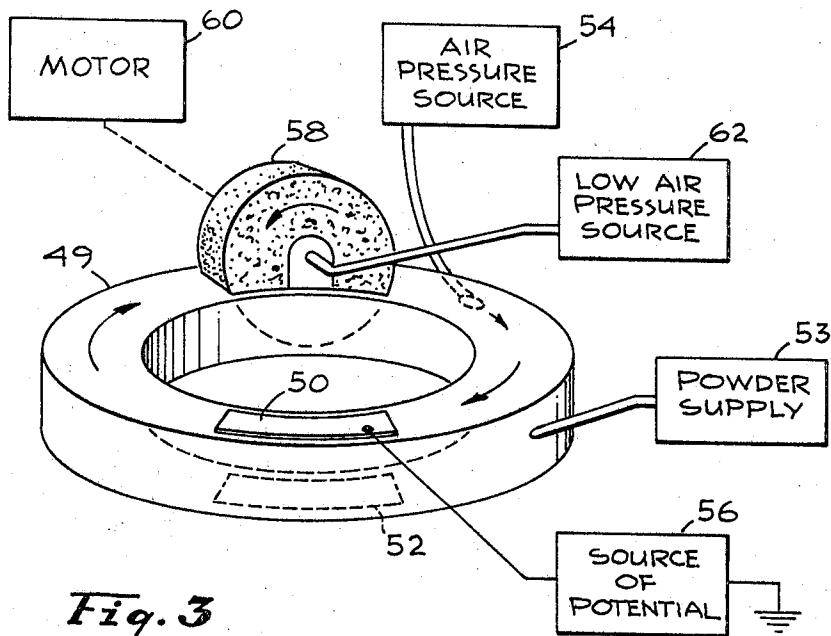


Fig. 3

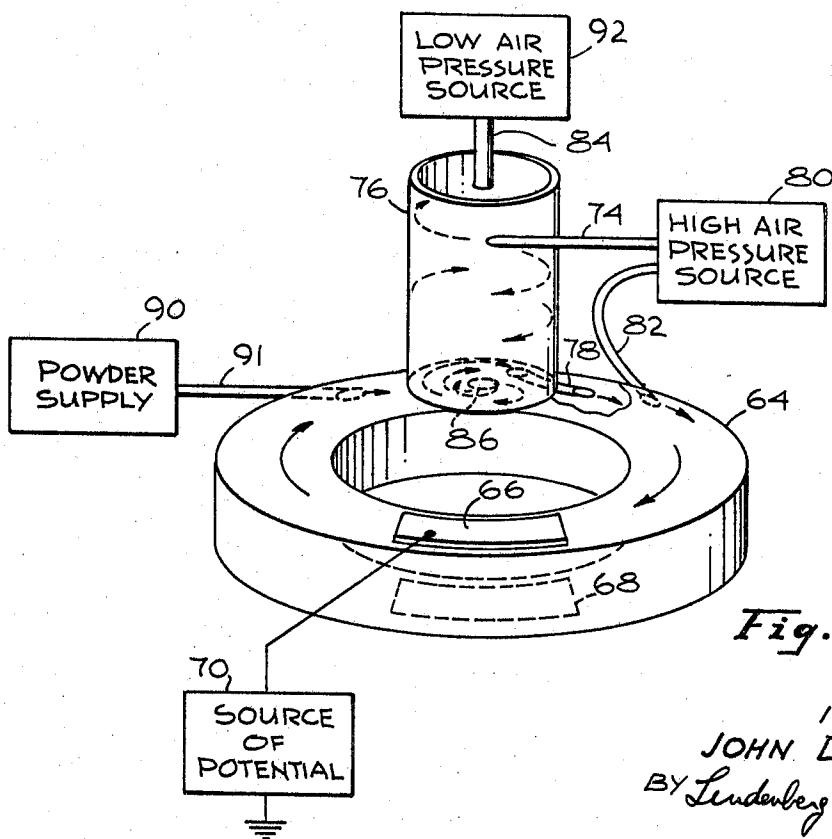


Fig. 4

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SLIT SCANNED ELECTROSTATIC PRINTING
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Filed May 8, 1968, Ser. No. 727,618

Int. Cl. B67d 5/06, 5/54; B05b 5/02

U.S. Cl. 222—76

8 Claims

ABSTRACT OF THE DISCLOSURE

In an electrostatic printing system of the type which employs electroscopic powder for printing, apparatus is provided which can produce, on a continuous basis, a substantially uniform powder cloud. The powder cloud may then be used to either uniformly coat a carrier which is applied to an image screen, or may be applied directly to the image screen.

