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Furman et al.

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[54] **FUSER ROLL CLEANING METHOD AND APPARATUS FOR PERFORMING IT**

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[52] **U.S. Cl.** .....**355/133**, 15/1.5, 263/6 E, 355/3

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

[58] **Field of Search**.....355/3, 14, 15, 17, 133; 219/216; 263/6 E; 15/1.5

[56] **References Cited**

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[57] **ABSTRACT**

The backup roll of a roll fuser for fixing xerographic images is periodically cleaned by passing plain paper through the fuser roll couple at a slow rate while the backup roll is heated above a toner melt temperature. Roll cleaning is accomplished automatically by providing a xerographic document copier with a special slow rate operating cycle wherein image production is inhibited so that plain paper is fed through the roll couple in accordance with the cleaning method.

7 Claims, 2 Drawing Figures

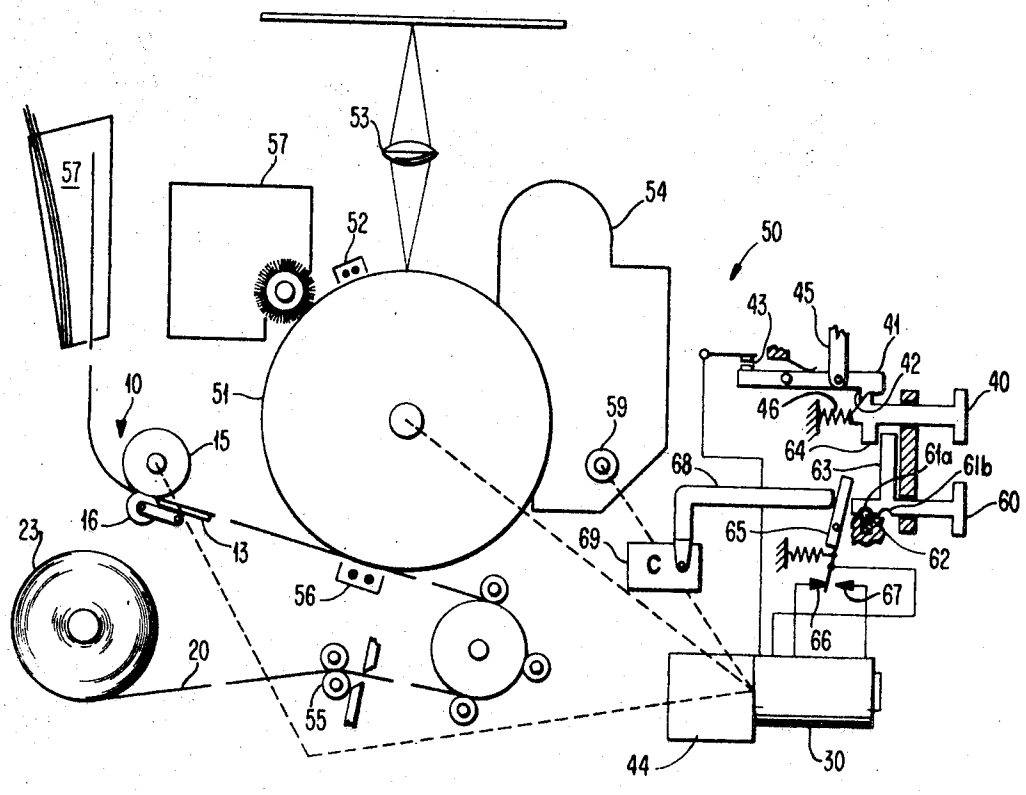

FIG. 1

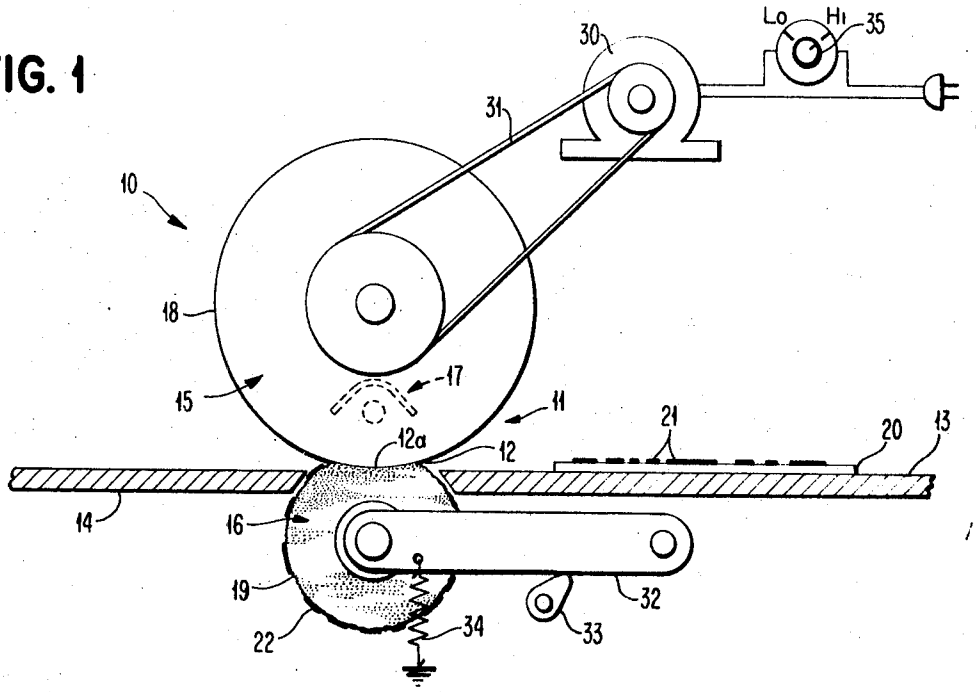
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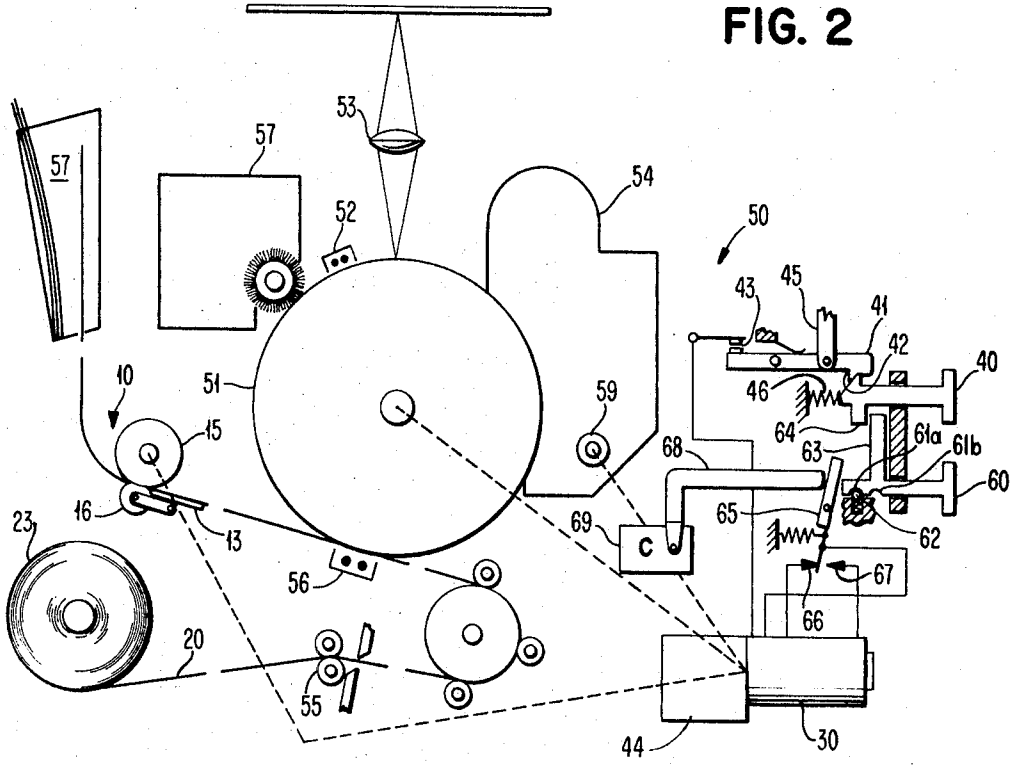
FIG. 2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FUSER ROLL CLEANING METHOD AND APPARATUS FOR PERFORMING IT

