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POWDER CLOUD DEVELOPMENT APPARATUS

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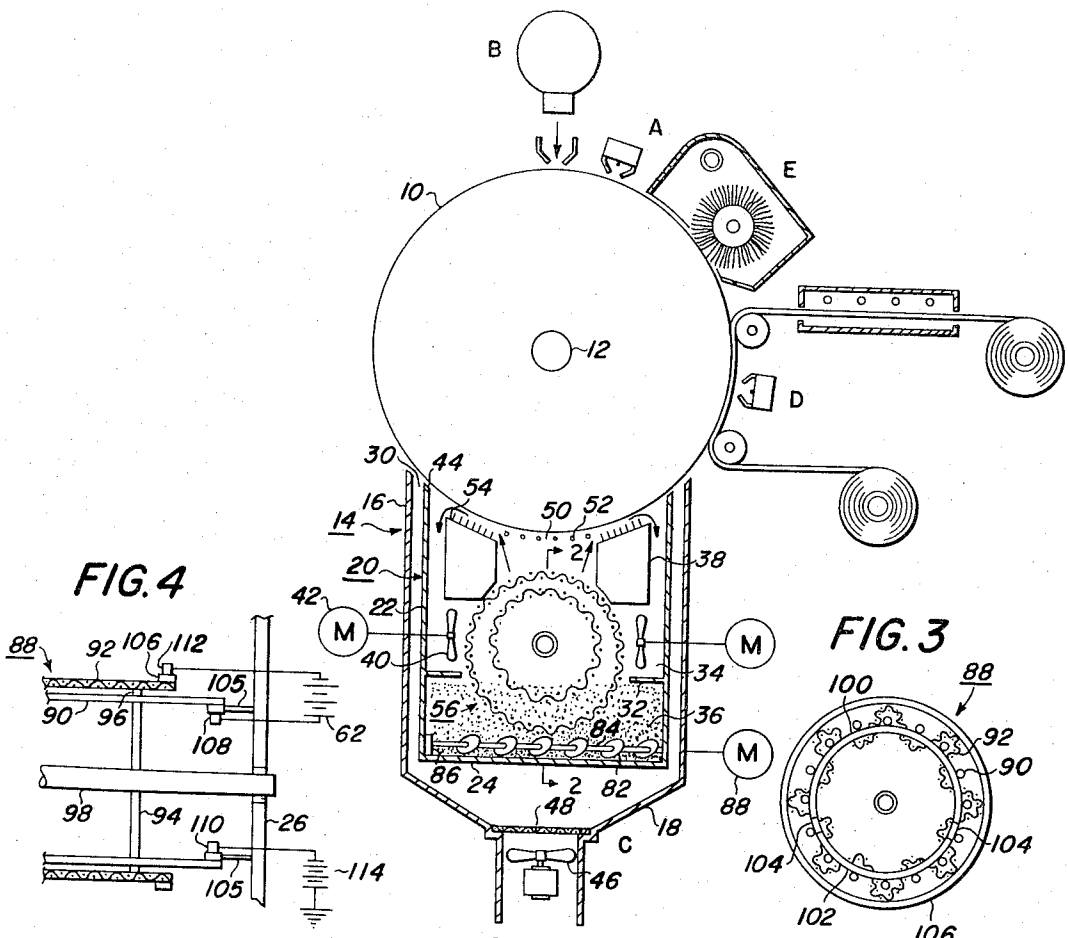


