Feb. 25, 1964 J. J. GRIMM ETAL 3,122,455

XEROGRAPHIC TONER DISPENSER

Filed Dec. 30, 1960 3 Sheets-Sheet 1

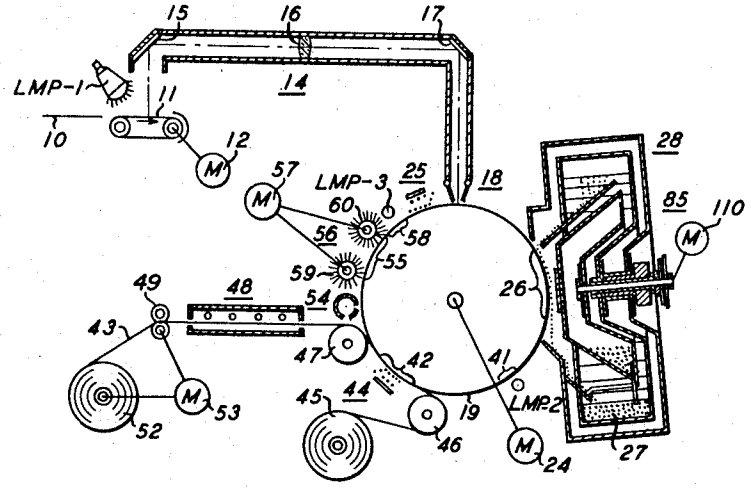


FIG. 1

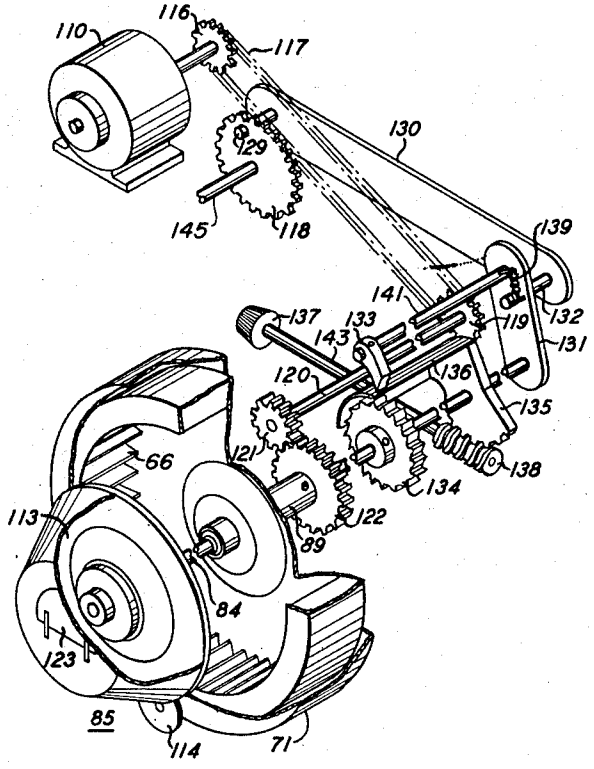


FIG. 5

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XEROGRAPHIC TONER DISPENSER

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3 Sheets-Sheet 2

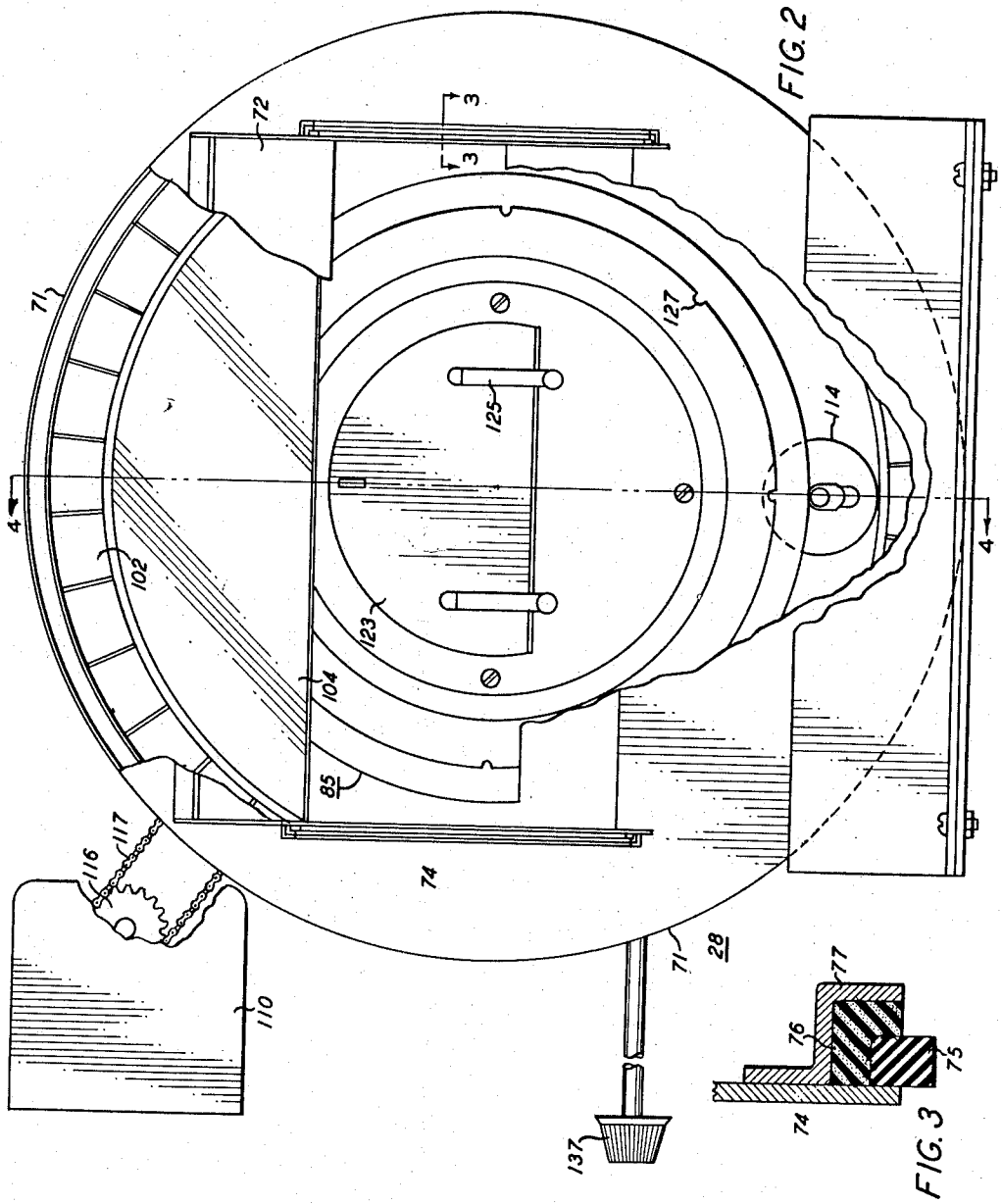


FIG. 2

FIG. 3

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XEROGRAPHIC TONER DISPENSER

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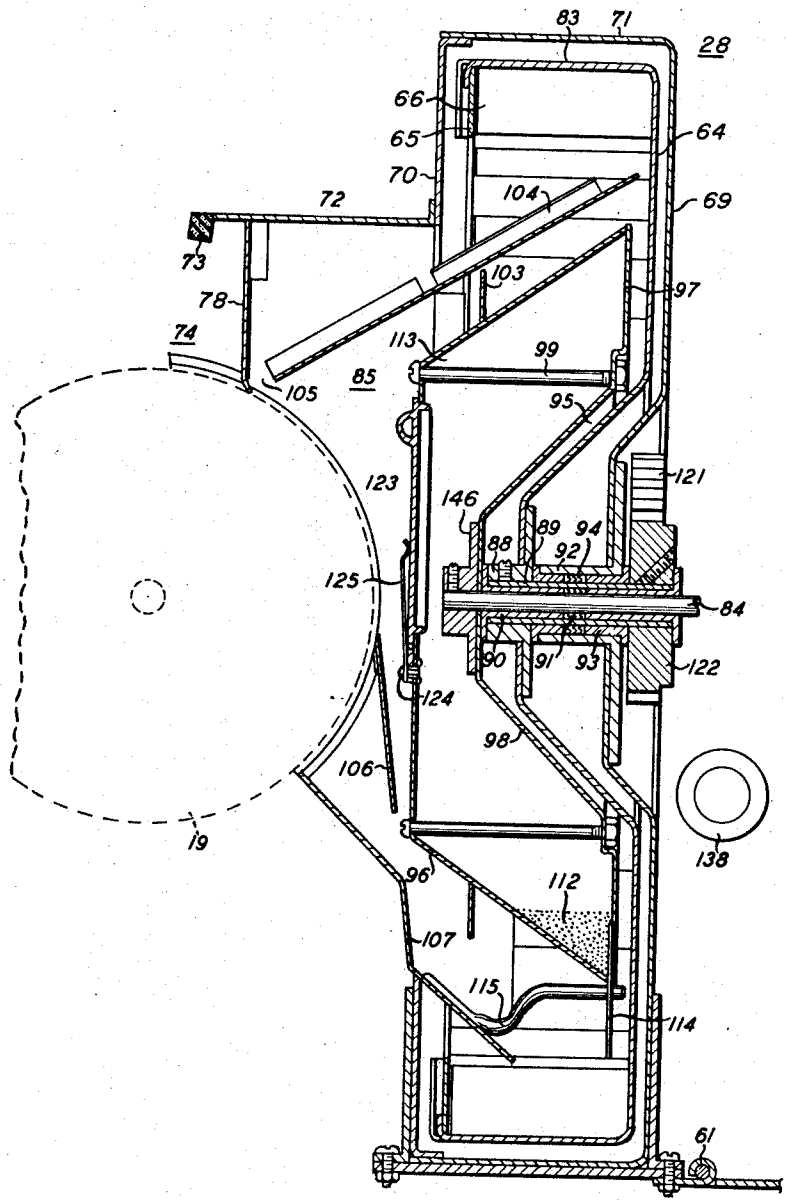


FIG. 4

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United States Patent Office 3,122,455 Patented Feb. 25, 1964

3,122,455

XEROGRAPHIC TONER DISPENSER

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Filed Dec. 30, 1960, Ser. No. 79,702
6 Claims. (Cl. 118—637)

This invention relates to improvements in apparatus for dispensing powder or granular material and particularly to improvements in xerographic toner dispensing apparatus.

More specifically the invention relates to an improved toner dispenser that is particularly adapted for use in a xerographic developing apparatus wherein in order to develop an electrostatic latent image formed on a xerographic plate, it is required to dust the image with a developer powder, whereby the powder particles are selectively attracted to the charged areas of the plate to form a visible powder particle image of the electrostatic latent image.