PROCESS AND APPARATUS FOR PRODUCING CONTINUOUS COATINGS

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FIG. 4

FIG. 3

FIG. 5

FIG. 6B

FIG. 6A

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The present invention relates to protective coatings and to a method and apparatus for producing such coatings on the surfaces of articles.

This application is a continuation-in-part of copending application Serial No. 569,595, filed March 5, 1956, now abandoned, by Conrad J. Dettling and Robert E. Hartline.

The U.S. patent applications of Erwin Gemmer, Serial No. 427,481, filed May 4, 1954, and Serial No. 551,945, filed December 8, 1955 (now abandoned), the U.S. Patent No. 2,844,489, dated July 22, 1958, and the German Patent No. 933,091, disclose a process of applying coatings to a variety of objects by immersing the object in a fluidized bed of pulverulent coating material that has a melting point lower than the melting or decomposition point of the material from which the particles are to be coated are made. The bed is fluidized by an upwardly moving stream of gas passing therethrough which causes the bed to expand. The article is heated while in contact with the fluidized pulverulent material so that a certain amount of material adheres to and melts on the surface of the article to form the coating. The method described in the Gemmer applications and patent is very useful for forming coatings of materials which have superior resistance to chemicals and solvents or which are electrical insulators or which are resistant to mechanical abrasion or frictional wear. A variety of types of coating materials may be used as described in the Gemmer applications and patent. The present invention is an improvement in the Gemmer process and apparatus.

In the practice of the aforementioned Gemmer invention, it was generally contemplated that the articles to be coated are to be held or supported in some positive manner by an article-holding means such as a pair of pliers as the article is dipped into the fluidized bed and removed therefrom. Although the Gemmer invention is not necessarily limited to this feature, the Gemmer patents do not teach any other method for the support of the article as the coating is applied. Various holding devices such as screw clamps may be used in addition to pliers. Small wires which may be soldered or welded to the surface of the article and removed after coating, supporting hooks on which the article may be hung, or other similar devices may also be employed.

It has been found that a very serious disadvantage arises from the use of such positive supporting means for the article to which the coating is being applied. This disadvantage is that in every case there is a discontinuity or interruption in the coating at the point or points on the article engaged by the holding device. This discontinuity in the coating is likely to be particularly serious where the corrosion-resistant properties of the coating are of primary importance and where the coated article is to be exposed to a corrosive environment. The coating discontinuity may be a serious disadvantage where the purpose of the coating is for protection against mechanical abrasion or for electrical insulation purposes. However, for these purposes, it is often possible to arrange for the discontinuity to appear at a position on the article which does not impair its utility.

A further disadvantage of the Gemmer invention is that in certain instances there is a coating thickness limitation which cannot be avoided without repeated post-heating and reimmersion steps. Continued repetition of this step is time consuming, and may be harmful to the initially applied coating.

Accordingly, it is another important object of the present invention to provide a continuous coating of the above description, but having no coating discontinuities occurring through the use of article-holding devices during the application of the coating material.

It is a further object of this invention to provide a high quality coating of increased thickness with one immersion and no more than one post-heating step.

As previously noted the bed of pulverulent coating material in the open-top container at first increases in volume when the air is turned on until it reaches a fluidized state having what is considered a maximum volume consistent with avoiding an undue amount of gaswearing and entrapment of dust from the container. In approaching the problems of the fluidized bed coating process of the Gemmer patent it has been observed that when the air flow is stopped or decreased substantially the bed at first shrinks rather rapidly (in the order of a few seconds) but thereafter contraction of the bed is very slow as long as the bed is kept quiescent and no positive pressure or vibration is applied thereto.

The bed in this quiescent "fluffed" state has very interesting properties. Clearly it is not fluidized for there is no air flow to maintain fluidization. However, it has some of the properties of the fluidized bed that an article can be inserted into it with little or no resistance and when immersed the powder will flow around the top of the article so as to cover and contact substantially all surfaces.

