

June 11, 1963

A. L. OLSON ETAL

3,093,510

COATING METHOD AND APPARATUS

Filed March 24, 1958

2 Sheets-Sheet 1

Fig. 1.

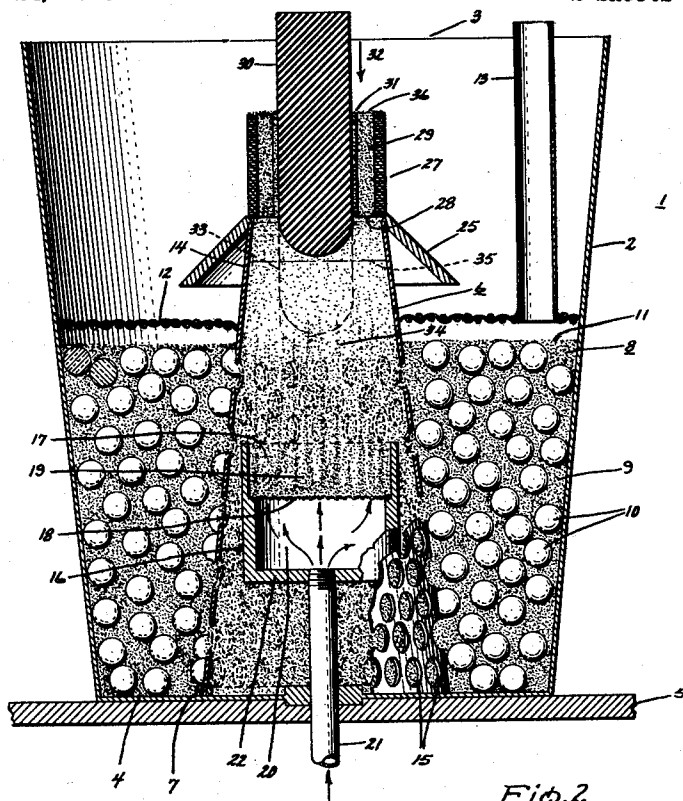


Fig. 2.

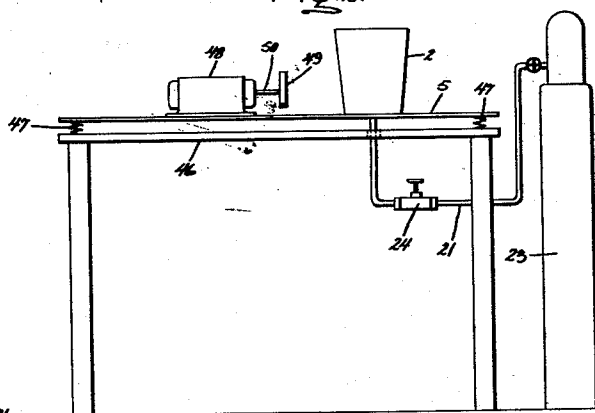
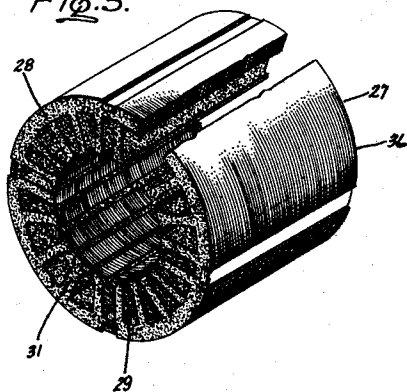


Fig. 3.



