June 26, 1956 M. I. TURNER, JR., ET AL 2,751,616

BRUSH CLEANING DEVICE

Filed July 17, 1953

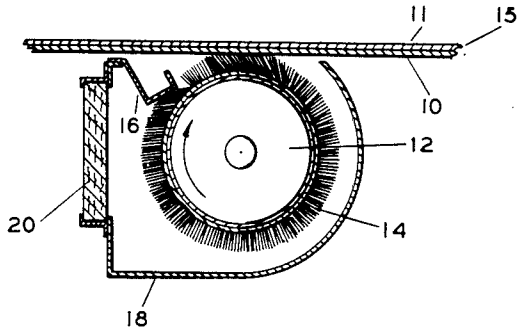


FIG. 1

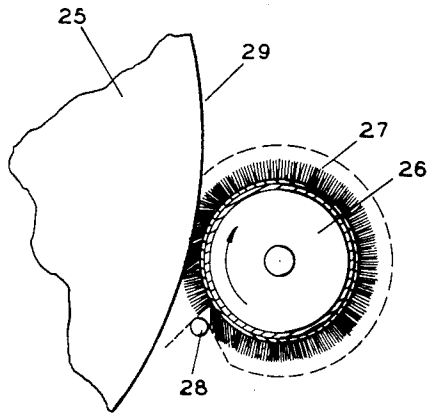


FIG. 2

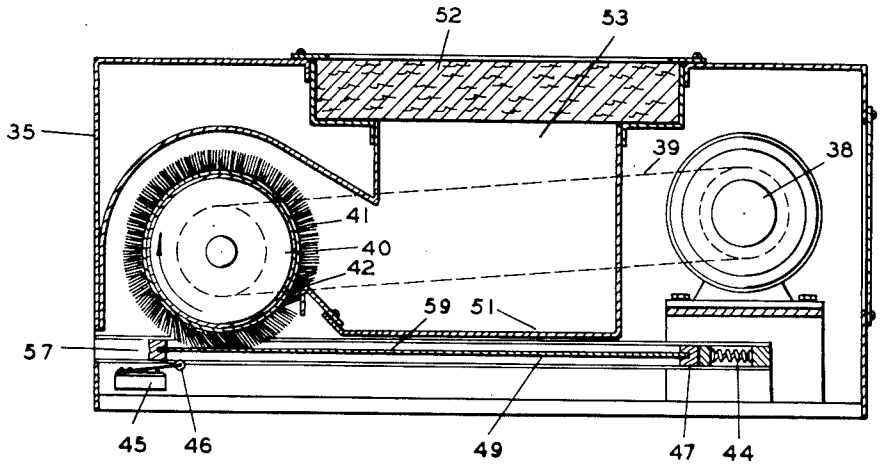


FIG. 3

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2,751,616

Patented June 26, 1956

2,751,616

BRUSH CLEANING DEVICE

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Application July 17, 1953, Serial No. 368,692

2 Claims. (Cl. 15—77)

This invention relates in general to xerography and, in particular to apparatus for the removal of electrostatically adhering particles from an insulating surface.

In the art of xerography it is usual to form an electrostatic latent image and to develop this image with an electrostatic attractable material which generally is a thermoplastic resin powder. This developed image is then transferred to a second surface. The transfer step causes a large amount of the resin material to adhere to the new base material but a significant proportion may remain on the original image bearing base.

An object of the present invention is the removal of this residual material from the xerographic plate and the problem is complicated by the fact that developer is electrostatically attracted to the xerographic plate surface and by the further problem that both the xerographic plate surface and the developer powder are, relatively speaking, electric insulators.

A problem exists with apparatus presently in use in that the residual material is not sufficiently removed for high quality reproductions and for rapid processes. Further each incomplete cleaning operation may leave a thin film on the plate. This effect is progressive. The more film there is, the faster additional films build up. For automatic machines this is a serious limiting factor since frequent solvent cleaning is almost out of the question in that it means stopping the machine for servicing. Also, this film may be a significant factor in plate life.

It is therefore another object of this invention to produce a novel apparatus for the rapid and thorough removal of the residual particles from the surface of a xerographic plate through the use of a rapidly rotating vacuum creating brush.

Additional objects of the invention will in part become obvious and will in part become apparent from the specification and drawings wherein:

Figure 1 is a diagrammatic cross sectional view of one embodiment of the invention wherein a flat insulating surface is cleaned;

Figure 2 is a diagrammatic cross sectional view of another embodiment of the invention wherein a cylindrical insulating surface shown in section is cleaned;

Figure 3 is a diagrammatic cross sectional view of another embodiment of the invention in an apparatus designed to remove residual material from a xerographic plate in a xerographic plate holder.