However, in marked contrast to the fluidized bed, the "fluffed" powder will support substantially the entire weight of even rather heavy objects such as metal objects. The same will be true of course for powders that have volumes lower or densities greater than the "fluffed" powder.

Of course all the various forms of powder are really a mixture of gas and pulverulent coating material, the different properties of the various beds being governed largely by the ratio of gas to coating material. In the "fluffed" bed the ratio of gas-to-coating material is such that the bed has substantially its maximum self-supporting volume, the particles of coating material being substantially immobile.

The degree of support provided by the bed of pulverulent coating material will vary with the density. A completely fluidized bed will provide relatively little buoyant effect, certainly not enough to support the article. On the other hand, a bed of substantially immobile particles of coating material at its maximum self-supporting volume will provide enough support to sustain the weight of most articles.

Another interesting characteristic of the "fluffed" bed is that since the particles are substantially stationary, when heavy objects are immersed in the bed or other objects are immersed with applied force, there is a tendency to compact slightly the powder beneath the article thereby to cushion it and to keep it supported in the bed. This compacting effect is ordinarily not enough to prevent immersion but is enough to keep the article from descending all the way through the bed to the porous plate.

For the purpose of clarifying terminology, the following definitions of terms and expressions used in the disclosure and claims are given. The term "rarefied" is applied to beds of pulverulent material that are either fluidized or "fluffed" so as to permit the immersion of articles with facility and without substantial resistance. Conversely, the term "unrarefied" refers to beds that have a lower volume and greater density and therefore do not
readily permit the immersion of articles therein. The term "fluffed" has already been discussed and implicitly defined to indicate a bed of substantially immobile particles of the coating material having substantially maximum self-supporting volume. Although the method of producing the "fluffed" bed has been previously described as involving the initial fluidization and subsequent defluidization, it may be prepared by other procedures such as inventing a closed receptacle containing the powder, by vibration, or by other methods.

The term "fluidized" has been extensively discussed in the Gemmer applications and patent. The corollary term "unfluidized" describes beds in which the particles are substantially immobile and therefore covers the "fluffed" beds as well as the more dense beds that do not readily permit the immersion of articles.

In carrying out the present invention a bed of pulverulent coating material is formed comprising a mixture of a gas and the pulverulent coating material. At least a portion of the mixture has a gas-to-coating material ratio in the range from that of a completely fluidized dense phase fluidized bed of the coating material to that of a bed of substantially immobile particles of the coating material at substantially its maximum self-supporting volume. The purpose of this first named portion of the fluidized bed is to make it easy to insert the article into the bed and once inserted, if desired to move the article around in the bed. Another characteristic of the body of powder is that it has at least a portion that is a mixture having a gas-to-coating material ratio in the range from that of a bed of substantially immobile particles of the coating material at its maximum self-supporting volume to that of unreacted powder. One of the purposes of the second named portion of the bed is to provide support to the article. As previously mentioned and as more fully described hereinafter, another very important characteristic of the second portion of the bed is that it has the capacity of forming a very thick coating on the article by reason of the particles being relatively stationary and the absence of air flow which would tend to cool the article and coating material and brush off particles that have only a very tenuous bond to the underlying particles in the layer.

It will be recognized that both portions encompass the "fluffed" powder that has both the capacity to permit ready insertion into the bed and also the ability to support the article. In a particular embodiment of the invention the first portion is fluidized either above the second portion or positioned laterally with respect thereto, i.e., at substantially the same elevation. The article to be coated is heated to a temperature above the melting point of the coating material and is then immersed in the bed of material so as to become completely surrounded thereby. During the period of immersion at least a portion of the surface of the article comes into contact with the second named portion of the bed. After the particles of coating material have been melted and coalesced on the surface of the article and at least partly solidified the coated article is removed from the coating material.