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2 Sheets-Sheet 2

Fig. 4

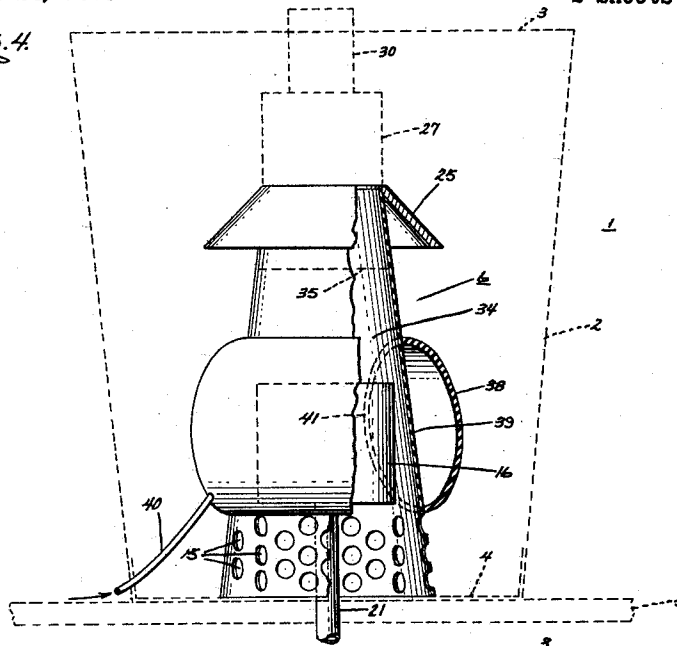
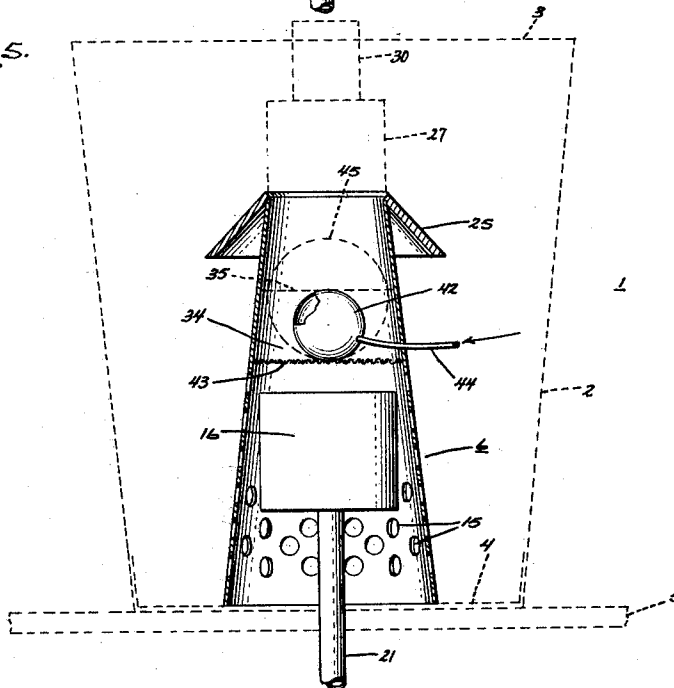


Fig. 5



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COATING METHOD AND APPARATUS

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6 Claims. (Cl. 117-230)

This invention relates generally to methods and apparatus for applying a coating on a surface of a solid article and more particularly to a coating method and apparatus employing the fluidized bed process.

A recent development in the art of applying coatings to the surfaces of solid articles has been the so-called fluidized bed process. In this process, a quantity of finely powdered material is placed in a container and a gas, such as an inert gas or air, is bubbled or passed upwardly through the powdered material; the upward passage of the gas through the powdered material causes it to act and appear as a fluid and thus articles may be dipped into such fluidized powder and coated thereby.

The fluidized bed process has been proposed for the application of integral insulation to the core members of dynamo-electric machines. Such core members generally are provided with a plurality of winding slots in which the windings of the machine are positioned and are conventionally formed from a stacked plurality of relatively thin laminations punched from suitable sheet magnetic material; the punching operation commonly results in the formation of small burrs on each lamination. Dynamo-electric machines in the smaller sizes conventionally have their windings formed of varnish-coated magnet wire and thus, if such wire were wound directly into the slots of the coated member, the burrs and other rough edges would result in abrasion of the wire and thus short circuits to ground. It has thus been conventional in the past to provide separate slot insulators, generally formed of such sheet insulating materials as kraft paper, cellulose acetate, or the newer polyester films, such insulators being individually placed in each slot and the windings in turn wound into the slots over the insulators. Since there is a further danger that the portions of the windings extending out of the slots, i.e., the end turns, will abraid against the exterior edges of the slots, cuffs have conventionally been formed at the outer ends of the slot insulators and in addition, separate end insulators have been provided at each end of the core member. The fabrication and insertion of such separate slots and end insulators has added appreciably to the over-all cost of dynamoelectric machines and thus, there have in the past been numerous proposals to provide an integral coating of insulating material on the walls of the winding slots and on the ends of the core. While numerous attempts have been made in the past to provide such a coating, there have been none known to the present applicants which have been entirely satisfactory, especially when employed in quantity production.

The fluidized bed process has therefore appeared particularly attractive for the application of such integral insulation and it has therefore been proposed that a powdered resinous material, such as epoxy resin, be employed, with the core member being previously heated to above the melting point of the resin and then dipped into the fluidized powder for a brief period of time; the heated core member will therefore melt the fluidized resin thereby to form an integral coating on the walls of the winding slots and ends of the core. Attempts to employ the fluidized bed process by dipping the heated core member into the fluidized resin have, however, not been completely successful, particularly with regard to the uniformity of the thickness of the coating thereby applied.