Referring more particularly to the drawing and to the embodiments of the invention therein shown for purposes of illustration, in Figure 1, **10** generally designates the surface of a xerographic plate. The plate **15** is generally constructed so that a conductive layer **11** underlies a photoconductive insulating layer **10**. A cylinder **12** is provided with a brush **14**. The length of the cylinder **12** is dependent upon the width of the xerographic plate **15**. A flicking member **16** extends from the hood generally designated as **18** into the area of rotation of the brush **14**. An area of the hood **18** is made up of a filter **20**. The entire apparatus shown in Figure 1 is enclosed by the hood **18** except between the points **16** or the flicking member and the top edge of the hood. Between these points, the brush **14** is disposed and positioned to ride above the enclosed area of the hood and thereby contacts the photoconductve insulating surface **10** of the xerographic plate **15**.

In Figure 2 a cylinder **25** is shown in section with a surface **29** made up of a photoconductive insulating material and used as the face of a xerographich plate; a cylinder **26** with an outer brush layer **27** which, when rotating, contacts with the brush layer **27**, the surface **29** of the cylinder **25**; a rod **28** positioned in such a way as to be within the area of rotation of the brush **27** and thereby causing the brush **27** to be compressed as it passes the rod **28**.

In Figure 3 another embodiment of this invention is shown in which an outside covering generally designated as **35** have as an integral part thereof a filter **52**. Leading into the device through wall **35** is an opening or slot **57** positioned and adapted to admit a xerographic plate **49**, in a plate holder **47** to guide ways provided along the sides of slot **57**. The head **46** of a microswitch **45** rides up into this opening **57** when the plate **49** is not in the apparatus. When the plate **49** is placed in the slot **57** the head **46** is depressed into the position shown, closing a circuit causing the motor generally designated as **38** to rotate, causing the belt generally designated as **39** to turn the cylinder generally designated as **40**. Cylinder **40** has an outer brush layer **41** which comes in contact with the surface of the xerographic plate **59** and the flicking edge **42**. At the end of the opening **57** is provided a spring **44**. This spring **44** is depressed when the xerographic plate **49** is inserted into slot **57**. When the pressure used to insert the xerographic plate **49** is released, the spring **44** will cause the xerographic plate **49** to be displaced partially out of the slot **57** to a point where it can be grasped and removed. A protective apron **51** is provided between the opening or passageway generally designated as **53** and the opening generally designated as **57** and extends from the flicking edge **42**, along the face of the xerographic plate surface **59** and up to the filter **52**.

In use and operation cylinder **12** of the embodiment shown in Figure 1 is energized from an external source. If the apparatus shown in Figure 1 is part of a manually operated xerographic apparatus, the cylinder can optionally be energized by throwing a switch to cause a motor to rotate and drive the cylinder. If the apparatus shown in Figure 1 is part of an automatic xerographic apparatus, the cylinder can be caused to rotate when the automatic apparatus is put into operation. When the apparatus is being used as an element in an automatic xerographic device, the cylinder **12** may optionally be constructed so that the brush may be removed from contact with the plate. The flicking member **16** is constructed so that it runs the length of the cylinder **12** and is positioned to compress an entire brush section as a brush section passes the flicking member. After a section of the brush has been compressed by the flicking member it passes into a vacant zone and then is brought into contact with the xerographic plate surface. It is not intended to limit this invention to any specific theory or mechanism of operation, however, one explanation of a possible theory follows. Any powder on the plate surface is removed by a number of co-operating elements as the sensitized plate surface is brought into contact with the brush. The individual bristles of the brush which were compressed as they passed the rod, flicking member, or flicking edge tend to spring up of their own accord due to the effects of centrifugal force in the vacant zone. In tending to extend outward due to centrifugal force after being compressed, the bristles contact the plate with more than nor-

mal wiping force. When a section of the brush is compressed by the flicking member all air in that section is driven from the brush. When this section of the brush reaches the vacant zone there is a rush of air to the brush area to equalize pressure. Additional air is brought to this area by the movement of the bristles seeking their normal position. The flicking member has, by compressing the bristles, driven the normal air supply from between the bristles, and air will be drawn into that area of the brush to fill the vacuum after the brush area passes the flicking member. A wind is also established following the direction of rotation of the cylinder. This combined air current travels across the surface of the plate while the brush is brought in contact with the plate. The air current and air filled brush section are brought under pressure when the brush section is brought into contact with the plate surface and the brush, having made friction contact with the flicking member, the plate surface, and the particles on the plate, draws those particles on the surface of the plate which are not blown or wiped into the hood. These factors combined produce a thoroughly cleaned plate rapidly. The particles which have been blown or wiped into the hood are carried by the air current within the hood. Any particles adhering to the brush are dislodged when the brush contacts the flicking member due to the sudden deceleration of the bristles or due to the compressing and wiping by the flicking member or due to physical removal by the outrush of air or due to an electrostatic reaction that takes place when the brush contacts the flicking member or due to a combination of these elements. These particles are likewise thrown into the air currents within the hood. The air currents within the hood are in the direction of rotation of the brush except at the region where the brush makes contact with the flicking member. At this point air is compressed out of the brush and two opposing currents meet and tend toward the area of least resistance or pressure, or the area where the filter **20** is placed, the filter allowing the air currents to escape from within the hood area.

