United States Patent [19]

Thettu

[11] **3,921,573**

[45] **Nov. 25, 1975**

[54] **CLEANING SYSTEM FOR ELECTROSTATIC REPRODUCING APPARATUS**

[75] Inventor: **Raghulinga R. Thettu,** Webster, N.Y.

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

[22] Filed: **May 29, 1973**

[21] Appl. No.: **364,573**

[52] **U.S. Cl.** **118/70;** 432/60; 432/228; 118/60

[51] **Int. Cl.²** **B05C 11/00**

[58] **Field of Search** 118/70, 126, 637, 204, 118/203, 60; 117/21; 15/256.52; 432/59, 60, 227, 228

[56] **References Cited**

UNITED STATES PATENTS

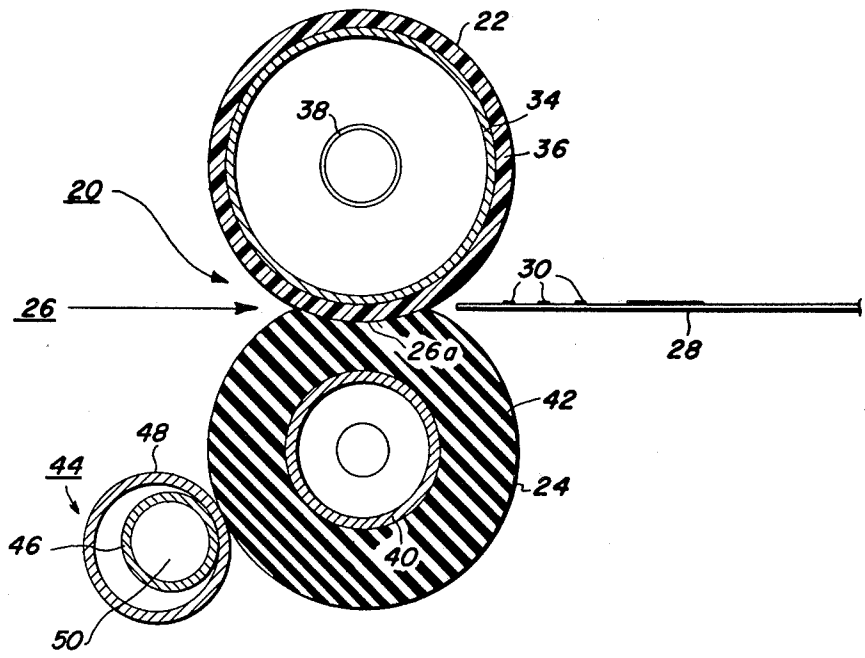
3,105,133	9/1963	Norton	432/228
3,649,992	3/1972	Thettu	15/256.52
3,666,247	5/1972	Banks	432/228 UX
3,811,821	3/1974	Ariyama et al.	432/60

Primary Examiner—Ronald Feldbaum

[57] **ABSTRACT**

A roll fusing device for a xerographic reproducing apparatus characterized by the provision of a heated roll for cleaning toner material from a back-up or pressure roll. The cleaning roll has a higher surface energy than the back-up roll, consequently, when sufficient heat is supplied to toner particles on the back-up roll to cause the toner particles to become tacky the back-up roll releases the toner to the cleaning roll which, due to its higher relative surface energy or adherence factor, has a greater affinity for the toner than does the back-up roll.

