Sept. 30, 1969 C. B. GIBBONS 3,470,417

METHOD OF ALTERING ELECTROSTATIC CHARGE ON AN INSULATING MATERIAL

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FIG. 1

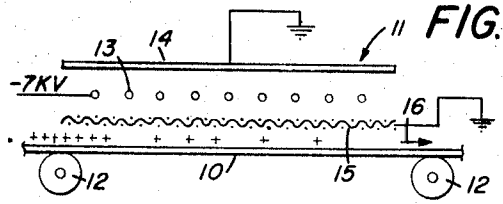


FIG. 3

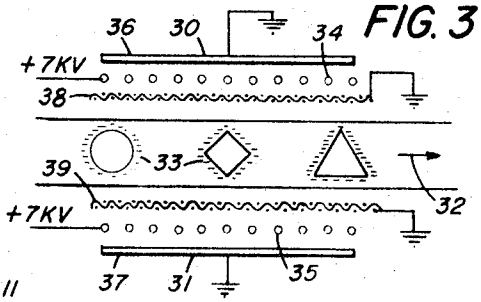


FIG. 2

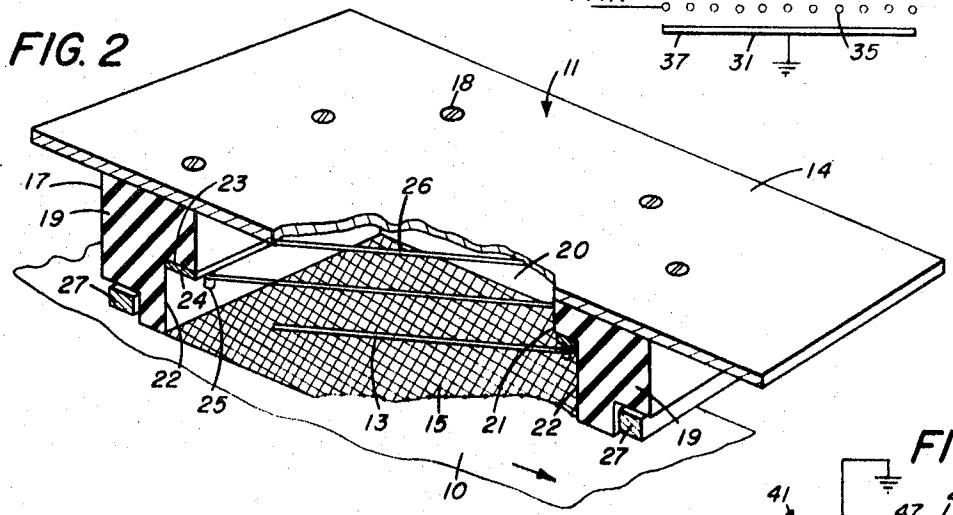


FIG. 4

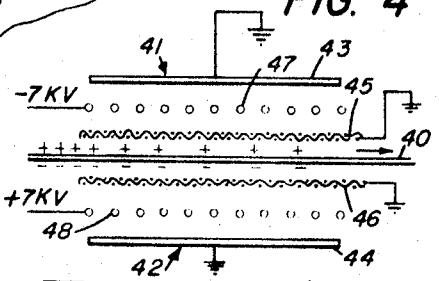
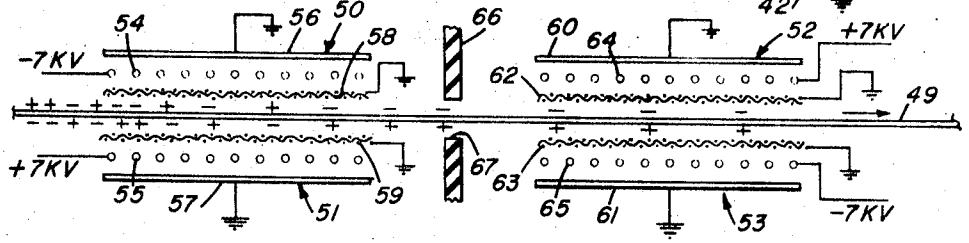


