United States Patent

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[54] CLEANING APPARATUS FOR FUSING SYSTEM

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[52] **U.S. Cl.**.....**15/256.52,** 15/1.5, 101/425, 355/15

[51] **Int. Cl.**.....**G03g 15/00,** B03b 1/02

[58] **Field of Search**.....134/1, 3, 5, 6, 17, 32, 38; 15/256.52, 1.5, 89; 101/425; 355/15; 118/70, 637

[56] **References Cited**

UNITED STATES PATENTS

3,410,206 11/1968 Dorr .....101/425 X

3,526,457 9/1970 Dimond et al. .....15/1.5 X

FOREIGN PATENTS OR APPLICATIONS

1,559,020 8/1969 Germany 15/89

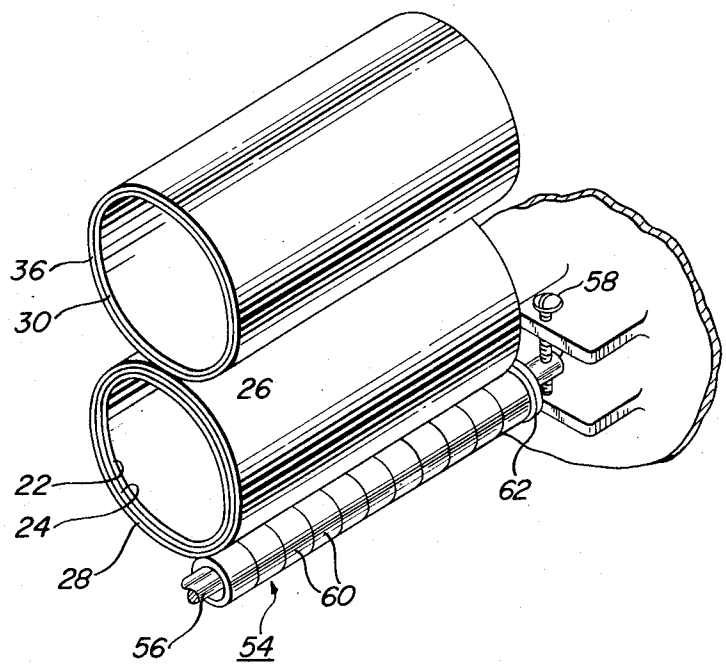
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[57] **ABSTRACT**

Apparatus for removing extraneous toner particles from a heated fuser roll in a heat-pressure xerographic fusing system. The apparatus includes a fixed cylindrical rod positioned adjacent the fusing roll to be cleaned and a plurality of cylindrically shaped cleaning rollers rotatable about the rod in rolling contact with the fusing roll. The cleaning rollers function to contact and remove toner particles therefrom.

