Nov. 8, 1955 C. D. TUTTLE ET AL 2,722,908

ELECTROSTATIC SPRAY PAINTING APPARATUS

Original Filed March 25, 1949 2 Sheets-Sheet 1

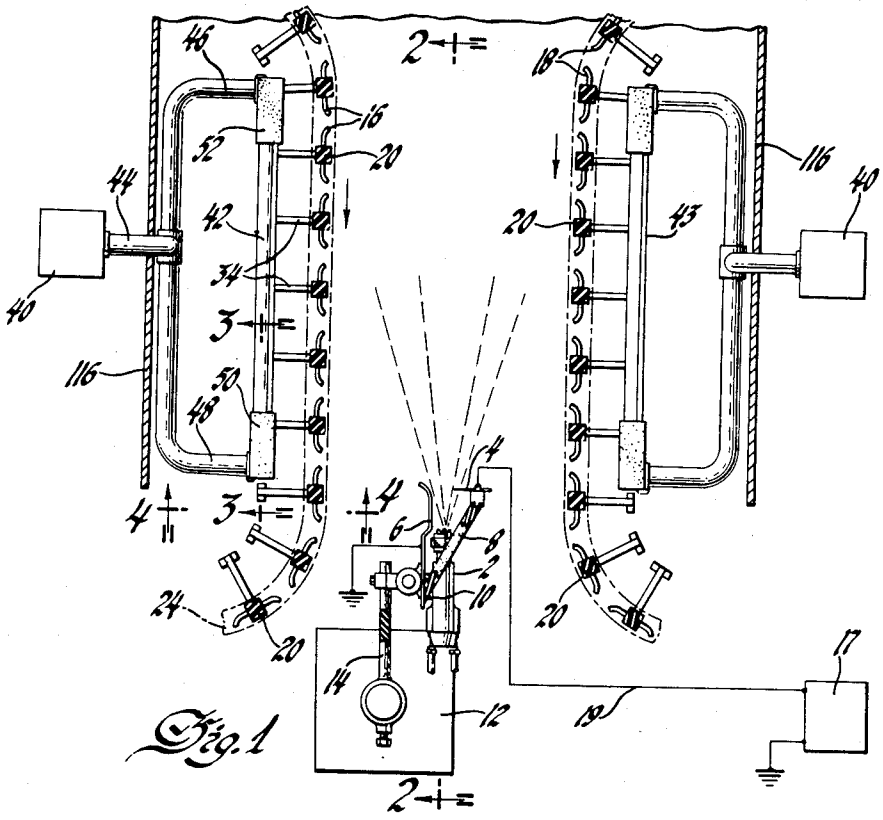


Fig. 1

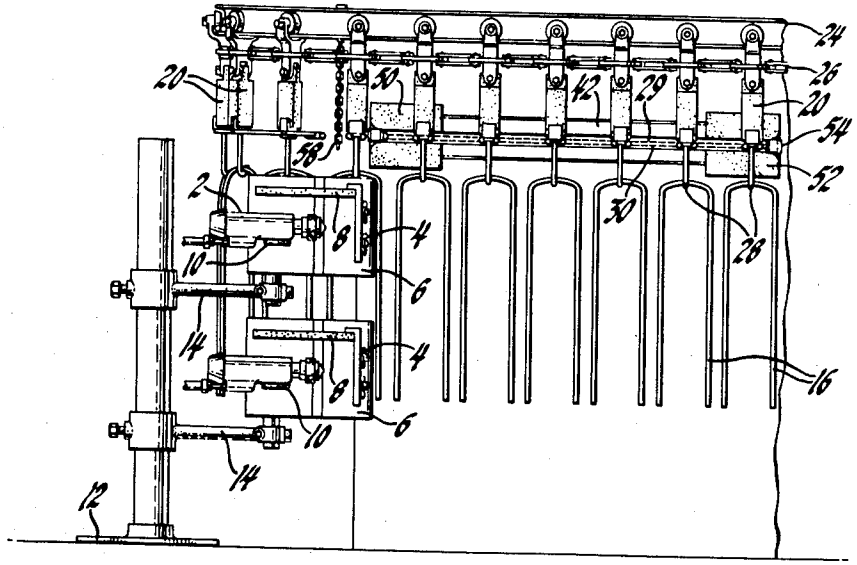


Fig. 2

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

Nov. 8, 1955 C. D. TUTTLE ET AL 2,722,908

ELECTROSTATIC SPRAY PAINTING APPARATUS

Original Filed March 25, 1949 2 Sheets-Sheet 2

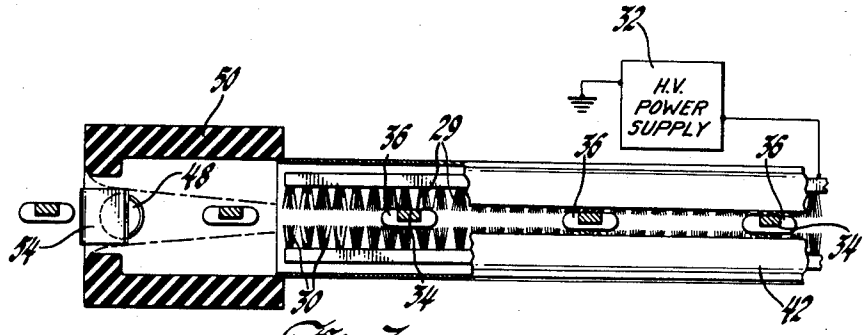


Fig. 3

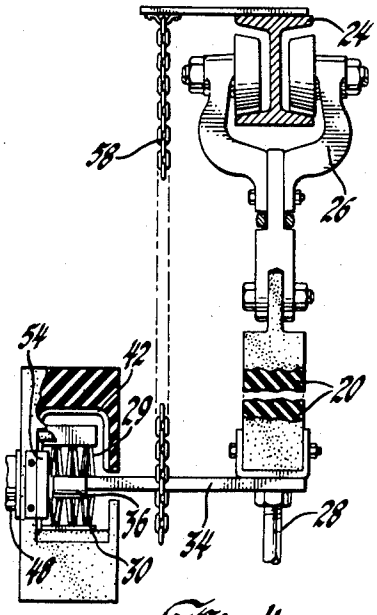


Fig. 4

