July 28, 1970 I. SZASZ 3,521,815

GUNS FOR THE ELECTROSTATIC SPRAY COATING OF OBJECTS WITH A POWDER

Filed May 7, 1969

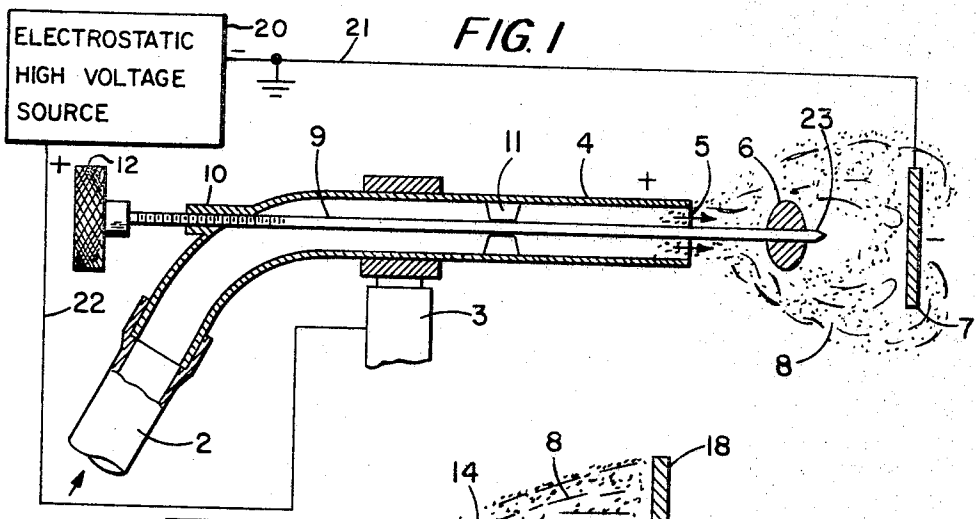

FIG. 1

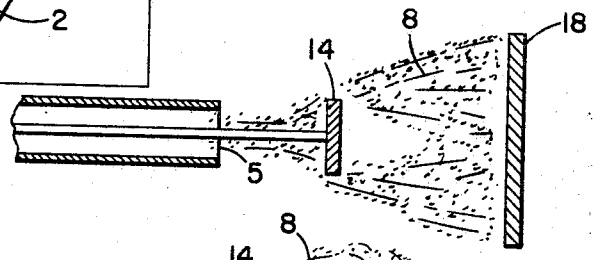

FIG. 2

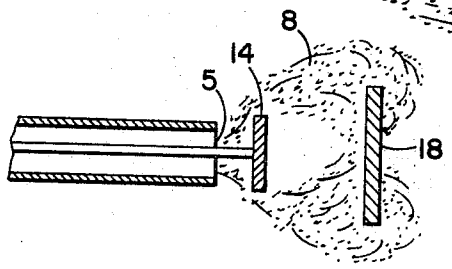

FIG. 3

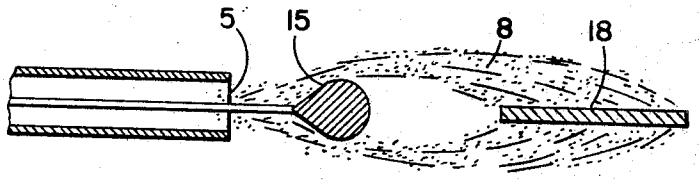

FIG. 4

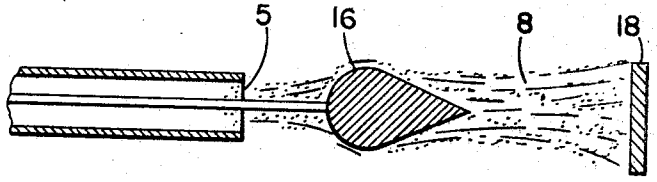

FIG. 5

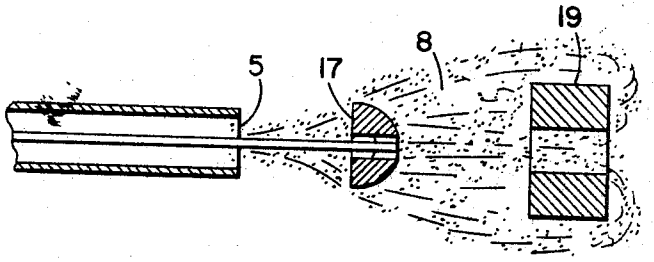

FIG. 6

United States Patent Office 3,521,815
Patented July 28, 1970

3,521,815

GUNS FOR THE ELECTROSTATIC SPRAY COATING OF OBJECTS WITH A POWDER

Imre Szasz, Krazernstrasse 114, St. Gall, Switzerland

Continuation-in-part of application Ser. No. 599,444, Dec. 6, 1966. This application May 7, 1969, Ser. No. 822,557

Int. Cl. B05b 5/04

U.S. Cl. 239—15 13 Claims

ABSTRACT OF THE DISCLOSURE

The present invention involves new and useful improvements in electrostatic spray coating of objects with a powder by means of a gun utilizing a unique deflecting means located at a point beyond the end of the gun nozzle, placed directly in the path of a uniform moving powder cloud, and affecting the powder cloud aerodynamically thus producing a variety of useful coating patterns.

This application is a continuation-in-part of my copending application, Ser. No. 599,444 filed Dec. 6, 1966, now abandoned, entitled "Guns for the Electrostatic Spray Coating of Objects With a Powder."

SUMMARY OF THE INVENTION

The invention relates to a powder spray gun for coating objects in an electrostatic field, in which the pulverulent coating material is conveyed by a gas stream, particularly a stream of air, and a deflector is arranged in the path of the discharged powder jet. Objects of complicated shapes can be given a coating of the most uniform thickness, or certain portions of the surfaces of objects can be given a thicker coating. In mass production the gun is held stationary or caused to pivot and the objects to be coated moved past the gun by a suitable conveying means.

The particles of powder are blown by the air stream towards the object to which they are attracted because the latter is oppositely charged with respect to the powder.

When the powder is blown by air, a relatively high speed air blast is required to avoid the powder settling along the long path from the powder container to the gun. Unless special precautions in regard of the gun are taken, the powder is discharged from the gun as a high velocity stream, which leads to uncontrollable and uneven coating of the objects, and even to the removal of powder already deposited on the objects.

