United States Patent

Whitmore, Jr. et al.

[15] **3,670,203**

[45] **June 13, 1972**

[54] METHOD OF AND APPARATUS FOR IMPARTING AN ELECTRICAL CHARGE TO A WEB OF FILM OR PAPER OR THE LIKE

[72] Inventors: **Thomas C. Whitmore, Jr.**, Rochester; **Robert G. Cunningham**, Pittsford, both of N.Y.

[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[22] Filed: **April 20, 1970**

[21] Appl. No.: **29,816**

[52] **U.S. Cl.**.....**317/2 R**, 317/262 A

[51] **Int. Cl.**.....**H05f 3/00**

[58] **Field of Search**.....317/262, 2; 18/1 FZ; 324/32; 250/49.5 TC, 49.5 GC; 118/620, 621

[56] **References Cited**

UNITED STATES PATENTS

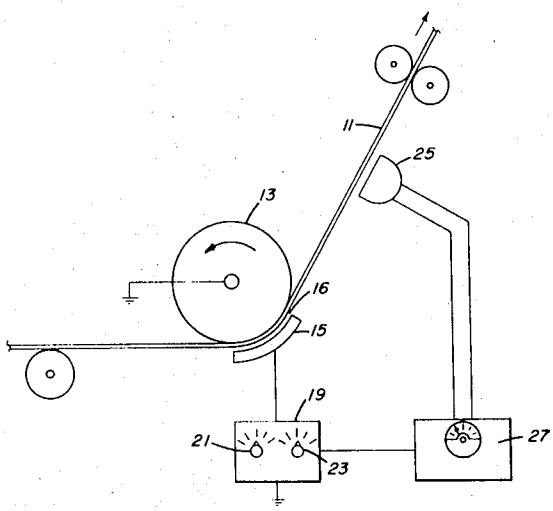
2,562,138	4/1950	Bump et al.	317/2 X
3,164,747	1/1965	Yahnke	317/2
3,396,917	8/1968	Carter	317/2 X
3,503,526	3/1970	Crafton	317/2 X
3,536,528	10/1970	De Geest	317/262 A
3,196,063	7/1965	Paquin et al.	317/262 A
2,879,396	3/1959	McDonald	317/262 A X
3,405,052	10/1968	Schirmer	250/49.5 X

Primary Examiner—L. T. Hix
Assistant Examiner—Harry E. Moose, Jr.
Attorney—Walter O. Hodsdon and Henry M. Chapin

[57] **ABSTRACT**

An electrical charge is applied to a moving web of flexible material such as film or paper by transporting the web over a grounded roller while maintaining a stationary electrically charged plate adjacent to the web but spaced slightly therefrom. A direct current voltage of the required sign and magnitude is applied to the plate from any suitable source such as a generator or battery. Alternatively the plate can be grounded and the voltage applied to the roller.