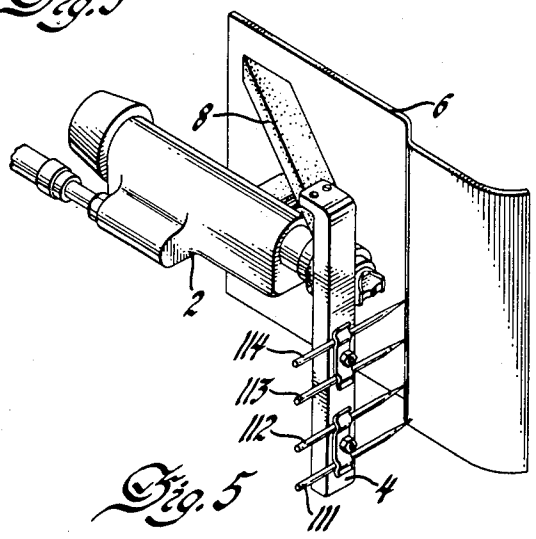


Fig. 5

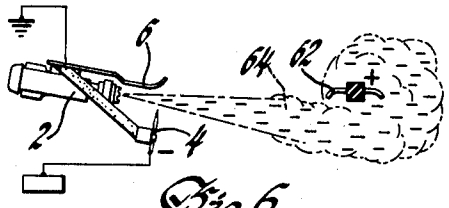


Fig. 6

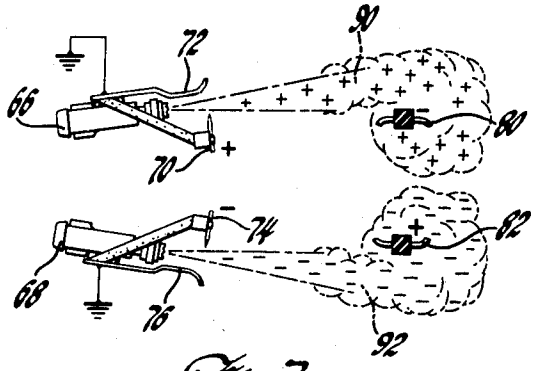


Fig. 7

By

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

United States Patent Office 2,722,908
Patented Nov. 8, 1955

2,722,908

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

Continuation of application Serial No. 310,232, September 18, 1952, which is a continuation of application Serial No. 83,509, March 25, 1949. This application April 20, 1954, Serial No. 424,650