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer.

Development of the image is effected with developers which comprise, in general, a mixture of a suitable pigmented or dyed electroscopic powder, hereinafter referred to as "toner" and a granulated carrier material which functions to carry and to generate triboelectric charges on the toner. In addition, the carrier material functions to provide mechanical control to the powder by carrying the powder to an image surface and simultaneously to provide almost complete homogeneity of charge polarity. In the development of the image the toner powder is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

In the mixture of toner particles and carrier material, the toner particles, which are substantially smaller than the carrier particles, adhere to and coat the surface of the carrier particles as a result of the electrostatic attraction between them. During development, as the powder coated carrier particles roll or tumble over the xerographic plate carrying an electrostatic latent image formed of charge of opposite polarity to the toner, the toner adheres to the latent image charge and partially denudes the carrier particles which pass off the plates. As toner powder images are formed the toner consumed must be replenished to the developer mixture substantially in proportion to the amount consumed.

Excessive toner concentration in the developing material effect heavy deposits of toner in the image areas in combination with an undesirable deposit of toner in the non-image background areas producing prints of poor contrast. Also with a low concentration of toner particle, the resulting images are faint and produce prints of low contrast.

In automatic xerographic machines for the reproduction of copy it is usual to have a constantly moving xerographic plate which may be in the form of a cylindrical drum. By means of a continuously operating developing apparatus a continuous flow of developing material is delivered to the xerographic plate. Since original copy have varied image characteristics which vary the image coverage, as for example, standard typewriter copy has approximately five percent coverage, it is necessary in order to produce prints of consistently good quality to vary the toner dispensing rate in accordance with the characteristics and frequency of copy being reproduced. Thus, in automatic xerographic machines, the dispensing rate is preferably achieved automatically in regulated quantities.

