United States Patent

Volkers

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[45] **Mar. 21, 1972**

[54] SWITCHING DETECTOR

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[73] Assignee: **Xerox Corporation,** Rochester, N.Y.

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[52] **U.S. Cl.** **355/3,** 117/17.5, 118/637, 271/57

[51] **Int. Cl.** **G03g 15/00,** B65h 7/06

[58] **Field of Search** .....355/3, 8, 14, 17; 118/637; 250/49.5 ZC; 96/1.4; 117/17.5; 271/57

[56] **References Cited**

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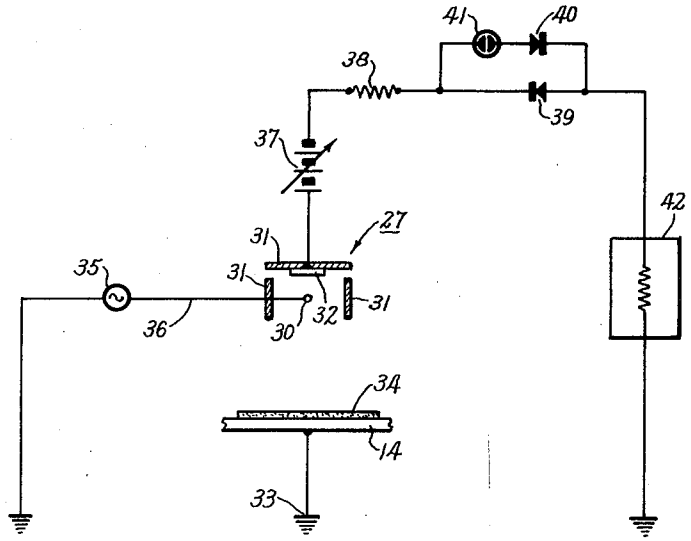
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[57] **ABSTRACT**

In an electrostatographic copying machine in which a developed image on the surface of a reproducing member is transferred to a transfer sheet in contact with said image, a device is provided for detecting the undesired continued presence of the transfer sheet on the reproducing surface after the image has been transferred, said device including a power source for providing a current flow between an electrode and the reproducing surface at a point beyond the image transfer area and a switching circuit coupled to the electrode and power source for indicating a change in the current flow caused by the presence of the transfer sheet between the electrode and the surface, thereby indicating continued contact of the transfer sheet with the reproducing surface. The electrode is part of a corona discharge unit constructed so as to employ an AC potential source for activation. The switching circuit can be used to discontinue the operation of the machine.

