May 30, 1950 E. M. RANSBURG ET AL 2,509,276

APPARATUS FOR ELECTROSTATICALLY DEPOSITING ADHERENT COATING MATERIALS

Filed June 28, 1944 3 Sheets-Sheet 1

FIG. 1

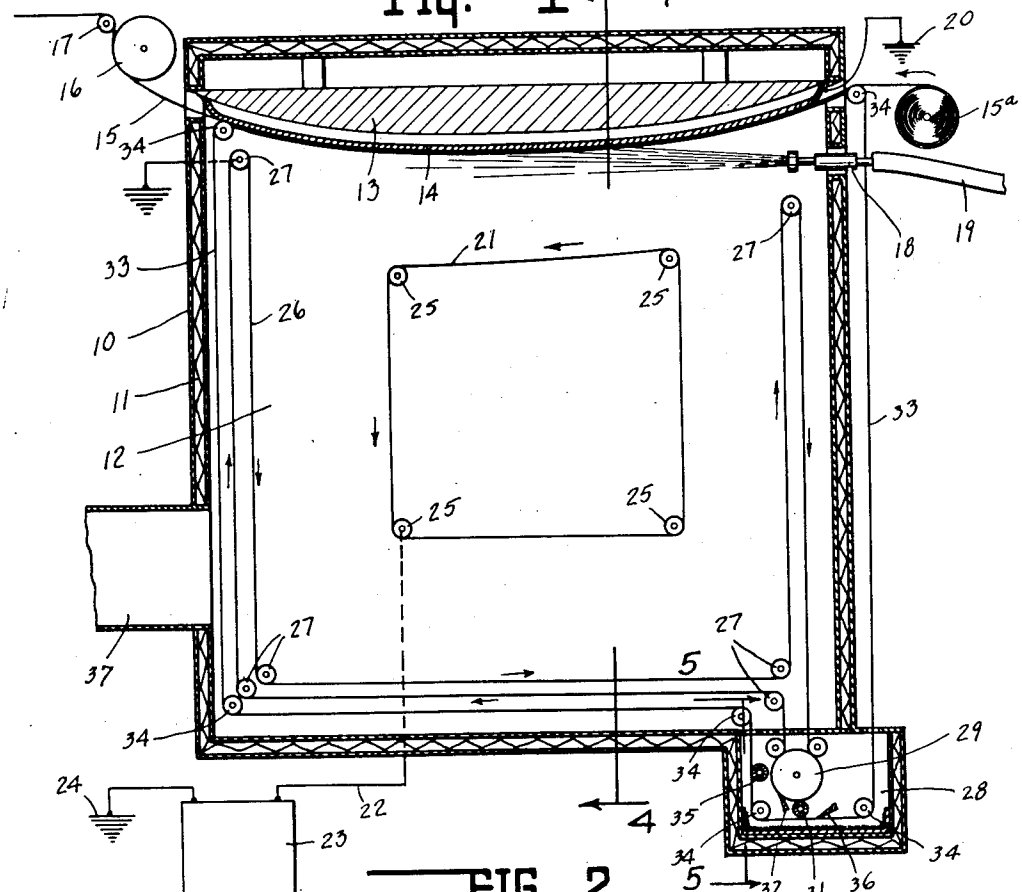


FIG. 2

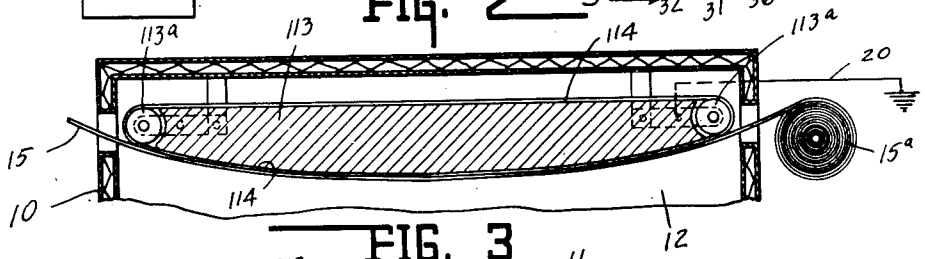
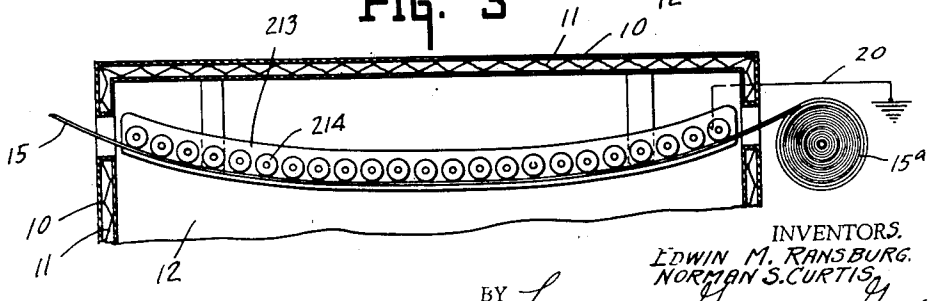