6 Claims, 3 Drawing Figures



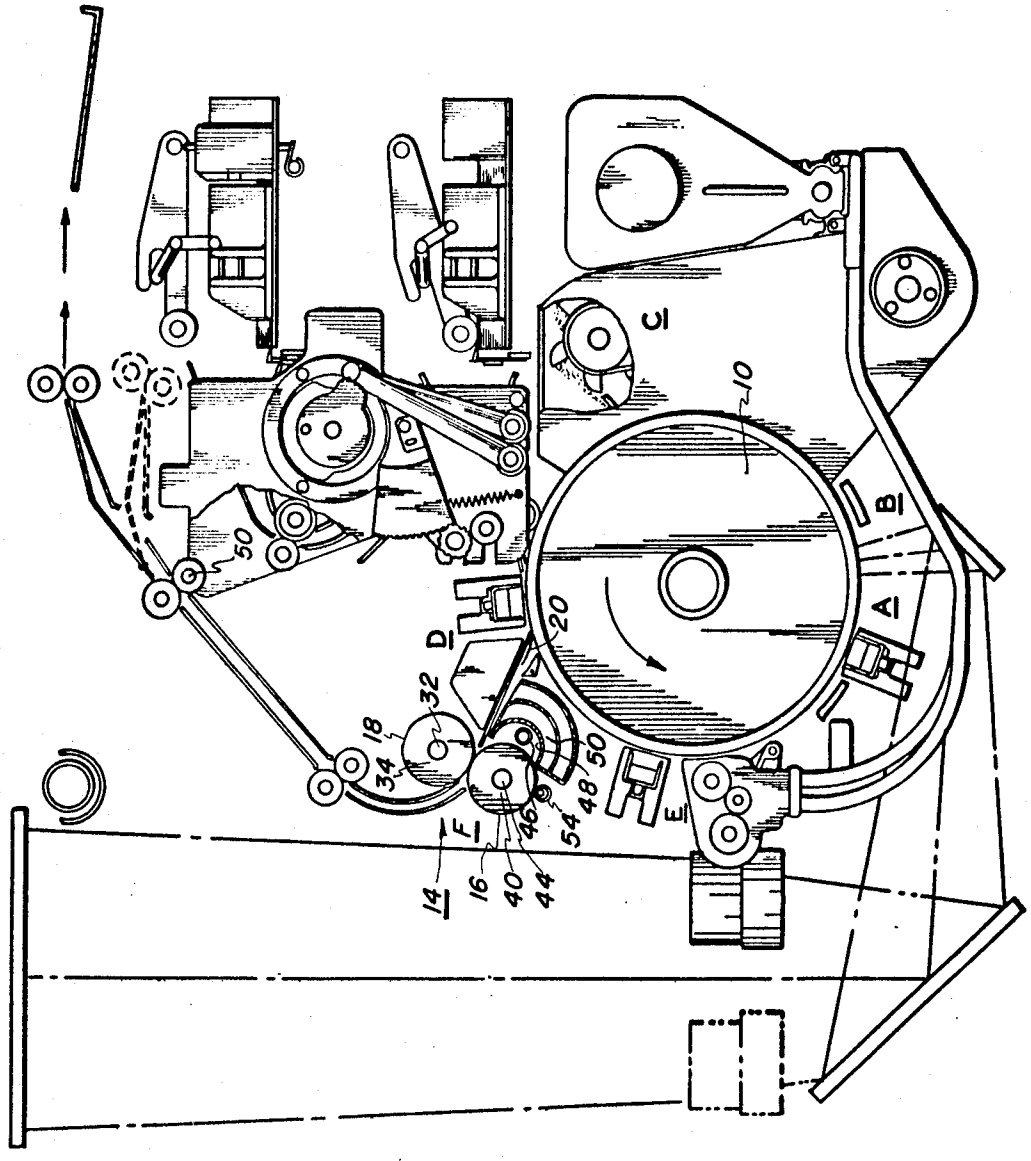


FIG. 1

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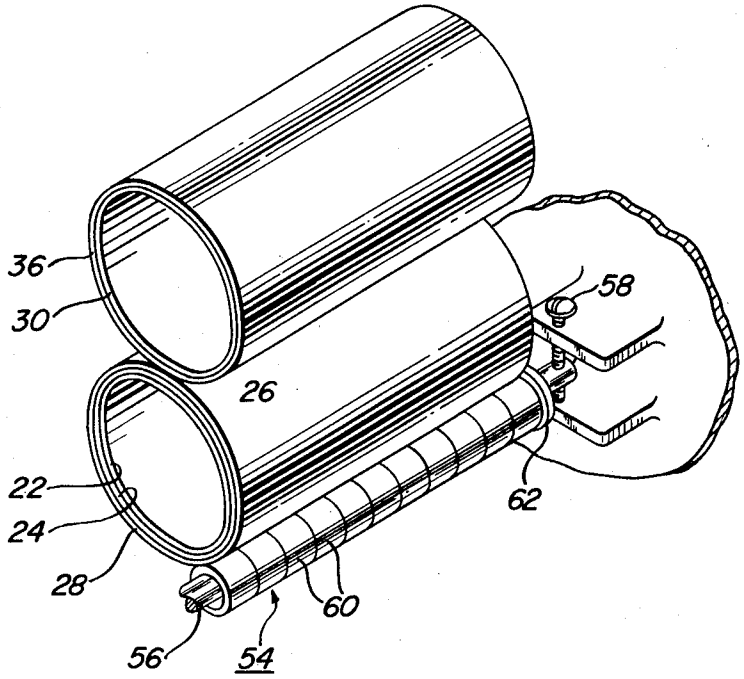


