May 2, 1967 P. T. FERRARI ET AL 3,316,878

CASCADE DEVELOPING APPARATUS

Filed Dec. 30, 1965 3 Sheets-Sheet 1

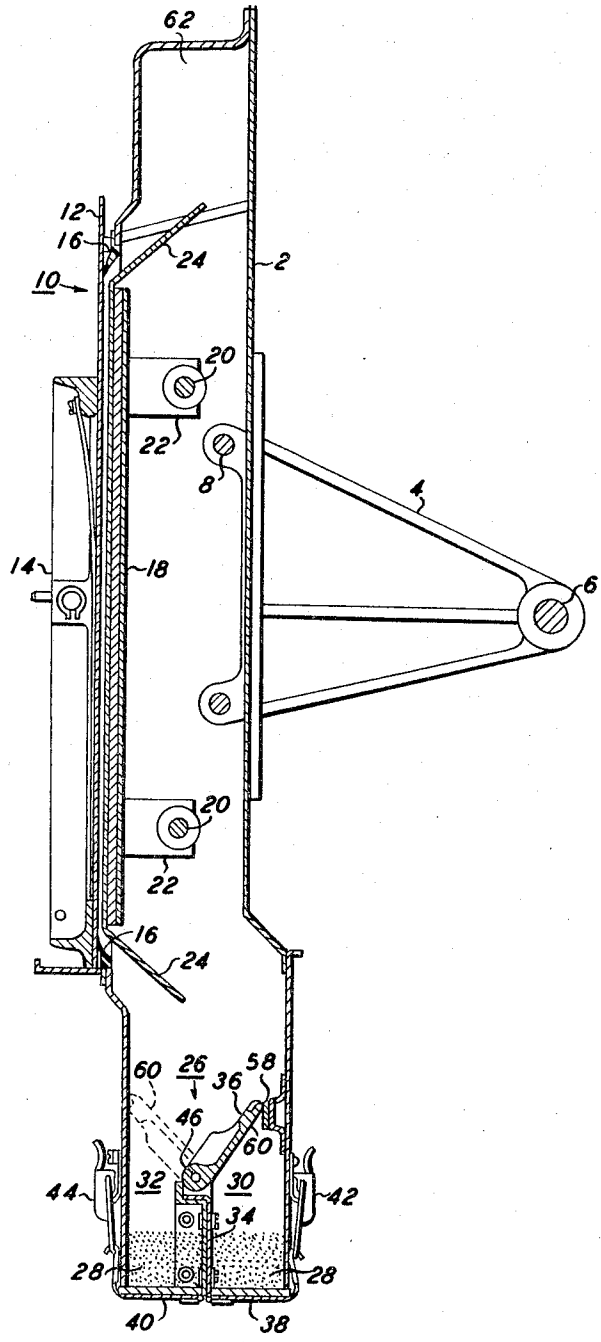


FIG. 1

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Filed Dec. 30, 1965 3 Sheets-Sheet 2

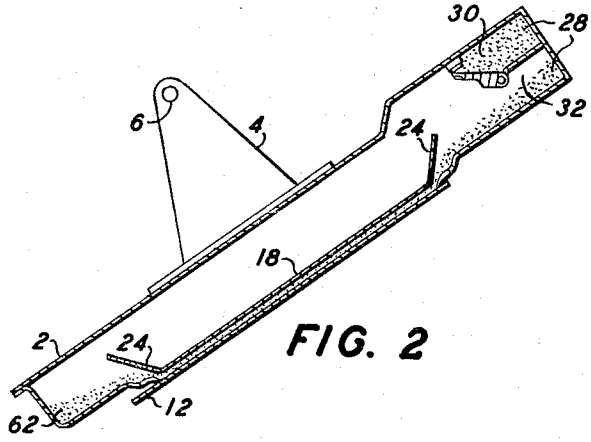


FIG. 2

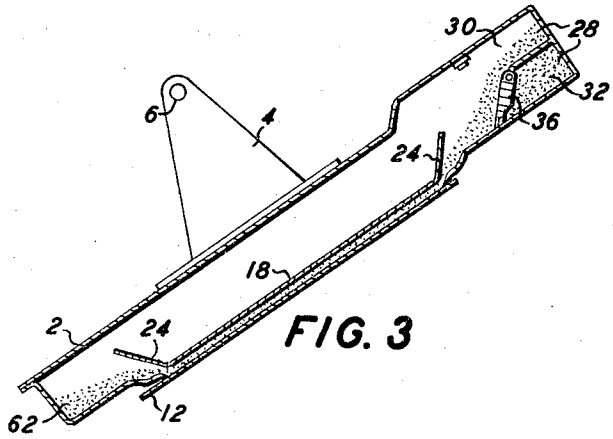


FIG. 3

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CASCADE DEVELOPING APPARATUS

