United States Patent [19]

Probst

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[54] **ELECTROSTATIC COATING METHOD**

[76] Inventor: **Richard O. Probst,** 3939 W. 56th St., Indianapolis, Ind. 46208

[22] Filed: **May 25, 1971**

[21] Appl. No.: **146,822**

Related U.S. Application Data

[63] Substitute for Ser. No. 833,401, June 16, 1961, Pat. No. 3,630,442.

[52] **U.S. Cl.** ..... **117/17,** 117/21, 117/104 R, 117/105.4, 118/621, 118/627, 118/308, 239/3, 239/15

[51] **Int. Cl.** **B05b 5/02,** B44d 1/94

[58] **Field of Search** .....117/17, 21, 105.4, 104, 117/93.4 R, 93.42; 118/621, 627, 308; 239/3, 15

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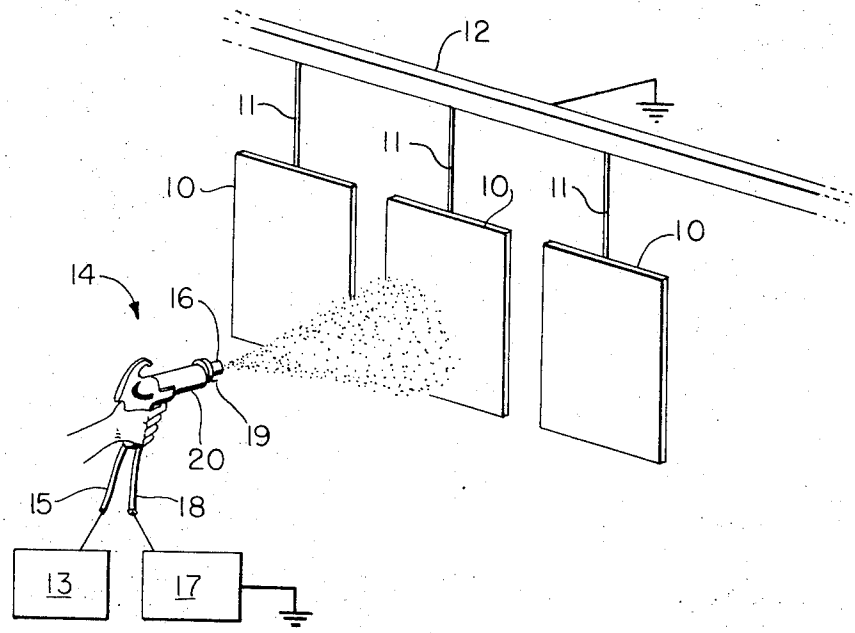
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Primary Examiner—William D. Martin
Assistant Examiner—Michael Sofocleous
Attorney, Agent, or Firm—Merrill N. Johnson; Harry E. Downer; David H. Badger

[57] **ABSTRACT**

A method for electrostatically applying solid particles to an article includes the steps of forming the solid particles into a pattern and directing them at the article, preferably in a relatively flat, fan-like spray. An electrostatic field is established between the article and an electrode that creates a single highly ionized zone offset from and rearwardly of the spray. The percentage of solid particles which are sprayed but remain undeposited is reduced using this method.

