

[54] **TONER CLEANING APPARATUS FOR A PHOTOCOPY MACHINE**[75] Inventor: **John R. Sargis**, Chicago, Ill.[73] Assignee: **Addressograph-Multigraph Corporation**, Mount Prospect, Ill.[22] Filed: **May 20, 1971**[21] Appl. No.: **145,513****Related U.S. Application Data**

[63] Continuation of Ser. No. 883,477, Dec. 9, 1969, abandoned, which is a continuation-in-part of Ser. No. 794,213, Jan. 27, 1969, abandoned.

[52] U.S. Cl. **355/15, 355/3**[51] Int. Cl. **G03g 15/00**[58] Field of Search **355/3, 15**[56] **References Cited****UNITED STATES PATENTS**

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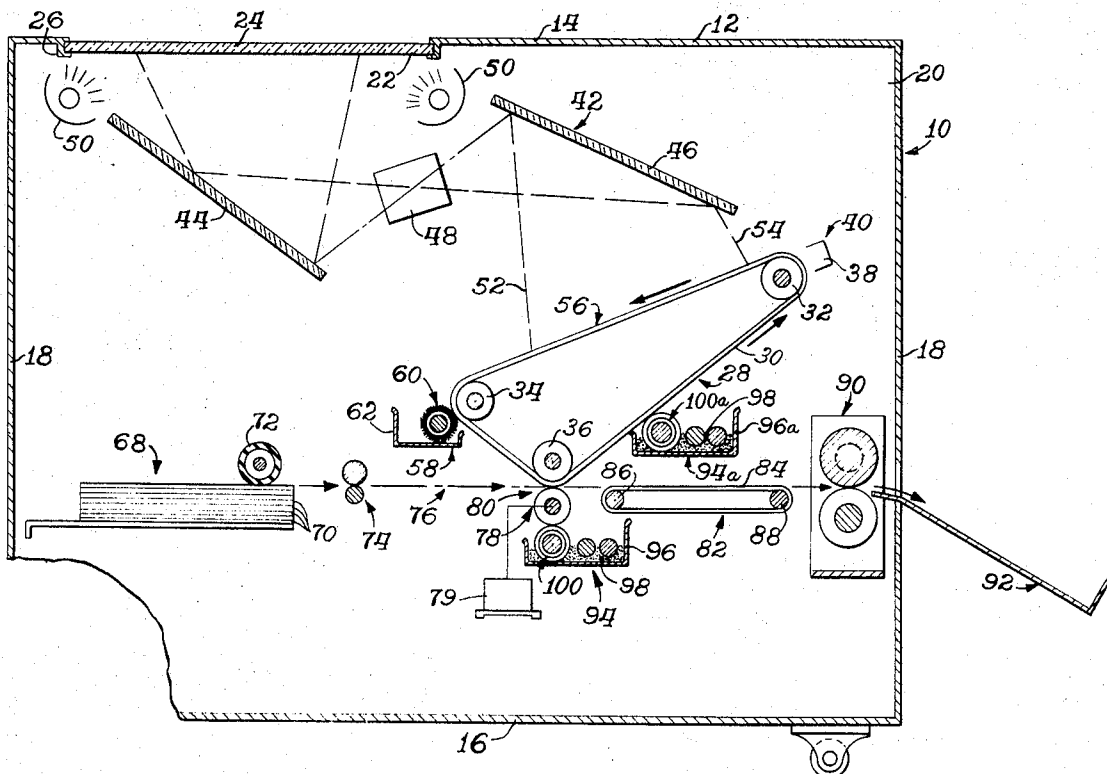
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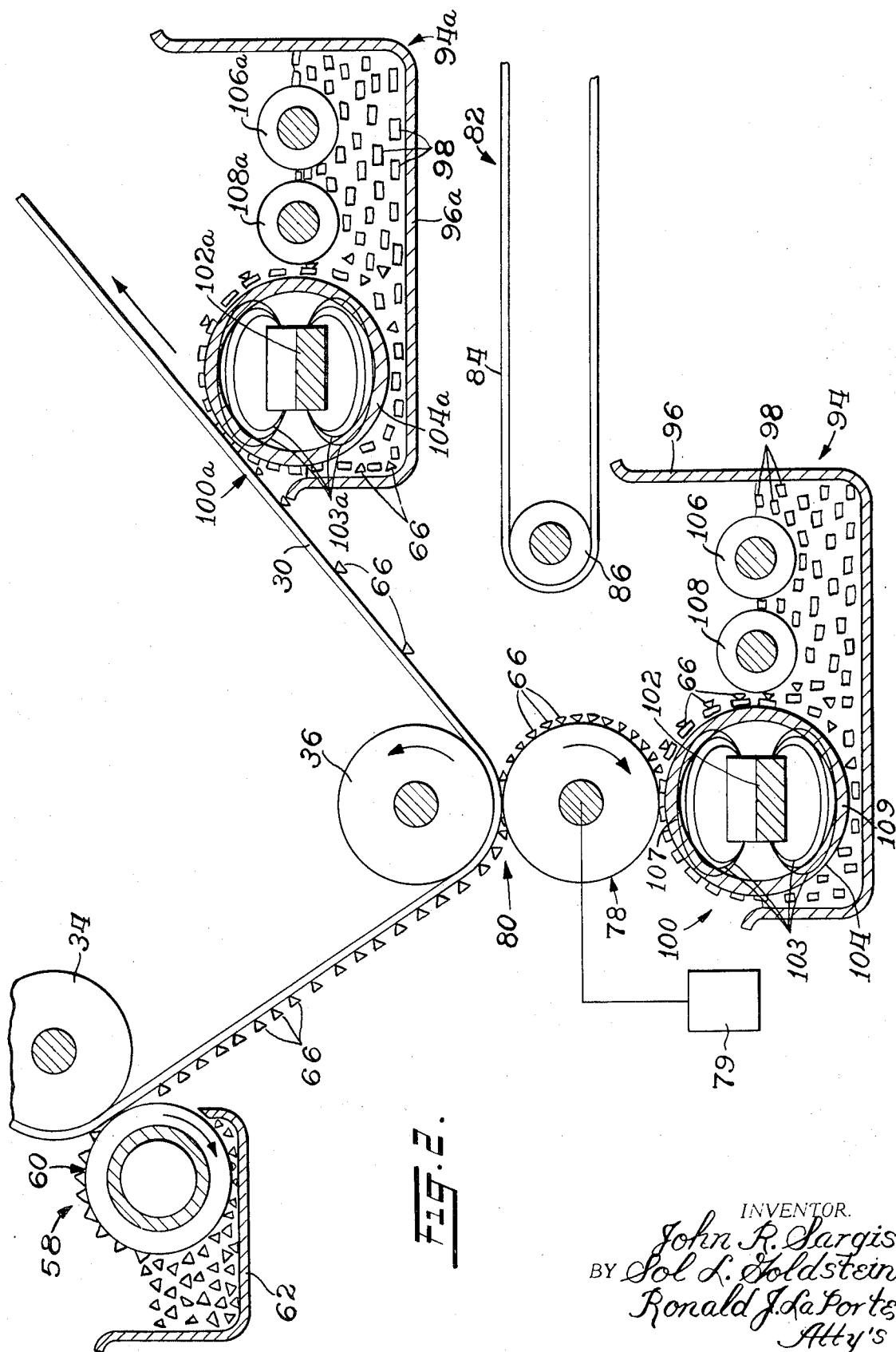
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[57] **ABSTRACT**

Apparatus for removing toner from a transfer roller and/or a recording member of an electrostatic copying machine, comprising a magnetic cleaning roller having the outer surface thereof covered with magnetizable particles and mounted for rotation in a trough partially filled with a supply of magnetizable particles, and in contacting relation with the transfer roller or member. Toner particles adhering to the outer surface of the transfer roller or member are attracted by triboelectric forces to the cleaning roller and are deposited in the trough. In a preferred embodiment, a pair of rotatable, auxiliary rollers are provided within the trough to stir the magnetizable particles and to aid in the deposition of toner particles removed.

