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C. D. TUTTLE ET AL

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ELECTROSTATIC SPRAY PAINTING APPARATUS

Original Filed March 25, 1949

2 Sheets-Sheet 1

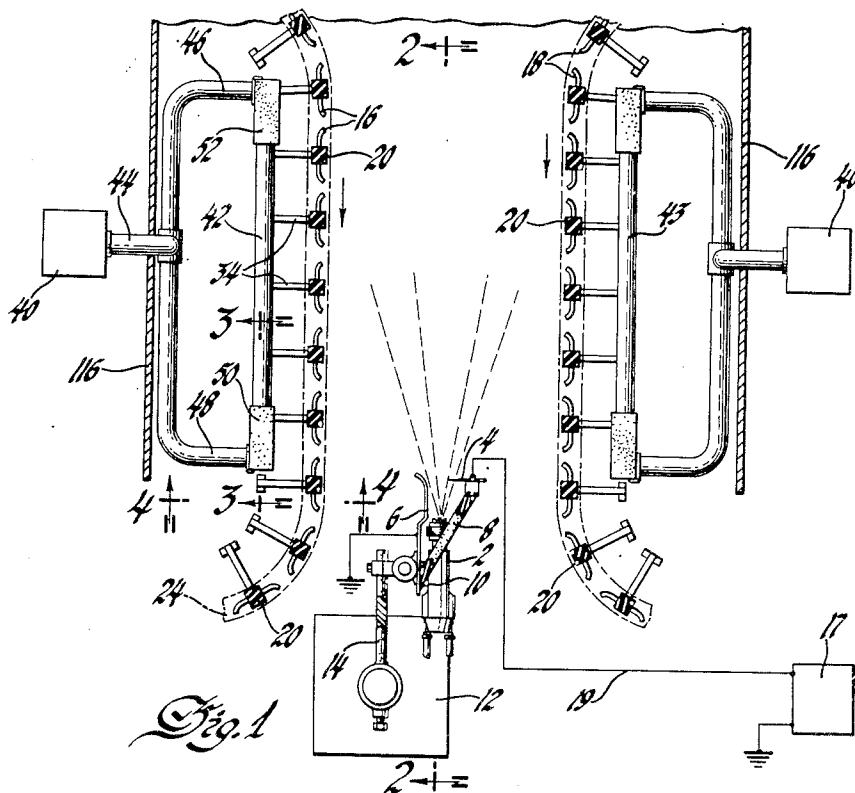
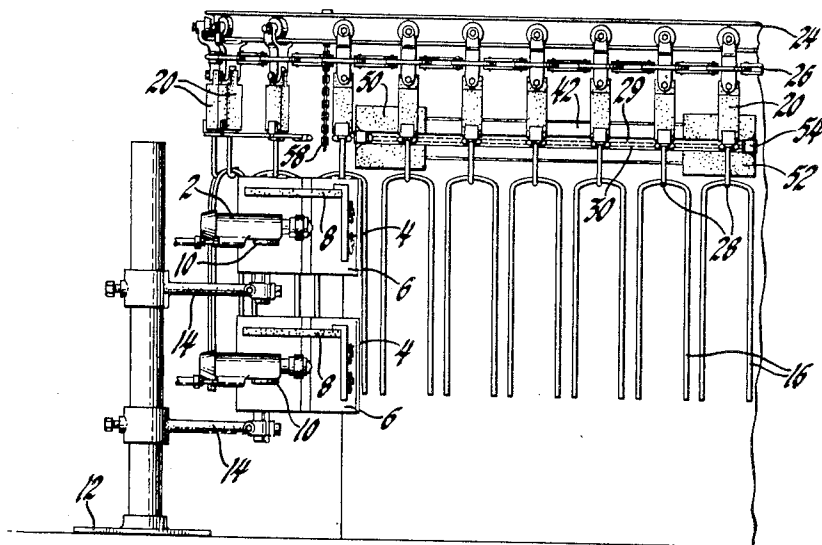


Fig. 2

Inventors  
Charles Derwood Tuttle &  
Grayland T. Larsen  
L. P. Burch  
Attorneys

