United States Patent [19]

Gerbasi

[11] **3,752,576**

[45] **Aug. 14, 1973**

[54] **TRANSPORT FOR PARTICULATE MATERIAL**

[75] Inventor: **Dennis P. Gerbasi**, Webster, N.Y.

[73] Assignee: **Xerox Corporation**, Stamford, Conn.

[22] Filed: **May 27, 1971**

[21] Appl. No.: **147,567**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 838,816, July 3, 1969.

[52] **U.S. Cl.** **355/15**, 355/3, 118/637

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** 355/3, 15; 118/636, 118/637; 117/17.5; 15/1.5, 256.51

[56] **References Cited**

UNITED STATES PATENTS

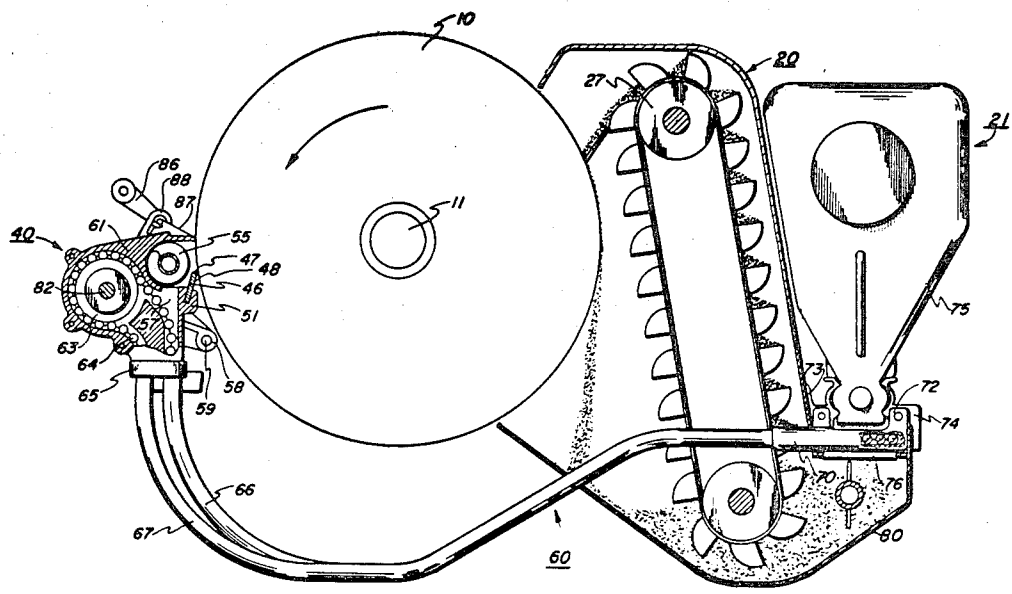
3,405,682	10/1968	King et al.	118/637
3,572,923	3/1971	Fisher	355/15
3,552,850	1/1971	Royka et al.	355/15
3,438,706	4/1969	Tanaka et al.	355/15
2,876,737	3/1959	Carlson	118/637
2,937,390	5/1960	Bolton et al.	355/15 X
3,032,009	5/1962	Magnusson	118/637
3,538,887	6/1968	Rueckwald	118/637 X
3,538,994	11/1970	Olden	118/637 X
3,590,412	7/1971	Gerbasi	118/637 X
3,534,427	10/1970	Severynse	355/15 X

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Alan Mathews
Attorney—James J. Ralabate, Donald F. Daley and Thomas J. Wall

[57] **ABSTRACT**

Apparatus for use in an automatic xerographic reproducing apparatus for cleaning residual toner material from the photoconductive surface after the image has been transferred to a final support material and for returning the residual toner to a xerographic developing station for reuse in the xerographic process.