One of the advantages of the present invention is in providing a coating as described above in which no appreciable deformation of the coating is caused by engagement of the coated article with the bottom or sides of the coating container. Another important advantage is in providing a way of forming very thick coatings in a single heating and immersion cycle. Still other advantages will be apparent from the following description and the accompanying drawings containing the following figures:

FIGURE 1 is a sectional view of a preferred form of apparatus for carrying out the present invention; FIGURE 2 is an enlarged sectional view of a modified form of porous plate containing nonporous portions shown in FIGURE 3 which may be advantageously used for carrying out the present invention;

FIGURE 3 is a top view of a porous plate containing nonporous portions;

FIGURE 4 represents an additional embodiment of this invention wherein the container and porous plate are inclined at an angle of approximately 45°.

FIGURE 5 shows a typical magnetic pickup device for use according to this invention; and

FIGURES 6A and 6B are directed to typical supporting surfaces shaped to conform to the surfaces of a coated article, for use during a post-heating step.

Referring in more detail to FIGURE 1 of the drawings there is shown a container 10 which may be constructed of a convenient structural material such as steel, for instance, and which has an open top as indicated at 12. The container 10 is divided into an upper chamber 14 in which the pulverulent coating material is confined and a pressure chamber 16 by a gas pervious partition 18.

This partition, which should be pervious to the gas used but impervious to the particles of coating material, may preferably take the form of a porous ceramic plate, although other similar structures may be advantageously used. A porous plate structure which is preferred is composed of an aluminum refractory material formed of fused alumina grains bonded together with an aluminous glass at a high firing temperature as described in the Gemmer cases referred to.

The container 10 is provided with a gas inlet opening 20 which is adapted for connection through a shut-off valve 21 to a suitable source of gas under pressure in order to pressurize the pressure chamber 16. The source of gas under pressure is not shown since it may consist of any conventional source such as a steel "bottle" of precompressed gas or, if air is to be used, a conventional air compressor and accumulation tank may be used. When air is to be used, it is also possible to attach an air blower or pump directly to the inlet connection 20.

In the practice of the process of this invention, a quantity of very finely divided coating material is placed in the upper chamber 14 of the container 10 and gas under pressure is admitted through the connection 20 into the pressure chamber 16. The gas from the lower chamber 16 passes through the gas-permeable partition 18 and flows upwardly through many finely divided streams or in what might be characterized as a parallel upward flow from the entire upper surface of the finely divided or pulverulent coating material. This upward moving gas causes some of the particles to be raised and separated from the others in what has been called a fluidization of the coating material. In this state, the coating material has the feeling and appearance of a liquid although it is actually simply a dry mixture of gas and solid particles. This fluidization of the coating material is such that solid objects may be immersed within the coating material so as to be completely surrounded thereby just as such an article might be dipped into a liquid.

The portions of this apparatus and process described immediately above generally correspond to the apparatus and process described and claimed in the aforementioned Gemmer U.S. Patent 2,844,489.

In accordance with one embodiment of the present invention, rather than holding the article which is to be coated as it is inserted into the fluidizing material and removed therefrom, the article, after heating, is simply inserted into the fluidized material and released therein. This may be accomplished by releasing the article over the open top 12 of the container and permitting the article to drop into the fluidized coating material in chamber 14. The article acquires a porous coating of the melted particles of the coating material. When coated by the present process, when the article is removed, the coating usually con-
sists of a completely continuous inner portion which is directly adjacent and adherent to the outer surface of the article with superposed portions which are more porous, the outermost portions of adherent coating material consisting of particles which have only melted slightly so as to have a degree of adherence to the inner portions, but not enough to form a smooth and continuous appearance. Such a coating is entirely satisfactory for some purposes. However, for most purposes, it is desired to have a completely solid and smooth appearing coating. This can be accomplished by applying additional heat to the article after it is removed from the fluidized bath. This heat may be applied for a short period such as a few seconds by means of a gas flame, but preferably it is applied over a longer period such as by placing the coated parts in a suitable oven which is heated to a temperature slightly above the softening or melting temperature of the coating material.

