Nov. 7, 1972 C. B. GIBBONS ET AL 3,702,258

WEB TREATMENT METHOD

Filed March 5, 1969 2 Sheets-Sheet 1

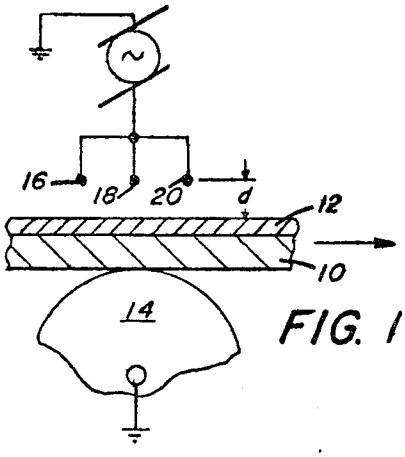

FIG. 1

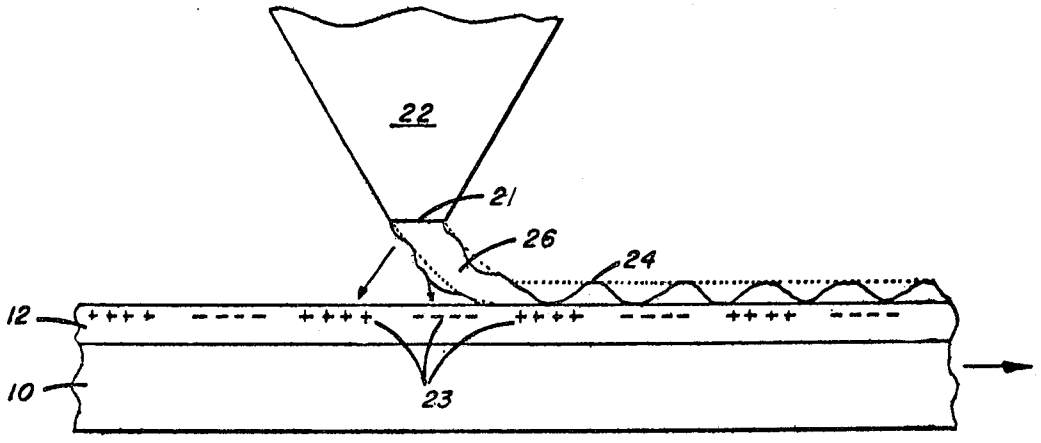

FIG. 2

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FIG. 3

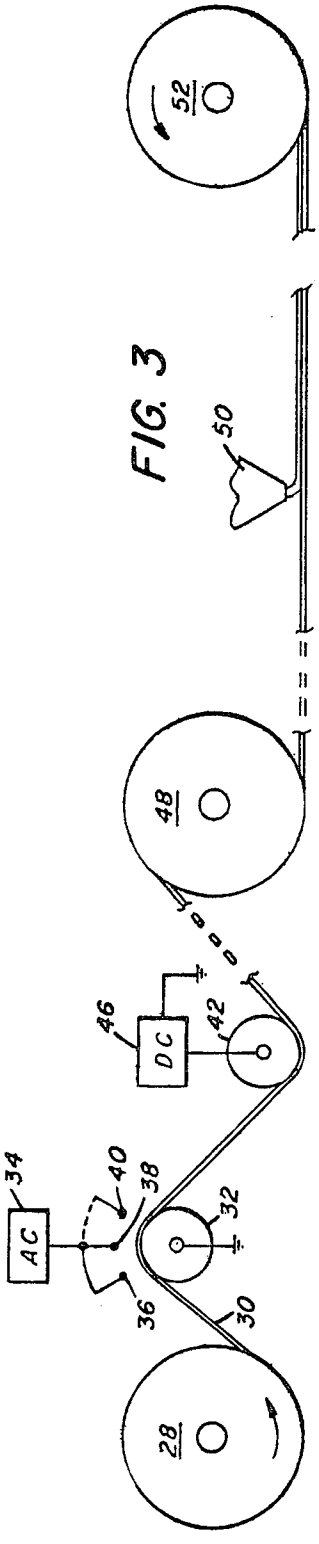


FIG. 4