10 Claims, 2 Drawing Figures



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TONER CLEANING APPARATUS FOR A PHOTOCOPY MACHINE

This application is a continuation of patent application Ser. No. 883,477 filed Dec. 9, 1969 which, in turn, is a continuation-in-part of patent application Ser. No. 794,213, filed Jan. 27, 1969, both now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to electrostatic copying apparatus and more particularly to copying apparatus using a photoconductive member from which developed images are transferred to produce copies.

In copying machines, such as, for example, of the type described in copending patent application filed in the name of Loren E. Shelffo, Henry A. Mathisen and Frank L. Schwager, assigned to the same assignee, wherein a recording member having a photoconductive surface is used to transfer developed images therefrom to copy sheets coming into contact therewith, developing means are provided which deposit developer powder or toner particles onto the imaged areas of the member just prior to contacting the copy sheet. The toner particles, being charged oppositely to the recording member, are attracted to the member and are carried thereby towards the copy sheet path.

A transfer roller is provided in the copy sheet path adjacent the moving member for bringing the surface of the copy sheet against the toner laden member for effecting transfer to the copy sheet. The transfer roller is also charged electrically oppositely to that of the toner particles, but with a greater potential than that of the belt member so that the toner particles are attracted towards the roller. Thus, when a copy sheet is interposed between the roller and the toner covered recording member, the toner particles, being attracted by the charged transfer roller, are transferred to the copy sheet. While substantially all of the particles transfer, there is a small residual amount of toner that clings to the member.

In the event a copy sheet is not passed between the charged transfer roller and the recording member after the image on the member has been developed, the residual toner particles on the last-mentioned member nevertheless will be transferred, but now instead of to the copy sheet, to the transfer roller. As a result, a build up of toner particles on the transfer roller occurs, causing the back surfaces of subsequently passed copy sheets to be smeared with the toner from the roller.

In addition to the above-described condition, often a small quantity of toner particles remains on the recording member subsequent to transfer. In the case wherein many copies are being processed at a relatively rapid rate, toner build up on the recording member can cause the blurring of the developed images of subsequently made copies.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide apparatus for overcoming the above-mentioned difficulties.

It is a more specific object of the present invention to provide apparatus for removing toner from the transfer roller and/or the recording member of a copying machine of the type described heretofore.

Briefly, a preferred embodiment of toner or developer powder removing apparatus according to the invention comprises a magnetic roller mounted for rotation so as to be partially immersed longitudinally in a container of magnetizable particles, such as iron filings or the like. A portion of the outer surface of the roller, extending outwardly of the container, is located adjacent the surface to be cleaned; i.e., the electrically charged transfer roller and/or the recording member of the copying machine. Developer powder clinging to the recording member after transfer and/or powder transferred inadvertently to the transfer roller as the case may be, is picked off by the magnetizable particles on the outer periphery of the toner removing roller through triboelectric forces. As the last-mentioned roller rotates, the magnetizable particles now having toner powder attracted thereto, are passed through the container. A pair of auxiliary rollers are provided in the container for stirring the iron filings, thereby to facilitate the removal of toner laden magnetizable particles from the magnetic roller as the roller turns in the container of magnetizable particles. The quantity of toner particles which is able to be removed by the cleaning device according to the invention is limited to some extent since the iron filings within the container become saturated when the mixture becomes approximately 50/50 of toner particles and iron filings. When this occurs, however, the container need only be emptied and the supply of iron filings be replenished.

DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention and its organization and construction may be had by referring to the description below in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side sectional view of a diagrammatic representation of a copying machine employing toner removal apparatus according to the invention; and

FIG. 2 is an enlarged, fragmentary view of the machine of FIG. 1, illustrating the toner removal apparatus and functioning thereof according to the invention.

DETAILED DESCRIPTION

A copying machine in which toner removal apparatus according to the invention may be used is illustrated in FIG. 1 of the drawings and is designated generally by the numeral 10. The copying machine 10 includes an outer housing 12 having an upper wall 14 and a base wall 16 joined by a pair of end walls 18 and a pair of side walls 20, only one of which is shown. The upper or top wall 14 of the housing 12 includes an opening 22 into which there has been placed a transparent platen 24, of glass or the like material. The platen 24 is mounted at opposite sides thereof in a pair of guide channels 26 connected to the upper wall 14 and extending inwardly into housing 12. Thus, the platen is substantially co-planar with the outer surface of the top wall of the housing.

A photoconductive member, generally designated by the numeral 28, herein taking the form of an endless belt 30, is mounted for counterclockwise movement as indicated by the arrows, on a plurality of predetermined spaced rollers or pulleys 32, 34 and 36. In the vicinity of roller 32 adjacent belt 30, there is located a

charging station 38, comprising a corona unit 40 of the well-known type, for charging the photoconductive surface of the belt 30. Counterclockwise about the belt from charging station 38, there is mounted an optical assembly 42, including a pair of inclined reflecting mirrors 44 and 46 and a lens 48 interposed therebetween. Light from light sources 50 mounted within housing 12 adjacent platen 24, is reflected from an original placed on the platen from which copies will be made, and transmitted via optical assembly 42 to a given area, defined by reflected light rays 52, 54 on belt member 30 to comprise an exposure station 56 for selectively discharging the charged photoconductive surface of the belt, thereby to form a latent image on the latter.

A developing station 58 including a magnetic brush developer 60 of a well-known type immersed in a container of toner particles 62, is provided near roller 34 upon which belt 30 is mounted. The developing station 58 is immediately counterclockwise about belt 30 from exposure station 56 as shown in the figure. Toner particles or developer powder from the magnetic brush 60 are deposited on the charged image areas of the belt 30 as the belt passes adjacent the developing station. This is illustrated best in FIG. 2 of the drawings, wherein toner particles, indicated by numeral 66, are shown attracted to the outer surface of the belt member 30.

A copy sheet stack 68 is provided at the left of the copying machine as seen in FIG. 1. Single sheets 70 are fed from the stack in synchronism with the movement of belt 30 about rollers 32, 34 and 36. Initially, the feed roller 72 moves the top sheet of the stack 68 in the direction of the arrow toward roller pair 74. The roller pair continues to move the sheet along the copy sheet path 76 until the leading edge thereof reaches roller 36. At this time, the developed image on belt 30 is also coming about and a leading edge of the imaged portion thereof is nearing roller 36.

A transfer roller 78 charged electrically by power supply 79, is mounted for rotation adjacent roller 36 and belt 30 to form therewith a transfer station 80. The roller 78 serves to move a copy sheet along the copy sheet path of the machine as well as to maintain the copy sheet in close proximity to the moving belt carrying the toner particles so that the particles will be transferred from the belt to the sheet. The electrical charge of transfer roller 78 is opposite in polarity to that of the toner particles so that the latter are attracted from the belt towards the roller 78. Normally, a copy sheet will be interposed between transfer roller 78 and belt 30 so that the particles will be deposited on the upper surface of the copy sheet as they leave the imaged areas of the photoconductive member.

From the transfer station 80, the copy sheet is carried via a conveyor belt arrangement 82 including an endless belt member 84 mounted for movement on spaced-apart rollers 86, 88 to a fuser device 90. As the copy sheet passes through the fuser 90, the developer powder is heated and thereby caused to permanently adhere to the surface of the copy sheet, thereby to produce a completed copy. From the fuser the completed copy is carried out of the copying machine into an inclined tray 92 provided on the outside of the machine.

