Electrostatic Powder Coating on Heated Parts

Inventors:
William C. Hurt, Jr.
Raymond P. Boehm

by Francis K. Wagle
Their Attorney.
This invention relates to a method of coating the surface of articles and, more particularly, to an improved method of applying protective coatings on the surfaces of articles by electrostatic deposition of powder.

There are presently many known methods of providing protective coatings to articles. Probably the most widely known and used method is that of spray painting. A variation of the paint spray method, and one which has enjoyed some measure of popularity, is electrostatic spray painting. In this latter method an electrostatic field is established between the paint and the article to be sprayed, causing the paint to be charged and attracted to the article and adhere to such article by means of the electrostatic charge. In this method more efficient use of paint is provided since less paint is required to coat a given article and since the over-spraying of paint is substantially diminished. However, many problems of coverage arise in using electrostatic paint spraying. In many instances uniform coverage is difficult to obtain, especially on irregular shapes. Usually it is necessary to rotate the object to obtain adequate coverage of the hidden surfaces, and the bottom portions of many articles are not properly coated without direct spraying of such portions of the article.

Another widely used coating method is that of fluidizing the article. In this method a container of powdered material is agitated by an air stream such that the powder has the appearance of a fluid material. A part to be coated is heated to the fusion temperature of the powder to cause the powder material to adhere to the article. The article is then dipped into the fluid bed. The coated article is then usually baked at the fusion temperature of the powder so as to adequately fuse the powdered coating to the article. One of the most objectionable problems in this coating method is the quantity of powdered material demanded to form the fluid bed. Obviously, the container of the powder must be sufficiently large such that any object to be coated may be immersed into the fluid powder. Further, it is often difficult to adequately mask the various portions of the article which it is desired to be free of the coating.

Another popular coating method is that of electrostatic powder spraying. In this method a powdered material is sprayed on an article through an electrostatic field whereby the powdered material adheres to the article by the electrostatic charge. The field used to provide the electrostatic charge must be sufficient to cause the powder to remain on the article until it can be baked in an oven to fuse the coating into a continuous surface. However, it is difficult to obtain desirable film thickness on coated parts by this type of coating, without additional spraying. The electrostatic powder spraying has certain advantages over both the paint spraying and fluid bed methods. For example, it eliminates the necessity of paint solvents and it provides a substantial reduction in the powder used. However, the problem arising in the obtaining of coatings of adequate thickness by the electrostatic charge and the masking of the parts of the article, which it is desired to be maintained free of the coating, present substantial problems in the electrostatic powder spraying method.

It has been discovered that if the article to be coated by electrostatic powder spraying is first heated that the powder will adhere to the article in much thicker films and that masking can be readily accomplished by the use of cold masking fixtures.

It is, therefore, an object of this invention to provide an improved method of electrostatically powder coating articles.

A further object of this invention is to provide an electrostatic coating method using a novel masking technique to prevent coating of undesired areas of the article.

A still further object of the invention is to provide an improved method of electrostatically spraying powdered coating on an article such that the coatings of desired thickness will firmly adhere to the portions of the article desired to be coated until such time as the coating can be properly fused by a baking.

In carrying out this invention in one form, an article to be coated with powder is first pre-heated to a temperature which is below the fusion temperature of the powder. Cold masking fixtures are placed on the article covering areas where coating is not desired. An electrostatic field is developed between the article to be coated and a powder spraying apparatus, and the powder is then sprayed on the article. The powdered material adheres to the article by means of the heat and the electrostatic charge. After coating, the masking fixture may be either removed or the powder which electrostatically adheres to the fixture may be removed by means of a low powered air jet. The article may then be baked in an oven at a temperature sufficiently high to fuse the powdered coating to provide a smooth, continuous coating to the article.

The invention which is desired to protect by this application will be particularly pointed out in the claims appended hereto. However, it is believed that the invention and its various objects and advantages, as well as other objects and advantages thereof, will be better understood by reference to the following detailed description of a preferred embodiment thereof, especially when taken in connection with the accompanying drawing, in which:

FIGURE 1 is a flow diagram of the main steps of the preferred method of this invention; and

FIGURE 2 is a diagrammatical showing of a preferred embodiment of the invention.

In coating articles it is desired that a smooth, continuous coating be provided which is free from pin holes and the like. Electrostatic powder spraying provides an efficient, economical method of coating articles. However, problems often arise in such coatings due to the inadequate thickness of the coatings applied to such articles. Generally, after a certain thickness has been obtained, any further powder deposited on the article will fall off.

