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ELECTROSTATIC CLEANING OF XEROGRAPHIC PLATES

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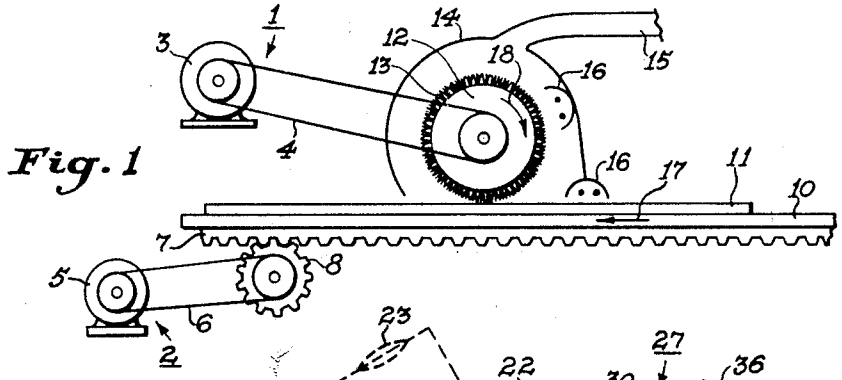


Fig. 1

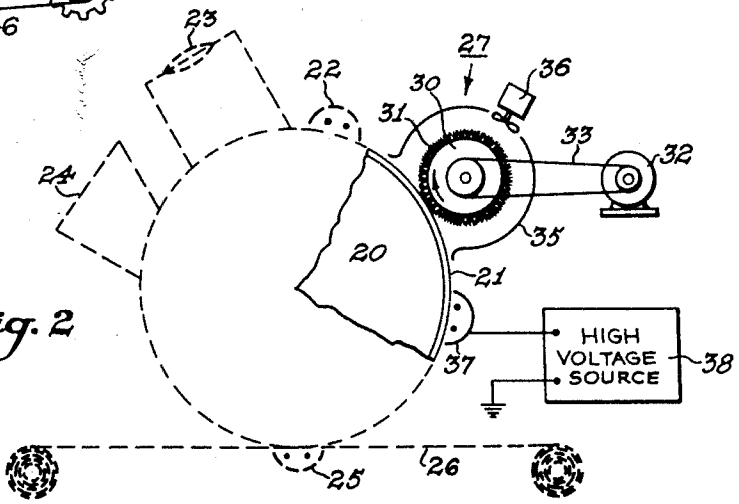


Fig. 2

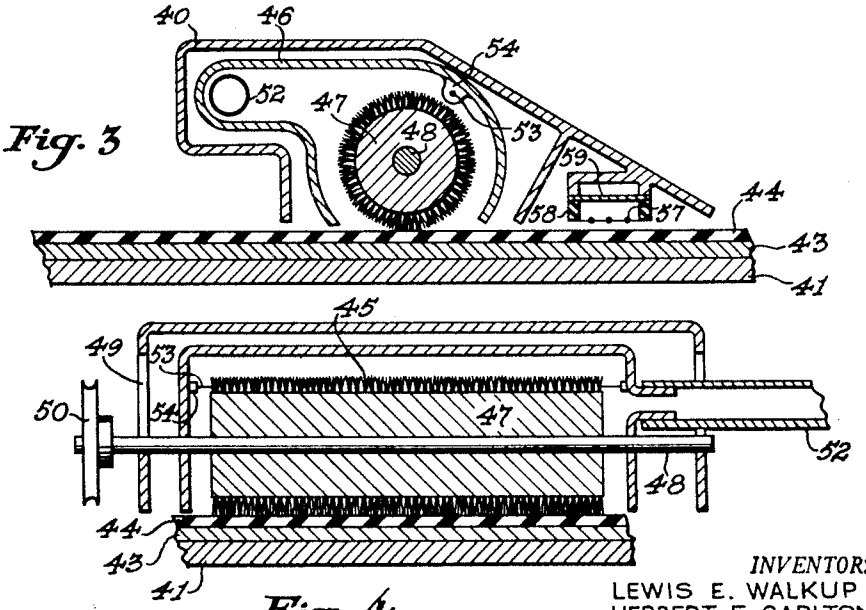


Fig. 3

Fig. 4

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ELECTROSTATIC CLEANING OF XEROGRAPHIC PLATES

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3 Claims. (Cl. 134—1)

This invention relates in general to a method of the removal of electrostatically adhering powder particles from an insulating surface and, in particular, to a method of cleaning a xerographic or electrophotographic plate. This is a continuation-in-part of Walkup and Carlton pending application Serial No. 269,958 entitled, "Electrostatic Cleaning Device and Method."