Filed Dec. 30, 1965 3 Sheets-Sheet 3

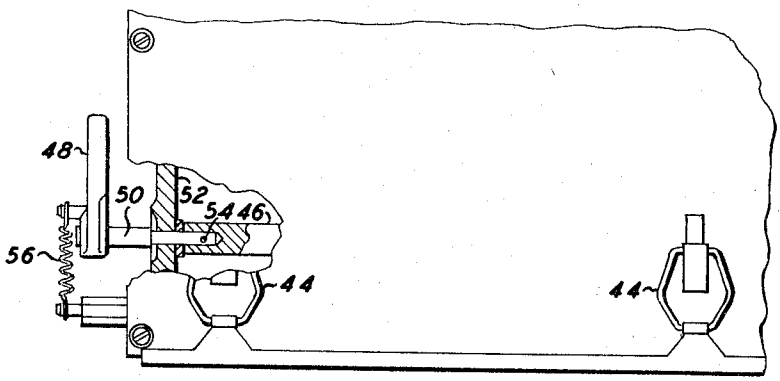


FIG. 4

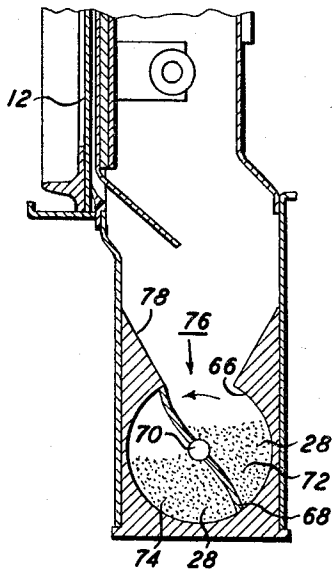


FIG. 5

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3,316,878

CASCADE DEVELOPING APPARATUS

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6 Claims. (Cl. 118—637)

This invention relates to xerographic development apparatus and, in particular, to apparatus for developing both line and tone xerographic images each with different developer material.

More specifically, the invention relates to a xerographic developing apparatus adapted to contain two different developer materials, one for use in developing line copy and one for use in developing tone copy. In the art of xerography electrostatic latent images are produced on a photoconductive surface in accordance with a light image of the original copy being reproduced. The electrostatic images are developed to visible images with a pigmented resinous powder referred to herein as toner. The toner is brought into contact with the photoconductive surface and the electrostatic charge thereon attracts the toner material and causes it to adhere to the photoconductive surface in image configuration.

A method commonly used to bring the toner material into contact with the photoconductive surface is referred to as cascade development. In cascade development a carrier material consisting of glass or sand beads coated with a resinous material is mixed with the toner to provide mechanical control for the toner. The mixture of carrier and toner is referred to herein as developer. In cascade development the developer material is agitated to produce contact between the carrier and the toner and create a triboelectric charge which causes the toner to adhere to the surface of the carrier beads. The developer is then cascaded over the surface of a xerographic plate and toner particles on the carrier beads are attracted to the electrostatic latent image. Carrier beads and excess toner are returned to a sump where they are further agitated with additional toner and again recycled through the cascade process.

In the development of line copy, that is copy which does not contain continuous tone or half-tone images, the developer material is merely cascaded over the surface of the plate and the electrostatic image is such that the toner will be attracted to the image areas. However, in the development of continuous tone or half-tone images or the development of large solid areas a development electrode is used to intensify the electrostatic charge so that it will attract the toner material uniformly in proportion to the charge density.

A development electrode consists of a grounded or an electrically biased conductive surface placed in close proximity to the photoconductive surface. The development electrode increases the intensity of the electrostatic charge in image areas and increases the ability of the charge to retain toner.