There has been developed recently, a novel type of developing apparatus for automatic xerographic machines that is referred to in the art as "the wheel-type carrier elevator" and which is described below and disclosed in copending application Ser. No. 79,600, filed December 30, 1960, in the names of James J. Grimm and Harold E. Trumbull. Whereas various forms of toner dispensers have been extensively used heretofore, typical of which is disclosed in copending application Ser. No. 776,976, filed November 11, 1958, in the name of Hunt, and now Patent 3,017,703, it and other similar types are best suited for developing apparatus other than the wheel-type carrier elevator, such as a belt and bucket apparatus disclosed in copending application Ser. No. 393,058, filed November 19, 1953, in the name of Mayo et al., and now abandoned, and are not truly compatible with the developing apparatus of James J. Grimm and Harold E. Trumbull.

Furthermore, some materials employed as toner, such as those having a polyethylene base, have a tendency to agglomerate and cling strongly to surfaces which it touches. Also, if compressed, it forms into a hard mass that will powder if scraped but will also chip and break off into small lumps. Therefore, any dispensing apparatus for dispensing toner of this type should contain means to overcome the agglomeration tendency.

The principal object of the invention, therefore, is to improve apparatus to dispense powder or granular material.

Another object of the invention is to improve apparatus to dispense powder or granular material having a tendency to agglomerate.

Another object of the invention is an improved toner dispensing system whereby accurately metered amounts of toner are added to the developer mixture in a xerographic developing apparatus in relation to the amount of toner used by the apparatus to make xerographic copy.

A further object of the invention is a toner dispensing apparatus that is more compatible with a wheel-type carrier elevator developing apparatus than dispensing apparatus employed heretofore.

These and other objects of the invention are achieved by means of the dispensing apparatus of the invention which in the preferred embodiment includes a frustroconical or cup-shaped reservoir capable of containing toner and adapted for rotation, a rotatable disk supported on a shaft and extending between a pair of contiguous walls of the reservoir to provide a localized dispensing opening therebetween, and drive means to rotate the reservoir at preregulated rates.

A preferred embodiment of the invention is illustrated in the accompanying drawings in which:

FIG. 1 is a schematic illustration of a typical xerographic machine utilizing a wheel-type carrier elevator developing apparatus;

FIG. 2 is a front elevation of the developing apparatus incorporating the dispensing apparatus of the invention;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 2;

FIG. 5 is an exploded isometric view of a suitable combined arrangement for the developing apparatus and the toner dispenser.

General

For a general understanding of the xerographic processing system in which the invention is incorporated, reference is had to FIG. 1 in which the various system components are schematically illustrated. As in all xerographic systems based on the concept disclosed in the above-cited Carlson patent, a radiation image of copy to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the electrostatic latent image is usually developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the electrostatic latent image, on the plate surface. The powder image is then usually transferred to a support surface to which it is fused by any suitable form of fusing device, whereby the powder image is caused permanently to adhere to the support surface.

The xerographic apparatus described herein typically may be of the type disclosed in the copending application S.N. 837,173, filed August 31, 1959 in the name of Cerasani, et al., and now patent 3,076,392. As in the apparatus thereof, original copy is placed on a support tray 10 from which it is fed onto an endless conveyor 11, driven by motor 12. The conveyor moves the original copy past the optical axis of projection lens system 14 that is illuminated by a projection lamp LMP–1. The image of the original is reflected by mirror 15 through an adjustable objective lens 16 and then reflected by mirror 17 downwardly through a variable slit aperture assembly 18 and onto the surface of a xerographic plate in the form of drum 19.

Xerographic drum 19 includes a cylindrical member mounted in suitable bearings in the frame of the machine and is driven in a clockwise direction by a motor 24 at a constant rate that is proportional to the transport rate of the original whereby the peripheral rate of the drum surface is identical to the rate of movement of the reflected radiation image. The drum surface comprises a layer of photoconductive material on a conductive backing that is sensitized prior to exposure by means of a screened corona generating device 25, which may be of the type disclosed in Walkup Patent 2,777,957, and which is energized from a suitable high potential source (not shown).