3 Claims, 2 Drawing Figures



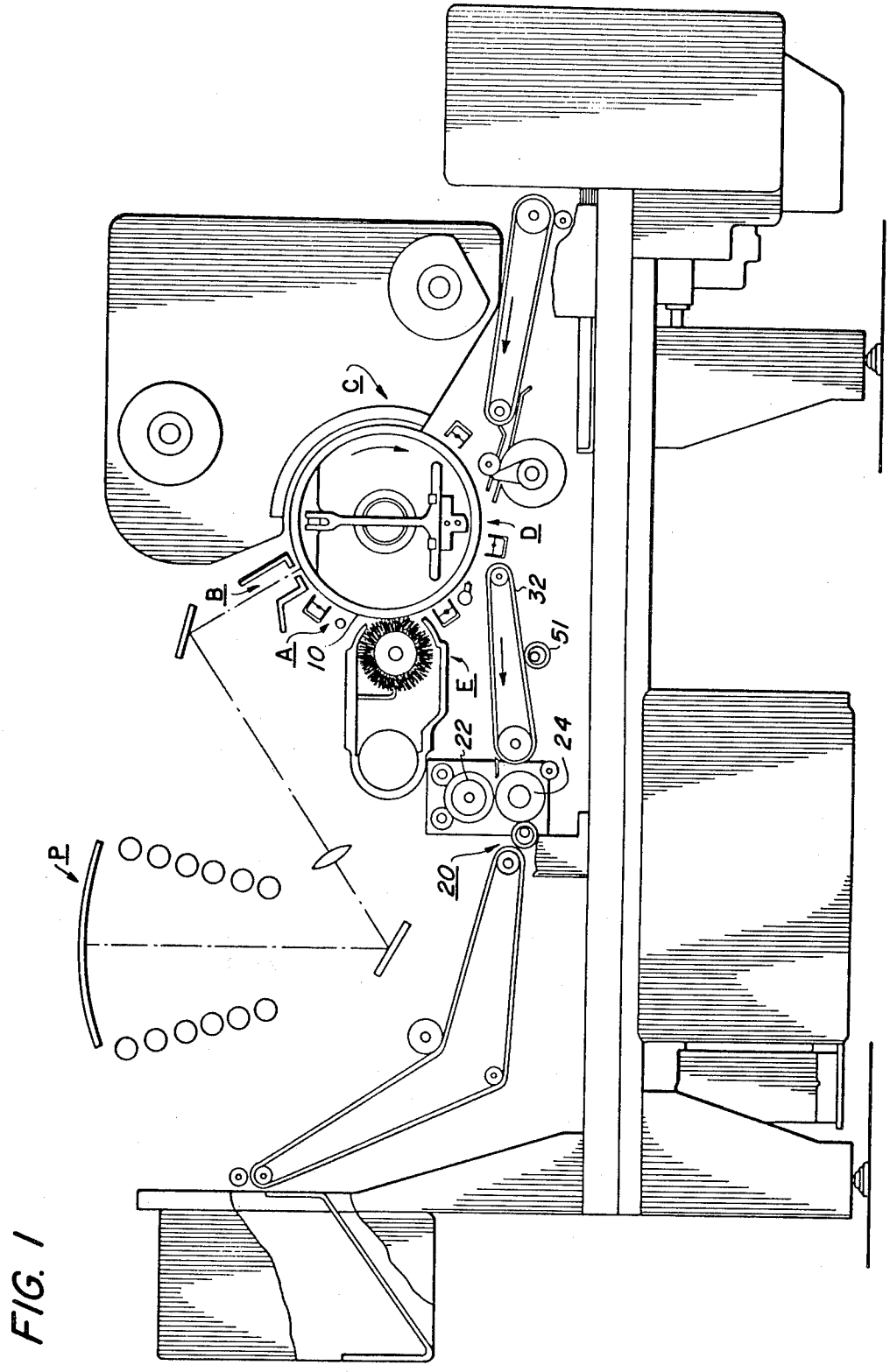
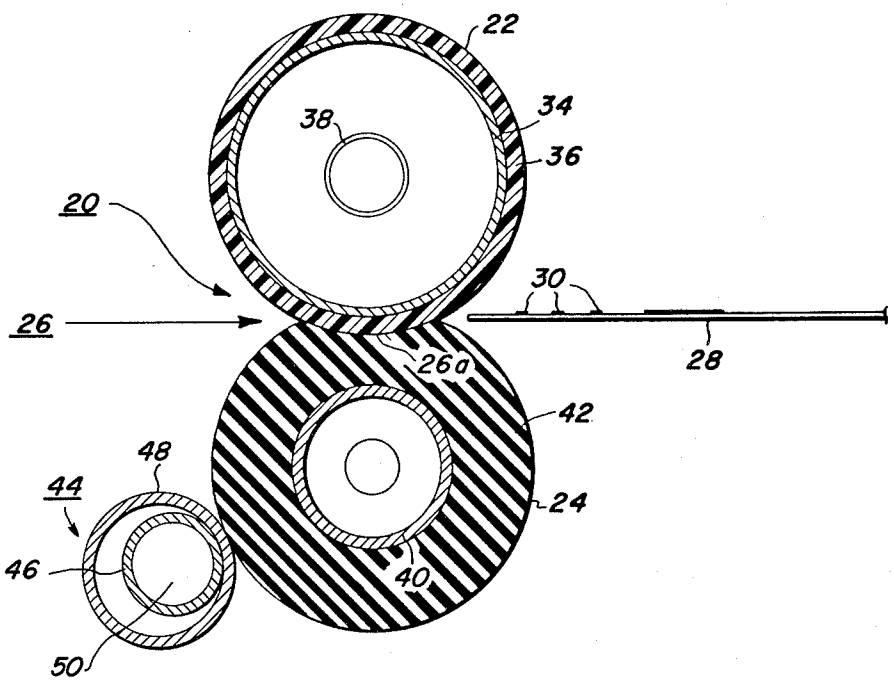


FIG. 1

FIG. 2



CLEANING SYSTEM FOR ELECTROSTATIC REPRODUCING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to xerographic copying apparatus and, more particularly, to a roll fusing system for fixing electroscopic toner material to a support member wherein there is provided a heated cleaning roll for cleaning toner material from the back-up roll.