When a development electrode is used during development the carrier may be of a size smaller than that used for line development so that the developer material will pass freely between the development electrode and the xerographic surface. Also the toner concentration may vary for the developer used for tone or line copy. In xerographic machines which are designed to operate on both line and tone copy, an electrode plate is positioned to be moved into and out of operative relationship with the xerographic plate. It is necessary, however, when switching from line copy to tone copy to completely switch the charge of developer material used in the development apparatus. This process is difficult, dirty and

time consuming. It is therefore the primary object of this invention to improve xerographic apparatus to accommodate two separate charges of developer material.

It is also an object of this invention to improve xerographic developing apparatus to permit line and tone copy to be developed in the same apparatus with different developer charges without removing or replacing the developer charge in the apparatus.

It is a further object of this invention to improve xerographic developing apparatus so that two different developer materials may be cascaded over the surface of a xerographic plate from the same angle.

These and other objects of this invention are attained by means of developer pods or containers which contain different developer material and which may be alternately operated to permit developer material from one pod to cascade over the surface of a xerographic plate while the developer material in the other pod is retained.

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 connection with the accompanying drawings wherein:

FIG. 1 is a sectional side view of a xerographic developing apparatus incorporating one embodiment of this invention.

FIG. 2 is a schematic side sectional view of the xerographic developing apparatus of FIG. 1 in a position wherein the developer from one pod is cascading over the plate.

FIG. 3 is a schematic representation of a side sectional view of a xerographic developing apparatus of FIG. 1 in a position wherein developer from the other pod is cascading over the plate.

FIG. 4 is a partial front view of the apparatus shown in FIG. 1 with portions broken away to show internal structure.

FIG. 5 is a partial sectional view of a xerographic developing apparatus showing an alternate embodiment of the developer container.

Referring to the drawings, there is seen in FIGURE 1 a xerographic developer apparatus of a type suitable for use in an automatic xerographic camera of the type generally disclosed in copending application S.N. 348,950, filed Mar. 3, 1964, now Patent No. 3,272,101, and entitled, "Xerographic Apparatus." The developer mechanism consists of a housing 2 supported from a bracket 4 which is rotatably mounted on a shaft 6. The housing 2 is secured to the bracket 4 by pins 8 and the bracket 4 can be rotated about the shaft 6 so that the housing 2 is inverted to the positions shown in FIGS. 2 and 3.

The housing 2 is an enclosed container having an opening generally indicated as 10 over which a xerographic plate 12 may be secured by a clamp 14. The clamp 14 urges the plate 12 against a resilient gasket member 16 extending around the outside of the opening 10 to seal the opening and prevent spillage of developer material.

The xerographic plate 12 consists of a conductive base coated with a photoconductive layer. Prior to the insertion the photoconductive layer of the xerographic plate is charged uniformly with an electrostatic charge and exposed to a light image of copy to be reproduced. With the plate 12 in position to be developed, as shown in FIG. 1, a development electrode 18 is positioned closely adjacent to the surface of the plate 12. The development electrode 18 is supported on a pair of shafts 20 by brackets 22 and is movable towards and away from the surface of the xerographic plate 12 by a mechanism not shown. The electrode is moved away from the surface of the plate 12 when line copy, that is, copy consisting primarily of printed material, rather than large solid areas or photographs, is

to be reproduced and is moved towards the surface of the plate **12** when copy containing continuous tone or halftone images or solid areas is to be reproduced. The electrode **18** has a pair of flared guides **24** which extend outward and back from the front surface of the electrode for the purpose of directing developer material over the surface of the xerographic plate.

At the bottom of the developer housing **2** there is located a two-compartment developer pod indicated generally as **26**. The developer pod contains a developer material **28** which consists of a pigmented resinous powder and a glass or sand carrier bead coated with a resinous material. The toner or powder is attracted to and held on the surface of the carrier material by triboelectric attraction; the toner is carried across the surface of the xerographic plate **12** by the carrier material when the developer housing **2** is inverted to the position shown in FIGS. 2 and 3. The normal size of the carrier particles used in developing line copy is 600–750 microns in diameter, and in developing tone copy 250 microns in diameter. The smaller carrier size permits the electrode plate **18** to be positioned closer to the surface of the xerographic plate **12** without interfering with the flow of developer material.