The exposure of the drum to the radiation image discharges the photoconductive layer in the areas struck by radiation, whereby there remains on the drum a latent electrostatic image in image configuration corresponding to the radiation image projected from the original. As the drum surface continues its movement, the electrostatic latent image passes through a developing station 26 in which a two-component developing material 27, of the type disclosed in Walkup Patent 2,638,416, is cascaded over the drum surface by means of a developing apparatus 28 which may be of the wheel-type carrier elevator as disclosed in the above cited James J. Grimm and Harold E. Trumbull application.

In the developing apparatus, described below, developing material is delivered to a drum surface for cascading thereover. Located within the developing apparatus is the toner dispensing apparatus 85 which dispenses toner to the developing apparatus to maintain a required consistency of toner concentration therein.

After developing, the xerographic powder image passes a discharge station 41 at which the drum surface is illuminated by a lamp LMP–2, whereby residual charges on the non-image areas of the drum surface are completely discharged. Thereafter, the powder image passes through an image transfer station 42 at which the powder image is electrostatically transferred to a support surface web 43 by means of a second corona generating device 44 similar to corona charging device 25.

The support surface to which the powder image is transferred may be of any convenient type, such as paper, and is fed from a supply roll 45. The support surface is then fed over guide rolls 46 and 47, and is directed into surface contact with the drum in the immediate vicinity of transfer corona generating device 44. After transfer, the support surface is separated from the drum surface and guided through a suitable fusing apparatus 48 which may be of the type disclosed in Crumrine Patent 2,852,651, whereby the powder image is permanently affixed to the support surface. Thereafter, the support surface is fed over a system of guide and tensioning rolls 49 and onto a take-up roll 52 that is driven by means of motor 53.

After separation of the support surface from the drum, a corona generating device 54, which may be of the type described in copending application S.N. 845,482, filed October 9, 1959 in the name of Vyverberg, and now Patent 2,965,766, directs a negative charge to a residual powder image on the drum surface and to the support surface before leaving guide roll 47.

Thereafter the xerographic drum surface passes through a cleaning station 55 at which its surface is brushed by a cleaning brush assembly 56, which includes a pair of brushes 59 and 60 rotated by a motor 57, whereby residual developing material remaining on the drum is removed. Thereafter, the drum surface passes through a second discharge station 58 at which it is illuminated by a fluorescent lamp LMP–3, whereby the drum surface in this region is completely flooded with light to remove any electrostatic charge that may remain thereon. Suitable light traps not shown are provided to the system to prevent any light rays from reaching the drum surface other than the projected image during the period of drum travel immediately prior to sensitization by corona generating device 25 until after the drum surface is completely passed through the developing station 26.

Developing Apparatus

Referring now to FIGS. 2, 3, 4 and 5, the developer apparatus 28 includes a cylindrical housing having a peripheral wall portion 71, a rear wall portion 69 and a removable front wall portion 70. Secured to the front wall 70, as by welding, are a pair of side walls 74 positioned in spaced-apart parallel relation to each other, a top wall 72 having a depending wall portion 78 secured thereon, and a bottom wall 107.

As shown in FIG. 4 the side walls 74 are formed with a concave edge portion in conformity with the shape of the xerographic drum to permit the developing housing to be positioned closely adjacent to the xerographic drum. Suitably secured to the outer faces of the side walls are a pair of seal holders 77 (see FIG. 3), also formed to conform with the shape of the drum. Seal holders 77 support seals 75, preferably made of a self-lubricating material, and a resilient back support 76. The seals contact the outer peripheral edges of the drum to form a powder tight seal between the developer assembly and the xerographic drum. Secured to the top wall 72 is a gasket 73 adapted to cooperate with an enclosure (not shown) for the optical assembly of the machine to shield the drum from extraneous light.

For containing and delivering developer material to the xerographic drum, there is provided a wheel type conveyor including a circular disc 64 with a peripheral shell portion 83 formed integral therewith, and partly enclosed by annular ring 65, and having laterally extending vanes 66 suitably secured thereon, as by welding, forming open ended buckets for conveying developer material to the top of the developer housing.

For supporting the wheel conveyor assembly for rotation within the housing, there is provided a flanged bearing support 92 secured to the rear wall 69 of the developer

housing. The flanged bearing support extends through a suitable opening formed therein.