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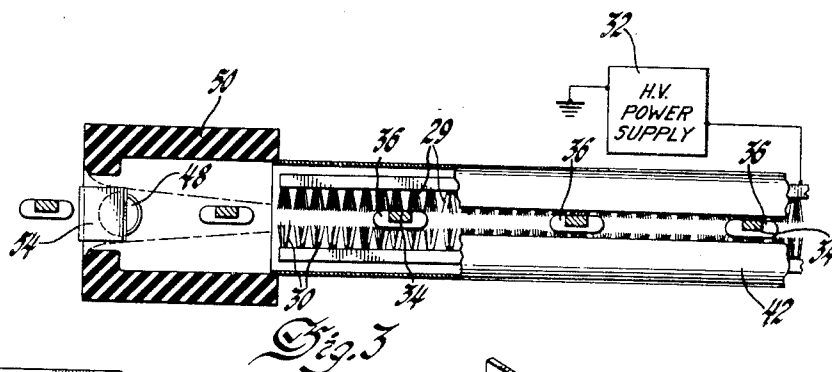


Fig. 3

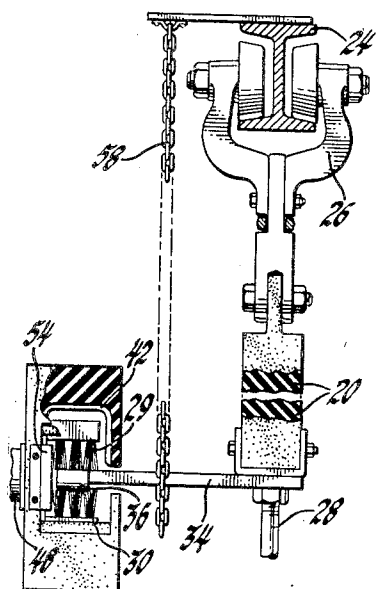


Fig. 4

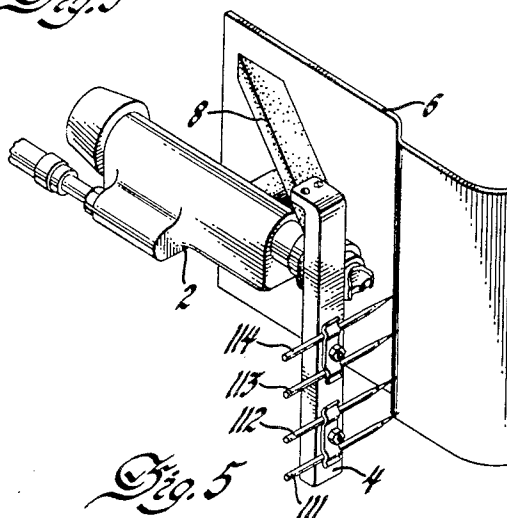


Fig. 5

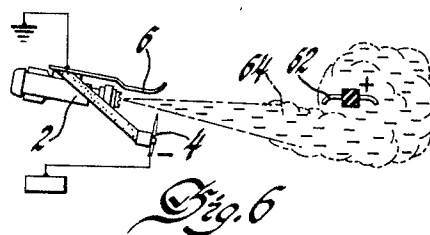


Fig. 6

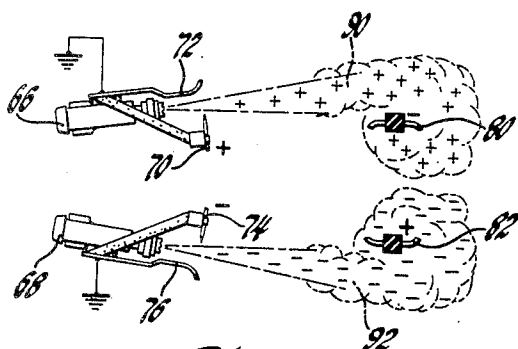


Fig. 7

Inventors  
Charles Derwood Tuttle &  
Grayland T. Larsen

L. R. Burch

Attorneys

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## ELECTROSTATIC SPRAY PAINTING APPARATUS

Charles Derwood Tuttle, Wyandotte, and Grayland T. Larsen, Flint, Mich., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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8 Claims. (Cl. 118—635)

This application is a division of abandoned application Serial No. 83,509, filed March 25, 1949, of which applications Serial Nos. 310,232, filed September 18, 1952, now abandoned and 424,650 now Patent No. 2,722,908 are successive continuations, and it relates to apparatus for preventing sparking between an electrically charged rail and a conveyor associated therewith.

The invention is specially, although not exclusively, suited for use in electrostatic spray depositing installations and has utility in other installations in which an electrical circuit is completed through a pair of relatively moving contacts to current consuming electrical apparatus.