9 Claims, 6 Drawing Figures



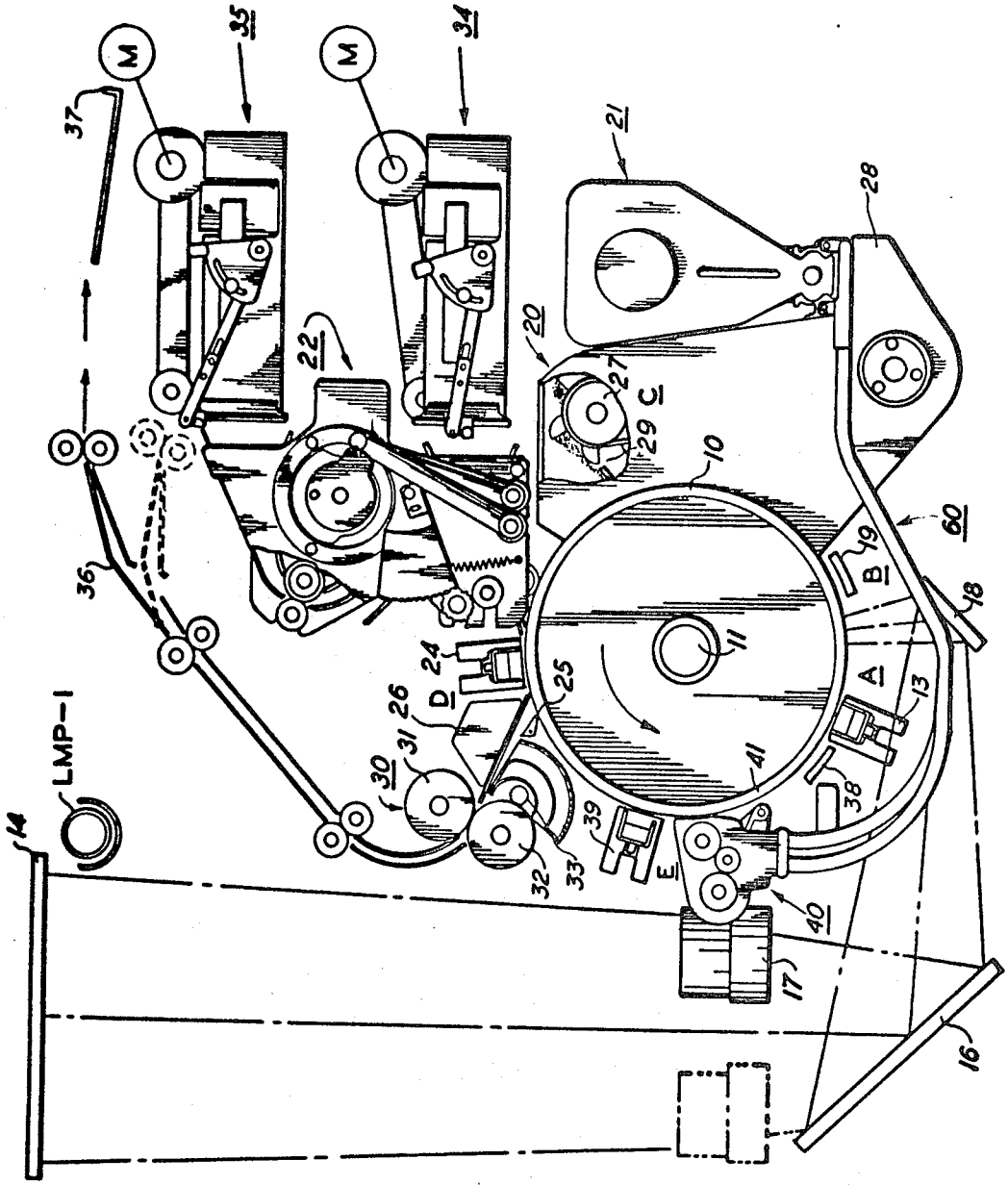


FIG. 1

INVENTOR.
DENNIS P. GERBASI

BY

ATTORNEY

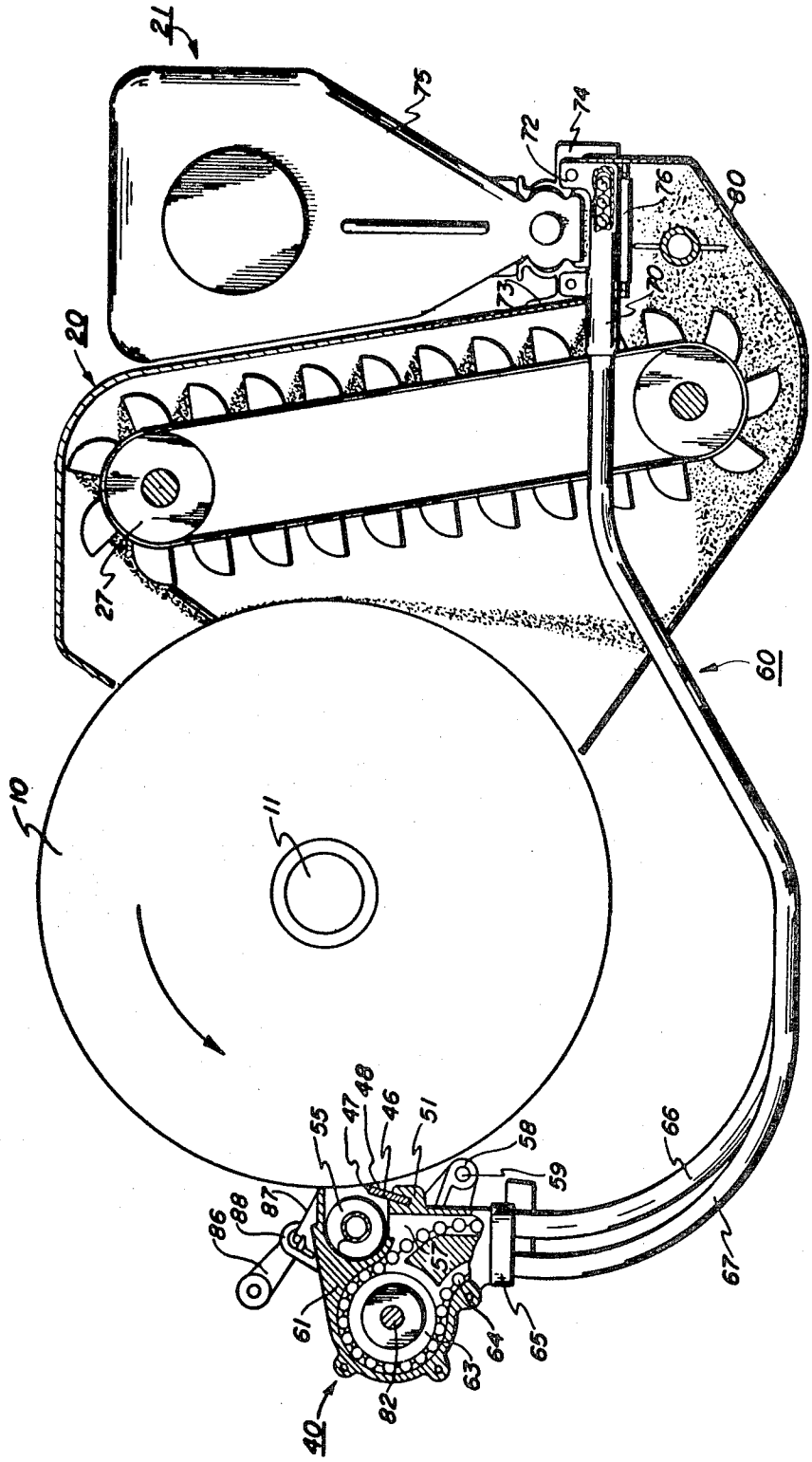

21
75
72
74
76
80
73
70
20
27
60
10
11
55
47
48
46
51
58
59
66
86
88
87
61
63
64
65
67
82
40