BACKGROUND OF THE INVENTION

Xerographic images are commonly formed by a pigmented thermoplastic resin powder that is electrostatically deposited onto a suitable support sheet, usually paper. The powder image can be fixed to the support sheet by various techniques including radiant heat, conductive heat, and solvent vapor. One of the most efficient fixing techniques suitable for high speed operation is the so-called roll fuser which employs direct conductive heat transfer to the toner powder from the surface of a roll held in pressure contact therewith by a backup roll. By proper control of heat transfer to the toner and selection of roll surface materials, it is possible to fuse the xerographic image without transferring significant toner particles to the surface of the hot fusing roll. Although the backup roll of the roll fuser couple is ordinarily not in contact with the toner particles of a xerographic image, it has been found that toner material will accumulate on the backup roll over relatively long periods of time, such as thousands of cycles. A main source of the toner material that accumulates on the backup roll is minute amounts of residual toner floating in the air space within the machine covers. Small amounts of toner may also be left on the fusing roll and from there transferred to the backup roll at times when the rolls are in direct mutual contact. While it is preferred to separate the roll couple in the absence of copy paper positioned therein, it is difficult to completely prevent all contact between the rolls of the fusing couple at the beginning and end of a fusing operation on cut sheet copy.

Roll fusers also are used efficiently for fusing copy on a sheet that has previously fixed copy on its reverse side. Although the reverse side image will not be disturbed by the fusing of the second side image, if the backup roll temperature is maintained sufficiently low, minute amounts of toner from the reverse side image will be picked up by the backup roll as a further contribution to the toner accumulation thereon.

Excessive accumulation of toner on the backup roll of the fuser couple will soil the reverse side of the copy sheet and, in extreme cases, can cause the copy sheet to stick to the backup roll and create a paper feed failure.

Disclosure of the Invention

We have determined that the backup roll of a roll fuser couple can be conveniently and efficiently cleaned by passing plain paper or other absorbent sheet material through the roll fuser couple while the couple operates at a relatively low speed. Whereas in ordinary fusing operation, the peripheral speed of the fuser rolls prevents the transfer of substantial heat to the backup roll; in our cleaning method, the lower roll feed rate allows the backup roll to be heated into the toner melting temperature range. Thus, as the plain paper passes through the fuser roll, the accumulated toner on the backup roll surface will become soft and mobile and thus will adhere to the plain paper rather than the backup roll surface. The slow speed also allows cleaning of the heated roll, if required.

The method of our invention can be implemented in an automatic xerographic document copier with a minimum of changes. The document copier will include plain paper feed for copying purposes, and it is only necessary to inhibit the image production process of the copier to allow the plain paper to be fed through the fusing roll couple. By changing the drive speed of the fusing roll couple, significantly more heat will be transferred to the backup roll to accomplish the cleaning cycle. Accordingly, an operator control is provided to select operation that inhibits image production and provides for a low speed paper movement but otherwise operates the copier in accordance with its usual cyclically performed functions.

These and other features, objects, and advantages of our method and the apparatus for implementing it will be apparent to those skilled in the art from the following description of an illustrative embodiment of our inventive concepts wherein reference is made to the accompanying drawings of which:

FIG. 1 is an elevational side view partly in cross section of a fusing roll couple in which our method can be performed, and

FIG. 2 is a side elevational schematic view of a xerographic document copier illustrating the implementation of our method into the automatic processes of the copier.