FIG. 5



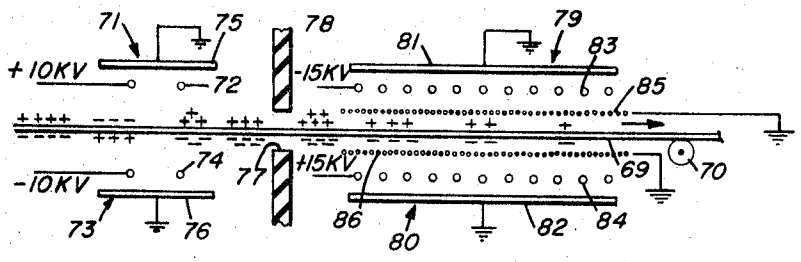


FIG. 6

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METHOD OF ALTERING ELECTROSTATIC CHARGE ON AN INSULATING MATERIAL

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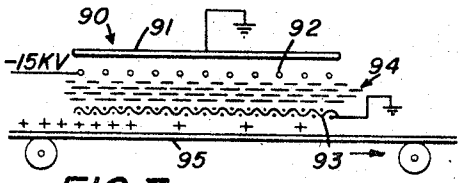


FIG. 7

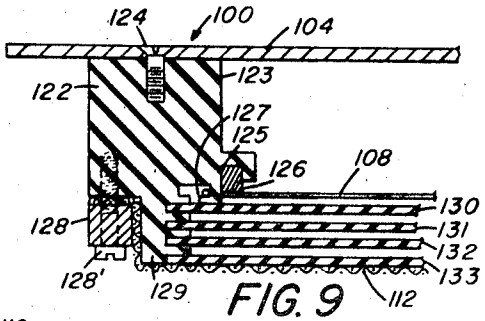
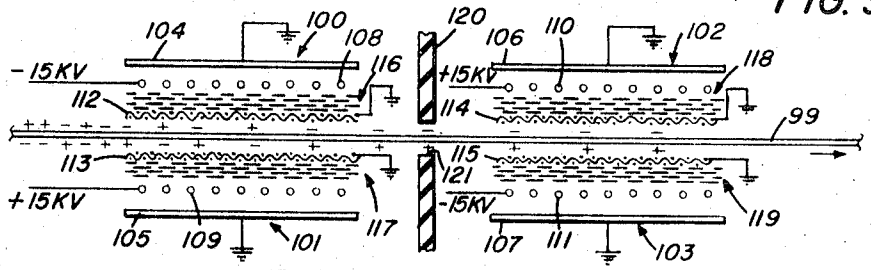


FIG. 9

FIG. 8



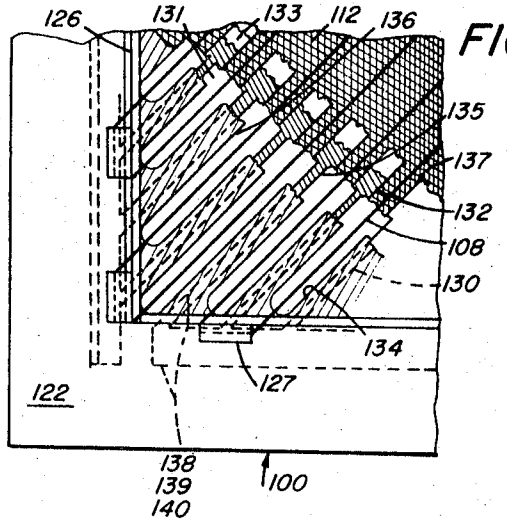
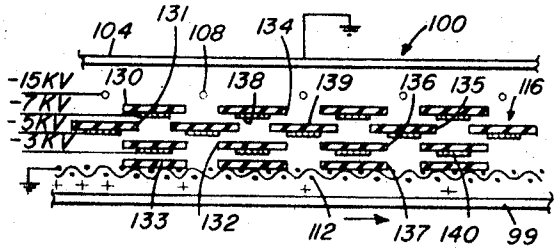


FIG. 11

FIG. 10



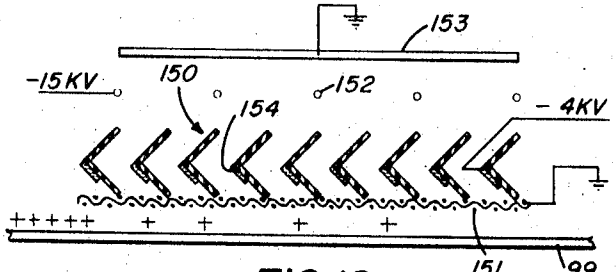


FIG. 12

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3,470,417

METHOD OF ALTERING ELECTROSTATIC CHARGE ON AN INSULATING MATERIAL

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Int. Cl. H05f 1/02
U.S. Cl. 317—4 10 Claims

ABSTRACT OF THE DISCLOSURE

A method by which an electrostatic charge on one or both surfaces of a sheet or a web of insulating material can be altered to a desired potential or completely neutralized. This is accomplished by positioning or moving the sheet or web of insulating material between at least one pair of corona charging stations. Each corona directs a flow of ions through a wire screen or grid arranged close to the surface of the web and to the surface of the material. The wire screen can be grounded or held at some preselected potential depending on the alteration to be made of the charge on the surface of the material facing the screen. The wire screen controls the flow of ions to the respective surface of the insulating material.