BACKGROUND OF THE INVENTION

This invention relates to electrostatic printing and more particularly to improved arrangements for feeding electroscopic powder for an electrostatic printing system.

In Patent No. 3,081,698 to Childress et al., an electrostatic printing system has been described wherein electroscopic powder is applied to one surface of an image screen, which lets the powder through only in areas which are in the form of a desired image. The powder which passes through the screen then enters into an electric field which carries it to a substrate. The powder is thereafter caused to adhere to the substrate. The structures for applying the powder to the image screen take a number of different forms. Regardless of the form however, it is desirable to apply the powder in as uniform a manner as possible, to the image screen in order to obtain a uniform powder deposit on the substrate. Also, in order to enable the printing to occur over a reasonably short interval, which is especially the case where the image screen is in motion, it is desirable to apply the powder to the image screen in a reasonably dense form, to obtain the best possible coverage on the substrate in the shortest time.

A number of different arrangements for applying the electroscopic powder to the image screen are known, including the use of a brush or a belt, or a powder cloud.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is to provide an improved powder cloud generator for an electrostatic printing system.

Yet another object of this invention is to provide a powder cloud generator which generates a uniform and dense powder cloud.

Still another object of this invention is the provision of a novel and useful powder cloud generator for an electrostatic printing system.

The foregoing and other objects of the invention may be achieved by circulating a powder cloud in a closed loop path within a chamber which has a slot in one wall. Opposite to the slot is a plate or electrode. The powder cloud circulates between the slot and the electrode whereby, when a potential of the proper polarity is applied to the electrode, powder is forced out of the slot in response to the electric field which is established. In one embodiment of the invention, the powder is circulated by a rotating brush and the electrode is disposed centrally of the chamber whereby, as the brush rotates a powder cloud is formed which moves in a path around the plate. In another embodiment, a substantially circular chamber is provided into which the powder cloud is introduced. Also, air is introduced for the purpose of driving the powder cloud around

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the chamber. In one wall of the chamber is an electrode. In the opposite wall there is an opening or slot through which the powder cloud is caused to move, upon the application of the proper potential to the electrode. Provision is made to remove the introduced air since otherwise the buildup of air pressure would cause the powder to leave the chamber in an uncontrolled fashion.

The novel features of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an isometric view of an electrostatic printing system showing the manner of the application of this invention.

FIGURE 2 is an isometric view of a powder delivery device in accordance with this invention.

FIGURE 3 illustrates another powder delivery device in accordance with this invention.

FIGURE 4 illustrates yet another powder delivery device in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGURE 1 illustrates an arrangement of an electrostatic printing system of the type which can employ this invention. An image screen 10 is supported stretched between two rollers respectively 12, 14. One of the rollers is driven by a motor 16 whereby the screen can move past a location at which printing occurs. An electroscopic powder delivery device 18 applies powder to one side of the image screen 10. The powder passes therethrough under the influence of an electric field which is established between the image screen and a plate electrode 20. The powder delivery device is connected to a source of potential 22, as is the image screen and the electrode 20. As a result a powder delivery field is established which causes the powder to move from the powder delivery device up to and through the screen and therefrom toward the electrode 20. The substrate, which here is shown as a roll of paper 24 is pulled by a take-up roll 26, driven by a motor 28, past the printing station. This is defined as the space between two positioning rollers 30, 32, which guide the paper off the roller 24 and between the electrode 20 and the screen 10. The powder image is affixed to the paper by a fixing device 34. This can comprise a set of heating coils.

FIGURE 2 illustrates an embodiment of the invention which may comprise the powder and delivery device 18. This comprises a hollow housing 40 which has a slot opening 42 in one face thereof. Supported substantially centrally of the housing is a conductive electrode 44. At the base of the housing is a rotatably driven brush 46 or other suitable mechanical actuator driven by the motor 48. A source of powder 47, supplies powder, when required, by injecting same over a tube, connected to the bottom of the housing 40.

The brush is rotatably driven in a clockwise direction. As a result of its rotation, it causes air to circulate in the direction shown by the arrows. This is, up the region between the electrode 44 and the back surface of the housing, and thereafter over the electrode and the space between it and the top of the housing and down the front surface of the electrode to the brush 46. The brush is positioned so that its bristles come in contact with a supply of electroscopic powder which is in the bottom of the housing. As a result, not only do the rotating brush bristles move air but they also move powder which is thrown upward into the air and thus forms a powder cloud. Thus the powder cloud is made to circulate. An external terminal 45 affords the connection of a potential

source of the electrode 44. Should an electric field be established thereby between the electrode 44 and say the screen 10, shown in FIGURE 1, the powder in the powder cloud is directed by the field through the slot 42 and onto and through the screen.

