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3,496,352

SELF-CLEANING CORONA GENERATING APPARATUS

Filed June 5, 1967

2 Sheets-Sheet 1

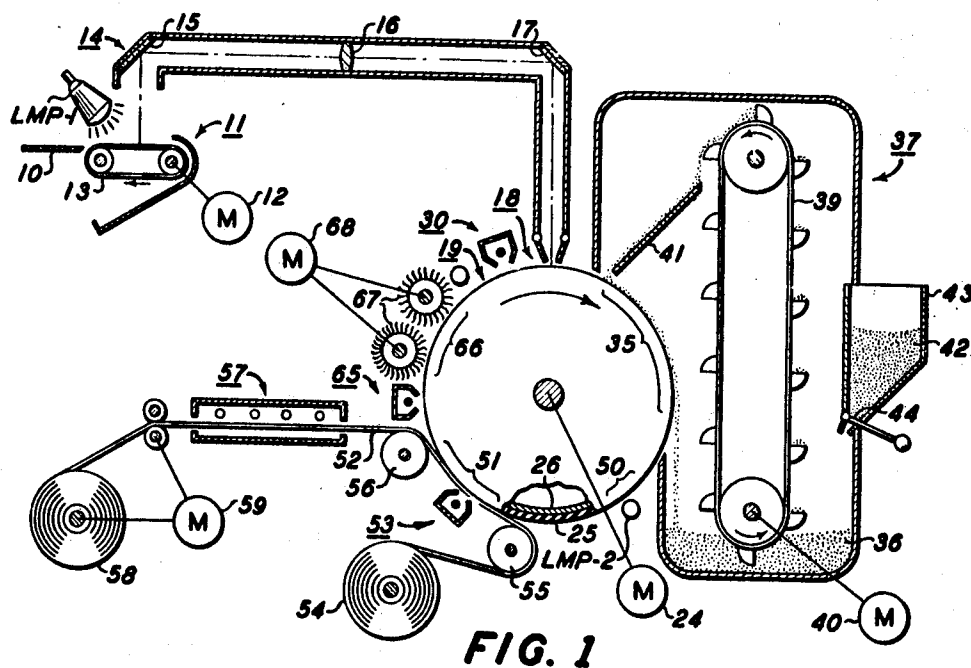


FIG. 1

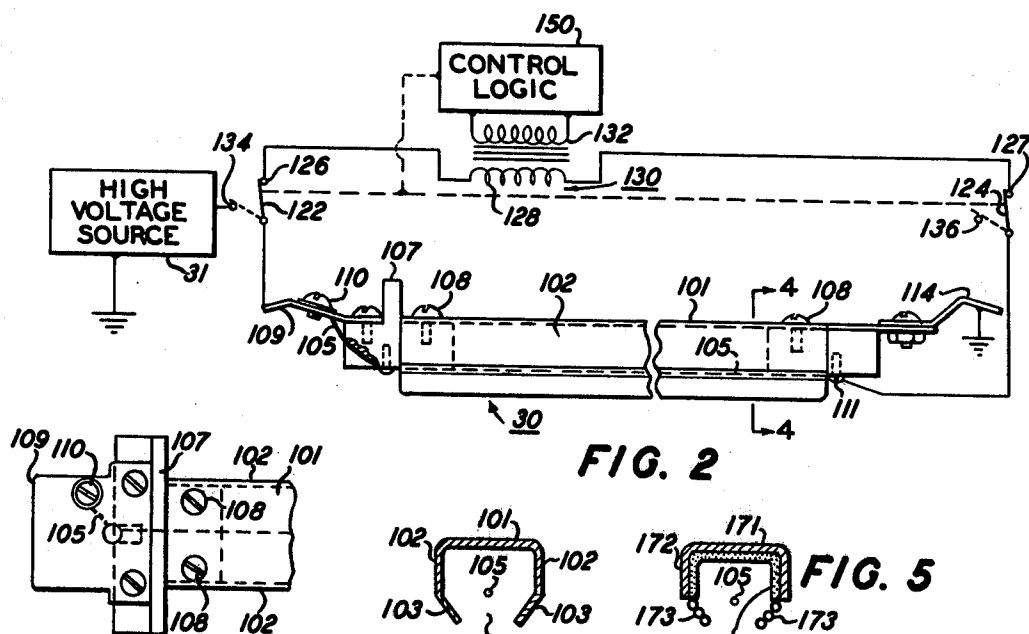


FIG. 2

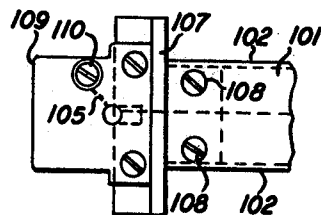


FIG. 3

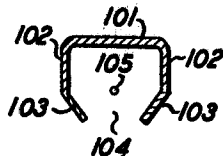


FIG. 4

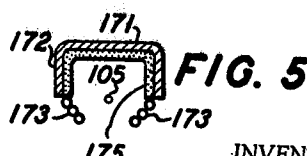


FIG. 5

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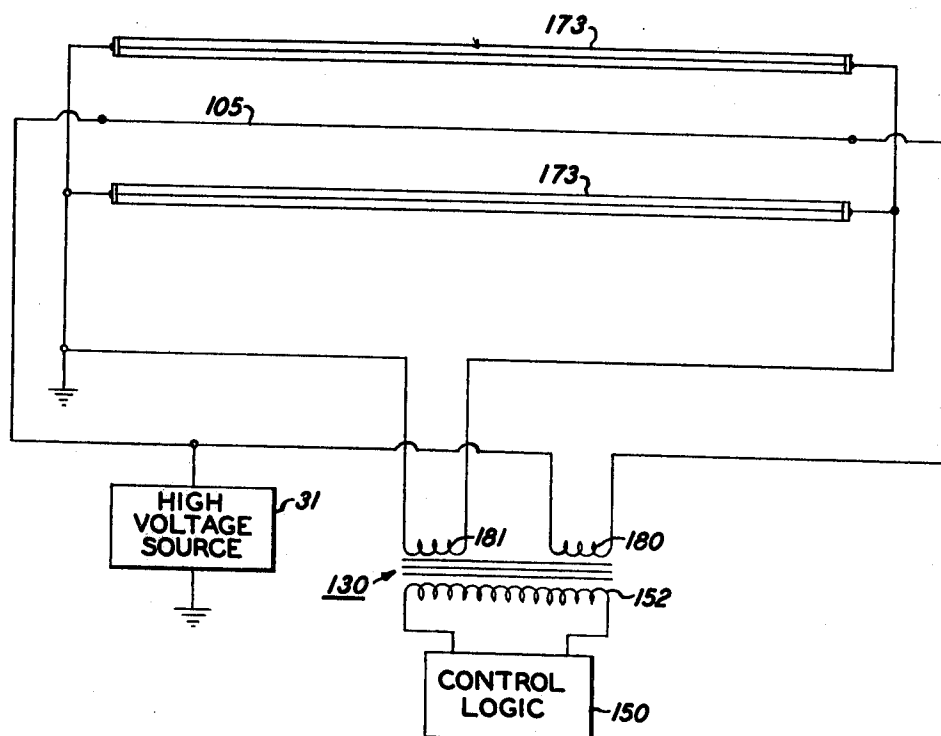


FIG. 6

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SELF-CLEANING CORONA GENERATING APPARATUS

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6 Claims

ABSTRACT OF THE DISCLOSURE

A self-cleaning corotron in which current is selectively flowed through the electrode wire to raise it to a temperature sufficient to vaporize and therefore clean away dust and stray electroscopic powder. In a second embodiment current is also selectively flowed through a portion of the housing adjacent the generating device to effect a combined cleaning action of the electrode and adjacent housing.