The present invention relates to altering electrostatic charge on an insulating material, and more particularly to a method by which such electrostatic charge can be altered by positioning or moving the material between at least one pair of D.C. corona charging devices.

One of the problems that arise with moving an insulating material through a path defined by a number of rollers, or by a series of endless belts, is the electrostatic charge accumulated on one or both surfaces of the material. Such a charge can present a hazard to an operator from the standpoint of safety due to the large potential which may accumulate on the material. Also, such a charge can present a problem in windup of a continuous web of insulating material, or when such web is slit into individual sheets. In the latter case, it is necessary to interleave a sheet of paper or similar material having no electrostatic charge between each sheet of insulating material in order that the latter can be readily separated from one another. In the handling and processing of light-sensitive materials, the electrostatic charge accumulated on the surfaces of the material also presents a problem when light-sensitive coatings are applied to the material. However, in certain instances, it is desirable to have a predetermined charge on the material for reasons set forth hereinafter.

An insulating material can accumulate a "net" or "free" charge on one or both surfaces or a "polar" charge. The net or free charge is characterized by being related to low per unit area capacitance due essentially to the space between the material and some more or less distant electrode. This type of charge gives rise to high voltage levels for a low charge density. The polar charge is characterized by having equal but opposite charges on opposite sides of the material. The capacitance associated with this type of charge is the relatively high capacitance of only the material, which gives rise to a low voltage for a high charge density. Depending on the type of material and the manner in which the material is handled, both types of charges can be accumulated on the surfaces of the same material.

It is well known to utilize corona charging devices using an A.C. corona to remove the accumulated electrostatic charge on the surface of an insulating material.

Such devices usually comprise a plurality of corona wires connected to a pulsed source of potential for controlling the removal of the charge. These devices do not discharge the surfaces completely because the rate of discharge is relatively slow owing to the recombination of positive and negative charges before they can be used for neutralization of the charge on the insulating surface. There is also a high population of charge of one polarity that is not used in neutralizing and which must be disposed of so it will not settle on the surface, thereby recharging it. In some discharge devices a D.C. corona has been used, but this requires suitable control of the flow of ions to the surface to be neutralized. This control has been attempted by using devices for controlling the flow of ions which sense the potential of the charge on the web immediately before it passes under or over the corona device. From a practical standpoint, such a method is difficult to use because the sensing device measures only the average potential over a relatively large area of the material and any local variations cannot be completely neutralized.

In the field of electrophotography, it is well known to use corona charging devices for uniformly charging an insulating layer. Such devices use a plurality of regulating wires to control the charge level placed on the insulating layer. It is also known in electrophotographic systems to charge a photoconductor to a given voltage level by passing it under or over a D.C. corona source that has a screen or set of parallel wires close to the photoconductor and biased at the given voltage level. These types of D.C. corona chargers do not, however, provide a device that is compatible with the problem of altering the electrostatic charge on an insulating material. U.S. Patent 940,429, which relates to a method of neutralizing static electricity in which a control screen is used, does not provide the flexibility of operation that is possible with that of the present invention.

It is an object of the present invention to provide a method by which a sheet or a web of insulating material having an electrostatic charge on one or both surfaces can have such charge altered to a desired potential or completely neutralized.

Another object of the invention is to provide a method by which the electrostatic charge on a sheet or a web of insulating material can be reduced by flooding each surface of the sheet or web with a flow of ions of the proper polarity and in numbers sufficient to alter or neutralize the charge on the material.

A further object of the invention is to provide a system by which local variations in the surface potential of a sheet or web of insulating material can be altered by depositing gas ions from a corona on different parts of each surface of the web in such numbers as to substantially reduce the nonuniformity of the surface potential while at the same time reducing the average potential of the sheet or web to a predetermined value including ground potential.

A still further object of the invention is to provide a system by which a flow of ions required for altering the electrostatic charge on each surface of a sheet or web of insulating material is automatically regulated within the device without need for a separate potential sensing element for controlling the flow of ions.

And yet another object of the invention is to provide a system for altering electrostatic charge on a light-sensitive material in which the irradiation of the corona charging device is blocked from the material by a baffle arrangement which also controls the flow of ions to the material.

