March 21, 1961 J. W. BIRD, JR 2,975,758

APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGES

Filed March 13, 1958

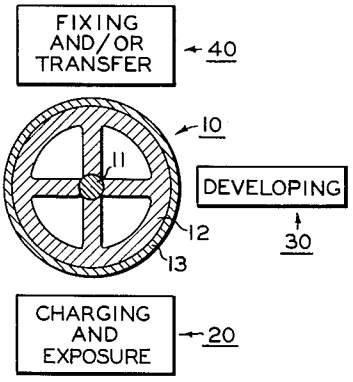


FIG. 1

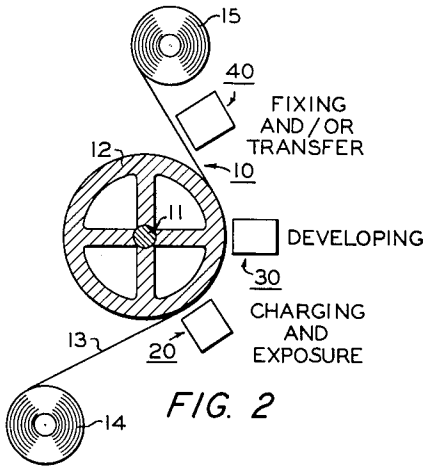


FIG. 2

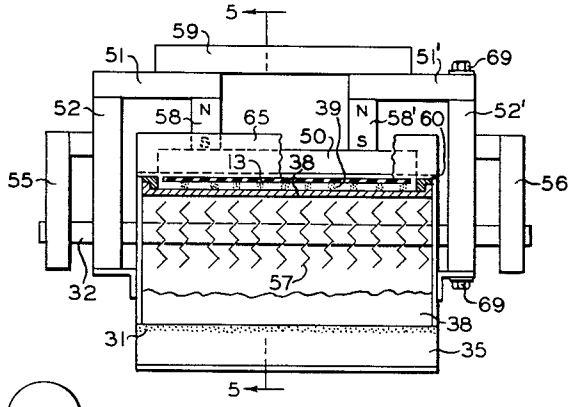


FIG. 4

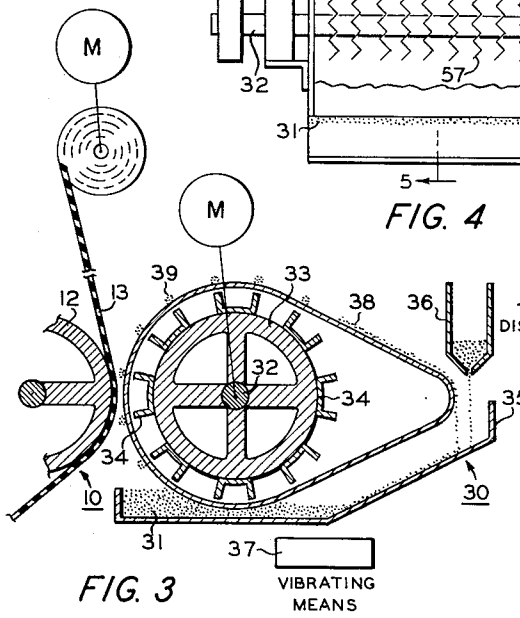


FIG. 3

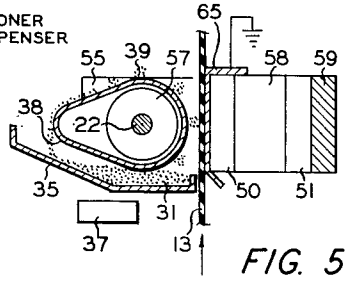


FIG. 5

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APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGES

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7 Claims. (Cl. 118—637)

My invention relates to xerography and more particularly to improved means for applying electroscopic developer material on to a surface bearing an electrostatic image.