In the process of xerography, a light image of an original to be copied is typically recorded in the form of a latent electrostatic image upon a photosensitive member with subsequent rendering of the latent image visible by the application of electroscopic marking particles, commonly referred to as toner. The visual image can be either fixed directly upon the photosensitive member or transferred from the member to a sheet of plain paper with subsequent affixing of the image thereto.

In order to permanently affix or fuse an electroscopic toner material onto a support member by heat, it is necessary to elevate the temperature of the toner material to a point at which the constituents of the toner material coalesce and become tacky. This action causes the toner to be absorbed to some extent into the fibers of the support member which, in many instances, constitues plain paper. Thereafter, as the toner material cools, solidification of the toner material occurs causing the toner material to be firmly bonded to the support member. In both the xerographic as well as the electrographic recording arts, the use of thermal energy for fixing toner images onto a support member is old and well-known.

One approach to thermal fusing of electroscopic toner images onto a support has been to pass the support with the toner images thereon between a pair of opposed roller members, at least one of which is either externally or internally heated. During operation of a fusing system of this type, the support member to which the toner images are electrostatically adhered is moved through the nip formed between the rolls with the toner image contacting the fuser roll to thereby produce heating of the toner images within the nip. By controlling the heat transferred to the toner virtually no offset of the toner particles from the copy sheet to the fuser roll is experienced 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 liquify and cause a shearing action in the molten toner to thereby result in "hot" offset. Shearing occurs when the inter-particle forces holding the viscous toner mass together is less than the surface energy forces tending to offset it to a contacting surface such as the fuser roll. Further, by the provision of proper roll surface materials, therefore, adhesive materials, offset of toner particles is minimized.

Occasionally, however, toner particles will be offset to the fuser roll by an insufficient application of heat to the surface thereof; (i.e., "cold" offsetting) by imperfections in the properties of the entire surface of the roll, or by the toner particles insufficiently, adhering to the copy sheet by the electrostatic forces which normally hold them there. In such a case toner particles may be transferred to the surface of the fuser roll with

subsequent transfer to the back-up roll during periods of time when no copy paper is in the nip and before the back-up roll can be moved out of contact with the fuser roll.

Moreover, toner particles can be picked up by the fuser and/or back-up roll during fusing of duplex copies or simply from the surroundings of the reproducing apparatus.

It will be appreciated that in order to prevent such toner particles being transferred to the copy paper, it is necessary to remove the toner particles from the fuser roll and/or the back-up roll. It will be further appreciated that if enough toner accumulates on the fuser and/or back-up roll the paper feed through the fusing system will be adversely affected.

One arrangement for minimizing the foregoing problems, including that which is commonly referred to as "offsetting", has been to provide a fuser roll with an outer covering or sleeve of polytetrafluoroethylene commonly known as Teflon, to which a release agent such as silicone oil is applied. Silicone based oils, which possess a relatively low surface energy, have been found to be a material that is suitable for use in the heated roll fuser environment. In practice, a thin layer of silicone oil is applied to the surface of the heated roll to thereby form an interface between the roll surface and the toner images carried on the support material. Thus, a low-surface energy layer is presented to the toner as it passes through the fuser nip and thereby prevents toner from adhering or offsetting to the fuser roll surface. Cleaning or removal of any toner that may offset to the fuser roll is accomplished in a conventional manner such as by wiping the fuser surface with a blade or pad element. In certain prior art devices, the back-up roll is provided with a Teflon sleeve which is cleaned by contact with a web or wick cleaning member without the aid of oil or other release agent being applied thereto.

Wiper-type cleaning arrangements may be abrasive particularly when solidified toner, solid foreign particles, or carrier beads are trapped between the wiper element and the surface being cleaned thereby promoting degradation of the surface.

Accordingly, it is the principal object of this invention to provide a new and improved fuser for a xerographic copying apparatus.

Another object of this invention is to provide in a xerographic copying apparatus a toner fusing device including improved means for preventing toner offset to the copy paper.

Still another object of this invention is to provide a new and improved roll fusing device for a xerographic copying apparatus wherein there is provided a new and improved method and apparatus for cleaning fuser roll members in order to prevent toner offset to the copy paper and paper jams.