5 Claims, 5 Drawing Figures



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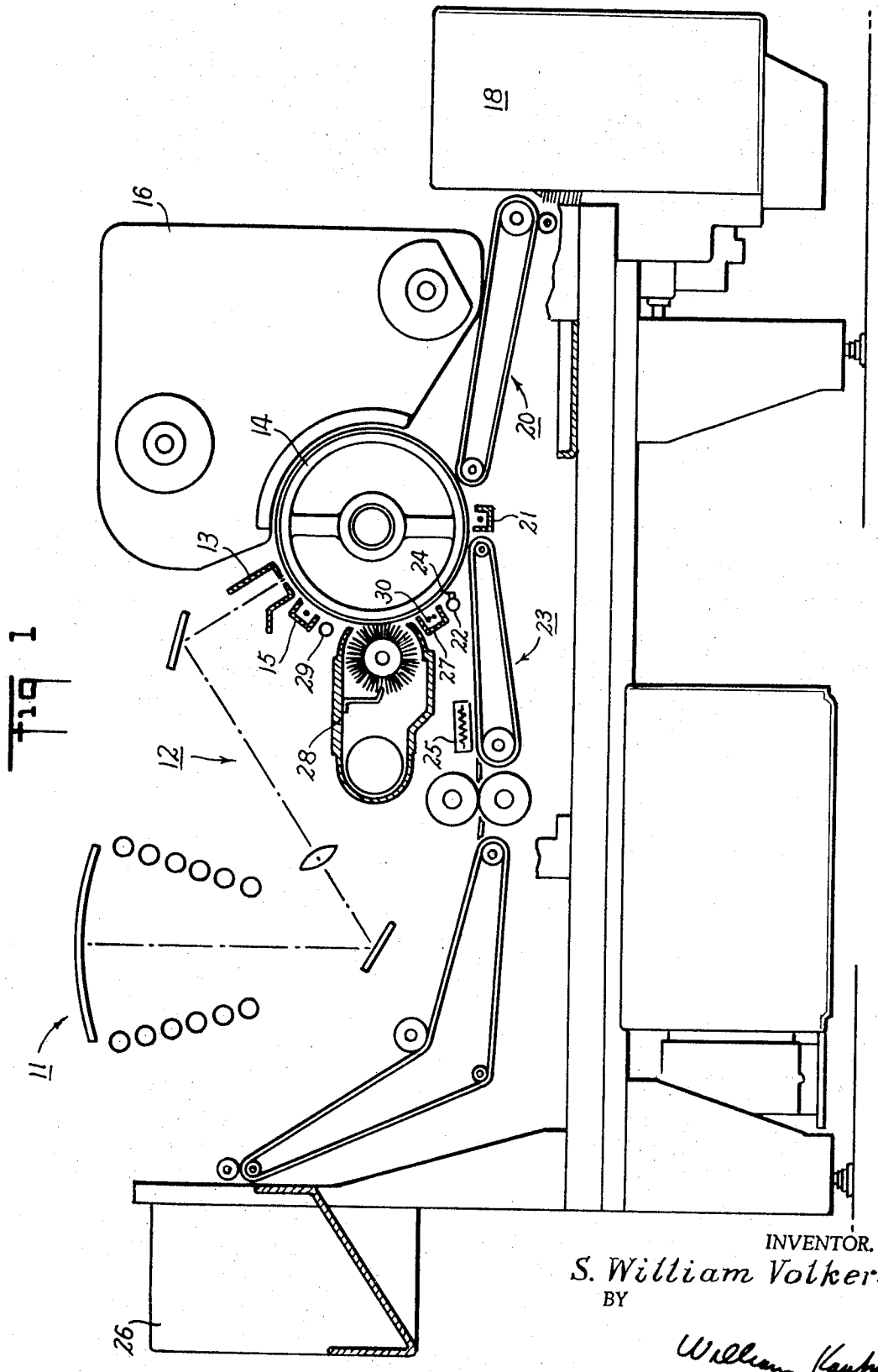


