April 2, 1968 D. C. WHITAKER ET AL 3,376,156

SPRAY PAINTING EMPLOYING HIGH VOLTAGE CHARGING

Filed March 19, 1964 3 Sheets-Sheet 1

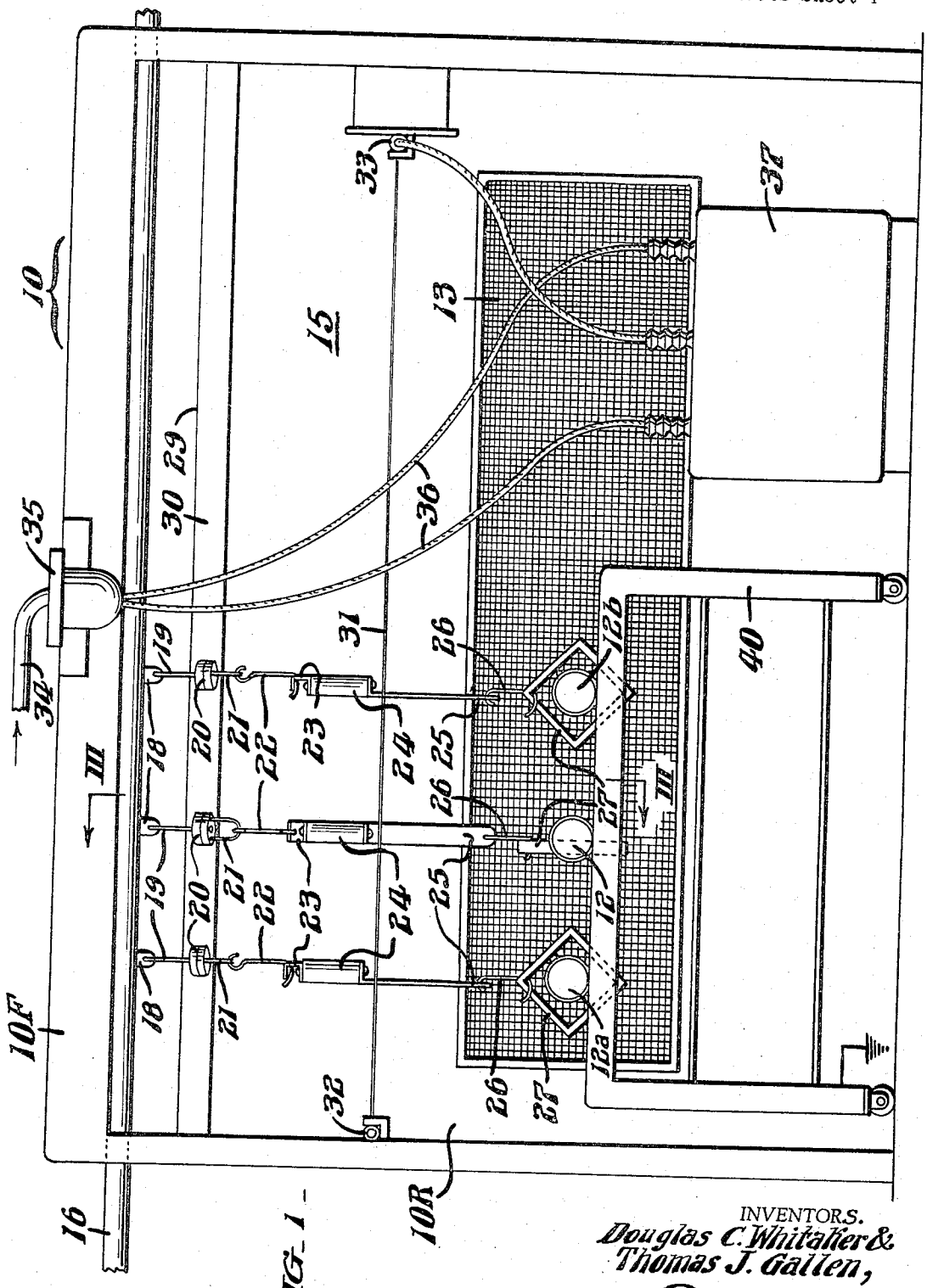


FIG. 1

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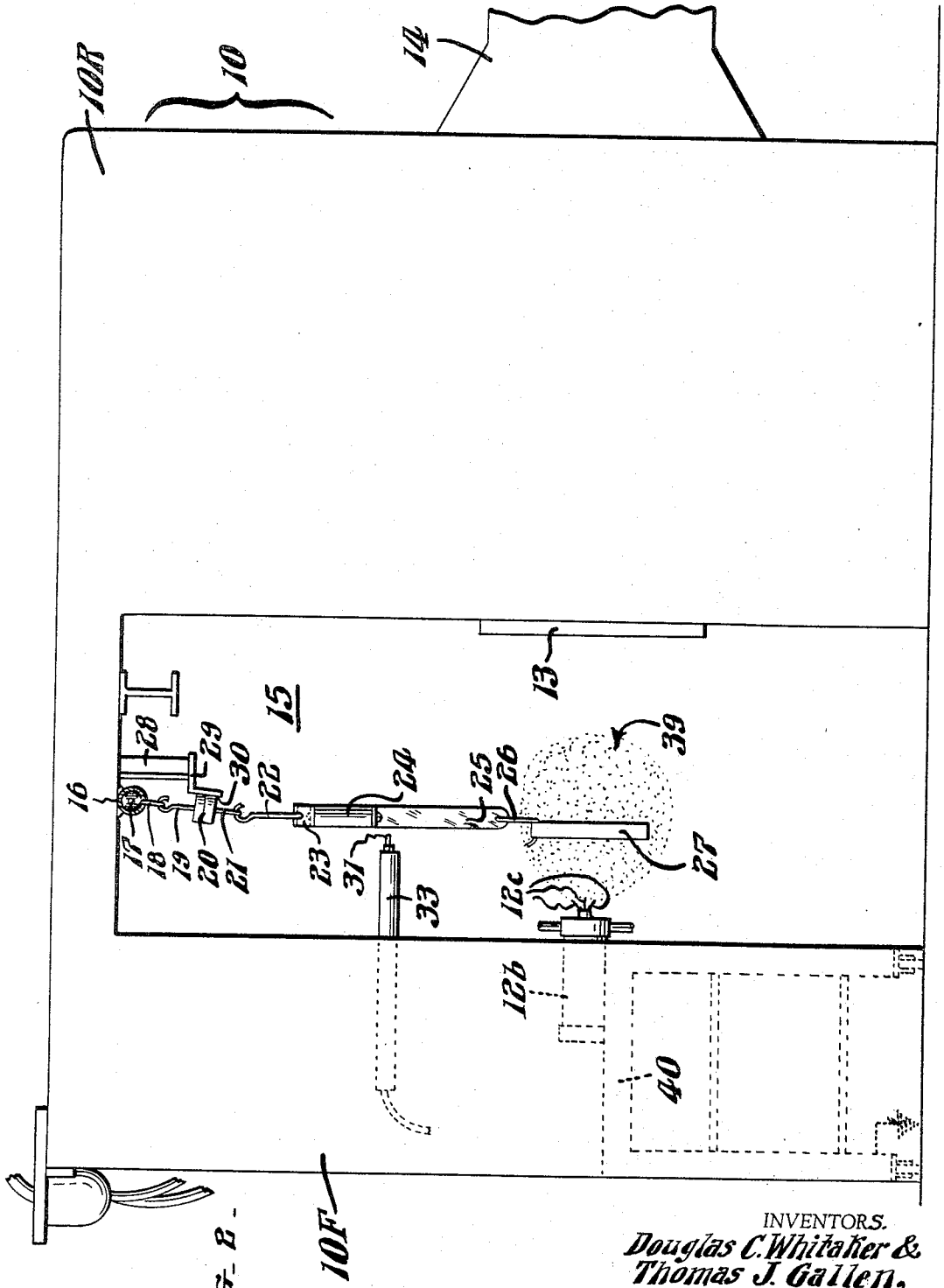


FIG. 2.