It has been found that a low potential conducting surface placed in close proximity to the surface containing the electrostatic image will increase the electric field of large uniformly charged areas and improve the development characteristics of the image. The electrode is usually connected to the metal or conductive substrate of the xerographic plate. Preferably the electrode is placed as close as possible or in contact with the xerographic plate, however, in order to be able to cascade the developer material over the surface of the xerographic plate the electrode must be spaced therefrom. By using the smaller 250 micron size carrier material the development electrode may be placed closely adjacent to the surface of the plate without impeding flow of developer. During the development of line copy, however, the electrode plate should be moved away from the surface of the xerographic plate so that background charges, that is, small electrostatic charges located in non-image areas, are not strengthened and developed by the close proximity of the development electrode. One of the inherent characteristics of a development electrode is that background, toner deposited in non-image areas, is increased over development processes not utilizing development electrodes.

The pods **30** and **32**, containing developer for use with tone and line copy respectively, are intended to be used separately and are, therefore, each capable of being entirely enclosed to prevent the developer material located therein from cascading over the surface of the xerographic plate. A separator wall **34** extends upward from the base of the housing **2** and supports a movable cover or flap **36**. The bottom of the housing **2**, which also is the bottom of the pods **30** and **32**, consists of compartment doors **38** and **40**. The doors **38** and **40** are used to empty the pods **30** and **32** and are secured in a closed position by latches **42** and **44**. The pods **30** and **32** are filled with developer through the plate opening **10**. The pod cover **36** is pivotally mounted on a shaft **46** and extends the full length of the pods **30** and **32**. Operation of the cover **36** is best seen in FIG. 4 wherein a handle **48** is mounted on a stub shaft **50** journaled in the side wall **52** of the housing **2** and secured to the shaft **46** by means of a pin **54**. Movement of the arm **48** rotates the shaft **50** and the shaft **46** to move the cover **36** to either of the positions shown in FIG. 1. A tension spring **56** biases the handle **48** towards the closed position of the cover **36** in both positions. With the cover **36** in the position shown by the solid lines in FIG. 1, that is covering pod **30**, the top of the cover **36** engages and cooperates with an elevated strip **58** in the side walls of the housing **2** to provide a seal for the developer **28**. With the cover **36** moved to the position indicated by the dotted lines in FIG. 1, the contour of the cover is such that contact with the side walls of the housing **2** also provides a seal for the developer **28** in the pod **32**. In this position the back of the pod, indicated by numeral **60**, provides a smooth surface over which the developer in pod **30** may flow as it is being cascaded over the surface of the xerographic plate.

FIGURES 2 and 3 show the flow of developer material from each of the pods **32** and **30** respectively. As seen in FIG. 2, as the housing **2** is rotated so that the pod **32** is elevated above the plate **12**, the developer material **28** cascades out of the pod **32**, and is deflected by the guide **24** across the surface of the xerographic plate **12**. At the lower end of the housing **2** the developer accumulates in a receiver pod **62** in a position to be cascaded back across the surface of the xerographic plate to the pod **32** when the housing **2** is rotated to a position wherein the pod **62** is elevated above the surface of the xerographic plate **12**. In FIG. 3 the developer material **28** is cascading out of the pod **30** over the surface of the cover **36** down across the surface of the plate **12** to the pod **62**. Again, when the housing **2** is rotated to the position wherein the pod **62** is above the surface of the xerographic plate **12**, the developer material will be deflected by the guide **24** across the surface of the plate **12**, back over the surface **60** of the cover **36** to the developer pod **30**. The flowing action of the developer material across the surface of the xerographic plate produces development of electrostatic images on the plate surface.

The various parameters involved in the development of electrostatic images are all critical and very often affect the degree of development accomplished. For example, the angle at which the developer material is cascaded across the surface of the xerographic plate is important to the quality of the image developed. Likewise, the angle at which the developer material approaches the surface of the xerographic plate is also critical. An embodiment of the present invention which permits the developer material **28** to approach the xerographic plate from the same angle is seen in FIG. 5. In this embodiment, the developer material **28** is contained in a cylindrical container **66**. A partition member **68** extends radially outward from a shaft **70** to divide the container **66** into two compartments **72** and **74**. The shaft **70** may be rotated by the handle in the same manner as the shaft **46** shown in FIG. 4. However, in this embodiment there is no need for a biasing spring **56** since the partition member **68** presses against the sides of the housing **66** and prevents unintentional movement of the shaft **70**. Rotation of the shaft **70** produces movement of the partition member **68** so that first one compartment is exposed to an opening **76** in the top of the container **66** and then the other compartment is exposed to the opening **76** while the first compartment is sealed off. In this manner the developer material from either compartment may be cascaded over the surface of the xerographic plate **12** while the developer material **28** in the other compartment is retained in the container **66**. In either event, the developer material **28** leaves the container **66** through the same opening **76** and cascades down a surface **78** toward the xerographic plates so that the approach angle of the developer material is the same regardless of the compartment from which it originated.