FIG. 4

FIG. 3

FIG. 1

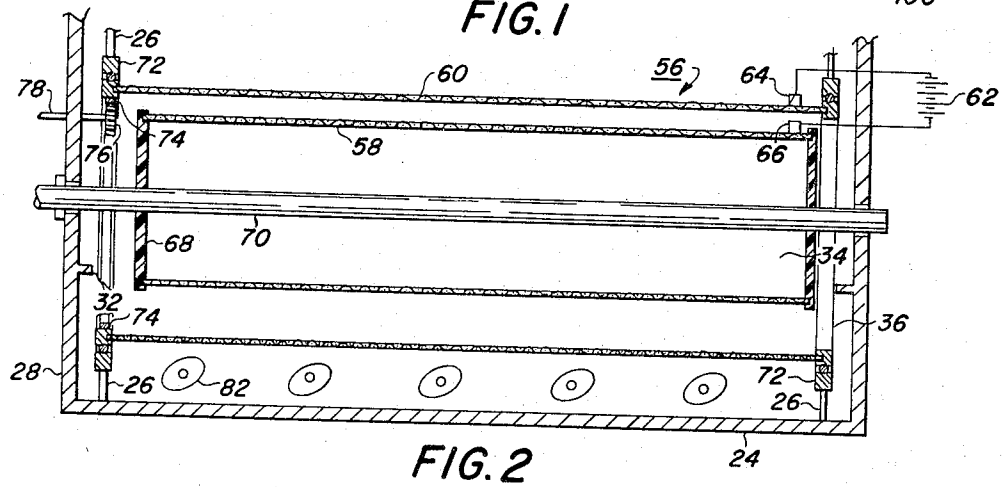


FIG. 2

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POWDER CLOUD DEVELOPMENT APPARATUS

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ABSTRACT OF THE DISCLOSURE

A powder cloud development system with a toner trap for the electrostatic removal of improperly charged toner particles from the powder cloud as the cloud moves towards the development zone. The toner trap is shaped in the form of two cylindrical screen electrodes which are biased to attract and retain improperly charged toner particles from the cloud. The screens rotate through the developer sump for the creation of the cloud as well as for the cleaning of improperly charged toner particles which have become attracted to the surfaces of the electrodes.

This invention relates in general to apparatus for developing electrostatic images, and in particular to apparatus for developing electrostatic images with a cloud of powder material.

In the practice of xerography, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to create and support electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby dissipate the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed with a finely divided electrostatically attractable material such as a resinous powder. The powder is held in image areas by the electrostatic charges on the layer. Where the charge is greatest, the greatest amount of material is deposited; and where the charge is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the copy being reproduced. The powder may subsequently be transferred to a sheet of paper or other surface and suitably affixed to thereby form a permanent print.

The electrostatically attractable developing material commonly used in xerography consists of a pigmented resinous powder referred to herein as "toner." In order for the toner to attach itself to the electrostatic charge corresponding to the image areas, the toner particles are charged to a polarity opposite from the charge on the image areas.

One method for developing latent electrostatic images is the powder cloud system which is the system employed in the instant invention. In powder cloud development, a quantity or cloud of toner particles is moved into the space adjacent a latent electrostatic image bearing surface. In order for the toner to deposit itself on image areas, a triboelectric charge must first be imparted to the individual toner particles.

Charging of toner can be accomplished by frictional contact of the particles against the walls of a tube or other container. By properly selecting the material from the triboelectric series, triboelectric charging of the powder will occur during contact. The charged cloud of toner particles may then be moved adjacent a latent electrostatic image for development thereof.

Alternatively, a charged cloud of toner particles may

also be created by agitating a quantity of carrier granules with excessive amounts of toner. The toner is usually a pigmented resinous powder. The carrier is usually a glass or sand bead coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the powder and granular carrier upon mutual agitation. The toner particles thus become properly charged for development of images due to their interaction with the carrier. The agitation in this particular application also causes the toner to suspend itself in a powder cloud which may be moved adjacent to an electrostatic image to cause xerographic development thereof.

In powder cloud development there is a natural tendency for a minority of toner particles to become charged oppositely from the polarity intended. When such occurs, the oppositely charged toner particles become attracted to non-image areas and manifest themselves as unwanted background in non-image areas.

The inability to create a cloud wherein all of the toner particles are of like polarity is thought to be due to mechanical shortcomings of the apparatus. In triboelectric toner charging there are invariably some toner particles which receive incomplete or inadequate rubbing contact with the charge generating material, i.e., the carrier in this case. This incomplete contact and interaction results in incomplete charging of all toner particles which make up the cloud.

Regardless of the cause of improperly charged toner particles within the cloud, it is an observable fact that such errant toner particles do exist. It is therefore desirable to remove them from the cloud prior to development if background is to be minimized.

Therefore, it is an object of the present invention to develop latent electrostatic images.

It is a further object of the present invention to improve powder cloud development apparatus in xerographic machinery.

A further object of the present invention is to remove improperly charged toner particles from a developing cloud of charged toner powder prior to development of xerographic images.

A further object of the present invention is to electrostatically remove from a powder cloud, by the use of a self-cleaning electrode, those toner particles which are charged to the same polarity as the portions of the latent electrostatic image to be developed.

