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PROCESS OF HANDLING A CHARGED WEB

Filed Sept. 13, 1968

FIG. 1

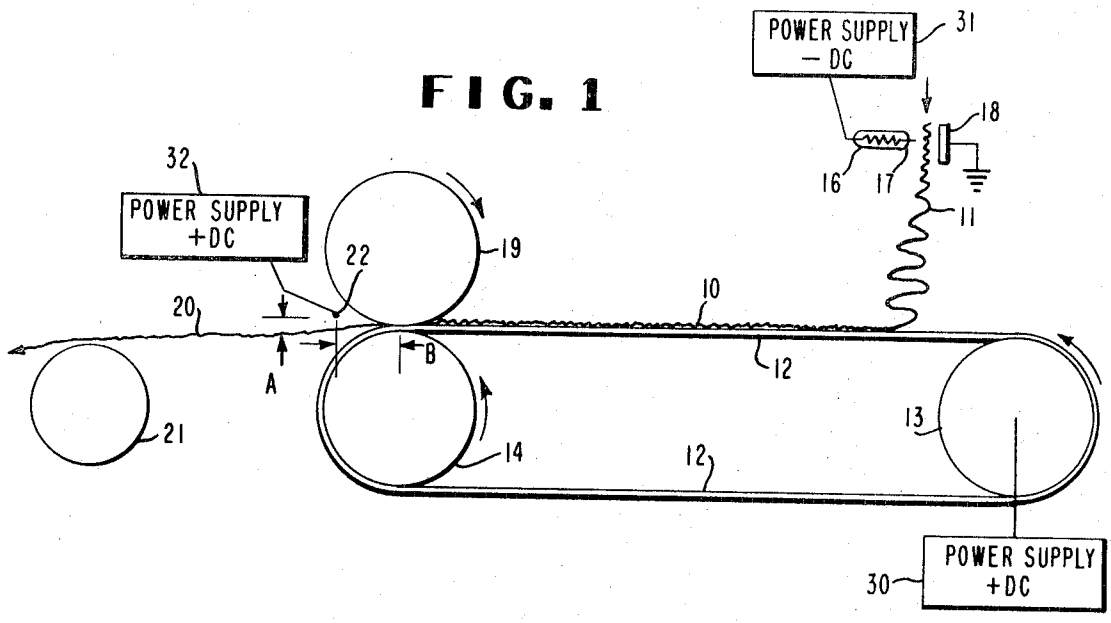
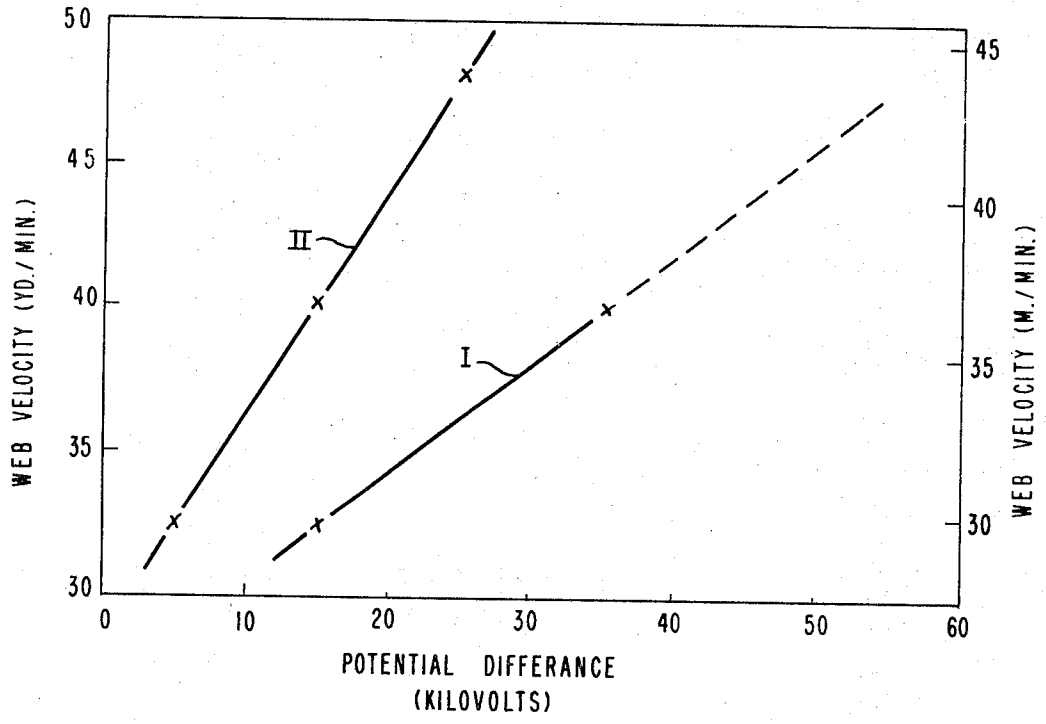