The above objects of the invention are attained by positioning or moving a sheet or web of insulating material between at least one pair of spaced corona charging

stations. Each corona directs a flow of ions to a surface of the material, the polarity of each flow of ions being opposite in sign to the charge on the respective surface that is to be altered. The ions are directed through a wire screen or grid arranged close to the surface of the web. The wire screen can be grounded or held at some preselected potential depending on the alteration to be made of the charge on the surface facing the screen. A sheet of insulating material is positioned, or a web of insulating material is moved continuously, between the stations and ions of appropriate sign will flow through the grid to the surfaces of the insulating material so long as a potential difference exists between the material and the wire screen. Each flow of ions will therefore alter the potential on the respective surface of the insulating material so as to make the surface approach the potential of the grid, or wire screen. In the description which follows, it will be evident that such stations can be used with respect to one or both surfaces of the sheet or web, as well as in single or multiple pairs spaced longitudinally of the material so as to alter charges of either sign on one or both surfaces of the material either simultaneously, or successively.

Reference is now made to the accompanying drawings in which like reference numerals designate like parts and wherein:

FIG. 1 is a schematic arrangement showing a corona device for altering the charge on one surface of an insulating material;

FIG. 2 is a partial perspective view showing the structure of a corona device such as that disclosed schematically in FIG. 1;

FIG. 3 is a schematic view showing an arrangement of a pair of the corona stations shown in FIG. 1 by which electrostatic charges on irregularly-shaped objects can be altered;

FIG. 4 is a schematic view of a pair of the corona devices shown in FIG. 1 that are arranged for altering the charge on respective surfaces of a sheet or web of insulating material;

FIG. 5 is a schematic view showing two pairs of corona stations for removing or altering the charges on the surfaces of an insulating material in which each surface has random charges of both polarities;

FIG. 6 is a schematic view showing a system in which an insulating material having polar charges is first subjected to a corona charging device of the usual type and then to a corona charging device having a control screen for altering the charges on each surface of the material;

FIG. 7 is a schematic view of another embodiment of the invention showing a baffle arrangement arranged between the corona wires and the control screen of a corona charging station as shown in FIG. 1 for use in conjunction with a light-sensitive insulating material;

FIG. 8 is a schematic view of the device shown in FIG. 7 in which two spaced pairs of the devices are arranged in the direction of movement of the insulating material;

FIG. 9 is a partial vertical sectional perspective view through a corona charging device incorporating the baffle arrangement shown in FIG. 7;

FIG. 10 is an enlarged schematic view of the corona charging device shown in FIG. 7;

FIG. 11 is a plan view with the backing electrode removed of the corona charging device shown in FIG. 9; and

FIG. 12 is a schematic view of a corona charging device showing another embodiment of the baffle arrangement shown in FIGS. 7–11.

With reference to FIG. 1, a length or web of insulating material **10** is moved beneath a corona charging device **11** by means of a plurality of spaced rollers **12**. The corona device **11** comprises, preferably, a plurality of corona wires **13**, a backing electrode **14** and a control screen **15**. Corona needles or any other form of corona generating means can be used in place of wires **13**. The backing electrode **14** and the control screen **15** are connected to ground and a potential of 7 kilovolts is connected to the corona wires **13**. The web **10** moves from left to right as indicated by the arrow **16**. Initially, a part of the flow of negative ions generated by corona wires **13** will move to the screen or grid **15** and its charge will flow to ground. Another part of the flow of ions will pass through the screen **15** to the facing surface of the web tending to neutralize any charge of opposite polarity thereon until there is no potential difference between the screen **15** and the surface of the web. At this point, the facing surface of the web will be at substantially ground potential. When the surface of web **10** reaches ground potential, a field no longer exists between web **10** and the screen **15** so that all ions approaching the screen will flow to the screen and their charge will flow to ground. The polarity of the potential applied to the corona wires **13** determines in which way the electrostatic charge on the surface of the web **10** will be altered. In FIG. 1 it has been assumed that only a positive charge is on the surface of web **10** facing the screen **15**. If a negative charge were on this same surface, then a positive potential would be applied to corona wires **13**.