In the art of xerography, it is usual to form an electrostatic latent image and to develop this image with an electrostatically attractable material which generally is a thermoplastic pigmented resin. This developed image is conveniently transferred to its ultimate base material by an electrostatic transfer step in which a substantial proportion of the image is caused to adhere electrostatically to a transfer material to which it may be later permanently secured, for example, by fusing. In this transfer step, a large amount of the resin material is transferred to the transfer base but a significant proportion may remain electrostatically secured to the original image bearing member.

The problem which is solved according to the present invention is the removal of this residual material from the xerographic plate and the problem is complicated by the fact that both the xerographic plate surface and the developer powder are, relatively speaking, electric insulators. In Carlson U. S. 2,357,809, there is shown a cleaning device for xerographic surfaces on which a simple brush mechanism removes the powder from the plate. With this device, however, it was found that fusible powder particles were not removed sufficiently cleanly and rapidly for rapidly repeated automatic operation, but instead became smeared or redeposited on the plate. In fact, after operation through several cleaning cycles, Carlson's cleaning brush itself might contain enough of the developer powder to become a powder agitator providing available material for redeposition on the plate. In addition the cleaning brush of Carlson can be a friction charging unit for charging the plate, thus attracting back again some of the powder being removed. It has also been proposed in Copley Patent No. 2,484,782 to remove this residual image by flowing a granular material across the surface of the xerographic plate. However, such a cleaning process is better for a manual process than for a mechanized one, first, because this process requires additional equipment for dispensing and returning a separate material which must be kept isolated from the developer material and, second, because the granular cleaning materials must be replaced after a few hundred cleaning cycles. Since mechanization opens up the possibility of rapid operation for thousands of xerographic copying cycles, a need exists for a method and apparatus operating to clean the xerographic plate, cleanly and repeatedly, without the need for equipment and materials not suited for high speed automatic operation.

It is, therefore, an object of this invention to provide a method of removal of residual powder material electrostatically adhering to an insulating surface.

More specifically, it is an object of this invention to

provide a method of the removal of residual powder image from a xerographic plate.

It is a further object of the invention to provide a method of the cleaning of xerographic plates wherein the electrostatic adhesion of the powder particles is electrically overcome and the particles are cleanly removed by means of a rapidly rotating brush.

Additional objects of the invention will in part be obvious and will in part become apparent from the specifications and from the drawings in which:

Figure 1 is a diagrammatic view of a cleaning mechanism according to one embodiment of this invention;

Figure 2 is a diagrammatic representation of cleaning mechanism according to another embodiment of the invention;

Figure 3 is a side elevation in section of the cleaning apparatus according to a further embodiment of the invention;

Figure 4 is a front elevation in section of the mechanism shown in Figure 3.

The mechanism shown in Figure 1 is a simple cleaning device according to one embodiment of the invention. This comprises a support member or bed plate **10** on which is positioned a surface to be cleaned, such as, for example, a xerographic plate **11**. Above and bearing on the surface of this plate is a rotatable cylindrical member or brush having hair, fibres, or the like **13** on its outer surface, the brush optionally being retractable into and out of contact with the plate. A hood arrangement **14** at least partially surrounds the portion and preferably terminates a short distance above the plate. A vacuum or other air flow line **15** leads from the hood to an externally positioned vacuum source (not shown). According to the preferred mechanism, a source of ions such as a corona discharge electrode **16** is mounted adjacent to the portion and optionally positioned to direct a flow of ions either onto the surface of the plate being cleaned or onto the fibres of the brush, or optionally both. Drive means **1** and **2** are operable to cause the brush and the plate to undergo relative motion, for example, driving the plate in the direction shown by arrow **17**, and to rotate the brush in the direction shown by arrow **18**. Drive means **1** is composed of a motor **3** and a belt **4** which connects motor **3** to brush **12**. Drive means **2** is composed of a motor **5**, a belt **6**, a rack **7**, and pinion **8**. The motor **5** drives pinion **8** through belt **6** and rotation of pinion **8** while meshed with rack **7** causes movement of the plate.

In use and operation according to Figure 1, a xerographic member or like surface having an electrostatically adhering residual powder layer is placed on bed plate **10** and brush **12**, if retractable, is brought into light contact therewith. Drive means **1** and **2** then is activated to rotate the brush and to cause relative movement between the axis of the brush and the surface of the plate. Preferably, one or both of the corona electrodes **16** will be energized to discharge ions either on the surface of the plate or onto the fibres of the brush. Simultaneously, the vacuum is operated to withdraw air from the brush area, thus drawing separated powder particles away from the brush.