FIG. 3



INVENTORS.
EDWIN M. RANSBURG.
NORMAN S. CURTIS.

BY Lockwood, Goldsmith & Galt.
ATTORNEYS.

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FIG. 4

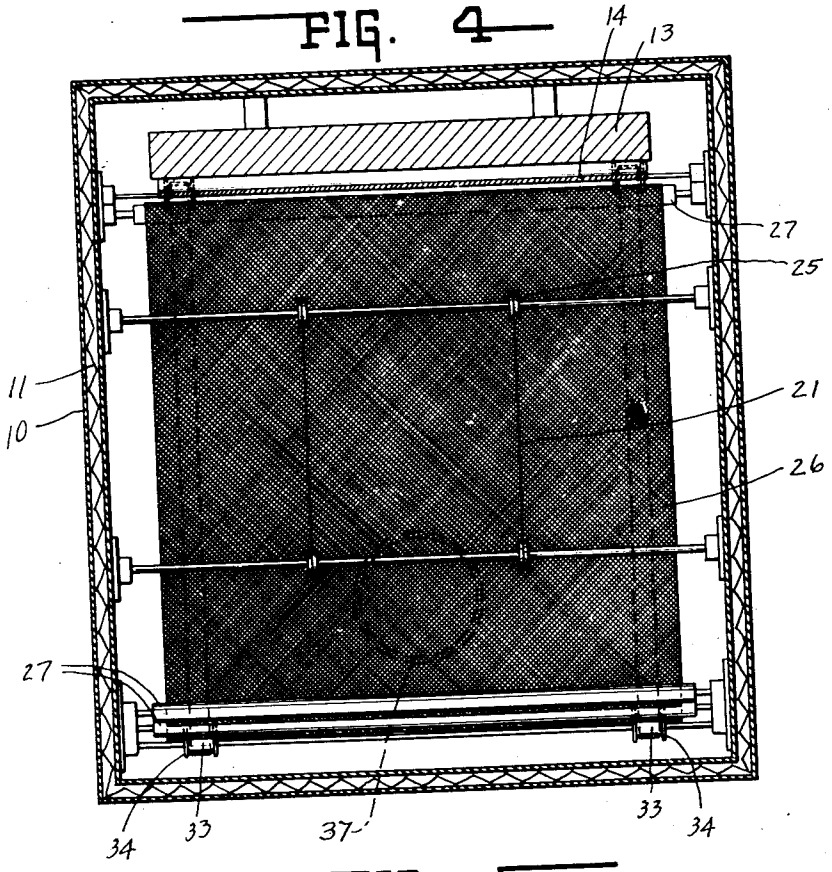
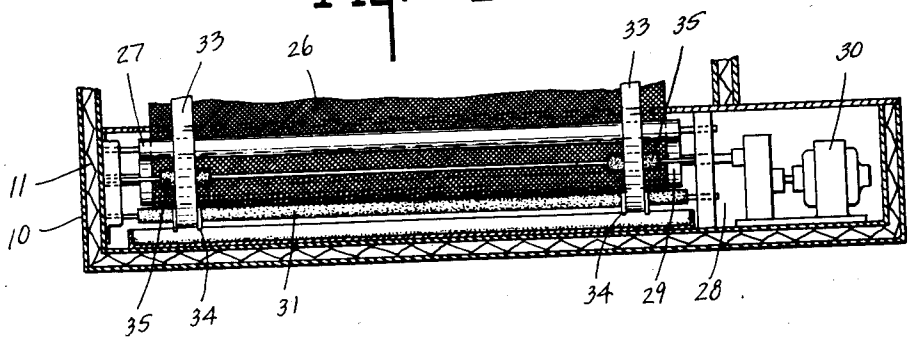


FIG. 5



INVENTORS.
EDWIN M. RANSBURG.
NORMAN S. CURTIS.