The particular embodiment of the invention shown in FIGURE 2 effectively moves the air, which is within the chamber, and does not take in any new air or does not require any new air in order to maintain powder cloud circulation. The result is that the powder cloud is fairly dense, powder being added thereto and redispersed continuously by the rotation of the brush. A rich air-powder mixture is expelled from the slot 42, as a result, when a potential is applied between the electrode 44 and an external electrode. The dispersion of the powder which is expelled from the slot is fairly uniform over the entire area of the slot and provides very uniform and dense prints. Furthermore, since the air content within the chamber is not changed, the powder emitted from the slot is completely under the control of the potential applied to the electrode and is not due to an air flow out of the slot.

It will be appreciated that while the powder delivery device 18 shown in FIGURE 1 delivers the powder directly to the image screen, its utility may be, if desired, for delivering the powder to a moving belt or brush to provide a uniform coating thereon. The brush or belt may be used subsequently for applying powder to an image electrode.

FIGURE 3 shows another arrangement for supplying a uniform powder supply over the region of a slot. This time a ring-shaped hollow housing 49 is used. An electrode 50 is positioned in one wall of the housing and in the wall opposite to the electrode is a slot aperture 52 represented by dotted lines. The housing 49 forms an oval track around which a powder air mixture is moved. A high velocity air source 54 injects air tangent to the outer wall of the housing 49. Powder is injected from a powder supply 53 into the housing 49. The powder mixes with the air and the powder-air mixture moves around the track defined by the housing 49. When the mixture passes between the electrode 50 and the slot 52, powder can be directed outwardly through the slot by applying a potential from a source 56 between the electrode and the external structure toward which it is desired the powder to be directed.

Air in sufficient quantity to avoid air pressure buildup within the housing is removed from the system, without removing powder, by using a rotating porous foam circular structure 58. This is supported so that a portion of its periphery extends into the chamber of the housing 49. A motor 60 drives the structure 58 so that it rotates in a direction to assist the circulation of the powder-air mixture in the housing. That is, assuming the direction of motion of the mixture to be that of the arrows drawn on the housing 49, the Scott foam structure 58 will rotate in a counterclockwise direction. A low pressure air source 62 is connected through the center support for the rotatable foam structure 58.

In operation, the powder is injected into the chamber 49 and moves around it in the direction indicated by the arrows. As the powder passes between the electrode 50 and the slot 52, upon the application of an electrical potential between the electrode and the outside structure against which it is desired to erect the powder, powder comes out of the slot moving in a direction perpendicular to the plane thereof. The low air pressure source serves to draw excess air out of the chamber 49 and the foam circular member 58 prevents the powder in the chamber from being drawn out with the air. The air must be removed otherwise the pressure in the chamber would soon increase to a value at which it would move powder out of the slot without any potential being applied to the electrode. The powder which adheres to the surface of the foam pad 58 is thrown off from the periphery of the pad

by reason of the rotation thereof. If this does not result in a sufficient release of the powder, the low air pressure source may be interrupted from time to time, or the connection between the low air pressure source 62 and the center of the pad 58 may be such that the low air pressure source is applied successively to different portions of the pad.

FIGURE 4 shows another arrangement for circulating a powder-air mixture between an electrode and a slot. This arrangement employs a chamber 64, which is similar to the chamber 49. Also, in the upper wall of the chamber is an electrode 66. In the wall opposite the electrode is a slot 68 (shown dotted). The source of potential 70 is connected between the electrode and the object upon which it is desired to transfer powder from the powder cloud within the chamber 64.

A high air pressure source 80 is connected through a pipe 74 so that the air is directed as a high velocity stream tangentially along the inner wall of a cylindrical container 76. A pipe 78 which has one opening tangentially adjacent the inner wall of the container 76, at its other end, opens into the container 64. Air is withdrawn from the chamber by means of a low air pressure source 92, which is connected through a pipe 84 to the center of the top of container 76. Part of the powder-air mixture which is circulating in container 64 is drawn through an opening 86 into container 76. The powder-air mixture rotates rapidly within container 76. Powder, being the higher density component of the mixture, concentrates near the periphery of the chamber due to centrifugal force. This concentrated mixture will spiral down the wall of container 76 and be directed by pipe 78 into chamber 64. The centrifugal pressure differential in container 76 causes the pressure near opening 86 to be less than at the opening to pipe 78. The air flows in pipes 74, 82, 84 are adjusted so that the pressure in container 64 is between these two pressures, and is low enough that air is not expelled through slot 68. The high air pressure source 80 is directed by pipe 82 into container 64 so as to cause the air-powder mixture to circulate around chamber 64. Powder may be added to chamber 64 from a powder source 90 by means of a pipe 91.