FIG. 2

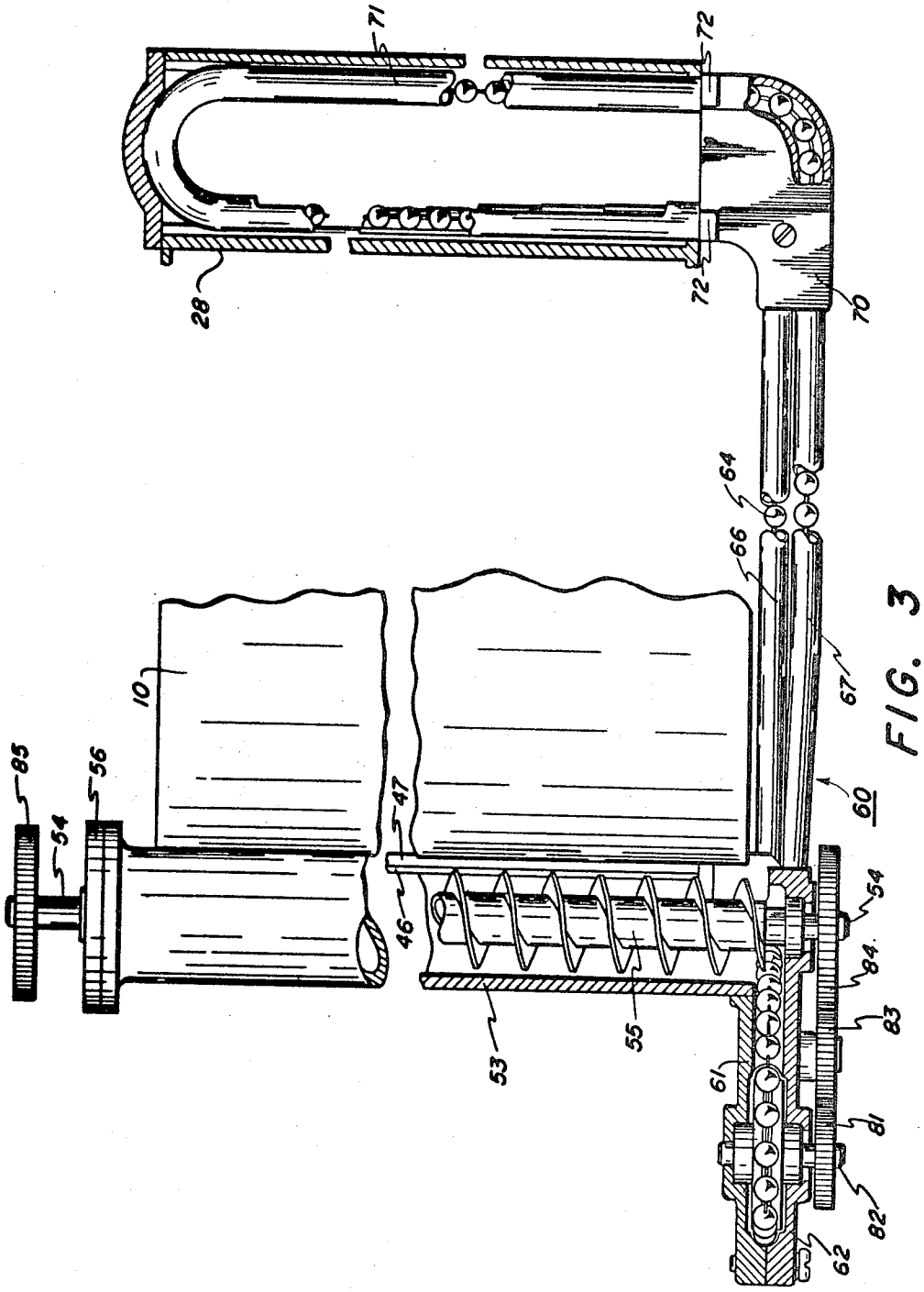


FIG. 3

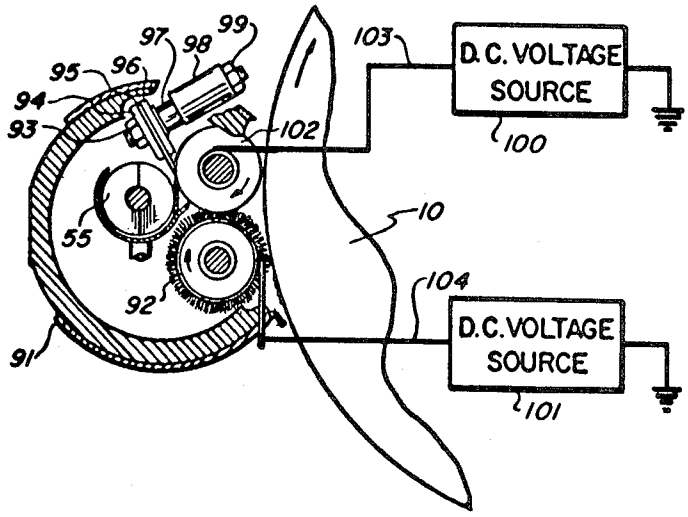


FIG. 5

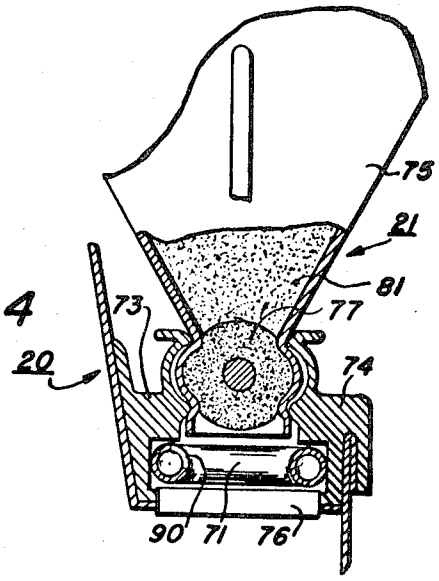


FIG. 4

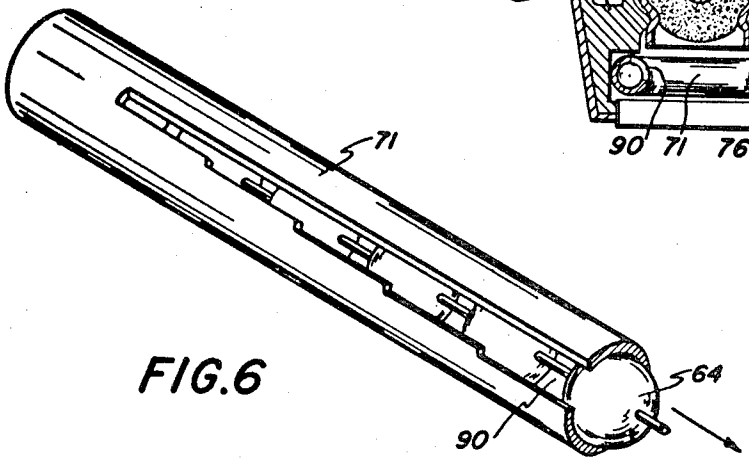


FIG. 6

TRANSPORT FOR PARTICULATE MATERIAL

This is a continuation-in-part of application Ser. No. 838,816 filed July 3, 1969.

This invention relates to xerographic apparatus and, in particular, to recovering unused toner material from a photoconductive surface after the xerographic image has been transferred and reusing the recovered toner once again in the xerographic development process.

More specifically, this invention relates to apparatus for use in automatic xerographic reproducing apparatus for removing and collecting residual toner material from a moving photoconductive surface after image transfer and returning the collected residual toner to a xerographic developing apparatus where it is once again reused in the xerographic process.

In the art of xerography, as originally disclosed by Carlson in U.S. Pat. No. 2,297,691, a xerographic plate, which is formed of a conductive backing upon which is placed a photoconductive insulating material, is charged uniformly and the surface of the plate exposed to a light image of an original to be reproduced. The photoconductive coating is caused to become conductive under the influence of the light image so as to selectively dissipate the electrostatic charge found thereon thus producing an electrostatic latent image. The latent image is made visible by developing the image with any one of a variety of pigmented resins which have been specifically developed for this purpose. In the xerographic process, the pigmented resin material, or toner, is electrostatically attracted to the latent image on the photoconductive surface in proportion to the amount of charge found thereon. Areas of small charge concentration become areas of low toner density while areas of greater charge concentration become proportionally more dense. The fully developed image is then transferred from the plate surface to a final support material, as for example, paper, and the image fixed thereto to form a permanent record of the original copy.

