Nov. 23, 1971 A. C. WALBERG 3,621,815

SPRAY GUN

Original Filed Sept. 16, 1966 2 Sheets-Sheet 1

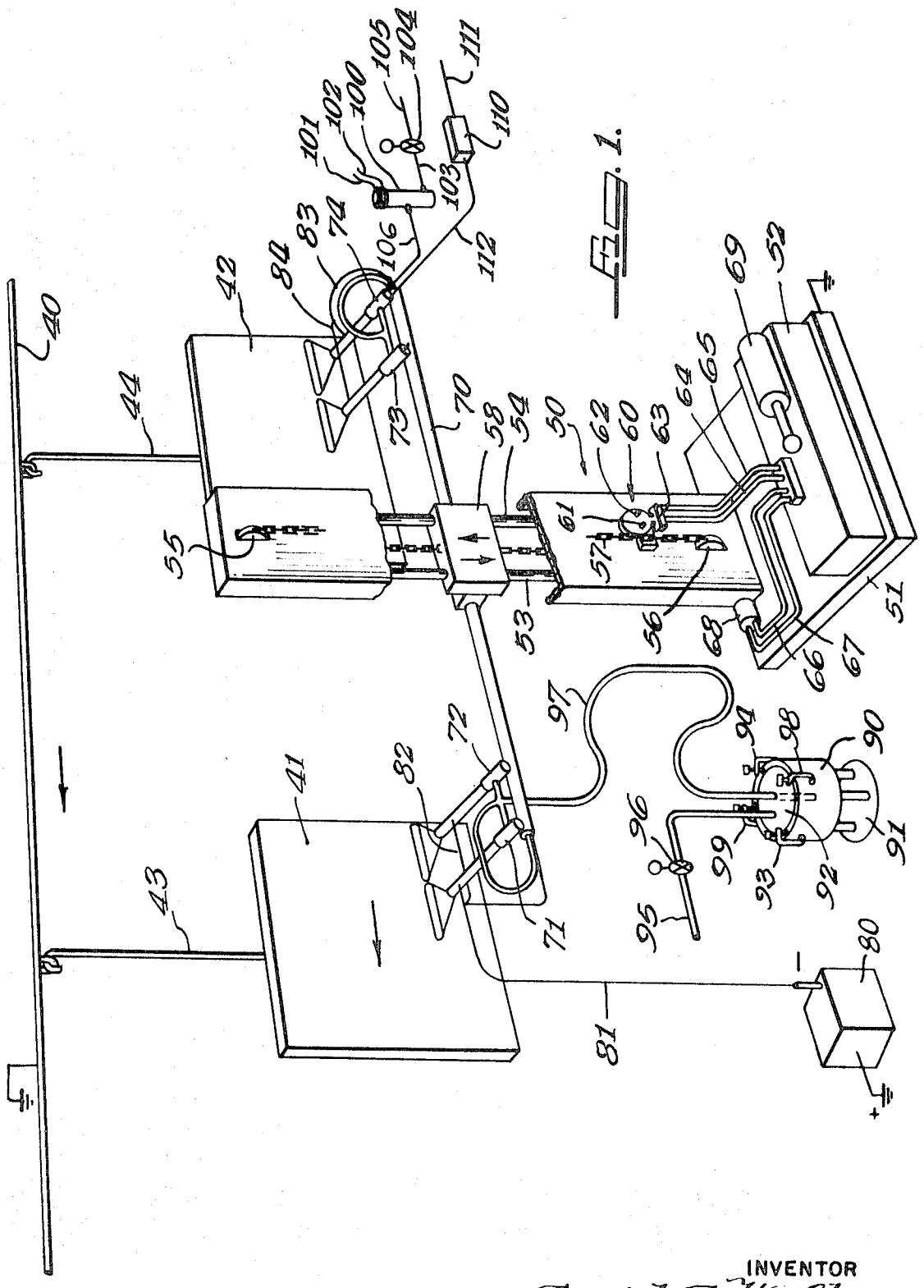


FIG. 1.