FIG. 2

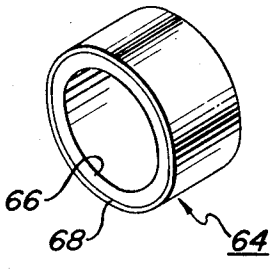


FIG. 3

CLEANING APPARATUS FOR FUSING SYSTEM

This application relates to fusing systems and in particular to apparatus for removing toner particles from a heated fusing roll.

In the practice of xerography as described in U.S. Pat. No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic surface is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where the light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed by contacting it with a finely divided electrostatically attractable material such as a powder. The powder is held in image areas by the electrostatic charges on the layer. Where the charge field is greatest, the greatest amount of powder is deposited; where the charge field is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the document or object being reproduced. The powder is subsequently transferred to a sheet of paper or other surface and suitable affixed thereto to form a permanent print.

One typical device for fixing the toner particles to the backing sheet is described in pending application Ser. No. 731,965 filed May 24, 1968 in the name of Rabin Moser. According to that disclosure, the fixing of the toner particles to the backing sheet occurs as the backing sheet electrostatically supporting toner particles in imagewise configurations is passed between a pair of rolls. The roll, contacting the toner images, is heated as by an external heat source whereby the heat energy is retained adjacent its surface. Upon movement between these rolls with the toner contacting the heated fusing roll, the toner will become affixed to the backing sheet.

In such systems, as in any other heated roll fixing systems for xerographic copy, care must be taken to remove unwanted toner particles from the heated fuser roll prior to its contact with the copy being fused. If care is not taken to keep the fuser roll free of toner particles, these toner particles can build up on the face of the fuser roll and degrade the quality of fix by decreasing the fusing properties on the surface of the roll contacting the copy sheet and toner images. Furthermore, such unwanted toner particles can be released from the fusing roll upon its subsequent contact with the copy sheet to fuse toner particles to the copy sheet in non-imaged areas.

It is therefore an object of the instant invention to clean unwanted toner particles from a fusing roll in heated roll type fixing system.

It is a further object of the instant invention to roll a toner-cleaning member in contact with a fuser roll at a location remote from the fusing zone to keep it clean.

These and other objects of the instant invention are attained by apparatus including a plurality of cylindrical washer-shaped rollers mounted on a fixed rod adjacent a fusing roll whereby rolling contact between the fusing roll and the washers causes the transfer of unwanted toner from the fusing roll to the rollers for maintaining the fusing roll clean.

Further objects of this invention, together with additional features and advantages thereof, will become apparent from the following detailed description of one embodiment of the invention when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic representation of an automatic xerographic reproducing machine, utilizing the fusing roll cleaning apparatus of the instant invention;

FIG. 2 is a perspective view of the fusing pressure rolls and cleaning apparatus of FIG. 1 with parts shown in section to show internal constructions thereof and

FIG. 3 is a perspective view of a modified cleaning roller.

Referring now to the drawings, there is shown in FIG. 1 an embodiment of the subject invention in a suitable environment such as an automatic xerographic reproducing machine. The automatic xerographic reproducing machine includes a xerographic plate or surface **10** formed in the shape of a drum. The plate has a photoconductive layer or light receiving surface on a conductive backing, journaled in a frame to rotate in the direction indicated by the arrow. The rotation will cause the plate surface to sequentially pass a series of xerographic processing stations. For the purposes of the present disclosure, the several xerographic processing stations in the path of movement of the plate surface may be described functionally as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive plate;

An exposure station B, at which light or a radiation pattern of copy to be reproduced is projected onto the plate surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic image of the copy to be reproduced;

A developing station C at which xerographic developing material, including toner particles having an electrostatic charge opposite that of the latent electrostatic image, is cascaded over the latent electrostatic image to form a toner-powder image in configuration of the copy being reproduced;

A transfer station D at which the toner-powder image is electrostatically transferred from the plate surface to a transfer material or a support surface; and

A drum cleaning and discharge station E at which the plate surface is brushed to remove residual toner particles remaining thereon after image transfer and at which the plate is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

It is felt that the preceding description of the xerographic process is sufficient for an understanding of the instant invention. Further details may be had by reference to pending application Ser. No. 838,816 filed July 3, 1969 in the name of Dennis P. Gerbasi.