Still a further object of the invention is to create a powder cloud wherein all toner particles are charged to a like polarity.

These and other objects of the present invention are achieved by powder cloud development apparatus employing a rotating cylindrical, screen-type electrode assembly which acts to remove improperly charged toner particles from an image developing powder cloud and which, simultaneously therewith, cleans itself while agitating the toner into the powder cloud.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates schematically a side cross-sectional xiew of xerographic machine employing the instant invention.

FIG. 2 is a cross-sectional view taken along line 2—2 of FIG. 1 with parts removed for clarity.

FIG. 3 is a side cross-sectional view schematically illustrating a modified developer agitating and toner trap assembly.

FIG. 4 is a partial cross-sectional view of the modified

developer unit shown in FIG. 3 and taken along a vertical centerline thereof.

Essentially the developing apparatus of the instant invention includes a bed of heavily toned developer material, that is, toner plus carrier, positioned beneath a latent electrostatic image bearing surface. Between the image bearing surface and the bed of developer is an electrode assembly and a series of fans. The electrode assembly includes two electrically biased cylindrical members, each of a length approximately equal to the length of the bed of developer and each arranged to have a cross-sectional configuration in the form of an endless closed curve. The two cylindrical members are preferably arranged to rotate about a common axis or parallel axes. When rotated, the electrode members move through the bed of developer to agitate the toner with respect to the carrier. The agitation of the toner within the bed, as caused by the electrode assembly, causes the toner to become triboelectrically charged due to its interaction with the carrier granules within the developer bed. The agitation of the toner within the bed, when taken in conjunction with the air flow created by the fans, causes the toner particles to form a powder cloud which may be moved into contact with the image bearing surface for development thereof.

The electrode assembly is so constructed and oriented that the toner within the powder cloud must pass through the electrode screen on its path of travel towards the image bearing surface. By properly biasing a portion of the electrode assembly to a polarity the same as that desired on the individual toner particles, the electrode assembly will electrostatically attract and retain those toner particles having a polarity opposite from that intended. In this respect, the electrode assembly may be considered a toner trap.

The electrode assembly is mounted for a rotary movement whereby at least a portion of it will be continually passing through the bed of developer. With such an arrangement the bed of developer presents a frictional medium for continually wiping the electrode clean of the toner particles which have become attached to the electrode due to the attraction and retention of such particles from the powder cloud.

Referring now more specifically to the first illustrated embodiment, there is shown in FIGURES 1 and 2 an embodiment of the present invention constructed for continuous and automatic operation. All the processing stations are conventional in the xerographic arts except for the development station which forms the basis of the instant invention.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the xerographic surface may be described as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic drum;

An exposure station B, as which the light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic image of the copy to be reproduced;

A development station C, which forms the basis of the present invention, at which a xerographic developing material consisting of a cloud of toner particles having an electrostatic charge opposite to that of the latent electrostatic image, are moved into contact with the drum surface, whereby the toner particles adhere to the latent electrostatic image to form a xerographic powdered image in the configuration of the copy being reproduced;

A transfer station D, at which the xerographic powder image is electrostatically transferred from the drum surface to a transfer material or a support surface; and

A drum cleaning and discharge station E, at which the drum surface is brushed to remove residual toner particles remaining thereon after the image transfer, and at which the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The drum **10** is mounted for rotation on main drum drive shaft **12** for movement through the several processing stations. Power may be imparted to the main drum drive shaft and drum by any convenient power source, not shown.

Positioned beneath the drum is the developing station. All of the elements of the developing station are housed within an exterior developer housing cover **14** which is formed with upstanding side walls **16** and lower facing walls **18**. Within the exterior developer housing cover is an interior developer housing **20** also constructed of upstanding side walls **22** and a lower face **24**. The interior and exterior housing units are secured in position adjacent inner and outer end walls **26** and **28** which define passages **30** therebetween.

Extending inwardly from the interior of the developer housing side walls is a ledge **32** which divides that space into an upper area or development chamber **34** and a lower area which constitutes the developer material sump **36**.

The sump is adapted to be filled with a bed of developer material including a large quantity of toner powder and a relatively small quantity of carrier granules. The purpose of the carrier granules is to impart the necessary triboelectric charge to the toner powder upon mutual agitation of the two materials. Upon further agitation, the toner powder is then blown into a developing powder cloud of toner having the polarity necessary to effect development.

