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APPARATUS FOR APPLYING DEVELOPER POWDER TO
PHOTO-CONDUCTIVE INSULATING MATERIAL
Filed Aug. 13, 1962 3 Sheets-Sheet 1

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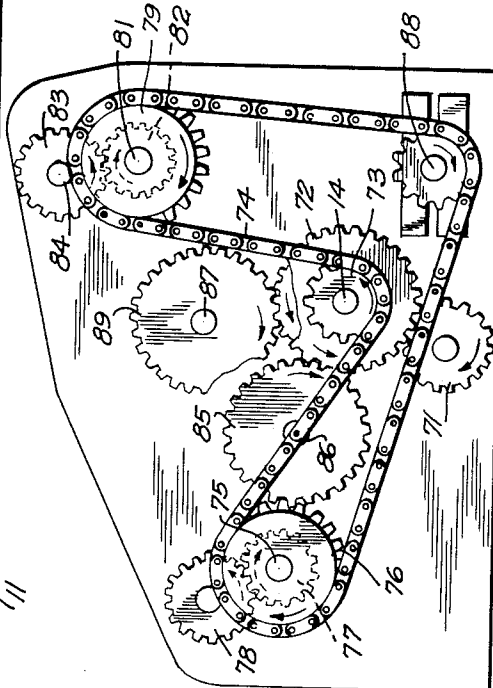
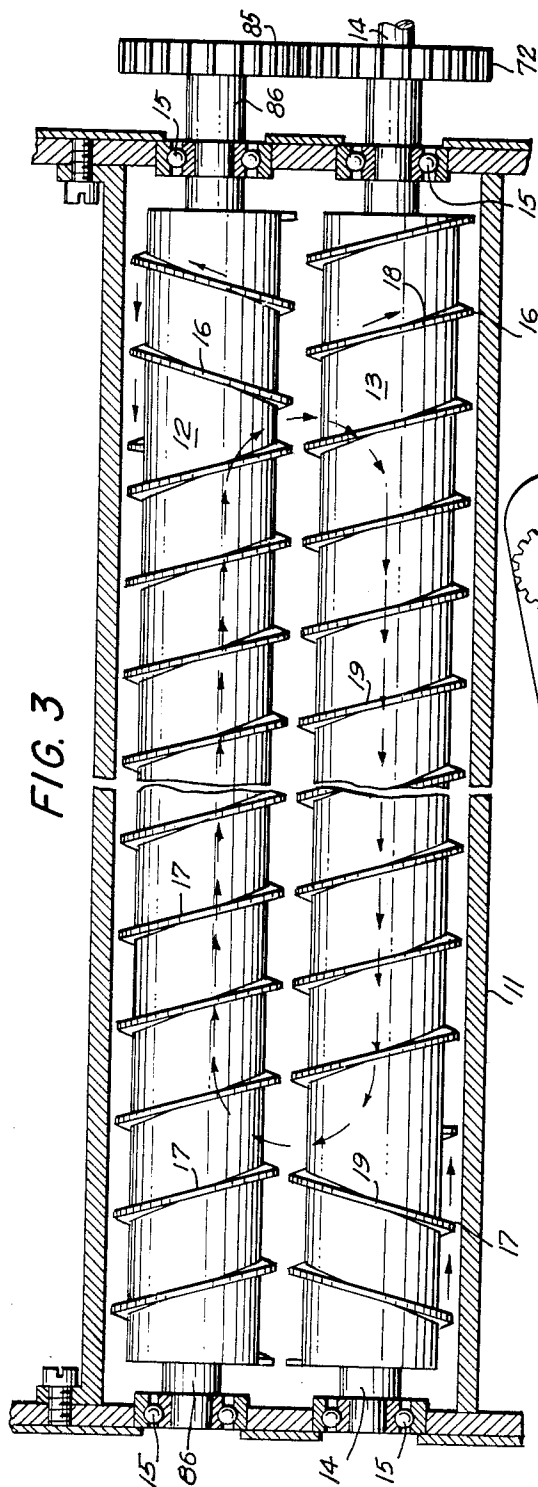
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3 Sheets-Sheet 2



