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Gaynor et al.

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[54] **ELECTROSTATIC CHARGING APPARATUS**

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[52] **U.S. Cl.** **317/262**

[51] **Int. Cl.** **G03g 15/02**

[58] **Field of Search** ..... 317/2, 3, 4, 262 A

[56] **References Cited**

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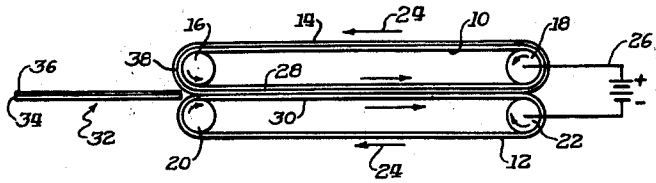
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[57] **ABSTRACT**

An apparatus for electrostatically charging a photoconductive sheet or web member comprising a pair of movable surfaces between which the member to be charged passes. The contact area between the two movable surfaces is of sufficient size to accommodate the entire photoconductive member, and an electric voltage is applied to the movable surfaces while the member is passing therebetween. At least one of the movable surfaces is coated with an insulating material.

9 Claims, 2 Drawing Figures



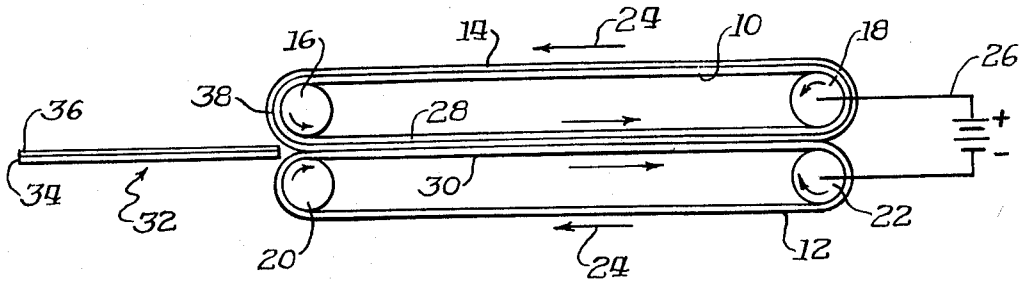

16
14
24
10
18
26
38
28
36
34
32
30
22
20
24
12
+
-

Fig.1.