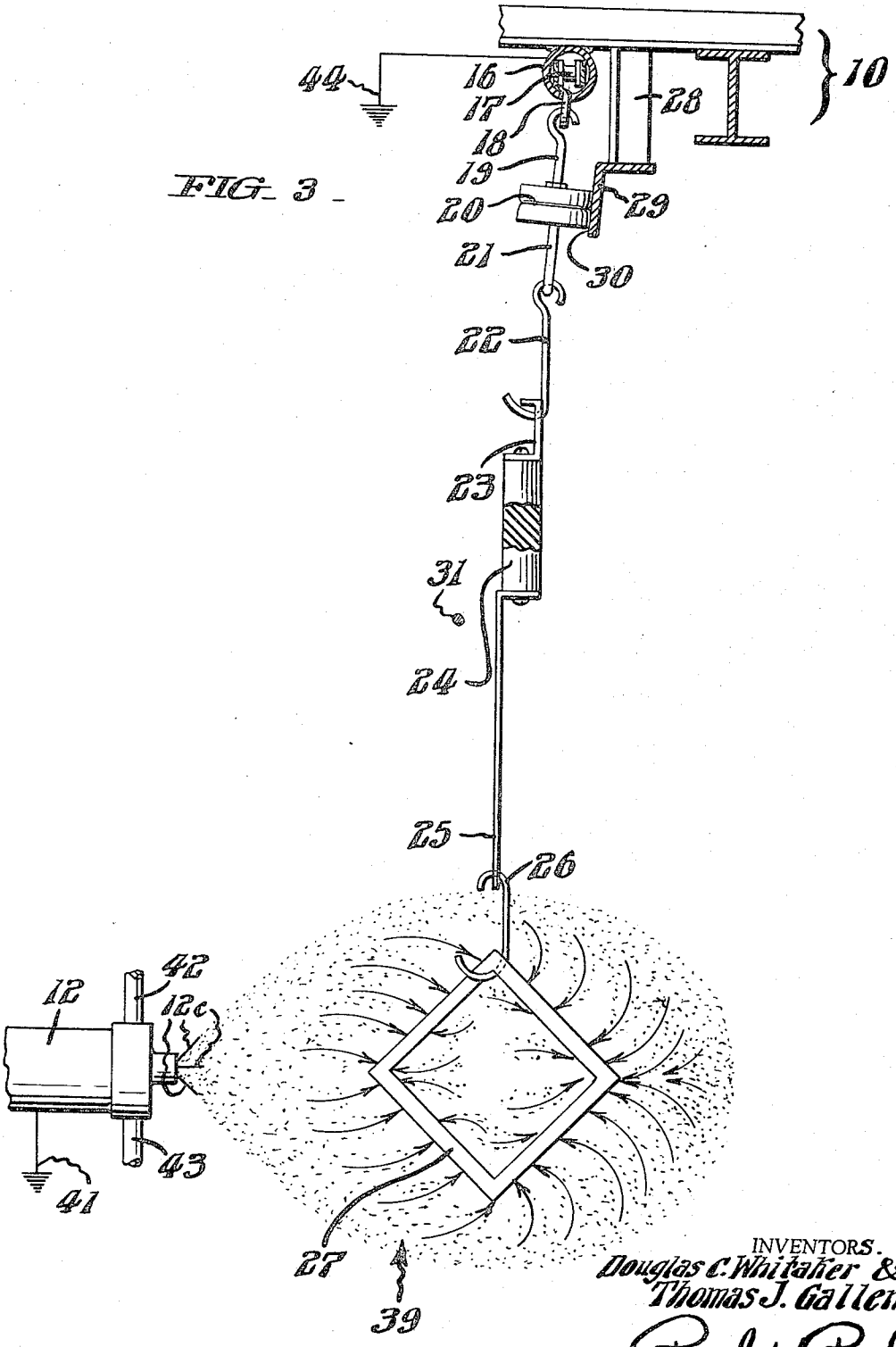
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SPRAY PAINTING EMPLOYING HIGH VOLTAGE CHARGING

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FIG. 3



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3,376,156

SPRAY PAINTING EMPLOYING HIGH VOLTAGE CHARGING

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for spray painting work pieces is disclosed in which atomized paint particles are ejected from a grounded spray gun and directed at, or into the path of, inductively charged work pieces.

This invention relates to spray painting.

A particular object of the invention is to provide an improved method and apparatus for spraying paint (or other coating materials) on to shaped (or other) articles to form uniformly even coatings of suitable thickness, and with a minimum waste of paint.

In accordance with our present invention, the spray painting is performed in a charged high-voltage atmosphere. However, as will be pointed out later, there are a number of important differences between the spray painting system of the present invention and the electrostatic spray painting systems of the prior art.

Referring now to the drawing;

FIG. 1 is a diagrammatic side elevational view of a preferred form of spray painting apparatus according to the present invention;

FIG. 2 is a diagrammatic and elevational view looking in from the right in FIG. 1; and

FIG. 3 is an enlarged elevational view looking along the line III—III of FIG. 1.