As seen in FIG. 4 the wheel conveyor is supported for rotation by a flanged hub 88 secured thereto and to one end of sleeve 89 which is journaled for rotation in the flanged bearings 93 which in turn is positioned in the flanged bearing support. A suitable packing 94 is provided between these bearings. The wheel conveyor is maintained in axial alignment and is driven by spur gear 122 secured to the opposite end of sleeve 89.

As shown in FIG. 5, the wheel conveyor is driven by means of motor 110 operatively connected to drive shaft 120 by means of chain 117 which runs on sprockets 116 and 119 fixedly mounted on the shaft of motor 110 and to one end of drive shaft 120, respectively. The motor 110, mounted by means of bracket 144 to the housing 68, is connected to a source of electric power and is controlled by switching means (not shown). Drive shaft 120 is suitably journaled and held in axial alignment in rear wall 69 and carries intermediate its ends a pinion gear 121 which meshes with spur gear 122 to drive the wheel conveyor.

With a charge of developer material in the conveyor, as the buckets commence inverting and the developing material begins spilling, the first spillage is baffled by carrier ring 103, so as to cascade the spilled material over the toner dispenser into the lower buckets. Developing material which is further elevated ultimately spills onto slide hopper or chute 104 secured to side wall 74 and while gravitating down effects mixing and triboelectrification between the toner and carrier particles which then pass through a preset opening 105 formed between the hopper and the shield section 78 of the housing. The opening 105 is of a dimension to pass a requisite quantity of material and also to produce some backup accumulation and thereby effect substantially uniform discharge of material across the axial width of the drum.

Thereafter, the developing material cascades down over the drum surface until being diverted by a return baffle 106 onto return baffle or bottom wall 107 upon which the material descends into the uprighted buckets below. With the wheel in constant rotation there is a constant delivery of developing material to the hopper which through opening 105 effects uniform delivery to the xerographic drum.

In a typically constructed developing apparatus operated with a drum of approximately 4 inch diameter and 8 inch width, it was found that 35–40 pounds of developing material could be delivered per minute to the drum employing an 11¼ inch diameter wheel, 1½ inches wide, having 36 buckets 1 inch deep. Delivery was effected by rotating the wheel at approximately 48–52 r.p.m. when loaded with an initial charge of 1½–2 pounds of material to pass through an opening 105 of approximately 5/16 inch wide and with the entire apparatus inclined toward the drum at approximately 6–10 degrees from the vertical. Obviously, the above values are typical and not to be construed as limiting as various combinations of speed and dimension will produce the required rate of delivery for any particular application.

Dispensing Apparatus

As the developing mixture is cascaded over the xerographic drum, toner particles are pulled away from the carrier and deposited on the drum to form powder images, while the partly denuded carrier particles pass off the drum into the reservoir. As toner powder images are formed, additional toner particles must be supplied to the developing mixture in proportion to the amount of toner deposited on the drum. To supply additional toner particles to the developing mixture, a toner dispenser 85 is used to accurately meter toner to the developer mixture.

The reservoir is former of a front section 96 and a rear wall 97 which is contiguously held, except as separated by disc 114, to the front section by means of brace 98 and screws 99 so as to provide a substantially powder tight enclosure therebetween.

The rate of toner consumption for xerographic reproduction varies, as mentioned above, dependent upon the image characteristics of the original copy. For example, standard 8½" x 11" typewriter copy having approximately 5 percent image coverage consumes approximately 21 mg. of toner per image and a larger percent of coverage consumes proportionally larger amounts of toner. In conventional ranges and rate of copy reproduction the rate of toner consumption is known to be approximately between 5 and 40 grams per hour. It is apparent, therefore, that the reservoir should have ample storage space such that frequent refilling is not required. With maximum consumption rates conventionally encountered currently in xerography approximately 28 cubic inches would provide a 12 hour supply.

It is also desirable that means provided for the addition of toner to the dispensing apparatus be readily and easily accessible, particularly when assembled to a developing apparatus with which it is to be employed.

For adding toner to the reservoir, there is provided a loading door 123 which pivots about hinge 124 secured to the front of the reservoir and is maintained in a closed position by resilient detent means 125. A plurality of keyslots 127 are provided whereby the drum can be rotated by an operator to place the door into an upright position before opening.