With the housing returned to a vertical position, as shown in FIG. 1, and all the developer material returned to the particular developer pod from which it originated the xerographic plate **12** may be removed from the clamp **14**. A new xerographic plate can then be placed on the clamp **14** and secured to the housing **2**. This plate may have either line or tone copy and, depending on the type of copy to be reproduced, the development electrode will be positioned relative to the xerographic plate. The operator may also select the type of toner desired by either flipping the cover **36**, shown in the first embodiment, or by rotating the partition **68** of the second embodiment to accommodate the particular type of image on the plate **12**.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the

details set forth, and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. Apparatus for developing electrostatic images on a xerographic plate including

a developer housing having its longitudinal axis extending vertically and an opening in one side of a size sufficient to accommodate a xerographic plate,

clamping means positioned to hold a xerographic plate over the opening in the housing,

chamber means adjacent one end of the developer housing to contain two separated charges of developer material,

means to cascade each of the charges of developer material over the surface of the xerographic plate,

said chamber means including a displaceable wall member arranged compatible with the flow path of the developer material to retain one charge of developer material while the other charge is being cascaded.

2. The apparatus of claim 1 wherein said chamber means to contain separate charges of developer material comprises two pods located at the bottom of the developer housing and having one surface open to the interior of the developer housing,

and said displaceable wall member means to retain each developer charge is mounted between the developer pods and movable from a first position enclosing one developer pod to a second position enclosing the other developer pod.

3. The apparatus of claim 1 wherein said chamber means to contain two developer charges comprises a substantially cylindrical hollow member in the bottom of the developer housing having an opening exposed to the interior of the developer housing, said displaceable wall member being mounted on an axis position in the center of said hollow member to define two compartments whereby the wall member seals off one portion of the hollow member while the other portion is exposed to the opening and upon rotation will expose the other portion of the hollow member to the opening while the first portion is sealed.

4. A developing apparatus for developing electrostatic latent images by selectively cascading developer material thereacross according to the electrical characteristics of the latent image comprising:

contiguous walls forming an enclosed longitudinally extending housing, a one of the longitudinally extending walls being formed with an opening therein to receive a xerographic plate having an electrostatic latent image formed thereon, said one wall being inclined outwardly adjacent the opening to define a trough with said xerographic plate for receiving developer material,

support means to suspend and mount said housing about an axis which is transverse with respect to its longitudinal extent and adapted to pivotally rock said housing to thereby cascade developer material, alternately back and forth, across the latent image;

a backing electrode extending parallel to said plate along substantially the length thereof and closely spaced thereto, said backing electrode carrying guide means at the ends thereof which are flared away from said plate to guide developer material into said trough and said electrode, including the guide means are adapted for movement toward and away from said plate according to the size of the developer material cascaded;

chamber means located at one end of said housing to separately contain two different developer materials associated with producing line and tone copy, said chamber means being in communication with the interior of said housing and including a displaceable wall movable to retain a one of said developer materials while permitting the other developer material to cascade across said latent image, said chamber means having an interior contour compatible with the flow path of the developer material; and

settable means to position said displaceable wall according to the particular developer material utilized in the development of the electrostatic latent image.

5. Apparatus according to claim 4 wherein said chamber means comprises a pair of compartments having a common fixed wall bottom of the developer housing each compartment being in communication with the interior of the housing, said displaceable wall being pivotably mounted on said common wall and movable from a first position to close off a one of said compartments to a second position to close off the other.

6. Apparatus according to claim 4 wherein said chamber means comprises a member having a substantially cylindrically shaped recess exposed to the interior of the developer housing, said displaceable wall member being rotatably mounted on an axis positioned in the center of the recess to divide said member into adjoining compartments.

References Cited by the Examiner

UNITED STATES PATENTS

956,942	5/1910	Clemmer	222—142.6
982,371	1/1911	Lacy	222—142.6
1,835,247	12/1931	Smagola	222—142.6
2,550,724	5/1951	Sabel et al.	118—57 X
2,550,738	5/1951	Walkup	118—57 X
2,606,691	8/1952	Lindly	222—142.6 X
3,160,057	12/1964	Murray et al.	95—1.7 X

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