

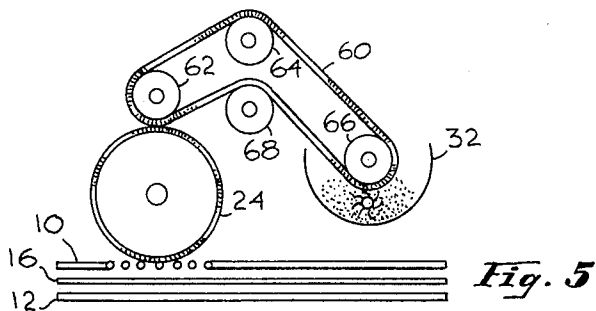
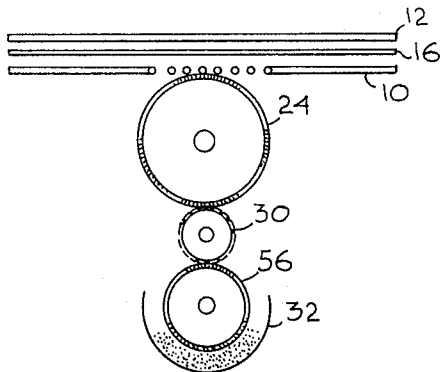
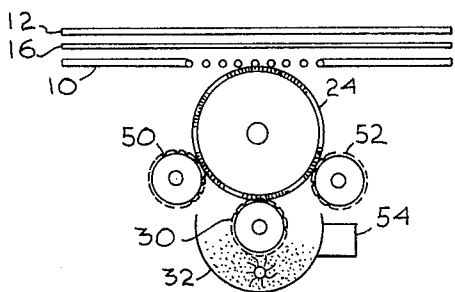
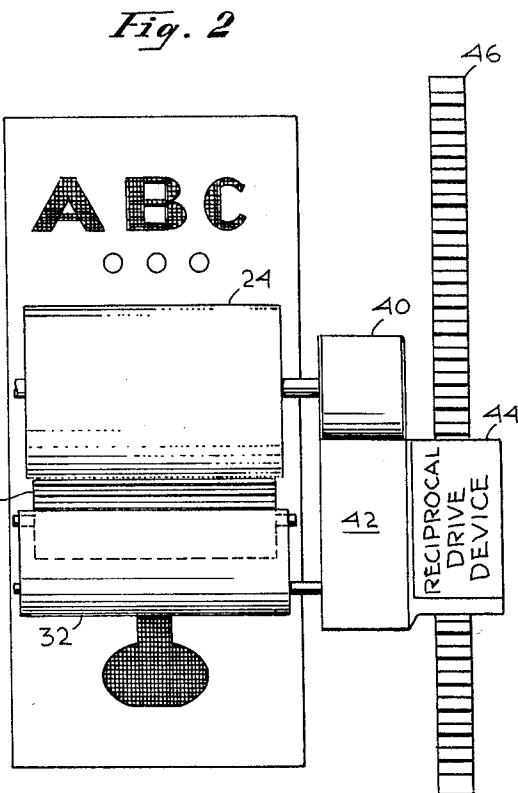
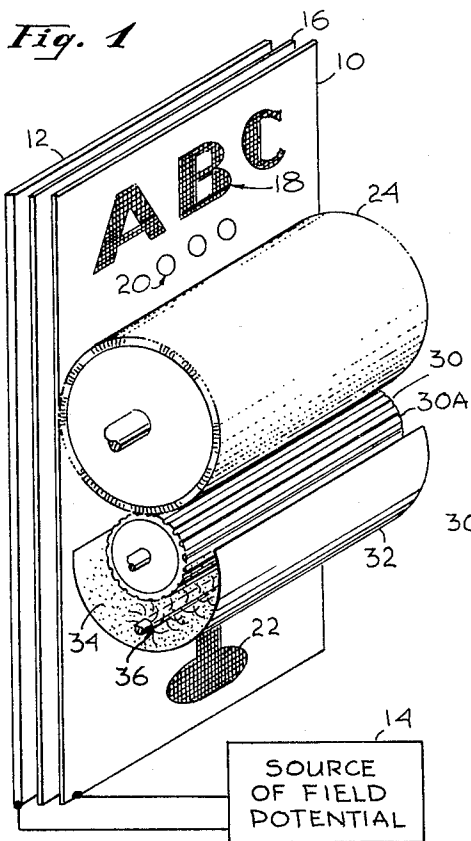
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C. O. CHILDRESS ETAL

3,283,703

ELECTROSTATIC PRINTING BRUSH POWDER FEED SYSTEM

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3,283,703

ELECTROSTATIC PRINTING BRUSH POWDER FEED SYSTEM

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4 Claims. (Cl. 101-114)

This invention relates to a powder feed system for a brush used in electrostatic printing systems of the type wherein said brush transfers said powder into an electric field through an image screen electrode, and more particularly to improvements therein.

