

July 23, 1963

D. F. KELLER ETAL

3,098,765

XEROGRAPHIC BRUSH

Filed March 16, 1959

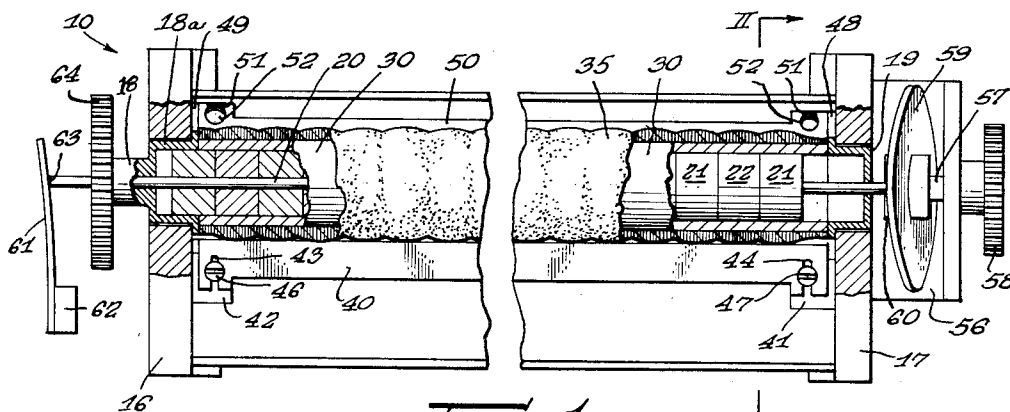


FIG. 1

II

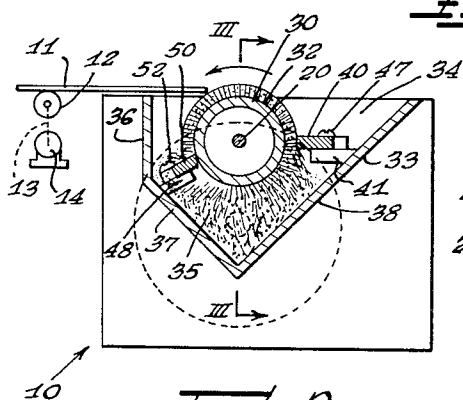


FIG. 2

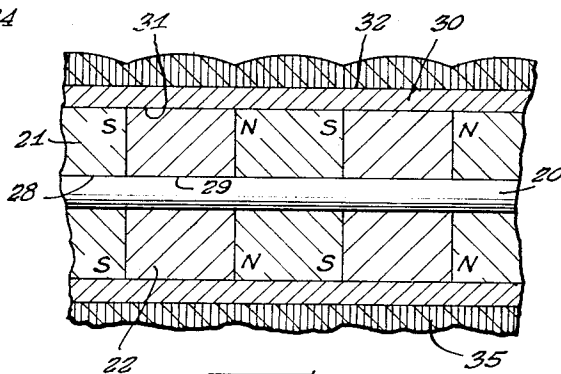


FIG. 3

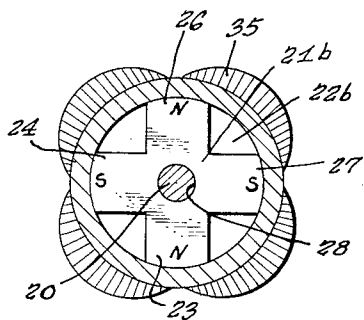


FIG. 4

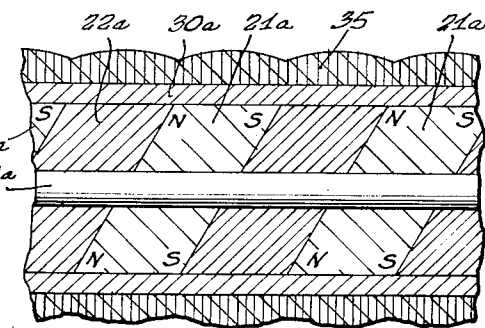


FIG. 5

INVENTORS

Daniel Franklin Keller

William R. Beck, Jr.

By Hill, Sherman, Morris, Gross & Simpson

Attys

1

3,098,765

XEROGRAPHIC BRUSH

Daniel Franklin Keller, Kenilworth, and William R. Beck, Jr., Norridge, Ill., assignors to Robertson Photo-Mechanix, Inc., Chicago, Ill., a corporation of Illinois
Filed Mar. 16, 1959, Ser. No. 799,545
8 Claims. (Cl. 118—637)

This invention relates generally to xerographic apparatus and processes and more particularly relates to a so-called xerographic brush which is adapted to present electroscopic developer powder from a mixture of such powder and a quantity of magnetizable particles onto a member bearing an electrostatic charge image.