In the course of normal operation to clean xerographic plates, the composite xerographic plate surface carrying a residual image is characterized by possessing positive electric charge following the usual electrostatic transfer step. Removal of the residual image from the surface of the plate is best accomplished and substantially facilitated, it has been found, by spraying electrostatic charge from a corona discharge electrode or other ion source to result in a negatively charged composite exerographic plate surface carrying a residual image. This can conveniently be accomplished by operating the corona

discharge electrode at a high voltage alternating potential, for example, 60-cycle A. C. of about 6,000 to 10,000 peak volts, with the voltage biased at a slightly negative potential such that the positive current is 20 to 25 microamps and the negative current is about 80 to 100 microamps for an electrode extending across about a 24-inch width and moving at a speed of about 4 inches per second. When the corona discharge electrode is directed toward the rotating brush rather than toward the plate being cleaned, similar results can be achieved with a relatively high direct voltage such as 6,000 to 8,000 volts negative.

Although the underlying theory of improved cleaning by first making the composite xerographic plate surface and residual image negative is not fully understood and, although there is no intention to limit this invention to any particular mechanism of operation, it is presently believed that following transfer of the developed image a positive, albeit reduced positive, electrostatic latent image remains on the surface of the plate. The particles of the residual image remaining on the surface of the plate are believed to retain a substantial charge of their original or negative polarity although the upper surface of these particles is in all likelihood positive. The spraying of negative charge to the composite xerographic plate surface carrying the residual image, it is believed, results in negative charging of areas of the surface of the plate and negative charging of the residual image particles. The particles then being of a like sign as the charge on the plate surface tend to be repelled from the plate surface and are efficiently removed during the brushing or wiping operation.

When working with the powder materials conventionally used in the xerographic process, it has been found that relatively high brush speeds are necessary in order to avoid smearing the powder material on the surface of the plate during its removal. The brush speed is variable within limits depending on the nature of the powder material being removed, since factors such as thickness, smear, fusibility may alter the speed requirements. However, with the present commercial xerographic developer a peripheral brush speed of about 20 feet per second is desirable and a convenient speed is achieved with a brush rotation of about 1700 R. P. M. using a brush of four or five inches in diameter. With this brush speed, a rate of travel of about four inches per second for the brush moving across the surface of the member being cleaned can easily be achieved with excellent cleaning of the surface at this linear rate.

In Figure 2 there is shown another embodiment of the invention wherein the mechanism is employed to clean a residual powder layer from the surface of the cylinder. According to this embodiment a supporting cylinder **20** supports and moves an insulating surface **21** which may be in any desired form such as a layer on the cylinder surface or a separate member removably attached to at least one segment of the cylinder. Where this mechanism is employed in conjunction with a xerographic process the cylinder is adapted to move the active surface through several stations or positions around its circumference such as, for example, a charging station **22**, an exposure station **23**, a developing station **24** and a transfer station **25** whereby an electrophotographic image is formed, developed and transferred to a transfer member **26**. The plate is then carried into the cleaning station generally designated **27** where residual powder is removed therefrom in accordance with the present invention.

The cleaning station comprises a rotating cylindrical brush **30** having fibre members **31** around the surface thereof and bearing against the surface **21** to be cleaned. A drive member such as for example, motor **32** operates through belt **33** to rotate the cylinder at a desired speed, which may, as in the case of the device in Figure 1, be a speed of at least about 20 to 25 linear feet per second. Preferably a hood **35** surrounds the brush and contains a vacuum member **36** to draw air through the hood and withdraw powder from the fibres of the brush.

At the leading edge of the hood is positioned a charging member **37** which is operably connected with a high voltage source **38**. This charging member preferably is electrically connected as in the case of Figure 1 to a biased high voltage A. C. source to deliver 20 to 25 microamps, positive corona current and 80 to 100 microamps, negative current per 24-inch width.

The operation of the mechanism is similar to that of the device in Figure 1. When it is desired to remove an electrostatically adherent powder particle from the insulating surface, brush **30** is rotated, vacuum source **36** is set into operation and, optionally, a precharging unit **37** is energized. The plate **21** is thereby carried over the charging unit **37** where the composite plate surface and residual image are made negative, and the plate is then carried to the position where these particles are removed by the fibres and then withdrawn by the vacuum. The insulating surface if, for example, a xerographic plate, is then ready for re-use in the xerographic process.