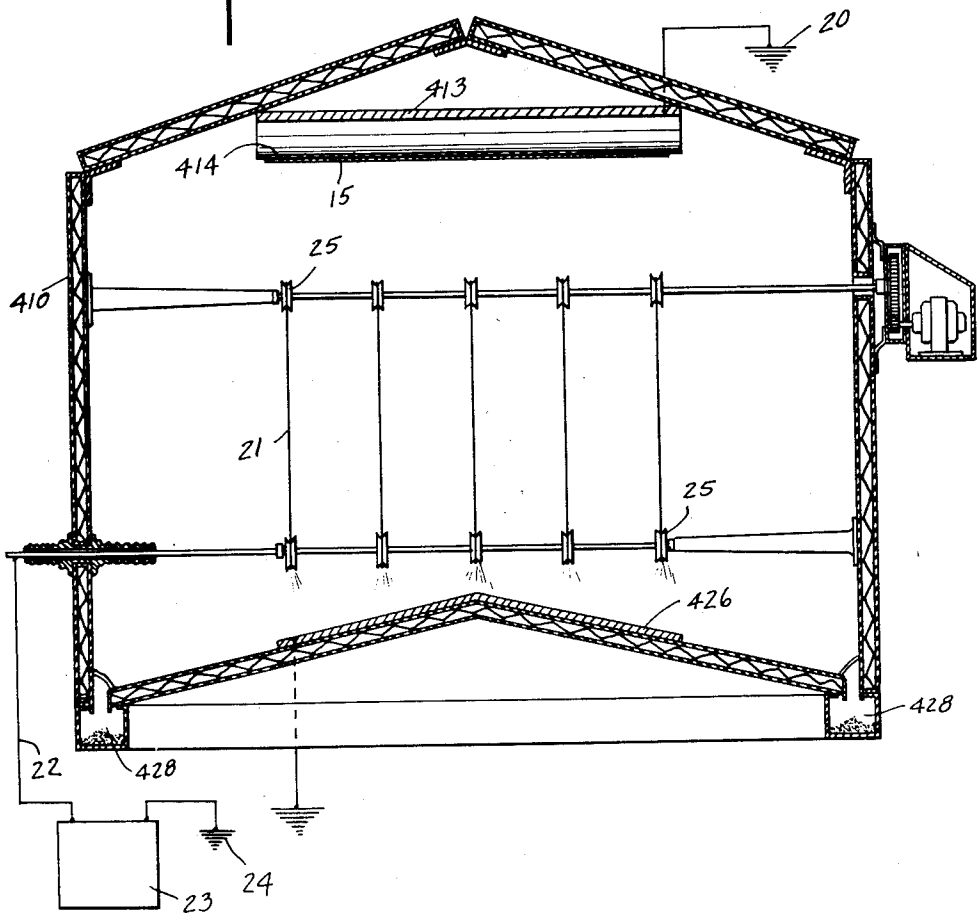
BY Lockwood, Goldsmith & Galt
ATTORNEYS.

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FIG. 6



INVENTORS.
EDWIN M. RANSBURG
NORMAN S. CURTIS
BY Lockwood, Goldsmith & Galvin
ATTORNEYS.

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APPARATUS FOR ELECTROSTATICALLY DEPOSITING ADHERENT COATING MATERIALS

Edwin M. Ransburg and Norman S. Curtis, Marion, Ind., assignors, by mesne assignments, to Ransburg Electro-Coating Corp., Indianapolis, Ind., a corporation of Indiana

Application June 28, 1944, Serial No. 542,503

26 Claims. (Cl. 91—18)

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This invention relates to the electrostatic deposition of adherent coating materials. Its principal object is the provision of electrostatic-coating apparatus which will effect an improved deposition of coating material, especially upon continuous sheets or webs and where uniformity of coating-thickness is a desideratum. More specific objects of the invention include the retardation or prevention of coating-material deposition on the walls of a booth in which the coating operation is performed, the recovery of coating material which escapes deposition on the article or articles being coated, the production of relatively thin coatings free from voids, and the prevention of accumulations of coating material on an electrode from which accumulated coating material might "detear" in the form of unduly large drops to the article or articles being coated. Another object of the invention is to provide a coating apparatus in which unduly large coating material particles introduced into the coating zone will escape deposition on the surface or surfaces being coated, where they might produce objectionable localized increases in coating thickness. Still another object is to facilitate the electrostatic coating of thin, relatively weak webs or sheet material.