Another problem arising in the electrostatic powder coating, which is also present in most other coating methods, is the problem of properly masking the article to prevent coating undesired portions of the article. In general, a masking fixture will be sufficiently conductive such that some of the powder will adhere thereto during spraying. If the fixture is removed prior to baking the powder adjacent thereto will be disturbed and thus lead to a poor finish on the article in the vicinity of the masking. If the fixture is left on during the baking of the coating the coating adheres to the fixture, making it difficult to remove without adversely effecting the coating adjacent thereto.

It has been discovered that these problems can be substantially eliminated by heating the article to be coated prior to spraying the charged powder over the article. In general, the article should be heated to a temperature which is below the fusion temperature of the powder. It has been found that the best temperature for heating the article is a temperature which is just below the temperature at which the particular powder used would adhere to the article without the electrostatic charge. Thus, as used throughout this application the terms "a heated ar-
article" or "the heating temperature" will relate to an article which has been heated to a temperature, or to the temperature, at which the coating material being used will not adhere to such article without the use of an electrostatic charge. When a heated article is coated with an electrostatically charged powder coating, a coating of three to four times the thickness of the coatings on cold parts can be obtained. Further, masking may be readily obtained by using cold masking fixtures. The term "cold masking fixtures" as used herein refers to masking fixtures which are at a temperature below that of the heated part. In general, it is preferred that such masking fixtures be at room temperature since no pre-heating or chilling is required to obtain the benefits of this invention. The charged particles will not adhere as firmly to the fixtures and can be readily removed by a low pressure air jet. If desired, the fixture may be removed prior to baking without disturbing the adjacent coating, since the adjacent coating adheres firmly to the heated article and thus is not removed with the fixture.

It has also been discovered that the low temperature method used in this method allows a much greater latitude in the use of masking material than is possible with fluid bed techniques. For example, when masking tape is used in a fluid bed the tape adhesive becomes very soft and is difficult to remove. Also, the heat of the article causes the powder to fuse to the masking tape, making it difficult to remove without damaging the adjacent coating. Similar problems do not arise at the temperatures used in this invention.

FIGURE 1 of the drawing shows a flow diagram of the preferred steps used in the method of this invention. As is shown in FIG. 1, the article to be coated is first heated to a temperature which is below the fusion temperature of the powder to be applied. Then, if desired, masking fixtures are applied to the article to those areas where coatings are not desired. After the article has been masked, electrostatically charged powder is sprayed over the entire article. After coating with the electrostatic powder the fixture or fixtures are then removed from the article, thereby leaving the electrostatically charged powders coating over all areas of the article which is desired to be coated. The article is then placed in a baking oven and is baked to a temperature above the fusion temperature of the powder, such that the powder will congeal and form a continuous coating over all portions of the article which is desired to coat. Thus, as will be apparent, by means of the method of this invention electrostatic powdered coatings may be applied to articles which provide a continuous, smooth coating over the entire surface of the article where such coatings are desired.

Referring now to FIG. 2 of the drawing, there is shown in diagrammatic fashion apparatus for use in the preferred embodiment of this invention. As is shown in FIG. 2, a spray gun 10 is provided for spraying powdered material on an article 12 to be coated. The spray gun 10 is connected by means of a hose 14 to a container 16 which contains the powdered material to be applied to the article 12. Also connected to the spray gun 10 is an air line 18 from an air supply 20 which provides air to the gun to draw powder from the container 16 through hose 14 and cause such powder to be sprayed from the nozzle 22 to the article 12, as indicated. In order to provide an electrostatic charge to the powder material a power supply 24 is provided which is connected to the spray gun 10 by means of a cable 26. As indicated in the drawing, the power supply is grounded as shown, and the article 12 to be coated is also grounded. In general, the grounding is provided by grounding of the carrier or trolley 28 on which the article 12 is carried by means of a hook member 30, as is indicated. As will be understood by means of the trolley 28 articles 12 may be carried from a pre-heating oven (not shown) to the spraying area as indicated in the drawing, and after spraying may then be carried to a baking oven (not shown) for baking of the coating on the article.