1 Claim, 3 Drawing Figures



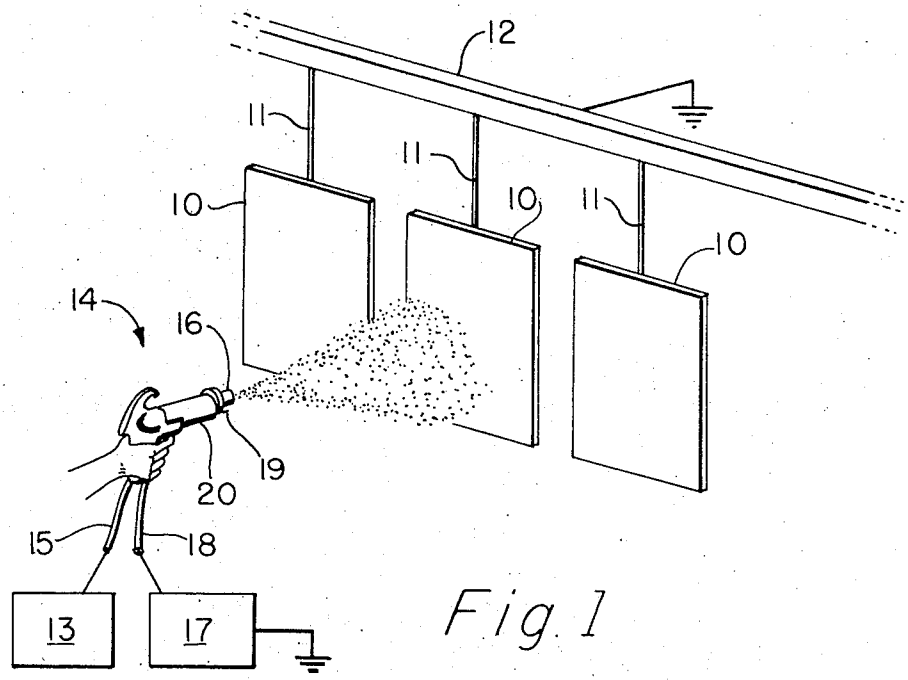


Fig. 1

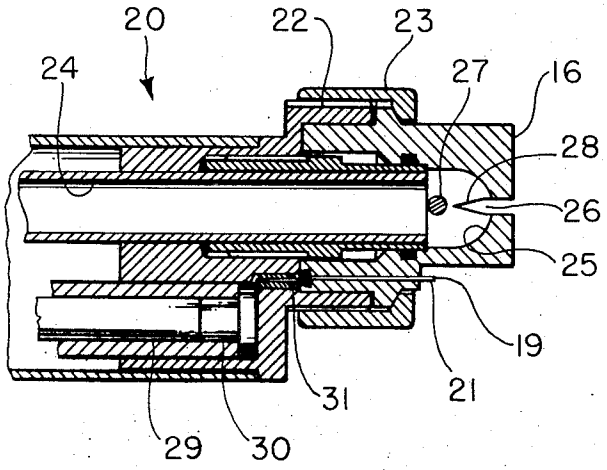


Fig. 3

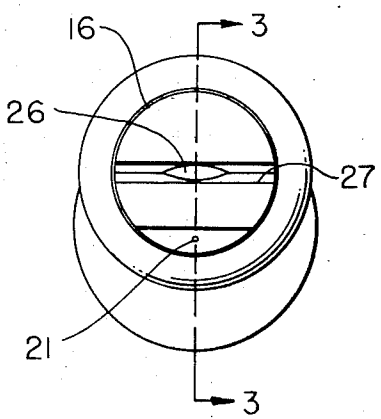


Fig. 2

ELECTROSTATIC COATING METHOD

This is a division of application Ser. No. 833,401 filed June 16, 1969, now U.S. Pat. No. 3,630,442.

BACKGROUND OF THE INVENTION

This invention relates to a method and apparatus for electrostatically charging and depositing a spray of solid particles on an article.

Many coatings are more advantageously applied in dry powder form than as resins dissolved in a liquid carrier. Such coatings include those formed from pigmented resins of polyethylenes, nylon, polyvinyl chloride and epoxides among others. Because of the expense of such materials, it is desirable, when applying such coating, to reduce the amount of material which is not deposited on the articles being coated.

Where thermoplastic or thermosetting powder material is to be applied to an article, the article in some instances is raised to a temperature above the fusion temperature of material but below the temperature at which the material is deleteriously affected. The solid particles of material upon being deposited upon the article are fused into a continuous film. In other instances where electrostatic charging is used, heating is sometimes unnecessary and the solid particles which are deposited on the article are retained on the surface of the article as a coating of discrete particles by virtue of their electrostatic charge until they can be fused.