Referring now to the drawing, the reference numeral **10** represents a structural housing or booth which is divided by a through passage **15** into a front portion **10F** and a rear portion **10R**. Mounted in the front portion **10F** are one or more spray guns **12** and associated equipment. Three guns **12**, **12***a* and **12***b* are shown in FIG. 1. Each gun is mounted, as on bench **40**, to point rearwardly toward an exhaust grill **13** in the rear portion **10R** through which air is drawn from the passage **15** and exhausted in a controlled manner, as by an exhaust fan not shown, into the exhaust duct **14**.

An overhead conveyor passes through the passage **15** from which are suspended, at spaced intervals, the articles or pieces of work to be coated. The overhead conveyor, which may be of any suitable type, is illustrated as comprising an overhead channel or track **16** in the form of a cylindrical pipe or tubing having therein an endless chain **17** which is pulled through the track **16** by any suitable drive means, not shown. The under surface of the track **16** is provided with a continuous slot through which protrude a plurality of eyes **18** which are secured to the chain **17** at spaced intervals.

Secured to and supported by each of the chain eyes **18** are a group of supporting and insulating components connected in series and from the lower end of which the work piece **27** is suspended. In the illustrated embodiment, the series of components includes, starting at the top the hook rod **19** having thereon the roller **20**, the U-hook **21**, the double-ended hook **22**, the insulator support arm **23**, the insulator **24**, the angle member **25**, and the work hook **26** from which the work piece **27** is suspended. The rod **19** has a hook at its upper end for inserting into the hole of the chain eye **18**. Rotatably secured to the lower end of rod **19** are a pair of cylindrical metal cups in back-to-back relation, forming the roller **20** adapted for rotation about the axis of the rod **19**. Secured to the lower cup of the roller **20** is a U-hook **21** which turns rotationally when roller **20** is rotated. Suspended from the U-hook **21** is a double-ended hook **22** from which is vertically suspended a dependent metal support arm **23**. To the lower end of the metal support arm **23** is secured a rod-like insulator **24**, to the lower end of which is secured a metal angle member **25**, having a hole in its vertical portion for receiving the double-ended metal hook **26** from which is suspended the work **27** to be painted. In the drawing, the work to be painted is illustrated as being a rectangular metal frame **27**, but this is merely illustrative since the work could have many different shapes.

A beam **28** is fastened to the ceiling of the booth **10** at a location close to the conveyor track **16** and in a position which parallels the track **16** at a small spaced separation therefrom. Secured to the under surface of beam **28** is an angle member **29**, having a vertical depending portion, the surface **30** of which, facing the roller **20**, is provided with an abrasive coating or is otherwise roughened, so that as the conveyor is moved the roller **20** frictionally engages the abrasive or roughened surface **30** and is caused to rotate, thereby causing the rotation of all of the parts which are suspended from the U-hook **21**, namely, the double-hook **22**, the metal support arm **23**, the insulator **24**, the angle member **25**, the support hook **26**, and the work piece **27**, all of which rotate continuously as the conveyor chain moves through the booth **10**.

A high-voltage wire **31**, supported at each side wall of booth **10**, is so mounted as to extend through passage **15** below the level of the insulator **24**, preferably just below the lower end thereof. The location of wire **31** is very close to the path traveled by the members **25**. The preferred spacing between wire **31** and the members **25**, as they are moved through the booth by the conveyor system, is of the order of 1"–1½". High-voltage wire **31** is supported at each side of the booth by the high-voltage insulators **32** and **33**. One end of wire **31** (the right end in FIG. 2) is connected to a high-voltage supply, which may take any suitable form, and may be of the order of 40,000–100,000 volts D.C. In the drawing, the high-voltage supply is illustrated as being comprised of power line cable **34**, the support insulator **35**, the feed wires **36**, and the high-voltage transformer and rectifier **37**. The other end of the high-voltage wire **31** is merely terminated at the insulator **32**; this end of wire **31** is not grounded. Thus, wire **31** is at a high potential relative to ground.

The spray guns **12**, **12***a* and **12***b* may be of any known form of atomizer to which liquid paint is fed and which spray out atomized paint. Each gun may preferably be a centrifugal atomizer to which liquid paint and compressed air are supplied and which projects a hollow cone-shaped cloud **39** of atomized paint as depicted in FIGS. 2 and 3. In FIGS. 2 and 3, liquid paint may be assumed to be fed to gun **12** through the piping **42** and compressed air through the hose **43**.