Dispensing is effected by means of a rotatable disk 114 which is supported to force a localized opening between front section 96 and rear wall 97. The disk may be plain or toothed and is journaled for rotation on a bent stub shaft 115 secured, as by welding, to the bottom wall 107. In the embodiment shown, the disk is approximately 2 inches in diameter and .005 inch wide and as the reservoir rotates the disk is forced to rotate about its own fixed center by friction with the rear wall 97 and the open edge of front section 96.

The disk is located below the rotational axis of the reservoir and provides a fairly uniform slot opening at a point where dispensing occurs. Rotation of the disk effects a shearing action on the toner to keep it well mixed and also prevents toner bridging or agglomerating at the slot opening.

The rate of dispensing by means of the apparatus of the invention is primarily a function of the rotational rate of the reservoir although it is known that ambient conditions of temperature and humidity above standard atmosphere affect the powder in a manner to impede dispensing. However, in conventional operational ranges this effect can be compensated for by variations in the rotational rate.

Rotation of the reservoir is effected from motor 110 which drives sprocket 116 and through chain 117 which drives sprocket 118 mounted on shaft 145 suitably journaled in rear wall 69. A pin 129 is rotatably secured to the side face of sprocket 118 and to arm 130, thus the arm 130 moves eccentrically as sprocket 118 is rotated. Movement of the arm 130 is transmitted as a cranking motion to plate 131, pivotably supported at one end on shaft 84, through pin 132 to move pawl 133 in an oscillatory motion. Pawl 133 is secured to pin 141 rotatably secured to the opposite end of plate 131 and is normally biased into driving engagement with ratchet 134 by means of spring 139. With each forward movement the pawl engages a tooth of ratchet 134 to effect its rotation and through which is rotated shaft 84 to which the dispensing apparatus is secured.

Shaft 84, carrying ratchet 134 fixed thereon, is journaled for rotation with respect to sleeve 89 by means of flanged bearings 90 positioned within the sleeve. A packing 91 is inserted between the bearings 90. The reservoir is secured to the front end of shaft 84 by hub 146 secured to the inner face of brace 98. Attached to the opposite end of shaft 84 is a collar 142 positioned to maintain the plate 131 in alignment on the shaft.

The rate of reservoir rotation is controlled by con-

trolling the angle of movement effected with each forward movement of the pawl. Control of the angle is effected by means of a segmental gear 135 supported loosely on shaft 84 and which has a cam 136 extending therefrom to cover a toothed portion of ratchet 134. By means of handknob 137, connected to shaft 143 carrying worm gear 138 which meshes with gear 135, cam 136 is indexed to expose the ratchet tooth on which the pawl in its forward stroke first engages the ratchet. The pawl is urged downward by spring 139 so as to successively ride the cam and then engage the ratchet. When the pawl engages the ratchet at the beginning of its forward stroke maximum rotation of the reservoir is effected, whereas pawl engagement with the ratchet near the end of stroke effects a minimum rotation of the reservoir. After engagement by the pawl the relative rotation rate of the reservoir is substantially the same whether engaged at the beginning or near the end of the pawl stroke. However, the absolute rates, i.e., the rotational displacement per unit of time differ by the relative angles of displacement after pawl engagement. As the reservoir rotates, disk 114 rotates simultaneously therewith and it has been found that in addition to dispensing through the localized opening provided by the disk a minute amount of toner is carried and dispensed from the disk periphery.

Since the dispenser provides a uniform dispensing rate per unit of rotation, obviously other means such as a variable speed motor could be provided to vary the rotational rate. As another alternative different rates of dispensing can be effected by varying the dispensing opening as by movable wedge shaped disks or by using interchangeable disks of different dimensions.

Operation

In operation, xerographic drum 19 is constantly rotated and an electrostatic latent image formed thereon passes through developing station 26 for developing the latent image by cascading of a developing material thereover. Developing material is delivered to the drum for cascading by means of developing apparatus 28. In the developing apparatus, a supply of developing material is contained in the lower buckets 66 which are formed around the inside of wheel 83. As the wheel rotates, the buckets containing the material are elevated until inverting and spilling the material onto slide-hopper 104. On the hopper the material descends through opening 105 onto the drum. The cascaded material is thereafter retrieved by means of baffles 106 and 107 which deflect the falling material into the upright buckets below. The cycle is continuous.