Fig 1

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Fig 2

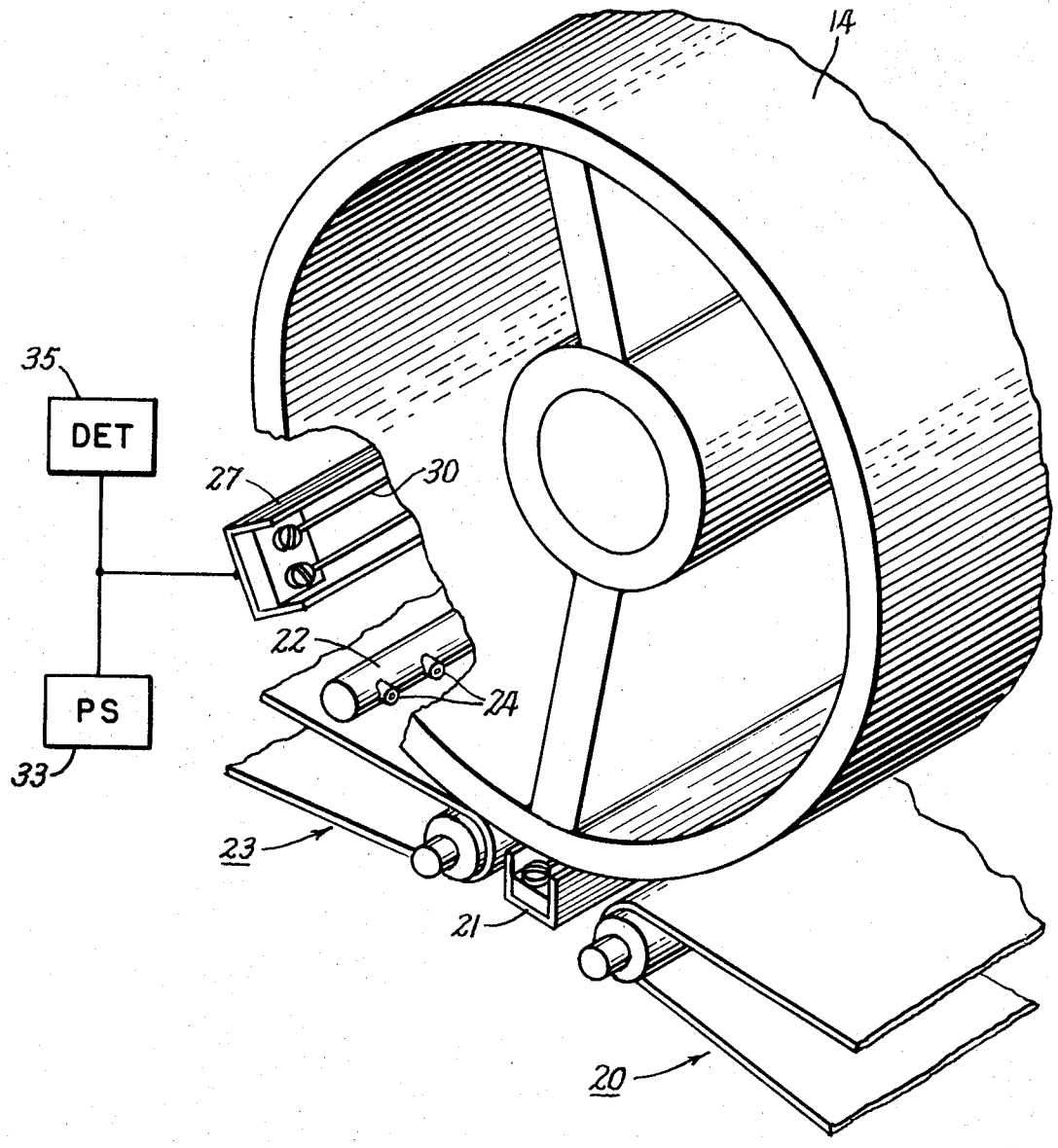


Fig 3

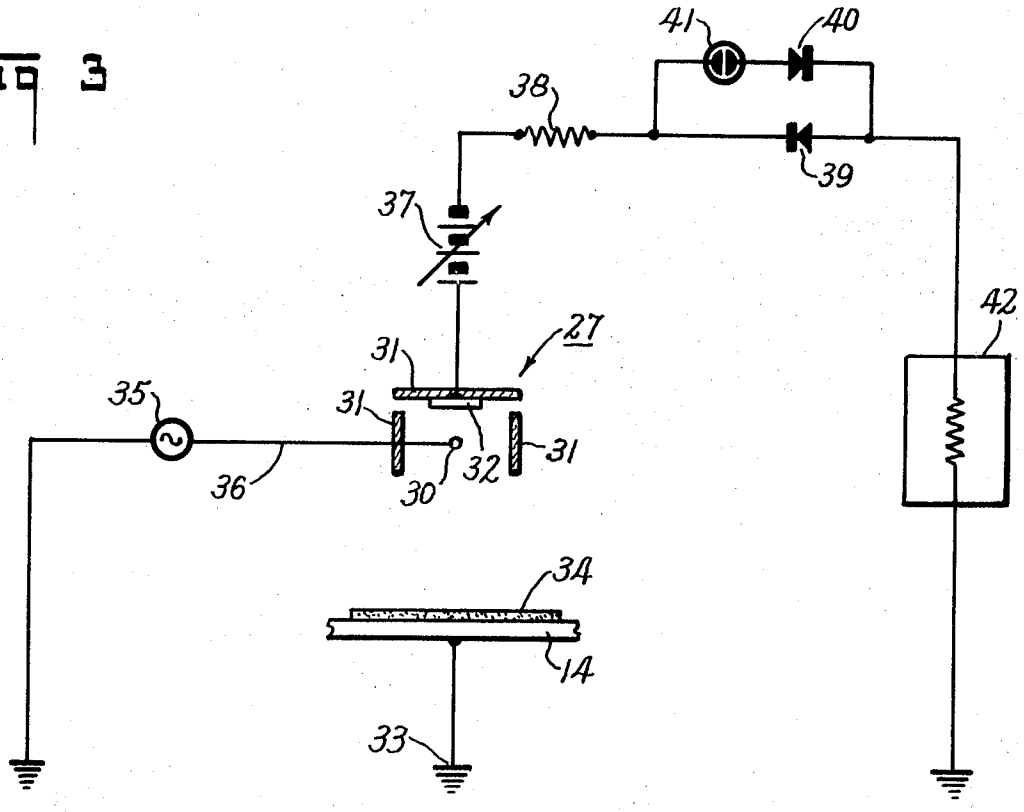


Fig 4A

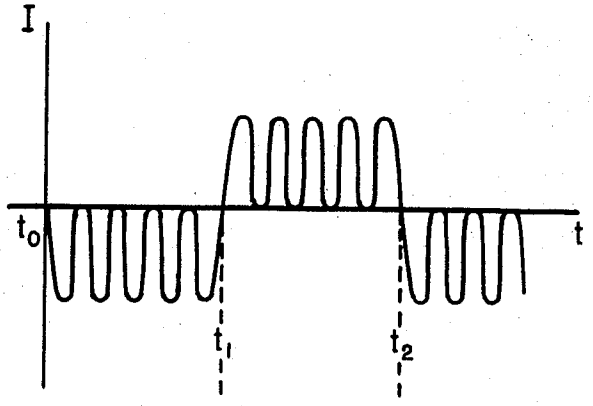
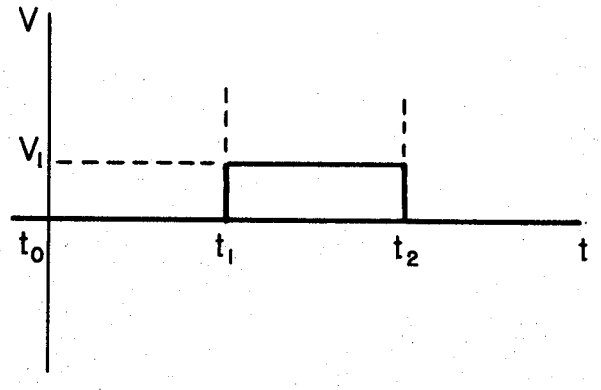


Fig 4B



SWITCHING DETECTOR

This invention relates to electrostatographic reproduction and more particularly to electrostatographic reproducing apparatus adapted to automatically detect any malfunction preventing timely removal of the transfer material from the surface of the reproducing member, hereinafter referred to as the reproducing surface.

The formation and development of images employing photoconductive materials by electrostatic means is well known. The basic electrostatographic process, as taught by C. F. Carlson in U.S. Pat. No. 2,297,691, involves placing a uniform electrostatic charge on a photoconductive insulating layer, exposing the layer to a light-and-shadow image to dissipate the charge on the areas of the layer exposed to the light and developing the resulting electrostatic latent image by depositing on the image a finely divided electroscopic material referred to in the art as "toner." The toner will normally be attracted to those areas of the layer which retain a charge, thereby forming a toner image corresponding to the electrostatic latent image. This powder image may then be transferred to a receiving surface such as paper, and the insulating layer neutralized with an electrostatic charge application such as by a corona discharge. The transferred image may be subsequently permanently affixed to a support surface by heat. Instead of latent image formation by uniformly charging the photoconductive layer and then exposing the layer to a light-and-shadow image, one may form the latent image by other means such as directly charging the layer in image configuration. Any other suitable fixing means such as solvent or overcoating treatment may be substituted for the foregoing heat fixing step.

