# United States Patent

**Donohue et al.**

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## [54] TONER RECLAIMING SYSTEM


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[52] **U.S. Cl.** ..... **118/637**, 117/17.5, 355/15

[51] **Int. Cl.** ..... **G03g 13/00**

[58] **Field of Search** ..... 355/15; 118/637; 117/17.5; 15/1.5



[56] **References Cited**

UNITED STATES PATENTS

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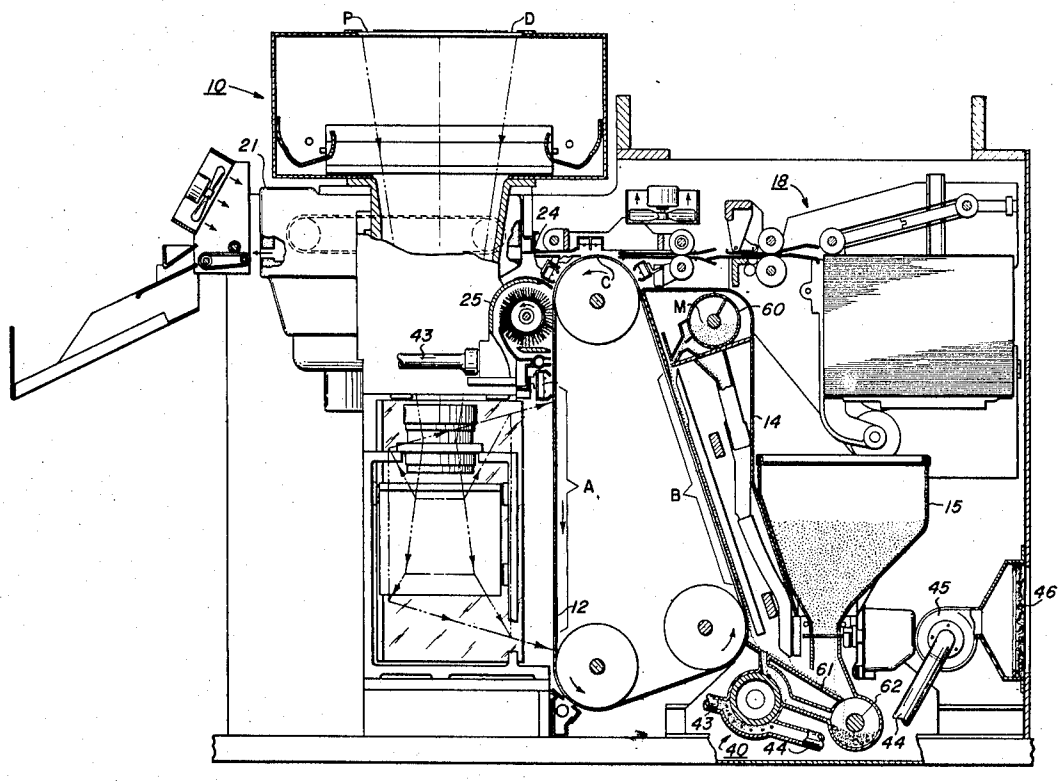
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[57] **ABSTRACT**

A toner powder reclaiming apparatus for use with the developing system of an electrostatic reproduction machine including a rotating drum in the path of movement of an air flow containing electrically charged toner particles which become attracted to the drum. Means such as carrier beads are brought into contact with the drum for cleaning the toner off the collecting surface thereon. After the toner particles become triboelectrically attracted to the carrier beads, they are directed automatically into the developing system for the machine.