There has been described and shown herein a novel and useful arrangement for passing a cloud of electroscopic powder past a slot, with provision being made for directing the powder through the slot and onto a receiving object, upon demand. This arrangement for delivering powder uniformly and with the required density, finds use in situations where a moving belt, or a moving screen must be coated, or where an optimum powder delivery is desired over a narrow region for nip printing on curved surfaces.

What is claimed is:

1. An electroscopic powder delivery system comprising walls defining a closed chamber, a slot opening in one of the walls of said closed chamber, an electrode positioned spaced from said slot, an air-electroscopic powder mixture in said chamber, means for circulating said air-electroscopic powder mixture around said chamber and between said electrode and said slot, and means for applying a potential to said electrode when it is desired to direct electroscopic powder out of said chamber through said slot.

2. Apparatus as recited in claim 1 wherein said electrode extends to divide said chamber into two parts, there being a space between opposite ends of said electrode and adjacent walls of said chamber, a supply of electroscopic powder being deposited at one of said ends of said chamber, and said means for circulating an air-powder mixture around said chamber between said electrode and said slot including rotatably supported brush means in contact with said supply of powder, within said chamber, and means for rotatably driving said brush means.

3. Apparatus as recited in claim 1 wherein said chamber is shaped as a ring, said means for driving said air-

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powder mixture including a source of air under pressure, means for directing air from said source tangentially along an outer wall of said ring-shaped chamber, and there is included means for withdrawing air from said chamber.

4. Apparatus as recited in claim 3 wherein said means for withdrawing air from said chamber comprises porous foam means, means for rotatably supporting said porous foam means with one end extending within said chamber, and means for applying low air pressure to the center of said porous foam means for withdrawing air from said chamber while leaving the powder particles within said chamber.

5. Apparatus as recited in claim 3 wherein said means for withdrawing air from said chamber comprises a cylindrical container having one end adjacent one of the walls of said chamber, means defining an opening through one end of said cylindrical container and said one wall of said chamber, and means for applying low pressure air to the end of said cylindrical container which is opposite to the end having an opening therein.

6. Apparatus for delivering electroscopic powder to a receiving device comprising walls defining a hollow chamber, a slot shaped opening in one of said walls, a conductive partition supported in the center of said chamber opposite said slot, said partition extending for dividing said chamber into two parts with access between the two parts being afforded at opposite ends of said partition, a supply of electroscopic powder particles at one end of said chamber, rotatable brush means supported rotatably at said one end of said chamber and in contact with said electroscopic powder particles, means for rotatably driving said rotatable brush means for circulating a powder-air mixture around said chamber and between said partition and said slot, and means for applying a potential to said partition when it is desired to remove powder from said chamber through said slot.

7. A powder delivery system comprising walls defining a hollow ring-shaped chamber, a slot in one wall of said chamber, an electrode in the wall of said chamber opposite to the wall having said slot, means for introducing air

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at a pressure in excess of atmospheric pressure into said chamber to circulate around said ring-shaped chamber, means for introducing electroscopic powder into said chamber to be carried therein by said air, means for removing excess air from said chamber, and means for applying a potential to said electrode when it is desired to remove powder from said chamber through said slot.

8. Apparatus as recited in claim 7 wherein said means for introducing air at a pressure in excess of atmospheric pressure into said chamber to circulate around said chamber includes a hollow container having one end positioned adjacent one wall of said ring-shaped container, a source of air at a pressure in excess of atmospheric pressure, means for directing air from said source tangentially at one end of said cylindrical container, means for directing air from the other end of said cylindrical container into said ring-shaped container, means for introducing air under pressure tangentially along a wall of said ring-shaped container for circulating said powder-air mixture, walls defining an opening extending between the end of said cylindrical container adjacent said one wall of said ring-shaped container and into and through said one wall of said ring-shaped container, source of air at a pressure less than atmospheric, and means for coupling said source of air at a pressure less than atmospheric to the interior of said cylindrical container through the other end thereof.

References Cited

UNITED STATES PATENTS

2,928,575	3/1960	Carlson	222—193
2,935,234	2/1960	Huber	222—193
3,221,938	12/1965	Yonkers et al.	222—76

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U.S. Cl. X.R.

222—193; 118—637