In xerography it is usual to form an electrostatic image on a surface. One method of doing this is to charge a photoconductive insulating surface and then dissipate the charge selectively by exposure to a pattern of activating radiation as set forth, for instance, in U.S. 2,297,691 to Chester F. Carlson. Other means of forming electrostatic images are set forth in U.S. 2,647,464 to James P. Ebert. Whether formed by these means or any other, the resulting electrostatic charge pattern is conventionally utilized by the deposition of an electroscopic material thereon through electrostatic attraction whereby there is formed a visible image of electroscopic particles corresponding to the electrostatic image. Alternatively, the electrostatic charge pattern may be transferred to an insulating film as disclosed, for example, in U. S. 2,825,814 to L. E. Walkup and the electroscopic particles deposited thereon to form the visible image. In any case this visible image, in turn, may be transferred to a second surface to form a xerographic print or may be fixed directly to the photoconductive surface.

The usual process of applying the developer to the electrostatic image is set forth in U.S. 2,618,552 to E. N. Wise and involves the use of a finely-divided colored material called a toner deposited on a slightly more coarsely divided material called a carrier. This two-component developer is cascaded across the electrostatic image areas. The toner and carrier being rubbed against each other while cascading impart an electrostatic charge to each other by triboelectric charging. To produce a positive of the electrostatic image a toner and carrier are selected such that the toner will be charged to a polarity opposite to that of the electrostatic image, the carrier being charged to the same polarity as the electrostatic image. When a carrier particle, bearing on its surface oppositely charged particles of toner, crosses an area on the image surface having an electrostatic charge, the charge on the surface exerts a greater attraction for the toner than the carrier and retains the toner in the charged area and separates it from the carrier particles. The carrier particles being oppositely charged and having greater momentum are not retained by the charged areas of the plate. When a toned carrier particle passes over a non-charged area of the plate, the electrostatic attraction of the carrier particles for the toner particles is sufficient to retain the toner on the carrier preventing deposition in such areas as the carrier particles momentum carries both toner and carrier past. By this mechanism, the image is developed, i.e., made visible.

As disclosed in U.S. 2,618,551 to L. E. Walkup, such carrier particles may have magnetic properties. When a developer mix comprising a toner and a ferromagnetic carrier material is contacted with a magnet so that streamers are formed which constitute a brush-like mass, the brush then passed over the surface bearing the electrostatic latent image whereby the brush contacts the image-bearing surface, the developer is both triboelectrically charged and deposits on the electrostatic image in a manner similar to that wherein the toner and carrier mix is cascaded across the image-bearing surface.

An object of the present invention is to provide a novel means for applying electroscopic developer powder to an electrostatic image-bearing member.

Another object of this invention is to provide suitable means as set forth, wherein the developer mix is applied by a magnetically maintained brush.

A further object is to provide developing means as set forth, wherein electrostatic images may be continuously developed and wherein the supply of developer powder may be continuously replenished without interrupting the development process.

Other objects and advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description in connection with the accompanying drawings in which:

Fig. 1 is a side elevation, partly schematic, illustrating apparatus for practicing the overall xerographic process including the instant invention.

Fig. 2 is a side elevation, partly schematic, illustrating apparatus according to another embodiment for practicing the overall xerographic process including the instant invention.

Fig. 3 is a side elevation partly schematic and partly in section illustrating apparatus constructed in accordance with the present invention.

Fig. 4 is a top plan view of apparatus according to another embodiment of the present invention.

Fig. 5 is a section taken on line 5—5 of Fig. 4.