Yet another object of this invention is to provide apparatus for cleaning contaminants such as toner particles from paper transporting mechanisms of an electrostatic copying apparatus.

BRIEF SUMMARY OF THE INVENTION

The above-cited objects are accomplished by the provision of a roller-type cleaning system which comprises a cleaning roller supported such that there is rolling contact between it and the surface or surfaces to be cleaned with little or no slip between the surfaces.

The roller is provided internally thereof with a Cal Rod or any other suitable type heater for elevating the temperature of the cleaning roller. For example, the roller surface could be provided by spray coating or etching, with a suitable resistance heater or a resistance heating element could simply be affixed to the outer surface.

The heated cleaning roller serves to change the state of the toner, (for example, from powder or solid to tacky) to be removed from a fuser back-up roll or other components of an electrostatic reproducing apparatus such as document and copy transport belts and/or rollers. When the toner is in a plastic state, it tends to stick to the cleaning roller due to the force of attraction between the toner and the cleaning roller being greater than the force of attraction between the toner and the roller surface being cleaned. Stated, differently, when the relative surface energy of the cleaning roller is higher than the relative surface energy of the surface being cleaned the latter will give up the toner to the former.

The thermal energy transferred to the toner is controlled to insure that it is sufficient to render the toner tacky and not cause it to melt in which case, the viscosity forces of the toner are such as to be weaker than the relative attraction between the toner and the surfaces involved (i.e., warm cleaning roller and roller surface to be cleaned). This results in toner splitting, therefore, only some of the toner being removed from the surface being cleaned.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of the xerographic reproducing apparatus to which the inventive concept relates; and

FIG. **2** is a side elevational view in cross section of a fusing device incorporated in the apparatus of FIG. **1.**

DETAILED DESCRIPTION OF THE INVENTION

For a general understanding of the apparatus incorporating the improved fusing device, reference may be had to FIG. **1** in which the various system components for the xerographic copying apparatus are schematically illustrated. A light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it is fused whereby the powder is caused to permanently adhere to the support surface, which surface usually comprises plain paper.

In the illustrated apparatus, an original to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly and image rays are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate in the form of a drum generally indicated by the reference numeral **10.**

The drum **10** is mounted upon the frame of the machine and is adapted to rotate in the direction of the arrow at a constant rate. During this movement of the drum, it passes a charging station A where a uniform electrostatic charge is applied to the surface thereof. Next at an exposure station B, exposure of the drum surface to the light image discharges the xerographic plate in the areas struck by light, whereby there remains on the surface a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the drum surface continues its movement, the electrostatic image passes through a developing station C in which there is positioned a developer assembly. The developer assembly delivers developing material to the upper part of the drum whereat the material is directed to cascade over the drum surface in order to provide development of the electrostatic image. As the developing material is cascaded over the drum surface toner particles in the development material are deposited on the surface to form powder images.

The developed electrostatic image is transported by the drum to a transfer station D whereat a sheet of copy paper is moved at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism adapted to transport sheets of paper from a paper handling mechanism to the developed image on the drum at the station D.

After the sheet is stripped from the drum, it is conveyed to a fuser apparatus generally indicated by the reference numeral **20** whereat the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto as will be described more fully hereinafter. After fusing, the finished copy is discharged from the apparatus by a belt conveyor to a suitable point for collection externally of the apparatus. Suitable drive means are arranged to drive the drum in conjunction with timed exposure of an original to be copied to effect conveying and cascading of toner material to separate and feed sheets of paper and to transport the same across the transfer station D and to convey the sheet of paper through the fuser apparatus in timed sequence to produce copies of the original.

The fuser apparatus **20,** as illustrated in FIG. **2,** comprises a fuser roll **22** and a back-up roll or pressure roll **24** having a nip **26** defined therebetween, through which copy paper **28** is moved in order to permanently affix images of toner **30** thereto.

The copy paper **28** having the toner images electrostatically adhered thereto is moved to the nip **26** by means of a conveyor belt **32** which receives the copy paper from the photosensitive member **10,** herein disclosed by way of example as a drum structure.

The fuser roll **22** may be fabricated from any conventional material by well-known techniques in the art, whereby a roll structure is provided which comprises a rigid heat conductive substrate or support **34** such as aluminum, overcoated with an abhesive layer **36,** formed, for example by polytetrafluoroethylene. The fuser roll is provided internally thereof with a source of thermal energy such as an infra red type heating element, for heating the roll to operational temperatures. Power is supplied to the element **38** such that during operation the outermost surface temperature of the polytetrafluoroethylene is on the order of 200°–400°F. It will be appreciated that the layer **36** may comprise other suitable materials, for example, metals, silicone rubber or plastic materials.