In the art of xerography or electrostatic printing as it is sometimes referred to, the reproduction image takes the form of a latent electrostatic charge image forming a magnetic pattern. To develop the latent image, a developer mixture is applied to the image-bearing member. Although developer mixtures take many different forms, a typical developer mix comprises a so-called toner powder or developer powder and a quantity of magnetizable particles such as iron filings, or the like.

According to prior art arrangements, sometimes the developer mixture is merely cascaded over an image-bearing member in anticipation that the toner or developer powder will be deposited in the form of the charge pattern, thereby developing the image. The image-bearing member is then subjected to a fixing process to render the image permanent.

In other forms of apparatus of the prior art, applying means are provided which include magnetic field-producing means taking the form of polar members forming a so-called "brush" of developer mixture. Because of the physical limitations imposed by such polar arrangements, it is extremely difficult to move image-bearing members of commercially practicable sizes past the applying means.

Other difficulties have been encountered with prior art apparatus. For example, it is extremely difficult to move a paper weight image-bearing member through a pre-established "brush," which pre-established brushes are frequently characteristic of the prior art devices. Furthermore, many prior art devices form the streamers or brush-like tufts directly on the magnetic field-producing means with the result that the brush eventually constitutes a greater proportion of magnetizable particles or iron filings than toner powder and an undesirable deposition of mixture is obtained.

All of the deficiencies of the prior art referred to are successfully overcome in accordance with the principles of the present invention by the provision of an apparatus utilizing a source of supply of mixture of developer powder and magnetizable particles through which is moved a non-magnetic surface having magnetic field-producing means behind the non-magnetic surface, thereby to form the brush-like tufts or streamers of the mixture in projecting relationship to the non-magnetic surface. The non-magnetic surface is sequentially passed through the mixture and towards a presentation zone for brushing contact with the image-bearing member. After such brushing contact, the brush-like tufts or streamers are readily and conveniently removed from the non-magnetic surface so that the non-magnetic surface may be conditioned to take on a new supply of mixture.

2

Accordingly, with the present invention the optimum proportions of magnetizable particles and toner powder are always positioned in the presentation zone for brushing contact with the image-bearing member and the application of the mixture to the image-bearing member is accomplished in a gentle brushing fashion and in such a manner that the apparatus is free of objectionable projections and may accommodate image-bearing members of any commercially practicable size.

It is an object of the present invention, therefore, to provide an improved xerographic brush.

Yet another object of the present invention is to provide improved method and apparatus for depositing electroscopic developer powder from a mixture of the powder and a quantity of magnetizable particles onto a member having a latent electrostatic charge image thereon.

Another object of the present invention is to provide developer mixture applying means utilizing a non-magnetic presentation surface, thereby facilitating removal of the mixture from the surface to condition the surface for taking on a fresh supply of mix.

Another object of the present invention is to form a developer mixture applying means which can accommodate image-bearing members of any commercially practicable size.

A further object of the present invention is to provide a method wherein an image-bearing member is sequentially subjected to a series of separate brushing contacts, thereby to reduce the quantum of magnetizable particle residue, while increasing the quantum of powder deposited in the pattern of the charge image.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheet of drawings in which a preferred structural embodiment of apparatus incorporating the principles of the present invention is shown by way of illustrative example. It is believed that the methods of the present invention will become manifest to those versed in the art from the detailed description of the apparatus employed for practicing the steps of the method.

On the drawings:

FIGURE 1 is a top plan view with parts broken away and with parts shown in cross-section illustrating a xerographic brush provided in accordance with the principles of the present invention;

FIGURE 2 is a cross-sectional view taken on line II—II of FIGURE 1;

FIGURE 3 is a fragmentary cross-sectional view taken on line III—III of FIGURE 2;

FIGURE 4 is a fragmentary cross-sectional view showing a modified form of magnet; and

FIGURE 5 is a view similar to FIGURE 3 but showing an alternative arrangement in accordance with the present invention.

As shown on the drawings:

The xerographic brush of the present invention is indicated generally by the reference numeral 10 and it will be understood that the apparatus disclosed is utilized in conjunction with xerographic apparatus or may be used in connection with the practice of xerographic processes wherein an image-bearing member is provided with an electroscopic charge pattern. A typical image-bearing

member is indicated in FIGURE 2 at 11. Means for moving the image-bearing member 11 are shown diagrammatically at 12 and are mechanically driven through suitable mechanical connection means 13 by a motor 14.