The invention seeks to prevent explosions caused by sparking of electrical apparatus used in an inflammable atmosphere and has for its object to provide improvements in spark preventing apparatus in installations of the above and of a related character.

Referring more particularly to the drawings,

Fig. 1 is a partial sectional plan view of a spark preventing apparatus in accordance with the present invention.

Fig. 2 is a longitudinal sectional view taken along the lines 2—2 of Fig. 1;

Fig. 3 is a partial sectional view taken along the lines 3—3 of Fig. 1;

Fig. 4 is a partial sectional view taken along the lines 4—4 of Fig. 1;

Fig. 5 is a perspective view of a paint charging installation in which the apparatus of the present invention may be employed; and

Figs. 6 and 7 are schematic views of related forms of electrostatic paint spraying installations in which the spark preventing apparatus of the present invention may be employed.

In the electrostatic depositing installations of the aforementioned applications, a high D. C. voltage is placed on sharp pointed electrodes or other electrodes having a small radius of curvature so as to ionize the atmosphere in the vicinity of the electrode, and a current collecting electrode is provided having a very large radius of curvature so that a minimum of ionization is produced at that electrode. Coating material in a finely divided state is projected through this ionized zone between the discharge electrode and the current collecting electrode. A current of electricity thereby passes from the pointed discharge electrode through the ionized atmosphere to deposit an electrical charge on the surface of the particles of coating material. This electrostatic charge is of the same polarity as that of the pointed discharge electrodes.

The electrostatic depositing installations of the aforementioned applications are premised upon the principle that a mass carrying an electrostatic charge is attracted to a mass which is held at ground potential or carries an opposite charge, due to electrostatic attraction between them and comprehends projecting particles of coating material through an electrostatic charging zone into an area adjacent the article to be coated and thereafter-

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allowing the particles to be attracted to the article by electrostatic attraction between the particles and the article.

Referring now to Fig. 1, a means, here illustrated as a spray gun 2 of conventional design, is provided for projecting the coating material through an electrical charging zone toward the articles to be coated 16 and 18. This charging zone is produced between the pointed electrical discharge electrode 4 and the current collecting electrode 6. The discharge electrode 4 may include a series of sharp points or may consist of a fine wire. It is necessary that the discharge electrode be provided with a discharge area having a very sharp radius of curvature in order to provide an electrical charge concentration sufficient to produce electrical discharge. The electrical discharge here produced causes a current flow into the zone between electrodes 4 and 6 with resulting ionization of the atmosphere in the portion of this zone surrounding the discharge area of the electrode 4.

The particles of coating material projected from the gun 2 pass through this ionized atmosphere and are thereby given an electrostatic surface charge of the same polarity as that introduced on the pointed electrodes 4. It is well-known that the electrical discharge from a conductor is an inverse function of its radius of curvature and a direct function of the potential impressed upon the electrode. It may therefore be seen that the potential necessary to produce a predetermined desirable degree of ionization depends upon the radius of curvature of the attenuated pointed members on the electrode 4. It has been found that by using sharp pointed electrodes satisfactory results may be obtained with an electrical potential of 30,000 volts impressed on the electrode 4. In order to prevent electrical discharge from the collecting electrode 6, it is necessary that this member be provided with a very large radius of curvature and a large surface area. If a sufficiently large surface area and radius of curvature is not provided, an electrical discharge is produced at electrode 6 which is opposite in polarity to that produced at the electrode 4. Such an opposite polarity electrical discharge tends to neutralize the electrical charge on the spray of coating material produced by the electrode 4 with a resulting loss in painting efficiency and coalescing of the coating material particles. The high voltage potential difference between the electrodes 4 and 6 is provided by a D. C. power supply 17 through conductor 19. The current collecting electrode 6 is here shown at ground potential but it may of course be maintained at a positive or negative potential depending on apparatus design and other factors. The important condition is that a high potential difference be maintained between the electrodes 4 and 6, to produce an ionized atmosphere between them.

The electrode 4 is mounted on an insulator 8. The gun 2 is usually maintained at ground potential and is here shown as being insulated from the electrode 6 by means of insulator 10. If desired the entire assembly may be insulated from the mounting stand 12 by means of insulator 14. If, however, the collecting electrode 6 and the gun 2 are both at ground potential, there is no necessity of insulating the gun from this collecting electrode or insulating either one of them from the stand 12. The gun and its supporting electrodes are shown in greater detail in Figure 5 and will be described later.