In this post-heating step, it is necessary that the article be supported on a surface which does not adhere to the softened coating and which will withstand the temperatures encountered. A suitable material for this purpose has been found to be polytetrafluoroethylene. In order to prevent any substantial flow of the softened coating material away from the article engaged by the supporting surface due to the force of the weight of the article, it is preferable to provide substantial supporting surfaces which are shaped to conform to corresponding surfaces of the coated article for engagement therewith. In this way, the force of the weight of the article is adequately distributed over the softened coating so that this force is insufficient at any one spot to cause a substantial flow and thinning of the coating. The problem is most simply solved, of course, if the coated article is provided with a substantially large plane surface on which the article can be supported on a flat supporting surface.

FIGURES 6A and 6B of the drawings show supporting surfaces shaped to substantially conform to corresponding surfaces of the coated article. FIGURE 6A depicts a concave supporting surface 32 arranged to support a coated article 34 having a corresponding convex surface. In FIGURE 6B, the supporting surface 36 is in the form of a plane corresponding to the plane surface of the coated article 38.

It will be appreciated that this process permits the application of a coating which is absolutely continuous and completely surrounds and covers all of the surfaces of the article which is to be coated.

A suitable device such as a wire basket 22 may be used to remove the coated articles from the fluidized bed container, as described below. One method for avoiding damage of the newly formed coating and to concurrently avoid any possibility of damage to the porous plate 18 is to provide a substantially unfluidized or unrarefied layer of coating material in some portion, preferably near the bottom, of the chamber 14. The upper level of the unfluidized or unrarefied portion of the coating material is indicated in FIGURE 1 of the drawings for instance at 24, while the upper level of the fluidized portion of the coating material is indicated at 26.

It has been found that there are a number of practical methods for obtaining an unfluidized or unrarefied layer of the coating material near the bottom of the chamber 14. For instance, one excellent method is simply to shut off the supply of fluidizing gas to the chamber 14 through the inlet 20. If the articles to be coated are changed into the pulverulent coating material in chamber 14 immediately after the gas is shut off, the upper portions of the coating material remain sufficiently rarefied so that the articles may drop through the upper layers so that they are completely submerged and surrounded with pulverulent coating material. The effect is somewhat similar to that which is encountered when an object is dropped into light, fluffy, dry new fallen snow. In the use of this method, however, it has been discovered that the lowermost portions of the pulverulent coating material are not sufficiently rarefied to permit the article to fall on through the bottom of the basket 22 or to the porous plate 18. Thus, the article rests and is supported entirely within the pulverulent coating material with the result that a completely continuous and uninterrupted layer completely surrounding the article is formed.

The embodiment described immediately above, in which the flow of fluidizing or rarefying gas is interrupted before the article is dropped into the pulverulent coating material serves to illustrate that in the practice of the present invention it is not absolutely essential that a fluidizing gas must be used with a porous plate apparatus as shown in the drawings as long as at least the upper portions of the pulverulent coating material can be somewhat rarefied. This rarefaction might be accomplished by other methods, for instance, such as by applying a temporary cover to the container and overturning the container and then returning it to an upright position. However, it has been discovered that other methods for rarefaction of the pulverulent coating material are not generally as satisfactory as the fluidization with an upwardly moving current of gas.

When the portions of the gas stream which has passed through the chamber 16. It has been discovered that with a relatively low gas flow, only the upper portions of the pulverulent coating material can be somewhat rarefied.
coating material are actually fluidized and the lower portions remain relatively dense. By proper adjustment of the gas pressure, therefore, a bottom layer of pulverulent coating material which is sufficiently dense to support the article being coated at the desired height can generally be obtained.

A variation of the low gas flow method described in the above paragraph in which the upper level 24 of the unfluidized or unarrested bottom layer of coating material may be better defined by predetermined and controlled is by employment of relatively large, coarse, coating material particles for this bottom layer while employing the usual very fine particles in the upper raredfied portions of the coating material. For instance, the particles in the lower unarrested portions may have a particle size in the order of from two to four times or more the particle size of the raredfied portions. The preferred particle size ranges for the practice of this invention are discussed more fully below. This method of using two distinctly different particles sizes is operable partly because of the fact that the fluidization action of the upwardly moving stream of gas is effective to a greater degree on the finer particles than on the larger particles. Accordingly, contrary to what might be expected, the two different sizes of particles are not mixed to an appreciable degree unless the rate of gas flow is made to be extremely rapid compared to the rate required for fluidization only of the finer particles. Accordingly, with appropriate control of the maximum rate of flow of the fluidizing gas, the use of the coarse particles of material to form the lower layer of unfluidized supporting material provides excellent results.