**5 Claims, 3 Drawing Figures**



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SHEET 1 OF 2

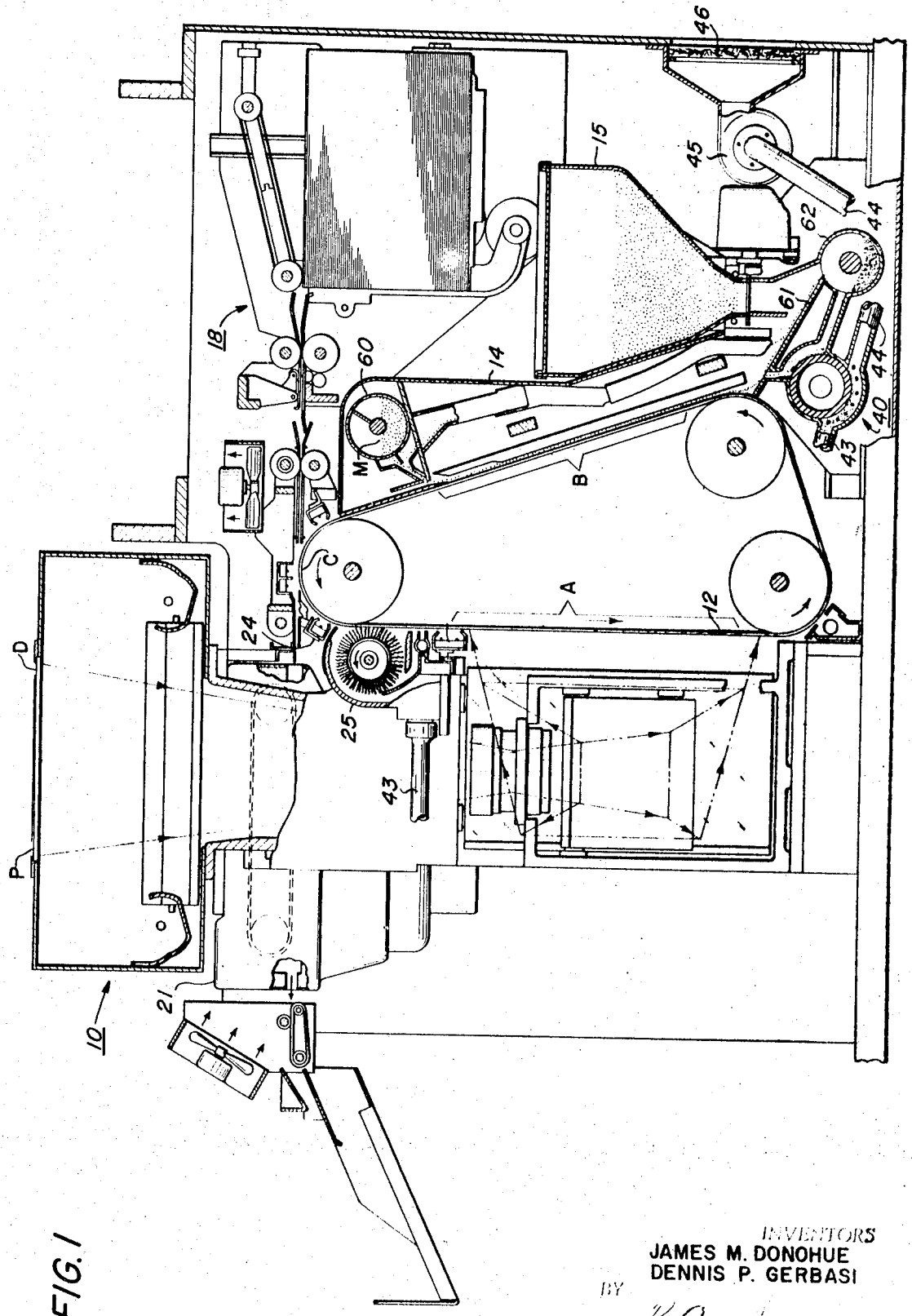



FIG. 1

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FIG. 2

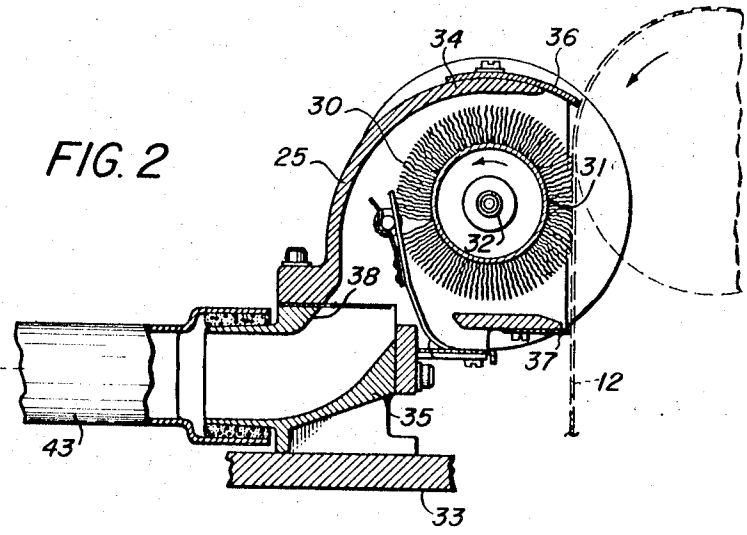
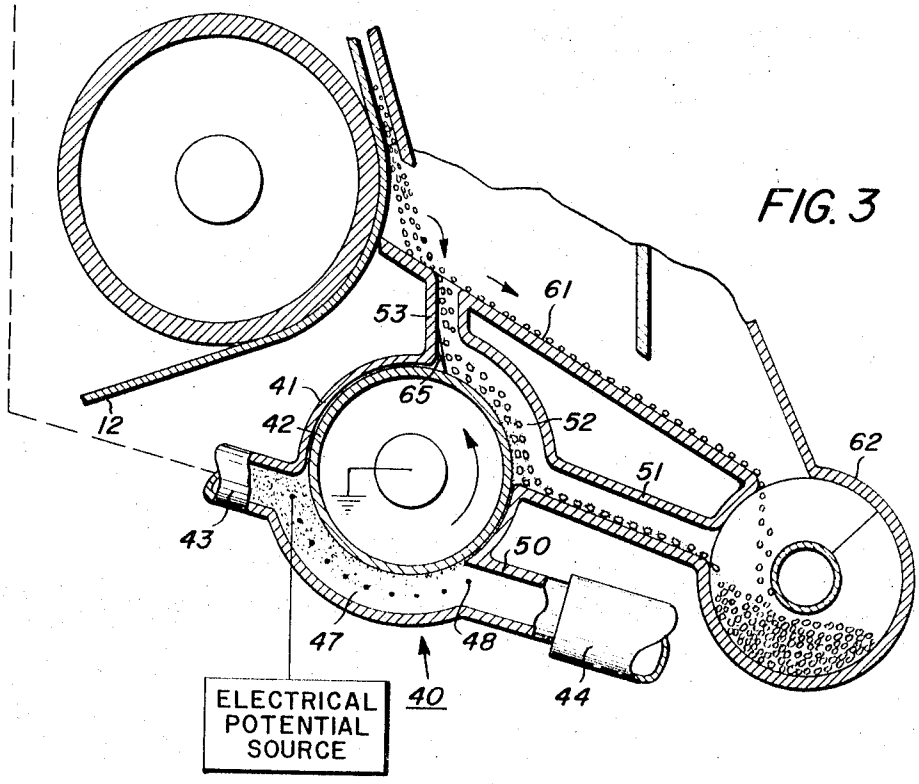

34
36
30
25
31
32
38
37
12
35
43
33

FIG. 3


61
53
41
65
52
42
12
62
51
43
50
47
48
40
44
ELECTRICAL POTENTIAL SOURCE

# TONER RECLAIMING SYSTEM

This invention relates to particle reclaiming systems, and particularly to a toner reclaiming system that is particularly adapted for use with automatic copiers/reproducers capable of high speed operation.

As is well known in recent years, the steadily increasing size of various industries has required an enormous increase in the amount of paper work that must be accomplished, maintained and made available for wide interplant circulation. Present day commercial automatic copiers/reproduction machines for this purpose are adapted to produce copies of between 10 and 60 sheets of copy per minute and are capable of effecting solid area development. Enormous amounts of developing material are consumed during long run productions and to a large extent a relatively large amount of some of this material is lost or diverted, requiring frequent additions of the material to the development system for the machines. Heretofore, there has been no effective way in which to recover residual toner collected or otherwise made available from a developing system and which will insure the opportunity to recover the toner particles for latter use.