In the present invention, the articles to be coated 16 and 18 are suspended from a monorail conveyor or other carrying means so that they pass through a zone into which the atomized coating material has been projected. These articles to be coated, here shown as 16 on one conveyor, and 18 on the opposite conveyor, may be carried by the conventional monorail conveyor system and maintained at ground potential. Alternatively, the arti-

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cles may be maintained at a high electrical potential opposite in polarity to that of the electrode 4 as shown in Figs. 1 to 4 so as to enhance the electrostatic attraction between the charged coating particle and the article to be coated.

Referring to Figs. 2 and 4, a monorail conveyor system including a monorail 24 with conveyor linkage 26; both maintained at ground potential, is illustrated. Suspended from the conveyor linkage 26 are a plurality of insulating members 20 provided to prevent the conduction of electricity from the high voltage system to the grounded monorail 24. Attached to the lower end of each of these insulators 20, a hanger 28 made from electrical conducting material, is provided for supporting and furnishing electrical contact to the articles to be coated 16, which articles are of material capable of receiving a charge. Normally these articles are of conducting material, or if non-conducting have a conducting material backing plate.

Referring now more specifically to Figs. 3 and 4, we have provided brush type contact members 29 and 30. These brush contact members, here shown as wire brushes, are connected to a source of high voltage 32 which is shown as a power source separate from source 17. This high voltage power supply maintains the brushes at a potential of 5 to 100 kilovolts, the exact voltage used depending on particular installation design factors and the parts being coated. In using higher voltages than 50 kilovolts, one must guard against the same troubles prevalent in the prior art in which the article to be coated is one of the electrodes producing the electrostatic field, namely, the detearing effect at the sharp corners of the articles being coated. This detearing results in poor paint coverage at these corners. An arm 34 of conducting material is attached to the supporting member 28 and has a contact shoe 36 thereon for providing electrical contact to permit the conduction of electricity from the high voltage power supply 32 to the article to be coated 16.

In order to minimize the fire hazard resulting from minute arcing at the point of contact between the brushes 29 and 30 and the contact shoe 36, we have provided in the present invention an enclosure for this electrical contact system with an air circulating system to prevent the accumulation of inflammable gases in the vicinity of the contact between the brushes and the contact shoe. The conduits 42 and 43 form electrostatic shields around the electrical contact brush members spaced therefrom. These shields tend to minimize the corona discharge which would otherwise occur at these members if no shields were used. This reduction in corona discharge reduces the tendency for electrical arcing at these brushes.

Referring now to Figs. 1 and 2, a general arrangement of the air scavenging system is illustrated. 40 is a source of air which may be a blower or other conventional air supply. Air scavenging for the contact zone within the channel 42 is provided from this source 40 by means of conventional air conduits 44, 46 and 48. As is shown in these figures the air is forced in at either end of the channel and escapes through the slot admitting the arm 34.

A detail showing of the construction of this channel is illustrated in Figs. 1, 3 and 4. The channel 42 is insulated from the conduits 46 and 48 by means of insulators 50 and 52. The use of these insulators permits the conduits 46 and 48 to be maintained at ground potential, and thus the conduits may be connected to a convenient source of air supply. Air from the conduit 48 is projected along the internal surface of the channel 42 by means of a deflector 54. This brush system permits the charging of the articles to be coated to a high potential and maintained at this high potential during the coating period. It is quite desirable that these members have their charge removed before they leave the spray booth in order to prevent shocks being given personnel handling the articles as they leave this booth.

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To provide such a current discharge means a grounded chain 58 is provided at the exit end of the spray booth.

In the installation shown in Fig. 1, the articles to be coated pass in two parallel paths through the coating area while charged particles of coating material are sprayed into the area between these two paths. Under certain conditions it may be desirable to utilize only a single conveyor with the article to be coated maintained at ground potential or at a potential opposite to that of the particles of coating material. This modification is shown in Fig. 6. In Fig. 6 the article to be coated 62 is subjected to a cloud of charged coating material 64 which is projected by the spray gun 2 and charged by the discharge electrode 4 and current receiving electrode 6.