Another method for providing an assurance of appropriate unfluidized portions of the pulverulent coating material near the bottom of the chamber 14 may be accomplished by providing a regular pattern of unfluidized spots or portions in the porous plate 18. A typical pattern, for instance, would be a geometrically regular polka dot pattern. This procedure results in the maintenance of small mounds of unfluidized pulverulent coating material on the upper surface of the porous plate immediately above the nonporous portions thereof. This arrangement is most effective when the article which is being coated is large enough to be supported upon a number of these small unfluidized mounds. The nonporous portions of the plate can be easily and simply provided by placing small quantities of suitable scaling materials over such spots on the upper surface of the porous plate.

This modification of the structure of the porous plate 18 carrying out this method is illustrated in FIGURES 2 and 3 in enlarged detail views of only a portion of the porous plate 18. As described above, small nonporous portions of the plate are provided by means of spots of scaling material indicated at 28 which at least adhere to the surface of the porous plate and which may preferably penetrate to at least a small depth into the surface of the porous plate. Various well-known substances may be used for this purpose, such as tar or tar-like compositions. As a result of the lack of porosity of these spots 28 on the plate, most of unfluidized material accumulate above such spots as indicated at 30 which provide the support for the articles being coated as described above.

Another method for providing an unfluidized portion of the bed for support purposes involves the tilting of a conventional container of fluidized coating material as shown in FIGURE 4. When, for example, the container 10 is tilted to an angle of approximately 45° from the vertical, an area of increased whirling is obtained at the shallow end 40 of the upper chamber 14. The powder level, of course, remains parallel to the floor. The powder in the deeper end 42 of the chamber 14 is substantially less fluidized, and may be completely unfluidized, depending on the rate of gas flow through the porous plate 18.

In using this embodiment, the heated article is immersed in the shallow portion 40 of the chamber, the desired amount of coating is permitted to adhere to the article, and the article thereafter is moved into the deeper end 42 and released. Because of the powder in the deeper end of the tilted container is in a less rarified condition, the lower reaches thereof provide a cushion preventing the coated article from touching the bottom or sides of the tank. After sufficient powdered material has adhered to the surface of the article, it is subjected to a post-heating step if necessary. All of the methods described above provide a cushion of substantially unfluidized pulverulent coating material for supporting the article being coated above the air-perivious partition. In each of the process modifications, the bed of pulverulent coating material may be rarefied (i.e., more fluidized or fluffed) at some stage.

It has been found desirable in some instances to return the powdered coated material in the container to a fluidized condition while the article to be coated is retained therein. In instances where the article has retained sufficient heat to cause the coating material to fuse on the surface of the article, the thin or poorly coated portions of the article may be again advantageously contacted with additional coating material by this subsequent fluidizing step.

The methods described above make possible the production of completely continuous coatings on articles by removing the necessity for a positive support other than the coating material itself. It has also been found that the thickness of the coating obtained may be substantially increased over the thickness of a similar coating obtained according to the process outlined in the aforementioned Gannower patents. The embodiment of this invention wherein the heated article is immersed in a fluidized bed and the supply of fluidizing gas is thereafter interrupted to permit the fluidized bed to collapse about the heated article has been found to be particularly effective in this regard. The article before immersion is heated to a predetermined temperature above the melting point of the coating material, but below the rapid decompositional temperature of the coating material. The latter temperature limitation cannot be exceeded without deleterious effects on the coating thus obtained. As the thickness of the coating depends upon the heat capacity of the article being coated, this upper temperature limit effectively limits the thickness of coating material deposited on the article during immersion thereof in a fluidized bed. In addition, it is believed that attrition of the rapidly moving particles of the fluidized bed serves to remove the weakly bonded particles on the exterior of the coated article while it remains in the fluidized bed. Regardless of the reason, it has been found that coatings from two to three times the thickness of coatings obtained from a fluidized bed may be obtained where the fluidized bed is employed to apply the initial coating followed by the retention of the thus coated article in the bed during collapse thereof, or in similar operations where the heated article is contacted with unfluidized, e.g., powdered fluid.