The invention is especially suited for use, and a realization of its several objects is perhaps most fully attained, in the production of carbon paper, where the electrostatic force is employed to produce a thin, uniform coating of wax-like material on a paper base. Accordingly, although the invention has other uses, it is illustrated and described herein as embodied in apparatus for use in the production of carbon paper. In the drawings, which show a preferred form of such an apparatus,

Fig. 1 is a central vertical section through a booth in which the coating operation is performed. Fig. 2 is a section through the upper portion thereof showing a modified form of backing shoe plate. Fig. 3 is the same as Fig. 2, showing a further modification of the backing plate. Fig. 4 is a section taken on the line 4—4 of Fig. 1. Fig. 5 is a section taken on the line 5—5 of Fig. 1. Fig. 6 is the same as Fig. 1, showing a modified form of heated cabinet and overspray recovery.

In the drawings there is shown a cabinet 10 having insulated walls with an electric heating element 11 mounted thereon for maintaining the enclosed spray booth chamber 12 at a sufficiently high temperature to permit the free flow of the coating material, such as may incorporate a waxy base.

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In the upper portion of the cabinet there is provided a concave downwardly extending backing plate 13 faced with a spring shoe 14 over which the material 15 to be coated is drawn. Said material may be in the form of a paper strip continuously drawn over the backing plate from a roller 15a and guided in its passage therefrom by passing between the rollers 16 and 17.

Mounted in one wall of the cabinet there is one or more spray guns, indicated at 18, connected by a suitable hose 19 to a source of supply, not shown. The gun 18 is mounted to direct a spray of coating material over the under exposed surface of the material to be coated substantially parallel to and in the direction of its travel, being herein shown as directed tangentially to the curvature of the backing plate. By thus directing the spray along the under exposed surface of the paper, any globules will pass on under their inertia and not be deposited on the surface of the paper. Only the finer spray particles will be attracted to and precipitated on the surface of the paper due to the electrostatic force to which they are subjected.

For effecting the electrostatic precipitation of the finer particles to thereby produce a more evenly distributed coating of material, the backing plate 13 and shoe 14 are electrically connected to ground as indicated at 20. Spaced therefrom and supported within the cabinet there is provided a discharge electrode 21 connected by a conductor 22 to a source of high voltage 23, said source having one terminal thereof grounded at 24. The discharge electrode 21 is in the form of a plurality of endless wires movably mounted about a series of rollers 25, one of which comprises a driving roller for continuously moving said wires in the direction of the arrows.

The backing plate 13 and shoe 14 comprise a grounded collecting electrode, wherein the spaced discharge electrode 21 is at high potential relative thereto such as to establish an electrostatic field therebetween into which the coating material is sprayed for electrical attraction to and deposition upon the surface of the paper in the manner more specifically set forth in Letters Patent to Ransburg and Green, No. 2,247,963, granted July 1, 1941, for "Apparatus for spray coating articles."

For reclaiming the overspray and any globules discharged from the gun, the opposite walls and bottom of the cabinet are protected by a metal mesh belt 26 adapted to be continuously caused to move about a series of rollers 27 in the direction of the arrows. Said belt is also grounded

through its rollers 27, and since it moves about the several sides of the discharge electrode 21, it acts as a collecting electrode in a manner similar to the backing plate 13. Thus, any overspray particles or globules passing into the electrostatic field created between the discharge electrode 21 and the collecting electrode or overspray belt 26, will be attracted to said belt for deposition thereon rather than on the insulated walls of the booth.

In the manner of the invention of Charles K. Gravley, filed January 15, 1940, Serial No. 313,914, now Patent No. 2,359,476, issued October 3, 1944, entitled "Electrostatic method and apparatus," any accumulation of said coating material on the discharge electrode wires 21 will be carried to the bottom of the electrode, there accumulating in droplets which will be "de-teared" by the electrostatic forces for deposition on the overspray collecting belt 26 passing thereunder and acting as a collecting electrode, in the same manner as set forth in the above-mentioned application.