12 Claims. (Cl. 118—51)

The present invention relates to apparatus for coating articles of manufacture by utilizing electrostatic attraction between charged coating material particles and the article to be coated. This invention further relates to a means for projecting particle of coating material through an electrical discharge zone into a zone adjacent the article to be coated so that the particles of coating material may acquire an electrostatic charge and thereafter be attracted to the article to be coated.

It is therefore an object of the present invention to provide apparatus for spray coating in which the coating material is projected through an electrical charging zone and thereafter caused to deposit on the article to be coated by electrostatic attraction resulting from its own charge.

It is a further object of the present invention to provide means for subjecting the article to be coated to a high potential opposite in polarity to that of the coating particles to enhance the electrostatic attraction between the particles and the article to be coated.

It is a further object of the present invention to provide an efficient and reliable means for coating articles of manufacture by using electrical discharge to place an electrostatic charge on the particles of coating material.

It is a further object of the present invention to provide a system for producing electrostatic charges on particles of coating material which system includes a multiplicity of pointed electrodes with their axes normal to the path of travel of the particles.

It is a further object of the present invention to provide a means for spraying two articles of manufacture simultaneously which includes charging the particles of coating material and projecting them between the two articles so that they may be equally attracted to both articles.

It is a further object of the present invention to provide means for spraying two clouds of coating material having opposite polarity charge so that the mutual attraction between the clouds will enhance their coating efficiency.

It is a still further object of the present invention to provide a pair of ionizing electrodes in which the discharge electrode consists of a plurality of attenuated projections normally disposed to an extended surface current collecting electrode.

Other objects of this invention will become apparent upon reading the specification and inspection of the drawings and will be particularly pointed out in the claims.

Referring more particularly to the drawings,

Figure 1 is a partial sectional plan view of one modification of the present invention.

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

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

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

Figure 5 is a perspective view showing details of the paint charging apparatus.

Figure 6 is a schematic view of a second modification of the present invention.

Figure 7 is a schematic view of a third modification of the present invention.

In each of these modifications, the article to be coated may be maintained either at ground potential or at a predetermined electrical potential other than ground and opposite in polarity to the charge on the coating particles projected into the zone adjacent said article.

It is well-known that the impressing of a high voltage on an electrode with a small radius of curvature will cause an electrical concentration of charge or electrical stress sufficient to cause ionization of the atmosphere in the vicinity of this radius of curvature. This phenomena is more pronounced as the radius of curvature is decreased and is maximum for sharp pointed electrodes. It is also quite well-known that ionized atmosphere is a good conductor of electricity while atmosphere not in the ionized state is a comparatively poor conductor. In the present invention 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. 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. It is also well-known that a mass carrying an electrostatic charge is attracted to a mass held at ground potential or carrying an opposite charge due to electrostatic attraction between them. In the present invention the coating material particles are attracted to an article to be coated by means of this electrostatic attraction between the particle of coating material and the article to be coated. In short, the invention consists of projecting particles of coating material through an electrostatic charging zone into an area adjacent the article to be coated and thereafter allowing the particles to be attracted to the article by electrostatic attraction between the particles and the article.

Referring now to Figure 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 DC 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.

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. In one modification of the present invention the articles to be coated are maintained at ground potential. In another modification of the present invention the articles to be coated are maintained at a high electrical potential opposite in polarity to that of the electrode **4** so as to enhance the electrostatic attraction between the charged coating particle and the article to be coated. A method of maintaining the articles at a high potential is shown in Figures 1, 2, 3 and 4 as part of the present invention.

Referring to Figures 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 Figures 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**. 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. 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 articles 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 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. These shields tend to minimize the corona discharge which would otherwise occur at these members. This reduction in corona discharge reduces the tendency for electrical arcing at these brushes.