A contact roll fuser mechanism **10**, as shown in FIG. 1, comprises a fusing roll couple **11** defining a nip **12** therebetween that is aligned with a paper delivery table or feed plate **13**. Unfixed copy in the form of a sheet of toner receptive support material such as paper **20** bearing an unfused thermoplastic toner particle image **21** thereon is passed along the paper table **13** to the nip **12** and through the nip to exit table **14**.

The roll couple **11** includes a fuser roll **15** and a resiliently deformable backup roll **16** which mutually cooperate to form a contact area **12***a* at the nip **12** by deformation of the backup roll **16** due to the pressure applied between the rolls. A heat source **17** is mounted within the fusing roll **15** and preferably comprises a tungsten filament quartz envelop radiant heat lamp. The heat transferred by conduction from the roll **15** is a function of roll speed, heat source power, and the contact dwell time as controlled by the arc of contact area **12***a*. The fusing roll **15** ordinarily operates with a high surface temperature of between 300° and 400° F.

Fusing roll **15** has an external surface covering **18** of a material selected for its low surface energy or nonadhesive characteristics. Certain elastomers and polymers have been found suitable for this purpose and are commercially available. By controlling the heat from source **17** and the contact area **12***a*, ordinary fusing is performed by direct heat conduction to the particles of image **21** with a minimum of heat transfer to the paper **20** and backup roll **16**. In fact, the backup roll **16** ordinarily operates with a surface temperature of about 100° – 200° F. The heat transferred to the toner particles of image **21** is controlled to produce a toner viscosity that tends to cause the toner to adhere completely to the paper **20** and to separate completely from the hot fusing surface **18**.

The fusing roll **15** is driven clockwise in FIG. 1 by a motor or other power means **30** through a chain or belt connection **31**. Typically, the surface speed of roll **15** will be about 10 inches per second or faster.

The backup roll **16** is made of a relatively thick elastomeric material having an external surface **19**

which, like the surface **18** of the fuser roll **15**, is selected to have a low surface energy so as to exhibit low adhesion for toner particles. Suitable materials include, for example, various commercially available silicone rubbers. The resilience of the bulk of the backup roller **16** enables the production of the footprint or contact area **12***a* for control of fusing heat transfer as explained above. Typically, the contact area **12***a* is about 0.1 – 0.4 inches. The backup roll **16** is mounted on support arms structure **32** and is positionable from its position as shown to a retracted position by operation of cam **33** and spring **34** to be separated from the fusing roll **15** when copy is not being fused. It is necessary, however, to bring the rolls **15** and **16** together slightly before the leading edge of sheet **20** and to maintain them in contact slightly beyond the trailing edge of the sheet **20**. This necessity makes it possible for minute residual toner material **22** to remain on the fuser roll surface **18** and be transferred to the backup roll surface **19** in spite of the low adhesion characteristics of both surfaces.

The rolls **15** and **16** are normally driven by motor **30** at a high rate of speed, for example, 15 inches per second, that is generally comparable to the speed at which an image is placed on the paper **20** by associated electrophotographic development apparatus. At this relatively high speed, most of the heat is transferred to the toner **21** and some heat is transferred to the paper **20**. It is desired to minimize the heat transfer to paper **20** as this heat is, for the most part, wasted. It is further desired to further minimize transfer of heat to the backup roll **16** since this also would be a waste of heat and further would make the roll couple unsuitable for fusing copy on support paper **20** having a previously formed and fixed thermoplastic image on the reverse side thereof.