INVENTOR
David C. Walberg
BY
Mason, Celbright & Stansbury
ATTORNEYS

Nov. 23, 1971 A. C. WALBERG 3,621,815

SPRAY GUN

Original Filed Sept. 16, 1966 2 Sheets-Sheet 2

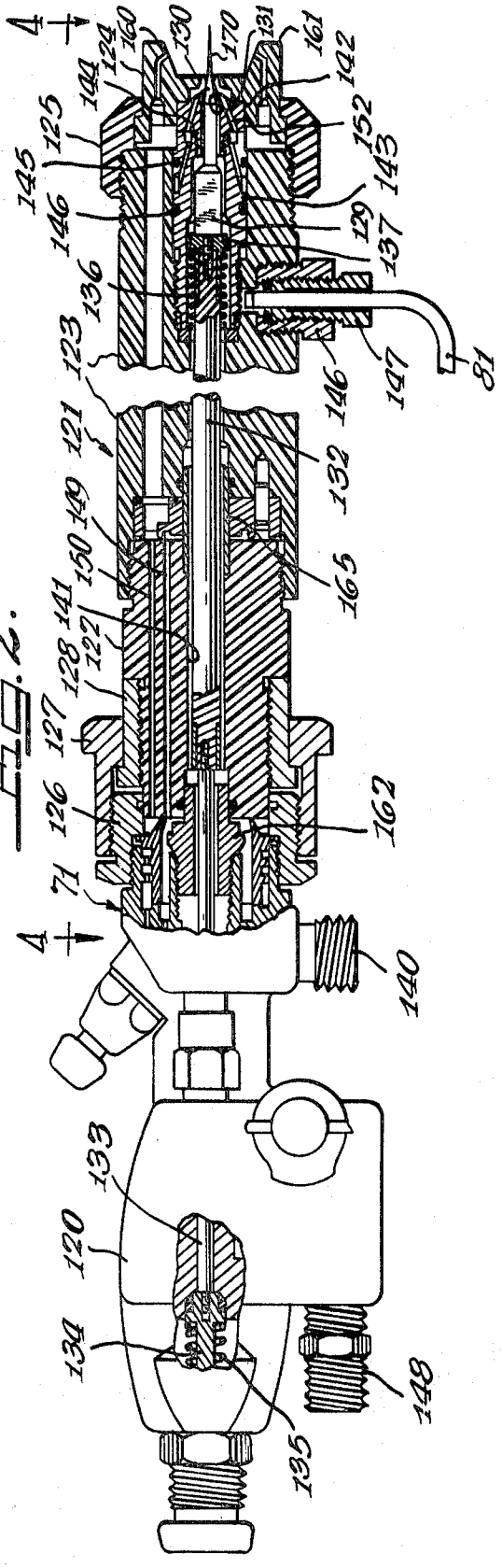


Fig. 2.

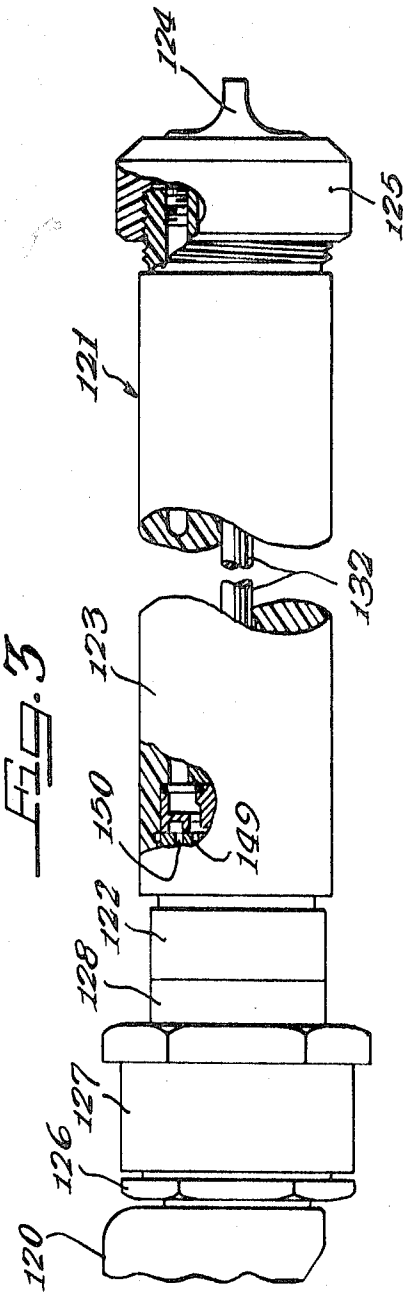


Fig. 3

INVENTOR
David C. Walberg
BY
Mason, Albright & Stansbury
ATTORNEYS

United States Patent Office 3,621,815
Patented Nov. 23, 1971

3,621,815

SPRAY GUN

Arvid C. Walberg, Lombard, Ill., assignor to Graco, Inc., Minneapolis, Minn.