It is, therefore, the principle object of this invention to improve electrostatic reproduction machines by returning most of the residual developing material cleaned from an electrostatic insulating plate to the developing system for reuse upon the plate.

Another object of this invention is to reclaim toner particles previously removed from an insulating plate automatically and to convey the toner particles with supporting carrier particles back into the developing system.

These and other objects of this invention are obtained by means of an electrically biased rotating drum arranged in the path of movement of an air flow containing toner previously cleaned from a photoconductor plate and directing carrier beads upon the drum to clean off and permit the return of the toner particles back into a developing system.

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 is a schematic sectional view of a reproduction machine incorporating the present invention therein with the processing components in section to better illustrate the environment for the present invention;

FIG. 2 is a toner cleaning mechanism for the reproduction machine; and

FIG. 3 is a schematic view, partly broken away, of a reclaiming system used in conjunction with the cleaning mechanism for the reproduction machine.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIGS. 1 and 2 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed at a working zone with an oppositely charged developing material comprising carrier beads and smaller toner particles triboelectrically adhering thereto to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fixed by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

The electrostatically attractable developing material commonly used in dry electrostatic printing comprises a pigmented resinous powder referred to here as "toner" and a "carrier" of larger granular beads formed with glass, sand, polymer material or steel cores coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the toner powder and the granular carrier. The carrier also provides mechanical control so that the toner can be readily handled and brought into contact with the exposed xerographic surface. The toner is then attracted to the electrostatic latent image from the carrier to produce a visable powder image on an insulating surface while the partially toner-depleted carrier beads are brought back into the developing system for the machine wherein it is mixed with developing material and a new supply of toner prior to reuse.



In the illustrated machine, an original D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly generally indicated by the reference numeral **10**, arranged at the left end of the machine. While upon the platen, an illumination system flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system to an exposure station A for exposing the photosensitive surface of a moving xerographic plate in the form of a flexible photoconductive belt **12**.

The exposure of the belt surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the belt surface continues its movement, the electrostatic image passes through a working zone or developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14** and where the belt is maintained in a flat condition. The developer assembly **14** comprises horizontally and vertically conveying mechanisms which carry developing material to the upper part of the belt assembly whereat the material is dispensed and directed to cascade down over the upwardly moving inclined selenium belt **12** in order to provide development of the electrostatic image.

As the developing material is cascaded over the xerographic plate, toner particles in the development material are deposited on the belt surface to form powder images. As toner powder images are formed additional toner particles are supplied to the developing material in proportion to the amount of toner deposited on the belt during xerographic processing. For this purpose, a toner dispenser generally indicated by reference numeral **15** is used to accurately meter toner to the developer material in the developer assembly **14**.

The developed electrostatic image is transported by the belt **12** to a transfer station C whereat a sheet of copy paper is moved at a speed in synchronism with the moving belt in order to accomplish transfer of the developer image. There is provided at this station a suitable sheet transport mechanism adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **18** to the developed image on the belt at the station B.

After the sheet is stripped from the belt **12**, it is conveyed into a fuser assembly generally indicated by the reference numeral **21** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

The next and final station in the device is a belt cleaning station having positioned therein a corona precleaning device **24** similar to a corona charging device to impose an electrostatic charge on the selenium belt and residual toner particles adherent thereto to aid in effecting the removal of the particles, a belt cleaning assembly **25** including a rotating brush device adapted to remove any powder remaining on the xerographic belt after transfer.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using an illumination system constructed in accordance with the invention. For further details concerning the specific construction of the electrostatic copi-

er, reference is made to copending application Ser. No. 731,934, filed May 24, 1968 in the name of Hewes et al.