Also with the development chamber is a pair of bar members **38**, shaped similarly to each other, extending the length of the developing housing and suitably secured to the end walls. Between the bars and the sump are a series of fans **40** which are adapted to cause an air flow from the developer material, up to the latent electrostatic image on the drum, around the bars and back again to the fans. A series of such fans suitably mounted through the side walls provide the required air flow. Power is supplied by motors **42**. The bars act to define the path which the air and developer take during the normal cycle of operation. Note the arrows as shown in FIG. 1.

As can be seen in FIG. 1, the upper lips **44** of the side walls of the developer housing are slightly spaced beneath the drum. To insure that the powder cloud does not pass therebeyond, an exhaust fan **46** is positioned in the lower facing of the exterior developer housing covering. The fan **46** acts to cause a supplemental flow of air through the spaces between the exterior housing cover and interior developer housing. This supplemental flow of air adjacent the space between the upper lip of the interior developer housing and drum helps to cause the primary air and developer flow within the interior developer housing to be confined therein. In the event, however, that some of the developer cloud does move into the space between the interior and exterior developer housings, a filter **48** is placed adjacent the exhaust fan to catch such extraneous toner.

For the purpose of increasing solid area capabilities of the development system, a development electrode is positioned adjacent the image in the development zone **50**. The development electrode, as employed herein includes a series of spaced conductive wires **52** positioned close to the drum surface. Supplemental electrode elements may also be mounted on the bar members **38** adjacent the drum for extending the development electrode coverage. These supplemental electrodes are shown as closely spaced groupings of pin-like members **54**. The electrode elements are adapted to be grounded or biased relative tc the conductive substrate of the photoconductive surface. The conductive elements, when biased, tend to neutralize the fields within the background for improved develop-

ment quality. As in most commercial systems, a positive bias of 150 volts has been found suitable to eliminate background during image development.

Also positioned within the development chamber are a pair of rotatable electrode screen which make up the electrode assembly **56**. The interior or first electrode screen **58** is a relatively wide mesh or low area cylindrical screen. Exteriorly of the first screen is a second cylindrical electrode screen **60** composed of a higher area or fine mesh screen that is adapted to be biased relative to the first mentioned screen. This second screen is adapted to be biased to a polarity opposite from the charges on the image areas of the photoconductive drum surface. A suitable bias may be obtained by a potential source **62** with leads interconnected to stationary brushes **64** and **66** which contact the various screens during their rotation. The location of the rotatable electrode screens should be sufficiently displaced from the development electrodes and image bearing surface so that the separate and distinct fields created by electrode screens and development electrodes can each act to effect their separate function without mutual electrostatic field interference.

The bias applied to the exterior high area electrode screen is the same polarity as the properly charged toner particles of the developing cloud of toner powder. It is opposite from the image areas of the photoconductive surface to be developed as well as the improperly charged toner particles. The difference in polarity between this exterior screen and the improperly charged toner particles will thus permit this screen's electrostatic attraction and retention of the improperly charged toner particles from the developing cloud. During this process, some properly charged toner particles will become electrostatically attracted to the interior low area screen. This is somewhat undesirable. This undesirable aspect is, however, minimized by the use of a low area screen whereby the area to which the toner particles may be attracted is reduced. In contrast, the high area exterior screen will entrap virtually all improperly charged toner particles from the cloud by presenting more area in which contact and entrapment may be achieved. As a practical matter, little problems are encountered in this respect since the number of properly charged toner particles greatly exceeds the number of improperly charged toner particles in a typical developing powder cloud. The high area screen, however, must be sufficiently apertured to permit the properly charged toner particles to pass therethrough.

As can be seen in FIGS. 1 and 2, the screens are individually mounted adjacent their respective ends for movement about parallel but offset axes. The first electrode screen **58** has its ends suitably secured in grooves formed in circular end plates **68**. The end plates **68** are in turn mounted for rotation with shaft **70**. The second electrode screen **60** is mounted for rotation about an axis vertically displaced beneath the shaft **70**, the axis of the first electrode screen. This second screen is held in position by the inner races of circular bearings **72** formed with grooves for the reception of the ends of the screen. The outer races of bearings **72** are fixedly secured within circular openings in the inner end wall **26**. The internal face of the inner race of one of the circular rings **72** is formed with gear teeth **74** so that the second screen may be rotated as by pinion **76** mounted on shaft **78**. The screen impelling shafts **70** and **78** may be driven in synchronism by any conventional power sources not shown.