Original application Sept. 16, 1966, Ser. No. 580,468, now Patent No. 3,463,121, dated Aug. 26, 1969. Divided and this application Aug. 22, 1969, Ser. No. 852,253
Int. Cl. B05b 5/02
U.S. Cl. 118—631 14 Claims

ABSTRACT OF THE DISCLOSURE

Work is electrostatically coated with highly conductive materials by hydrostatic atomizing spray guns. The rate of material application to work for water base material such as porcelain enamel is high being in excess of three mils of film thickness in less than sixty seconds to prevent "dry spray." The problem of "dry spray" is further controlled by placing the spray guns very close to the work (less than twelve inches).

This is a divisional application of U.S. patent application Ser. No. 580,468, filed Sept. 16, 1966, now Pat. No. 3,463,121, issued Aug. 26, 1969.

The present invention relates to spraying systems for applying coating material and more particularly to systems which are capable of electrostatically depositing coating materials having water as a carrier.

Attempts to spray porcelain enamel electrostatically using water as a carrier have met with failure during the past fifteen years. The quality of finish has been unsatisfactory. The various electrostatic systems utilized causes defects such as (1) dry spray, (2) insufficient film thickness, (3) poor atomization, (4) non-uniform film thickness, (5) incomplete coverage and (6) poor electrostatic "wrap-around."

Dry spray was caused by building the film thickness too slowly or by having the atomized spray travel excessively long distances before it is deposited on the surface of the ware. The basic design of the systems used prevented the correction of the above problem. Since the liquid used in the poreclain enamel solution is water, the "wetness" or "dryness" cannot be adjusted in the same manner that solvent adjustments are made in electrostatic painting systems. When "dry spray" is encountered in painting, a slower "wetter" solvent can be added to the paint mixture. A paint that is too "wet" can be corrected by adding a faster solvent. This adjustable feature is missing when water solutions are sprayed electrostatically and this factor prevented prior art electrostatic systems from properly applying water base materials.

Insufficient film thickness was applied in previous attempts to master the spraying of porcelain enamel electrostatically. A heavy paint film falls in the 1.0 to 1.5 mils range of film thickness. Equipment that was designed to apply films of this thickness was not adequate to meet the 3.0 to 6.0 mils of thickness specified for porcelain enamel. Poor atomization of the porcelain enamel occurred when attempting to atomize the larger volumes of material needed to apply the heavy film thickness indicated above.

Non-uniform film thickness was caused by stacking several electrostatic spray guns in a vertical plane to spray ware that was wider than the 12 inch maximum that could be handled by one gun. It was difficult if not impossible to mate the adjacent spray patterns together to avoid an improper boundary effect. If the adjacent spray patterns overlapped, there was a heavy build-up of enamel in the overlapped area. If the spray patterns fell short of meeting, a light streak could occur. The resulting quality was not acceptable.

Some attempts were made to overcome the above problem by oscillating the spray guns in a vertical plane. This moved the heavy and light streaks around somewhat, but it did not correct the basic problem.

Incomplete coverage encountered with previous electrostatic systems was due to the excessive amount of waste caused by the poor operating efficiency of these systems. Some systems had better charging characteristics and wasted less porcelain enamel but could not penetrate into recessed areas, corners, or other hard-to-reach areas. The net result was incomplete coverage and excessive amounts of manual touch-up to complete the job. The actual savings received, if any, was slight.

Poor electrostatic "wrap-around" caused by previous attempts in the spraying of porcelain enamel electrostatically resulted in poor coverage of the ware. The air spray guns used required excessively high atomizing air pressures to atomize the high volume of porcelain enamel that had to be sprayed. This caused excessive spray velocity and reduced electrostatic "wrap-around." Disc-type atomizers, on the other hand, cannot atomize electrically conductive materials by electrostatic forces alone and had to be operated at exceptionally high rotational speed to atomize the porcelain enamel centrifugally. This again resulted in high velocity that caused poor electrostatic "wrap-around." For the above reasons, electrostatic systems that have proved successful in applying paints and similar coatings have proved unsuccessful when used to apply porcelain enamel.