If, during the copying process, a copy sheet 70 is not fed from the stack along the copy sheet path 76

towards the transfer roller 78, toner particles 66 which have been deposited on the belt 30 may nevertheless be transferred at the transfer station 80. The attractive force between the oppositely charged transfer roller 78 and the toner particles 66, causes the latter to move away from the belt towards the transfer roller and to be deposited on the outer surface of the roller, as shown in FIG. 2. As mentioned heretofore, if nothing were provided to remove the toner particles from the surface of transfer roller 78, subsequently fed copy sheets entering into the transfer station would be smeared with toner from the transfer roller on the back surfaces thereof.

To prevent the above described occurrence, toner removal apparatus, generally designated by the numeral 94, has been provided in copying machine 10. The device 94 comprises an open top container 96 having the shape of a trough or the like. The container 96 is partially filled with magnetizable particles, each designated by the numeral 98 (FIG. 2), such as, iron filings, etc. A cylindrical cleaning roller 100 having a stationary, permanent magnet 102 provided therein and extending along the axis of the roller between the ends thereof, is mounted for rotation within the container about the magnet so that a longitudinally extending portion of the outer peripheral surface 104 of the cleaning roller always moves through the magnetizable particles in the container 96. The portion of the peripheral surface 104 of the roller opposite that immersed in the container 96, is likewise always closely adjacent the outer peripheral surface of the transfer roller 78, see FIG. 2. As will be noted in FIG. 2, the flux lines, indicated generally by the numeral 103, and produced by the magnet 102, are more concentrated at opposite sides 107, 109 of the outer surface of the rotating cleaning roller providing a magnetic field of greater strength nearest the transfer roller and directly opposite or 180° about the cleaning roller, within the container 96, so that the magnetic particles 98 are magnetically secured thereat but are held less securely to the surface of the roller as they pass to the weaker area of the magnetic field due to the rotation of the cleaning roller. Thus, magnetic particles which have removed toner particles from the transfer roller are more easily deposited in the container 96 as they pass from the greater magnetic concentration towards the container.

A pair of smaller auxiliary rollers 106 and 108 are mounted for rotation within the container 96 and are also partially immersed in the magnetizable particles 98. The rollers are spaced from each other, having their axes of rotation parallel to the axis of rotation of the larger magnetic cleaning roller 100. The smaller rollers 106 and 108 are provided in container 96 to maintain the separation of the magnetizable particles therein, and to assist in the distribution of toner laden magnetizable particles, within the container 96. The smaller rollers may be fluted along the outer surfaces thereof in a well-known manner for a better mixing action of the magnetizable particles.

In operation, the large magnetic cleaning roller 100 having its outer surface covered with iron filings, rotates so that the filings are closely adjacent or in contacting relation with the outer surface of the transfer roller 78. If toner particles are present on the outer surface of the transfer roller they are, by triboelectric

forces, attracted to the iron filings covering roller 100 and are thereby removed from the surface of roller 78. The removed toner particles 66 (FIG. 2), are carried into the supply of magnetizable particles within the trough 96 whereat the magnet field produced by the permanent magnet 102 is reduced, and are deposited in the container.

If desired, the magnetic cleaning roller may also be electrically charged with the same charge polarity as that of the transfer roller and belt member, so as to cause an attraction of toner particles to the cleaning roller. The charge on the cleaning roller serves to aid the triboelectric attraction of toner particles to the cleaning roller.

While the toner removal apparatus 94 according to the invention is highly efficient in removing toner particles from the transfer roller 78, a small quantity of toner particles is nevertheless, in some instances, not attracted toward the transfer station, but remains on the recording member. The latter occurs in both the cases when copy sheets are fed properly or improperly through the transfer station. The developer brush 60 does aid somewhat in removing a portion of the toner particles clinging to the member, but in the case where many copies are made in rapid succession, in a relatively short period of time, the accumulation of toner particles on the belt member can cause the blurring of images on the later made copy sheets, as well as other undesirable results.