A blast of secondary air having a radial component in the gun nozzle is customarily used in powder spraying but is not satisfactory. A rotating gun nozzle does permit the desired powder distribution, but it requires additional parts for obtaining or transferring the rotational movement in the nozzle. The additional parts and the rotation lead to more wear and other undesired side effects.

In order to provide workpieces with a layer of paint, an electric insulation layer, or a corrosion inhibiting layer, dry processes are preferred which consist of coating the workpiece with a layer of a suitable powder and subsequently subjecting it to a heat treatment. For applying the powder layer, several methods and corresponding apparatuses have been developed. An inexpensive method which can be used for a variety of different applications consists of atomizing the coating powder by means of a spray gun, electrically charging the powder particles and transporting them in an electrostatic field produced between the spray head and the object to be coated. In order to form a perfect, unobjectionable coating, the applied powder layer must be of uniform thickness, it must perfectly adhere to its support, and be free of defects such as craters, pores, lumps or clots. A number of difficulties are to be overcome for producing perfect powder layers by means of spray guns; only a few of them shall be mentioned in the following.

Difficulties are encountered when feeding the powder to the spray head of the gun. When, as usual, a carrier gas, for example compressed air is used, a relatively high flow speed of the air is required in order to avoid any deposit of powder on the internal walls of the feed conduit between the supply container and the spray head. However, a high velocity of the air jet discharging from the spray gun is not desired, since, on the one hand, the danger exists that the air jet may carry away a powder layer already deposited on the object, and on the other hand, a strong electrostatic field is required for guiding the electrically charged powder particles, and such a field can be produced only by extremely high voltages which in turn require different safety provisions for avoiding dangerous short-circuits and formation of sparks.