The apparatus to be described employing the invention in illustrative form in general comprises a cylinder having a plurality of magnetic field producing means attached to the periphery of the cylinder, the cylinder being rotatably mounted on a frame, means for rotating the cylinder sequentially through a brush forming station, a powder deposition station and a powder releasing station. A continuous non-magnetic shield encloses the cylinder and is so spaced relative to the cylinder that the cylinder rotates freely within the shield and the lines of force from the magnetic surface of the cylinder extend through and beyond the shield at the brush forming station and the powder deposition station with the shield extending beyond the lines of force at the brush releasing station. Suitable means as a trough supply magnetic developer particles in contact with the non-magnetic shield at the brush forming station. The apparatus also includes an electrostatic image-bearing member and means to move the image-bearing member through the magnetic field of the cylinder at the powder deposition station. The portion of the shield at the brush releasing station is positioned and adapted so that magnetic developer particles are moved over the brush-releasing portion of the shield by the forces of gravity and inertia.

Referring now to the drawings in more detail, there is shown in Fig. 1 suitable apparatus for xerographically reproducing an image pattern of light and shadow. The apparatus comprises a drum **10** mounted to rotate on its axis **11**. The drum **10** comprises a photoconductive insulating surface **13** coated on a conductive surface **12**. Positioned around the periphery of the drum **10** in the direction of motion of the drum are charging and exposing means **20**, developing means **30**, and fixing and/or transfer means **40**.

In operation, the drum **10** is caused to revolve whereby a given portion of the photoconductive insulating surface **13** first passes under suitable charging means followed by exposure to a pattern of light and shadow to be reproduced at charging and exposure station **20**. Any suitable

charging and exposure means known to those skilled in the art, may be used, such as those shown in U.S. Patent 2,543,051 to Oughton and Bixby or in U.S. 2,690,394 to C. F. Carlson.

After leaving the charging and exposure station 20, the portion of the photoconductive surface 13, now bearing an electrostatic image, passes through a development station 30, to be described in more detail later, whereby the electrostatic image is made visible by the deposition thereon of electroscopic powder particles in conformity with the electrostatic charge pattern.

The powder image on the photoconductive surface now passes through a fixing and/or transfer station where, desirably, the image is first transferred to a suitable support material as paper, plastic or the like and fixed thereto. Any such transfer and fixing means known to those skilled in the art may be used, such as, for example, those illustrated in U.S. 2,701,765 to Codichini, Benson and Mayo.

The photoconductive insulating surface 13 may consist either of a continuous film of a photoconductive insulating material such as amorphous selenium, sulphur, anthracene, mixtures thereof either with each other or with various additional materials such as tellurium, etc. Alternatively, the photoconductive material may be placed on the support in the form of finely-divided particles in a binder composed of a highly insulating resinous binder. Suitable photoconductors for application in binder form include not only the above named photoconductive insulators but also photoconductive phosphors such as the oxides, sulfides and selenides of zinc and cadmium, mixtures thereof with each other, titanium dioxide, tetragonal lead monoxide, mercuric sulfide, etc. Suitable insulating binders include silicone resins, acrylic resins, vinyl resins, etc., as is well known to those skilled in the art. The photoconductive insulator, either in a continuous film or in a binder, is coated on the conductive surface 12 such as aluminum, brass, conductively coated glass, etc.

Alternatively the photoconductive insulating surface 13, rather than being coated directly on the conductive back ing 12 as in Fig. 1, may be applied to a web or sheet as of paper, plastic or the like which is supplied from feed roll 14 to take-up roll 15, so positioned as to move the paper through the charging and exposure (20) and developing (30) stations in electrical contact with the conductive backing 12 of the drum 10 as shown in Fig. 2. A material highly suited for such a device is a suitable photoconductor as described above in an insulating binder coated on a paper backing. The method of operation of the device is the same as in Fig. 1 except that here the powder image need not be transferred from the photoconductive surface but instead may be affixed thereto at the fixing station 40 as by heat, solvent vapors or the like. A flux concentrating means may desirably be positioned within the drum bearing the electrostatic latent image adjacent to the development station as will be described hereafter.