The belt cleaning assembly **25** shown in FIG. **2** comprises an elongated rotatable brush **30** of such construction as to apply extremely light pressure to the photoconductive surface of the selenium belt **12** and to dislodge any powder particles that may adhere thereto. The brush is preferably formed of synthetic fur secured to a rigid cylinder **31** to a shaft **32** of a motor (not shown) mounted in the frame **33** of the machine. The brush is rotatably supported in an elongated housing **34** secured by nuts to a discharge nozzle adaptor **35** which in turn is supported on the machine frame **33**.

For containing toner powder particles removed from the belt **12** by the belt cleaning device, the housing **34** encompasses approximately the entire brush area and when applied to the belt **12** the opened end of the housing is nearly rendered closed by the adjacent surface of the belt. In order to insure as close as possible an air tight relationship between the selenium belt **12** and the interior of the brush housing **34**, the upper edge portion of the housing is provided with an adjustable seal plate **36** which may be moved circumferentially relative to the housing wall in order to permit close positioning of the leading edge of the seal plate to the selenium belt during movement thereof. Similarly the lower wall section of the housing **35** is provided with an adjustable seal plate **37** which has a leading edge that may be moved toward and away relative to the belt **12** in order to minimize the spacing therebetween.

At the other end remote from the side thereof which faces the selenium belt, the housing **35** is formed with an exhaust opening **38** in the form of an elongated slot having its longitudinal axis parallel to the axis of the brush cylinder **31** and a length generally equal to the length of the cylinder. The adaptor **35**, which is in communication with the interior of the housing **34**, serves to connect the housing to an inlet duct of a toner reclaiming system generally indicated by the reference numeral **40**.

The toner reclaiming system comprises a generally cylindrical housing **41** having mounted therein for rotation by suitable bearings a drum **42** arranged with its circumferential wall concentric with the outer wall of the housing **41**. The interior of the housing **41** is connected to the interior of the brush housing **34** by a duct **43** by way of the adaptor **35**. The interior of the housing **41** is also connected by way of a duct **44** to an exhaust blower **45** having its outlet arranged to direct exhaust air out of the machine and into the surrounding atmosphere. A filter **46** is in the path of movement of this exhaust air in order to insure that only filtered air reaches the atmosphere. In conventional brush cleaning exhaust systems for electrostatic machines, the brush cleaner **25**, the ducts **43**, **44** and the exhaust blower **45** with the filter **46** comprise the usual electrostatic plate cleaning system.

Some of these conventional machines may replace the plane filter **46** with a filter bag adapted to not only insure the atmospheric exhaust of clean air, but also to accumulate toner particles which then can be removed from the filter bag and repackaged for toner supply purposes. In the present invention, however, the toner reclaiming system **40** is interposed between a brush cleaner and its conventional exhaust system.

The duct **43** serves as the input for the reclaiming system housing **41** and because of the blower **45**, directs a flow of air therein from the interior of the brush housing **34**. This flow of air conveys and directs toner particles just previously removed from the photoconductive belt **12** upon the circumferential surface of the reclaiming drum **42** at an acute angle relative to a tangent at the point of contact therewith. The air is then directed through an arcuate space **47** defined by the surface of the rotating drum and the adjacent section of the housing **41**. Within this space is insulatingly mounted corona emitting wires **48** electrically connected to a source of electric potential.

The potential induced upon the wires **48** is relatively high and the toner particles passing through the space **47** become electrically charged due to the high ionizing field produced by the corona emitting wires. The charged toner particles, now ionized, seek the nearest surface of different potential which will be at the surface of the drum **42**, preferably held at ground potential. Air effectively free of toner leaves the space **47** and enters the duct **44** to be exhausted by the blower **45**. As the drum **42** continues rotation, it collects and carries the toner adhering to its surface past a baffle structure **50** held close to the peripheral surface of the drum **42** and which separates the exhaust duct **44** from a return duct **51**. The return duct **51** is in communication with an arcuate space **52** separating another portion of the peripheral surface of the drum **42** and the interior surface of the adjacent section of housing **41**. This space **52** is also in communication with a duct **53** which is connected to a source of carrier beads for the development material being utilized by the electrostatic machine. These carrier particles are somewhat depleted of toner particles and, therefore, are in condition for accepting additional toner particles when brought in contact therewith.