The back-up or pressure roll **24** comprises a rigid support **40** and a relatively thick resilient layer **42** of silicone rubber. The back-up roll **24** and fuser roll **22** are supported in a conventional manner (not shown) by the main frame of the apparatus such that one or the other can be driven from the main drive of the ma-

chine, with rotation of the member not driven by the main drive being affected, for example, by suitable gears coupling the members for simultaneous rotation. While the layer **42** has been disclosed as a silicone rubber it will be appreciated that other materials are suitable, for example, polytetrafluoroethylene.

Pressure is applied to the back-up roll **24** such that it is deformed to provide a contact surface area indicated at **26A.** The heat transfer to the toner images is a function of speed and surface temperature of the fuser roll and the time attributed to the contact surface area **26A.** Typical pressures are 50 to 100 PSI.

In a typical fuser of the type herein described, a release fluid such as silicone oil is applied to the adhesive surface **36** to enhance the toner release characteristics thereof such that if toner does find its way onto the surface, such toner will be given up to a fuser roll cleaning member (not shown).

A roll **44** for cleaning contaminates, for example, toner from fuser roll surface, contacts the pressure roll **24** and is drivingly coupled thereto, for example, by gears, not shown. Other methods of driving the cleaning roll may be employed. The cleaning roll **44** comprises an inner rigid, heat conducting support member **46** such as steel and an outer member **48** in the form of a metal tube. A resistance heater structure **50,** preferably a Cal Rod element is supported at the center of the support **46** and is substantially coextensive with the longitudinal axis thereof. The cleaning roll may comprise other structures such as a belt arrangement, the specific configuration being dependent upon the particular machine configuration and operating requirements thereof. The surface of the support **46** is hardened such that it is harder than member **48** in order to minimize wear of support **46.**

The heater structure provides heat for elevating the surface temperature of the roll **44** to a temperature sufficient to render the toner particles tacky, such temperature by way of example being on the order of 200°F, the exact temperature being a function of the particular toner employed. It will be appreciated that a cleaning roll similar to roll **44** can be employed for cleaning other parts of the apparatus from which the copy paper or documents to be reproduced (in the case of an automatic document feed) could pick up contaminants. For example, the belt **32** that moves the copy paper to the fuser could be cleaned of contaminants in the contemplated manner by a cleaning roll **51** (FIG. 1).

Where, as in the case of the rolls **22** and **24,** the outer surfaces are of resilient material, these rolls are mounted such that when the machine is in a stand-by condition, the back-up or pressure roll **24** can be withdrawn from contact with the fuser roll. Such mounting is not illustrated since it can be accomplished with the employment of routine skills. To this end, both rolls could be movable or the cleaning roll could be stationary with only the back-up roll being movable. Alternatively, one of an engaging roll pair could be provided with a flat surface extending the longitudinal extent thereof and the rolls could be synchronized such that the flat is always opposite the other roll of the pair when the rolls are stopped. It will also be appreciated that the cleaning roll **44** could also be mounted such that it can be disengaged from the back-up roll **24.**

During operation the cleaning roll **44** heats the toner on the back-up roll **24** thereby rendering it tacky. The surface materials of the contacting rolls is so chosen as to provide a cleaning roll surface having a higher relative surface energy than that of the back-up roll surface or in other words such that the cleaning roll has a greater attraction for the tacky toner than does the back-up roll or in the case where a roller such as **44** is provided for cleaning the fuser roll **22;** greater than the fuser roll.

While the invention has been described with reference to the structure disclosed herein, it is not necessarily confined to such specific details as set forth and this application is intended to cover such modifications or variations which may come within the scope of the following claims.

What is claimed is:

1. A thermal fuser for use in fixing toner particles to a substrate carrying such particles, said fuser comprising:

a heated fuser roll;

a backup roll member adapted to be moved in contact with said heated member and forming a nip therebetween through which said substrate is passed such that the toner particles carried by said substrate contact said heated member; and

internally heated cleaning means supported in contact with said backup roll member for tackifying toner offset thereto, said cleaning member having a surface exhibiting a greater affinity for said tackified toner than said backup roll member.

2. Structure according to claim **1,** wherein said cleaning member comprises a rigid thermally conductive support member having a heating element disposed internally thereof and further comprises an outer tubular member contacted by said support.

3. Structure according to claim **2** wherein said rigid support and said tubular member are eccentrically mounted.

* * * * *