One system used consisted of a standard air-atomizing spray gun spraying through an ionizing electrode charged to 100,000 volts at the grounded ware passing on a conveyor at right angles to the direction of the spray. The ionizing electrode consisted of two vertical tubes mounted 12" from the surface being sprayed and on 20" centers. A row of needle point ionizers were attached on 2" centers to the tubes on the side facing the ware. The needles pointed toward the ware. A spray gun or a station of several spray guns mounted on a vertical plane were arranged to spray between the two vertical electrodes. The guns were at ground potential and were positioned 12" behind the ionizing electrodes or about 24" from the grounded surface being sprayed. This 24" distance of travel of the atomized spray particles caused excessive drying of the spray particles resulting in a dry coat being applied to the product. There was insufficient flow-out. The quality of finish was not acceptable. In addition, all of the aforementioned faults were encountered in this system.

A variation of the above system called for mounting the guns to spray substantially parallel to the ware moving along on the conveyor. The spray passed between an ionizing electrode and grounded ware and was deposited on the ware by the electrostatic field. The distance traveled by the spray was again excessive and the resulting finish was unsatisfactory due to dry spray. All of the other faults indicated above were also encountered.

Both of the above ssytems were also unsuccessful because of low operating efficiency. Too much enamel was wasted.

A newer electrostatic system consisted of a horizontal spinning disc reciprocating in a vertical plane with a conveyor carrying the ware in a loop around the disc. The disc was charged to 100,000 volts D.C. and the porcelain enamel was distributed over the disc by centrifugal force to be atomized at the edge of the disc. The disc normally atomizes paint electrostatically but it will not atomize electrically conductive material electrostatically. Since poreclain enamel is electrically conductive, it was necessary to drive the disc at high speed to atomize the porcelain enamel by centrifugal force. This system was more

efficient since it atomized the material at the zone of ionization but the material was applied slowly as the ware passed around a 20 foot conveyor loop. This caused dry spray and required complete respraying of the surface with conventional air-atomizing spray guns to obtain an acceptable quality.

The disc type atomizer also has severe limitations on the volume of porcelain enamel that could be atomized per unit of time. This greatly limited material delivery and caused insufficient film thickness and required excessive manual touch-up to complete the job.

A disc type atomizer had an additional disadvantage since it sprayed at all empty spaces between the products on the conveyor and caused excessive waste and uncontrolled buildup of coating on edges of a product that happened to be adjacent an open space.

The present invention overcomes a major share of the problems encountered in previous systems. Dry spray is not a problem. It was overcome by placing specially designed electrostatic spray guns at a much closer distance to the surface being sprayed. A spacing of 8" to 10" was found satisfactory. This spacing would be unsafe if a solvent-based paint was used in the system. The entire film of several mils is applied in a relatively short distance of conveyor travel. The actual coating operation is complete in six feet of conveyor travel or less. The velocity range of conventional conveyors is from ten feet per minute to twenty four feet per minute. Thus, the present invention applies the required film thickness in less than sixty seconds. This assures the desired wetness and the desired quality of finish.

Therefore, it is a principal object to provide a new and improved electrostatic spraying system for spraying abrasive material.

Another object of the present invention is to provide an electrostatic spraying system which is capable of effectively spraying porcelain enamel or other highly abrasive material that requires control of the temperature of the atomizing air so as to counteract the effect of humidity in the atmosphere and thereby control "wetness" or "dryness" of the applied film.

Further objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of an automatic electrostatic spraying system embodying the present invention;

FIG. 2 is a partial sectional drawing of the electrostatic spray gun illustrated in FIG. 1; and

FIG. 3 is a partial broken-away elevational drawing of the electrostatic spray gun illustrated in FIG. 2 taken alone the line 4—4.

While this invention is susceptible of embodiment in many different forms, there will be described herein in detail an embodiment of the invention with the understanding that the present disclosures are to be considered as exemplifications of the principles of the invention and are not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

Referring now specifically to FIG. 1, a conveyor **40** of any conventional design well known to those skilled in the art propels work to be coated, such as panels **41** and **42**, when they are connected to the conveyor **40** by means of conductive hangers **43** and **44**, respectively. The conveyor **40** is electrically connected to an electrical ground and therefore the work carried by the conveyor, such as panels **41** and **42**, are also connected to ground through the respective electrically conducting hangers, such as **43** and **44**, and the conveyor **40**. A hydraulic reciprocator generally indicated at **50** has a base **51** upon which is mounted a hydraulic unit **52** and vertical guide rails **53** and **54**. A pair of pulleys **55** and **56** are rotatably mounted to the guide rails **52** and **54** near the top and bottom of the rails. The pulleys **55** and **56** have grooves shaped to receive a drive chain **57** which has its ends connected