Referring now to Figure 1, it will be noted that the conveyor system carrying the articles **16** is identical to that system carrying the articles **18** and therefore a detailed description of the system carrying the articles **16** alone is believed necessary.

Referring now to Figures 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**.

Referring now to Figures 1, 3 and 4, a detail showing of the construction of this channel is illustrated. 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 both. To provide such a current discharge means a grounded chain **53** is provided at the exit end of the spray booth.

In the preferred form of the present invention, 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. The articles being coated may either be maintained at ground potential or maintained at an electrical potential opposite in polarity to that of the charge on the coating particles. The preferred form is shown in Figures 1 and 2.

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 Figure 6. In Figure 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 articles to be coated. This modification of the present invention is shown in Figure 7. In this modification of the present invention 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.

The apparatus used for charging the paint particles in the various modifications of the present invention is shown in its preferred form in Figure 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, we have 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.

Operation of preferred form of the invention

The operation of the preferred form of the invention as shown in Figures 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 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** 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.

It may be desirable to utilize a plurality of spray guns, some of which may be located as to project the coating material at an acute angle to the path of travel of the articles to be coated.

While the invention has been described in its preferred form and certain preferred embodiments of that form, it is not intended that it should be limited to these specific forms or to the specific location of the spray guns or paint charging electrodes but that the invention should be construed as broad as possible consisting of the following claims.

This is a continuation of our application Serial No. 310,232, filed September 18, 1952, which is a continuation of our application Serial No. 83,509, filed March 25, 1949, both now abandoned.

We claim:

1. Apparatus for applying a siccative coating material to two articles of manufacture simultaneously, including: means for atomizing the coating material and projecting the atomized coating material through a zone of electrical discharge into an area between the two articles of manufacture, said discharge zone being formed between a series of parallel pointed discharge electrodes and a broad flattened extended surface current collecting electrode having an expanse substantially exceeding that of all said pointed electrodes, said last mentioned electrode surface extending normal to the axes of the discharge electrodes; and means for impressing upon said discharge electrodes and said current collecting electrode an electrical potential difference of several thousand volts.

2. Apparatus for applying a siccative coating material to two articles of manufacture simultaneously as claimed in claim 1 including means for maintaining both articles of manufacture at substantially zero electrical potential.

3. Apparatus for applying a siccative coating material to two articles of manufacture simultaneously as claimed in claim 1, including means for maintaining said two articles of manufacture at an electrical potential opposite in polarity to that of said discharge electrode.

4. Apparatus for applying coating material to articles of manufacture, including: means for producing an electrical discharge zone by impressing a high unidirectional voltage between a series of attenuated rod discharge electrodes and an extended broad flattened surface current collecting electrode having an expanse many times greater than that defined by said rod electrodes, said current collecting electrode being located in a plane normal to the axes of said discharge electrodes; means for projecting particles of coating material through the electrical discharge zone produced between said discharge electrodes and said surface electrode into an area adjacent the articles to be coated; to cause migration of said particles of coating material to said articles by electrostatic attraction between said particles and said articles; and means for maintaining said articles at an electrical potential opposite in polarity to that of said discharge electrodes.

5. Apparatus for applying coating material to articles of manufacture, comprising: a coating zone; means for conveying a series of articles through said zone; means for projecting charged particles into said zone into proximity to said articles, said last recited means comprising a sprayer for coating particles, a discharge electrode made up of a plurality of pointed elements disposed in substantially parallel relation to one another and normal to the axis of the sprayed particles, and a broad flattened collecting electrode disposed substantially normal to the axes of said pointed elements and cooperating with said elements to form an ionization space about the discharge end of said sprayer; means for maintaining said articles at an electrical potential opposite in polarity to that of said discharge electrodes; and means for charging said elements to high potential to cause charging of said particles

and deposition of the same onto the articles on said conveyor.