Such powdered resin material generally is in the form of solid particles having an average size in the range of 200 to 400 mesh. Solid particles other than thermoplastic or thermosetting materials having sizes outside of this range may also be applied using this invention.

Guns for spraying an air-suspension of solid particles and for electrically charging the spray of solid particles are now in common use. Many combinations of spray nozzles and charging electrodes in a variety of configurations and arrangements are known. For example, it has been common in such guns irrespective of whether the discharged spray is of either conical or flat, fan-like form, to effect the charging of powder by the use of an annular ionizing electrode surrounding the spray. Such an annular electrode has been formed at one or both edges of an annular slot in a nozzle that forms the solid particles into a conical spray. Annular ionizing electrodes have also been formed on one edge of a nozzle that forms the solid particles into a spray having a flat, fan-like form so that they surround the spray near its source. An annular ionizing electrode located rearwardly of the spray, in some instances, supplemented the electrode formed on the edge of the nozzle.

Other ionizing charging electrodes disclosed for use with nozzles having an elongated spray emitting orifice and creating an elongated, flat spray pattern of solid particles have included elongated ionizing electrodes forming one or both edges of the elongated orifice. Elongated ionizing electrodes have also been positioned in an elongated flat spray pattern of solid particles with their long dimension coextensive with the long dimension of the elongated spray pattern.

In addition, it has been suggested that solid particles can be formed into a spray pattern and charged by adjustably positioning particle deflectors, which have been connected to a source of high voltage, in front of an orifice emitting the solid particles. Such deflectors have included ellipsoidal, cylindrical and hemispherical shapes, among others, located on the axis of the orifice to electrostatically charge and deposit solid particles.

A single wire ionizing and charging electrode projecting forwardly along the axis of a nozzle and within a spray pattern of solid particles is known. Such single wire electrodes, however, have not proved to achieve satisfactory results. Also known is the use of a wire electrode projecting forwardly beyond the orifice at one side of and space slightly from the spray. Such an electrode arrangement, however, provides lower transfer efficiency (the ratio of the weight of material deposited on an article to the weight of material discharged from a gun) in a powder gun than does an annular-electrode of the types described above.

FEATURES OF THE INVENTION

In the method of electrostatically depositing solid particles which comprises this invention, the solid particles are formed into a pattern and directed at the article upon which the particles are to be deposited. An electrostatic field is established to the article from a point offset from the spray pattern and located rearwardly of the pattern. At this point a single highly ionized zone is created. Apparatus to practice this method may be achieved by providing, in a system including a source of solid particles and means to provide a flow of solid particles, a nozzle of non-conducting material to form the solid particles into a pattern that is emitted from an orifice and directed at an article, and a single elongated electrode, preferably carried by the nozzle, having a tip located offset from and rearwardly of the orifice. In such a system when the single elongated electrode is charged to high voltage with respect to the articles, it creates a single highly ionized zone and a strong electrostatic field to the article. In using this invention, the number of solid particles emitted from the nozzle that are not ultimately deposited upon the article being coated is greatly reduced. With a non-conducting nozzle that forms solid particles into a flat, fan-like spray and that includes an electrode formed of 0.020 wire and having a tip located offset one-half inch laterally from the plane of the spray and about one-half inch rearwardly of the orifice, the percentage of solid particles not deposited upon the article can be reduce by 20 to 30 percent over prior solid particle electrostatic spray methods and apparatus, under similar conditions.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective drawing of a system for electrostatically charging and applying solid particles to the articles to be coated using the method and apparatus of this invention.

FIG. 2 is a front view of a nozzle and electrode embodying this invention.