Referring again to the figures, there is shown in combination with the continuous and automatic xerographic reproducing machine a xerographic fixing system **14** including a fusing roll **16** and a pressure roll **18**. The fusing roll is positioned beneath the pressure roll so as to contact the surface of a backing sheet bearing the toner images as they are conveyed from the xerographic drum with toner images electrostatically adhering to the lower face of the backing sheet. A typical fusing system with which the fuser roll cleaning apparatus of the instant invention may be employed is described in the aforementioned Moser application. According to that disclosure, the fusing roll includes a metallic cylinder **22** encompassed by a blanket **24** of, for example, silicone rubber having a radial thickness of sufficient thickness and pliability to permit indentation thereof at the nip **26** when the upper roll is in pressure relationship therewith. The blanket is, in turn, encoated with a thin coating **28** of a room temperature vulcanizing compound such as the Dow Corning Agent 236 produced by the Dow Corning Company. Since this material, as such, is highly reflective, it is preferred that it be mixed with approximately five percent by weight with Dow Corning RTV 735 sealing adhesive, which diminishes the reflective quality of the basic material without affecting the release quality thereof. This greatly enhances the heat absorbing ability of the coating with the blanket. This coating serves as a release agent for the resinous toner particles that are brought into contact therewith during the fusing operations while the blanket serves as a heat barrier relative to the supporting structure for the fusing roll.

The upper or pressure roll **18** comprises a metallic cylinder **30** supported on a shaft **32** by means of end caps **34** secured to the shaft and to the interior surface of each end of the roll. A coating **36** of insulating adhesive material such as Teflon surrounds the cylinder **30** and is of sufficient hardness to produce the indentation of the material on the fuser roll when in pres-

sure contact. This area of indentation at nip **26** is the actual fixing area. The upper roll may be provided with suitable supports for retaining it for movement whereby it may be pivoted away toward the lower roll during nonoperational times in a manner as described, for example, in the aforementioned Moser et al. application. The lower fusing roll **16**, like the pressure roll **18**, has insulating end caps **40** coupling the roll to frame sections through shaft **44**. Motive power is applied to the rolls through suitable means such as any conventional motor means. The rollers extend a length equal to the width of the copy sheet being fused.

The lower fuser roll has heat applied thereto externally by means of a heat source such as quartz lamp **46** mounted on the fuser frame along the length of the lower roll so that its axis is generally parallel thereto. The lamp is surrounded by a reflector **48** which also extends with the length of the lower roll and is backed with a thermally insulated material **50**. The lamp **46** and the fuser and pressure rolls are mounted about horizontal axes.

Fusing is accomplished by the principals of low thermal mass fusing. With heat being applied to the fusing roll externally by the heat lamp and reflector, the blanket serves as the heat barrier to the heat applied externally thereto. This minimizes heat losses due to the roll and supporting shaft and the bearings which support the shaft for rotation in the fuser housing. This results in the utilization of practically all of the heat produced by the lamp for fusing purposes except for slight radiation and conduction losses. In addition, the response time for heating elements of this type is relatively fast, since the entire mass of fusing roll need not be brought to the fusing temperature for operation. It is this heat applied to the exterior of the roller which is all the heat required for high speed xerographic fusing.