One embodiment of developing apparatus according to the instant invention is shown in detail in Fig. 3. Positioned adjacent to the drum 10 bearing the photoconductive insulating layer 13 is a cylinder 33 rotating about axis 32. Positioned on the drum 33 are a series of bar magnets 34 mounted around and flush with its periphery. A teardrop shaped non-magnetic shield 38 surrounds the cylinder 33 and is so oriented that the large end of the shield 38 is in close proximity to the surface 13 bearing the electrostatic latent image. A trough or similar reservoir 35 holds a supply of magnetic developer particles 31 in contact with non-magnetic shield 38 at a point in the direction of rotation of cylinder 33 immediately prior to its passing in proximity to the image-bearing surface 13. The shield 38 is so positioned relative to the magnets 34 that the lines of force from magnets 34 extend through the shield 38 except at the small end of the teardrop. Suitable means (not shown) as a motor are provided to rotate drum 33.

The method of operation of the device is as follows: Suitable means (not shown) are actuated whereby the surface 13 bearing the electrostatic image thereon is moved through the development position. At the same time the means are actuated causing drum 33 to rotate on axis 32. As the magnetic field producing means 34 passes above the supply of developer mix 31 in trough 35, the lines of force extending from such field producing means 34 cause the developer mix 31 to be oriented against non-magnetic shield 38 in brush-like streamers or masses 39. As the cylinder 33 continues to rotate, the brush-like streamers 39 move over the surface of shield 38 from the brush-forming station opposite trough 35 to the powder deposition station where the drum 12 is adjacent to cylinder 33. The spacing between these members is such that the brush-like streamers 39 on shield 38 pass over the electrostatic image-bearing surface 13 in brushing contact therewith whereby a portion of the toner particles in said developer mix are abstracted from the magnetic carrier component of the brush-like streamers and deposit on the surface 13 in faithful conformity to the electrostatic image thereon. The motion of the brush-like streamers 39 over the shield 38 causes the streamers to approach the small end of the teardrop-shaped shield 38 which is so positioned and adapted that the combined forces of gravity and inertia cause the developer mix to move along said shield 38 beyond the effective action of the lines of force from said field producing means 34 whereupon the developer mix ceases to be oriented by the action of the lines of force into brush-like streamers and assumes the configuration of discrete particles of magnetic carrier coated with toner particles. Desirably, these free developer mix particles are then recycled to the supply of developer mix 31 as by positioning the trough 35 so as to receive the expended developer mix as shown or, if desired, by the use of suitable conveyor means.

There are thus provided extremely simplified means whereby the magnetic brush is continuously reformed in each pass over the developing position. In reusing a magnetic brush the limited amount of toner in the brush is rapidly depleted thereby causing variable densities in the resulting developed powder images. In the instant invention wherein the magnetic brush is continuously reformed from a large supply of developer mix 31, a large number of copies may be produced without reduction in image density or quality due to toner depletion. Furthermore, if desired, toner may be added continuously as through a hopper 36, the rate of addition being automatically selected by the operator according to the average density of the electrostatic images developed. In this manner the apparatus may be run continuously without the necessity of stopping the operation to retone the supply of developer mix. Desirably, suitable vibrating means 37, as a solenoid, may be provided to agitate trough 35 and hence the developer mix 31 thereby assuring uniform mixing of toner and carrier in the developer mix 31.

Another embodiment of apparatus according to the instant invention suitable for either automatic development of electrostatic images or for the development of cut sheets bearing electrostatic images is shown in illustrative form in Figs. 4 and 5. A shaft 32 mounted in bearings 55 and 56 has a plurality of spaced corrugated discs 57 secured thereto at an angle to the axis of the shaft 32. Desirably, the angle is about 90°. The depth of the corrugations should be greater than the spacing between the discs. Magnets 58 and 58' as of Alnico have their south poles connected by pole piece 50. The north poles of the magnets are connected magnetically to the shaft 32 through soft iron members 51, 52 and 51', 52', respectively. Soft iron member 52 and bearing 56 are removably secured by fastening means 69.