The edge of the hood is constructed so as to be as close as possible to the surface of the plate without making contact with the delicate surface. Particles removed from the plate surface are not thrown through the slight space that exists between the edge of the hood and the plate surface due to a negative pressure that exists in the brush surface as the brush surface passes from the points of last contact with the plate. This lower pressure area causes air to be sucked in from without the hood through this opening and adds to the wind currents in the hood thereby preventing any of the removed particles from being thrown through this opening.

The fact that a negative pressure exists at the area where the brush surface passes from the point of last contact with the plate creates at this point a vacuum effect which also cooperates with the other factors in removing electroscopic material from the plate surface.

In Figure 2 another embodiment using a rotating cylinder **25** shown in section is illustrated. The brush **27** is mounted on a cylinder **26** which can optionally be placed so that it remains in contact with the rotating cylinder **25** at all times or so that it may be removed from contact with the rotating cylinder **25** during cycles. The photosensitive xerographic plate surface **29** is cleaned in a similar manner as the xerographic photosensitive plate surface **10** in Figure 1 was cleaned. When the cylinder **26** is positioned to clean the xerographic photosensitive surface **29** the brush **27** will contact both the rod **28** and the xerographic plate surface **29**. The explanation of the method for cleaning the device found in Figure 1 will also apply to the device found in Figure 2. Optionally, a hood similar to the hood provided in Figure 1 can be provided for the apparatus in Figure 2 or some other device to collect the particles removed from the xerographic plate surface **29** and so that air currents as discussed above will be created.

The illustrative device shown in Figure 3 is specifically constructed to clean a xerographic plate **49** in a xerographic plate holder **47**. As the xerographic plate is inserted in slot **57** a circuit is closed through micro-switch **45** causing the cylinder **40** with the brush surface **41** as an outer layer to rotate. The cylinder **40** with the brush surface **41** as an outer layer will continue to rotate at all times while the xerographic plate is in opening **57**. Since the cylinder **40** is in a relatively fixed position the brush surface **41** will always, while rotating contact the flicking edge **42**. The direction of wind currents in this embodiment generally follow the direction of rotation of the cylinder **40** as the wind currents in Figure 1 and Figure 2 generally followed the direction of rotation of the cylinders **12** and **26**. The particles removed from the surface **59** of the xerographic plate **49** are therefore thrown into the opening **53** and directed toward the filter **52**. The apron **51** acts as a shield between the opening **53** and the xerographic plate member in the opening **57**. It thereby prevents any of the removed particles from falling back on the plate surface. The explanation given for the device shown in Figure 1 as to how the plate surface is cleaned would apply to the device shown in Figure 3.

It has been found that the direction of rotation of the brush is not critical as long as the rod, flicking member or flicking edge is positioned to contact the brush at a point along its direction of rotation just before the brush contacts the plate surface and therefore applicant's invention is not limited to any specific direction of rotation, however, it is preferred to rotate the brush in a direction so that the bristles pass over the plate surface in a direction opposite to the direction of the movement of the plate, in that a dirty brush surface will not contact a cleaned plate surface. When working with powder materials conventionally used in the xerographic process, it has been found that a relatively high brush speed is necessary in order to produce thorough cleaning rapidly. The brush speed is variable within limits, depending on the nature of the powder material being removed, the brush material being used, the contact being made by the brush against the plate surface and the speed with which the plate surface passes over the brush, and other related factors. With present commercial xerographic developers it has been found that a minimum speed of 20 feet per second is required and a highly efficient speed is achieved with a brush rotation of 1800 revolutions per minute using a brush layer on a cylinder of 3 to 5 inches in diameter.

It has been found that the brush material should have certain desirable characteristics for proper operations. The material should be sufficiently soft so that it does not abrade the delicate insulating surface, and at the same time it should be sufficiently stiff so that the brush itself does not become matted upon repeated use. Another desirable characteristic is that the material should be such that it does not deposit any oil or liquid on the surface being cleaned, or that any material thus deposited be non-injurious to the xerographic plate surface and the xerographic system. Other properties of the brush which lead to improved efficiency of operation appear to be proper position in the triboelectric series and proper humidity characteristics. In addition, it is desirable that the brush itself be relatively wear resistant to obviate frequent replacement.