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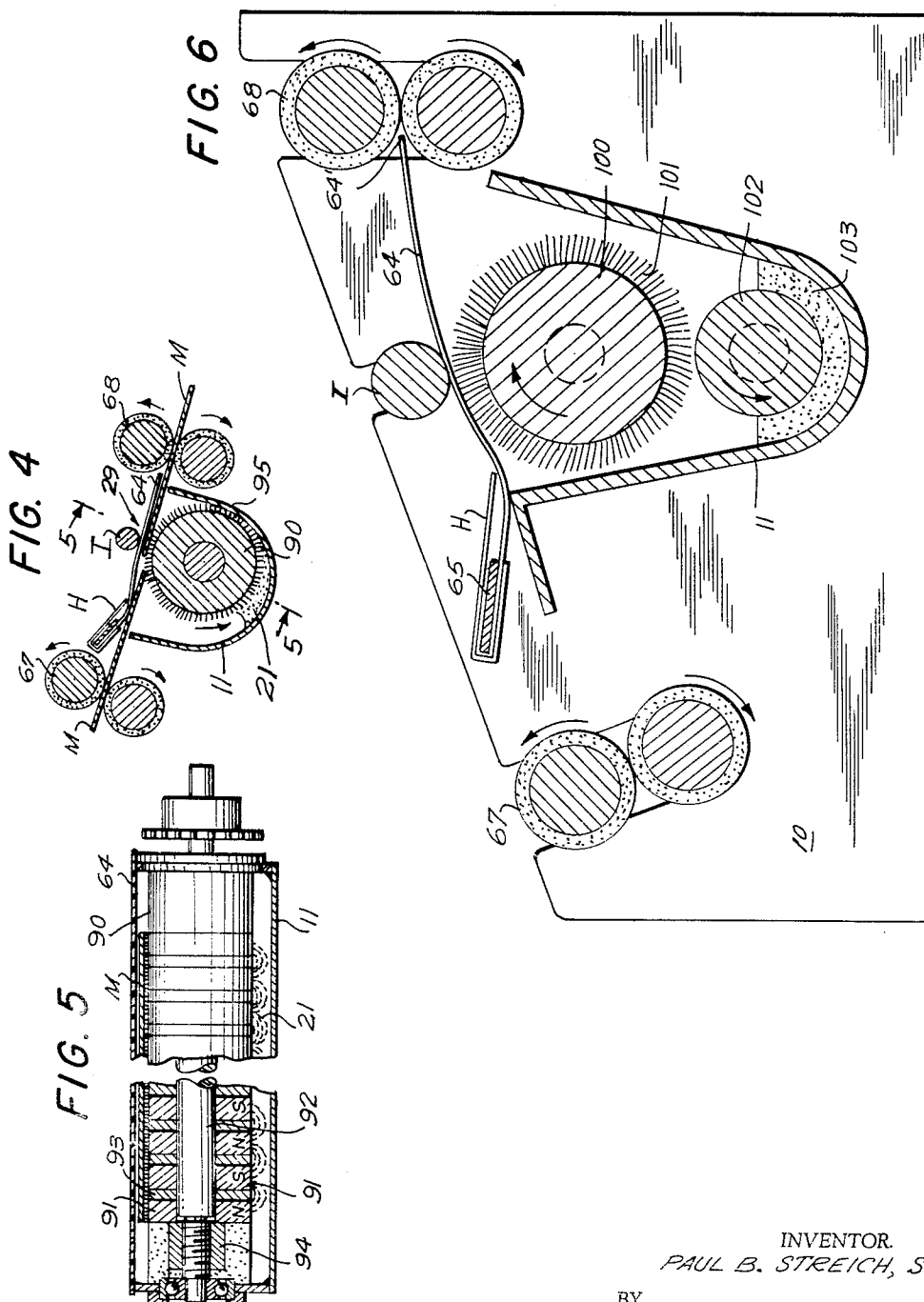
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1

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APPARATUS FOR APPLYING DEVELOPER POWDER TO PHOTO-CONDUCTIVE INSULATING MATERIAL

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This invention relates to apparatus for developing electrostatically charged latent images and more particularly to improved apparatus for applying the developer powder or toner to electrostatically charged latent images on photoconductive insulating material prior to the fixing of the developer powder to produce the desired prints.

This application is a continuation-in-part of application Serial No. 748,501, filed July 14, 1958, now abandoned.