FIG. 2



INVENTOR

HARRY J. WHITE

BY Don M. Kerr

ATTORNEY

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PROCESS OF HANDLING A CHARGED WEB

Harry J. White, Portland, Oreg., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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U.S. Cl. 226—5 5 Claims

ABSTRACT OF THE DISCLOSURE

In separating a charged web of insulating material from an oppositely charged moving belt conveyor, lightning discharge between the conveyor and web occurs, resulting in burn holes in the web. This is prevented by locating a corona discharge device (e.g. wire) transversely of and above the web near the point of separation and applying to the device a potential of the same polarity as but 5 to 50 kilovolts greater than the belt potential.

BACKGROUND

This invention relates to a process for eliminating lightning discharge during separation of a charged web of insulating material from an oppositely charged moving conveyor of the web.

The elimination of lightning discharge during separation of oppositely charged bodies is a problem old in the art, and numerous devices have been introduced for dealing with this problem. Circumstances in which two bodies are held together by opposite electrostatic charges may develop accidentally during processing or may be generated intentionally in order to hold a web or a conveyor. In either event, separation of web and conveyor is usually necessary, and this is frequently accompanied by lightning discharge (i.e., instantaneous discharge of static electricity) between the web and conveyor. Such discharges can burn holes through the web or cause chemical changes which then or later become unsightly spots on the web.

Among the known devices for eliminating lightning discharge are self-inductors. Ordinarily, self-inductors are electrically conductive wires or brushes stretched across the width of the web oppositely from the conveyor near the point of separation of web and conveyor. Electrostatic potential on such devices has been provided through electrical connection to the conveyor. Sometimes, electrically conductive flexible strips (such as aluminum foil) are hung from such self-inductors to contact or nearly contact the web. The latter have the disadvantage for use with fibrous webs that they quickly become fouled by loose fibers and become ineffective. Also known are a variety of devices charged with alternating electric current.

The known devices are effective for preventing lightning discharge only when positioned within about 1 inch (2.5 cm.) of the location of separation of the web from the conveyor, at least for web-velocities in excess of 25 yd./min. (23 m./min.). Sometimes, however, the apparatus involved is so constructed that an eliminator cannot be positioned close enough. Such close spacing is also disadvantageous in that, with fibrous webs at least, there is a tendency for the wire to come into contact with the moving web, causing a serious hangup problem.

SUMMARY OF THE INVENTION

This invention is an improvement in the process which comprises conveying a web of electrically insulating material on a moving conveyor, holding the web to the conveyor electrostatically by providing a first electrostatic potential on the conveyor and a second electrostatic potential of opposite polarity on the web, and continuously

separating the web from the conveyor by conveying the web away from a fixed line where the separation commences. The improvement is the elimination of lightning discharge between the web and the conveyor during separation by:

(1) Positioning a corona discharge device transversely across the web and parallel to the fixed line such that

(a) the length of a perpendicular dropped from the device to the surface of the web is less than about 3 inches (7.62 cm.),

(b) the distance beyond the fixed line, along the web and in the direction of web-conveyance, to the intersection of the perpendicular of step 1(a) with the web is less than 10 inches (25.4 cm.),

(c) the web passes between the discharge device and the conveyor; and

(2) Applying to the discharge device a direct-current electric potential

(a) of the same polarity as the first electrostatic potential, and

(b) of a magnitude from 5 to 50 kilovolts greater than the first electrostatic potential and sufficient to generate corona discharge to the web.

The improvements of this invention are particularly advantageous for cases where apparatus geometry prevents locating a corona device close to the line where web and conveyor begin to separate and where web-velocities in excess of 25 yd./min. (23 m./min.) are employed. It was unanticipated that the simple step of separately charging the corona device to a DC potential of the same polarity as and 5 to 50 kilovolts higher than that of the conveyor would provide these advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows diagrammatically, in vertical side view, a process and apparatus to which this invention is particularly applicable.

FIG. 2 represents graphically the relationship between web-velocity and effective potential difference between a corona device and a conveyor, as described in Example 1.

DETAILED DESCRIPTION

The improvements of this invention are particularly useful for process and apparatus as represented by FIG. 1. This process is useful, for example, in preparing nonwoven sheets such as those described by Steuber in U.S. Pat. No. 3,169,899, which sheets are formed of continuous lengths of plexifilaments disposed in multidirectional, overlapping, and intersecting arrangement throughout the sheet and which plexifilaments comprise a three-dimensional integral plexus of synthetic organic, crystalline polymeric, fibrous elements each with a film-fibril structural configuration and a film-thickness of less than 4 microns.