Frame member 59 connects between 51 and 51'. The edges of the discs 57 should be in close proximity to the pole piece 50: Enclosing the discs 57 as closely as possible without interference with the radial movement of the discs 57 is non-magnetic shield 38. Shield 38 terminates at each end at shoulders 60 and on the side away from pole piece 50 extends beyond the effect of the line of flux emanating from discs 57. Under the shield 38 is trough 35 arranged to support the developer mix 31 so that the shield 38 dips therein. The top and forward portions of the pole piece 50 may be covered by a sheet 65 of brass so as to provide a suitable bearing surface against which the member 13 bearing the electrostatic image may be readily moved. Any suitable means (not shown) may be used to rotate the shaft 32 and to move the member 13.

In operation a magnetic circuit passes from the north poles of magnets 58 and 58' through tthe end pieces 51, 52 and 51', 52' into the rotary shaft 32 and discs 57. An inner gap of high magnetic flux density exists between the pole piece 50 and the edges of discs 57 thereby in effect acting as a flux concentrating means. As the corrugations of the discs 57 are of greater depth than the spacing between the discs 57, the lines of force of the field producing means effectively cover the entire surface of shield 38 adjacent to said discs 57. Accordingly, when a quantity of magnetic developer mix 31 is placed in the trough 35 and the shaft 32 rotated, the upwardly moving edges of the discs 57 adjacent the shield 38 attract and pick up the magnetic carrier particles and the toner particles adhering thereto and move them along the outside edge of shield 38 in the form of long brush-like streamers into the high flux density magnetic gap between discs 57 and pole piece 50 where the streamers brush over the surface of member 13 bearing the electrostatic image. Here, the toner particles are attracted to the oppositely charged electrostatic image and a portion thereof separated from the carrier particles. The continued rotation of discs 57 causes the brush-like streamers to move over shield 38 past the deposition position until the combined forces of gravity and inertia move the developer mix over shield 38 past the effect of the lines of magnetic flux from said discs 57. The discrete particles of the developer mix are now free to be returned to trough 35. Desirably, vibrating means 37 agitate the trough 35 thereby assuring complete mixture of the carrier and toner particles in the developer mix.

As the toner is used up in operation, additional toner must be added from time to time. There is thus obtained a visible powder image faithfully conforming to the electrostatic image to be developed. The magnetic brush is reconstituted with every rotation of the discs 57 thereby assuring optimum image uniformity even during long, continuous runs.

If it is desired to change the type of developer used as to change from reversal to positive development or to change the color of the toner in the developed images, it is necessary merely to undo fastening means 69, remove the soft iron member 52' bearing 56 assembly and then remove shaft 32. As the discs 57 are pulled through shield 38 the magnetic developer 31 is moved in the direction of motion of shaft 32. Shoulders 60 retain the developer mix 31 in the space above trough 35. Rotating shaft 32 while it is being moved prevents undue compaction of powder between shield 38 and bearing surface 65. When the shaft 32 has been removed from shield 38 there is no longer any magnetic force to retain developer 31 on the outer walls of shield 38. Accordingly, gravity causes the developer 31 to fall into trough 35. The trough 35 is emptied and the new type of developer added. Reinsertion of shaft 32 into shield 38 and securing bearing 56 and soft iron member 52 by fastening 69 quickly and easily reconstitutes the magnetic brush.