BACKGROUND OF THE INVENTION

This invention relates to xerography and particularly to improved corona generating apparatus for applying an electrostatic charge onto a recipient surface.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued Oct. 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate area in accordance with the radiation intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material such as an electroscopic powder that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

In automatic xerographic equipment, it is common to employ a xerographic plate in the form of a cylindrical drum which is continuously rotated through a cycle of sequential operations including charging, exposure, developing and transfer. During the cycle, copy is reproduced onto a support surface and after transfer, the plate is cleaned before reuse. It is usual to charge the xerographic plate with corona of positive polarity by means of a corona generating device having an electrode which when supplied with potential above the corona threshold produces an emission corona ions that deposit uniformly onto the plate surface. Typical of the corona generating devices employed heretofore are those described in U.S. Patent 2,777,957 to Walkup and U.S. Patent 2,836,725 to Vyverberg, each constructed generally of an electrode wire or wires supported relatively close to the surface to be charged. A grounded metallic shield generally surrounds the electrode except for an opening through which charge is emitted and is adapted to attract surplus emission emanating therefrom.

Inherent in xerographic apparatus of the type described above is the continuous presence of dust generated by the operations and generally comprising particulate quantities of stray electroscopic powder. With continuous operation, dust accumulates on and about the interior of

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the corona generating device to such an extent that the charging efficiency thereof decreases substantially as the density of dust accumulation increases. As a result there is a sharp drop-off in the quality of prints reproduced.

To ensure a high charging efficiency the corona generating device requires frequent cleaning and maintenance. For example, in order to maintain the entire apparatus operating effectively it has been necessary to clean the corona generating device completely after approximately several hundred reproductions and even sooner with machines operating at very high rates. Normally this necessitates removing the corona generating device from the machine and cleaning the entire assembly including wire and housing with a suitable cleaning solution. It goes without saying that this is a very time consuming operation not to mention the fact that the machine must remain idle during this period and thus can be of no benefit to the user.

With millions of copies being printed yearly, the costs of servicing represents a significant economic overhead. At the same time in order to ensure uninterrupted operation within a plausible programmed maintenance schedule, it has been found necessary to operate these corona generating devices at a potential substantially above the threshold potential to maintain the required potential for corona emissions. When it is considered that many copying machines have several corona generating devices, the problem of how to clean the devices without adversely affecting machine operation or requiring machine shutdown becomes increasingly apparent.

Now in accordance with the instant invention, there has been discovered a novel corona generating apparatus that is self-cleaning as to be capable of operating more efficiently than those used heretofore. Generally speaking the self-cleaning operation is accomplished by selectively flowing an electrical current through the generating device to raise it to a temperature sufficient to vaporize and therefore clean away dust or stray electroscopic powder. In a second embodiment current is also selectively flowed through a portion of the housing adjacent the generating device to effect a combined cleaning action resulting in a more efficient dissemination of corona discharge on the xerographic surface.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to improve corona generating devices for applying electrostatic charge onto a recipient surface.

It is another object of the invention to enhance performance and increase the operating efficiency of corona generating devices whereby a substantially greater proportion of total current is utilized effectively in applying charge onto a recipient surface.

It is a further object of the invention to provide a corona generating device which is self-cleaning resulting in a prolonged consistency of charging efficiency.