In order to establish a presentation zone in which a developer mixture is presented to the image-bearing member for developing the latent electroscopic image, there is provided the apparatus 10 shown in detail in FIGURES 1 and 2. Thus, spaced apart standards 16 and 17 are formed and carry bearings 18 and 19 to rotatably journal a non-magnetic shaft member 20.

Arranged in a longitudinal row along the length of the non-magnetic shaft 20 are alternately spaced magnetic field-producing means or magnets 21 in FIGURE 3, 21a in FIGURE 5 and 21b in FIGURE 4 and magnetic insulators 22 in FIGURE 3, 22a in FIGURE 5 and 22b in FIGURE 4, the shaft 20 together with the parts 21 and 22 forming a generally cylindrical core. As will be evident from comparing FIGURES 3 and 4, the magnetic members 21 may conveniently be ordinary cylindrical disks but may also take the form of a cross-shaped disk 21b having radially extending legs identified at 23, 24, 26, and 27. The outer peripheral surface of the legs 23, 24, 26 and 27 is rounded, thereby to prescribe a cylindrical peripheral surface.

The magnetic insulators 22 conveniently take the form of cylindrical disks and the outer peripheral surface of the disks 22 corresponds in diametral dimension to the surfaces prescribed by opposing leg members 23 and 26 and 24 and 27.

The magnetic members 21 are cylindrical magnets magnetized along the axis of rotation and are formed with center apertures 28 receiving the shaft 20 and the magnetic insulators 22 are formed with center apertures 29 for the same purpose, but it will be understood that the magnetic members 21 and the magnetic insulators 22 are firmly mounted on the shaft 20 for corotation therewith.

In order to closely embrace the core and to form a non-magnetic surface adapted to support projecting streamers or brush-like tufts of developer mixture, a tubular member or sleeve 30 is provided. The sleeve 30 is made of non-magnetic material and can conveniently comprise a glass material or plastic or any of the non-magnetic metals such as brass, aluminum or copper may be employed. In any event, it will be understood that it is important that the sleeve 30, as well as the shaft 20 and the magnetic insulators 22 be made of suitable non-magnetic material, thereby to develop the advantageous features contemplated herein.

The sleeve 30 has a through bore 31 of an inside diameter accommodating the outside dimension of the magnetic members 21 and the magnetic insulators 22. The sleeve further includes an outer peripheral surface 32 adapted to support and carry the developer mixture.

It will be understood that the magnetic members 21 or 21b can conveniently comprise permanent magnets and, as shown in the drawings, the permanent magnets exhibit the polarities indicated by legend showing the north and south poles. Thus, magnetic fields are produced which result in lines of flux passing through the non-magnetic sleeve 31 and forming flux concentrations such that streamers or brush-like tufts of developer mix will be formed in projecting relationship to the peripheral surface 32 and prescribing an undulating pattern as shown in the drawings. It is advantageous in providing independent magnets as arranged in FIGURES 1 and 3 that the flux produced from magnetic pole to pole is relatively constant across the face of the disks, thereby overcoming the disadvantages of long pole pieces where flux distribution is difficult to control.

In order to sequentially move the non-magnetic surface 32 through a source of the developer mixture and towards a presentation zone, there is provided means forming a supply source and more particularly comprising a trough shaped member 33 extending between the standards

16 and 17 and carried thereby, thereby to provide a hopper 34 in which is received a supply of developer mixture. The developer mixture can comprise any suitable material used in the xerographic arts for developing latent electroscopic images, however, it will be understood that one example of such a mix comprises a developer or toner powder and a ferromagnetic carrier material such as iron filings. The developer mixture is indicated by the reference numeral 35. The trough-shaped member 33 forming the hopper 34 has a vertical wall 36 and first and second inclined walls 37 and 38. The shaft 20 is positioned in the standards 16 and 17 to position the sleeve 30 with the peripheral surface thereof just adjacent the top boundary of the hopper 34. Thus, the open top of the hopper 34 forms a presentation zone over which the image-bearing member 11 is moved for brushing contact with the mixture carried on the non-magnetic surface 32 of the sleeve 30.

In order to provide an evenly projecting mass of mixture on the surface 32, a doctor blade 40 is carried on spaced supporting brackets 41 and 42, the ends of the doctor blade 40 being slotted as at 43 and 44 and cooperating with screw fasteners 46 and 47 so that the doctor blade may be positioned towards and away from the surface 32 of the sleeve 30. Thus, as the sleeve 30 is sequentially moved through the supply of mixture 35 in the hopper 34, the magnetic field-producing means or magnet members 21 will form streamers or brush-like tufts on the surface 32, the doctor blade 40 trimming the mass of developer mixture to a uniform thickness on the surface 32.