Known electrostatic printing techniques comprise producing an electrostatic charge upon the surface of a photoconductive insulating material, such, for example, as paper in sheet or web form, coated with a finely-divided photo-conductor, e.g., zinc oxide, applied to the paper base in a vehicle which is a dielectric film-forming material. The vehicle may be a resin solution or suspension, such as a solution of a silicone resin in a suitable solvent, a suspension of a polyvinyl acetate resin in an aqueous medium or an aqueous medium containing melamine formaldehyde resin and a thermoplastic resin as disclosed in U.S. Patent 2,959,481, granted November 8, 1960. Further description of the photo-conductive insulating material is believed unnecessary because the present invention may be used for applying developer powder to all known photo-conductive insulating materials. For the sake of brevity, the expression "prints" will be used herein to refer to such photo-conductive material bearing a latent image.

The latent image may be produced by any known procedure; for example, by exposing the charged surface to a light image, thus discharging the portions irradiated by the light rays while leaving the remainder of the surface in a charged condition. The latent image is then developed by applying a developer powder which is held electrostatically to the charged area. This powder is then fixed to the photo-conductive surface, for example, by heat in those cases where the powder is a resin or other material which can be fixed by heat, or by application of a solvent or by other known fixing technique.

Known developer powder mixtures, so applied, consist, for example, of a mixture of finely-divided carrier particles, e.g., coarse granular material, glass beads, and, when magnetic developers are used, magnetic particles such as finely-divided iron, magnetite or ferrites and developer powder of a particle size appreciably smaller than the carrier particles, such as the developer powders described, for instance, in United States Patents 2,297,691, 2,618,552 and 2,638,416, including dyed or pigmented resin powders, e.g., Vinsol resin (treated pine resin) dyed with suitable dyes, coumarone-indene resins, polystyrene resins, gum copal, rosin, wax, asphalt, etc. Developer powders can be used consisting entirely of pigmented or dyed resin, i.e., containing no carrier particles.

The developer powder and carrier particles, when used, are selected in accordance with their triboelectric properties, so that when mixed the developer powder has the desired charge depending on the charge carried by the electrostatically charged latent image. Thus, in developing photo-conductive insulating material carrying a positively charged latent image, the developer powder should

2

be so chosen that when mixed with the carrier particles, it is negatively charged. Conversely, if the photo-conductive insulating material has a negatively charged latent image, the developer powder should be chosen so that when mixed with the carrier particles, it carries a positive charge. Developer powders which when mixed with carrier particles, such as iron, acquire the desired charges by triboelectric action are well known and can be selected from many materials that have been tested and occupy recognized positions in a triboelectric series. Thus, for example, pigmented rosin when mixed with iron becomes positively charged and can be used as the developer powder for developing negatively charged images. Colored Vinsol resin when mixed with iron becomes negatively charged and can be used for developing positively charged images. As such mixtures containing developer powder and carrier particles and developer powders having the desired charge are well known and per se do not form part of the present invention, further description thereof is considered unnecessary. Developer apparatus heretofore known have a tendency to produce excessive dust, at times a cloud of fine powder, in the vicinity of the developer which creates an objectionable atmosphere. It is of course not feasible to completely seal the container or trough containing the developer powder because provision must be made for the feed of the prints through the developer apparatus. Attempts heretofore made to provide a closure or seal which permits the entrance and exit of the prints, invariably resulted in soiling of the backs of the prints, due chiefly to powder collecting on the closure or seal, which powder is transferred in part at least to the backs of the prints fed through the developer.

It is among the objects of the present invention to provide improved apparatus for applying developer powder to prints which minimizes or completely prevents objectionable dust formation in the vicinity of the developer and at the same time minimizes soiling of the backs of the prints.

Other objects and advantages of this invention will be apparent from the following description thereof.

In the accompanying drawings forming a part of this specification and showing, for the purposes of exemplification, a preferred form of this invention, without limiting the claimed invention to such illustrative instances:

FIGURE 1 is a vertical section through a developer machine embodying the present invention;

FIGURE 2 is a fragmentary side elevation of the machine showing the driving mechanism;

FIGURE 3 is a horizontal section through the reservoir or trough containing the developer powder and shows the circulating or feed conveyor screws for this mixture, the section is broken away to permit illustration on a larger scale than would otherwise be possible;

FIGURE 4 is a vertical section through a modified form of developer apparatus embodying this invention;

FIGURE 5 is a composite view partly in vertical section and partly in elevation and shows the developer powder applicator roll of FIGURE 4; and

FIGURE 6 is a vertical section through still another modified form of developer apparatus embodying this invention.