In Patent No. 3,081,698 to C. O. Childress et al. there is described an electrostatic printing system which comprises a system wherein electroscopic powder particles are applied to the surface of an image receiving member which is positioned in an electric field defined on one side by an image forming member and on the other side by a back plate. The image forming member may comprise a screen having only the openings therein unblocked which are in a pattern in accordance with the image desired. The powder particles may be entered into the electric field by means of a brush which first has the powder applied to the surface thereof and then is rolled over the image defining member to urge the powder particles through the openings therein into the electric field.

It has been found that when a brush is used for the purpose described above, the same difficulties arise, as arise in the wet ink printing process. The brush must constantly present an evenly loaded surface to the image defining electrode. This evenly loaded surface must be maintained, in spite of the uneven demand placed thereon by image areas which may vary from fine images, such as fine type, covering a very small percent of the area of the brush, to large solid regions where the demand upon the brush approaches almost 100 percent. If the powder on the brush is not fully replenished in areas of maximum depletion, this is likely to result in "ghosting"; that is, the next region to be printed with this surface of the brush will show a lack of full print density, comparable in area to the previous heavy demand area. This then represents a "ghost" of the previous image. In the process of replenishing the powder on the brush, the heavily depleted areas must be replenished without overloading adjacent areas upon which there has been very little powder demand.

A number of attempts have been made to accomplish the proper replenishment of the pigment powder on the brush, employing methods analogous to those used in wet ink printing. One of these methods is to redistribute the powder remaining on the brush by means of oscillating rollers or by using a shroud over the brush with a comb-like series of vanes which channel the powder across the brush to provide redistribution thereof on the brush surface. A constant amount of powder is then added along the full length of the brush by means such as a vibrating hopper containing the powder.

These methods still do not provide a complete answer to the problem. The redistribution apparatus causes greatly increased wear on the brush and only approximately compensates for uneven depletion of the powder on the brush. It has also been found difficult to meter new powder onto the brush surface at a rate precisely corresponding to the different amounts used by reason of the different image densities along the image screen, so as to prevent a gradually increasing surplus or deficit.

An object of this invention is to provide an arrangement for substantially replenishing the supply of electro-

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scopic powder to a brush in amounts required to properly perform such replenishment without causing excessive replenishment or depletion.

Another object of the present invention is to provide an improved arrangement for supplying electroscopic powder to a brush in an electrostatic printing system wherein the ghosting problem is eliminated.

Yet another object of the present invention is to provide a novel and improved system for supplying electroscopic powder to a brush used for electrostatic printing.

These and other objects of the present invention are achieved by first transferring electroscopic powder from a source of such powder to a solid and imperforate surface made of material having triboelectric properties such that the powder will adhere to this surface and when thereafter removed will have acquired a charge of the desired polarity. The powder is thereafter removed from this surface by bringing it in contact with the brush surface which effectively picks up a uniform layer of powder from the material. The brush is then revolved in contact with the image screen for transferring the powder into an electric field established between this screen and a backup electrode. The brush, despite continual contact with the surface of the triboelectric material, does not pick up powder beyond a limited saturation amount. The amount of powder on the brush remains uniform as does the amount of powder on the surface of the triboelectric material, where the brush has been saturated, until powder is removed from the brush by the image electrode.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is an isometric view of the brush powder feed arrangement in accordance with this invention.

FIGURE 2 is a front view of the embodiment of the invention shown in FIGURE 1.

FIGURE 3 is a side view of another brush powder feed arrangement in accordance with this invention.

FIGURE 4 shows yet another arrangement of a brush powder feed system in accordance with this invention, and

FIGURE 5 shows a brush powder feed arrangement in accordance with this invention for supplying powder to a brush which is positioned above the image screen electrode.

FIGURE 1 is an isometric view illustrating how the embodiment of this invention is employed for replenishing a brush in an electrostatic writing system with electroscopic powder particles, in a manner so that the brush is evenly loaded despite the powder demands thereon. An electrostatic printing system comprises an image forming electrode or screen 10 and spaced therefrom and parallel thereto is a back plate 12. Both are made conductive for the purpose of establishing an electric field therebetween when a source of field potential 14 is connected to them.

An image receiving member 16, which may be paper, or cloth, or corrugated board, is inserted in the electric field between the two field establishing electrodes. The screen 10 has apertures therethrough which have the shape of the desired image, be it a letter, number, or pattern. By way of example, on the image screen 10 there are shown large letters 18, smaller letters 20, and a pattern 22.