In FIG. 2 a detailed disclosure of the structure comprising the corona charging device **11** is shown. The backing electrode **14** is a metal or electrically conductive plate on which a frame **17** is secured by suitable means, such as screws **18**. The frame **17** comprises, preferably, a single rectangular member having a cross-section as shown in FIG. 2, or can comprise a pair of spaced side members **19** and a pair of end members **20**, only one of which is shown in FIG. 2. In either case, the frame **17** has a central opening **21** which has a length at least equal to the width of web **10** and a width that can be variable depending on whether the device **11** is to be used with a movable web or a stationary sheet. The members **19** and **20** are provided with an intermediate cutout portion **22** which forms a shoulder **23** on which a metal strip **24** is mounted and secured by screws not shown. The strip **24** carries a plurality of spaced pins **25** around which a single wire **26** can be strung to form wires **13** which extend transversely, and preferably diagonally, of the direction of movement of web **10**. The control screen **15** is secured to the bottom of frame **17** or members **19** and **20** by bars **27** which are secured to frame **17** by screws not shown. The corona charging device **11** is proportioned such that the screen **15** is midway between the insulating material **10** and the backing electrode **14** and the corona wires **13** are arranged midway between the screen **15** and backing electrode **14**.

A corona device such as that shown in FIGS. 1 and 2 can be used to remove the electrostatic charge on various shaped articles that can be moved between a pair of spaced corona charging devices **30** and **31**, for example, by means of an endless belt **32**, see FIG. 3. Containers made from an insulating material, such as plastic, accumulate a charge on their surface during the course of manufacture. If this charge is not removed or neutralized, the charge attracts particles of dust and dirt so as to detract from the appearance of the article when placed on a shelf for display. It has been found that an arrangement of corona charging devices **30** and **31**, such as shown in FIG. 3, will successfully remove or neutralize the charge on such articles irrespective of their shape. In FIG. 3, the articles, generally designated by the numeral **33**, are shown as having a negative charge on their exterior surface that can be neutralized by a positive charge. With such a charge, a positive potential is applied to the corona wires **34**, **35** of both devices. Each of the devices **30** and **31** is identical in structure to that shown and described with respect to FIGS. 1 and 2, that is, having backing electrodes **36** and **37** and control screens **38** and **39**, respectively. It will be readily appreciated that if the charge accumulated on the exterior surface of the articles

is a positive charge then a negative potential is applied to each set of corona wires **34** and **35**.

In order to alter or remove the electrostatic charge accumulated on both surfaces of an insulating material **40**, a corona charging device **41** and **42** can be arranged relative to each surface of the material. As shown in FIG. 4, one surface of the material has accumulated a positive charge, whereas the other surface has a negative charge. As in FIG. 1, the backing electrodes **43** and **44** are connected to ground as well as the control screens **45** and **46**. The corona wires **47** are connected to a negative potential while the corona wires **48** are connected to a positive potential. In this arrangement the flow of ions from corona wires **47** will neutralize any positive charge on the surface of material **40** facing screen **45** and positive ions generated by corona wires **48** will neutralize any negative charge on the other surface.

FIG. 5 discloses a strip of material having random positive and negative charges on each surface thereof. As in the embodiments previously described, the material **49** can be moved between two pairs of spaced corona charging units, designated by numerals **50**, **51**, **52** and **53** by suitable rollers as in FIG. 1. In the device **50** the corona wires **54** are connected to a negative potential whereas the corona wires **55** are connected to a positive potential. The backing electrodes **56** and **57** as well as screens **58** and **59** are held at ground potential. In this section of the system, the negative ions generated by the corona wires **54** will discharge the positive charges on the facing surface of the material. Similarly, the positive ions generated by corona wires **55** will discharge the negative charges on the other surface of the material **49**. As the material passes between the units **52** and **53** it will still carry a negative charge on certain portions of the surface facing unit **52** and a positive charge on portions of the surface facing unit **53**. As in the first section, the backing electrodes **60** and **61** as well as the screens **62** and **63** are connected to ground potential. The corona wires **64** are connected to a positive potential whereas the corona wires **65** are connected to a negative potential. As a result, the material **49** after leaving the second section will have all of the charges on both surfaces neutralized or removed. In order to separate the corona wires of opposite polarity and to confine the flow of ions, an insulating wall **66** having a slot **67** for the material **49** is arranged between the first and second units. Such a wall **66** can be considered as a part of frame **17**, or the side members **19**, as shown in FIG. 2.