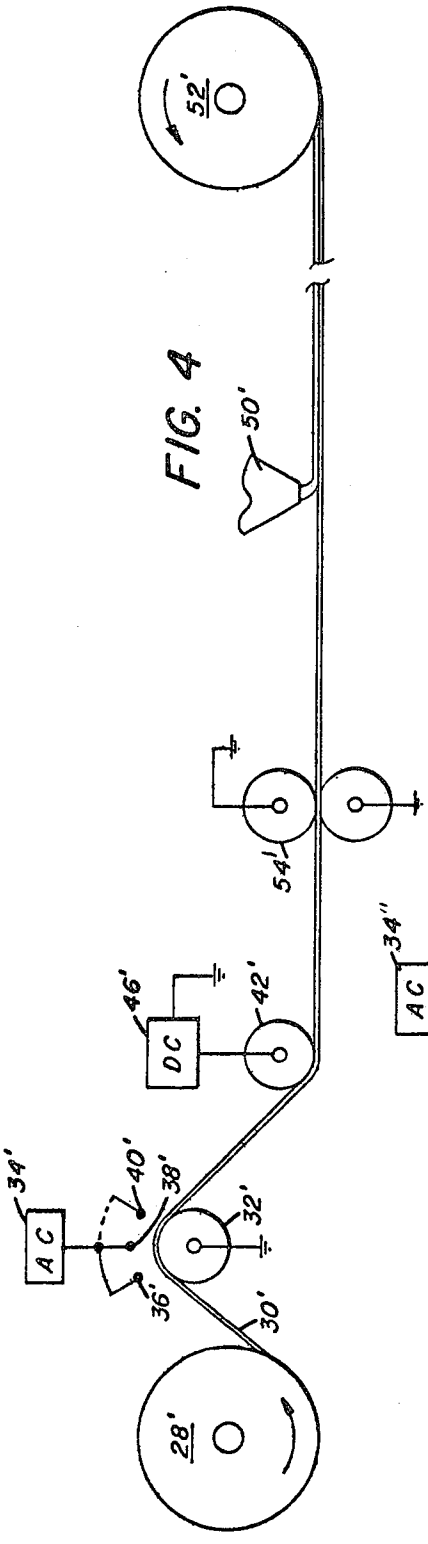
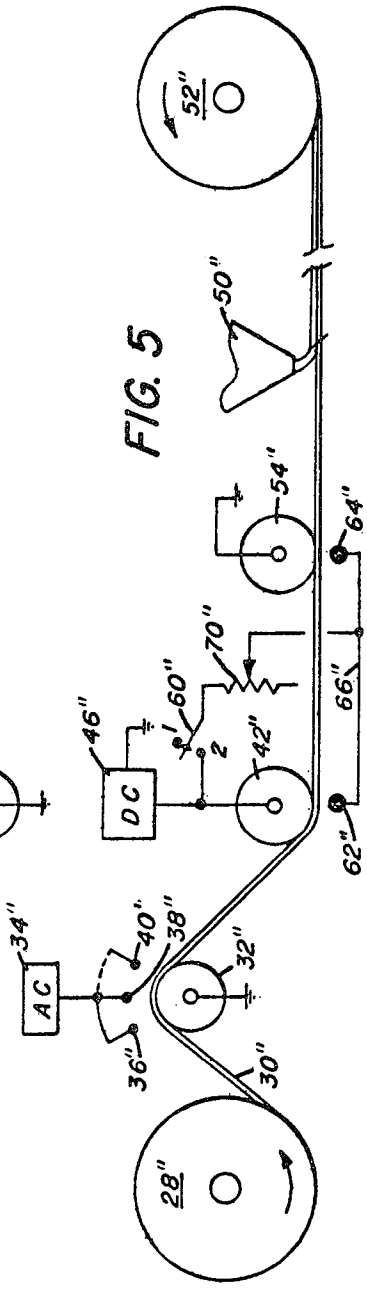


FIG. 5



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3,702,258

WEB TREATMENT METHOD

Carl B. Gibbons and William C. Kerr, Rochester, and Roger H. Maddocks, Hilton, N.Y., assignors to Eastman Kodak Company, Rochester, N.Y.