A variety of materials may be used to construct the non-magnetic shield such as aluminum, brass, glass, various plastics such as phenolformaldehyde resins, glass fiber laminates, etc. The main requirements are that the material be non-magnetic and possesses the requisite physical properties, as strength. By the term non-magnetic as used herein is meant a material which does not interefere with the lines of force of a magnetic field, i.e., a material having a permeability not substantially different from that of free space. It is particularly preferred to construct the shield out of a material which is not only non-magnetic but also electrically insulating. Thus the shield may be glass, plastic as phenol-formaldehyde, glass fiber laminate, etc. or may be a non-magnetic material as aluminum or brass coated with a suitable electrically insulating resin. Such a shield isolates the magnetic carrier particles constituting the brush so that the average potential of the magnet is determined by the average potential it "sees" on the paper. Thus, the magnet constitutes, in effect, a development electrode whose potential floats at that potential approximating the background potential. This method is highly effective in reducing "background," i.e., deposition of toner in background areas which should reproduce as pure white. If the magnet is too large, it then "sees" a lot of grounded surrounding objects and hence is not influenced exclusively by the background potential.

The carrier material used in the magnetic mix herein consists of magnetically attractable powders such as magnetic ferrites as described in U.S. patents to J. L. Snoeck, Nos. 2,452,529, 2,452,530 and 2,452,531 all dated October 26, 1948, iron carbonyl, alcoholized iron, etc., while any of the large number of toner materials known to those skilled in the art such as those described in U.S. 2,618,551 to L. E. Walkup, U.S. 2,618,552 to E. N. Wise and U.S. patent application Ser. No. 327,452, filed December 22, 1952 by R. B. Landrigan, now Patent 2,753,308, are suitable for mixing with a magnetic carrier to form the developer mix to be employed in the present invention. The ferrites developed by Snoeck described above may also be used as a single component magnetic developer, i.e., the ferrite may act as both carrier and toner.

It is possible to develop a reversal image on a direct image by selecting a toner above or below a desired carrier in the triboelectric series. Alternatively, the same results may be obtained by selecting a carrier above or below a specific toner in the triboelectric series. These and other variations of the instant invention will at once be obvious to those skilled in the art.

There has thus been provided an improved novel means for applying electroscopic developer powder to an electrostatic image. While the present invention, as to its objectives and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

I claim:

1 An apparatus for depositing electroscopic powder from a supply of magnetic developer particles onto an electrostatic image bearing member comprising a frame, a cylindrical magnetic structure producing a magnetic flux externally outside said cylindrical structure and rotatably mounted on said frame, means operatively connected to said frame for rotating said cylindrical structure sequentially through a magnetic brush-forming station, an electrostatic image development station and a magnetic brush-releasing station, a continuous rigid stationary non-magnetic shield operatively connected to said frame and enclosing said cylindrical structure and closely spaced therefrom so that the lines of force from said cylindrical structure extend through and beyond said non-magnetic shield at said magnetic brush-forming station and said development station, said shield sloping downwardly be-

yond the lines of force of said cylindrical structure at said magnetic brush-releasing station, trough means operatively connected to said frame beneath said cylindrical structure and positioned and adapted to retain the supply of magnetic developer particles in contact with said non-magnetic shield whereby said particles are formed into a brush-like array by the lines of force of said cylindrical structure, an electrostatic image-bearing member, means operatively connected to said frame to move said image-bearing member through the magnetic field of said cylindrical structure at said power deposition station, the rotation of said cylindrical structure causing said developer particles to move through said deposition station over said shield in brush-like configuration contacting said image-bearing member at said development station, said non-magnetic shield being positioned and adapted so that as the rotation of said cylindrical structure moves said developer particles through said development station into said magnetic brush-releasing station, the force of gravity causes said particles to move through said magnetic brush-releasing station after said shield has removed said particles beyond the lines of force of said cylindrical structure.