It is a still further object of the invention to operate automatic xerographic equipment more economically than heretofore.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and features of the invention will become apparent on reading the following description in connection with the drawings wherein:

FIG. 1 is a schematic illustration of an automatic xerographic apparatus for use with the corona generating apparatus of the invention;

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FIG. 2 is a side view of the corona generating device and circuitry according to the present invention;

FIG. 3 is a partial plan view of one end of the corona generating device of FIG. 2;

FIG. 4 is a sectional view taken substantially along the line 4—4 of FIG. 2;

FIG. 5 is a sectional view similar to that shown in FIG. 4 of a second embodiment of the corona generating device, and

FIG. 6 is an electrical circuit for use with the corona generating device shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For a general understanding of the xerographic processing system in which the invention is incorporated, reference is had to FIG. 1 in which the various system components are schematically illustrated. As in all xerographic systems based on the concept disclosed in the above-cited Carlson patent, a radiation light image of copy to be reproduced is projected onto the sensitized surface of a xerographic plate to form electrostatic image thereon. Thereafter, the latent image is usually 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 may be fused by any suitable form of fusing device, whereby the powder image is caused permanently to adhere to the support surface.

The xerographic apparatus described herein typically may be of the type described in Cerasani et al. U.S. Patent 3,076,392. In the apparatus referred to, copies to be reproduced, which usually are positive in form, are placed on a support tray 10 from which they are fed onto a suitable transport mechanism designated 11. Suitable drive means are provided for the transport mechanism from motor 12 to endless belts 13 whereby the copy is moved past the optical axis of projection system 14 and illuminated by projection lamp LMP-1. The image of the copy is reflected by mirror 15 through an objective lens 16 and then is reflected by mirror 17 downwardly through a variable slit aperture assembly 18 and onto the surface of the xerographic plate in the form of drum 19.

Xerographic drum 19 includes a cylindrical member mounted in suitable bearings in the frame of the machine and is driven in a clockwise direction by a motor 24 at a constant rate that is proportional to the transport rate of the copy, whereby the peripheral rate of the drum surface is identical to the rate of movement of the reflected light image. The drum surface comprises a layer of photoconductive material 25 such as vitreous selenium, on a conductive backing 26 such as aluminum. The photoconductive material is sensitized prior to exposure by means of a self-cleaning corona generating device 30 as will be described more fully below, and which is energized from a suitable high voltage source 31 (FIG. 2).

Exposure of the drum 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 from the copy. As the drum surface continues its movement, the electrostatic latent image passes through a developing station 35 at which a two-component developing material 36, which may be of the type disclosed in Walkup Patent U.S. 2,638,416, is cascaded over the drum surface by means of developing apparatus 37. In the developing apparatus, developing material is carried upward by conveyor 39 driven by suitable drive means from motor 40 and is released onto chute 41 wherefrom it is cascaded down over the drum surface. Toner component 42 of the developer, which is consumed in developing, is stored in dispenser 43 and is released in amounts controlled by gate 44.

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After developing, the xerographic powder image passes a discharge station 50 at which the drum surface is illuminated by a lamp LMP-2, whereby residual charges on the non-image areas of the drum surface are completely discharged. Thereafter, the powder image passes through an image transfer station 51 at which the powder image is electrostatically transferred to a support surface web 52 by means of a second corona generating device 53 similar to corona generator 30 as will be hereinafter described.

The support surface to which the powder image is transferred may be of any convenient type such as paper and is obtained from a supply roll 54 to pass over guide rolls 55 and 56 and over suitable tensioning rolls being directed into surface contact with the drum in the immediate vicinity of transfer corona generating device 53. After transfer, the support surface is separated from the drum and is guided through a suitable heat fusing apparatus 57 whereby the powder image is permanently affixed to the support surface. Thereafter, the support surface is fed over a further system of guide and tensioning rolls and onto a take-up roll 58 that is driven by motor 59.

Following separation of the support surface from the drum, a corona generating device 65, likewise constructed in accordance with the invention hereof as will be further described below, directs negative electrostatic charge to the residual powder image on the drum surface and simultaneously applies additional illumination for discharging residual charges thereon prior to being cleaned. The drum surface then passes through a cleaning station 66 at which the surface is brushed by cleaning brushes 67, rotated by a motor 68, whereby residual developing material remaining on the drum is removed. Suitable light traps are provided in the system to prevent any light rays from reaching the drum surface, other than the projected image, during the period of drum travel immediately prior to sensitization by corona generating device 30 until after the drum surface is completely passed through the developing station 35.