A specific structure which may be employed with either the embodiment of Figure 1 or the embodiment of Figure 2 is shown in Figures 3 and 4. This device comprises essentially a frame or carriage **40** which may be suitably mounted as part of an entire electrophotographic machine. A plate support member or bed plate **41** is positioned closely adjacent thereto and adapted to support a surface to be cleaned, such as, for example, a xerographic base plate **43** having on one surface thereof a photoconductive insulating layer **44**. Mounted within the frame **40** is a hood assembly and support **46** which carries cylindrical member **47** carrying brush **45** and rotatable on an axle **48**. The axle **48** preferably extends through the sides of **46** and may if desired have a bearing mounting at the point where it meets each side wall. Preferably the entire hood assembly is movable to bring the brush into and out of contact with layer **44** and for this reason the axle may extend through a slit **49** in the supporting frame member to permit the necessary motion therebetween. A pulley **50** or drive member is mounted on the axle whereby it may be driven by a separately mounted power source such as an electric motor.

A vacuum line **52** leads to the inner hood assembly **46** whereby vacuum may be supplied to the fibres of the brush. Optionally an electrode or ion source **53** may be mounted within the hood assembly by insulating mounts **54**. This member **53** may, if desired, be a corona discharge electrode spaced somewhat from the fibres in order to prevent mechanical damage to the electrode or may, if desired, be a conductive bar mounted to contact the fibres as they are carried around the surface of the cylinder.

Preferably mounted near the leading edge of the hood assembly is a corona discharge electrode **56** comprising a plurality of corona wires **57** mounted on insulating supports **58** and closely adjacent to a conductive ground plate **59** which is electrically grounded. The corona discharge wires **57** or, optionally, member **53** are conductively connected to a high voltage source to supply a high voltage such as described in connection with Figures 1 and 2.

It has been found that the fibre or brush material has certain desirable characteristics which improve its operation in order to permit complete removal of residual powder images throughout the course of numerous repetitive cycles without the need of solvent cleaning of the xerographic plate. Desirably the brush material should be sufficiently soft so that it does not abrade the insulating surface which usually is selenium, and at the same time it should be sufficiently stiff so that the brush itself does not become matted upon repeated use. Likewise it is necessary either that the brush material not deposit any oil or liquid on the surface being cleaned or else that any material thus deposited be noninjurious to the xerographic process. Other properties of the brush which lead to improved efficiency of operation appear to be a proper position in the triboelectric series, proper humidity

characteristics and relatively low electrical conductivity. In addition, it is desirable that the brush itself be relatively wear-resistant to obviate frequent replacement.

Among the materials which have been satisfactorily used for the cleaning brush are various types of furs such as, for example, beaver fur, gray fox fur, domestic rabbit fur, New Zealand sheared and dyed rabbit fur, and the like. In addition, other fibre-like materials may be used including, for example, synthetic fibre materials such as nylon or the like.

The usual procedure in preparing a material for use as the cleaning brush is to give the raw fur or other material a thorough washing, preferably with usual dry cleaning solvents, in order to remove greases and the like. On the other hand, it frequently is desirable to have small quantities of liquids which are compatible with the xerographic process. Thus, the brush material may, if desired, be treated with small amounts of oils such as hydrocarbon oils, waxes and the like including silicone oils and other natural oily materials. These materials such as oils and the like may be added to the fibre in an amount to control the conductivity of the brush, either to make the brush conductive or to make it nonconductive, as desired. Thus, for example, a fur may be treated with a small quantity of an electrically conductive oil to improve its conductivity and thus assist in removal of the residual image powder particles.

What is claimed is:

1. The method of cleaning a residual xerographic image comprising particulate material remaining after transfer of the developed image from the surface of the photoconductive insulating layer of a xerographic plate, said method comprising placing a negative electrostatic charge on the surface of the photoconductive insulating layer carrying the residual image to make the composite surface of the xerographic plate and the residual image electrostatically negative, and rapidly brushing the surface to remove the residual image.

2. The method of cleaning a residual xerographic image comprising particulate material remaining after transfer of the developed image from the surface of the photoconductive insulating layer of a xerographic plate, said method comprising placing sufficient negative electrostatic charge on the surface of the photoconductive insulating layer carrying the residual image to make the composite surface of the xerographic plate and the residual image electrostatically negative, then rapidly brushing the surface with a brush to remove the residual image from the plate surface and to disperse the particles comprising the residual image in surrounding air, and withdrawing a stream of air and said particles from the brush and the surrounding air during the brushing operation.

3. The process of claim 2 wherein an electrostatic charge is applied to the brush following brushing of the surface of the photoconductive insulating layer to counteract the electrostatic attraction between the brush and particles to facilitate the releases of pariculate material to the withdrawing stream of air.

No references cited.