The toner consumed in the formation of powder images is replenished by means of the dispensing apparatus 85 of the invention. Dispensing is effected from a reservoir 113 through a localized opening provided in the reservoir by a rotatable dispensing disk 114 and is achieved by rotating the reservoir. The dispensing rate can substantially be regulated by means of a rotatable cam 136 which changes the number of teeth in ratchet 134 picked up by constantly oscillating pawl 133 and varies the speed of the dispenser and consequently the dispensing rate.

By the apparatus above described there is disclosed an improved powder dispensing apparatus and particularly apparatus for dispensing powder of the type employed to develop xerographic images. The apparatus includes easily adjustable mechanism for varying the dispensing rates to provide for inherent fluctuations in the dispensing mechanism, the coverage of the copy, and the effects of temperature and humidity on the toner dispensing rate.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for dispensing granular material, including the combination of;
a reservoir for containing granular material, said reservoir consisting of two contiguous walls,
the first contiguous wall being cuplike in shape and enclosing all but one side of the reservoir,
the second wall being disk-like in shape and enclosing the remaining side of the reservoir,
said reservoir being adapted for rotational movement;
a plate member rotatably supported between the edges of said walls for maintaining a localized opening therebetween during rotation of the reservoir, means for rotating said plate member during rotation of the reservoir,
and means to rotate said reservoir.

2. Apparatus for dispensing granular material, including
a reservoir adapted for rotation about a substantially horizontal axis,
said reservoir consisting of a first wall of concave configuration and a second wall of substantially disk-like configuration, and fastening means to hold said first wall and said second wall in close contact such that a sealed enclosure is formed in the concave space of said first wall;
a plate member supported below the axis of rotation of said reservoir and extending between the first and second walls of said reservoir to provide a localized opening in said reservoir whereby granular material contained therein may be dispensed from the reservoir;
and means to rotate the reservoir proportional to the amount of granular material required during rotation of the reservoir.

3. Dispensing apparatus for delivery of toner material to the developing apparatus of a xerographic reproduction unit, including the combination of
a frustro-conically shaped reservoir for toner material and adapted for rotation about a substantially horizontal axis,
the base of said frustro-conical reservoir being a wall held in pressing contact with a peripheral wall of the reservoir;
a plate member rotatably supported below the axis of rotation of the reservoir between the edges of said walls for maintaining a localized opening therebetween during rotation of the reservoir, and means for rotating said plate member during rotation of the reservoir,
and means in said reservoir through which granular material may be added,
means for rotating the reservoir whereby toner material is dispensed through the localized opening in proportion to the degree of rotation.

4. The apparatus of claim 3, wherein said member is a disk which is rotatably supported on a shaft below and parallel to the axis of rotation of the reservoir.

5. In combination with a wheel type elevator including a rotatable wheel with buckets spaced around the inside of the wheel, said buckets having one open side facing the axis of rotation of the wheel, and a chute extending from a point outside the wheel into the space enclosed by the wheel;
a granular material dispensing reservoir adapted for rotation about a substantially horizontal axis,
said reservoir including
a frustro-conically shaped wall open at the larger end,
a disk-shaped wall in contact with the peripheral edge of the open end of the frustro-conically shaped wall,
a plate member rotatably supported below the axis of rotation of the reservoir and extending between the edges of said walls for maintaining a localized opening in the reservoir, means for rotating said plate member during rotation of the reservoir,

and means to rotate both the wheel type elevator and the reservoir at proportional speeds,

said means being adjustable whereby the proportional rate of rotation of the reservoir with respect to the wheel type elevator may be varied.

6. In the developing apparatus of a xerographic reproduction machine,

the combination of a rotatable wheel type elevator for delivering developing material to a xerographic drum during rotation of the elevator and a particle dispenser for supplying developing material to the wheel type carrier elevator,

said particle dispenser including a rotatable reservoir for containing developing material and formed by a first wall of concave configuration and a second wall of disc-like configuration,

said second wall being arranged in pressing contact with said first wall and covering the open end of said concave wall,

a disk rotatably supported below the axis of said reservoir and extending between the said first and second walls, thereby providing a localized opening in the reservoir,

and means to rotate the reservoir in proportion to the rotation of the wheel type elevator whereby the developing material may be dispensed through the localized opening to the wheel type elevator in proportion to the amount used by the xerographic reproduction unit.

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