The overspray and "de-teared" coating material will be recovered from the overspray belt by passing it into a heated recovery sump 28 about a driving roller 29 driven from a motor 30. As the belt passes about the roller 29 the material is brushed and eliminated therefrom by the rotating brushes 31 and scraped from the belt and brushes by the scraper blades 32. Thus, all overspray is eventually recovered in the sump 28 from which it may be removed for re-use while the walls of the booth and the discharge electrode are maintained comparatively free of accumulation of the coating material.

Wherein it is desired to protect certain portions, such as the edges of carbon paper, from being coated, endless masking strips 33 are carried about the rollers 34 in such manner as to be pressed against the surface to be coated during its travel through the booth for masking the prescribed portions thereof. Since it is necessary that such masking strips be cleaned of the material before again coming in contact with the surface to be coated, they are directed into the sump 28 where the material is brushed therefrom by the roller brush 35 and scraped by the scraping blade 36 before leaving the sump and passing exteriorly of the booth into contact with the paper as it leaves the supply roll 15a.

To maintain equalization of pressure inside the booth, an exhaust port 37 is provided on one wall thereof.

In the modified form of backing plate, shown in Fig. 2, said plate 113 carries a pair of rollers 113a at each end thereof over which an endless belt 114, in lieu of the stationary spring shoe 14 above described, is caused to travel. The paper strip to be coated is drawn over the under downwardly curved side of the shoe in direct contact with the belt 114, said belt being driven by one of the rollers 113a at the same linear speed at which the paper is drawn. This arrangement permits the coating of very light weight material because it eliminates the drag incident to sliding the paper in frictional contact with the stationary surface in the manner of said spring shoe 14 above described.

In the modified form illustrated in Fig. 3, the backing plate 213 is comprised of a series of rollers 214 over which the paper strip 15 is drawn in rolling contact therewith to in this manner reduce drag and thereby permit of coating a lighter and more fragile material.

Fig. 6 is the same as Fig. 4 showing a modified form of cabinet booth wherein the walls thereof are arranged for drainage of the overspray. In this modification the walls of the cabinet 410 are similarly insulated and heated electrically, as in the above described cabinet, to a temperature sufficiently high to be consistent with good flow of the material and also to prevent undue condensation. The material 15 to be coated is drawn through the cabinet over a shoe 414 mounted on a backing plate and serving as a collecting electrode 413 in the manner above described. In this arrangement of booth it may be assumed that no masking strips are required in respect to the material to be coated, and that the only requirement in connection therewith is the recovery of the overspray. For this purpose a collecting electrode 426 is mounted on the floor of the booth to "de-tear" the discharge electrode wires 21. Said collecting electrode, as well as the floor, are arranged to slope downwardly from the middle to either side, to direct the flow of accumulated coating material into the sumps 428 extending along each wall. Similarly, the side walls terminate into said sumps and are maintained at such temperature that the coating material collected thereon will flow freely down the inner surface and drip therefrom.

The terms "discharge" and "collecting" as applied to the oppositely charged electrodes between which the field exists are used herein in the following sense—namely, a discharge electrode is one which presents sharply curved surfaces of relatively small area toward the collecting electrode, while the collecting electrode, either of itself or in co-operation with a base, article, or web in contact with it, presents surfaces of relatively large area and slight curvature toward the discharge electrode. Because of the shape and curvature of the discharge electrode, an electrical discharge can be created over its surface thus causing the surrounding air to become ionized and conducting with the result that coating-material particles entering such air become charged without contacting the discharge electrode. No such phenomenon exists at the surface of the collecting electrode, because of its large area and slight curvature. A field existing between a small-area, sharply curved "discharge" electrode and a large-area, gradually curved or flat "collecting" electrode is characterized by the fact that the lines of force diverge from the discharge electrode toward the collecting electrode and by the fact that the local potential gradient is much higher adjacent the former electrode than adjacent the latter. This is in contrast to a field existing between two extended, flat or gradually curved plates, for in such field the lines of force are approximately parallel and the local potential gradient is substantially the same at both electrodes.

The invention claimed is:

1. Apparatus for coating the surface of sheet material, comprising a collecting electrode, means for continuously drawing said material over the underside of said electrode, a discharge electrode mounted below said collecting electrode and spaced relative thereto, said collecting electrode presenting toward the discharge electrode an extended surface of relatively large area, and said discharge electrode presenting toward the collecting electrode sharply curved surface portions of relatively small aggregate area, a source of unidirectional high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an ionizing elec-

trostatic field therebetween, and a spray gun mounted to discharge a spray of adherent coating particles of different size into said field below said collecting electrode and over and generally parallel to the under exposed surface of said material whereby the finer of said particles are deposited on said sheet material.