Similarly other methods are known for applying the electroscopic particles to the electrostatic latent image to be developed. Included within this group are the "cascade" development technique disclosed by E. N. Wise in U.S. Pat. No. 2,618,552; the "powder cloud" technique disclosed by C. F. Carlson in U.S. Pat. No. 2,221,776 and the "magnetic brush" process disclosed, for example, in U.S. Pat. No. 2,874,063.

A difficulty often encountered in apparatus embodying such electrostatographic processes is that jamming can be caused by failure of the transfer material to be timely removed from the photoconductive surface, after transfer of the image. One solution has been to employ photo detection devices positioned at a point on the reproducing surface immediately past the position at which the transfer material is removed. Failure of the transfer material to be timely removed is thus optically detected and an appropriate signal generated for disconnecting the mechanism from the power source to prevent jamming. A disadvantage of photo-optical devices, however, lies in their inherent unreliability in field use, their susceptibility to erroneous indications due to ambient light levels, their expense, and the inconvenience of adding additional components to the mechanism. Another solution utilizes mechanical fingers which contact the drum and position sense the presence or absence of improperly positioned transfer material. However, this method can result in fatigue and physical damage of the reproducing member due to finger contact. A proposed solution utilizes the corona preclean unit normally used to provide a neutralizing charge to the reproducing surface after images transfer to provide a current flow differential in response to failure of removal to energize a machine stop sequence or to otherwise be detected in appropriate circuitry. These solutions utilize the existing negative or positive corotron as the detecting unit. It is however also desirable to employ an AC corotron as the detector.

It is, therefore, a primary object of this invention to provide an improved means for detecting malfunction in a reproducing mechanism employing an AC corotron.

It is a further object of this invention to provide an arrangement for detecting malfunctions caused by jamming of transfer material in an electrostatographic device utilizing AC corotron components within the electrostatographic device.

It is a still further object of the invention to provide a non-contacting arrangement for detecting failure of transfer material to be timely removed from a reproducing surface, which arrangement is reliable in operation and relatively inexpensive.

The foregoing objects are accomplished by providing a current flow between an electrode of an AC corotron and the photoconductive surface at a position immediately past the point at which the transfer material is normally removed. The presence of transfer material on the reproducing surface will serve to alter the current flow between the electrode and the photoconductive surface. The electrode can be coupled to suitable electrical circuitry which will respond to the change in current flow level and thereby indicate the presence of transfer material past its point of proper removal. Such indication can be employed to disconnect the mechanism from its power source, and thus prevent jamming. In the electrostatographic device, the corona preclean unit may be constructed as an AC corotron unit and having a DC electrode coupled to a detection circuit for indicating current flow differential.

The foregoing objects and brief description of the invention as well as further objects will become more apparent from the following detailed description of a preferred embodiment, with reference to the appended drawings wherein:

FIG. **1** is a schematic view of an electrostatographic reproducing apparatus in elevation;

FIG. **2** is a partial isometric view of the transfer station and photoconductive surface showing the use of the present invention;

FIG. **3** is a schematic representation of a circuit and an AC corotron construction and for providing an indication of a change in current flow, caused by failure of removal of transfer material, in accordance with the invention; and

FIGS. **4A** and **4B** are wave form diagrams illustrating the operation of the invention with respect to time.

Referring now to FIG. **1**, a typical electrostatographic reproducing apparatus is shown.