In accordance with our present invention, the movement of air from the passage **15** of the booth **10** through the exhaust grill **13** and out the exhaust duct **14** is carefully controlled, so that the fog or cloud of atomized paint particles, produced by each gun, tends to move slowly in the direction of the exhaust grill **13**. The guns **12**, **12***a* and **12***b* are mounted at such a level that the cloud of atomized paint particles produced by each gun lies in the path traveled by the work **27** as it is conveyed through the passage **15**.

It is important to the operation of the apparatus of the present invention that the spray guns be grounded, as is

indicated at **41** in FIG. 3. This may be done by a direct lead from the gun to ground, or by conductively mounting the gun or guns on a metal bench **40** of good conductivity, and grounding the table. The conveyor track **16** is also grounded, as indicated at **44**.

Since the terminal end of the high-voltage wire **31** is insulated from ground by insulator **32**, the wire **31** is at a high potential substantially equal to the voltage applied to its input end **33**. This applied voltage may preferably be of the order of 40,000–100,000 volts D.C. A strong electrostatic field thus surrounds the wire **31**, and as the work pieces **27** carried by the conveyor move through the booth **10**, each work piece acquires by induction a high potential relative to ground. The work piece thus attracts the atomized particles of paint in the suspended cloud **39**, and particles of paint move toward the work piece from all directions, as is indicated in FIG. 3 by the arrows. In this manner, the article **27** is coated with a coat of paint, evenly and uniformly.

By establishing a proper relationship between the rate of movement of the articles **27** through the booth and the amount of atomized paint projected from the gun or guns and formed into the suspended cloud or clouds **39**, having due regard for the size and surface area of the work, a large proportion of the particles of paint projected from the guns may be attracted to and coated on to the work, with little paint being lost by exhausting on to or through the exhaust grill **13**.

The important features of the apparatus of the present invention, as described above, and its manner of operation, include the following:

(1) The spray gun or guns are at ground potential. The guns are not charged to a high voltage, and thus the particles of paint are not charged by the gun, as is the case in some prior art electrostatic spray painting systems.

(2) The paint ejected from the gun or guns is atomized by compressed air and/or by centrifugal forces. The paint is not atomized electrostatically by a high-voltage spray gun.

(3) The movement of air in the vicinity of the projected particles of atomized paint is carefully controlled to cause a cloud or fog of paint particles to move slowly across the path of the articles to be painted.

(4) The articles of work to be painted are passed through the slowly moving cloud of paint particles.

(5) A high-voltage conductor is placed in the vicinity of, but out of contact with, the work. This high-voltage conductor is also located outside of the cloud of atomized paint particles.

As a result of the features listed above, a number of advantages are derived, which include the following:

(1) As the work is passed through the slowly moving cloud, particles of paint are drawn to the surface of the work from all directions, thereby effecting wrap-around and thereby providing a uniform and even coating of paint on the article even though it be of irregular shape.

(2) As contrasted with prior art systems, there is considerably less overspray and loss of paint. The atomized particles of paint, being at ground potential as they leave the grounded gun, tend to pick up a charge as they move toward the work piece and toward the electrostatic field. In prior art systems in which the particles of paint are charged by reason of the spray gun itself being charged, the work is grounded, and reliance is placed upon the potential difference between the charged paint particles and the grounded work to deposit the particles of paint on the work. It seems, however, that a charged particle of paint approaching a grounded piece of work tends to lose its charge much more rapidly than a particle of paint which leaves the gun uncharged and approaches a charged piece of work.

(3) The fact that the spray gun itself is unchanged enables the system of the present invention to handle paint materials which are highly conductive, as for example, paints which contain powdered metal. In the prior art systems in which the spray gun itself is at high potential, if a metalized or other conductive coating of paint is used, the charge on the gun is carried back through the conductive fluid in the paint supply line to the container or other source of conductive paint supply, and the supply container assumes a dangerously high potential. This makes it necessary to insulate the paint container and the pumps from ground. Hence, whenever it is necessary to replenish the supply of paint in the container, it is necessary to cut off the high voltage. Moreover, it is sometimes desirable to heat the paint before supplying it to the gun. In the prior art systems in which a charged gun is employed, it is not possible, or at least it is very hazardous, to employ a recirculating electric paint heater, due to the high potential on the container. In the system of the present invention, on the other hand, a recirculating electric paint heater may be safely employed.

(5) Because the spray gun itself is at ground potential, the operator may safely adjust the atomizing head for optimum conditions while the system is in operation, without shutting it down.