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U.S. Cl. 117—34 4 Claims

ABSTRACT OF THE DISCLOSURE

A web with a plastic surface is disclosed as being exposed to an A.C.-produced corona thereby to increase its printability and coatability. As a result of such treatment the web surface undesirably acquires patterns of charge. A circuit technique is disclosed for so erasing such charge patterns that the web surface is assuredly left substantially uncharged.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates in general to web handling apparatus and methods; and in particular the invention provides new and improved ways to assure proper adhesion of materials such as coatings to plastic surfaces; e.g. the surface of a plastic web; or the surface of a plastic coated web; etc.

(2) Description relative to the prior art

It is well known that the surfaces of synthetic plastics such as polyolefins (e.g. polyethylene, polypropylene and the like) and polyesters (e.g. polyethylene terephthalate) are naturally resistant to printing and other coatings; and that the corona-treatment of such surfaces will minimize such resistance. As is known, corona-treatment occurs when a corona glow exists from a corona-producing electrode to a surface being treated. The amount of corona-current which flows through a surface has a direct bearing on the adhesion quality of such surface; and for substantial current to flow through a surface, such current should be alternating—rather than direct—because direct currents are self-extinguishing, i.e. they merely charge up a surface.

As used herein alternating currents and voltages are any such currents and voltages which vary, such for example as sinusoidal and pulsating currents and voltages.

In corona-treating a web by means of alternating voltages, it is usual—though not necessary—to employ an array of treating electrodes, thereby to assure that the whole face of the web will be corona-treated. FIG. 1 indicates this expedient; and is presented at this point in the specification to facilitate an appreciation of the problems(s) which has been solved by means of the invention. FIG. 1 shows, in a partial side elevational view, a web **10** (e.g. paper) which is coated with a plastic **12** (e.g. polyethylene). The web **10** passes over a grounded roller **14**, and moves in the direction indicated. An array of electrodes **16, 18, 20** corona-treat the plastic coating **12** with an alternating voltage (e.g. about 16 kv., at a distance *d* of .02 inch); and such electrodes **16, 18, 20**

cooperate to assure that the whole face of the web is corona-treated.

To dissipate any corona-produced voltage which may be stored on the coating **12** of the web **10**, it had been considered to roll up the web, or to ground both sides of same. It was found however that rolling the web left it charged to about 250 volts; and grounding the web left it charged to about 700 volts. While stored voltages of such magnitudes could be handled in many instances, it was found that in coating such a corona-treated web, the coating took on a striped pattern, rather than be evenly distributed across the whole face of the web. A study was made to find out why the coating followed a particular pattern; and it was determined that the last of the electrodes **20** to corona-treat the web **10** not only charged the web in accordance with the aforementioned pattern, but often augmented such pattern by redistributing the charges placed on the web by the other electrodes **16, 18**. FIG. 2 is presented at this point in the specification to illustrate the effect of a charge pattern on a web which is to be coated. The corona-treated web **10** moves in the indicated direction past the mouth **21** of a coating hopper **22**. Ideally, the coating solution **26** should flow onto the web in the manner indicated by the dotted line **24**. However, because of the charge-pattern **23** produced by the electrode **20**, ions within the coating solution **26** realign in accordance with such charge-pattern, causing surface modulation of the coating solution **26** as it leaves the mouth **21** of the hopper **22**. The amplitude of such modulation increases as the coating solution **26** nears the web **10** and, attendantly, the coating solution **26** gets deposited on the web in accordance with the indicated charge pattern **23**.