For a general understanding of the processing system in which the present invention is incorporated, reference is had to FIGS. **1** and **2** wherein like numerals refer to like components in which the various system components are schematically illustrated. In the electrostatographic system shown, a light image of copy to be reproduced is projected onto the charged surface of an electrostatographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged electroscopic developing material to form a powder image, corresponding to the latent image, on the plate surface. The powder image can then be electrostatically transferred to a web of suitable transfer material in sheet form to which it may be fused by a fusing device, whereby the powder image is caused permanently to adhere to said transfer sheet material.

In the system disclosed herein, documents to be reproduced are placed at the imaging station, generally designated by reference character **11**, which includes a light projecting system, for the purpose of scanning. The illuminated data is projected downwardly by means of a mirror-lens imaging assembly **12** and through a slit aperture assembly **13** and onto the reproducing surface of an electrostatographic plate in the form of a drum **14**.

The electrostatographic drum **14** includes a cylindrical member mounted in suitable bearings in the frame of the machine and is driven in a clockwise direction as viewed in FIG. **1** by a motor at a constant rate that is proportional to the scan rate whereby the peripheral rate of the drum surface is substantially identical to the rate of movement of the reflected light image. The drum surface comprises a layer of photoconductive material on a grounded conductive backing that is sensitized prior to exposure by means of a corona generating device **15**.

The exposure of the drum surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the drum a latent electrostatic

image in image configuration corresponding to the light image projected. As the drum surface continues its movement, the electrostatic latent image passes through a developing station in which there is positioned a developer apparatus including a housing **16** for developing material. A suitable driving means is used to carry the developing material to the upper part of the developer housing where it is cascaded down over a hopper chute onto the electrostatographic image on the drum.

As the developing material is cascaded over the electrostatographic drum, toner particles are pulled away from the carrier component of the developing material and deposited on the drum to form powder images, while the partially denuded carrier particles pass off the drum into the developer housing sump.

Positioned next and adjacent to the developing station in a clockwise direction is an image transfer station which includes a sheet feeding mechanism adapted to feed sheets successively to the developed image on the drum at the transfer station. This sheet feeding mechanism, generally designated **18**, includes a sheet source for a plurality of sheets of a suitable transfer material that is typically, sheets of paper or the like, a separating roller adapted to feed the top sheet of the stack to feed belt and rollers **20** which direct the sheet material into contact with the rotating drum at a speed preferably slightly in excess of the rate of travel of the surface of the drum in coordination with the appearance of the developed image at the transfer station. In this manner, the sheet material is introduced between the feed rollers and is thereby brought into contact with the rotating drum at the correct time and position to register with the developed image. To effect proper registration of the sheet transfer material with the feed roller and to direct the sheet transfer material into contact with the drum, guides are positioned on opposite sides of the feed rollers.

The transfer of the powder image from the drum surface to the transfer material is effected by means of a corona transfer device **21** that is located at or immediately after the point of contact between the transfer material and the rotating drum. The corona transfer device **21** is substantially similar to the corona discharge device **15** in that it includes an array of one or more corona discharge electrodes that are energized from a suitable high potential source and extend transversely across the drum surface and are substantially enclosed within a shielding member.

In operation, the electrostatic field created by the corona transfer device is effective to tack the transfer material electrostatically to the drum surface, thus causing the transfer material to move synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract a significant portion of the toner particles, forming the powder image, from the drum surface and cause them to adhere electrostatically to the surface of the transfer material.

Immediately subsequent to the image transfer station is positioned a transfer material stripping apparatus or paper pickoff mechanism, generally designated **22**, for removing the transfer material from the drum surface. This device includes a plurality of small diameter, multiple outlet conduits **24** of a manifold that is supplied with pressurized aeriform fluid through the outlet conduits into contact with the surface of the drum slightly in advance of sheet material to strip the leading edge of the sheet material from the drum surface and to direct it onto a horizontal conveyor **23**. The sheet material is then carried to a fixing device in the form of a fuser assembly **25**, whereby the developed and transferred powder image on the sheet material is permanently fixed thereto.