2. Apparatus for coating the surface of sheet material, comprising a collecting electrode, means for continuously drawing said material over the underside of said electrode, a discharge electrode mounted below said collecting electrode and spaced relative thereto, said collecting electrode presenting toward the discharge electrode an extended surface of relatively large area, and said discharge electrode presenting toward the collecting electrode sharply curved surface portions of relatively small aggregate area, a source of unidirectional high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an ionizing electrostatic field therebetween, and a spray gun mounted below said collecting electrode and material to direct a spray of adherent coating particles of different size in a direction substantially parallel to and with the travel of said sheet material within said field, said electrostatic field and the force of gravity acting on said coating material whereby the finer particles thereof are deposited on said sheet material.

3. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted to discharge a spray of coating material into said field and over the said exposed surface of said sheet material, and an endless screen mounted for travel about the inner walls of said booth arranged relative to said field and spray to receive and carry off overspray therefrom.

4. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted to discharge a spray of coating material into said field and over the said exposed surface of said sheet material, an endless screen mounted for travel about the inner walls of said booth arranged relative to said field and spray to receive and carry off overspray therefrom, and means for engaging said screen in its travel to remove excess coating material therefrom.

5. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted to discharge a spray of coating material into said field and over the said exposed surface of said sheet material, an endless screen mounted for continuous travel about the inner walls of said booth arranged relative to said field and spray to receive and carry off overspray therefrom, a collecting sump through which said screen is adapted to travel, and means mounted in said sump for removing excess coating material therefrom.

6. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode movably mounted in said booth and having movable surfaces, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted on said booth arranged to discharge a spray of coating material into said field directed over the said exposed surface of said sheet material, a second collecting electrode positioned on the opposite side of said discharge electrode and electrically connected with said source of high voltage, and means for moving said discharge electrode from adjacent said first-mentioned collecting electrode to adjacent said second mentioned collecting electrode whereby overspray on said discharge electrode will become "de-teared" by the electrostatic force of said second collecting electrode.

7. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode movably mounted in said booth and having movable surfaces, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted on said booth arranged to discharge a spray of coating material into said field directed over the said exposed surface of said sheet material, a second collecting electrode positioned on the opposite side of said discharge electrode and electrically connected with said source of high voltage, means for moving said discharge electrode from adjacent said first-mentioned collecting electrode to adjacent said second mentioned collecting electrode whereby overspray on said discharge electrode will become "de-teared" by the electrostatic force of said second collecting electrode, and means for engaging said second collecting electrode to remove accumulated and "de-teared" overspray therefrom.

8. Apparatus for coating the surface of sheet material, comprising a support having a flexible shoe secured to the under side thereof, means for continuously drawing said sheet material over the lower exposed face of said shoe, a discharge electrode in opposed spaced relation to said shoe and the exposed surface of said material, said discharge electrode presenting toward the shoe sharply curved surface portions of relatively small aggregate area, a source of high voltage to establish an ionizing electrostatic field between said shoe and said electrode, and a spray gun arranged to discharge a spray of adherent coating material into said field directed over and generally parallel to the exposed surface of said sheet material.

9. Apparatus for coating the surface of sheet material, comprising a collecting electrode hav-

ing an endless belt associated therewith, means for moving said belt and drawing said material in contact therewith past said electrode, a discharge electrode mounted in opposed spaced relation to said collecting electrode and the exposed surface of said material, said collecting electrode presenting toward the discharge electrode an extended surface of relatively large area, and said discharge electrode presenting toward the collecting electrode sharply curved surface portions of relatively small aggregate area, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an ionizing electrostatic field therebetween, and a spray gun arranged to discharge a spray of adherent coating material into said field directed over and generally parallel to the exposed surface of said sheet material.

10. Apparatus for coating the surface of sheet material, comprising a collecting electrode having a series of rollers mounted over the under side thereof to provide a contact shoe, means for drawing said material over and in rolling engagement with said rollers, a discharge electrode mounted in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, and a spray gun mounted to discharge a spray of coating material into said field directed over the exposed surface of said sheet material.

11. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted in said booth arranged to discharge a spray of coating material into said field directed over the exposed surface of said sheet material, an overspray collecting sump associated with said booth, an endless overspray collecting screen embracing said field and the spray from said gun for intercepting any overspray therefrom, means for moving said screen through said collecting sump, and means mounted therein engageable with said screen for removing excess overspray therefrom.

12. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted in said booth arranged to discharge a spray of coating material into said field directed over the exposed surface of said sheet material, and an overspray collecting electrode screen at least partially surrounding said field and electrically connected to said first-mentioned collecting electrode, said screen being spaced below said discharge electrode for establishing an electrostatic field therebetween effective to "de-tear" excess coating from said discharge electrode to said screen.

13. Apparatus for coating the surface of sheet material, comprising a spray booth, a collecting electrode mounted therein, means for drawing said material over said electrode, a discharge electrode mounted in said booth in opposed spaced relation to said collecting electrode and the exposed surface of said material, a source of high voltage having its opposite terminals electrically connected with said electrodes respectively to establish an electrostatic field therebetween, a spray gun mounted in said booth arranged to discharge a spray of coating material into said field directed over the exposed surface of said sheet material, an overspray collecting electrode screen at least partially surrounding said field and electrically connected to said first-mentioned collecting electrode, said screen being spaced below said discharge electrode for establishing an electrostatic field therebetween effective to "de-tear" excess coating from said discharge electrode to said screen, means for moving said screen, and means engageable therewith for removing excess overspray therefrom.

14. In apparatus for applying a coating to the surface of a continuous sheet of flexible material, a collecting electrode, movable means associated with said collecting electrode in position to engage and move with said sheet and to hold it in curved condition, means for drawing said sheet longitudinally past said collecting electrode and in contact with said movable means, a discharge electrode located in opposed spaced relation to said collecting electrode, said collecting electrode presenting toward the discharge electrode an extended surface of relatively large area, and said discharge electrode presenting toward the collecting electrode sharply curved surface portions of relatively small aggregate area, means for imposing upon said electrodes a substantial potential difference to create between them an ionizing electrostatic field capable of propelling finely divided particles of coating material toward said collecting electrode and causing them to become deposited on said sheet, and means for introducing finely divided adherent particles of coating material in said field.

15. The invention set forth in claim 14 with the addition that said movable means comprises an endless belt.

16. The invention set forth in claim 14 with the addition that said movable means comprises the peripheral portions of a plurality of rollers arranged in a curved series.

17. In apparatus for applying a coating to the surface of a continuous sheet, spaced collecting and dicharge electrodes, means for moving said sheet through a coating zone between said electrodes and in spaced relation to said discharge electrode, means for discharging a spray of finely divided coating material into the space between the sheet and discharge electrode and in a direction generally parallel to the sheet, a flexible overspray screen, means for moving said screen over a path which includes a portion located beyond said coating zone and toward which said spray is discharged, and means for maintaining a substantial potential difference between said two electrodes and between said discharge electrode and said screen to create in the coating zone between said electrodes an electrostatic field urging particles of coating material in the coating zone toward the sheet for deposition thereon and to create between said discharge electrode and screen an electrostatic field urging particles

of coating material beyond the coating zone toward the screen for deposition thereon.

18. In apparatus for applying a coating to an article, an article support, an endless flexible discharge electrode, a detearing electrode, means supporting said discharge electrode for movement over a closed path including one portion spaced from and opposed to an article on said support and another portion spaced from and opposed to said detearing electrode, means for moving said discharge electrode over said path, means for introducing finely divided particles of coating material in the space between said first path-portion and an article on said support, and means for maintaining a potential difference between said discharge electrode and an article on said support and a potential difference between said electrodes, said first named potential difference being sufficient to create over the surface of an article on said support an electrostatic field urging coating material particles toward such article and said second potential difference being sufficient to create between said two electrodes an electrostatic field capable of causing coating-material particles on said discharge electrode to move therefrom and to the detearing electrode.

19. In apparatus for applying a coating to an article, an article support, a discharge electrode, a detearing electrode, means supporting said discharge electrode for movement between a first position opposed to and spaced from an article on said support and a second position opposed to and spaced from said detearing electrode, means for moving said discharge electrode between said positions, means for introducing finely divided particles of coating material in the space between said first position and an article on said support, and means for maintaining a potential difference between said discharge electrode and an article on said support and a potential difference between said electrodes, said first named potential difference being sufficient to create over the surface of an article on said support an electrostatic field urging coating material particles toward such article and said second potential difference being sufficient to create between said two electrodes an electrostatic field capable of causing coating-material particles on said discharge electrode to move therefrom and to the detearing electrode.