In FIGURES 1, 2 and 3 of the drawings, 10 indicates the frame of the machine on which is suitably fixed a container or trough 11, generally elongated in a direction extending at right angles to the direction of movement through the machine of the insulating material or print M, which may be in sheet or web form. For convenience in describing the machine, this dimension at right angles to the direction of movement of material M will be referred to as the width of the machine. Trough 11 desirably extends for the full width of the machine

and has its base sloping downwardly as shown in FIGURE 1.

Positioned near the base of trough 11 are two circulating or feed conveyor screws 12 and 13 extending substantially the full length of the trough 11, and disposed in relatively closely spaced parallel relationship as shown in FIGURE 3. Screw 13 is positioned in the lower rear corner of the trough 11 and screw 12 in the lower front corner. The shafts 14 of these screws are suitably journaled for rotation in ball bearings 15 (FIGURE 3) mounted in the end walls of the trough 11.

Screw 12 has on its periphery helical feed threads 16, and reverse thrust threads 17 at the ends thereof pitched as shown in FIGURE 3. Screw 13, which rotates in the opposite direction relative to the direction of rotation of screw 16, has on its periphery helical feed threads 18 and reverse thrust threads 19 at the ends thereof pitched as shown in FIGURE 3. Thus, when these screws are rotated the mixture 21 of magnetic particles and developer powder is circulated within the trough 11. This mass or body of mixture 21 extends to a level indicated by the line L, which is just above the top of the threads on screw 13. Threads 16 move this mixture from left to right, viewing FIGURE 3, until it reaches the reverse thrust threads 17 which prevents further movement in that direction. Threads 17 cooperate with threads 19 at the right hand end of the machine, to cause feed of the mixture to take place first transversely in the trough 11 and then in a reverse direction. Threads 18 on screw 13 move the mixture from right to left until it reaches the reverse thrust threads 19 at the left of the machine, viewing FIGURE 3. These threads 19 prevent further movement in the right to left direction and cooperate with thrust threads 17 on screw 12 to move the mixture first transversely and then in a generally longitudinal direction. Thus the mixture is circulated in an elongated elliptical path as indicated by the arrows on FIGURE 3, this circulation being continuous during operation so as to produce a uniform and substantially homogeneous mixture.

Additional developer powder is supplied from time to time to the trough 11 to replenish that deposited on the photo-conductive insulating material passed through the equipment. For this purpose, a funnel 23 or hopper may be provided for supplying the added developer powder in the non-magnetic zone 24 of the machine.

Disposed in trough 11 just above the circulating screws 12, 13 is an applicator roller 25 of non-magnetic material. This roller is suitably mounted for rotation in trough 11. Applicator roller 25 is positioned as shown in FIGURE 1 so that as it rotates over the mass of mixture 21, its periphery passes in series through zones 28, 29, 24 and back to 28. The latter zone is where the formation of the magnetic brush on the periphery of the applicator roller 25 takes place. Zone 29 is the zone where the brush is brushed over the surface of the photo-conductive insulating material M and the developer powder is thus applied thereto. Zone 24, as indicated, is the non-magnetic zone where the mixture of magnetic particles and developer powder is no longer held by magnetic attraction on the periphery of the applicator roller 25 and as the periphery moves downwardly to complete the circular path through which it moves, the mixture falls from the periphery of the applicator roller 25 and is returned to the circulating mass of the mixture in trough 11.

A metering plate 31 is positioned on the top of trough 11 and has its forward knife-like edge 32 spaced from the periphery of the applicator roller 25 a suitable distance to control the thickness of the brush B formed on the applicator roller 25 as it rotates. Plate 31 is adjustably mounted so that the distance between knife-like edge 32 and the periphery of the applicator roller 25 can be changed to control the thickness of the brush B and, hence, the amount of developer powder applied to the photo-conductive insulating material. A spacing of ap-

proximately $\frac{5}{64}$ of an inch from the knife-like edge 32 and the periphery of the roller 25 usually gives satisfactory operation.

Mounted within roller 25 is a magnet 33. This magnet, desirably, is a permanent magnet; it may be made of Alnico 5 or other known magnetic material. It is of a length slightly longer than the width of the photo-conductive insulating material passed through the machine. It may be a single magnet or may consist of a plurality of magnets, two or more, disposed in abutting relationship and extending within applicator roller 25 a length approximately equal to the length of the path of circulation of the mixture 21 in trough 11, which path is shown in FIGURE 3. As conventional, it consists of north and south pole pieces 34, 35, desirably shaped as shown in FIGURE 1. It is immaterial whether the pole pieces be disposed with the north pole piece to the right-hand side or left-hand side of the south pole piece.