After fusing, the finished copy is preferably discharged from the apparatus at a suitable point **26** for external collection, in a copy collector positioned at a convenient place for copy removal by the machine operator.

The next and final station in the device is a drum cleaning station having positioned therein a corona precleaning device **27**, to impose an electrostatic charge on the drum and residual power adherent thereto to more readily permit removal of residual or untransferred toner. To aid in effecting removal of the powder a drum cleaning device **28**, adapted to remove any powder remaining on the drum surface after transfer, is also provided as is a source of light **29** whereby the photoconductive drum is flooded with light to cause dissipation of any residual electrical charge remaining thereon.

In general, the electrostatic charging of the electrostatographic drum in preparation for the exposure step and the electrostatic charging of the support surface to effect transfer are accomplished by means of corona generating devices whereby electrostatic charge is applied to the respective surfaces. Although any one of a number of types of corona generating devices may be used, a corona charging device of the type disclosed in Vyverberg U.S. Pat. No. 2,836,725 is used for both the corona charging device **15**, the corona transfer device **21**, each of which is secured to suitable frame elements of the apparatus and connected to suitable power sources.

As will be evident from FIGS. **1** and **2**, the paper pickoff mechanism **22** is positioned just past the image transfer station. Failure of the burst or puff of aeriform fluid to dislodge the transfer material from the drum **14** at that point will result in jamming of the reproducing apparatus by the sheet material. Such failure is commonly referred to as a "miss-puff."

Detection of the miss-puff or failure to remove transfer material is accomplished in accordance with the present invention through use of the corona precleaning device **27**, in conjunction with the circuit as shown in FIG. **3**.

The principle of operation involves the discontinuity in the level flow of current from the corona precleaning device **27** caused by alteration of the flow of current between the corona device and the reproducing surface of the drum **14**. The disruption is that created by the miss-puff, i.e., the continued presence of the transfer material in contact with the drum surface.

Referring to FIG. **3**, an arrangement for detecting the current discontinuity is shown. Using like reference numerals to represent like components, FIG. **3** shows a corona precleaning device **27** constructed as an AC corotron with an AC electrode **30** and insulating shield walls **31** constructed of a suitable insulator such as a plastic or the like and provided with air vent spacing to permit the circulation of air therein, one wall having thereon a DC electrode **32**. The drum **14** is connected to an electrical reference point **33** illustrated as ground, and includes a suitable photoconductive surface layer **34**. The electrode **30** is coupled to a source of AC potential supply **35** by a supply line **36**. The DC electrode **32** is coupled by an adjustable DC bias source **37** to a current limiting resistance **38** and a detector including a two terminal unilateral conduction device such as a diode **39**, a further two terminal unilateral conduction device such as a diode **40** connected in series with a threshold ignition device such as a neon lamp **41**, the diode **40** and lamp **41** being connected in parallel with the diode **39**. The diodes **39** and **40** are oppositely poled with respect to each other, as shown in FIG. **3**. An output device or load **42** is connected between the detector and a reference point, and completes the circuit.

The AC potential source **35** provides the corona current flow through the electrode **30** to the surfaces **34** and **32**. The circuit coupled to the electrode **32** is biased by adjustment of the DC source **37** such that under normal operating conditions, that is the absence of a transfer sheet between the surface **34** and electrode **30**, the lamp **41** does not ignite. As shown in FIG. **4A**, the current flow I, as through the resistance **38** assumes a first condition between times t_0–t_1 which corresponds to normal operating conditions wherein no transfer material is present between the electrode **30** and the surface **34**. In this condition, the effect of the current flow between the electrodes **30** and **32** results in the fluctuating wave form shown in the t_0–t_1 zone of FIG. **4A**. The bias of the DC source **37** is such that the resulting current fluctuation through the electrodes **30** and **32** is insufficient to ignite lamp **41**. When transfer material appears beneath the electrode **30**, the cur-