During such a fusing procedure, the copy sheet electrostatically bearing the toner images is brought into contact with the nip of the rolls with the toner image contacting the fuser roll. The heat is such that there will be virtually no offsetting of the toner particles from the copy sheet to the fuser rolls under normal conditions. This is because the heat applied to the surface of the roller is insufficient to raise the temperature of the surface of the roller above the hot offset temperature of the toner whereat the toner particles in the image areas of the toner would liquefy and cause a shearing action in the central portion of the molten toner to thereby result in offset. Shearing occurs when the interparticle forces holding the viscous toner mass together is less than the surface energy forces tending to offset it to a contacting surface. Occasionally, however, extraneous toner particles will be offset to the fuser roll by the improper application of heat to the surface thereof, by imperfections in the properties of the entire surface of the roll, or by the toner particles insufficiently adhered to the copy sheet by the electrostatic forces which normally hold them there. In such case, extraneous toner particles may be transferred to the surface of the fuser roll beyond the nip.

In order to avoid the problems which would be encountered through the retention of the toner particles thereon as they are moved into contact with subsequent toner images on the same or subsequent sheets, the fuser roll cleaning apparatus is provided adjacent an area of the fuser roll prior to any subsequent passage of sections of the fuser roll beneath the heat source.

The fuser roll cleaning apparatus **54** includes a cylindrical rod **56** having a circular cross sectional configuration extending at least the length of the surface of the fusing roll and spaced a predetermined distance therefrom. Adjustment means **58** including an adjusting nut mounted through threaded extensions of the frame and through threaded holes in the rod may be provided at each end of shaft for positioning it closer or farther away from the fusing roll and to facilitate its removal. Located on the rod are a plurality of washer shaped cleaning rollers **60** which are cylindrically shaped with an inside diameter slightly larger than the exterior diameter of the rod and an exterior diameter whereby all of the rollers may by positioned in rolling contact with the fusing roll. The rod and rollers are mounted on an axis parallel with the axis of the fusing roll. Removable end caps **62** may be positioned at one or both ends of the rod for the removal and interchanging of the rollers. The interior and exterior faces of the rollers are concentric to improve their rolling capabilities. The rod may be mounted on shiftable frame portions to move it away from the fusing roll during non-use.

In the preferred embodiment, the cleaning rollers are preferably formed of a wear resistant material which is a good thermal conductor to function as a heat sink. Brass, stainless, steel, aluminum, or cold roll steel can all be employed to this end. The rod is preferably of a hard, wear resistant material such as cold rolled steel which is also a good thermal conductor for functioning as a heat sink.

In operation, with the fusing and pressure rolls rotating to fuse toner to copy sheets, the fusing roll is in contact with the cleaning rolls to rotate them at a common surface speed therewith. If no toner particles are on the fusing roll at this location of contact between the fusing roll and cleaning rollers, the cleaning rolls merely rotate in contact therewith. If for any reason, however, toner particles should be attached to the fusing roll at this location, they will contact the cleaning rolls and offset thereto. The toner particles transferred to the cleaning rolls will then cool and solidify on the cleaning rollers before they can be rotated into subsequent contact with the fusing roll.

Due to the fact that there is a slight difference in diameter between the exterior diameter of the rod and the inner diameter of the cleaning rolls, a slight build up of toner particles on any one of the cleaning rolls will not affect the operation of the entire assembly since the cleaning roll with a toner buildup will merely rotate at an axis slightly offset from its axis of rotation prior to receiving a buildup of toner particles. As seen in FIG. 1, the axis of the fuser roll cleaning apparatus **54** is offset from a vertical plane passing through the axis of the fusing roll so that toner buildups on a cleaning roller may more readily offset the axis of rotation of the cleaning roller and still permit good rolling contact with the fusing roll.

During the fusing and cleaning operations, the temperature of the toner must be kept between the hot offset temperature of the toner and the cold offset temperature of the toner. If the temperature of the toner were to rise above the hot offset temperature at either the fusing zone or cleaning zone, the viscous toner material would be sheared with part of the toner transferring fusing roll at the fusing zone or partially remaining on the fusing roll at the cleaning station. The same would happen if the temperature of the toner were below the cold offset temperature. By keeping the toner temperature between these tow points, shearing of toner is controlled.