The pole pieces 34, 35 are positioned relatively close to the inner periphery of the applicator roller 25 to create in zones 28 and 29 magnetic flux lines extending from a point just above the feed screw 12 to a point at the termination of zone 29.

Magnet 33 is bolted to a U-shaped frame 37 by bolts 38 (FIGURE 1). This frame 37 is suitably secured to the frame of the machine, thus maintaining the magnet 33 stationary within the rotating applicator roller or drum 25. Desirably, the magnet 33 is adjustably mounted within the applicator roller or drum 25 so that the position thereof relative to the periphery of the drum can be changed as desired. As any suitable adjustable mounting can be used, further description thereof would serve no useful purpose.

Downwardly extending flange 60 on the top wall of the trough 11 prevents jamming of the developer powder magnetic particles mixture in zone 28 under the metering plate 31. Edge 32 of the metering plate 31 is positioned closer to the periphery of roller 25 than is the end of flange 60. Hence the metering plate serves to densify the brush produced on the applicator roller 25 as this brush moves past edge 32.

Adhesively or otherwise secured to the underside of metering plate 31, is a flexible sealing member 62. This sealing member is of a width equal to or greater than that of the trough 11; thus its width is greater than that of the sheets or webs fed through the machine.

As shown in FIGURE 1, lip 63 of sealing member 62 extends beyond edge 32 of the metering plate 31.

A flexible top sealing cover 64 has one end suitably secured to a bar 65 the ends of which are mounted for pivotal adjustment in bearings secured to the walls of the machine. A plate H (FIGURE 1) is carried by bar 65 and the forward end of this plate engages the sealing cover 64 to position it so as to impart a slightly upwardly curved shape to the sealing cover 64 in zone 28, as shown in FIGURE 1. This upward direction of curvature of sealing cover 64, it will be noted, is in the direction of movement of the sheets or webs through the machine.

A weighted roll or bar I is positioned with its vertical diameter approximately coincident with the right hand end of zone 29, viewing FIGURE 1. Roll I engages the sealing cover 64 and maintains this cover properly positioned relative to the brush on applicator roller 25, i.e., the sealing cover is thus maintained in light contact with the tips of the "bristles" of brush B.

The free edge 64' of the sealing cover 64 rests on the lower of the pair of feed rolls 68, hereinafter described, below the bite of these feed rollers. The sealing member 62 and cover 64 are of suitable material, e.g., plastic film, having a thickness of, say, about 0.003 inch, of approximately equal width and having the desired flexibility and spring characteristics. The material of the sealing cover is selected depending upon triboelectric properties of the developer powder. If the developer powder carries a negative charge, a material positioned at the negative end

of the triboelectric series is chosen for the cover 64. Examples of such materials are polyester, acrylic and polyethylene films. For developer powder carrying a positive charge, a material at the positive end of the triboelectric series is chosen. Examples of such materials are nylon film, mica and glass cloth. In this way, there is a repelling magnetic force between the developer powder and the material of the sealing cover 64, and, hence, the developer powder is not deposited on nor does it adhere to the underside of the cover 64 as the brush B moves thereunder. On the contrary, the underside of cover 64 remains clean; hence, the back of the prints passed through the machine remains clean.

Member 62 and cover 64 cooperate to form a seal at S through which seal the sheets or webs are passed; this seal opens for this purpose sufficiently to permit the leading edge of the sheets or webs to pass therethrough and then reforms by contact with the top and bottom of the sheets and webs passing therethrough. Thus, both the leading edges and the side edges of the sheets and webs passed through the machine are sealed, preventing escape of developer powder from the trough into the atmosphere. The trailing edge of the sheets or webs is held against the sealing cover 64 by the feed rollers 68, which it will be noted, lifts the trailing edge upwardly against cover 64 (due to the fact that the free edge of cover 64 is disposed below the bite between the feed rollers 68). Hence the top of the trough is sealed along all four sides of the sheets passing therethrough and is also sealed when no sheets or webs are passing therethrough by the sealing cover 64 and the cooperating sealing member 62. This seal minimizes or prevents escape of developing powder into the atmosphere with consequent cleaner and more satisfactory working conditions for the operator.