The most difficult problem is the guiding of the powder particles. Workpieces of complicated shape can be formed with pointed surface portions at which the field strength can be substantially higher than at the other surface portions, or they can be provided with narrow and relatively deep gaps and cavities which electrically represent a Faraday cage. It will be understood that coating of such a workpiece of complicated shape with an even powder layer is extremely difficult. Further, there are to be considered the layer thickness to be obtainable, the rate of deposition of the powder on the workpiece, the efficiency, i.e. the proportion or ratio between the deposited amount of powder and the atomized amount of powder, etc. In the electrostatic powder coating method, the manner of atomization and of electrically charging the powder particles is of considerable importance. All phenomena appearing generally or also in specific cases are not yet fully explored, and no guide-lines and technical instructions are available for the construction of coating apparatus, and particularly of powder spray guns. The different construction of spray guns can only be compared with each other by the obtained quality of the powder layers and since, as mentioned, it is actually not possible to recognize or discern and explain in detail all phenomena occurring in any known spray gun, particularly in relation with mechanical and/or electrical atomization of the powder material and of its electrical charging, it is impossible to determine beforehand which means will give better results.

It has been shown in practice that with known spray guns, obtaining of unobjectionable coatings is subject to certain conditions, while workpieces of complicated shape cannot be coated without defects at all.

It is an object of the present invention to avoid such drawbacks of known spray guns. According to the subject application, the spray gun is provided with a longitudinally movable rod extending coaxially within the gun barrel, which is adapted for connection to the supply conduit for the powder-gas mixture, a deflector formed as a simple body of revolution being fixed coaxially with said gun barrel to the front end of said rod situated outside of the barrel discharge opening, at least the front portion of the barrel and of said rod and the deflector being made of, or coated with, an electrically insulating material such as plastics.

For optimum adaptation of the powder spray jet produced by the spray gun to the shape of the particular object to be coated, exchangeable deflectors in the shape of a sphere, a hemisphere, an ellipsoid, a cone or a drop-shaped body are provided, the deflector being shaped, at least on the side facing the discharge end of the barrel, to offer only a small resistance against the flow of the impinging jet, so that a powder cloud of limited lateral spreading can be obtained. The deflector body can be

provided with a bore extending in the direction of the jet when in addition to a cone-shaped spray jet a coaxially directed thin spray jet with a greater speed of the powder particles shall be produced.

These and further objects of the invention will be apparent from the following detailed description of various forms of the invention, read in conjunction with the figures of the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration, in cross section, of the entire arrangement, employing a deflector of the first embodiment; and

FIGS. 2–6 illustrate additional forms of the deflector in cross section.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1, a gun barrel tube **4** is connected by a hose **2** to a receptacle (not shown) containing the powder material by which the object **7** is to be coated. The barrel **4** and thus the entire spray gun is carried by a holder **3**. An ellipsoidal deflector **6** is held in front of the discharge opening **5** of the powder stream by means of an adjusting rod **9** extending coaxially in the straight barrel portion. The rod **9** is held in position in the barrel by supports **11** and is threaded into the gun portion **10**, so that the position of the deflector can be adjusted along the axis of the tube barrel **4** by turning a knob **12** of the rod. The distribution of the sprayed powder between the discharge opening **5** and the object **7** to be coated is represented by lines of a powder cloud showing the movement of the powder particles.

At least the front portion of the gun barrel **4** and of the rod **9** between the support **11** and the discharge opening **5**, and between the support **11** and the deflector **6**, as well as the deflector **6** itself are made of an electrically insulating material, such as plastics, or are coated by such material, so that the powder particles are electrically charged by friction.