rent direction reverses due to the increased flow between the electrodes **30** and **32**. The bias of DC source **37** is such that the reversed flow will not go negative during the miss-puff conditions. Thus, as shown in FIG. **4B**, the current flow effectively reverses and the wave forms swing positive between times t_1–t_2, the time of the duration of improper appearance of the transfer sheet between the electrodes. The reversal of current flow at t_2 will back bias diode **39**, building up the potential thereacross until sufficient potential is achieved to fire the neon lamp **41**. The lamp thus serves as a thresholding device for preventing noise or other spurious lower level pulses from passing through diode **40**. When the lamp **41** is triggered, the positive going wave forms will provide an indication of the condition of the drum surface. Since an overlap in voltage ranges between normal and miss-puff conditions exists, the lamp **41** provides a thresholding switch to insure that no conduction through the diode **40** will occur during normal conditions. Restoration of the normal condition after time t_2 will restore the circuit to its original state.

Obviously, margins can be increased by placing a further neon lamp or other thresholding device in series with the diode **39** to widen the overlap range permissible.

The output device **42** can be designated to respond to the positive going wave shapes between t_1–t_2 to provide a suitable output voltage pulse V_1 as shown in FIG. **4B** which can be employed to activate an automated stop sequence.

Other variations are obviously possible within the scope of the invention. For example, the lamp can be replaced by other means of thresholding such as a zener or breakdown diode. Further, other variations of connections between lamp and diodes accomplishing the same function are within the scope of this invention.

What is claimed is:

1. An electrostatographic reproducing apparatus comprising:

an electrostatographic surface adapted to have formed thereon a powder image for transfer to a transfer material applied to said surface, pickoff means for removing said transfer material from said surface after transfer of said image thereto; cleaning means positioned above said surface at a point beyond said pickoff means and including an AC electrode and a DC electrode, a source of AC potential coupled to said AC electrode for applying an electrostatic charge to said surface, and a device connected to said DC electrode for detecting failure of removal of said transfer material from said surface after transfer of said image to said material, said device including a source of DC potential and a detector, said detector responsive to provide a first condition in response to a first current flow between said DC and said AC electrode caused by the absence of transfer material at said position and a second condition in response to a second current flow between said DC and said AC electrode caused by the presence of transfer material at said position.

2. The combination of claim **1** wherein said second current flow is a reversal of said first current flow, and said detector includes means for distinguishing between said first and second current flows.

3. The combination of claim **1** wherein said cleaning means includes insulating shield walls surrounding said AC electrode, said DC electrode forming the interior of one of said walls, said walls being spaced to permit air to circulate therein.

4. The combination of claim **1** wherein said detector includes a first diode poled in a first direction and a second diode poled in the other direction, said second diode including an indicator means connected in series therewith, said second diode and indicator connected in parallel with said first diode, said parallel circuit being connected between an output means for sensing the condition of said detector and said source of DC potential.

5. An electrostatographic reproducing apparatus comprising an electrostatographic surface adapted to have formed thereon a powder image for transfer to a transfer material applied to said surface, pickoff means for removing said transfer material from said surface after transfer of said image thereto, cleaning means positioned above said surface at a point beyond said pickoff means, said cleaning means including an AC electrode and a DC electrode, said AC electrode surrounded by insulating walls with air venting spacing, a source of AC potential coupled to said AC electrode for applying an electrostatic charge to said surface, a source of DC potential having an adjustable valve coupled to said DC electrode, a detector coupled to said DC potential source, a utilization load coupled between said detector and a reference point, said detector including a first diode poled in the same direction as said DC potential source and connected between said utilization load and said DC potential source, a second diode poled in a direction opposite to said first diode and connected in series with a threshold ignition device, the series connection of said second diode and said threshold ignition device being connected in parallel with said first diode, said DC potential source being adjustable such that in the absence of transfer material between said cleaning means and said surface a first current flow insufficient to ignite said threshold device is provided in said utilization load, and in the presence of transfer material between said cleaning means and said surface a second current flow sufficient to ignite said threshold device is provided in said utilization load.

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