With reference to FIG. 1, a fibrous material **11** from a source not shown is collected in suitably patterned manner on belt **12** (the conveyor) such as to form a continuous fibrous web **10**. Belt **12** is trained around drive-rolls **13** and **14** and driven thereby in the direction shown by arrows. Belt **12** and rolls **13**, **14**, **19**, and **21** extend transversely at least across the whole width of web **10**. A power supply **30** provides a positive DC potential to belt **12**. This is accomplished in this case by using electrically conductive materials for belt **12** and for rolls **13** and **14**, and by electrically connecting power supply **30** to roll **13**. Belt potential is ordinarily between about 15 and 50 kilovolts.

In passing toward belt **12**, fibrous material **11** goes through a gap between ion gun **16** and electrically conducting target plate **18**. Negative DC potential is supplied

by power supply **31** to ion gun **16** whereby corona discharge from discharge needles **17** to target plate **18** occurs. Fibrous material **11** becomes negatively charged in the gap, and is thereby attracted to and firmly held upon the oppositely charged belt **12**.

Web **10** is then conveyed continuously to and through the nip between consolidation roll **19** and belt **12**, continuing as self-coherent sheet **20** beyond this nip and over, for example, guide roll **21** to further processing. As is apparent from the figure, sheet (or web) **20** and belt **12** are separated mechanically beginning at the nip between consolidation roll **19** and belt **12**. Since the sheet **20** is composed of electrically insulating material, the top of the sheet remains at a negative potential. When the sheet **20** leaves the moving belt **12** the potential increases until an electrical discharge occurs between the sheet and belt, resulting in burn holes in the sheet.

According to this invention, lightning discharge is prevented by stretching a corona discharge device **22** transversely across sheet **20** and by charging it via separate power supply **32** to an electrostatic potential of the same polarity as that on belt **12** and of a mignitude from 5 to 50 kilovolts greater. Device **22** is positioned parallel to the surface of sheet **20** at a separation, A, of less than 3 inches (7.62 cm.) but preferably at least 1 inch (2.54 cm.), to prevent mechanical interaction with sheet **20**. The surprising observation is that dimension B, along the web from the fixed line where separation of sheet **20** and belt **12** commences to the sheet-location perpendicularly below device **22**, can be as great as 10 inches (25.4 cm.), while effective elimination of lightning discharge is maintained. When a consolidation roll **19** is employed, the perpendicular distance from device **22** to the surface of roll **19** is ordinarily made about the same as dimension A.

A suitable corona discharge device **22** is generally a wire. It may be provided with a continuous sharp edge or with spaced needle-like projections directed toward the fixed line where separation of web and conveyor commences. Wires of round cross-section are suitable, however, and are therefore preferred. They must be of small enough diameter to be stretched straight but large enough to remain unbroken when stretched. Diameters of 0.025 inch (0.064 cm.) or less are found effective. They are held in place by electrically insulating arms long enough to prevent undesirable discharge to surrounding metal parts. For long lengths of wire, supporting arms may be spaced along the wire. Frequently it is desirable to provide two or more wires within the specified locations and with the specified voltages. It is also desirable that the assembly supporting the wires be retractable from the operative position to prevent interference with sheet **20** during initial stages of sheet-production and to facilitate servicing.

Suitable webs for use in this invention can be either fibrous or non-fibrous. Fibrous webs include woven, knit, or non-woven sheets. Non-fibrous structures include continuous films and foils. In every case, the web is composed of electrically insulating material.

The above discussion in connection with FIG. 1 specifies positive DC potential for belt **12** and corona device **22** and negative potential for web **10**. This invention is not so limited, however, and applies equally to reversed polarities of all three potentials. The polarity of charge on web **10** must be opposite to that on belt **12**; the polarity of charge on corona device **22** must be the same as that on belt **12** and from 5 to 50 kilovolts greater.

While this invention is particularly applicable to those processes where consolidation roll **19** or any other component prevents very close access to the fixed line where separation of a web from its conveyor commences, it is also useful where the access is not limited. The application of a greater DC potential to corona device **22** than to conveyor **12** permits, in either event, greater spacing between device **22** and sheet **20** and/or operation at increased web-velocities.

The invention is in no way restricted to any particular means for generating charges of opposite polarity on the web and conveyor. FIG. 1 represents a preferred charging method for use in preparing spunbonded nonwoven sheets, but other charging means are well known to those skilled in the art.