6. Apparatus for applying coating material to articles of manufacture, comprising: means defining a coating zone; means for conveying a succession of articles to be coated through said zone; spraying means for projecting charged particles into said zone into proximity to said articles; particle charging means comprising a discharge electrode made up of a plurality of pointed elements disposed in spaced and substantially parallel relation to one another and substantially normal to the axis of the spraying means, and a broad flat electrode located on the side of said axis opposite to said discharge electrode and disposed in a plane substantially normal to the axes of the pointed elements and cooperating with said elements to form an ionization space adjacent the discharge end of said spraying means; and means for placing a potential on said pointed elements of different absolute value than the potential of the articles to be coated to cause charging of said particles and deposition of the same onto the articles on said conveyor as they pass through said zone.

7. Apparatus for applying coating material to articles to be coated, including: means for projecting the coating material through an electrical discharge zone into proximity to the article, said discharge zone being between at least one pointed element and a broad flat surfaced current collecting electrode spaced from said pointed element and disposed in a plane substantially normal to the axis of the pointed element; and means for placing on said pointed element a potential of different absolute value than the potential of the articles to be coated.

8. Apparatus of the character claimed in claim 7, wherein the potential on the pointed element is at least several thousand volts different from the potential on the flat surfaced electrode and the article to be coated.

9. Apparatus of the character claimed in claim 7, including means for maintaining the flat surfaced electrode and the article to be coated at low potentials near ground.

10. Apparatus for applying coating material to an electrically conducting workpiece, said apparatus comprising, in combination, discharge electrode means and collector electrode means spaced from said discharge electrode means, particle projecting means projecting particles of coating material between said discharge electrode means and said collector electrode means in a path toward the workpiece to be coated, said discharge electrode means being positioned on one side of said path of projected particles and said collector electrode means on the other, power supply means connected to said discharge electrode means and said collector electrode means and establishing a high potential electrostatic field therebetween substantially normal to said path of projected particles and of sufficient intensity to create a highly ionized current conducting atmosphere between said electrodes through which substantially all of said particles are projected, means mechanically supporting said workpiece outside of said electrostatic field that establishes said current conducting atmosphere and means maintaining the workpiece at a potential different from that of said discharge electrode means.

11. Apparatus for applying coating material to an electrically conducting workpiece, said apparatus comprising, in combination, a pointed discharge electrode and a collector electrode spaced from said discharge electrode, particle projecting means projecting particles of coating material between said discharge electrode and said collector electrode in a path toward the workpiece to be coated, said discharge electrode extending substantially normal to said path of projected particles and being positioned on one side thereof and said collector electrode on the other side thereof, high potential power supply means connected to said discharge electrode and said collector electrode establishing a high potential electrostatic field therebetween substantially normal to the direction of said path of projected particles and of sufficient intensity to create a highly ionized current conducting atmosphere between said electrodes through which substantially all of said particles are projected, means mechanically supporting said workpiece outside of said electrostatic field that establishes said current conducting atmosphere and means maintaining the workpiece at a different absolute potential from that of said discharge electrode.

12. Apparatus for applying coating material to an electrically conducting workpiece, said apparatus comprising, in combination, an array of pointed discharge electrodes and a collector electrode spaced from said discharge electrodes, a spray gun projecting particles of coating material between said electrodes in a path toward the workpiece to be coated, said discharge electrodes extending substantially normal to and positioned on one side of said path of projected particles and said collector electrode on the other side thereof, high potential power supply means connected to said discharge electrodes and said collector electrode establishing a high potential electrostatic field therebetween substantially normal to the direction of said path of projected particles and of sufficient intensity to create a highly ionized current conducting atmosphere between said electrodes through which substantially all of said particles are projected, conveyor means mechanically supporting said workpiece outside of said electrostatic field that establishes said current conducting atmosphere and conveying the workpiece past said spray gun and means maintaining the workpiece at a different absolute potential from that of said discharge electrodes.

References Cited in the file of this patent

UNITED STATES PATENTS

1,123,962	Walker	Jan. 5, 1915
1,958,406	Darrah	May 15, 1934
2,160,962	Formhals	June 6, 1939
2,239,695	Bennett	Apr. 29, 1941
2,247,963	Ransburg et al.	July 1, 1941
2,270,341	Ransburg	Jan. 20, 1942
2,466,906	Miller	Apr. 12, 1949

FOREIGN PATENTS

670,914	Great Britain	Apr. 30, 1952