4 Claims, 2 Drawing Figures



PATENTED JUN 13 1972

3,670,203

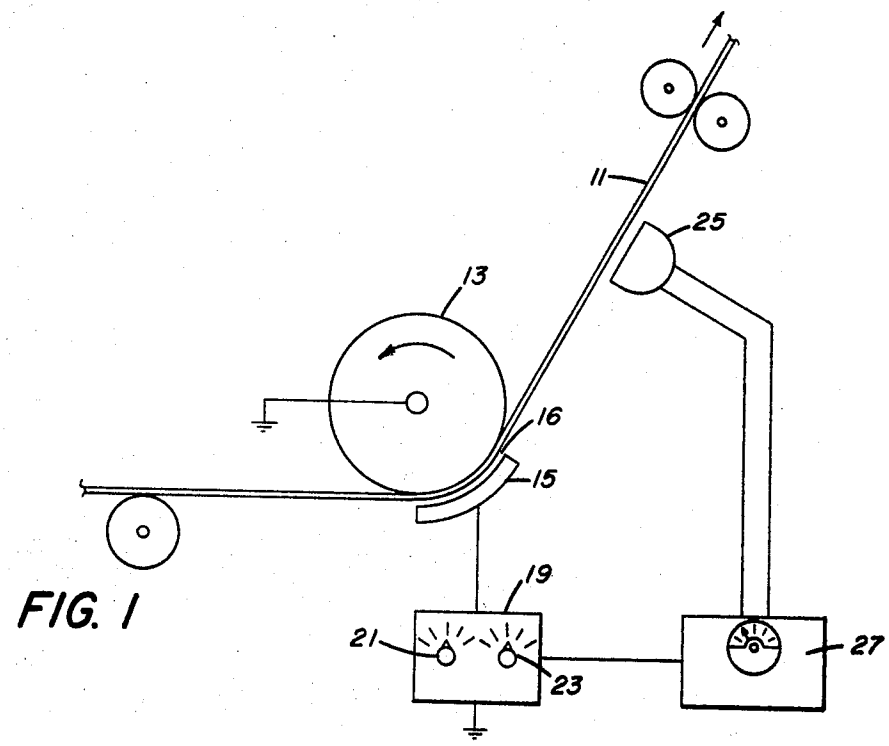


FIG. 1

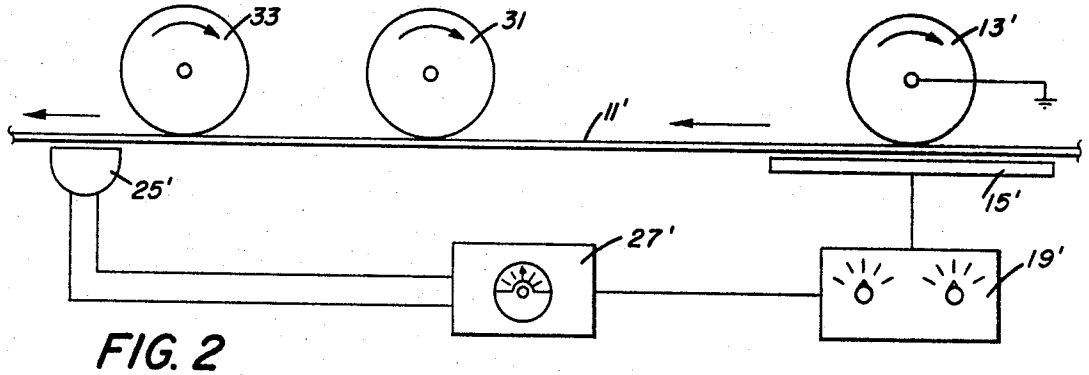


FIG. 2

THOMAS C. WHITMORE, JR.
ROBERT G. CUNNINGHAM
INVENTORS

BY Walter O. Hodsdon
Henry M. Chapin
ATTORNEYS

METHOD OF AND APPARATUS FOR IMPARTING AN ELECTRICAL CHARGE TO A WEB OF FILM OR PAPER OR THE LIKE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus for applying an electrical charge to a moving web of flexible material such as a continuous web of photographic paper or film.

In the manufacture of such webs, they are passed between and over rollers, or through other devices, which generate electrostatic charges on the moving webs. When such a charged web is brought near a grounded object, sparking may occur which will be harmful to the web. For example, if the web has already been coated with sensitized emulsions, the spark may cause localized exposure of the emulsion. Also, sparks occuring in a dark room will expose much more material than the immediate piece being operated on. Furthermore, when such sparks occur on subbed photographic webs which have not yet been coated with emulsion, they may burn the subbing layers so that the emulsion will not go on properly at a subsequent point in processing. Also, static electricity may be present in the form of islands of charge which will cause skips when the web is subsequently coated with emulsion. Static charges also may cause the attraction and accumulation of dust on the webs, which will be detrimental to quality.

2. The Prior Art

In British Pat. No. 976,027 there is described apparatus for applying a charge to a web by passing the web over a grounded roller while applying a voltage to the opposite side of the web through conductive bristles of nylon, brass, or the like which are in brushing engagement with the web. While this apparatus is operable, it has the disadvantage of possibly scratching the web, and of depositing particles from the bristles onto the web. Additionally, the bristles may attract and hold particles of dirt which may be deposited on the web. Another disadvantage is that if the web breaks or runs out, direct contact can occur between the bristles and the grounded roller, with the formation of sparks which are particularly detrimental when photographic film or paper is being processed in a darkroom.