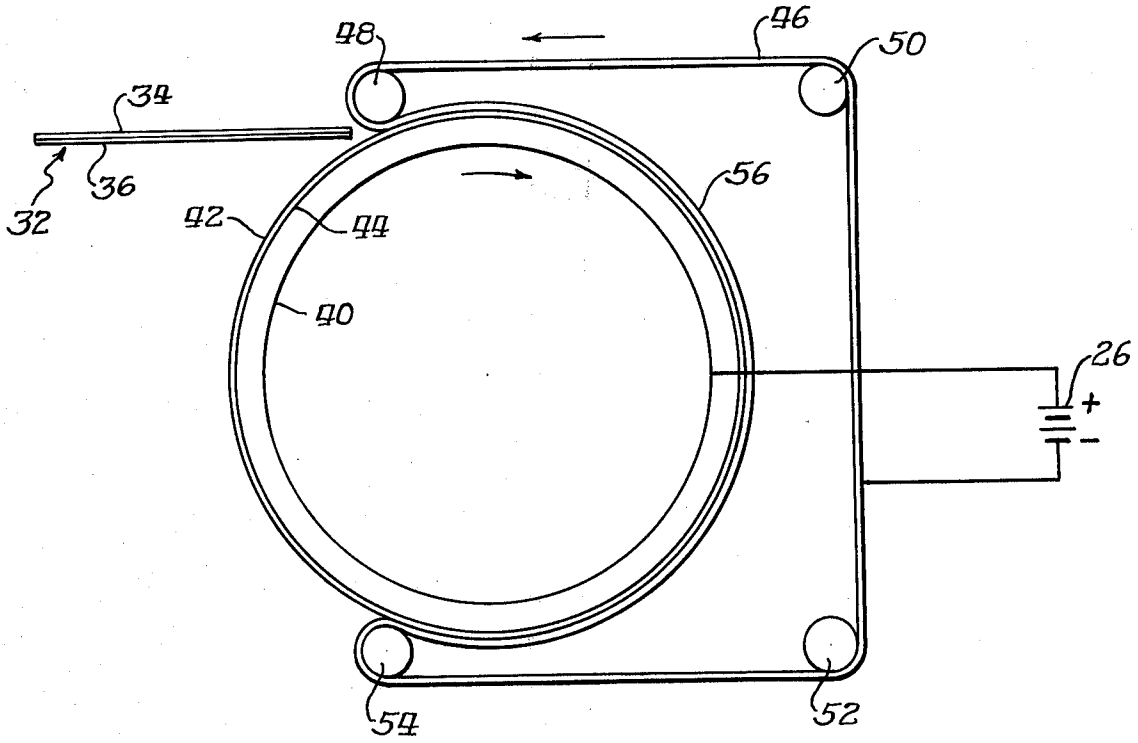

48
46
50
34
36
32
42
44
56
40
26
+
-
54
52

Fig.2.

ELECTROSTATIC CHARGING APPARATUS

The present invention relates to an apparatus for applying an electrostatic charge to a photoconductive member as usually found in electrostatic image transfer and reproduction systems. More specifically, it relates to an apparatus for charging or polarizing a photoconductive member by supplying sufficient contact area between the member and a properly electrically conductive surface.

In the electrophotographic arts, it is customary to form electrostatic images on photoconductive members by first imposing an electrostatic charge pattern on the surface of the photoconductive member and then exposing the precharged surface to a pattern of activated radiation, corresponding to a desired image, to selectively dissipate the charge in a manner consistent with the image transferred.

A variety of photoconductive members have become widely accepted for use in electrophotographic processes. It is known, for example, that suitable photoconductive members can be constructed from a web of foil or paper containing a lacquer coating of a photoconductive pigment, such as zinc oxide dispersed in a resin binder.

In any case, however, during the electrophotographic process, an electrostatic charge is imposed on the surface of the photoconductive member before the member is exposed to a radiation image. Consequently, to reduce production costs and to increase product efficiency, it is highly desirable that the photoconductive member which carries the electrostatic charge be charged in as short a time as possible, while ensuring that complete polarization is effected.

previous methods and apparatus for pre-charging a photoconductive member such as zinc oxide paper have included imposing approximately a 5K volt charge across a "sandwich" consisting of zinc oxide paper surrounded by polycarbonate or polyethylene terephthalate based polyesters in roll or magazine form. In this arrangement, the zinc oxide paper was observed to acquire a substantial charge after only rather short polarization times. However, this sandwich construction has proved to be rather cumbersome, since they must be partially disassembled in order to feed a sheet of zinc oxide paper. In addition, the amount of current needed for polarization was in the milli-amp range, which amounts to a relatively substantial power drain.

It is an object of the present invention to provide an apparatus for applying an electrostatic charge to a photoconductive member in a relatively shorter period of time than is possible using known devices.

It is an additional object of the present invention to provide an apparatus for applying an electrostatic charge to a photoconductive member with a minimum electrical power drain.

Still another object of the present invention is to provide an apparatus for providing sufficient surface contact area between a photoconductive member, an insulating material, and an electrical conductive element while applying an electrostatic charge to the photoconductive member.

Yet a further object of the present invention is to provide a sandwich type electrostatic charging device wherein only one outer element of the sandwich construction includes an insulating material.

In a first embodiment of the invention, a photoconductive member, such as a zinc oxide coated sheet, is passed between adjacent runs of a pair of endless conveyor belts providing a contact area at least as large as the photoconductive member itself. One of the belts is coated with an insulating material which is in full contact with the zinc oxide layer on the photoconductive member. An electric charge is applied across the conveyor belts, which is transferred to the photoconductive member.

In a second embodiment, a substantial portion of the periphery of a rotative drum having a conductive outer surface and covered with an insulating material comes into adjacent contact with a flexible conductive belt. The photoconductive element is adopted to pass between the belt and the insulating material on the drum, with the contact area between belt and drum being at least equal in area to that of the photoconductive element. With the element so located, an electric power source is connected between the drum and the conductive belt, and an electric charge is imposed on the photoconductive element.

Additional objectives and advantages of the present invention will become apparent from the following description of the embodiments of the invention, and with reference to the accompanying drawings in which:

FIG. 1 is a schematic-mechanical diagram of the two conductive conveyor belts and photoconductive element comprising the first embodiment of the invention; and

FIG. 2 is a schematic-mechanical diagram of the drum and belt configuration comprising the second embodiment of the present invention.