A preponderance of the toner material is transferred from the photoconductive surface to the final support material during the transfer operation. However, it has been found, that the forces bonding some of the toner particles to the photoconductive surface are stronger than the transfer forces involved and therefore some particulate material remains on the photoconductive surface after the xerographic image is transferred. This residual toner, if not cleaned from the xerographic plate in some manner, will have a deleterious effect on subsequent images processed on the plate.

Plate cleaning in automatic xerographic machines in which the plate is continually reused in the xerographic process is accomplished by various devices such as fiber brushes, cleaning webs, wiper blades or the like. The toner material so removed is usually collected and stored in the machine and then periodically removed and discarded. However, most of the commercially accepted methods of cleaning a photoconductive surface in automatic xerographic machines have been found to be dirt producing, wasteful and expensive. The fine residual toner material removed from the plate surface is extremely difficult to handle and the material often times migrates from the cleaning system into other areas of the machine to contaminate the machine component parts. It is also been found that the residual toner removed from the xerographic plate surface constitutes an extremely high percentage of the total toner used in the xerographic process. Discarding this toner, as heretofore practiced, results in increased operating costs.

It is therefore an object of this invention to improve xerography, and, in particular, automatic xerographic reproducing apparatus.

A further object of this invention is to reduce toner waste in an automatic xerographic reproducing apparatus.