It is desirable to form end plates **68** and the races of bearings **72** of a stiff insulating material, as for example, a phenolic resin, or the like, so as to allow the bias to be applied to the second screen with respect to the first screen. Attachment of the screen to the plate and inner races is through any commercially available cement-like material.

The displacement of the axes of the screen is to permit a strong toner attracting field adjacent the development zone and a weak field within the sump. The field strength which attracts and holds the charged toner to the biased screen is inversely proportional to the distance between the potential sources creating the field. Consequently, the mutual proximity of the screens adjacent the development zone causes a large toner attracting force in this toner trapping region. On the other hand, the greater distance between screens within the sump reduces the field strength in this area to thereby minimize the attractive forces of the screen for the charged toner. This orientation thus permits the attraction of improperly charged toner particles from the image developing cloud as it moves toward the image to be developed as well as the removal of the toner attracting force from the screens when the screens are within the sump.

The brushes **64** and **66** should be fixedly mounted with respect to end walls **26** and **28** of the machine as to make electrical contact with the electrode screens **58** and **60** at the upper portion of their paths of rotation. As can be seen by viewing FIGURE 2, if this contact were made at a lower portion of their paths of rotation, the contact would occur in the developer sump **36**. This would cause the developer to mechanically interfere with the electrical interconnections. The higher brush position allows only fringe portions of the toner cloud to come within the area of the electrical contact points. As such, developer interference with the brush to screen interface is minimized.

Also positioned within the sump **36** are rows of rotatable eccentric baffles **82**, non-radially mounted for rotation on shaft **84** and supported by suitable support elements **86**. The purpose of these baffles is to provide supplemental developer agitation within the sump. This permits more complete charging of the toner within the sump. Power may be imparted to rotate the baffles as by motor **88**.

During operation, a portion of the electrode assembly is continually being passed through the developer sump. This includes both the first and second screens during their rotation when they are at a greater space from each other. The purpose of this orientation is to permit the two electrode screens to be continually cleaned by contacting the developer in the sump while the toner attracting field is minimized. As these screens, with toner particles attached thereto after attracting them from the developer cloud, pass through the developer in the sump, the frictional contact of the screens against the higher mass of developer removes these electrostatically held toner particles. Some degree of toner removal is attained by the triboelectric attraction of the carrier within the sump. The majority of the cleaning, however, is achieved by the frictional forces imparted by the mechanical contact between the toner covered screens and the mass of developer while the toner attracting field is minimized.

Shown in FIGURES 3 and 4 is a second embodiment of the instant invention. All of the elements of this embodiment are the same as disclosed with respect to the embodiment of FIGURES 1 and 2 except for the rotating screen electrode assembly **88**. The rotating screen electrode assembly of this embodiment includes a series of wires **90** positioned parallel to each other in a cylindrical manner. These wires serve the same function as the interior first screen **58** of the first embodiment. The second electrode member which corresponds to the second or exterior screen **60** of the first embodiment is a conductive screen **92** positioned to be interwoven alternately through the various wires **90** for movement therewith. Note FIGURE 3 for the cross-sectional orientation.

The wires **90** and interwoven screen **92** are held in position relative to each other by stiff insulating end plates **94** and annular spacers **96** suitably cemented adjacent the ends of the electrode members. The plates are mounted for rotation on shaft **98** which may be driven by any conventional power source, not shown. The mounting of the electrode members at a fixed distance from each other, however, makes it impossible to vary the toner attracting force in the sump region as by varying the space therebe-

tween, as accomplished in the first embodiment. The reduction of this force is thus achieved electrostatically in a manner to be described.