20. Apparatus for coating a generally downwardly presented surface of an article having, in combination, means for imparting a first force substantially exclusively through a gaseous medium to adherent coating particles of different size for moving them into the space adjacent said surface where they are free to be moved away from said surface by the force of gravity, said first force having a component in a direction generally parallel to said surface, and means, including a unidirectional source of high voltage and a discharge electrode presenting toward the article surface sharply curved surface portions of relatively small aggregate area, for establishing an ionizing electrostatic field in said space, the force of said field being substantially opposed to the force of gravity, whereby said coating particles become charged on entry into said field and the field force opposes the force of gravity acting on the finer of said particles sufficiently to effect their deposition on said surface.

21. Apparatus for coating an article having, in combination, spaced collecting and discharge electrodes, means for moving said article through a coating zone between said electrodes, means for imparting a force to coating particles substantially exclusively through a gaseous medium to move them into the space between said article and said discharge electrode, catching means located outside said coating zone and opposite said coating introducing means, and means for maintaining a substantial potential difference between said two electrodes and between said discharge electrode and said catching means, said potential creating means being adapted to create in the coating zone between said electrodes an ionizing electrostatic field whose lines of force are transverse to the path of movement of said coating particles and which urges said coating particles in the coating zone toward said article for deposition thereon and which creates between said discharge electrode and said catching means an electrostatic field urging the coating particles that have passed beyond the coating zone toward said catching means for deposition thereon.

22. Apparatus for coating an article having, in combination, a discharge electrode means comprising a plurality of movable wires, each of said wires being positioned adjacent and spaced from another wire and each of said wires being adapted to be moved over a closed path; a detearing electrode; means for moving said wires to two positions, the first position being adjacent to and spaced from the article and the second position being adjacent to and spaced from said detearing electrode; means for introducing coating material into the space between the article and said discharge electrode means in said first position, some of the excess of said coating material being deposited on said wires; and means electrically connected to said article and said electrodes for maintaining a potential difference between said article and said discharge electrode means and also between said discharge electrode and said detearing electrode, said potential being sufficient to create between said electrodes an electrostatic field capable of causing the excess coating material on said wires to be removed therefrom to said detearing electrode when said wires are in said second position.

23. Apparatus for electrostatically coating sheet material having in combination a hollow casing, means for guiding through said casing the sheet to be coated, means for introducing a spray of finely divided coating material in a gas stream into said casing in a region adjacent the path of travel of the sheet, said casing having an air exhaust opening remote from the point of introduction of the coating material, and means for creating electrostatic fields in the region adjacent the point of introduction of coating material and in the region adjacent said exhaust opening, said last named means including a discharge electrode disposed in opposed spaced relation to the sheet adjacent said introducing means and presenting toward the sheet sharply curved surface portions of relatively small aggregate area.

24. In apparatus for applying an adherent coating material to continuous sheet material, a casing, means for guiding said sheet through said casing over a predetermined path, means for introducing particled adherent coating material into said casing and causing it to move generally parallel to and in the same direction as the sheet, and means for creating an electrostatic field over the surface of the sheet within the casing for urging the particled coating material toward the sheet, said means including a discharge electrode spaced from the sheet and presenting thereto-

ward sharply curved surface portions of relatively small aggregate area, the parts of said apparatus being so constructed and arranged that the force of gravity is without material effect in urging the particled material toward the sheet.

25. The invention according to claim 5 with the addition that said collecting sump is heated.

26. Apparatus for coating the surface of sheet material with an adherent coating material whose viscosity decreases with increased temperature, said apparatus having in combination a hollow casing, means for guiding through said casing the sheet to be coated, means for producing a spray of finely divided particles of the liquid coating material and introducing it into a coating zone adjacent the path of travel of said sheet, means including a discharge electrode disposed in opposed spaced relation to said sheet in said coating zone for creating an ionizing electrostatic field over a portion of the surface of said sheet, and means for heating the coating zone to promote fluidity of undeposited coating material in the spray.

EDWIN M. RANSBURG.
NORMAN S. CURTIS.

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