A still further object of this invention is to reclaim residual toner left in a xerographic plate after the transfer operation so that the toner can be reused in the xerographic developing process.

These and other objects of the present invention are attained by means of apparatus for removing the residual toner from a photoconductive surface, a reservoir for collecting the toner removed from the photoconductive surface, a closed conduit between the reservoir and the xerographic developing station, a bead chain passing through said conduit for transporting particulate toner material collected in the reservoir to the xerographic developing station, and means to uniformly distribute the return material at the developing station.

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 illustrates schematically an automatic xerographic reproducing apparatus employing the toner reclaiming system of the present invention;

FIG. 2 is a side elevation in partial section showing the drum cleaning station, the bead chain and bead chain drive, the xerographic development system, and the associated elements of the toner reclaiming system shown in FIG. 1;

FIG. 3 is a partial top view of the toner reclaiming system shown in FIG. 2 constructed in accordance with the present invention;

FIG. 4 is a partial sectional view showing the toner reclaiming bead chain positioned in relation to the toner dispensing apparatus of the automatic xerographic machine shown in FIG. 1;

FIG. 5 is another embodiment of the cleaning apparatus showing the use of a biased brush cleaning device in the present invention;

FIG. 6 is an enlarged perspective view of the bead chain and tubular conduit having metering means associated therewith to distribute toner material evenly throughout the developer housing.

As shown, the automatic xerographic reproducing apparatus comprises a xerographic plate including a photoconductive layer of a light receiving surface on a conductive backing and formed in the shape of a drum, generally designated 10, which is journaled in the frame of the machine by means of shaft 11. The xerographic plate is rotated in the direction indicated in FIG. 1 to cause the drum surface to pass sequentially through a plurality of xerographic processing stations.

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

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

an exposure station B wherein a light or radiation pattern of an original document to be reproduced is projected onto the drum surface to dissipate the charge found thereon in the exposed areas to form a latent electrostatic image;

a development station C, at which a xerographic developing material having toner particles possessing an electrostatic charge opposite to the charge found on the drum surface in the latent image areas are cascaded over the moving drum surface whereby the toner particles adhere to the electrostatic latent image to make visible the image in the configuration of the original document to be reproduced;

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

a drum cleaning and toner collecting station E, wherein the drum surface is first treated with corona and then wiped with a doctor blade to remove residual toner particles remaining thereon after image transfer and wherein the removed toner is collected from reuse in the xerographic process and in which the drum surface is exposed to an incandescent panel to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The charging station is preferably located at the bottom of the drum in the position indicated by reference character A in FIG. **1.** The charging arrangement consists of a corona charging device **13** which includes a corona discharge array of one or more corona discharge electrodes that extend transversely across the drum surface and are energized from a high potential source. The corona discharge electrode is substantially enclosed within a shielding member and is adapted to generate a charge confined within this specific area.

Next subsequent thereto in the path of travel of the xerographic drum is an exposure station B wherein a flowing light image of a stationary original is placed on the moving drum surface. Basically, the optical scanning and projecting assembly comprises a stationary transparent copy board **14** adapted to support the original to be copied: an illuminating means LMP-**1** to illuminate uniformly the original supported on the copy board; a folded optical system including an object mirror **16** movable lens system **17,** and an image mirror **18** arranged in light projecting relationship with the moving drum surface to project successive illuminated incremental areas on the original document onto the drum surface to form a flowing light image thereon. The lens element is positioned beneath the copy board and is arranged to move through a path of travel parallel to the plane of the copy board whereby the subject image of the original is scanned in timed relation to the movement of the light receiving surface on the xerographic drum.

Positioned adjacent to the exposure station is a fade out panel arranged to discharge or expose the drum surface in the areas between copies to a level below that required for xerographic development so that these charged but non-imaged areas will not be developed as the drum moves through the subsequent developing station.

Next adjacent to the exposure station is a developing station C in which is positioned developing apparatus **20** including a housing **28** having a lower sump portion therein capable of supporting a quantity of two component developer material. A bucket type conveyor **27,** having any suitable drive means, is employed to carry the developer material from the lower sump area to the upper part of the developer housing where it is deposited in hopper **29.** The developer material moves downwardly into contact with the upwardly moving photoconductive drum surface. Toner particles are deposited in the image areas on the drum surface in relation to the charge pattern found thereon to form a developed xerographic image. The unused developer material passes from the development zone back into the lower portion of the developer housing. Fresh xerographic toner material is supplied to the developer mix in proportion to the amount of toner deposited on the drum surface by means of dispensing apparatus positioned in the lower portion of toner dispensing bottle **21,** as well as by means of the toner reclaiming apparatus of the present invention which will be explained in greater detail below.

Positioned next and adjacent to the developing station is the image transfer station D. Individual sheets of final support material are fed seriatim into sheet registering and forwarding apparatus **22** from either upper feed tray **35** or lower feed tray **34.** The properly registered sheets are then forwarded into moving contact with the moving drum surface and the developed image electrostatically transferred from the drum to the final support material by means of transfer corotron **24.** In operation, the electrostatic field created by the corona discharge device electrostatically tacks the transfer material to the drum surface whereby the transfer material moves synchronously with the drum while in contact therewith.