Referring first to FIG. 1, there is shown a first electrically conductive movable surface comprising conveyor belt **10**, and a second electrically conductive movable surface comprising conveyor belt **12**. In the preferred configuration of this embodiment, the outer surface of belt **10** is coated with a layer of insulating material **14** which may be either a polycarbonate or polyethylene terephthalate based polyester, known in the trade as "Mylar." If desirable, the outer surface of belt **12** may also be coated with a layer of insulating material **14**, although that configuration is not illustrated.

The conveyor belt **10** passes endlessly around a set of rollers **16, 18** which are composed of an electrically conductive material. Likewise, conveyor belt **12** passes endlessly around a set of electrically conductive rollers **20,22.** Suitable mechanical power means are connected to one or more of the rollers to drive the belts **10, 12** in the direction shown by arrows **24** in FIG. **1.** Also, a source of electrical voltage **26** is applied across one of the rollers **18,** which supports conveyor belt **10,** and roller **22,** which supports conveyor belt **12.** Inasmuch as the rollers **18** and **22,** and belts **10** and **12** are electrically conductive, an electrical circuit is formed between the adjacent runs **28, 30** of belts **10,12,** respectively, which runs are in intimate contact with each other with insulating material **14** extending therebetween.

The aforementioned structure is adapted to deposit an electrostatic charge on a photoconductive member such as web member **32** which comprises a substrate **34** supporting a photoconductive layer **36.** Photoconductive layer **36** may be composed of any suitable material capable of holding an electrostatic charge, such as, by way of example, zinc oxide. For proper utilization of

the present inventive concept, the width of conveyor belts **10, 12** is at least equal to the width of web member **32** to provide sufficient contact area between conveyor belts **10, 12,** and web member **32.**

To further insure proper electrical contact between conveyor belt **10** and insulating material **14,** an additional conductive coating **38** such as a film of evaporated aluminum is placed between the belt and the insulating material.

In operation, mechanical power is applied to one of rollers **16, 18** and to one of rollers **20, 22** to drive conveyor belts in the direction indicated by arrows **24.** As shown in FIG. **1,** the lower run **28** of belt **10** and the upper run **30** of belt **12** are in intimate contact with each other throughout their length and width. The layer of insulating material **14** covering belt **10** comes into direct contact with upper run **30** of belt **12.**

In the present invention, a sufficient contact area is provided between belts **10** and **12,** enabling the dynamic polarization (electrostatic charging) of web material **32,** which is coated with a photoconductive material such as zinc oxide, without the need for a complex roll or magazine sandwich structure. The web material **32** is fed into the nip created between rollers **16** and **20,** and is carried between conveyor belts **10** and **12** until it passes completely between rollers **18, 22.** Belts **10** and **12** have a mutual contacting area at least equal to the length of web material **32,** and the width of the contacting area is also at least equal to the width of the web material.

As the web material **32** passes between belts **10** and **12,** an electrical voltage in the range of 4–5K volt is applied across the belts through rollers **18, 22** and source **26.** As the web **32** passes between belts **10, 12** an electrostatic charge is deposited on the photoconductive layer **36** of the web.

Two methods of applying a charge to the web material **32** may be utilized in conjunction with the disclosed first embodiment of the invention. First, the sheet of web material **32** could already be in the charging apparatus between runs **28** and **30** of conveyor belts **10** and **12,** respectively, so that when the apparatus and the electrical voltage were turned on, the web material would be charged as it moved through the apparatus. For subsequent copies, additional sheets of web material **32** are fed into the nip formed by rollers **16** and **18** as required. In this way, a piece of web material **32** would always be left in the apparatus. By using this method, voltages measured on the surface of web material **32** are well within the range required to produce eminently satisfactory electrophotographic images and agree substantially with preconceived dynamic measurements. Currents drawn by the electrical power source **26** are in the microamp range, which represents a relatively small power drain for polarization apparatus of this type.

The second method of using this embodiment of the invention involves feeding a sheet of web material **32** into the nip of rollers **16** and **18** as required, and turning on the electrical voltage simultaneously to begin charging. Satisfactory results as described in connection with the first method of use were also found to be evident when the second method of operation was employed.

The second embodiment of the present invention is disclosed in FIG. **2,** and includes a rotatable drum **40** composed of an electrically conductive material. The drum is circumferentially covered with a layer of insulating material **42** which may be either a polycarbonate or polyethylene terephthalate based polyester, known in the trade as Mylar. Between drum **40** and insulating layer **42,** an additional coating of conductive material such as a film of evaporated aluminum is applied to enhance the electrical conductivity of the system.