As to particle sizes of the pulverulent coating material, it is particularly important in the practice of the present invention that coating material particles of extremely small size be employed. While it is generally preferred that the particles should be in the size range between about 0.001 and 0.012 inch, it has been found that the very best results are obtainable if the average particle sizes are kept below 0.004 inch in maximum diameter and are particularly important or necessary that the minimum size should be above 0.001. Generally, the smaller the average particle size of the pulverulent coating material, the higher the quality of the resulting coating. The particular aspect of quality which is referred to here is the smoothness and continuousness of the coating and the absence of minute holes or depressions which are sometimes referred to as "hot spots."

The thickness of the coating which is produced is dependent upon a number of factors including (in addition to the degree of particle movement) the particle size of
the coating material, the time of immersion in the coating material, and the temperature and heat capacity of the article which is coated at the time of immersion in the coating material. Generally speaking, small powder particle sizes are conducive to the production of thin coatings while large particle sizes are conducive to the production of thick coatings. Also, the greater the time of immersion, the thicker the coating becomes up to the point where the heat of the article is substantially dissipated. The temperature affects the coating thickness in that the higher the temperature and the greater the heat storage in the article which is coated, the thicker the coating may be. Most importantly, however, all other factors remaining constant, a much thicker coating is obtained where the particles are unfilled.

In the practice of one embodiment of the present invention, the article being coated will remain in the coating material until the formation of the coating is substantially complete and at least partially solidified. The time of immersion therefore is practically eliminated as a factor in determining coating thickness for the article is left in the coating material until substantially all of the heat storage in the article above the melting temperature of the coating material has been dissipated. Accordingly, the accurate determination and control of the pre-heating temperature of the container which is to be coated is particularly important in this practice. Because of the wide variations in heat storage characteristics of various different articles which may be coated, it is very difficult to specify preheat temperatures without determining such temperatures experimentally until coatings of satisfactory thicknesses are obtained. However, it may be generally stated that when polyethylene or polyamides are employed as the coating materials, the articles to be coated may be preheated to temperatures as much as 300°F. above the melting temperatures of the coating materials. The thickness of coatings produced from such coating materials is generally in the approximate thickness range from .010 to .030 inch.

In order to obtain the thinnest possible coatings of uniform thickness, when the coated articles are removed from the fluidized pulverulent coating material, the loosely adherent powder particles on the outer surface of the article may be removed by a rapidly moving stream of air, or by vibration or tumbling or other means prior to the post-heating treatment to form the smooth coating surface.

In the practice of the present invention, the removal of the coated articles from the fluidized coating material in chamber 14 may present somewhat of a problem. However, the basket 22 generally provides a convenient solution to this problem. The basket 22 may be simply raised from the chamber 14 through the top opening 12. The interstices of the basket are small enough to prevent the coated articles from falling through the bottom, while such openings permit the pulverulent coating material to fall through so as to separate the coated articles from the coating material. The coated articles may then be quickly emptied from the basket 22 and the basket replaced in the position shown within the chamber 14. If preferred, the coated articles may be “fished” out of the powder in chamber 14 by the use, for instance, of a mechanical rake or other similar mechanical devices other than the basket 22.

If the articles coated are composed of magnetic materials, magnetic pickup devices may be lowered into the pulverulent material to pick up the coated articles by magnetic attraction. One such device is shown in FIGURE 5 of the drawings. Referring to FIGURE 5, a magnetic article 50 is shown at the bottom of chamber 14 of the container of FIGURE 1. The container is provided with a pick-up device 52 comprising an electromagnet 54 mounted at the lower end of a rod 56. Electrical connections 58 are provided between the electromagnet 54 and a power source 60. The rod 56 is mounted above the container 10 (mounting not shown) to raise and lower the device 52 with respect to the container 10.