A mechanical stripper finger **25** is pivotally mounted in close proximity to the drum surface immediately adjacent to the transfer corotron. The finger is arranged to move into contact with the drum surface prior to the arrival of the leading edge of the support material. The arcuate shaped stripper finger moves between the drum surface and the leading edge of the final support material to mechanically break the electrostatic bond holding the material to the drum surface. Because of the positioning and the shape of the finger, the leading edge portion of the sheet of final support material is directed upwardly into contact with stationary vacuum transport **26.** The trailing edge of the support material which at this time is still electrostatically tacked to the drum surface, continues to drive the support material forward so that it moves along the bottom surface of the vacuum transport towards fuser assembly **30.**

The image bearing support material moving along the stationary vacuum transport moves into the nip between upper fuser roll **31** and lower fuser roll **32** of fuser assembly **30.** The two rolls coact to deliver pressure driving force to the sheet of support material positioned therebetween. A radiant heat source of heat energy **33** extends transverse to the lower roll surface and transfers heat energy to the roll. The roll is specifically coated so that the heat energy transferred thereto is stored on the outer surface of the roll. As the roll rotates in the direction indicated, the heat energy stored there is brought into rubbing contact with the image bearing support material passing through the nip between the two rolls where image fixing is accomplished by delivering a combination of heat and pressure energy to the image bearing support material.

After leaving the fuser assembly, the fixed copy is transported through a circular paper path into a mov-

able guide and drive roll assembly **36.** The movable guides can be prepositioned to either feed the paper delivered from the fuser into upper feed tray **35** or into discharge catch tray **37.** The apparatus can be programmed by means of the machine control logic system to precondition the paper handling equipment to accept simplex copies in upper feed tray **35.** The simplex copy is then once again reprocessed through the xerographic transfer station to form a duplex image and then discharged from the machine as described above.

The next and final station in the automatic xerographic reproducing apparatus is a drum cleaning and toner recovery station E at which cleaning apparatus constructed in accordance with the present invention removes substantially all residual toner particles remaining on the xerographic drum surface after image transfer and recovers the residual toner as removed for reuse in the automatic reproducing apparatus in a manner to be described below.

A rectangular shaped flexible blade is utilized in the preferred embodiment of the present invention to remove residual toner from the moving drum surface. The blade is mounted in blade holder **51** forming one wall of cleaning and collection apparatus **40** (FIG. **1**). The blade normally rests transversely in pressure contact with the photoconductive layer on the drum surface. The edge of the blade formed by the joinder of upper face surface **47** and front side surface **48** is positioned slightly below the horizontal center line of the drum. It should be noted that the blade is positioned so that the contacting edge cuts or chissels toner material from the drum surface much like a lathe cutting tool removes material from a work piece. In fact, it has been found that the forces experienced by the blade are quite similar to the forces encountered by the lathe cutting tool. The blade is therefore best supported in a tool like fashion having an end relief angle and a slight back rake angle. The is, the angle between the front side **48** of the blade and a plane tangent to the drum surface at the point of lead edge contact, can be varied for different blade materials to effectively eliminate blade chatter and other undesirable effects associated with improper blade positioning. Although not essential for the practice of the present invention, it is desirable to provide a slight back rack on face surface **47** so that a sharper cutting edge is presented to the drum surface resulting in more efficient drum cleaning.

Unlike the conventional web or brush cleaning apparatus known in the art, the present blade cleaning member will not become contaminated with toner during the cleaning operation. Because of the blade's novel cleaning action, the toner particles are cut cleanly from the plate surface and are allowed to fall freely into the collecting trough provided. As a result, the toner particles substantially retain their initial integrity throughout the cleaning process and are therefore in a condition to be immediately reused in the xerographic process without recourse to further treatment or processing thereof.

Any suitable non-metallic flexible cleaning blade material hich will remain uncontaminated during cleaning may be employed in the present invention. Typical non-metalic flexible materials include: polysiloxane rubber, polyurethane rubber, polytetrafluoroethylene resin, polytrifluorochloroethylene resin, styrene-butadiene rubber, nitrile rubber, nitro-silicone rubber, flexible polyurethane foam, polyethylene resin, and blends, mixtures and copolymers thereof. The blade should be sufficiently soft to minimize plate abrasion and particularly abrasion to a selenium type imaging surface. Preferably, the blade material should have a Shore hardness of less than 75 durometers. Tests have shown that a relatively wide latitude in blade thickness can be employed in the present apparatus with no noticeable change in the cleaning process.

It should be clear that by positioning the doctor blade slightly below the horizontal center line of the drum surface and providing the blade with a slight back rack, the removed residual toner material will be forced to fall to the backside of the blade, that is, to the side away from the photoconductive drum surface. As illustrated in FIGS. **2** and **3,** the removed toner falls into an open side channel **53** adjacent to and running longitudinally along the drum surface. A screw type conveyor **55** mounted upon shaft **54** is journaled for rotation in end plate **56** and cover plate **62.** The conveyor is supported in the open side channel in substantially parallel relation to the doctor blade and is arranged to convey the toner particles removed from the drum surface towards toner recovery drive housing **61.**

The open side channel **53** is closed at one end by means of end plate **56** while the opposite end of the channel is securely mounted in drive housing **61.** The channel communicates with a reservoir or collecting area, generally referred to as **57,** in the housing. A top portion of shaft **54** as seen in FIG. **3,** extends through end plate **56** and has rigidly affixed thereto driving gear **85.** Although not shown, driving gear **85** is driven from the machine main drive system to rotate the conveyor in a direction whereby the screw transports toner material laterally behind the blade into reservoir area **57** wherein the residual toner is collected.