to a spray gun carriage **58**. The carriage **58** has ball bearings mounted internally (not shown) which contact the respective rails **53** and **54** in order that the carriage **58** may be smoothly guided in vertical movement by the guide rails. An analog control generally indicated at **60** is operatively connected to the chain **57** and has a pair of cams **61** and **62** for engaging a "rabbit ear" hydraulic four-way valve **63**. The analog control **60** and the four-way valve **63** reverse the direction of travel of the spray gun carriage at the top and bottom of its stroke. By moving the cams closer together the unit will take a short stroke. The shortest stroke will be in the neighborhood of 12 inches. By moving the cams on the analog control further apart, the length of the stroke is increased up to the maximum possible for the size of the reciprocator. The maximum stroke is approximately three feet less than the height of the reciprocator **50**. The four-way valve **63** is connected to the hydraulic unit **52** by hydraulic lines **64** and **65**. Another pair of hydraulic lines **66** and **67** are connected between the hydraulic unit and a hydraulic drive motor **68** which is connected to the pulley **56** to drive it, and thereby drive the chain **57** and the spray gun carriage **58**. Since the hydraulic unit **52** may be any conventional source of hydraulic pressure well known to those skilled in the art, and since the valve **63** and drive motor **68** are connected and operated as is well known to those skilled in the art, this structure will not be described in detail.

A hollow cross arm **70** in the form of a tube of electrically insulating material is rigidly secured in the spray gun carriage **58**. The movement of the cross arm **70** is therefore controlled by the analog control **60**. The speed of reciprocation is adjusted by a manual control **69** which is mounted on and connected to the hydraulic unit **52**. A set of four spray guns **71–74** are clamped to the cross arm **70**.

A high voltage power supply capable of supplying voltages generally in the range of 60,000 to 150,000 volts **80** has its positive output terminal connected to electrical ground and its negative output terminal connected to the spray guns **71–74** by high voltage electrical lines **81**, **82**, **83**, and **84**. The high voltage line **83** passes through the hollow cross arm **70** in order to reach gun **74** and the gun **73** via line **84**.

A porcelain enamel pressure tank **90** is mounted on a three-legged insulator stand **91**. The tank **90** has a cover **92** which makes an air-tight seal for the tank **90** when screw clamps **93**, **94**, **98** and **99** are utilized to secure it. A source of air pressure (not shown) is connected to an air line **95** of electrical insulating material (such as nylon) which has a manually or remotely operated air regulator **96** placed therein. The air line **95** is connected to the tank cover **92** to supply air at controlled pressure to the interior of the tank. A fluid hose **97** of electrical insulating material (such as nylon) extends through the cover **92** downward into the tank **90** and is connected to each of the guns **71–74** to supply coating material thereto. It will be noted that the hose **97**, after it supplies coating material to the guns **71** and **72** through short connecting branches, passes through the hollow cross arm **70** to reach guns **73** and **74**.

An air heater **100**, which contains electrical heating elements (not shown), has these elements electrically connected to a source of electrical potential (not shown) by electrical leads **101** and **102**. The air heater **100** has its air passages connected to a source of high pressure air (not shown) through an air line **103**, a manual air pressure regulator **104**, and an air line **105** and connected to the gun **74** by an air line **106**. A similar atomizing air heater (not shown) is provided for each of the other spray guns. A solenoid air valve **110** is also connected to a source of high pressure air (not shown) by an air line **111**, and it is connected to the trigger mechanism of gun **74**, as will presently be described in greater detail, through the air hose **112**. Similar controls

(not shown) are provided for spray guns **71**, **72** and **73** as well.