In our pending U.S. Pat. application Ser. No. 3,434 which was filed Jan. 16, 1970, entitled "Method Of And Apparatus For Applying An Electrical Charge To A Moving Sheet Of Flexible Material," abandoned, and continuation-in-part application Ser. No. 91,342, filed Mar. 11, 1971, same title there is described apparatus for neutralizing a static electric charge, or for applying a desired charge, wherein a web passes between two connecting rollers, one of which is connected to ground and the other of which is connected to a source of direct current voltage for applying a charge of desired sign and magnitude to the web. The latter roller is preferably covered with a semi-conductive material which is sufficiently conductive for charge application, but which will not generate sparks if the two rollers come together when a web breaks or runs out. One of the covering materials for this roller is a plush fabric which has been treated with a surfactant to make it partially conductive. Our apparatus has proved to operate very effectively without scratching a web and without generating sparks. However, the plush fabric is apt to become contaminated with dust, or with other contaminants which may be imparted to the web. Such contamination is particularly disadvantageous when processing photographic film or paper through some steps in the production process, such as emulsion coating operations.

SUMMARY OF THE INVENTION

The problems set forth above are solved by our present method comprising applying an electrical charge to a moving web of a material such as photographic paper or film by transporting the web over a first electrically conductive body in the form of a rotating roller while maintaining adjacent to the web

on the side thereof opposite the roller a second electrically conductive body in the form of a plate or shoe which is spaced slightly from the surface of the web, such as between 1 and 15 millimeters therefrom.

One of the electrically conductive bodies is connected to ground and the other is connected to a source of a direct current voltage of sufficient magnitude to pass across the gap between the web and the second conductive member but without developing a corona discharge. The voltage should be of such magnitude and sign as to develop a desired electrical charge condition on the web, for example, neutral, or positively or negatively charged.

We have found it particularly desirable for an operator to determine the magnitude and sign of the static electrical charge on a web, and then to apply a voltage of the same sign and sufficient magnitude so as to neutralize the static charge, thus avoiding sparking when the web is subsequently brought near a grounded object.

In another mode of operation, a web can be precharged to a selected voltage by our method at one station in a production line, and subsequently, after intermediate processing steps, can again be treated by our method to neutralize the charge on the sheet which may or may not have picked up additional charge.

The apparatus for performing the method described above will be described in detail hereinafter.

THE DRAWINGS

In the Drawings:

FIG. 1 is a schematic side elevational view showing one form of apparatus for developing a desired electrical charge condition on a long continuous web of flexible material, such as photographic film or paper which is bent around a roller; and

FIG. 2 is a schematic side elevational view showing a modified form of apparatus for treating a web moving in a straight line.

THE PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, a long continuous web **11** of photographic film or paper is transported continuously in contact with an electrically conductive roller **13** which is connected to ground. An electrically conductive shoe or plate **15** of arcuate shape (coinciding with the curvature of the web **11** and the surface of roller **13**) and of sufficient width to extend across web **11**, is maintained in position on the opposite side of web **11** from roller **13** and is spaced slightly from the web to form a gap **16** which may vary from 1 to 15 millimeters so that the shoe is never in contact with the web. Shoe **15** and roller **13** can be made of an electrically conductive material such as brass or other metal; or may be made of a normally non-conductive material such as synthetic resin which has been made conductive by impregnation with a surfactant such as a sodium salt of an alkylaryl polyether sulfonate, or coated with a metal such as silver. A suitable variable power supply or source **19** of a direct current voltage is connected to the shoe **15** and is provided with voltage sign and magnitude adjusters **21** and **23** for applying the correct voltage to the shoe. Any source can be employed, such as batteries, or a D.C. generator, or a rectifier connected to an A.C. power line.

To reduce the charge on the web toward neutral, or to reverse the polarity of the charge, the voltage applied to the shoe **15** should have the same sign as the charge on the web; to increase charge on the web without changing its sign, the voltage applied to the shoe should have the opposite sign. (The change in potential on the web is of opposite sign to the potential applied to the shoe.)

While the correct voltage to apply can be empirically determined, we prefer to position an electrostatic field meter **25** adjacent to the web **11** after it has passed shoe **15**, so as to continuously measure or monitor the electrostatic field resulting from any electrical charge on the web, and to display it on a

meter 27. The operator observes the voltage and its sign on the meter 27, and adjusts the voltage supply 19 as needed so as to assure the correct charge and sign. An electrostatic field meter suitable for this purpose is described in the July, 1950 issue of the "Journal of the Society of Motion Picture and Television Engineers" in an article by H.W. Cleveland on pages 37–44 entitled, "A Method of Measuring Electrification of Motion Picture Film Applied to Cleaning Operations."