2. An apparatus for depositing electroscopic powder from a supply of magnetic developer particles onto an electrostatic image bearing member comprising a frame, a cylindrical magnetic structure producing a magnetic flux externally outside said cylindrical structure and rotatably mounted on said frame, means operatively connected to said frame for rotating said cylindrical structure sequentially through a magnetic brush-forming station, an electrostatic image development station and a magnetic brush-releasing station, a continuous rigid stationary non-magnetic electrically insulating shield operatively connected to said frame and enclosing said cylindrical structure and closely spaced therefrom so that the lines of force from said cylindrical structure extend through and beyond said non-magnetic electrically insulating shield at said magnetic brush-forming station and said development station, said shield sloping downwardly beyond the lines of force of said cylindrical structure at said magnetic brush-releasing station, trough means operatively connected to said frame beneath said cylindrical structure and positioned and adapted to retain the supply of magnetic developer particles in contact with said non-magnetic electrically insulating shield whereby said particles are formed into a brush-like array by the lines of force of said cylindrical structure, an electrostatic image-bearing member, means operatively connected to said frame to move said image-bearing member through the magnetic field of said cylindrical structure at said development station, the rotation of said cylindrical structure causing said developer particles to move through said development station over said shield in brush-like configuration contacting said image-bearing member at said development station, said non-magnetic electrically insulating shield being positioned and adapted so that as the rotation of said cylindrical sturcture moves said developer particles through said development station into said magnetic brush-releasing station, the force of gravity causes said particles to move through said magnetic brush-releasing station after said shield has removed said particles beyond the lines of force of said cylindrical structure.

3. An apparatus for depositing electroscopic powder from a supply of magnetic developer particles onto an electrostatic image bearing member comprising a frame, a cylindrical magnetic structure producing a magnetic flux externally outside said cylindrical structure and rotatably mounted on said frame, means operatively connected to said frame for rotating said cylindrical structure sequentially through a magnetic brush-forming station, an electrostatic image development station and a magnetic brush-releasing station, a continuous rigid stationary non-magnetic electrically insulating shield operatively connected to said frame and enclosing said cylindrical structure and closely spaced therefrom so that the lines of force from said cylindrical structure extend through and beyond said non-magnetic electrically insulating shield at said magnetic brush-forming station and said development station, said shield sloping downwardly beyond the lines of force of said cylindrical structure at said magnetic brush-releasing station, trough means operatively connected to said frame beneath said cylindrical structure and positioned and adapted to retain the supply of magnetic developer particles in contact with said non-magnetic electrically insulating shield whereby said particles are formed into a brush-like array by the lines of force of said cylindrical structure, means operatively connected to said frame to agitate said trough, an electrostatic image-bearing member, means operatively connected to said frame to move said image-bearing member through the magnetic field of said cylindrical structure at said development station, the rotation of said cylindrical structure causing said developer particles to move through said development station over said shield in brush-like configuration contacting said image-bearing member at said development station, said non-magnetic electrically insulating shield being positioned and adapted so that as the rotation of said cylindrical structure moves said developer particles through said development station into said magnetic brush-releasing station, the force of gravity causes said particles to move through said magnetic brush-releasing station after said shield has removed said particles beyond the lines of force of said cylindrical structure, and means for recycling said particles to said trough.

4. An apparatus comprising a frame, means operatively connected to said frame for supporting and advancing a member bearing an electrostatic charge pattern past an electrostatic image development station, a drum rotatably mounted on said frame, a plurality of magnetic field producing means arranged in spaced relation about the periphery of said drum and operatively connected thereto, a continuous rigid stationary non-magnetic shield operatively connected to said frame and enclosing said drum and field producing means and spaced therefrom within the lines of force of said field producing means at a magnetic brush-forming station and the development station and sloping downwardly beyond said lines of force at a magnetic brush-releasing station, means operatively connected to said frame for rotating said drum and thereby each of said field producing means within said shield sequentially past a quantity of a developer mix including electroscopic developer powder and carrier particles of magnetic material, said mix being in contact with said shield at said magnetic brush-forming station, then past the development station and then said magnetic brush-releasing station, said mix forming a brush-like mass adhering to said shield opposite each of said field producing means and moving with the rotation of said drum in contact with said shield in brush-like configuration from said magnetic brush-forming station into brushing contact with said member bearing an electrostatic charge pattern at said development station to said magnetic brush-releasing station, said shield being positioned and adapted so that gravity and inertia move said developer mix through said magnetic brush-releasing station beyond the effect of said field producing means.