A bead chain drive sprocket **63** is rotatably mounted on shaft **82** which is journaled for rotation in drive housing **61.** The drive sprocket is driven directly from the main machine drive through screw conveyor shaft **54.** Driven gear **84,** mounted on the bottom end shaft **54,** as shown in FIG. **3,** turns intermediate gear **83** which in turn drives sprocket drive gear **81** which drives drive sprocket **63** through a common shaft **82.** Passing over the rim of the drive sprocket **63** is endless bead chain **64.** The drive sprocket is arranged to engage and guide the bead and link members of the chain to move the chain in the direction indicated.

In the present invention, the residual toner which is collected in reservoir area **57** of the drive housing **61** is transported back to the developer housing by means of a conveyor system made up of supply and return tubing **66, 67;** developer housing connector **70;** and toner metering and return loop **71.** The various parts making up the conveyor system are mated together so that a continuous substantially closed circuit conduit **60** having a uniform inside diameter runs from resevoir area **57** across the width of the developer housing and returns once again to said reservoir. As illustrated in FIGS. **2** and **3,** endless bead chain passes over drive sprocket **63** and is arranged to move through conduit **60** along a circular path of travel extending from the reservoir area through the developer housing and back. The inside diameter of conduit **60** is slightly larger than the diameter of the chain beads so that the beads will move freely through the conduit but yet be capable of pushing particulate toner material therethrough.

Although the apparatus of the present invention is disclosed in reference to a bead chain conveyor it should be clear to one skilled in the art that any suitable conveying means may be herein employed without departing from the spirit of the invention.

In operation, the endless chain moves downwardly through the collected toner material in reservoir area **57.** The chain beads mechanically force the particulate toner material downwardly into supply tubing **66.** The tubing is secured in operative relation with the drive housing by pressing the tubing firmly into the receiving adapted positioned in the bottom of the drive housing plate **55.** Although not necessary in the present invention, the tubing can be locked in place by means of set screws or the like. The opposite end of tubing **66** is similarly connected in developer housing connector **70.** Supply tubing **66** and the return tubing **67** are preferably constructed of a flexible plastic material which, as shown in FIG. **1,** is conveniently routed from the toner cleaning and collecting apparatus **40** to the developer housing **20** through the machine so as to avoid the stationary machine components. Clearly, the above arrangement gives the present apparatus an extremely wide flexibility of usage in that the toner cleaning and collecting area can be positioned at any remote position in the machine and still be able to operatively communicate with the developer system.

New toner is dispensed in the present apparatus by means of a roll dispenser **77** positioned in the bottom portion of toner dispensing bottle **75.** The bottle is seated between rails **73, 74** (FIG. **4**) extending laterally across the dispensing opening provided in the developer housing. The bottle is adapted to dispense toner at a predetermined rate directly into the developer housing as dispensing roll **77** is rotated in the direction indicated. Developer housing connector **70** is secured to the developer housing by affixing embossed sections **72** thereon to rails **73, 74** as for example, by screws. The bead chain, which has transported toner material through supply tubing **66,** is guided through approximately a **90°** turn as the chain passes through connector **70** so that the chain leaves the connector along a path of travel substantially parallel to rail **73.** Loop **71,** which is also fabricated of a relatively rigid plastic material, is supported in the connector **70** so that the loop is suspended just below the toner dispenser bottle in substantially parallel relation to the support rails. The bead chain entering the dispensing area of the developer housing first passes through a portion of tubing having a series of step-like cut-outs **90** formed in one side wall of the U-shaped tubing. As illustrated in FIG. **6,** the elevation of each cut-out is lowered incrementally as the tubing extends across the developer housing. As the chain moves toner through this area, the toner is dispensed through the cut-outs so that the toner is distributed equally across the width of the housing. The bead chain continues around the loop and once again makes a **90°** turn through connector **70** and returns once again to drive housing **61** through return tube **67.**

Although not shown, seals are provided between the open side channel **53** and the rotating drum surface to prevent residual toner material from escaping from the toner cleaning and collecting apparatus **40.** As can be seen, because a close system is thus provided, little or no free toner material is permitted to escape to the surrounding machine areas. The toner cleaning and recovery system as herein disclosed is not only extremely clean to operate but also protects the surrounding machine components from being contaminated by loose or free toner particles. The entire cleaning and collecting apparatus **40** (FIG. **1**) is pivotally supported upon pivot arms **58** mounted on tie rod **59** which is locked to the machine frame. To facilitate the removal of this from the machine, the entire assembly **40** is swung downwardly about rod **59** away from the drum surface. As can be seen, open side channel **53** pivots downwardly to form a trough capable of containing any loose toner particles which may be in process in the system at this time. When the assembly is moved to the operative position, as shown in FIG. **2,** a spring biased latch **86** is locked in supporting engagement with latch pin **87** and held in place by locking mechanism **88.** With the assembly in the operative position, the cleaning edge of the flexible self-adjusting blade is supported in pressure contact with the drum surface.