In order to provide the desired coating on the surface of the article 12 and yet not coat the opening indicated at 32, a masking fixture 34 is provided having spring members or the like (not shown) which fit within the opening 32 to firmly hold masking fixture 34 in the opening 32. As has been previously indicated, the article 12 to be coated is first pre-heated to a temperature below that at which the powdered material will adhere to article 12 without the means of the electrostatic charge. The fixture 34 is then inserted in opening 32 and is at a cold temperature; that is, at a temperature substantially below that of the article 12. The powder particles, indicated at 36, is then sprayed by means of spray gun 10 having been electrostatically charged through nozzle 22 by means of power supply 24 on to the article 12. The electrostatically charged powder 36 will adhere to the entire surface of the article 12 and also to the surface of the masking fixture 34. However, due to the pre-heating of the article 12 the charged particles 36 will strongly adhere to the article 12 while only being held on the masking fixture 34 by means of the electrostatic charge. After coating of the article 12, the masking fixture 34 may then be removed without disturbing the coating which is adherent thereto and, on the article 12, the coating will adhere more firmly to the heated article 12 than to the surface and sides of the masking fixture 34. However, if it is desired to leave the masking fixture in place during the baking or coating of the baking, then the material 36 may be removed from the surface of the coating fixture 34 by means of a gentle air jet. The air jet will blow all of the charged particles which have adhered by electrostatic charge to the fixture 34, but will not disturb any of the particles which adhere to the surface of article 12 since the pre-heating of the article 12 in conjunction with the electrostatic charge holds the particles firmly on to the article 12. Thus, the coating may be obtained either by removing the fixture or by blowing the charged material off the fixture, as is desired.

As an example of the use of this invention, a metallic part for use in an electrical cutout was pre-heated to a temperature of approximately 125°C. A powdered material comprising a composition of an epoxy resin, a polyvinyl acetate resin and a polyacrylate resin, as set forth in Patent No. 3,058,951 was then applied to the article by means of electrostatic powder spraying. The powder firmly adhered to all parts of the metallic article and could not be removed by a low-pressure air jet nor by hard shaking of the article. The article was then placed in an oven and heated to approximately 200°C at which temperature the powder fused and formed a continuous coating over the entire surface of the metallic part. When applying the above powder to the metallic part in a fluidized bed, the article is normally heated to 200°C or higher prior to insertion into the fluidized bed. The same metallic part heated to 125°C was placed in front of the spray gun and without using the electrostatic charge a substantially quantity of powder was sprayed over the part. Little or no powder adhered to the metallic part. Thus it can be seen that the 125°C was not sufficient to cause the powder to adhere to the metallic part. However, by the combination of the electrostatic charge and the heating the powdered material firmly adhered to the metallic part and could not be disturbed, either by shaking or by low pressure air jets. In the above method of coating the cutout part a final coating was obtained having a uniform thickness of approximately 15 mils. When the metallic part was heated in the same manner, but with the part at room temperature, the final coating obtained had a uniform thickness of approximately 5 mils. While much powder was sprayed on the cold part, it was not possible to increase the thickness of the coating. From this it is apparent...
that the method of this invention provides for an increase in thickness of the final coating by a factor of three. Clearly, this provides a substantially improved coating to the coated part.

The same article was pre-heated to 125° C. and then a cold metal mask was placed around a portion of the article. The article was then sprayed with electrostatically charged powder of the type indicated above. A gentle air jet was then blown over the entire article. All of the powder which adhered to the masking fixture was removed by means of the gentle air jet whereas none of the powder on the unmasked portions of the article were disturbed. From this it is apparent that by means of the heating of the article prior to the coating by the electrostatically charged powder that the charged powder will firmly adhere to the heated article, whereas it may be readily removed from cold masking fixtures.

Of course it will be obvious that instead of a cold masking fixture, that other parts of an article may be assembled at room temperature with pre-heated parts of the article. The electrostatically charged powder may then be sprayed over substantially the entire article. The powder which adheres to the parts at room temperature may be readily removed by a low pressure air jet. The article may then be baked to cause the powder to fuse to the pre-heated portions, while no coating will be on the parts assembled at room temperature. Thus, as will be apparent, by means of this invention, coatings may be applied to desired portions of composite articles, when the articles are in their assembled form.

From the above it will be apparent that this invention provides a novel method for coating of articles by use of electrostatically charged powder which provides a unique coating of desired thickness on the article and which readily provides the objects and advantages hereinbefore set forth. While there has been shown and described the present preferred embodiment of the invention, it will, of course, be obvious to those skilled in the art that various changes may be made in the steps of the method hereinbefore set forth and in the various equipment used without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed as new and which it is desired to secure by Letters Patent of the United States is:
1. A method of coating a metallic article with a material comprising a composition of epoxy resin, polyvinyl acetate resin and polystyrene resin comprising the steps of pre-heating the article to approximately 125° C., spraying the article with the material in the form of electrostatically charged powder, then baking the coated article at a temperature of at least 200° C. to fuse the coating.
2. A method of coating a metallic article with a material comprising a composition of epoxy resin, polyvinyl acetate resin and polystyrene resin comprising the steps of pre-heating the article to a temperature of approximately 125° C., applying masking fixtures substantially at room temperature to the pre-heated article, spraying the article with such material in the form of electrostatically charged powder, removing the masking fixtures from the article, and baking the coated article at a temperature of at least 200° C. to fuse the coating.

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ALFRED L. LEAVITT, Primary Examiner.

A. GOLIAN, Assistant Examiner.