Feed of the photo-conductive insulating material M is effected by two sets of feed rollers 67 and 68 suitably spaced as shown in FIGURE 1. These feed rollers feed the insulating material M under the sealing cover 64 into approximately tangential contact with the brush B on applicator roll 25 in the area 29. The feed rollers preferably are of the type disclosed in United States Patent 2,894,744, granted July 14, 1959, having their peripheries of nap or pile material to provide a soft firm drive for the insulating material M. The nap or pile material is of a material in the triboelectric series which is located in this series remote from the position in this series of the material of which the developer powder is constituted. Thus, if the developer powder carries a positive charge, the nap may be of Orlon, Dacron, Saran fiber or acetate rayon. If it has a negative charge, it may be of nylon, glass wool, wool or animal fur.

Any suitable drive for the applicator roller 25, circulating screws 12, 13 and feed rollers 67 and 68 may be employed. One such drive is illustrated in FIGURE 2. As shown in this figure, a drive gear 71 driven by a suitable motor, not shown, meshes with the gear 72 keyed to the shaft 14 of the circulating screw 13. Also fixed to this shaft is a sprocket 73 over which passes the drive chain 74. Drive chain 74 is thus driven and in turn drives the feed rollers 67 and 68. For this purpose, the shaft 75 on which the lower feed roller of the pair 67 is mounted has keyed thereto a sprocket 76 which is driven by the drive chain 74. This shaft 75 has keyed thereon a gear 77 which meshes with the gear 78 fixed to the shaft of the upper roll of the pair 67. Drive chain 74 also passes over a sprocket 79 fixed to the shaft 81 constituting the shaft of the lower roll of the feed rollers 68. Gear 82 on shaft 31 meshes with the gear 83 on the shaft 84 of the upper roll of the pair of feed rollers 68.

Gear 72 which drives the circulating conveyor screw 13 meshes with the gear 85 fixed to the shaft 86 of the feed screw 12. Gear 72 also meshes with the gear 89 fixed to shaft 87 of the applicator roller 25. An adjust-

able idler sprocket 88 is provided for taking up the slack in drive chain 74 when necessary.

The applicator roll 25, circulating screws 12, 13 and the trough 11 as well as all other parts which contact the mixture of developer powder and magnetic particles are of non-magnetic material, such as brass, aluminum or stainless steel. As noted, the magnet 33 may be a permanent magnet, such, for example, as Alnico 5.

In operation, the mixture of magnetic powder particles and developer are kept in a constant state of agitation in the trough 11 by the feed screws 12 and 13, which move the material beneath the applicator roller 25 in a substantially elliptical horizontal path, as illustrated in FIGURE 3. The applicator roll 25 rotates in substantially tangential contact with the body of moving mixture of developer powder and magnetic particles through the magnetic field created by the stationary magnet. As it rotates, the mixture containing the magnetic particles is attracted to its periphery. The brush B is thus formed continuously and carried continuously into contact with the prints. Preferably the peripheral speed of movement of the brush B is from three to five times faster than the linear speed of the prints. At these relative rates, uniform application of developer powder throughout the entire area of the photo-conductive insulating material M results.

The thickness of brush B is controlled by the adjustable metering blade 31. For best results, this thickness should be adjusted to give the desired application of developer powder to the photo-conductive insulating material, producing sharp copies having clean backgrounds. This can readily be determined for each type of photo-conductive insulating material by trial, i.e., passing a few of the sheets containing the electrostatic images with adjustment of the thickness of brush B in determining which gives the best results.

Individual sheets or a web may be passed through the zone 29. The individual sheets or webs thus fed by feed rolls 67, 68 have their underside brushed by the mixture. As the brush B is constantly being reformed in the area 28, each unit area of insulating material, whether sheet or web, has applied thereto the same relative amount, which amount can be varied as desired depending upon the material being developed, by adjusting the blade 31. In the continued rotation of the applicator roller 25 into the non-magnetic zone 24 the mixture of developer powder and magnetic particles, no longer being held by magnetic attraction to the periphery of applicator roller 25, gravitates therefrom into the body of the mixture within the trough 11. This mixture is kept in a constant state of agitation by the circulation effected by the screws 12 and 13. To this mixture is added, either continuously or from time to time, fresh developer powder to replace that applied to the photo-conductive insulating material M. This fresh powder is introduced in the non-magnetic zone 24. As it is added to a continuously circulating mass of the mixture, it is promptly uniformly distributed therethroughout so that the mixture forming the brush B throughout the operation contains a uniform amount of developer powder which is applied uniformly throughout the entire surface area of the photo-conductive insulating material M. Accordingly, there is produced uniform development of the images with the production of images having a clear background. It will be understood that from the feed roller 68 the photo-conductive insulating material M having the developer powder applied thereto passes through a fixing zone which may be a heater or fuser of any conventional type.