SUMMARY OF THE INVENTION

It is the intent of the invention to apply a strong D.C. field to a web which has been corona-treated with an alternating voltage. Such a D.C. field does not corona-treat the web further; but serves merely to apply charges to those web areas which have little or no charge. That is, though a charge-producing D.C. corona glow may exist, the web is not again corona-treated because such D.C. corona glow does not extend to, and lick, the web. In other words, any charge pattern which might have appeared on the web prior to its being "D.C. flooded" gets lost within such "flood."

In many instances where the coating solution **26** is not a light-sensitive one, stored web voltages such as the above-mentioned 250 and 700 volts are not especially troublesome. When the coating solution **26** is light-sensitive, however, it is desirable to discharge the web prior to its reaching the coating hopper **22**, whereby arcing will not occur between the web and the coating solution **26**. One way to assure such discharge is—in accordance with the invention—to treat the web successively with equal D.C. fields, the first of one polarity and the second of the opposite polarity. While such a technique is useful, it has been found further that the best way to assure equal intensity D.C.-treatment of a web is to have such fields formed as part of the same series-arranged circuit: A strong direct voltage is applied from a source, e.g. by means of a roller, to one face of the web; a first electrode

disposed at the opposite face of the web sees such voltage, and such first electrode is electrically shorted to a second electrode. The second electrode is disposed closer to the hopper, but is on the same side of the web as the first electrode. Opposite the second electrode, and in contact with the web, e.g. by means of a roller, is the electrical return for the direct voltage source. With such an arrangement, whatever charges are applied to the web at one point thereof for charge-pattern canceling purposes are intrinsically removed from the web prior to coating thereof; and so, the web has virtually no charge at its coating point.

The above-described technique presupposes that the resistivity of the web and its plastic coat is greater than about 10 logohms per square centimeter, i.e. that virtually no direct current flows within and along the web, and that all current entering at the first D.C.-treatment point is returned to the source via the second D.C.-treatment point. For application of the invention with respect to webs with resistivities less than about 10 logohms per square centimeters, a variation(s) of the above-described series-disposed circuit is indicated.

An object of the invention is to provide improved apparatus and methods for treating plastic surfaces.

Another object of the invention is to provide an improved technique for removing charge patterns from a plastic surface.

Another object of the invention is to provide apparatus and methods for use in applying light-sensitive coatings to the plastic surfaces of webs.

The invention will be described with reference to FIGS. 3 through 5 of which

FIG. 3 is a diagram illustrating how corona-produced charge-patterns can be eliminated from a web, such web being so handled that it can fairly easily be coated with a light-sensitive solution,

FIG. 4 is a diagram similar to the diagram of FIG. 3 but indicating how a procedure thereof may be obviated if the web-coating concerned is not (especially) light-sensitive, and

FIG. 5 illustrates a presently preferred technique(s) for so removing corona-produced charge-patterns from a web that the web is left substantially uncharged, whereby the web may be directly coated with a light-sensitive solution.

The corresponding parts of FIGS. 3 through 5 are all similarly numbered, the part numbers of FIGS. 4 and 5 being, however, primed and double-primed respectively.

Reference should be had to FIG. 3: A stock roll **28** of polyethylene-coated paper web **30** is fed over an electrically grounded roller **32**. An alternating voltage is applied from a source **34** thereof to a plurality of electrodes **36, 38, 40**. Such electrodes are so disposed opposite the grounded roller **32** that substantial alternating currents may flow through, and thereby corona-treat, the web **30**. As indicated above, the electrode **40**, being the last to see any given point on the web, causes patterns of charges to appear and reside on the surface of the web **30**.

The web is passed over an electrically conductive roller **42**, to which a source **46** of direct voltage (approximately 9,000–15,000 volts) is connected. Such an expedient so deposits charges on the web **30** that the patterns thereof disappear (although by this expedient the web is left highly charged). To reduce appreciably such charge (say to about 250 volts, as indicated above), whereby the web **30** could fairly safely be coated with a light-sensitive coating, the web **30** is re-rolled (**48**); after which it is unrolled for coating by means of a hopper **50**; and again re-rolled (**52**) after coating.