Since each of the spray guns **71–74** is identical in construction, only gun **71** will be described in detail. Referring now to FIGS. 2 and 3, the spray gun **71** comprises a metallic rear housing **120** and a barrel portion of nylon insulating material, generally indicated at **121**, which comprises a first barrel section **122** threaded to a second barrel section **123** and an air cap **124** secured to the second barrel section **123** by a threaded annular retainer **125**. The barrel section **122** is secured to section **120** by an annular fitting **126** to which an annular retainer **127** is secured by threads, and an annular cylinder **128** which is threaded onto section **122** and has an annular edge which contacts an annular edge of the retainer **127**. A stainless steel valve **130** closes a passage **141** through the barrel portion **121** and the rear housing **120** when it engages an annular tapering valve seat **131** in a fluid tip **142**. The valve **130** is connected to stainless steel square shaft **129** which is connected to a stainless steel operating shaft **132** which is in turn connected to a stainless steel shaft **133**. Shaft **133** is connected to an adjustable needle plunger **134** which has a spring **135** urging it towards the forward portion of the spray gun. A second spring **136** bears against a spring retainer **137** which is rigidly mounted on the shaft **132** to urge the shaft **132** and the valve **130** forwardly, closing the valve against the valve seat. Water carried porcelain enamel coating material from hose **97** enters an aperture **140** that connects with the passage **141** containing the shafts **129**, **132** and **133** in order that coating material may flow around the shafts to the fluid tip **142**. Thus, the coating material is conducted directly around the shafts which operate the valve in the front of the gun to the valve **130** within the fluid tip **142**. Preferably, all parts with which abrasive coating material contacts such as water based porcelain enamel are constructed of abrasive resistant material such as tungsten carbide and stainless steel. The fluid tip **142** is secured between the air cap **124** and a fluid tip housing **143**. Sealing rings **144**, **145** and **146** prevent fluid from the passage **141** from leaking past the fluid tip housing **143**. The fluid tip **142** and the fluid tip housing **143** are constructed of tungsten carbide and stainless steel, respectively, so the abrasive coating material such as porcelain enamel will have a minimum erosion effect upon these parts. The high voltage electric lead **81** is connected through an electrical lead bushing **146** and an electrical truss screw **147**. The air hose **106** is connected to the threaded fitting **148** to supply air to the passages generally indicated at **149** and **150**. The passage **150** supplies air to two air horns **160** and **161** which form part of the air cap **124**, and the passage **149** supplies air to an annular air passage **152** in the fluid tip **142**.

The forward edge of the fluid tip **142** and a needle **170** mounted on the valve **130** and extending through the orifice of the fluid tip **142** form an electrode.

The length of the overall barrel **121** is normally of the order of 18 inches which prevents any substantial electrostatic field from existing between the charged rear housing **120** and grounded product **41**. The strongest electrostatic field exists between fluid tip **142** and needle **170** toward grounded product **41**.

A pilot bushing **165** aids in completing the passage **141** across the junction barrel section **122** and **123**, and a cylinder adapter **162** aids in completing this passage across the junction of the rear housing **120** and the barrel section **122**.

The guns **71–74** are similar in construction and design to the hand gun shown in my U.S. Pat. 3,251,551, issued May 17, 1966, with the primary differences being that harder metals are use for such parts as the fluid tip **142** to resist abrasion, and that electrical connection is made directly to the fluid tip through an aperture in the side of the barrel rather than having an electrical lead run from one end of the insulated portion of the gun to the other end. While the gun illustrated in my U.S. Pat. 3,251,551, issued May 17, 1966, can be utilized for coating material having a resistivity of ten megohms or greater per inch cube, the guns illustrated in FIGS. 1–3 can spray electrostatically conductive materials such as water based materials and such as Teflon. When a coating material such as Teflon is sprayed, it is not necessary to utilize the air heater **100** in the system.

However, in spraying porcelain enamel, the air heater **100** is an important element of the system. Since porcelain enamel coatings require the use of water as a vehicle in the slip being sprayed, the relative humidity in the ambient air in the spray booth or spray area creates special problems in control of the operation. These problems are especially noticeable during the summer months when the variations in relative humidity are the greatest. The heater **100** increases the atomizing air temperature as the humidity of the ambient air increases. This evaporates moisture in the sprayed film of coating on the work at an increased rate to permit control of the "wetness" or "dryness" of the applied film. The operating temperature of the heater may be as high as the order of 210° F. The heater **100** can be either controlled by a manually operated control or by a humidistat. If a humidistat is utilized, a completely automatic system is achieved since the relative humidity in the spray area or booth can vary substantially and repeatedly without a resulting deterioration of the quality of the applied porcelain enamel.