To overcome the above-described problem, a toner removal apparatus 94a of the type used in cleaning the transfer roller may be positioned adjacent the belt member 30, downstream of the transfer station 80 for the purpose of removing toner particles 66 which remain on belt member 30.

The toner removal apparatus 94a is similar to apparatus 94, in that there is included therein a container 96a partially filled with magnetizable particles 98. A hollow cleaning roller 100a is provided, and is mounted for rotation about a permanent magnet 102a located therein. The peripheral surface 104a of the roller 100a is moved through the magnetizable particles 98 provided in container 96a, as in the case of toner removal apparatus 94, described heretofore.

The rotation of the roller 100a can be in the direction of movement of the belt member 30 or in a direction opposite thereto; however, better cleaning results are realized with the latter movement since there is provided, in addition to the attractive forces used to remove toner clinging to the belt member, a wiping action against the belt member surface.

A pair of auxiliary rollers 106a and 108a are likewise included in the container 96a to distribute the toner laden magnetizable particles throughout the particles in the container.

The operation of the toner removal apparatus is similar to the apparatus discussed. The toner particles 66 clinging to the belt member 30 are attracted by triboelectric forces to the magnetizable particles 98 covering the surface 104a of roller 100a. The attracted toner particles 66 are carried into the supply of magnetizable particles 98 within container 96 and along with the magnetizable particles to which they are attracted, are deposited in the container to be distributed throughout the supply of magnetizable particles in the trough by rollers 106a, 108a.

Just as in the case of toner removal apparatus 94, the magnetic cleaning roller 100a of apparatus 94a, may be electrically charged so as to cause an attraction of toner particles to the cleaning roller. Such an electrical charge may be provided by a power supply similar to supply 79 used to attract toner particles, to the transfer roller 78 from belt member 30.

The magnetic brush developer 60 described above and the cleaning device according to the invention, have similarities which should be noted. Both have a magnetic roller which is covered over the outer surface thereof with magnetic particles, such as iron filings or the like. In the case of the brush developer, however, a mixture of toner particles and filings is deposited in the container portion of the device. Thus, toner particles adhering by triboelectric forces to the iron particles are carried magnetically on the developer brush. The toner particles are attracted to the imaged areas of the recording element as it passes through the developing station, and thus a visible image is produced on the element. The cleaning roller as is described above has only iron filings on the outer surface area thereof. Thus, as the roller turns in contacting relation with a biased transfer roller of the copying machine and/or the recording member 30; toner particles which are clinging to the surface of either of the latter are, by triboelectric forces, attracted to the iron filings on the surface of the magnetic cleaning roller.

Auxiliary rollers 106 and 108 also mounted for rotation within the supply of magnetizable particles or filings within trough 96, serve to stir, and thereby cause a movement of the filings within the trough 96, which aids in the removal of toner laden magnetizable particles from the surface of the cleaning roller as well as to cause a migration of magnetizable particles from within the trough to the cleaning roller.

Through the use of the cleaning apparatus according to the invention, transfer roller 78 and belt member 30 are maintained substantially toner free, thereby preventing toner particles from being passed to the back surfaces of copy sheets passing through the transfer station 80 as well as to prevent the blurring of copy images produced by the copying machine.