Biases are adapted to be imparted to the wires and electrode screen through the use of conductive bands and brushes. A first annular band, constructed of a conductive upper arcuate portion **100** and a smaller arcuate portion **102** separated by insulating segments **104**, is secured in an insulating manner with respect to the end wall **26** to contact the rotating wire **90**. The band is fixedly positioned as by plastic supports **105** secured to end wall **26**. The individual wire elements may be sprung slightly inward so as to ensure continual contact with the band during rotation of the wires **90**. A second or outer conductive band **106** is conductively secured to the outer periphery of one end of the interwoven screen **92**. This band permits the application of a continuous potential to the interwoven screen in a manner as described with respect to the first embodiment. Separate potentials may be applied to the upper and lower portions of the segmented band as by individual brushes **108** and **110** or other suitable connectors, either brushingly or permanently contacting band portions **100** and **102**. Brush **112** is adapted to apply a continuous potential to the entire interwoven screen. Potential source **62** electrically interconnects the interwoven screen **92** with the wires **90** in the upper portion of the electrode assembly in the toner trapping region. In this respect the mode of operation for the toner trapping is identical with that described with respect to the first embodiment.

In this second embodiment, however, since it is not possible to minimize the toner trapping field in the sump region by increasing the electrode spacing, different electrostatic properties must be imparted to the electrode wires in the toner trapping region. This is accomplished by a potential source **114** which provides a bias on the electrode wires in the sump. The potential should be of the same potential as that on the interwoven screen **92**. Consequently, the potentials on the electrode members neutralize each other in the sump region to completely remove the toner attracting ability. A similar result could likewise be accomplished by substituting a ground or alternating potential source for the potential source **114**.

In practice, it has been found that the second embodiment is more efficient in removing the great majority of improperly charged toner particles from the developing cloud. In comparing the cross-sectional configurations of these two embodiments, it is noted that in the first embodiment the powder cloud moves through the area between the two screen electrodes parallel with the field between these two electrode elements. In the second embodiment, the cloud moves within the field as it approaches the electrode wires and continues in the field as it passes beyond the wires. Between these areas it moves perpendicularly through the field. As such, the toner cloud encounters the effects of the field for twice the time and space as it does in the first embodiment. This doubling of the field effect magnifies the system's ability to remove the improperly charged toner particles.

It has also been determined that the field acts more effectively on a toner cloud when the particles of the cloud move transversely across the field rather than parallel with it. The second embodiment permits this transverse cutting of the field to thereby remove the maximum number of improperly charged toner particles from the cloud.

Additional screen surface area for trapping the improperly charged toner particles is also presented to the cloud by the use of the elements of the second embodiment as compared with the first. Still more surface area could be presented by various design configurations of the electrode elements. For example, the individual wires of the second embodiment could be completely surrounded by screen electrodes of the same polarity as the interwoven screen electrode. This is easily achieved by merely employing two additional concentric cylindrical screens, one contacting and secured to the exterior crests of the interwoven electrode and the other contacting and secured to the interior valleys of the interwoven electrode. While it has been disclosed that screens of different areas or electrode wires with an interwoven electrode screen may be used as the toner trap field producing means, it should be understood that any similar conductive elements may be employed as the electrode traps. For example, elongated metal strips, an apertured conductive plate or various combinations of wires and/or screens may be used to effectuate the same toner trapping field effect. While it has been disclosed for the purposes of illustration, that the exterior screen should be the toner trap, the interior screen could readily serve the same function by the proper biasing of the two members. It should be further understod that it is sometimes desirable to form a cloud of positive toner particles, in which case the negative toner particles would be the improperly charged particles to be removed from the cloud. Proper selection of potentials on the screens could also effectuate this result. Furthermore, in the first embodiment, a greater number of concentric screens could be employed to multiply the trapping action of the electrode.

For the purposes of illustration only, a specific embodiment capable of carrying out the instant invention in the first embodiment includes a 10 kilovolt bias applied between the electrode screens. With such a potential a ⅛ to ½ inch spacing between the various potential carrying elements would be suitable. These parameters are by way of illustration only since the invention is capable of being carried out within a great variety of variable factors.

To operate the instant xerographic machine of either embodiment, a quantity of developer material is first positioned within the sump. The developer should include a large quantity of toner powder and relatively small quantity of carrier granules for the purpose of triboelectrically charging the toner. The various processing stations are then set in motion, as for example, by a general cycle initiating means, similar to that employed in known continuous and automatic xerographic machines. The general cycle initiating means will also initiate the rotation of the toner trapping electrodes and fans as well as establish the biases on the exterior screen electrode and development electrode elements. The rotation of the screen electrodes of either embodiment in conjunction with the rotating baffles will agitate the bed of developer to insure charging of the toner which forms the developing cloud. The fans will cause a flow of air and toner powder through the screen electrodes, adjacent their sides, then up through the higher portion of the trapping electrode near the drum. The passing of the cloud through the electrodes at two areas will act as a double trap to insure the removal of practically all improperly charged toner powder from the cloud.