In certain installations it may be desirable to use a twin conveyor system and two clouds of charged coating particles, these two clouds being of opposite polarity and projected in such a manner that the mutual attraction between the clouds will influence the paint particles toward the article to be coated, as shown in Fig. 7. In this modification two spray guns 66 and 68 are provided. As here illustrated the articles 80 and 82 are carried in parallel paths in a direction generally parallel to the direction of travel of the clouds of coating material 90 and 92. These articles may be maintained at ground potential or at a potential opposite in polarity to the polarity of the charge carried by the particles of coating material in the adjacent cloud 90 or 92. The spray gun 66 projects coating material past the discharge electrode 70 maintained at a positive potential and the grounded electrode 72 so as to charge the particles in the cloud 90 to a positive potential. The spray gun 68 discharges particles of coating material past the discharge electrode 74 maintained at a high negative potential and its mating current collecting electrode 76 so as to charge the particles in the cloud 92 to a negative potential. These clouds of coating material 90 and 92 are projected to the outside of the paths of travel of the articles 80 and 82 respectively so that the mutual attraction between the charged particles 90 and 92 causes these particles of coating material to migrate toward the articles to be coated 80 and 82 respectively.

A form of apparatus used for charging the paint particles in the various modifications shown herein is illustrated in Fig. 5 of the drawings. It has been found desirable, in order to properly coat articles having a large vertical dimension when suspended from the conveyor, to utilize one or more vertically disposed spray guns having a flat spray pattern with its major axis in a vertical plane. In order to most efficiently charge all the particles in such a flat spray plane, there is provided a series of pointed electrodes 111, 112, 113 and 114 on discharge electrode 4 said pointed members having their axes in a plane substantially normal to that of the surface of the collecting electrode 6. Such an arrangement of pointed electrodes provides what may be referred to as an electronic wind in a direction substantially parallel to the axes of the pointed electrodes. This so-called electronic wind causes the zone of ionization to extend in a direction parallel to the axes of the pointed electrodes toward the surface electrode 6. This provides a very efficient curtain of electrically charged ionized atmosphere to efficiently charge the particles of coating material as they are projected in a fan-shaped pattern from the spray gun.

The operation of the apparatus shown in Figs. 1 and 2 is as follows. The articles to be coated 16 and 18 are introduced into the spray booth 116 by means of two parallel monorail conveyors. These articles once they are in the spray booth may be maintained at ground potential or raised to a high D. C. potential opposite in polarity to that of the charge on the particles by means of the high voltage power supply 32 and the charging brushes included in the channels 42 and 43. The coating material may be atomized by air pressure in the spray gun 2 and projected between the discharge electrode 4

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and its mating electrode 6. While in the zone between these two electrodes the particles of coating material are subjected to a highly ionized current conducting atmosphere. This permits the particles of coating material to acquire an electrostatic charge of the same polarity as that of the discharge electrode 4. The ionized atmosphere acts as a conducting medium for transporting the quantity of electricity necessary to produce the electrostatic surface charge on the particles. These particles after acquiring an electrostatic charge from this ionized curtain are projected into an area adjacent the path of travel of the articles 16 and 18. It is well-known in the field of electrostatics that opposite charges attract each other. Obeying this law of electrostatics the charge on the particle of coating material is attracted to the article to be coated. The electrostatic attraction between the charge on the paint particle and that of either the grounded or oppositely charged article to be coated causes the paint particles to migrate to the article to be coated and adhere thereon to form an even coat. If the article to be coated has been charged to a high potential, it is quite desirable that this potential be removed after it proceeds out of the zone of deposition. This removal of charge is accomplished by grounded chain 58 located at the exit end of the spray booth.

While the spark preventing apparatus of the present invention has been described as applied to an electrostatic spray painting installation, it is apparent that the apparatus has application to other installations such as portable electric drills and other hand tools used in a conveyor installation and which are energized through an electrical circuit whose contacts are associated with the moving conveyor system.

We claim:

1. In apparatus for maintaining electrical contact between a source of electrical voltage and an article carried by a conveyor including; a movable contact member carried by said conveyor and electrically connected to the article, a stationary contact member mating with said movable contact member, a channel member insulated from and substantially surrounding said stationary contact member but having an opening therein to allow the entrance, exit and horizontal movement of said movable contact member, a source of compressed air, and means for introducing said compressed air into said channel to provide air movement across said contact surfaces and out of said channel through said opening for said movable contact member continuously during movement of said movable contact member by said conveyor through said channel

2. In apparatus for maintaining electrical contact between a source of D. C. voltage and an article carried by a conveyor as claimed in claim 1 including; means for electrically insulating said channel from said source of compressed air and means for deflecting the path of travel of said compressed air into a direction substantially parallel to that of said conveyor.