FIG. 3 is a cross-sectional view of this nozzle and electrode along the plane illustrated by line 3—3 of FIG. 2, through the center of the nozzle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The articles to be coated, which may be plate-like members **10** as illustrated in FIG. 1, are hung from conductive supporting members **11** depending from a conveyor **12**, which is maintained at ground potential. The articles **10** are electrically connected to ground poten-

tial by electrical contact with the conductive depending members **11** and the grounded conveyor **12.**

Solid particles of the coating material to be applied are placed in the material source **13.** Source **13** of coating material for the spray gun **14** includes a foraminous plate (not shown) upon which the solid particles of coating material rest. Compressed air is supplied below and flows through the foraminous plate within the source of coating material **13.** In operation, the flow of compressed air to the chamber is controlled by a regulator (not shown). The air passing through the foraminous plate produces a fluidized bed of solid particles within the source **13.** An injection pump within the fluidized bed is used to withdraw coating material particles from the bed and to entrain them as a suspension in a flow of compressed air for delivery to spray gun **14.**

Solid particles of coating material are conveyed through an elongated flexible tube **15,** as a suspension in compressed air, into spray gun **14.** Delivery of coating material to spray gun **14** is controlled by the operator of the spray gun by manipulation of a trigger which actuates solenoid valve (not shown) controlling the flow of air through the injection pump. Coating material particles are withdrawn from the fluidized bed **13** and entrained in the compressed air by the injection pump. When the operator of the spray gun wishes to apply coating material particles to an article to be coated, he merely depresses the trigger of the spray gun. Coating material particles are withdrawn from the source **13** in the manner described and delivered through the elongated flexible tube **15** to an orifice in spray nozzle **16** on the spray gun. Actuation of the trigger also turns on a source of high voltage **17.** Electric charge is delivered through a high voltage conductor **18** to spray gun **14.** Coating material particles issuing from the orifice are formed into a pattern suitable for application of the solid materials to the article and directed at the article. Solid particles emitted from the orifice are electrostatically charged and deposited by establishing an electrostatic field to the article from a highly ionized zone offset from and rearwardly of the spray pattern. Using such a method, the operator can apply solid particles to the article to be coated with little waste. The method can be practiced with apparatus permitting the operator to easily manipulate the spray gun directing a flow of charged solid particles at the article **10** to achieve a uniform coating on the article.

FIGS. **2** and **3** show the front end of spray gun **14.** The front end of barrel **20** is adapted to accept spray nozzle **16** and charging electrode **21.** The barrel contains a threaded portion **22** to accept nut **23** which attaches spray nozzle **16** to the front end of barrel **20.** Spray nozzle **16,** nut **23,** and barrel **20** are all made of non-conductive material such as nylon, acetal resin solid under the trade mark Delrin by E. I. du Pont de Nemours Co., polyethylene, polypropylene, polytetraflourethylene, phenolic, or nonconductive ceramics and the like. The solid particles are conveyed as a suspension in a flowing gas through passageway **24** in the barrel **20.** Solid particles are formed by nozzle **16** into a spray pattern issuing from an orifice **26** at the front of the gun. Spray nozzle **16** includes a body **16** of nonconductive material including a bore within the body defined by walls **25** that converge at an elongated orifice **26** at its forward end. The structure includes means **27** carried within the bore including a surface protruding into the bore rearwardly of the orifice **26** and an elongated electrode **21** carried by the body with its forwardmost tip **19** offset from and rear-wardly of the orifice **26.**

As will be clear from the drawings, the tip of the electrode **21** is offset laterally from the orifice **26** in a direction perpendicular to the common plane of the elongated orifice **26** and the spray discharged therefrom. Also as is clear from the drawing, the tip of the electrode is displaced rearwardly from the orifice of the nozzle. It is in this respect that the electrode of this invention differs from the fine-wire electrodes previously used in electrostatic guns. The distance between the electrode tip and the plane of the front face of the nozzle may vary.

When charged to high voltage, typically 40,000 to 100,000 volts D.C., electrode **21** establishes an electrostatic field to the articles to be coated **10.** The tip **19** of the electrode **21** creates a single highly ionized zone. This zone being located offset from and rearwardly of the spray pattern emitted from orifice **26** charges the solid particles in the pattern and results in a greatly reduced percentage of undeposited powder. Offset from and rearwardly of the spray pattern refers to the location for the tip of the electrode and the highly ionized zone it creates that is rearwardly of the orifice of the nozzle up to on the order of 1 inch or more and offset from the axis of the orifice a distance of about one-half inch although the offset can be up to 1 inch.