In the operation of the device shown in FIG. 5, it is possible to overcharge the insulating material **49**. For example, a negative corona unit may continue to supply a few ions to the material after all the positive charges have been neutralized. The spacing between the wires forming the screen and the spacing between the screen and material determine the extent of such overcharging. This overcharging can be eliminated by adding another pair of units in series with those disclosed in FIG. 5. A unit would be the same as the other sections except that the screen would have more wires per inch (finer mesh) and would be arranged closer to the material. Such a section would remove any charge that was deposited by the units **52** and **53** after all the negative and positive charges on each respective side had been neutralized. Due to the spacing between the wires in the two screens of the additional units, much better control of the ion flow is obtained. However, the ion flow is much lower and cannot handle high charge levels on the web as when it is first moved between units **52** and **53**.

When an insulating material has accumulated a polar charge, such a charge is very difficult to remove from the material because devices employed to remove a charge work on the field associated with the charge density on the web. In FIG. 6 an arrangement is disclosed by which a polar charge can be effectively altered or removed. The insulating material **69** is moved from left to right by means of one or more sets of spaced rollers **70**. Unit **71** comprises a corona charging device without a control grid. A pair of spaced corona wires **72** are connected to a positive potential and supply positive ions which will neutralize negative charges on the facing surface of the material **69**. In areas where the web is already positive the positive charge will be increased. On the other side of the material **69**, a second corona charging device is arranged which also includes a pair of spaced corona wires **74** that are connected to a negative source of potential. The negative ions from wires **74** will remove the positive charge from that side of the material and increase the charge in areas that are already negatively charged. Each of the devices **71** and **73** includes a backing electrode **75** and **76** connected to ground potential. The purposes of devices **71** and **73** is to establish a polar charge of a single polarity across the thickness of the material **69**. The material **69** passes through slot **77** in an insulating wall **78** and between a pair of spaced corona charging devices **79** and **80**. The devices **79** and **80** are similar to those disclosed in FIGS. 4 and 5 and comprise backing electrodes **81** and **82** connected to ground, corona wires **83** and **84**, and control grids **85** and **86** connected to ground. In this version of a corona charger, the grids or control screens **85** and **86** comprise spaced, parallel wires and the potential applied to corona wires **83** and **84** is substantially double that used in the units shown in FIGS. 4 and 5. Also, the spacing between the surfaces of the material and their respective control screens is reduced as much as possible and the path length of the material in the corona charger, that is, under the corona charger, is increased. These differences over the aforementioned units provide a supply of ions that is sufficient for neutralizing the charge on the material. As in the other devices, the negative ions generated by corona wires **83** neutralize the positive charge on the one facing surface of the material **69** and the positive ions from the corona wires **84** remove the negative charge from the other facing surface of the material. The control grids **85** and **86** function in the same way as already described to shut off the flow of ions once the field between the screens and the material is reduced to substantially zero.

Using this type of corona charging device, it is possible to neutralize or remove any randomly-located, so-called polar charge. As in the case of net charge discharging, there may be some overcharging of the material, that is to say, the web material will leave the corona charging devices **79**, **80** with a small polar charge which is negative on top, on the basis of the disclosure in FIG. 6. This polar charge overshoot is determined by the spacing between the wires of the grid, the spacing between the grid and the material, and the corona voltage that is used. This relatively small polar charge will be uniform and can be removed by a third section with a positive corona charging device on top and a negative corona charging device on the bottom. In some instances it may be desirable to retain this uniform polar charge on the material.

In the handling of light-sensitive materials, for example, photographic film and paper, it has been found that electrostatic charge accumulates on both surfaces of the material as it is moved through apparatus for applying the light-sensitive emulsion to a base material by a continuous process. If the material is subjected to a corona charging device, such as those described above, the irradiation generated by the corona wires is sufficient to cause some fogging of the emulsion. In order to eliminate this fogging and at the same time alter the electrostatic charge on the surfaces of the material, it has been found that this can be accomplished by arranging a baffle between the corona wires and the control screen and biasing the baffle to control the flow of ions to the surface of the material.

In FIG. 7 a corona charging device **90** comprises a backing electrode **91** connected to ground, a plurality

of corona wires **92** connected to a source of potential, a control screen **93** connected to ground and a baffle generally designated by the numeral **94** that is arranged between corona wires **92** and control screen **93**. Assuming that the surface of a web of light-sensitive material **95** which faces the device **90** has accumulated a positive charge on that surface, then a negative potential is connected to the corona wires **92**. In a like manner, if the charge were negative, then a positive potential would be used.