After several thousand copies have been fused by the roll couple **11**, it will be found that toner particles have accumulated on the surface **19** of the backup roll **16**. These toner particles may soil the back side of copy paper **20** or, in extreme cases, may cause the copy paper to tend to stick to the backup roll **16** and create a paper feed failure. To clean the fusing roll **15** and especially the backup roll **16** in accordance with our invention, motor speed control **35** is provided by which the fusing roll **15** and backup roll **16** can be driven at a relatively low speed, e.g., 0.5 – 1.5 inches per second, compared to normal fusing speed of about 10 inches per second or greater. While the speed control **35** shown in FIG. **1** is in the form of an electrical motor controller, those skilled in the art will recognize that other speed change means, such as gear shifting or a selective drive belt system, could be employed. With the roll couple **11** moving at slow speed, an untoned sheet of copy paper **20** or other absorbent material is passed through the nip **12**. The slow speed of the rolls **15** and **16** allows a substantial amount of heat to be transferred to the clean paper **20** and to the backup roll surface **19**. The toner accumulated on surface **19** thus becomes softened and mobile. The absorbent clean paper **20**, being more attractive of the thus softened toner, removes the toner from the surface **19** which, as explained above, has a surface quality of low adherence to toner particles. The process can be repeated several times if necessary to move substantially all of the accumulated toner from the backup roll **16**.

Inasmuch as document copy machines are constructed to be operated with a minimum of expert maintenance attention, it is useful to embody a roll fuser cleaning system into the automatic processes of the machine. A typical xerographic type copy reproducing machine **50** is shown in FIG. **2** and includes a xerographic copy surface or drum **51** that is rotatably mounted to traverse a series of image production processing stations. The copy process is initiated by depression of a start bar or key **40** that moves past a latch member **41** to allow the latch member to pivot clockwise to an active position where its latching surface **42** trips the start bar **40** and a switch **43** is closed to initiate rotation of the copy drum **51** through operation of drive motor **30**. Sequence control mechanism **44** operates in timed relation to copy drum **51** to cause automatic functioning of the various machine operations. The image production process begins at charge corona **52** where a uniform electrostatic charge is applied to surface **51**. This uniform charge is selectively discharged by an imaging station **53** and then is passed to an image development unit **54** where the actual physical toner image is created. The development station can be of several types, one preferred type being a simple bucket conveyor that delivers a mixture of developer carrier and toner powder to an elevated location above the surface **51** and allows this mixture to cascade over the surface **51**. The image production is completed by transferring the powder image thus created on surface **51** to sheet paper **20** that is fed in synchronism with the surface **51** from a roll **23** and sheet cutter knives **55**. Thus, operation is performed by transfer corona **56** that attracts the image **21** from the surface **51** and places it on the upper surface of the plain paper **20** without disturbing its image configuration. The paper **20** is then separated from the surface **51** and is fed onto feed plate **13** and into the nip **12** of roll fuser **10** substantially like that shown in FIG. **1**. After the image **21** has been fused, the finished copy is passed directly into an exit pocket **57** where it can be removed by the machine operator. The copy process is completed by continuing the copy surface **51** passed a cleaning station **58** to its starting point at the charge corona **52**. When the copy process is complete as indicated by a suitable mechanical sensing of the machine operation, a control link **45** is operated to withdraw latch **41** retransfer switch **43**, and enable the key **40** to be restored to its unoperated position by a spring **46**.

To automate the roll cleaning process, we have provided a manually operable auxilliary start key or cleaning-cycle-select control member **60** that is depressed by the operator to slow the paper feed, disable the image production mechanism and initiate a cycle of machine operation. The key **60** includes a pair of detent grooves **61***a* and **61***b* that alternately cooperate with a spring biased detent **62** to define a normal inactive key position as shown or a displaced active position upon key depression. Key **60** includes an extension **63** that overlies a tab **64** on the key **40** so that key **40** is depressed automatically upon depression of key **60**. This action insures the initiation of machine operation and provides for automatic termination of operation once a cycle has been completed. Key **60** further transfers an interconnecting control switch **65** from a high speed control contact **66** to a low speed control contact **67** to

thereby cause the motor **30** to operate at a relatively low speed. Paper **20** thus will be fed and processed passed the surface **51** at a low speed and will be fed to the contact fuser **10** at the same low speed.