For producing an electrostatic field between the spray gun and the object **7** to be coated, these parts can be connected in known manner by a suitable high voltage source. For this purpose the rod **9** can comprise a conductive core, for example of silver steel and comprises an end **23** which can be substantially flat or terminate in a point directed towards the object. The deflector is adjustably positionable axially upon the end **23** of rod **9** by any suitable means (not shown) such as by means of a set screw, mating screw threads, spring biasing, etc. The end **23** of rod **9** can be substantially flat and lie flush with the surface of the deflector **6** opposite the discharge end **5** of the gun barrel **4**, or it may be terminated inside the body of the deflector **6**, thereby leaving an opening in the deflector **6** leading from the end **23** of rod **9** to the surface of the deflector **6**. Alternatively, the end **23** can be in the form of a point which extends beyond the surface of the deflector **6** and directed towards the object **7**. If desired, the rod **9**, rod end **23**, and deflector **6** can all be electrically insulated by a thin layer of insulating coating material. The core of silver steel can be connected by the intermediary of the supports **11** and a feed line passing from the supports through the barrel **4** to one pole of the high voltage source such as at the holder **3**.

Additionally or alternatively, the gun tube **4** and the rod **9** can be electrically connected together at the threaded portion **10** of the gun. One side of the electrostatic high voltage source **20** is connected to the gun body at any place that is convenient, and is shown in FIG. 1 as being connected at the holder **3**, thus forming one of the two electrodes necessary to establish an electrostatic field. The other side of the high voltage source **20** is connected to the object **7** being sprayed on to a platform or hanger (not shown) that the object is in electrical contact with. Thus, powder particles accumulate charge as they pass

through tube **4** and around or through the deflecting means **6** assuming the same potential as the tube **4** and deflecting means **6**. The electrostatic field then exists mainly between the deflecting means **6** and the object **7** being coated. The powder particles flow along the electrostatic lines of force toward the object **7** and provide the advantages of electrostatic coating already known by those skilled in the art, such as minimizing powder waste, uniform coating action, etc.

The deflector **6** has no unusual electrostatic effects but rather affects the powder cloud aerodynamically offering complex force fields that act upon the powder particles as they pass by the deflecting means. Thus, the particles are positioned in desirable location near the object **7** to be coated, there to be acted on by the electrostatic field.

The electrostatic high voltage source can be any of known sources where the potential difference is obtained by friction or other means. The + and — signs at the high voltage source **20** output, at the discharge tube opening **5**, and at the object **7** in FIG. 1 establish the direction of the electrostatic field. The ground symbol is connected to the more negative source lead **21**. This allows the object **7** to be handled without precautions concerning electrical shock. The gun in this arrangement must be insulated sufficiently to protect the operator. However, the ground connection could just as easily be made on the more positive source lead **22**, allowing the gun to be used without insulation precautions but requiring precaution when handling the object **7** being sprayed.

A gas-powder jet of relatively high speed is discharged through the opening **5** of the gun barrel. By the action of the deflector on the powder jet, the kinetic energy of the moving powder particles is more or less dissipated, or these latter are deflected in whirling paths and form a powder cloud **8** between the opening **5** and the object **7**.

The width of the powder cloud formed in the electrostatic field between the atomizer gun and the object can be adjusted in simple manner by varying the distance between the opening **5** and the deflector **6**. Since the powder jet discharging from the opening **5** has the tendency to enlargen its cross-sectional area, the ratio between the deflector area acting on the jet and the cross-sectional area of the jet, and accordingly the amount of radial deflection will be great when the distance between the opening **5** and the deflector **6** is small. When this distance increases, the said ratio and accordingly the deflection becomes smaller.

Naturally, this ratio will also become greater when, as represented in FIG. 2, instead of a rounded streamlined deflector body **6**, a flat disc-shaped deflector **14** of the same transverse width but having faces extending substantially at right angles to the direction of movement of the discharged powder jet will be used. The value and the direction of the velocity of the powder particles are affected to a greater degree than in the case of an ellipsoidal deflector **6** in FIG. 1.

In FIG. 3, the distance between the barrel opening **5** and the deflector **14** is considerably reduced, so that the powder particles will obtain a greater radial speed component than in the arrangement of FIG. 2. Such a small distance between the opening **5** and the deflector **14** is particularly suitable for coating objects **18** of a larger size on both sides, i.e. also on the side opposite to that facing the discharge opening **5**.