3. In apparatus for maintaining electrical contact between a source of potential and an article carried on a grounded conveyor through a work rendering zone in which the article is connected to said source of potential comprising article support means carried by and insulated from said conveyor, a movable member extending from and carried by said article support means, a stationary contact member located in said zone and spaced from said article support means, said stationary contact member providing a sliding contact with said movable contact member carried by said article support means and being connected to one side of said source of potential the other side of which is connected to ground, and grounding means located outside of said zone in the path of the conveyor and in contacting relation with the article for grounding the article and removing any electrical charge remaining thereon after the article has been conveyed

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past said stationary contact member and through the zone.

4. Apparatus in accordance with claim 3 above wherein said grounding means includes a chain depending from a fixed part of said grounded conveyor, said chain being dragged across the movable contact member as the article moves past the grounding chain.

5. In an electrostatic coating installation in which an electrically charged spray of coating material is electrostatically deposited on an article conveyed through a coating zone including a grounded conveyor and a source of potential one side of which is grounded and its other side adapted to be connected to said article when it is in the coating zone; the improvement which comprises the combination of article support means carried by and insulated from said conveyor, a movable member extending from and carried by said article supporting means, a stationary contact member located in said zone and spaced from said article support means, said stationary contact member providing a sliding contact with said movable contact member carried by said article support means and being connected to the ungrounded side of said potential source, and grounding means located outside of said zone in the path of the conveyor and in contacting relation with the article for grounding the article and removing any electrical charge remaining thereon after the article has been conveyed past said stationary contact member and through the zone.

6. In an electrostatic coating installation in which an electrically charged spray of coating material is electrostatically deposited on an article conveyed through a coating zone including a grounded conveyor and a source of potential one side of which is grounded and its other side adapted to be connected to said article when it is in the coating zone; the improvement which comprises the combination of article support means carried by and insulated from said conveyor, a movable member extending from and carried by said article support means, a stationary brush contact member located in said zone and spaced from said article support means, said stationary contact member providing a sliding contact with said movable contact member carried by said article support means and being connected to the ungrounded side of said potential source, and electrostatic shielding means spaced from and surrounding said stationary contact member, said shielding means comprising an elongated tubular member that is electrically insulated from said stationary contact member enclosed therein and is open at its ends and slotted along its length to permit the entrance, exit and movement of said movable contact member therethrough without contact therewith.

7. In an electrostatic coating installation in which an electrically charged spray of coating material is electrostatically deposited on an article conveyed through a coating zone including a grounded conveyor and a source of potential one side of which is grounded and its other side adapted to be connected to said article when it is in the coating zone; the combination of article support means carried by and insulated from said conveyor, a movable member extending from and carried by said article support means, a stationary brush contact member located in said zone and spaced from said article support means, said stationary contact member providing a sliding contact with said movable contact member carried by said article support means and being connected to the ungrounded side of said potential source, electrostatic shielding means spaced from and surrounding said stationary contact member, said shielding means comprising an elongated tubular member that is electrically insulated from said stationary contact member enclosed therein and is open at its ends and is slotted along its length to permit the entrance, exit and movement of said movable contact member therethrough without contact therewith, and air circulating means including an air

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blower introducing air into said tubular member to provide air movement continuously across the contact surfaces of the stationary and the movable contact members.

8. In an electrostatic coating installation in which an electrically charged spray of coating material is electrostatically deposited on an article conveyed through a coating zone including a grounded conveyor and a source of potential one side of which is grounded and its other side adapted to be connected to said article when it is in the coating zone; the combination of article support means carried by and insulated from said conveyor, a movable member extending from and carried by said article support means, a stationary brush contact member located in said zone and spaced from said article support means, said stationary contact member providing a sliding contact with said movable contact member carried by said article support means and being connected to the ungrounded side of said potential source, electro-

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static shielding means spaced from and surrounding said stationary contact member, said shielding member comprising an elongated tubular member that is electrically insulated from said stationary contact member enclosed therein and is open at its ends and is slotted along its length to permit the entrance, exit and movement of said movable contact member therethrough without contact therewith, and grounding means located outside of said zone in the path of the conveyor and in contacting relation with the article for grounding the article and removing any electrical charge remaining thereon after the article has been conveyed past said stationary contact member and through the zone.

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