While reference is made in the specification to zone 24 as being non-magnetic, it will be understood that there may be some flux lines in this zone but, as compared with the flux lines in the zones 28 and 29, zone 24 is substantially non-magnetic i.e., the residual magnetism, if any, is not sufficient to maintain on the periphery of the applicator roller 25 the mixture of magnetic particles

and residual developer powder. Accordingly, when the applicator roll moves to complete its circular path in a downward direction through zone 24, the magnetic particles and residual developer powder gravitate therefrom onto the body of the mixture within the trough 11.

During the operation hereinabove described, the seal S prevents escape of developer powder from the trough into the atmosphere, and aids in maintaining the prints in substantially tangential contact with the magnetic brush formed on the periphery of the rotating applicator roller or drum 25. Moreover, the cover 64 of this seal being of a material in the triboelectric series, which carries the same charge as that of the developer powder being applied, repels the developer powder and thus prevents adherence thereof to the inside of the cover 64. Accordingly, when the prints pass through, soiling of the backs thereof is minimized if not completely prevented.

In the modification of FIGURES 4 and 5, in which like parts are indicated by these same reference characters, a magnetic applicator roller 90 is employed, of the type disclosed in my Patent 3,003,462, granted October 10, 1961, involving disc-shaped magnets 91 mounted on a shaft 92 and alternating with washer or disc-shaped pole pieces 93 also mounted on shaft 92, the assembly of magnets 91 and pole pieces 93 are held on shaft 92 in face to face contact by nut 94. The shaft 92 is mounted for rotation in the trough 11 in suitable ball bearings as shown in FIGURE 5, in the side walls of the trough. Trough 11 contains a body of developer mixture constituted of magnetic carrier particles and developer powder, which mixture, as the applicator roller 90 rotates, is fed in the form of a brush into the zone of application 29, where the prints M pass in a substantially horizontal plane in substantially tangential contact therewith, as shown in FIGURE 4. In this construction the side wall 95 of the trough 11 functions as a metering plate to control the thickness of the layer or brush of developer mixture consisting of magnetic carrier particles and developer powder formed on the applicator roller 90.

In FIGURE 4, 64 is the sealing cover of plastic film substantially completely covering the area of the top of trough 11, which film is selected depending upon the triboelectric properties of the developer powder used in trough 11 as hereinabove disclosed in connection with the modification of FIGURES 1 to 3, inclusive.

The modification of FIGURE 6 differs from the other two modifications chiefly in that the applicator roller 100 is not a magnetic applicator roller, but is a toner applicator roller covered with a soft nap 101, such as fur or other suitable material, properly located in the triboelectric series remote from the position in the series of the type of toner used. Hence the nap or surface covering 101 on roller 100 has a strong triboelectric attraction for the developer powder or toner. The developer powder or toner is supplied to the nap or surface 101 by a feed roll 102 which can be of metal, knurled if desired, or otherwise provided with a roughened surface to control the rate of feed of the developer powder from the bed 103 thereof in the base portion of the trough 11. In operation, rotation of the feed roll 102 in the direction indicated by the arrow on FIGURE 6 brings a continuously fresh supply of developer powder or toner to the surface of the applicator roller 100, which surface is indicated as constituted of a soft nap such as fur or other material providing a relatively soft rotating brush containing developer powder which, as the prints move beneath the cover 64 in substantially tangential contact therewith, applies the developer powder to the prints. As in the other modifications, the top of the trough 11 above the periphery of the brush formed on the applicator roller 100 is effectively sealed by the plastic film cover 64 which is dimensioned to completely overlie the area of the top of the trough 11. The prints are fed in substantially tangential contact with the brush

of developer powder formed on the periphery of the applicator roller 100 by the feed rolls 67 beneath the cover 64, and are fed from the developer by the feed rolls 68.

The roller I maintains the cover 64 properly positioned relative to the periphery of the nap or surface 101 containing the developer powder as applicator roller 100 rotates to apply the developer powder to the prints passing beneath the cover 64. As in the other modifications, cover 64 being of a plastic film of triboelectric properties, which develops a charge the same as that of the developer powder in trough 11, repels the powder and thus prevents adherence of the powder to the underside of the cover 64 with consequent minimization of soiling of the back of the prints as they pass through the developer apparatus of FIGURE 6.