Assuming that a web of light-sensitive material **99** has accumulated both positive and negative charges on each surface thereof, then the material can be moved between two pairs of spaced corona charging stations as shown in FIG. 8. In this arrangement the first pair of corona discharging devices is designated by the numerals **100** and **101** and the second pair is designated by the numerals **102** and **103**. Each unit comprises, respectively, backing electrodes **104**, **105**, **106** and **107**, corona wires **108**, **109**, **110** and **111**, control screens **112**, **113**, **114** and **115** and baffle systems **116**, **117**, **118**, and **119**. As seen in FIG. 8, the backing electrodes and control screens are connected to ground and the corona wires in each pair are connected to potentials of opposite polarity. As in the systems shown in FIGS. 5 and 6, the devices **100**, **101** and **102**, **103** are separated by an insulating wall **120** having an aperture **121** through which the material **99** is moved from one pair of devices to the other. A more detailed description of the baffle units follows with respect to the disclosures in FIGS. 9–12.

The corona devices **100–103** are identical in structure and similar to that shown in FIG. 2 with the exception of the addition of the baffle systems **116–119** and the corona potential of 15 kv. With reference to FIGS. 9–11, the corona charging device **100** comprises a frame **122** of insulating material that can be formed of one piece or of individual side members and end members as described above to form a central opening **123**. Frame **122** is secured to the backing electrode **104** by means of screws **124**. The frame **122** is provided with a recess **125** in which a metallic strip **126** is secured. Adjacent the strip **126**, the frame **122** is provided with a plurality of spaced ears **127** around which a single wire is strung to provide a plurality of corona wires **108** in the same manner as shown in FIG. 2. The control screen **112** is arranged across the bottom of the frame **122**, formed over along its edges and secured to the frame by suitable metallic strips **128** which are retained on frame **122** by screws **128'**, see FIG. 9. Between the ears **127** and the bottom **129** of the frame **122**, baffle plates **130**, **131**, **132** and **133** are arranged between the corona wires **108** and control screen **112** by means of suitable recesses provided in the frame **122** as shown in FIG. 9.

With respect to FIGS. 10 and 11, the baffles **130–132** are flat plates of an insulating material provided with elongated slots **134–137**, respectively, which are offset relative to each other and to the corona wires **108**, as shown schematically in FIG. 10 and by the actual structure in FIG. 11. Each of the areas between adjacent slots in each of the plates **130–132** has a thin conductor strip **138–140** secured thereto, the strips on each plate being interconnected. It has been found that best results are obtained when the strips **138–140** are covered with a thin layer of insulating material such as epoxy resin. It will be noted from FIGS. 9–10 that the baffle **133** actually contacts control screen **112** and does not have a conductor strip.

In FIG. 12 another embodiment of a baffle, or light lock arrangement, is shown. In this arrangement the baffle **150** comprises a plurality of angularly-shaped members, each having one end or leg in close proximity to the control screen **151** and the other end or leg adjacent the corona wires **152**. A backing electrode **153** is connected to ground and arranged over the corona wires **152**. At the vertex of each of the members, a conducting strip **154** can be secured as shown in FIG. 12, the strips **154** being interconnected.

It is known that a stream of ions at atmospheric pressure can be bent by proper control of the electric field lines. For use in conjunction with a corona charging device for light-sensitive material, this can be accomplished by establishing the proper potentials on the baffles **130–132** or any other form of light lock that may be used. If the potentials that are used are incorrect, the ions will either flow to the light lock or be repelled so they cannot flow through the gaps between adjacent sections of the light lock. The correct potential to be used for each surface must therefore be determined by the type and geometry of the light lock used, thereby controlling the flow of ions to the surface of the material.

In the arrangement shown in FIGS. 10 and 11, if the insulating material used for baffles **130–133** has sufficient resistance, then it is not necessary to bias the top surface by any external means. As shown in FIG. 10, a potential of 15 kv. is applied to the corona wires **108**. The conductor **138** is biased at approximately 7 kv. while conductors **139** and **140** are biased to approximately 5 kv. and 3 kv., respectively. Such biasing can be accomplished by a separate power supply for each of the baffles or by using a proper resistance value between the conductors of each baffle and grid **112**. As in the other corona charging devices already described, the backing electrode **104** and control screen **112** are connected to ground. In the case of the baffle shown in FIG. 12 this insulator has some leakage, thus making it necessary to connect the control grid to the bottom of the baffle. The same potential is applied to corona wires **152** as in the device shown in FIG. 10, but only a potential of approximately 4 kv. is applied to the conductor strips **154**.