FIG. **5** shows a second embodiment of the present invention illustrating the use of a biased brush in place of wiper blade to remove residual toner from the photoconductive surface. The apparatus comprises a housing **91** secured to the main machine frame which houses a fiber brush **92** positioned in the housing so as to contact the rotating drum surface. As the cleaning fibers are moved past the drum surface an external potential of a polarity opposite to the polarity of the residual toner particles is applied to the conductive support cylinder of the brush causing an electrical field or lines of force to eminate radially from the cleaning fibers to attract the toner particles from the drum surface to the brush hair fibers. To accomplish this, a DC voltage is supplied to the conductive cylinder by means of voltage source **101** acting through commutator line **104.**

Desirable cleaning fibers are made from any suitable non-conductive material which is capable of preventing the shorting of the applied DC voltage and which is substantially uneffected by changes in humidity. Typical cleaning fiber materials having these properties are acrylic, velvets, orlon, polypropylene fabrics, nylon, rayon, acetates, mohair, glass, dynel, dacron, cotton and other natural and/or synthetic fibrous materials and mixtures thereof. In addition, the brush fibers may be formed or coated with a material having a triboelectric traction to the common particles thus further enhancing the cleaning qualities of the brush. Typical materials having this triboelectric relationship to known toner materials are described in U.S. Pat. No. 2,618,551 to Walkup and in U.S. Pat. No. 2,618,552 to Wise. It should be clear to one skilled in the art that by enhancing the attraction properties of the brush by use of materials which are triboelectrically remote relative to the toner materials will normally allow for a decrease in voltage applied to the brush.

The toner particles are first attracted from the drum surface to cleaning brush **92** and then removed from the brush fibers to insure that the praticles will not be redeposited once again on the drum surface. An electrically biased roll **102** is positioned in the path of the cleaning fibers and the roll connected to an external biased source **100** through means of commutator line **103.** The roll is charged to a potential of a polarity opposite to that of the toner particles and of sufficient magnitude to attract the particles from the cleaning brush fibers to the roll. Roll **102** is mounted for rotation in the housing in a direction opposite to that of the

brush fibers at an angular velocity different than the speed of the cleaning brush so that a relative motion between the two members is constantly maintained. To present a continuously clean surface to the half fibers and also to facilitate in the recovery of toner particles so that they may be returned and reused in the development system, a scrapper assembly is positioned in the path of roll **102.** The scrapper assembly basically comprises a blade member **95** which is held firmly in place by blade holder elements **94, 96.** The blade holder elements are connected to housing **91** by one or more adjustable bolt members **93,** each of which is received through an insulating block member **98.** A nut **99** constrains the blade holding elements against a compressive spring **97** which is seated against insulating block **98.** Contact pressure of the blade member will roll **102** is adjusted by turning nut **99** received on the bolt member.

As the toner particles are removed from the surface of roll **102** they fall through **104** and are transported laterally into reservoir area **57.** The collected toner particles are then conveyed as described above by means of the bead chain conveyor system to the developer housing where the toner material is once again used in the development process.

While this invention has been described with refernce 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 scope of the following claims.

What is claimed is:

1. In an apparatus of the type having an image retaining plate upon which is recorded a latent electrostatic image, a developing means for applying particular developer material to said member to render the latent electrostatic image recorded thereon visible, means for transferring the developed image from said image retaining member to a sheet of final support material, and cleaning means for removing residual developer material remaining on said member after transfer from said member, the improvement comprising

a resilient elastomeric cutting blade biased into deforming contact against the surface of the moving image retaining member so that the cutting edge of the blade passes between the moving member and the residual developer material thereon whereby the developer material passes behind said blade and is directed away from the movingmember, a collecting means located adjacent to said blade and arranged to receive said developer material directed away from the moving member, and

conveyor means passing through said collecting means to automatically transport the separated developer material deposited in said collecting means back to the developing means wherein the separated developer material is reused in the developing process.

2. The apparatus set forth in claim **1** having further dispensing means operatively associated with said conveyor means for uniformly distributing the separated developer material within the developing means.

3. The apparatus of claim **2** wherein said conveying means is arranged to move through an endless loop between the collecting means and the developing means.

4. Apparatus for recovering residual toner material remaining on a moving image retaining member after a developed image is transferred from said member to a final support material including

means to separate the individual residual toner particles from the moving image retaining member after image transfer,

means to convey the separated residual toner particles to a collecting reservoir,

tubular means forming a relatively closed loop extending from said collecting reservoir through an image developing station and returning once again to said collecting reservoir,

an endless bead chain being arranged to pass freely through said tubular means,

means to drive said bead chain in a closed loop between said reservoir and said developing station whereby residual toner material is transported from the collecting reservoir to the developing station, and

dispensing means associated with that portion of said tubular means positioned within the developing station to uniformly deposit residual toner material transported by said chain within said developing station.

5. The apparatus of claim **4** wherein said means to separate residual toner from the moving image retaining member comprises a flexible cleaning blade having a cutting edge arranged to ride in contact with the surface of the image retaining member in a position wherein the cutting edge of the blade moves between the residual toner and the moving member surface so that the residual material passes behind said blade.

6. The apparatus of claim **4** wherein said means to separate residual toner from the image retaining member comprises an electrostatically isolated brush having non-conducting fibers biased to a polarity opposite to the polarity of the residual toner material.

7. The apparatus of claim **5** wherein said means to drive the endless bead chain comprises a drive sprocket having means associated therewith to positively engage the bead and link members of said chain and to guide said endless chain along a predetermined path of travel.

8. The apparatus of claim **7** wherein said moving image retaining member is a photoconductive drum.

9. The apparatus of claim **8** wherein said means to convey residual toner to said collecting reservoir comprises

a screw conveyor rotatably mounted transverse to the drum surface and being positioned behind said cleaning blade whereby the toner material separated from the drum surface falls into contact with said conveyor, and

means to rotate said screw conveyor wherein the separated residual toner is moved laterally into said reservoir.

* * * * *