Example I

A consolidated uniform web of polyethylene plexifilaments is prepared as shown in FIG. 1. The process is substantially as described in detail as Example II by Anderson & Romano in U.S. Pat. No. 3,227,794. The polyethylene employed is the high-density (i.e., "linear") type characterized by a melt-index of about 0.85 when measured according to ASTM–D1238–57T—Condition E. A homogeneous solution comprising 12.6 parts by weight of polyethylene in 87.4 parts of trichlorofluoromethane is prepared at 1640 p.s.i.g. (115.3 kg./cm.^{2} gauge) and 186±1° C. Just before flow through the extrusion orifice to form a plexifilament, pressure on the solution is reduced to 1050±12 p.s.i.g. (73.8 kg./cm.^{2} gauge). Each extrusion orifice is a cylindrical opening 0.030 inch (0.076 cm.) in diameter and 0.025 inch (0.064 cm.) in length. There are 22 orifices spaced laterally across the collection belt so that their machine direction centerlines are 4.1875 inches (10.636 cm.) apart. Each plexifilament is ejected horizontally against a vertical oscillating baffle which deflects it downward and oscillates it side to side at a frequency of 70 cycles/sec. such that each plexifilament is collected on the belt over a swath width of about 20 inches (50.8 cm.). As the plexifilament travels downward to the belt, it passes through a 340±10 microampere negative corona current in the 0.625 inch (1.588 cm.) wide gap between the needle-tips of an ion gun and a target plate.

The belt on which the web of overlapping plexifilaments is collected is constructed of woven wire and is 168 inches (4.27 cm.) wide. A positive charge of about 15 kilovolts is maintained on the wire, the velocity of the belt being variable from 30 to 175 yd./min. (27.4 to 160.0 m./min.) to produce sheets weighing 2.7 to 0.5 oz./yd.^{2} (91.6 to 17.0 gm./m.^{2}). The belt-supporting rolls (**13** and **14** of FIG. 1) are 24 inches (61.0 cm.) in diameter and 180 inches (457.2 cm.) long. The consolidation roll (**19** of FIG. 1) has the same dimensions as the other rolls, but its outer surface is nonconductive, being a 1 inch (2.54 cm.) thick layer of synthetic rubber.

A 15 foot (4.57 meters) long wire 0.016 inch (0.41 mm.) in diameter **22** is positioned as shown in FIG. 1. Two positions in terms of dimensions A and B, as defined hereinbefore, are evaluated. One labeled position I in FIG. 2 has a maximum A of 3 inches (7.6 cm.) and maximum B of 10 inches (25.4 cm.). The position labeled II has the approximately minimum practicable A of 1 inch (2.54 cm.) and B of 7.0 inches (17.8 cm.).

With the wire electrically connected to the collection belt, in either of positions I and II, frequent lightning discharge between sheet **20** and belt **12** occurs, each one burning a spot or hole in the sheet. Moreover, electrostatic attraction between the belt and sheet, resisting their separation, causes the sheet to sag appreciably and occasionally to wind around roll **14** to disrupt continuity.

The disadvantages above mentioned can be eliminated if the potential on the wire **22** is increased well above that on the belt, with the same electrical polarity. FIG. 2 shows the magnitude of the minimum required potential difference as a function of web-velocity for each of the extreme positions I and II.

I claim:

1. In the process which comprises conveying a web of electrically insulating material on a moving conveyor, holding the web to the conveyor electrostatically by providing a first electrostatic potential on the conveyor and a second electrostatic potential of opposite polarity on the web, and continuously separating the web from the conveyor by conveying the web away from a fixed line where the separation commences, the improvement for

eliminating lightning discharge between the web and the conveyor during separation which comprises:

(1) positioning a corona discharge device transversely across the web and parallel to the fixed line such that

(a) length of a perpendicular dropped from the device to the surface of the web is less than about 3 inches (7.62 cm.),

(b) the distance between the fixed line, along the web and in the direction of web-conveyance, to the intersection of the perpendicular of step 1*a* with the web is less than 10 inches (25.4 cm.),

(c) the web passes between the discharge device and the conveyor; and

(2) applying to the discharge device a direct-current electric potential.

(a) of the same polarity as the first electrostatic potential, and

(b) of a magnitude from 5 to 50 kilovolts greater than the first electrostatic potential and sufficient to generate corona discharge to the web.

2. Improvement of claim 1 wherein the length of the perpendicular of step 1*a* is at least 1 inch (2.54 cm.).

3. The improvement of claim 2 wherein the web velocity is in excess of 25 yds./min. (23 m./min.).

4. Improvement of claim 3 wherein the web is a fibrous nonwoven web of organic polymeric material.

5. Improvement of claim 4 wherein the web is composed of continuous lengths of polyethylene plexifilaments disposed in multidirectional overlapping and intersecting arrangement.

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