It will be appreciated that the present invention readily lends itself to conveyorization for mass production requirements. For instance, a suitable conveyor may be employed to convey the articles to be coated through a preheating furnace and to drop the heated articles into the pulverulent coating material in chamber 14. Also, baskets smaller than the basket 22 which do not surround the entire interior of the chamber 14 could be employed to sequentially pick up individual coated articles from the chamber 14 after a timed interval during which the article cools and the coating is formed. These baskets or other pick-up devices could also be associated with a suitable conveyor so that the entire operation would be on an automatic basis. Because of the fact that this conveyorization could be carried out in a number of different conventional ways, such a system is not illustrated in detail in the drawings.

The following claims are intended to define the valid scope of this invention over the prior art and to cover all changes and modifications falling within the true spirit and valid scope of the invention.

We claim:

1. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature, forming a bed of coating material comprising a mixture of a gas and a pulverulent coating material, at least a portion of the mixture having a gas-to-coating material ratio in the range of from that of a completely fluidized dense phase fluidized bed of the coating material to that of a bed of substantially immobile particles of the coating material at its maximum self-supporting volume, and at least a portion of the mixture having a gas-to-coating material ratio in the range of from that of a bed of substantially immobile particles of the coating material at its maximum self-supporting volume to that of an unretracted powder, and immersing the article in the bed so that at least a portion of the surface of the article comes into contact with said second named portion.

2. The process of claim 1 wherein the article is supported only by the forces provided by said second named portion of the bed during at least a part of the immersion period.

3. The process of claim 1 wherein said portion of the surface of the article remains in contact with said second named portion of the bed until the maximum amount of coating material has adhered thereto.

4. The process of claim 2 wherein said first named portion of the bed of pulverulent coating material is fluidized within an open-topped container.

5. The process of claim 4 wherein the fluidized portion of the bed is in the upper part of the container and the second named portion of the bed is in the lower part of the container.

6. The process of claim 4 wherein the fluidized portion of the bed is at substantially the same elevation as the second portion of the bed and the article is first immersed in the fluidized portion and thereafter moved to the second named portion of the bed.

7. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of pulverulent coating material to form a dense phase fluidized bed by means of an upwardly moving stream of gas within an open-topped container, then immersing the article in the fluidized bed and thereafter interrupting the flow of gas without agitation of the coating material to provide a bed of substantially immobile particles of the coating material at its maximum self-supporting volume surrounding and in direct contact with the surface of the article.

8. A process for the application of a continuous coat-
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1. A process for coating an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

2. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

3. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

4. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

5. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

6. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

7. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

8. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.

9. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature above the melting point of the coating material, fluidizing a quantity of the coating material to form a dense phase fluidized bed, and maintaining the fluidized coating material within an open-topped container, so that the fluidized coating material surrounds the article, while maintaining the coating material in the fluidized state.
fluidizing the upper portion of a quantity of pulverulent coating material in a dense phase within an open-topped container while maintaining lower portions thereof unfluidized, said coating material containing particles therein which melt when heated, releasing and immersing the article in the fluidized coating material while heated to a temperature below the melting temperature of the article but at least as high as the melting temperature of said particles and supporting the article upon the unfluidized coating material to form a coating thereon, removing the article from the coating material, supporting the article by engagement of a coated surface thereof with a supporting surface shaped to conform thereto, said supporting surface consisting of a nonadherent temperature-resistant material, and reheating said article to completely fuse the coating thereon while said article is so supported.

21. A process for the application of a continuous coating to an article comprising heating the article to a predetermined temperature, fluidizing a quantity of pulverulent coating material to form a dense phase fluidized bed by means of an upwardly moving stream of gas within an open-topped container, immersing the heated article in the fluidized bed and thereafter returning the bed of coating material to an unfluidized state while the article is immersed therein by interrupting the upwardly moving stream of gas.

22. The process of claim 19 wherein a pulverulent coating material is refloated while the article remains immersed in the bed.

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