A brush 24 is rolled over the screen surface. Electroscopic powder is deposited on the brush fibers and as the brush rolls over the screen, the powder particles which

are smaller than the openings in the screen 10, are urged through the screen openings into the electric field which transports them to the receiving substrate 16. They are deposited on the substrate with an image pattern substantially identical with the image pattern formed in the screen. The substrate 16 is removed after the brush has traversed the screen area and the powder image which is deposited thereon is fixed by known arrangements such as heating or fusing the powder to the paper, or by spray, or other arrangements depending upon the kind of pigment powder which is employed.

As previously indicated, heretofore, because of the varying powder demand on the brush due to different image sizes, exemplified by the screen images 18, 20, and 22, problems in maintaining the brush uniformly loaded with powder arose. In accordance with this invention, there is provided a powder transfer roller 30, having a solid and imperforate surface which is rotatably supported within a powder container 32, in a manner so that the periphery of the powder transfer roller is in frictional contact with the surface of the brush 24. Thus the powder transfer roller 30 rotates when the brush 24 rotates by reason of its frictional engagement with the surface of the brush. The powder container 32 holds powder 34 in the bottom thereof and the roller 30 picks up the powder from the bottom of the container.

In order to maintain the powder in the container 32 in a fluidized state so as to adequately coat the powder transfer rollers 30, known mechanisms such as a sparsely fibered brush 34 are provided. The brush 36 is rotatably supported in the container 32 and has its periphery in engagement with the powder transfer roller 30 and rotates when the powder transfer roller 30 rotates. Alternative means may be the use of very low pressure air fed into the container 32 through a porous base plate or, by vibrating the container.

As may be seen in FIGURE 2, which is a front view of the arrangement shown in FIGURE 1, the brush 24 may be independently rotatably driven by a motor 40, to the shaft of which the brush 24 is coupled. The motor 40 is supported on a frame 42. The container 32 is also attached to the frame 42. The frame 42 is reciprocally moved above the screen 18 for the purpose of bringing the brush 24 in contact with the entire surface of the said screen. The direction of rotation of the brush 24 is reversed for the purpose of maintaining the velocity of the brush periphery relative to the screen constant, which secures a constant density print. Since the frame 42 carries the brush powder replenishing mechanism, constituting the embodiment of this invention, the brush powder load and thereby the powder feed is maintained constant over the entire surface of the screen. The frame 42 is reciprocally actuated by an reciprocal drive device 44 to which it may be attached. This may be, by way of example, a motor which drives reciprocally a gear, not shown, which traverses a rack 46 having the proper length.

Further, in accordance with this invention, the powder transfer roller has its surface solid and substantially imperforate and made of a material having triboelectric properties such that electroscopic powder particles in the container 32 will adhere to its surface and thereby, when removed by the brush, will have acquired a charge of the desired sign. The roller, by virtue of its triboelectric property, picks up a uniform layer of powder. Upon revolving the brush and roller, this powder will transfer and adhere to the brush, up to a limited saturation point. Further contact does not substantially increase the amount of powder on the brush. The powder will remain uniform on both transfer roller and brush until the powder is removed from the brush by the image electrode powder. Powder will then transfer from the roller to the brush and from the reservoir to the roller in sufficient amounts to restore the equilibrium of the system. Thus, the brush

is constantly replenished in direct area and volume correspondence to the demand of the density distribution required by the screen image.

By way of illustration, and not by way of limitation, in one embodiment of the invention, a transfer roller was made of a polymethylmethacrylate such as Plexiglas and operated in a power reservoir trough of the same material. The brush periphery was made of mohair pile fabric. The electroscopic powder which was employed, is known as Xerox Toner Green, manufactured by the Xerox Company. This powder acquired a negative charge by contact with the Plexiglas roller. In order to provide an electric field which would transfer the negatively charged powder particles to the substrate, the image electrode was made negative relative to the back plate.

As another example of an embodiment of the invention, the roller was made of a polytetrafluoroethylene known as Teflon. The electroscopic powder used was Rocket Red A-13, manufactured by the Switzer Corporation. The container was constructed of aluminum. The powder which is charged positive requires for transfer by the electric field, that the image electrode be positive relative to the back plate. The choice of materials and charge direction may be arbitrary with some electroscopic powders, but may show improved performance in a given charge direction with those powders which accept and hold charges of one sign more readily than charges of the other sign.

It is believed that the equalization effects of the brush loading system in accordance with this invention may be explained in the following way. The removal of powder from the brush fiber surface leaves a localized charge on the fiber of opposite sign to the charge of the powder particles. This charge is proportional to the amount of powder released from a given area of the brush and transferred through the image openings of the screen. Those areas where powder has been withdrawn in large amounts are left with strong unsatisfied charges; where no powder has been withdrawn, the charges on the brush are equalized by the attached powder particles. The brush surface passes immediately in contact with the layer of adhered powder on the load roller, which releases powder to the brush in amount proportional to the unsatisfied charges present on the brush fiber surfaces.