Since certain changes in the developers, which embody the invention, can be made without departing from the scope of this invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. Thus, while in the structure of FIGURE 1 a seal S is provided between sealing member 62 and cover 64, through which the prints enter the developer apparatus, such seal can be provided by the portion of cover 64 overlying the left-hand wall of trough 11, viewing FIGURES 4 and 6. Furthermore, cover 64 need not contact the wall of trough 11 but a clearance can be provided between the cover and the wall of trough 11 therebeneath through which the prints enter the developer apparatus. With the cover 64 of a plastic material in the triboelectric series carrying the same charge as is carried by the developer powder extending over the top of trough 11, dust formation in the vicinity of the developer is minimized and prints having cleaner backs result.

What is claimed is:

1. Apparatus for developing electrostatically charged latent images on photo-conductive insulating material, comprising an open top trough containing developer powder, applicator roller means mounted for rotation in said trough for feeding the developer powder to the open top portion of said trough, a flexible sealing cover extending across the open top of the trough and thus minimize escape of developer powder from said trough, said sealing cover being of a material in the triboelectric series carrying the same charge as is carried by the developer powder to repel the developer powder and thus minimize deposition of developer powder on said sealing cover and means for feeding said photo-conductive insulating material having the latent images thereon across said open top beneath said sealing cover to receive the developer powder from said applicator roller means.

2. Apparatus for developing electrostatically charged latent images on photo-conductive insulating material comprising an open top trough containing a mixture of magnetic particles and developer powder, rotatable magnetic applicator roller means in said trough positioned to attract said mixture so that upon rotation a brush consisting of magnetic particles and developer powder is formed on said roller means, the upper portion of said brush rotating past the open top of said trough, a first pair of feed rollers disposed at one side of the open top of said trough, a second pair of feed rollers disposed at the other side of the open top of said trough, a flexible sealing cover between said first and second pair of feed rollers and sealing the open top of said trough, said cover being of a material in the triboelectric series carrying the same charge as is carried by said developer powder to repel said powder and thus maintain the inside of said cover relatively clean, and throat means cooperating with said sealing cover through which throat means the photo-conductive insulating material is fed into substantially tangential contact with the said brush on said applicator roller means beneath and substantially in contact with said flexible sealing cover.

3. Apparatus for developing electrostatically charged latent images on photo-conductive insulating material, comprising, an open top trough containing a mixture of magnetic particles and developer powder, magnetic applicator roller means in said trough, means for rotating said applicator roller means to form thereon a rotating brush consisting of magnetic particles and developer powder, the said brush rotating through the open top of said trough, a first pair of feed rollers disposed at one side of the open top of said trough, a second pair of feed rollers disposed at the other side of the open top of said trough, adjacent a wall of said trough defining one end of the open top, a flexible sealing cover of a material in the triboelectric series carrying the same charge as is carried by said developer powder to repel said powder and thus maintain the inside of said cover clean, throat means cooperating with one end of said cover to provide a seal for the inlet to said apparatus for feed of photo-conductive insulating material through said seal into substantially tangential contact with the said brush on said applicator roller means and with the back of the photo-conductive insulating material passing in substantial contact with the inner side of said sealing cover, the other end of said sealing cover being positioned to engage the lower roller of the second mentioned pair of feed rollers to provide a seal for the opposite end of said trough.

4. Apparatus for developing electrostatically charged latent images on photo-conductive insulating material comprising an open-top trough containing a body of magnetic particles and developer powder, applicator roller means in said trough, said applicator roller means com-

prising a rotatable mounted cylindrical drum of non-magnetic material and a stationary magnet rigidly mounted in said drum and arranged to create magnetic flux lines extending through said drum in a zone commencing with the upper surface of said body of magnetic particles and developer powder and extending through one side only of said drum, which side is the ascending side in the direction of rotation of said drum, means for circulating the mixture of magnetic particles and developer powder beneath said drum, means for rotating said drum to form thereon a brush consisting of magnetic particles and developer powder, a flexible sealing cover of a material in the triboelectric series carrying the same charge as is carried by said developer powder covering the open top of said trough, and means for feeding the photo-conductive insulating material under said flexible sealing cover and into tangential contact with the brush consisting of magnetic particles and developer powder on said drum.

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