Referring now specifically to FIGS. 2, 3, and 4 in which like reference numerals refer to the same parts there is shown a self-cleaning corona generating device 30 constructed in accordance with a first embodiment of the invention. The device comprises conducting shield or housing 100 preferably made of aluminum or stainless steel. Shield 100 is of generally inverted U-shaped cross-section and includes a top wall 101 and side walls 102 in perpendicular relation to the top wall. Side walls 102 terminate in converging portions 103, each arranged at an angle of approximately 45° to its side wall 102 and spaced apart to afford a corona discharge opening or outlet 104 at the bottom approximately one-half inch in width.

A corona emitting wire 105 made from any suitable noncorrosive material, such as stainless steel or platinum is stretched between and attached to blocks 106 and 107 of suitable insulating material. Wire 105 has a uniform exterior and a diameter of approximately three and one-half thousandths of an inch. Advantageously wire 105 is located approximately seven-sixteenths of an inch from the top wall. It should be understood that this distance is typical and in no way limiting on the invention. Blocks 106 and 107 are arranged between side walls 102 at the ends of the shield and attached by means of suitable fastening screws 108 extending through top wall 101. Attached to insulating block 107 is a conductive plate 109 to which one end of wire 105 is connected at screw 110 as best shown in FIG. 3. The opposite end of wire 105 is attached to insulating block 106 by a conductive pin 111. A conductive plate 114 is secured to the shield 100 for the purpose of grounding it in any suitable manner.

In accordance with the invention electrode wire 105 is connected to circuitry supplying it with a high voltage

sufficient for the emission of corona charge onto a recipient surface and also with a small current flow at predetermined intervals for purposes of cleaning it. To this end wire 105 is coupled to high voltage source 31 which supplies a sufficiently high voltage to emit corona charge from the wire. It has been found that DC voltages ranging from 4000 to about 8000 volts works well with the corona generating device described above.

To clean dust from wire 105 a pair of double throw switches 122 and 124 are moved to contact terminals 126, 127, respectively, which are connected to secondary winding 128 of a transformer 130. The primary winding 132 of the transformer is selectively energized for a predetermined time period as will be explained more fully hereinafter. It should now be clear that when switches 122, 124 contact terminals 134, 136, respectively, the machine is in the corona generating mode. However, when the switches contact terminals 126, 127, as illustrated, a predetermined current is passed through wire 105 causing the temperature of the wire to rise sufficiently high to boil off or vaporize dust such as electroscopic marking particles normally depositing on the wire. It has been found that currents ranging from 0.4 to 0.9 amps for 10 to 30 seconds are sufficient to vaporize particles deposited. An optimum cleaning action occurs at .84 amps for 10 seconds for corona wires described above.

The frequency at which the wire is cleaned is controlled by logic 150 which is programmed to operate in any suitable manner such as after a prescribed number of cycles or time period. Another convenient manner for cleaning is to have logic 150 programmed to the warm-up period in the machine. In this manner cleaning is accomplished daily to ensure a high corona generating efficiency. It should be noted that logic 150 provides the required power input and controls energization time of primary winding 132 as well as relays for positioning double throw switches 122 and 124. Also it should be understood that logic 150 can be adapted to manual as well as automatic operation.

It has been found that by employing wires at the lip portions of the corona generating housing it is possible to clean away dust or dirt deposited on the housing in a manner similar to that described. The embodiment illustrated in FIGS. 5, 6 is intended for this purpose. The housing comprises a conducting shield having top wall 171 and side walls 172. Extending at an angle of about 45° from side walls 172 are one or more wires 173 which define a slit opening through which charge is deposited on the xerographic plate. By passing a current through wires 173 at the same time current is passed through wire 105 as described above a combined cleaning action of the corona wire and housing closely adjacent the plate where dust and dirt are most prevalent is effected. An insulating layer 175 made of any suitable material, such as Teflon, is arranged on the interior of walls 171, 172 for the purpose of suppressing upwardly directed corona emissions from wire 105 and further to insulate the housing from wires 173. It should be noted that wires 173 are supported at their extremities by suitable insulating blocks not shown.