The presence of such charge variations in the brush may be easily ascertained by axially isolating cylindrical sections of such a brush so that they may be independently monitored by a suitable electrometer.

Charge loss from the brush to the screen and to atmosphere prevents the accumulation of excess charge in the brush. It is necessary that the brush fiber have relatively rapid charge decay time if the equilibrium of the system is to be maintained at high print speed rates.

A mohair plush fabric suitable for such a brush has a fiber length of 4 mm., which when compressed between 1 cm.² plates to a depth of 3 mm. has a resistivity of 10¹² ohms at 40% relative humidity.

The maintenance of charge equilibrium on the transfer roller is apparently due to charge decay to air and to charge leakage along the surfaces of the materials involved as well as charge exchange with brush fibers. Transfer rollers of solid plastic construction as well as rollers with a thin layer of plastic laminated to a conductive core, which may be grounded, have operated successfully in the described configurations.

A triboelectric charge exchange where more than two materials is involved may be quite complex. It is interesting to note that polished polymethyl methacrylate plastic, such as Rohm & Hass Plexiglas, will acquire a positive charge relative to a mohair fabric surface; however, if the Plexiglas has been machined, it will acquire a negative charge relative to the same material. A typical electroscopic powder, such as Xerox Toner Green, will acquire a negative charge from either a machined or

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polished Plexiglas surface or from a combination of either with a mohair pile surface.

Because of this complex charge interchange between the electroscopic powder and the transfer roller and the brush material, it has been found most expedient to choose triboelectric powder transfer components empirically relative to their performance with a given powder.

A further control of the amount of powder picked up on the transfer roller and thus available to the brush may be exercised by increasing the surface area of the powder transfer roller material by the use of suitable grooves or indentations 30A in the surface of the roller 30.

FIGURE 3 shows another arrangement, in accordance with this invention, for improving the brush powder feed mechanism. Those structures which have functions similar to the structure shown in FIGURE 1 bear similar reference numerals. In FIGURE 3, two rollers 50, 52, which may be the same as the roller 30, are rotatably supported, on either side of the brush 24, also to be in frictional engagement therewith and to be rotated by the rotation of the brush 24. These idler rollers 50, 52 serve the function of picking up and redistributing any localized overload of powder that may result from agglomerates which are caused by insufficient fluidization in the powder reservoir 36. The powder reservoir 36, in this figure of the drawing, is vibrated by a vibratory device 54 which may be an electromagnetic transducer such as a piezoelectric crystal or magnetostrictive device. As previously indicated, vibration of the container can serve to fluidize the powder therein so that a more uniform layer thereof may be deposited on the surface of the roller 30.

FIGURE 4 shows another variation of the embodiment of the invention. Here, a brush roller 56, which is rotatably supported within the container 36, is rotatably driven as a result of frictional engagement with the powder transfer roller 30 which in turn is frictionally engaged with the periphery of the brush 24 which is rotatably driven, as previously described. The brush 56 picks up powder from the powder reservoir and this powder is transferred to the powder transfer roller 30 which in turn loads the brush 24 so that a uniform powder supply is contained thereby.

FIGURE 5 is shown to illustrate the use of an endless belt 60, which is made of triboelectric material, and which may be used in place of the roller 30 to load the brush 24. The endless belt 60 is supported on four suitably spaced idler rollers respectively 62, 64, 66, 68. The belt is held to be in frictional engagement with the periphery of the brush 24 so that as it rotates it causes the belt to

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travel, dipping into the powder container 32 for a charge of particles which are then transferred to the surface of the roller 24 as required.

There has accordingly been described and shown herein a novel arrangement for properly charging with powder a brush, which is employed in an electrostatic printing system, whereby the brush is always uniformly loaded regardless of the powder demand made thereon by the image screen over which the brush is moved.

What is claimed is:

1. In an electrostatic printing system of the type wherein electroscopic powder is applied from a reservoir to a brush which is rotatably moved over the surface of an image forming screen electrode to transfer powder particles therethrough into an electric field, the improvement comprising a first roller having its surface made of a plastic material and having triboelectric properties, means for supporting said first roller rotatably with one portion of its periphery in frictional engagement with the periphery of said brush to be rotatable therewith, means for applying powder from said reservoir to another portion of said first roller periphery, and means for redistributing excess powder over the surface of said brush comprising a second roller having its surface made of plastic material and having triboelectric properties, and means for supporting said second roller rotatably with its periphery in frictional engagement with another portion of the periphery of said brush.

2. In an electrostatic printing system as recited in claim 1 wherein said roller surface is made of polytetrafluoroethylene.

3. In an electrostatic printing system as recited in claim 1 wherein said roller surface is made of polymethylmethacrylate.

4. In an electrostatic printing system as recited in claim 1 wherein each said roller surface has a plurality of grooves thereon for increasing the surface area thereof.

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