(5) In a preferred form, where centrifugal atomization is used, a Faraday screen in the form of forwardly projecting fine rigid wires **12***c* secured to and rotatable with the gun disc insures against electrostatic atomization at the leading edge of the spray head.

(6) Grounding the spray gun and its supply lines permits the use of compressed air in combination with mechanical energy as a means for effecting atomization without the need for isolating the electrical system. The pieces of work to be painted become charged by the high-voltage conductor as soon as they enter the spray booth, which is prior to entering the actual spray zone, and this high potential charge on the work is maintained so long as the work is within the booth. This assures a definite potential difference between the pieces of work to be painted and the atomizing spray gun or guns. The pieces of work become charged to a high potential by induction, due to the existence of a potential gradient between the high-voltage wire and the work, and between the work and the grounded spray gun. This arrangement has been found to eliminate virtually all ripple, assuming that a rectified and filtered D.C. potential is applied to the high-voltage wire.

(7) In the apparatus of the present invention, there are no grids in close proximity to the spray cloud to collect the overspray.

(8) The fact that the particles of atomized paint are not charged at the instant they leave the gun enables the air exhaust system to exert a better control on the advance of the spray cloud in the direction of the work path, since there is no initial forward drive of the paint at the instant that it leaves the gun.

While the work pieces **27** illustrated in the drawing have been described as rectangular metal frames, it is not essential that the work be metal or conductive. The apparatus of the present invention is perfectly capable of painting or coating non-conductive articles, such as articles of glass or porcelain. In such cases, however, the paint used should be conductive, preferably either a metallic paint or a water-base paint.

It has been stated hereinabove that the spray gun may be any known suitable type. One suitable form is a gun having a centrifugal spray head wherein the liquid paint is positively discharged against a plurality of annularly arranged accelerator members which are rapidly rotated by an air driven motor. The paint is thereby atomized creating a spray which is projected forwardly of the head and shaped into a pattern by the dished portion of the head which extends beyond the point at which the paint is mechanically atomized. The complete head is grounded electrically.

Having described our invention, we claim:

1. The method of spray coating a work piece comprising the steps of:

(a) creating an electrostatic field between an elonggated elevated horizontally-disposed high-voltage wire and ground,

(b) inductively charging the work piece to a potential substantially that of said high-voltage wire by supporting the work piece conductively at a remote distance from the high-voltage wire and moving the conductive support means along a path close to and parallel with the elongated high-voltage wire while connecting the conductive support means to ground through an insulator member,

(c) and projecting a cloud of atomized particles of coating material from a grounded gun into the path of the inductively charged work piece to effect deposition of said atomized particles of coating material on the work piece.

2. Spray coating apparatus comprising:

(a) an elongated high voltage conductor supported by insulator means in a generally horizontal position at a selected elevation above ground,

(b) high voltage supply means connected to said conductor,

(c) a grounded overhead conveyor having dependent hanger means for supporting the work piece to be coated,

(d) said hanger means including a conductor portion connecting to said work piece and an insulator portion between said conductor portion and said conveyor,

(e) said conveyor conveying said conductor hanger portion along the path which parallels and is close to said high voltage conductor but out of contact therewith for charging the work piece inductively;

(f) and grounded spray means for projecting a cloud of atomized particles of coating material into a zone which does not include the high-voltage conductor but which is in the path of the inductively charged work piece.

3. Apparatus according to claim **12** characterized in that said conveyor is provided with a plurality of said hanger means at spaced intervals.

4. Apparatus as claimed in claim **3** further characterized in that air-movement control means is provided

comprising exhaust means disposed on the opposite side of said work path from said spray means, for controlling the movement of said cloud across said work path.

5. Apparatus as claimed in claim **4** further characterized in that said conveyor includes means for rotating said work piece as it passes through said zone.

6. Spray painting apparatus comprising, atomizing means for projecting a shaped spray of atomized paint into a zone; exhaust means controlling the air movement in said zone; a conveyor having a plurality of spaced-apart elongated depending carriers for suspending work pieces therefrom and for transporting said work pieces through said zone, each of said carriers including conductor sections and an insulator section, the locus of said moving carriers being a vertical plane transversely disposed forward of said atomizing means and close thereto; a single high voltage wire disposed generally horizontally and parallel to the plane of movement of said carriers and a short distance therefrom, said wire extending to both sides of said zone below said insulator section and above the work piece; means for applying a high voltage to one end of said wire; and means terminating said other end of said wire in space.

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