After brushing contact has been established between the image-bearing member 11 and the developer mixture 34 carried on the surface 32, the sleeve 30 moves past a scraping means comprising spaced supporting brackets 48 and 49 carrying a scraping blade 50 which is slotted as at 51 for adjustable positioning in cooperation with screw fasteners 52. It will be noted that the rear edge of the scraper blade 50 is spaced from the vertical wall 36 and from the inclined wall 37, thereby to form an elongated opening permitting the scraped off residue to be reintroduced into the lower portion of the hopper 34. By positioning the scraping blade 50 closely adjacent the peripheral surface 32 of the sleeve 30, all of the residue is readily removed from the non-magnetic sleeve 30 and the surface 32 of the sleeve 30 is thereby conditioned to take on a fresh supply of developer mixture.

The core of the device comprising the non-magnetic shaft 20, the magnetic members 21 and the magnetic insulators 22 is relatively reciprocable inside the bore 31 of the sleeve 30. Moreover, if desired, the parts may be relatively reciprocated concurrently with the rotation of the sleeve 30 to vary the longitudinal spacing of the undulations exhibited in the developing mixture carried on the surface 32 and improving the brushing contact with the image-bearing member 11. To effect that end, the standard 17 is provided with a projection 56 in which is journaled a shaft 57 rotatably driven by a suitable prime mover including the gear part 58 and rotating an angularly inclined wobble plate 59.

One end of the non-magnetic shaft member 20 is provided with an engaging member 60 which engages against the face of the wobble plate 59 so that upon rotation of the wobble plate 59, the shaft and the sleeve will be relatively reciprocated. In FIGURE 1, there is shown a leaf spring 61 securely fastened as at 62 at one end and engaging against the opposite end of the shaft 20 as at 63 to continuously bias the core through the shaft 20 against the wobble plate 59.

It will be understood that the scraping blade 50 and the doctor blade 40, as well as the other accessory components, are preferably made of non-magnetic material.

In order to rotatably drive the shaft 20 and the sleeve 30, a suitable connection is provided to a prime mover and is illustrated as including a gear member 64 which is splined to the shaft 20 in driving relation. The sleeve

30 is rotatable and, as illustrated herein, the bearing 18 has a hub rotatable with the gear 64 and is connected to the sleeve 30 via a sleeve portion 18a. The bearing 19 is likewise connected to the sleeve 30 and the bearings 18 and 19 are journaled in the standards 16 and 17. The shaft 20, of course, is not only journaled by the bearings 18 and 19, but is slidable with respect thereto. Thus, it will be understood that while the device is being rotated, the core and the sleeve 30 are being relatively reciprocated, thereby agitating the developer mix on the surface 32 of the sleeve 30.

In the embodiment of FIGURE 5, the magnetic field-producing means are indicated as including magnetic members 21a and the magnetic insulators are indicated at 22a, the same being disposed in a longitudinal row on a shaft indicated at 20a. In this form of the invention, the members 21a and 22a comprise disks which are offset in angular relationship to the rotational axis of the shaft 20a and, accordingly, the undulations evidenced in the developer mixture on the external surface of the sleeve, herein indicated at 30a, will be distributed in the form of a partial helix. Accordingly, upon rotation of the sleeve 30a together with the shaft 20a, the relative position of the undulations will change with respect to the image-bearing member such as the image-bearing member 11 moved into the presentation zone.

In applying developer mixture to an image-bearing member, it is highly desirable that the deposit of toner powder on the charged image be maximized while the quantum of magnetizable particles retained as a residue on the image-bearing member be minimized.

In practicing xerographic development in accordance with the principles of the present invention, it has been found that excellent results are obtained by effecting a uniform relative movement between the image-bearing member 11 and the surface 32 of the sleeve 30 so that a continuous brushing contact is effected between the image-bearing surface of the image-bearing member 11 and the streamers or bush-like tufts of developer mixture 35.

It has been further noted, however, that the present invention lends itself to the provision of multiple units 10 arranged in series, thereby to sequentially subject an image-bearing member and a supply of brush-like tufts of the developer mixture to a series of separate brushing contacts, which sequential series of separate brushing steps operates to reduce the quantum of magnetizable particle residue while increasing the quantum of powder deposited in the pattern of the charge image.

It is also possible, of course, to reversely operate the motive means 12 and to repeatedly pass the image-bearing member 11 over a single applying unit 10 since it is characteristic of the present invention that the moving surface 32 is continuously conditioned to take on a fresh supply of developer mixture and thus the repeated brushing contacts are effected by sequentially subjecting the image-bearing member to a series of separate brushing contacts with the same unit 10.