Porcelain enamel is very abrasive and creates problems in regulators used to control its pressure. Standard pressure regulators presently used in the spray painting art will not stand up under porcelain enamel service. Therefore, the system illustrated in FIGS. 1–3 does not have a regulator between the tank and the spray gun, but instead utilizes a pressurized tank to eliminate the requirement of a regulator. By utilizing a stationary pressure source, there is a variation in the static head at the various gun elevations as the reciprocator raises and lowers the guns as the work passes through their spray patterns as illustrated in FIG. 1. This problem is overcome by the utilization of an orifice that creates sufficient back pressure at the desired delivery rate to cause a relatively high pressure to be maintained at the pressure tank **90** containing the porcelain enamel. Thus, the static head becomes a small percentage of the total fluid pressure at the spray gun. The static pressure of porcelain enamel varies approximately 0.65 to 0.75 p.s.i. for every foot of variation in elevation. When reciprocating the gun vertically, the gun will deliver more material at the bottom of the stroke and less at the top of the stroke. The film thickness on the product will vary in the same proportion. When a spray gun is positioned 36 inches above the floor, for example, a pressure at the gun of three p.s.i. can be established. If the pressure is controlled by a stationary pressure tank, this pressure will remain fixed. When the gun is raised 12 inches, the prressure will decrease approximately 0.75 p.s.i. leaving only 2.25 p.s.i. At 60 inches above the floor, the pressure will be reduced to 1.5 p.s.i. Thus, with only a two-foot stroke, there would be a pressure variation of 2 to 1 and the applied film thickness would vary in a ratio of approximately 2 to 1. By using a fluid orifice sufficiently small to cause a high tank pressure, the variation in film thickness from top to bottom of the panel will be greatly decreased. At 10 p.s.i. fluid pressure variation of 2 feet in elevation will still cause a variation in static head of approximately 1.5 p.s.i. This is only 15 percent of the total and is therefore more acceptable. At 15 p.s.i. tank pressure, the variation drops to 10 percent and is considered highly satisfactory. Therefore, a tank pressure of 15 p.s.i. or higher is utilized to maintain a substantially consistent film thickness.

Spray guns **71–74** have the ability to atomize much larger volumes of material than anything encountered in the past. This permits the applying of heavy film thicknesses at high operating speed (3.0 mil or greater in less

than sixty seconds) with a minimum amount of equipment. The fast build-up of film thickness also helps to provide the necessary wet coat and eliminates the problem of dry spray. With the guns mounted horizontally and reciprocated vertically for the full height rather than being stacked vertically as in previous systems, each gun can apply a minimum of two light coats of porcelain enamel. Therefore, the four guns can apply eight light coats in rapid succession. Thus, the system illustrated in FIGS. 1–3 can provide higher quality than was possible prior to the present invention.

While the spraying of porcelain enamel and Teflon in a waterbase carrier has been specifically referred to, those skilled in the art will recognize that other coatings composed of particles such as various glass materials can be handled in the same manner as poreclain enamel, and that other particle coatings such as a plastic may be handled without humidity control in the same manner as Teflon. While abrasive material such as porcelain enamel can only practically be handled by air atomizing spray guns as previously described herein, less abrasive materials such as Teflon and similar material can be sprayed as herein described both by air and hydrostatic spray guns. The scope of the appended claims is intended to include all such variations and modifications.

If it is desirable in a particular installation to have an electrode which will be highly erosion resistant beyond the structure illustrated in FIG. 2, the fluid tip **142** may be made of tungsten carbide or other similar erosion resistant material, and the needle **170** may be laterally offset from the nozzle of the fluid tip sufficiently so that material being ejected from the nozzle of the fluid tip does not impinge upon the needle. Such lateral offsetting of the needle **170** is accomplished by securing the needle to the fluid tip **142** rather than to the valve **130**. Such modifications are intended to be within the scope of the appended claims.

I claim:

1. An electrostatic coating material spraying system for porcelain enamel frit comprising:
- an automatic hydrostatic atomizing spray gun having a nozzle,
- mounting means supporting said gun and electrically insulating it from ground potentials,
- a container receiving a supply of poreclain enamel frit,
- another mounting means supporting said container and insulating it from said ground potentials,
- a conduit connecting said container to said spray gun,
- means for moving work to be coated relative to said spray gun at a predetermined rate,
- means operatively connected to said container, conduit and spray gun to force coating material from said container through said conduit and said spray gun nozzle at a rate sufficient to place a film of said material having a thickness of at least 3.0 mils on work to be coated as it is moved relative to said spray gun at said predetermined rate, and
- high voltage power supply means connected between said gun and work to be coated to provide an electrostatic field between work to be coated and said gun.

2. An electrostatic coating material spraying system in accordance with claim **1**, wherein all metal parts in said spray gun which contact said fluid material are constructed of abrasive resistant material.

3. An electrostatic coating material spraying system in accordance with claim **1**, wherein said mounting means reciprocates said spray gun vertically for at least the full height of work to be coated.