The charge which has built up on a web 11 of photographic material may be quite large, resulting in electrostatic potentials of anywhere from 100 to 50,000 volts. The charge may have a positive or negative sign, depending upon the nature of the web material, and of the rollers or other apparatus through or over which it has been passing. Thus, to neutralize, it is necessary to apply a voltage to the shoe of same sign as on the web by adjusting the variable power supply 19. The applied voltage to neutralize normally is about the same or greater than the potential on the web if the spacing is 1 mm or more between the shoe and the web. The magnitude of the voltage applied depends upon the desired charge on the web, and can be varied as desired. Anywhere between 10 volts and as high as 10,000 or even 30,000 volts may be applied as needed.

The types of web materials that can be treated by the invention are many and varied, such as cellulose triacetate film base or poly(ethylene terephthalate) film base or other polyester film bases, which may or may not have been coated with sensitized emulsions, subbing layers, or antihalation backing layers. Other webs can be formed of photographic paper which may or may not have coatings of photosensitive emulsions, polyethylene or the like. Our novel method operates effectively when the web material is electrically non-conductive, is in a dry condition, and is of constant thickness before and after passing between the roller 13 and plate 15 (without a liquid or semi-liquid layer thereon).

The roller 13 can be an idler roller, with the web 11 being transported by motor driven rollers located elsewhere.

Now referring to the embodiment shown in FIG. 2, the roller 13', the variable power supply 19', the field meter 25', and the voltage indicator 27', are all the same as described in connection with FIG. 1.

As shown in FIG. 2 a web 11' is passing straight through during a processing operation in contact with a series of rollers 13', 31 and 33, with each roller developing additional static charge on the web. Without using the present invention this static charge can become so large as to cause serious sparking if the web is subsequently grounded. Such sparking can have serious effects not only on the web itself but also on the photographic film or paper which is exposed to the action of light from the sparks. In order to counteract this, the meter 25' can be used to measure the charge at a point past the rollers, and the voltage can then be applied to the plate 15' to neutralize the static charge so as to prevent detrimental effects.

To summarize, some of the improvements provided by the present invention are:

Spark discharges are prevented when a web of photographic material is grounded, thus avoiding spark damage to the sheet itself, and avoiding the exposure of other photographic materials in the same darkroom.

The formation of detrimental islands of high charge density on a sheet of photographic film or paper base is prevented, thus improving subsequent coating operations.

Accumulation of dust particles on a sheet of photographic material can be prevented by reducing the static potential which tends to attract and hold dust particles.

The possibility of scratching a web or of depositing dirt particles, as may occur with the prior art, is eliminated.

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.

We claim:

1. In an apparatus for developing a predetermined electrical charge condition on a transported flexible web, the combination comprising:

means for transporting a web in a transport system of one or more conducting rollers;

first electrically conductive means of said transport system for supporting one surface of the web;

second electrically conductive means spaced from said first conductive means and between which the web is transported by said web transporting means;

means for grounding one of said first and second conductive means;

adjustable means for applying a direct current voltage of a selected magnitude and sign to the other of said first and second conductive means for generating an electrostatic field without generating a corona discharge;

means adjacent said first and second conductive means for monitoring the electrical charge on the web; and

means for adjusting said adjustable means in response to said monitoring means for generating a predetermined electrostatic field between said first and second conductive means for developing a predetermined electrical charge condition on the web.

2. The invention according to claim 1 wherein said first conductive means comprises a roller, and said second conductive means comprises an arcuate plate having a surface concentric with and spaced from said roller.

3. The invention according to claim 1 wherein said first conductive means comprises a grounded roller, said second conductive means comprises an arcuate plate having a surface concentric with and spaced from said roller and electrically connected to said adjustable direct current voltage applying means, and said monitoring means is positioned to monitor the charge on the web after it leaves the roller.

4. A method of developing a predetermined electrical charge condition on a flexible light-sensitive web material transported over a transport system of one or more conducting rollers, comprising the steps of:

transporting the web through opposed, spaced apart first and second conductive members, one of which is grounded, and one of which is engaged by one side of the web;

monitoring the electrical charge on the web; and in response to the monitoring,

applying a direct current voltage of a selected magnitude and sign to the ungrounded conductive member for generating a predetermined electrostatic field between said first and second conductive members developing a predetermined electrical charge condition on the web.

* * * * *