5. An apparatus comprising a frame, means operatively connected to said frame for supporting and advancing a member bearing an electrostatic charge pattern past an electrostatic image development station, a cylindrical magnetic drum for producing a magnetic flux externally outside said drum and operatively connected thereto, a continuous rigid stationary nonmagnetic shield operatively connected to said frame and enclosing said drum and field producing means and spaced therefrom within the lines of force of said field producing means at a magnetic brush-forming station and the development

station and sloping downwardly beyond said lines of force at a magnetic brush-releasing station, means operatively connected to said frame for rotating said drum within said shield sequentially past a quantity of a developer mix including electroscopic developer powder and carrier particles of magnetic material, said mix being in contact with said shield at said magnetic brush-forming station, then past development station and then said magnetic brush-releasing station, said mix forming a brush-like mass adhering to said shield opposite each of said field producing means and moving with the rotation of said drum in contact with said shield in brush-like configuration from said magnetic brush-forming station into brushing contact with said member bearing an electrostatic charge pattern at said development station to said magnetic brush-releasing station, said shield being positioned and adapted so that gravity and inertia move said developer mix through said magnetic brush-releasing station beyond the effect of said field producing means.

6. An apparatus comprising a frame, means operatively connected to said frame for supporting and advancing a member bearing an electrostatic charge pattern past an electrostatic image development station, a cylindrical magnetic drum for producing a magnetic flux externally outside said drum and operatively connected thereto, a continuous rigid stationary non-magnetic electrically insulating shield operatively connected to said frame and enclosing said drum and field producing means and spaced therefrom within the lines of force of said field producing means at a magnetic brush-forming station and the development station and sloping downwardly beyond said lines of force at a magnetic brush-releasing station, means operatively connected to said frame for rotating said drum within said shield sequentially past a quantity of a developer mix including electroscopic developer powder and carrier particles of magnetic material, said mix being in contact with said shield at said magnetic brush-forming station, then past the development station and then said magnetic brush-releasing station, said mix forming a brush-like mass adhering to said shield opposite each of said field producing means and moving with the rotation of said drum in contact with said shield in brush-like configuration from said magnetic brush-forming station into brushing contact with said member bearing an electrostatic charge pattern at said development station to said magnetic brush-releasing station, said shield being positioned and adapted so that gravity and inertia move said developer mix through said magnetic brush-releasing station beyond the effect of said field producing means.

7. An apparatus comprising a frame, means operatively connected to said frame for supporting and advancing a member bearing an electrostatic charge pattern past an electrostatic image development station, a cylindrical magnetic drum for producing a magnetic flux externally outside said drum and operatively connected thereto, a continuous rigid stationary non-magnetic electrically insulating shield operatively connected to said frame and enclosing said drum and fiield producing means and spaced therefrom within the lines of force of said field producing means at a magnetic brush-forming station and the development station and extending beyond said lines of force at a magnetic brush-releasing station, means operatively connected to said frame for rotating said drum within said shield sequentially past a quantity of a developer mix including electroscopic developer powder and carrier particles of magnetic material, said mix being in contact with said shield at said magnetic brush-forming station, then past the development station and then said magnetic brush-releasing station, means operatively connected to said frame for agitating said quantity of developer mix, said mix forming a brush-like mass adhering to said shield opposite each of said field producing means and moving with the rotation of said drum in contact with said shield in brush-like configuration from said magnetic brush-forming station into brushing contact with said member bearing an electrostatic charge pattern at said development station to said magnetic brush-releasing station, said shield being positioned and adapted so that gravity and inertia move said developer mix through said magnetic brush-releasing station beyond the effect of said field producing means, and means for recycling said developer mix from said magnetic brush-releasing station to said magnetic brush-forming station.

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