Key **60** further acts through a connecting link **68** to disengage a clutch **69** between the motor **30** and a drive shaft **59** of the developer unit **54** to prevent cascading of developer material over the surface **51**. With the developer unit **54** disconnected, image production is effectively inhibited. Thus, the machine will operate through a conventional copy cycle with the parts moving at a reduced speed and without the deposition of toner onto the paper **20** being fed from roll **23**. As the paper passes through the roll fuser **10**, toner will be withdrawn from fuser roll **15** and especially the backup roll **16** as described in connection with FIG. **1**.

If the copy machine is provided with a multiple cycle counter, several plain sheets of paper **20** can be automatically fed as necessary to provide a complete and thorough cleaning of the fuser backup roll.

Those skilled in the art will recognize that the foregoing illustrative embodiments of our invention represent but a single preferred implementation of our inventive concepts and that various modification, deletions, substitutions, and additions can be made to the apparatus shown without departing from the spirit and attained benefits of our inventive concepts. Accordingly, the scope of protection sought by Letters Patent is to be defined solely by the appended claims.

We claim:

1. The improved method of operating a contact fuser having cooperating members that provide contact surfaces for receiving support members bearing thermoplastic toner particle images therebetween, wherein one of said surfaces is maintained at high temperatures and the thermoplastic particle image on a support member is engaged under pressure by said one surface for a relatively short first period of time and wherein the improvement comprises the step of:

cleaning said contact surfaces of residual thermoplastic toner material by contacting said surfaces against a toner receptive member with said one surface at a high temperature for a second period of time that is substantially longer than said first period of time.

2. Fuser mechanism for fixing thermoplastic toner particle images to a support member and having a roll couple forming a nip therebetween, each roll of said couple having an external surface of low surface energy material, roll heating means directly thermally connected with only a first roll of said couple for maintaining the external surface of said first roll at high temperature, and power means operatively connected to said roll couple for rotating the rolls thereof, wherein the improvement comprises:

speed change means associated with said power means for causing said rolls to be driven at a normal relatively fast speed or selectively alternatively at a relatively slow speed,

means for delivering a sheet of toner receptive material into the nip of said roll couple, and

manually operable control means connected with said speed change means for selecting said relatively slow speed whereby said sheet and the second roll of said couple are heated by said first roll, and toner material on said first and second rolls is transferred to said sheet.

3. In a copy reproducing machine having a supply of copy material, image producing means for generating a thermoplastic toner particle image on a sheet of said copy material, a fusing roll couple for fixing the thermoplastic toner particle image to said copy material, and manually initiatable control means for producing an automatic sequence of operations including feeding a sheet of said copy material to said image producing means, producing the said image onto the sheet, and passing the sheet bearing the image to said roll couple, each roll of said couple having an external surface of low surface energy material, heating means directly thermally connected only with the one roll of said couple that engages said toner particle image for maintaining the external surface of said one roll at high temperature, and power means connected to said roll couple for rotating the rolls thereof, wherein the improvement comprises:

a cleaning-cycle-select control member having a normal inactive position and a displaced active position,

speed change means associated with said power means for causing said rolls to be driven at a normal relatively fast speed and further being controlledly connected with said clean-cycle-select control member for causing said rolls to be driven at a relatively slow speed in response to said control member being positioned in its displaced position, and

further means responsive to said control member being positioned in its displaced position for inhibiting operation of said image producing means,

whereby operation of said copy reproducing machine with said control member in its displaced position delivers a sheet of said copy material without an image thereon to said roll couple while said roll couple is moving at said relatively slow speed.

4. Fusing mechanism as defined in claim **3** wherein the other roll of said couple is heated only by conduction of heat from said one roll.

5. Fuser mechanism as defined in claim **2** wherein said relatively slow speed is about 10 percent or less of said relatively fast speed.

6. Fuser mechanism as defined in claim **2** where said low surface energy material is silicone rubber.

7. Fuser apparatus as defined in claim **2** wherein at least one roll of said couple is significantly deformable when placed in pressure cooperation with the other of said rolls whereby an area of contact between said rolls is created at the nip.

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