The reason why the viscous toner will not offset to the fusing roll at the fusing station but will offset to the cleaning roll at the cleaning station, so long as the toner is between the hot and cold offset temperatures, is not known. It is thought that this phenomenon is a function of the surface force energy of the material involved. The surface force energy is a force per unit area which is a function of the properties of associated and contacting materials tending to attract or to release a material from or toward a recipient surface. At the fusing zone, the surface force energy of the backing sheet has a greater attraction for the toner than does the release surface of the fusing roll. Consequently, viscous toner would tend to be retained on the copy sheet. Conversely, at the cleaning zone the surface force energy between the cleaning roll and the toner is greater than the surface force energy between the fuser roll and the toner. Consequently, viscous toner would tend to transfer to the contacting cleaning roll.

Note is taken that the cleaning rollers are positioned to receive a portion of the heat output of lamp **46**. This would give the necessary partial heating to the cleaning rollers to bring toner to a proper temperature if the system were reactivated after stopping with toner on the fuser roll in advance of the cleaning rollers. The location of the cleaning roll remote from the fusing area permits the cleaning at a temperature

slightly less than that at fusing. This assists cleaning since the fuser temperature may increase, in some instances, to above the hot offset temperature.

It has been found that the surface of the sections of the cleaning roll may be coated with various materials which will not decrease its surface force energy and after the above-discussed relationship. Such a roller **64** is shown in FIG. **3**. When such a coating **68**, as for example, a thin layer of toner material permanently fused, laquered or otherwise bonded to the core **66** constructed as roller **60** is employed, the offset of extraneous toner particles thereto will be continued but with added benefit. Typical toner materials are described in Carlson U.S. Pat. No. Re. 25,136. The laminated cleaning roll will attract thereto paper lint by surface forces of the warm toner layer on the dry lint.

Inasmuch as xerographic copies generally receive more image areas and more toner concentration in the central portion of copy sheets, it has been found that the central portion of the cleaning assembly or the more centrally located cleaning rollers on the rod will receive a larger toner buildup before the end cleaning roller. In such case, the assembly can be corrected by removing end caps **62**, removing any cleaning roller with the toner buildup and replacing it by a clean roller. Clean rollers adjacent the end of the primary shaft also could be positioned in a central portion thereof and the former central rollers could be placed on the exterior portions thereof for extended life of the cleaning assembly as a whole without replacing the dirty rollers.

While the instant invention has been described with reference to the structure disclosed herein, it is not intended to be confined to the details set forth and this application is intended to cover such modifications or changes that may come within the purpose or improvement for the scope of the following claims.

What is claimed is:

1. Apparatus for cleaning heat sensitive toner particles from the surface of a toner fuser roll including

a toner removing member comprising a metal cylinder having a high thermal conductivity capable of rapidly transmitting heat energy from said toner to said member and being constructed of a material such that the surface energy between the member and the toner is greater than the surface energy between the fuser roll and the toner, and

means to position said toner removing member in contact with the fuser roll whereby toner on the fuser roll is offset to said member.

2. The apparatus of claim **1** wherein said member is formed of cold rolled steel.

3. The apparatus of claim **1** wherein said member has a thin layer of toner material permanently fused to the surface thereof positioned in contact with said fuser roll.

4. Apparatus for cleaning residual toner material from the surface of a heated fusing element, the heated fusing element being arranged to move in contact with a toner image bearing sheet of final support material to heat fix the toner image to the sheet, said apparatus including

a toner cleaning member being constructed of a material having a high thermal conductivity and such that the surface energy between said member and said toner is greater than the surface energy between the fusing element and said toner, and

means to move said cleaning member into touching and substantially relatively immovable contact with the toner on the surface of said heated fusing element whereby toner on said heated fuser element is offset from the element to the contacting surface of said cleaning member.

5. The apparatus of claim **4** wherein said cleaning member includes a plurality of washer shaped cylindrical rollers with concentric internal and external faces mounted upon a support rod, the axis of the support rod being mounted in parallel alignment with the heated surface of the fusing element.

6. The apparatus of claim **4** wherein each hollow cylindrical shaped roller is formed of a material having a high thermal conductivity such that the temperature of said cylindrical roller is rapidly raised substantially to that of the heated fusing element when brought in contact therewith.

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