As pointed out hereinabove, conditions may exist or require that some accumulation of charge be left on one or the other surfaces of the material. For example, it has been found that certain material when moved over steel rollers will accumulate a negative charge on the surface in contact with the rollers. In such a case it may be desirable to remove the charge from the surface that does not contact the rollers and place a positive charge on the other surface equivalent to the negative charge that will be accumulated from the rollers, or vice versa. As a result, after the material has passed the rollers, both surfaces will then be at substantially ground potential. By biasing the control screen in one or both units, it is possible to control the amount of charge that is left on the surfaces of the material. The system or method described hereinabove lends itself to being adapted to altering any electrostatic charge condition that may be necessary to be met relative to any type of material being treated.

Accordingly, throughout the specification and claims phrases such as "faltering electrostatic charge," "removing electrostatic charge" and "neutralizing electrostatic charge" are to be considered as being synonymous. It is also pointed out that it is not essential for each pair of corona charging devices to be directly opposite each other, as disclosed. It has been found that a pair of such devices can also be spaced longitudinally relative to the direction of movement of the material, thereby obtaining the desired alteration of any electrostatic charge on the surfaces of the material.

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.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. The method of altering electrostatic charge on a length of insulating material which comprises the steps of:

supporting said material for movement between each of at least a first and a second pair of spaced screens;

charging all portions of one surface of said material positively relative to ground by directing a flow of positive ions through one screen of said first pair to said one surface;

charging all portions of the other surface of said material negatively relative to ground by directing a flow of negative ions through the other screen of said first pair to said other surface; subsequently

directing a flow of negative and positive ions respectively through each of said second pair of screens toward said positively and negatively charged surfaces of said material; and

shielding each surface from the irradiation generated by its respective corona source.

2. The method of altering electrostatic charge on a length of insulating material which comprises the steps of:

simultaneously flooding one surface of said material with positive ions and the other surface of said material with negative ions until all portions of each surface carry a resultant charge of the corresponding polarity; and

subsequently and simultaneously flooding the opposite surfaces of said material respectively with ions having a polarity opposite to that of the resultant charge on that surface while interposing in each path of said ions a control screen at substantially ground potential, and while

shielding each surface from the irradiation generated by its respective corona source.

3. The method of altering electrostatic charge on a length of insulating material movable between at least a first and a second pair of corona charging stations, each station including a charging unit arranged adjacent each surface of said material, which comprises the steps of:

flooding the opposite surfaces of said material at said first pair of stations respectively with a flow of positive and negative ions while interposing a first control screen in each flow of said ions; and

subsequently flooding the opposite surfaces of said material at said second pair of stations respectively with a flow of negative and positive ions while interposing a second control screen in each flow of said ions, and while

shielding each surface from the irradiation generated by its respective corona source.

4. The method of altering electrostatic charge on a length of light-sensitive material which comprises the step of:

flooding each surface of said material respectively with a flow of positive and negative ions while shielding each surface from the irradiation generated by its respective corona source.

5. A corona charging device for light-sensitive material comprising:

a backing electrode;

a control screen arranged in spaced, parallel relation to said backing electrode;

a plurality of corona electrodes arranged in a plane parallel to and between said backing electrode and said control screen and connectable to a source of potential for generating a flow of ions to said control screen; and

baffle means arranged between said corona electrodes and said control screen for shielding said material from the irradiation generated by said corona electrodes and for providing a plurality of circuitous paths for said flow of ions to said control screen.

6. A corona charging device in accordance with claim **5** including means for establishing a potential on said baffle means for controlling the flow of ions through said paths.

7. A corona charging device in accordance with claim **5** wherein said baffle means comprises a plurality of stacked, insulating plate members arranged in spaced, parallel relation to each other, to said control screen and to the plane of said corona electrodes, each of said plate members being provided with a plurality of parallel elongated slots that are parallel to and offset relative to those in adjacent plates.

8. A corona charging device in accordance with claim **7** including an electrically conductive member arranged between said slots on at least said plate member arranged adjacent said corona electrodes and connected to a source of potential for controlling the flow of ions to said control screen.

9. A corona charging device in accordance with claim **5** wherein said baffle means comprises a plurality of spaced, angular-shaped insulating members arranged transversely of said opening and of said corona electrodes with one leg of each of said members in close proximity to said control screen.

10. A corona charging device in accordance with claim **9** including an electrically conductive member arranged on said one leg of each of said angular-shaped members and connected to a source of potential for controlling the flow of ions to said control screen.

References Cited

UNITED STATES PATENTS

2,879,395	3/1959	Walkup	250—49.5
2,965,481	12/1960	Gundlach	250—49.5
3,068,356	12/1962	Codichini	250—49.5
3,332,396	7/1967	Gundlach	250—49.5

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