With the provision of the xerographic brush 10, the surface carrying the mixture is moved in direction opposite the direction of movement of the image-bearing member 11. For example, the rotational direction of the sleeve 30 is shown by the arrow in FIGURE 2 to be in counterclockwise direction while the image-bearing member 11 moves from left to right. The relative opposite movement insures good coverage of the image area without requiring excessive operational speeds.

Moreover, by providing sidewise sweeping of the image area through relative reciprocation of the inner and outer parts, directionalization blind spots in image development are obviated.

The use of the unit 10 also affords ready access to the source of supply for replenishing the toner powder or for adding mixture to the trough hopper 34.

Although various minor modifications might be sug-

gested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. A xerographic brush comprising a rotatable non-magnetic shaft, a plurality of magnets and non-magnetic members alternately spaced in a longitudinal row on said shaft to form a cylindrical core rotatable with said shaft, and a cylindrical sleeve of non-magnetic material on the outer periphery of said cylindrical core and co-rotatable therewith, said sleeve having an outer peripheral surface adapted to support brush-like tufts of xerographic developer mixture thereon, said core and said sleeve being relatively axially reciprocable and drive means rotatably driving said shaft and comprising a rotatably driven wobble plate, and spring biasing means loading said shaft against said wobble plate, thereby to effect said reciprocation concurrently with the rotation of said shaft.

2. A xerographic brush comprising a rotatable non-magnetic shaft, a plurality of magnets and non-magnetic members alternately spaced in a longitudinal row on said shaft to form a cylindrical core co-rotatable with said shaft, a cylindrical sleeve of non-magnetic material having an inside surface engaging said cylindrical core and being co-rotatable therewith, said cylindrical sleeve having an outer peripheral surface adapted to support brush-like tufts of xerographic developer mixture thereon, said core and said sleeve being relatively axially reciprocable, drive means for rotatably driving said core and said sleeve, and separate drive means including a wobble plate engaging said shaft and rotatably driving said wobble plate to effect reciprocation between said core and said sleeve concurrently with rotation thereof, means forming a supply of xerographic developer mixture subjacent said sleeve and into which said sleeve dips upon rotation thereof, and scraper means on one side of said sleeve for scraping mixture off of said sleeve and thereby conditioning said sleeve to take on a fresh supply of mixture.

3. A xerographic brush comprising a rotatable non-magnetic shaft, a plurality of magnets and non-magnetic members alternately spaced to form a cylindrical core co-rotatable with said shaft, a rotatable cylindrical sleeve of non-magnetic material having an inside surface engaging said cylindrical core, said cylindrical sleeve having an outer peripheral surface adapted to support brush-like tufts of xerographic developer mixture thereon, drive means to drive said core and said sleeve including separate means to rotate said core and said sleeve and to move said core and said sleeve relative to one another, means forming a supply of xerographic developer mixture subjacent said sleeve and into which said sleeve dips upon rotation thereof, and scraper means on one side of said sleeve for scraping mixture off of said sleeve and thereby conditioning said sleeve to take on a fresh supply of mixture.

4. A xerographic brush as defined in claim 3, said magnets and non-magnetic members comprising generally annular members disposed in right angular relationship on said shaft.

5. A xerographic brush as defined in claim 3, said magnets and non-magnetic members comprising annular members disposed in angularly offset relation on said shaft.

6. A xerographic brush as defined in claim 3, said drive means including said means for effecting relative movement of said sleeve and said core comprising a rotatably driven wobble plate and spring biasing means loading said shaft against said wobble plate, thereby to effect reciprocation of said core concurrently with rotation of said core and said sleeve.

7. A xerographic brush as defined in claim 3, said

7

magnets comprising annular disks having their opposite radial faces of opposite polarity.

8. A xerographic brush as defined in claim 3, said magnets comprising cross-shaped disks having radially extending legs of different polarity.

References Cited in the file of this patent

UNITED STATES PATENTS

456,507	Fiske	July 21, 1891
500,604	Payne	July 4, 1893
994,871	Payne	June 13, 1911

5

1,068,453
1,643,117
2,786,440
2,786,441
2,822,779
2,832,311
2,854,947
2,959,153
2,975,758
3,003,462
3,015,305

8

Rowand	July 29, 1913
Gustavson	Sept. 30, 1927
Gialmo	Mar. 26, 1957
Young	Mar. 26, 1957
Schroeder	Feb. 11, 1958
Byrne	Apr. 29, 1958
Gialmo	Oct. 7, 1958
Hider	Nov. 8, 1960
Bird	Mar. 21, 1961
Streich	Oct. 10, 1961
Hall et al.	Jan. 2, 1962