The cloud will then move up to the image areas on the drum adjacent the development electrode wires for xerographic development of the image. The cloud will then pass between the bars and upstanding side walls of the interior developer housing and return to the area of the fans for recycling through its path of travel. The movement of the cloud in two directions across the drum surface being developed helps minimize unidirectional effects such as streaked development which might otherwise occur.

It should be noted that toner powder is continually being added to the flow of the developer cloud by the constant agitation of the screen electrodes as they pass through the sump. This is necessary since the cloud is continually losing toner to image areas of the drum through the development of images. As the screen electrodes continually rotate, they will be passing through the bed of developer for agitation thereof. This movement of the electrodes through the bed of developer in conjunction with the minimized toner attracting force also

acts to clear the screen electrodes of those toner particles which have attracted themselves to the screen electrodes.

While the present invention, as to its objects 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.

What is claimed is:

1. In a xerographic development system of the type wherein a powder cloud of charged toner particles is used to develop latent electrostatic images, apparatus to remove from the powder cloud those toner particles of an undesired polarity, including,

means to create an electric field adapted to attract and retain toner particles of a like polarity from a powder cloud, the field creating means including a first conductive electrode member and a second conductive electrode member located remote from the field of the latent electrostatic images to be developed,

means to hold the first and second conductive electrode members spaced and electrically insulated from each other and

impelling means operatively positioned to move a cloud of charged toner particles from a toner supply to a xerographic development zone through the field creating means to thereby effect the removal of toner particles of the undesired polarity from the cloud.

2. Apparatus for developing latent electrostatic images as set forth in claim 1 wherein the second conductive electrode member is biased relative to the first conductive electrode member to a polarity opposite from that on image areas of the surface bearing the latent electrostatic images to be developed.

3. The apparatus as set forth in claim 2 wherein the first and second conductive electrode members are each apertured and shaped to a cylindrical configuration and further including:

means to mount the two cylindrical electrode members for rotation about displaced axes for varying the field so that charged toner particles may be removed from, as well as attracted to, the members.

4. The apparatus as set forth in claim 3 wherein the first conductive electrode member is provided with apertures wider than the apertures of the second conductive electrode member and further including

means to retain the first electrode member in a circular cross-sectional configuration and the second electrode member in a circular cross-sectional configuration but with a larger diameter than the first electrode member.

5. Apparatus for developing latent electrostatic images as set forth in claim 4 and further including

a supply of developer material made up of a relatively large quantity of toner particles and a relatively small quantity of carrier granules and

means to move the electrode members through the supply of developer material to thereby agitate the toner particles relative to the carrier granules whereby the toner particles become triboelectrically charged due to the agitation.

6. Apparatus for developing latent electrostatic images as set forth in claim 5 wherein the impelling means includes a plurality of fans adapted to create a continuous flow of toner particles from the fan and supply of developer material, through the electrode members, to the surface bearing the latent electrostatic images and back again to the fan.

7. Apparatus for developing latent electrostatic images as set forth in claim 1 wherein the first electrode member is a series of spaced and parallel elongated conductive elements oriented to define a substantially circular cross-sectional configuration and the second electrode member is a conductive screen interwoven through the elongated conductive elements to define a cross-sectional configuration of an endless closed curve.

8. Apparatus for developing latent electrostatic images as set forth in claim 7 and further including

means to sequentially reduce the electric field between the conductive members so that toner particles attracted thereto may be removed.

9. The apparatus as set forth in claim 8 wherein the conductive screen is biased relative to the elongated conductive elements in the toner trapping region to a polarity opposite from that on image areas of the surface bearing the latent electrostatic images to be developed.

10. Apparatus for developing latent electrostatic images as set forth in claim 9 and further including a supply of developer material made up of a relatively large quantity of toner particles and a relatively small quantity of carrier granules and further including

means to move the electrode members through the supply developer material to thereby agitate the toner particles relative to the carrier granules whereby the toner particles become triboelectrically charged due to the agitation.

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