An endless conductive flexible belt **46** passes over rollers **48, 50, 52,** and **54,** with a portion **56** of the belt in intimate contact with a substantial portion of the layer of insulating material **42** surrounding drum **40.** Belt **46** may or may not be insulated. The linear peripheral distance covered by the portion **56** of belt **46** is at least as long as the photoconductive web material **32** which is intended to be charged by the apparatus, and width of the drum **40** and belt **46** is sufficient to cover the entire width of web material **32.** Therefore, the area of contact between portion **56** of belt **46,** and drum **40** covers the entire surface area of sheet material **32.**

A source of electrical voltage **26** is applied between drum **40** and belt **46.** As web material **32** is fed between the nip formed between roller **48** and insulating layer **42,** it is held firmly between drum **40** and portion **56** of belt **46.** The potential difference between belt **46** and drum **40** causes an electrostatic charge to be applied to the surface of web material **32** in the manner described in connection with the operation of the embodiment disclosed in FIG. **1.** Sufficient contact is afforded between drum **40,** belt **46,** and web material **32** to perfect charging (or polarization) of the web material with a current drain in the microamp range.

Various other modifications and variations may be made to the disclosed apparatus without departing from the spirit and scope of the present invention. Therefore, the invention disclosed is not to be limited to the illustrated embodiments, except as defined by the appended claims:

What is claimed is:

1. An apparatus for electrostatically charging a photoconductive member having a photoconductive layer and a substrate carrying said layer including:

a first movable electrically conductive surface, a layer of insulating material applied to said first surface,

a second movable electrically conductive surface in intimate contact with a substantial portion of said layer of insulating material on said first movable surface,

said first surface and said layer of insulating material on said second surface contacting each other over a specified area,

said member being of a size substantially approximating the size of said area and adapted to pass between said layer of insulating material and said second movable surface in intimate contact therewith, whereby the whole of said member unitarily passes between said substantial portion of said insulating layer and said second movable surface, and

a source of electrical voltage connected across said first and second movable surfaces whereby the entire area of said member is electrostatically charged simultaneously as it passes between said movable surfaces.

2. The apparatus of claim **1** wherein said photoconductive layer on said member is zinc oxide.

3. The apparatus of claim **1** wherein said insulating material is selected from the group consisting of poly-

carbonate and polyethylene terephthalate based polyesters.

4. The apparatus of claim 3 wherein said second movable surface has a layer of insulating material applied thereto.

5. The apparatus of claim 4 wherein said insulating material applied to said second movable surface is selected from the group consisting of polycarbonate and polyethylene terephthalate based polyesters.

6. The apparatus of claim 1 wherein a conductive coating is disposed between said first movable surface and said layer of insulating material to assure satisfactory electrical contact between said first movable surface and said layer of insulating material.

7. The apparatus of claim 6 wherein said conductive coating is an evaporated aluminum film.

8. An apparatus for electrostatically charging a photoconductive member having a photoconductive layer and a substrate carrying said layer including:

a first conveyor belt having the property of electrical conductivity rotatively disposed around a first pair of rollers having at least one substantially linear run,

a layer of insulating material applied to said first conveyor belt having the property of electrical conductivity rotatively disposed around a second pair of rollers having at least one substantially linear run,

said substantially linear run of said first belt and said insulating material disposed in adjacent contact with said substantially linear run of said second belt over a specified area,

said photoconductive member being of a size substantially approximating the size of said area and adapted to pass between said substantially linear run of said insulating material and said second conveyor belt in intimate contact therewith,

a source of electrical voltage connected across said first and second conveyor belts whereby the entire area of said member is electrostatically charged simultaneously as it passes between said conveyor belts.

9. An apparatus for electrostatically charging a photoconductive member having a photoconductive layer and a substrate carrying said layer including:

rotatable drum means having an electrically conductive outer surface,

a layer of insulating material applied to said outer surface of said drum,

endless belt means having a portion thereof in intimate contact with a substantial portion of said layer of insulating material on said drum over specified area,

said member being of a size substantially approximating the size of said area and adapted to pass between said insulating material and said belt means in intimate contact therewith whereby the entire area of said member unitarily passes between said substantial portion of contact between said insulating material and said belt means, and

a source of electrical voltage connected across said drum means whereby the entire area of said member is electrostatically charged simultaneously as passes between said drum means and said belt means.

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