Fiber materials, furs and the like may be used including, for example, synthetic fiber materials such as nylon, cellulose derivatives and the like, and natural fibers such as cotton, wool, hair and the like. Among the materials which have been satisfactorily used with a cleaning brush are various types of furs, such as, for example, beaver fur, grey fox fur, New Zealand sheared and dyed rabbit fur, and the like.

The usual procedure in preparing a material for use as a 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 treat the brush material to control the conductivity of the brush, either to make the brush conductive or to make it non-conductive, as desired. Thus, for example, a fur may be treated with a small quantity of an electrically conductive impregnating material to improve its conductivity and thus assist in the neutralization of residual electric charge on the powder particles.

A variable factor referred to above as influential in the cleaning process is the contact made by the brush with the xerographic plate surface. Since the contact made by the brush surface with the plate surface can effect efficiency, it is preferred that the cylinder having an outer layer of fur be constructed and mounted so that it is adjustable from a point where the edge of the bristles just touch the surface of the plate to a point where almost the entire bristle contacts the surface of the plate. It has been found desirable to bring from one-thirty-second to one-fifth of the bristle length into contact with the plate surface when the cylinder with the outer layer of brush is rotating at approximately 1800 cycles per minute for excellent cleaning.

It is also desirable to construct and mount the rod, flicking member, or flicking edge adjustably so that the contact made by the rod, flicking member, or flicking edge with the brush layer is variable and controllable. Using a cylinder of from 3 to 5 inches in diameter rotating at 1800 revolutions per minute it has been found desirable to adjust the rod, flicking member, or flicking edge to contact the brush surface by extending ½ of the distance between the outer edge of the extended brush material and the cylinder.

The rod, flicking member, or flicking edge may or may not be a conductor and it may or may not be grounded; however, it has been found that a grounded conductive material produces more efficient operation in the present state of the art. The edge of the rod which contacts the brush should be constructed in such a way as to inhibit wear of the brush material.

Optionally the hood itself may, if desired be constructed and adapted to operate both as the hood and rod, flicking member, or flicking edge by bringing an area of the hood into contact with the brush layer.

The hood should be constructed in such a way as to allow sufficient clearance between the hood and brush surface so that the air currents can function properly. It has been found that a clearance of ⅛" between the outer edge of the brush material when extended and the hood is proper for efficient operation.

The filter is constructed and placed in the apparatus in such a way as to be easily removed and replaced. The filter may be any material which will catch the particles removed and yet allow free passage of air. An example of a type of filter used would be a standard glass wool filter often found in home heating systems.

What is claimed is:

1. Apparatus for removal of electrostatically adhering particles from a xerographic plate surface comprising a rotatable brush mounted within a hood, means to support a xerographic plate surface to be cleaned in contact with said brush, means to guide the surface to be cleaned past the rotatable brush, means for rapidly rotating the brush, flicking means along the length of the brush to compress the brush whereby air from between the brush bristles is expelled, said flicking means for compressing the brush comprising a member positioned at a point along the direction of rotation of the brush just before the brush contacts the plate surface and positioned to impinge substantially deeper into the brush bristles than does the surface to be cleaned, a passageway disposed to receive air ejected from the brush and convey said air away from the hood area, said passageway extending to said flicking means and the hood thereby maintaining removed particles away from the surface being cleaned.

2. Apparatus for the removal of electrostatically adhering particles from a xerographic plate surface in a xerographic plate holder comprising a cabinet with a filter mounted thereon, and opening to receive a xerographic plate in a xerographic plate holder, a switch mounted within the opening and operable by insertion of a xerographic plate in a xerographic plate holder therein to energize a motor to cause a brush to rotate when a xerographic plate in a xerographic plate holder is inserted in the opening, a spring mounted at the far end of the opening to cause a xerographic plate in a xerographic plate holder to be displaced out of the opening, an apron positioned and disposed within the cabinet above and across the opening, a flicking edge mounted on the apron and positioned and disposed to contact and depress the brush along its length at a point along its direction of rotation just before the brush contacts the plate surface as it rotates past the flicking edge attached to the apron, the flicking edge and apron as a unit acting to prevent any removed particles from returning to the xerographic plate surface, the brush being positioned and disposed to contact the xerographic plate surface across the width of the xerographic plate in the xerographic plate holder, as the xerographic plate in the xerographic plate holder is inserted and removed into and out of the opening.

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