To avoid the "re-roll and unroll" procedure of FIG. 3, the charged web **30'**, after it is exposed to the D.C. field at the roller **42'**, may be passed, as indicated in FIG. 4, between electrically grounded rollers **54'**, whereby a fair amount of charge is bled off the web **30'**. Such a practice, while solving one significant cost-consuming web handling problem, leaves the web fairly highly charged (about 700 volts as indicated above); and obviously such a web could not be coated with a light-sensitive solution very easily.

The method(s)/apparatus of FIG. 5 removes charge-patterns from a corona-treated web, without necessitating the "re-roll and unroll" procedure, and which method(s)/apparatus leaves the web substantially uncharged: FIG. 5 indicates a switch **60''** which, in its position **1**, provides the above features for webs of resistivities greater than about 10 logohms per square centimeter; for web resistivities less than about 10 logohms per square centimeter, the switch **60''** is placed in its position **2**.

In essence, the presently preferred application of the invention indicates the disposition of electrodes **62''** and **64''** (which may themselves be web rollers) opposite the charge and discharge rollers **42''** and **54''** respectively; and the electrical shorting of such electrodes by a lead **66''**. Thus, the charge-discharge circuit is turned into a series circuit, with the electrode **62''** being electrically as much of one polarity as the electrode **64''** is of an opposite polarity. Since the rollers **42''** and **54''** are connected electrically to the opposite terminals of the source **46''**, the charge which is added to the web **30''** by the roller **42''** is necessarily the same as the charge which is removed from the web **30''** by the roller **54''**.

For instances where the web **30''** is of a resistivity less than approximately 10 logohms per square centimeter, e.g. when such web **30''** is provided or formed with an antistatic agent or coating, some leakage current may flow from the source **46''** through the web **30''**, and back to the source **46''** without flowing via the electrodes **62''** and **64''**. If such were to occur, the charge applied to the web via the roller **42''** would probably be greater than that removed via the roller **54''**. To compensate for this charge differential, the invention suggests that the switch **60''** be closed (position **2**), whereby a compensation current—equal to the leakage current—may be applied through a current controlling rheostat **70''** to the electrode **64''**.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

What is claimed is:

1. In a method for removing non-uniform charge patterns on a polymeric surface of a web, at least one of whose surfaces have been subjected to an alternating current corona treatment, the method including the steps of:

(a) charging a first surface of the web uniformly to a relatively high potential with an electrode having a first direct potential, and

(b) reducing the relatively high potential on the first surface by thereafter exposing said first surface to a second electrode of opposite polarity to said first electrode,

the improvement of balancing the steps (a) and (b) so as to substantially eliminate the potential on said first surface, said improvement comprising the steps of:

(c) coupling said first and second electrodes to opposite poles of a single source of direct potential,

(d) depositing on a second surface of said web from a counter electrode means of said first electrode an equal amount of charge of opposite polarity to the charge applied in step (a),

(e) removing the charge deposited on the second surface by providing a counter electrode means of said second electrode, and

(f) electrically shorting the counter electrode means of said first and second electrodes so that for each charge of one polarity deposited on said second surface by the counter electrode means of said first electrode, a charge of opposite polarity is provided at the counter electrode means of said second electrode to remove such charge of said one polarity, whereby substantially all the charge applied to said first sur-

face by said first electrode may be removed by said second electrode.

2. The invention according to claim 1 wherein the web includes a relatively conductive layer, the process of charge removal being further balanced by coupling said counter electrode means through a resistor to said source.

3. The invention according to claim 1 wherein the counter electrode means is isolated relative to ground and one of said first and second electrodes is electrically grounded.

4. The invention according to claim 1 and including the step of depositing a light-sensitive coating on said web.

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WILLIAM D. MARTIN, Primary Examiner

W. R. TRENOR, Assistant Examiner

U.S. Cl. X.R.

117—47 A, 68, 76 F, 93. 1 CD; 118—11, 638; 204—168, 312