A specifically preferred embodiment of my invention is the pattern forming and electrostatic charging structure shown in FIGS. **2** and **3.** The bore in the body of spray nozzle **16** has walls **25** that are hemispherical in form and converge at an elongated orifice **26.** In this specifically preferred embodiment, the elongated orifice **26** is formed at the intersection of a V-shaped groove **28** extending transversely across the front end of the nozzle with the hemispherical walls **25** of the interior bore of the spray nozzle. The body of spray nozzle **16** is formed of Teflon (registered trade mark of E. I. du Pont de Nemours Co.) reinforced with glass fibers. Spaced rear-wardly within the nozzle are means **27** to intercept and de-flect a portion of the gaseous suspension of solid particles flowing through nozzle **16.** As shown in FIG. **3,** the means **27** is a cylindrical pin within the bore of the spray nozzle and spaced rearwardly from the orifice. The nozzle shown in FIG. **3** acts upon the flowing gaseous suspension of solid particles emitted from passageway **24,** forming the suspension into an expanding fan-like spray at the orifice **26** and creating an elongated spray pattern with uniformly distributed particles.

An elongated wire-like electrode **21** is carried by spray nozzle **16** with its tip **19** rearwardly about one-half inch of the orifice from which the spray is emitted and laterally offset from the plane of the spray pattern about one-half inch. Such an electrode is desirably a short length (about 1 inch) of music wire having a diameter of 0.020 of an inch. The high voltage from voltage supply **17** is carried to the gun by high voltage cable **18** within the barrel **20** in the spray gun **14.** The high voltage cable **18** is connected to resistor **29** which is connected at its forward end with conductive plug **30** and wire **31.** Electrode **21** is electrically connected to wire **31** when nozzle **16** is attached to the front of the gun barrel. If desired, the spray nozzle **16** can be formed with a conductive plastic ring in the rear sur-

face in contact with the rear end of the elongated wire-like electrode. Resistor **29** typically has a value of 160 megohms. When short, wire-like electode **21** is connected to high voltage through a sufficiently small wire **31,** a plug **30** comprised of material having a high resistivity, and a 160 megohm resistor, the electrostatic method and apparatus of this invention can be used safely.

All parts at the forward end of the gun except the electrode **21** and the conductive elements through which high voltage is applied to the electrode are made of insulating material in order to avoid shielding of the electrode-tip. When the electrode **21** of the specifically preferred embodiment is charged with a high voltage of about 90,000 volts D.C., the spray nozzle **16** is spaced about 7 inches from a grounded article and supplied with powder at a rate of about 375 grams per minute, the percentage of powder not deposited on the article is reduced below that obtainable with any other relationship between the spray pattern and the tip of the electrode and the single highly ionized zone it creates.

While I have shown and described the preferred embodiment of my invention, it is to be understood that it is capable of modification. For example, the electrostatic field and highly ionized zone may be created by charging the articles to be coated and grounding the electrode adjacent the spray pattern. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the following claims.

I claim:

1. A method of electrostatically depositing solid particles on an article comprising, conveying the solid particles as a suspension in a flowing gas to a nozzle, forming the solid particles at the nozzle into a spray pattern by expanding the suspension into a plane in a fan-like form to create an elongated pattern with a uniform distribution of particles directed at the article, changing the particles in the pattern for electrostatic deposition by establishing an electrostatic field between the article and a single highly ionized zone offset about one-half inch from the plane of the elongated fan-like spray pattern and about one-half inch rearwardly of the formation of the pattern and depositing the charged particles on an article to form a coating thereon.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,793,049 Dated February 19, 1974

Inventor(s) Richard O. Probst

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 46, "reduce" should read -- reduced --. Column 3, line 56, "solid" should read -- sold --. On the cover sheet insert -- [73] Assignee: Ransburg Electro-Coating Corp., Indianapolis, Ind. --.

Signed and sealed this 24th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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