As previously stated, the carrier particles are made of material or, are coated with material occupying a position on the triboelectric scale different than the position of the toner particles so that when the carrier beads and toner particles are brought into contact, the toner will adhere to the carrier beads. The source of carrier beads is preferably a part of the developing system itself which for the present illustration will originate from a point wherein the carrier beads are in their most depleted stage.

As shown in FIG. **1**, the developing material M is shown as being directed from an upper horizontal conveyor dispenser tube **60** and into position to cascade over the upperly moving run of the photoconductive belt **12**. As the carrier bead cascades down the inclined slope at the development station B, toner is removed from the beads during the developing process. As the remaining development material is directed away from the belt **12** by means of a chute **61**, it is returned back into the developing system of the machine by being conveyed into a lower horizontal conveyor tube **62**. A vertical conveying means (not shown) will carry the remaining developing material along with newly added toner particles upperly from the conveyor tube **62** and into the conveyor tube **60** in order to present a continuous flow of development material during operation of the machine.

For the developing system shown in FIG. **1**, the point where carrier beads which are in the most depleted condition will be while they are being removed from the vicinity of the belt **12** and sliding down the chute **61**. The input tube **53** for the carrier beads is connected to an opening formed in the chute in order to receive some of the depleted carrier beads and to direct the same into the toner reclaiming system **40** by force of gravity. With the drum **42** moving in a direction indicated by the arrow, and with the carrier beads being driven against the surface at an acute angle relative to the tangent at the point of engagement with the periphery of the drum, the carrier beads will strike the drum surface thereby dislodging the adhering toner particles therefrom. With the carrier beads in the space **52** and the ducts **51**, **53** moving in the direction indicated by the arrows, the dislodged toner particles are removed from the space **52**. From the space **52**, the carrier beads — toner particle mixture, is directed by the duct **51** and conveyed to the interior of the lower conveyor tube **62** for the developing system **14**. In this manner, the carrier beads with their toner particles adhering thereto to form usable developing material are returned to the developing system to be utilized therein for continued development by the system. A blade **65** is secured to the housing **41** and contacts the surface of drum **42** at an angle relative to the tangent of the drum at that point. The blade cleans off the remaining toner particles still adhering to the drum and is arranged so that the scraped off toner is in the flow of carrier beads that contact toner particles in the space **52**.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth; but is intended to cover such modifications, or changes as may come within the scope of the following claims.

What is claimed is:

1. In an electrostatic reproduction machine having an electrostatic insulating plate upon which is formed an electrostatic latent image, a developing apparatus for applying developing material to the latent image for developing the same, the material comprising granular carrier particles and toner particles triboelectrically attractable to the toner particles, and a cleaning mechanism for removing excess toner particles from the plate after development of the latent image, the improvement comprising

collecting means adapted to receive the excess toner particles from the cleaning mechanism,

means associated with said collecting means for combining the excess toner particles with carrier particles, and

means for automatically transporting the combined particles into the developing apparatus for reuse thereby.

2. The improvement of claim 1 wherein said collecting means includes a housing connected with the cleaning mechanism, and a movable collecting surface.

3. The improvement of claim 1 wherein said means for combining excess toner particles with carrier particles includes means for placing an electrostatic charge on the toner particles and conveying means for directing carrier particles into contact with the charged particles.

4. A particle reclaiming system for use in a machine having a working zone to which particles are supplied in excess of quantities needed and from where some of the excess particles are removed therefrom including,

a collecting surface adapted for movement through first and second spaces,

means for receiving the particles to be removed and for conveying the same into said first space for contacting said surface,

means for electrically charging the particles while in said first space for impressing an electrostatic charge thereon different from the electrostatic charge on said surface to which charged particles are attracted and adhere during movement thereof,

means for conveying granular material into contact with the surface for separating the particles from the surface in said second space, said granular material being electrostatically attracted to the charged particles for carrying the same away from the surface and,

means for returning the removed particles to the working zone for reuse therein.

5. The reclaiming system of claim 4 wherein the collecting surface is in the form of a rotating drum.

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