4. An electrostatic coating material spraying system for porcelain enamel frit comprising:
- a multiplicity of automatic hydrostatic atomizing spray guns having nozzles,
- mounting means supporting said guns in a horizontal line and electricaly insulating them from ground potentials, said mounting means reciprocating said spray guns vertically for at least the full height of work to be coated,
- a container electrically insulated from ground potentials receiving a supply of porcelain enamel frit,
- a conduit electrically insulated from ground potentials connecting said container to said spray guns,
- means for moving work to be coated relative to said spray guns at a predetermined rate,
- means operatively connected to said container, conduit and spray guns to force coating from said container through said conduit and spray guns at a rate sufficient to place a film of said material having a thickness of at least 3.0 mils on work to be coated as it is moved relative to said spray guns at said predetermined rate, and
- high voltage power supply means connected between said gun and work to be coated to provide an electrostatic field between work to be coated and said gun.

5. An electrostatic coating material spraying system for conductive fluid material comprising:
- a hydrostatic atomizing spray gun,
- fluid coating supply means connected to said gun,
- a source of compressed gas,
- temperature control means,
- means for operatively connecting said temperature control means between said source of compressed gas and said gun to control the temperature of a flow of gas from said source at its ejection from said spray gun, wherein
- said temperature control means is a heating means for raising the temperature of said flow of gas before its ejection from said spray gun, and
- a humidistat connected to said heating means to automatically vary the temperature of said flow of gas in response to variations in the humidity of air surrounding work being coated by said spraying system.

6. In combination with the electrostatic coating material spraying system as specified in claim **5**:
- a mounting means connected to said spray gun for reciprocating said spray gun vertically for at least the full height of work to be coated, and
- a pressure means operatively connected to said spray gun to force coating material through said gun under a pressure of at least 15 p.s.i.

7. An electrostatic coating material spraying system in accordance with claim **6**, wherein said fluid coating supply means is a container electrically insulated from ground potentials.

8. An electrostatic coating material spraying system for porcelain enamel frit comprising:
- an automatic hydrostatic atomizing spray gun having a nozzle,
- mounting means supporting said gun at a distance less than twelve inches from work to be coated whenever the gun is operated to coat the work and electrically insulating said gun from ground potentials,
- a container receiving a supply of porcelain enamel frit,
- another mounting means supporting said container and insulating it from ground potentials,
- a conduit connecting said container to said spray gun,
- means for moving the work to be coated relative to said spray gun at a predetermined rate,
- means operatively connected to said container, conduit and spray gun to force coating material from said container through said conduit and said spray gun nozzle at a rate sufficient to place a film of said material having a thickness of at least 3.0 mils on

the work to be coated as the work is moved relative to said spray gun at a predetermined rate, and

high voltage power supply means connected between said gun and the work to be coated to provide an electrostatic field between the work and said gun.

9. An electrostatic coating material spraying system in accordance with claim 1, wherein said film has a thickness of at least 3.0 mil applied to said work to be coated in less than sixty seconds.

10. An electrostatic coating material spraying system in accordance with claim 8, wherein said film has a thickness of at least 3.0 mil applied to said work to be coated in less than sixty seconds.

11. An electrostatic coating material spraying system in accordance with claim 1, wherein said material comprises porcelain enamel frit and water.

12. An electrostatic coating material spraying system in accordance with claim 4, wherein said pressure means maintains a fluid material pressure greater than 15 p.s.i. in said gun.

13. An electrostatic coating material spraying system in accordance with claim 4, wherein the variation in the static pressure of the fluid material in said gun does not exceed fifteen per cent of the maximum pressure utilized during the reciprocation of said spray guns by said mounting means.

14. An electrostatic coating material spraying system in accordance with claim 8, wherein said gun ejects said fluid material into the atmosphere at a distance from said work to be coated of not greater than ten inches and not less than eight inches.

References Cited

UNITED STATES PATENTS

2,736,671	2/1956	Ransburg et al.	118—631 X
2,764,125	9/1956	Juvinall	118—626 X
2,780,565	2/1957	Juvinall	118—626 X
2,893,894	7/1959	Ransburg	239—15 UX
3,169,882	2/1965	Juvinall et al.	239—3 X
3,169,883	2/1965	Juvinall	239—3 X
3,463,121	8/1969	Walberg	118—631

MERVIN STEIN, Primary Examiner

U.S. Cl. X.R.

239—15