The embodiment of FIG. 6 utilizes a filament-type transformer as is known by those skilled in the art. With this type transformer the windings are heavily insulated making it possible to couple high voltage source 31 directly to corotron wire 105. In this case, transformer 130 has two secondary windings 180, 181 for cleaning corona wire 105 and housing wires 173, respectively. It should be noted that wires 173, which form the lip portions of the corona generating housing, are electrically in parallel so that if they should touch no arcing occurs since they are all at the same potential along their longitudinal extent.

By the above description, there has been disclosed a novel corona generating apparatus having a high current efficiency by virtue of its capability of operating insen-

sitively to dust accumulation by electroscopic particles as has occurred heretofore. With the cleaning arrangement described above, the unit has been found to disseminate a greatly increased ion flow to the xerographic surface charged for an indefinite period. Moreover, because of the inherent ability to consistently maintain high efficiency, the unit is capable of being operated closer to the corona threshold. Furthermore in one embodiment current is selectively flowed through a portion of the housing to achieve a combined cleaning action.

Since many changes can be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Self-cleaning apparatus for applying a unipolar charge uniformly onto a chargeable member comprising a frame,

a pair of electrically non-conductive members secured to said frame in spaced apart relation along the longitudinal extent thereof,

a corona discharge electrode extending generally lengthwise between said non-conductive members, a terminal at which is connected a source of high potential sufficient to emit a corona discharge from said electrode when coupled thereto,

circuit means for connecting said terminal across said electrode and including current generating means actuatable in response to a discrete signal, and control means for emitting a signal to said current generating means at predetermined intervals to flow a current through said electrode for a time period sufficient to raise the temperature of said electrode to a level to vaporize substantially all particles deposited thereon.

2. Apparatus according to claim 1 wherein said circuit means include switching means movable from a first position in which said electrode is operative to emit corona charge to a second position in which said current generating means is operative to flow current through said electrode.

3. Apparatus according to claim 1 wherein said frame comprises a top wall and side walls, at least one resistance wire coextensive with each side wall and positioned inwardly at an angle thereto to define a narrow opening through which corona charge may be emitted, said resistance wires being coupled to said circuit means to receive the current from the current generating means in common with said electrode whereby particles deposited on said wires are vaporized simultaneously with the aforementioned particles deposited on said electrode.

4. Apparatus according to claim 3 wherein an electrically non-conductive layer overlies the interior surface of said walls.

5. Apparatus according to claim 1 wherein said current ranges from about .4 to about .9 amps for a time period of about 10 to about 30 seconds.

6. In a xerographic apparatus including a xerographic drum comprising a photoconductive layer on a conductive substrate, and drive means to continuously rotate said drum sequentially past a plurality of processing stations including a charging station and a development station at which electroscopic marking particles are applied to a latent electrostatic image on said photoconductive layer, corona generating apparatus for applying electrostatic charge uniformly onto the surface of said drum comprising in combination

a frame,

a pair of electrically non-conductive members secured to said frame in spaced apart relation along the longitudinal extent thereof,

a corona discharge electrode extending generally lengthwise between said non-conductive members,

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a terminal at which is connected a source of high potential sufficient to emit a corona discharge from said electrode when coupled thereto,
circuit means for connecting said terminal across said electrode and including current generating means 5 actuable in response to a discrete signal, and
control means for emitting a signal to said current generating means at predetermined intervals to flow a current through said electrode for a time period sufficient to raise the temperature of said electrode 10 to a level to vaporize substantially all electroscopic marking particles depositing thereon.

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