For coating objects **18** which are moved past the gun barrel in the position shown in FIG. 4 a deflector body **15** is provided having a cone-shaped portion facing the discharge opening **5** and a rounded or hemispherical portion facing the object **18** to be coated. It is obvious that the shape of the deflector body **15** does not produce any substantial enlargement of the powder cloud even when the deflector is situated very close to the discharge opening **5**. The powder cloud will obtain a shape approaching that of a stream or jet.

In FIG. 5 a deflector **16** is shown having a shape similar

to that of FIG. 4 but its situation in the powder stream is reversed with respect to the deflector **15** of FIG. 4. The action on the speed of the powder particles here is increased, i.e. a greater modification of the value and the direction of the particle velocity can be produced.

According to FIG. 6, the deflector **17** which is hemispherical as well as the object **19** are provided with bores or passages extending in the direction of flow of the powder particles discharging from the opening **5**. With this arrangement a still better coating effect than with the arrangement of FIG. 4 is obtained on objects having axially extending surfaces and bores, since a portion of the powder jet is not intercepted by the deflector and will impinge at high velocity against the object **19**.

For reason of safety of operation, the high tension feed lines of the spray gun are coated with suitable insulating resin material.

Practical tests carried out with the described spray gun have shown that powder types of different electrostatic charging capacity can be successfully used for coating objects of quite complicated shape with unobjectionable powder layers of uniform thickness.

The invention is not to be construed as limited to the particular forms disclosed herein, since these are to be regarded as illustrative rather than restrictive.

What I claim is:

1. A powder spray gun for coating objects in an electrostatic field with a pulverulent coating material conveyed by a gas stream comprising:

a body;

a gun barrel formed within said body substantially in the form of a hollow tube adapted for connection to a supply conduit containing said coating material;

a longitudinally movable electrical conducting rod having first and second ends extending coaxially within said gun barrel;

a deflector formed as a simple body of revolution attached to said first end of said rod and disposed coaxially to said gun barrel and remote from the discharge end of said gun barrel, said reflector being fabricated from an electrically insulating material and adjustably mounted on said first end of said rod for relative axial movement with respect to said gun barrel; and

wherein at least the inner front portion of said barrel and the outer surface of said rod are fabricated from an electrically insulating material.

2. A powder spray gun according to claim **1** wherein said inner front portion of said barrel and said outer surface of said rod are fabricated by coating said inner front portion and said outer surface with an electrically insulating material.

3. A powder spray gun according to claim **1** wherein said deflector is in the shape of a plane disc.

4. A powder spray gun according to claim **1** wherein said deflector is in the shape of an ellipsoid.

5. A powder spray gun according to claim **1** wherein said deflector is in the shape of a ball.

6. A powder spray gun according to claim **1** wherein said deflector is in the shape of a hemisphere.

7. A powder spray gun according to claim **1** wherein said deflector is in the shape of a cone.

8. A powder spray gun according to claim **1** wherein said deflector is in the shape of a drop-shaped body.

9. A powder spray gun according to claim **1** in which the deflector is traversed by a bore extending in the direction of the powder jet.

10. A powder spray gun according to claim **1** wherein said first end of said rod terminates as a pointed end.

11. A powder spray gun according to claim **10** wherein said first end of said rod extends through said deflector and emerges on the side of said deflector opposite the discharge end of said gun barrel.

12. A powder spry gun according to claim **1** wherein said first end of said rod terminates flush with the side of the deflector opposite from said discharge end of said gun barrel.

13. A powder spray gun according to claim **1** wherein said first end of said rod is substantially flat and terminates inside the body of said deflector thereby defining a cavity within said deflector on the side of said deflector opposite said discharge end of said gun barrel.

References Cited

UNITED STATES PATENTS

3,065,106	11/1962	Rhodes et al.	239—15
3,317,138	4/1967	Fraser	239—15
3,448,925	6/1969	Cross	239—15

ALLEN N. KNOWLES, Primary Examiner

J. J. LOVE, Assistant Examiner

U.S. Cl. X.R.

239—513