While a particular embodiment of the invention has been shown and described, it should be understood that the invention is not limited thereto since modifications thereof may be made. It is contemplated to cover by the present application any and all such modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a copying machine comprising a source of copy sheet material, a photoconductive recording member, exposure means for producing electrostatic images of an original on said photoconductive member, developing means for applying toner to said electrostatic images on said photoconductive member, means for effecting a transfer of said developed image to said copy sheet material including a transfer roller mounted for rotation adjacent said photoconductive member, whereby said toner is attracted toward said transfer roller to be deposited on said copy sheets synchronously interposed between said transfer roller and said photoconductive member, cleaning means for cleaning toner inadvertently transferred to the surface of said transfer roller comprising magnetic means mounted adjacent the outer surface of said transfer

roller for removing the toner thereon by triboelectric forces created between said toner and said magnetic means, comprising a roller member mounted for rotation including magnetizable particles carried thereon for triboelectrically attracting toner from the surface of said transfer roller.

2. Cleaning means as claimed in claim 1 wherein said roller member includes mounted therein a stationary magnet about which said roller member rotates.

3. Cleaning means as claimed in claim 1 further including a container of magnetizable particles in which said cleaning roller member rotates for replenishing said particles on the outer surface of said last-mentioned roller member as the particles become toner laden.

4. Cleaning means as claimed in claim 1 further including means mounted in said container of magnetizable particles for stirring said particles to cause a movement thereof within said container.

5. In a copy machine comprising a source of copy sheet material, a photoconductive member, exposure means for producing images of an original on said photoconductive member, and developing means for applying developer powder of a first polarity to said images on said photoconductive member, a transfer station including a combination of a transfer roller having an electrical charge of a polarity opposite to that of said developer powder and mounted for rotation adjacent said photoconductive member, whereby said powder is attracted toward said roller member to be deposited on copy sheet material interposed between said transfer roller and photoconductive member and cleaning means for cleaning toner inadvertently transferred to said transfer roller from the surface of said transfer roller comprising a roller member and a stationary permanent magnet mounted within said roller, the magnetic field created by said magnet being greatest in strength adjacent said surface and 180° therefrom, said roller being rotatable about said magnet and including magnetizable particles held magnetically to said roller by said magnet, for triboelectrically attracting developer powder from said surface, thereby to remove said powder therefrom.

6. A copying machine as claimed in claim 5 wherein said cleaning means further includes a source of magnetizable particles for replenishing the supply thereof on the outer surface of said cleaning roller as said particles become toner laden.

7. In a copying machine comprising a source of copy

sheet material, a photoconductive member, exposure means for producing images of an original on said photoconductive member and developing means for applying electroscopic developer powder of a first polarity to said images on said photoconductive member, a transfer station including, in combination, a transfer roller having an electrical charge of a polarity opposite to that of said developer powder, mounted for rotation adjacent said photoconductive member, whereby said powder is attracted toward said transfer roller to be deposited on copy sheet material interposed between said transfer roller and photoconductive member, and transfer roller cleaning means including magnetic means mounted adjacent said transfer roller whereby developer powder carried on said transfer roller is triboelectrically attracted from said transfer roller to said magnetic means and is thereby removed from the former, said transfer roller cleaning means including a cleaning roller member mounted in axial alignment with and adjacent said transfer roller and having mounted therein, along the axis thereof permanent magnet means, said cleaning roller being rotatable about said magnet means and including magnetizable particles disposed on the outer surface of said cleaning roller by said magnet means for triboelectrically attracting developer powder from the surface of said transfer roller thereby to maintain the surface of said last mentioned roller free of developer powder.

8. A copying machine as claimed in claim 7 wherein said transfer roller cleaning means further includes a container partially filled with a supply of magnetizable particles for the replenishment of said particles on the outer surface of said cleaning roller member, said cleaning roller member being mounted within said container so that a portion of the outer surface thereof is always in contact with said supply of magnetizable particles located therein.

9. A copying machine as claimed in claim 8 wherein said container further includes mounted therein stirring means for circulating the magnetizable particles within said container.

10. A copying machine as claimed in claim 7 wherein said cleaning roller member is charged with a polarity opposite to that of said developer powder so as to attract said developer powder from said transfer roller thereby to aid the triboelectric attractive force between said developer powder and magnetizable particles on said cleaning roller.

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