We have discovered that by causing the fluidized resin

to move upwardly so as to contact the surface to be coated, rather than by immersing the object in the fluidized material, as has been the prior practice, not only is a superior coating obtained, but also the apparatus is greatly simplified since no complicated mechanism for dipping and subsequently removing the heated article from the fluidized material is required.

It is therefore an object of this invention to provide an improved apparatus employing the fluidized bed process for applying a coating on the surface of a solid article.

Another object of this invention is to provide an improved apparatus employing the fluidized bed process for applying a coating on the surface of a solid article, the apparatus causing the fluidized material to rise thereby to come into contact with the surface to be coated.

A further object of this invention is to provide an improved method for applying a coating on the surface of a solid article employing the fluidized bed process.

Our invention, in its broader aspects, provides a container for the powdered coating material with upwardly extending conduit means positioned therein and arranged for admission of the powdered material thereto. Means are provided for supporting the article to be coated adjacent the upper end of the conduit means and means are provided within the conduit means for fluidizing the powdered material. Means are finally provided for forcing the fluidized material upwardly in the conduit and into contact with the article thereby to coat the desired surface. The upward movement of the fluidized material in the conduit means may be accomplished by a suitable increase in the fluidizing gas pressure, by the insertion of an object of sufficient volume into the conduit means thereby to displace the fluidized material upwardly, by contraction of the conduit means, or by expansion of a member within the conduit means.

Our improved coating method therefore contemplates the positioning of the article to be coated above a quantity of powdered material, the material being fluidized as by passing a stream of gas upwardly therethrough, with the resulting fluidized material being caused to move upwardly thereby to contact the surface to be coated.

Further objects and advantages of our invention will become apparent by reference to the following description and the accompanying drawings, and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings,

FIG. 1 is a cross-sectional view showing the preferred embodiment of our invention incorporated in apparatus for applying integral insulation to the stator core member of a dynamoelectric machine;

FIG. 2 is a schematic side-elevation view showing the apparatus of FIG. 1, together with the gas supply and vibratory means associated therewith;

FIG. 3 is a view in perspective, partly broken away, showing a stator member having integral insulation applied by the apparatus of FIGS. 1 and 2;

FIG. 4 is a fragmentary cross-sectional view showing a modified form of our invention; and

FIG. 5 is an other fragmentary cross-sectional view showing another modification of our apparatus.

Referring now to FIG. 1, our improved fluidized bed coating apparatus, generally identified as 1, includes a container member 2 having an upper open end 3 and a bottom wall 4 resting on a supporting table 5. A frusto-conical conduit or baffle member 6 is provided having its larger end 7 resting on bottom wall 4 of container 1, and preferably suitably secured thereto, as by welding. The annular space 8 between the container 2 and the conduit member 6 is filled to the level shown with finely powdered resinous material 9, such as an epoxy resin,

and we have found it desirable to admix the powdered resinous material 9 with relatively larger pellets 10, which may for example be small glass marbles; the pellets 10 prevent the powdered resinous material 9 from compacting in the lower portion of the container 2. The admixed powdered resinous material 9 and pellets 10 normally fill the container 2 to the level 11, an annular screen 12 positioned between the conduit member 6 and the wall of container 2 preventing the pellets 10 from being vibrated out of the container when the container is vibrated as will be hereinafter described. A suitable filling pipe 13 extends downwardly through the screen 12 for filling the container 2 to the level 11 with the powdered resinous material 9 and pellets 10.

The smaller end 14 of the frusto-conical conduit or baffle member 6 extends upwardly above level 11 of the admixed powdered resinous material 9 and pellets 10, and its lower portion below the level 11 has a plurality of openings 15 formed therein communicating with the interior thereof; openings 15 are smaller than the pellets 10 and thus serve to admit only the powdered resinous material to the interior of the conduit member 6. A generally cup-shaped member 16 is positioned within the conduit member 6 below the level 11 of the admixed powdered resinous material 9 and the pellets 10 with its open end 17 facing upwardly, as shown; a porous diffusing member 18, for example formed of sintered stainless steel, extends across the cup-shaped member 16 defining an upper cavity 19 communicating with the open end 17 and a lower cavity 20. A gas supply line 21 extends through the bottom wall 4 of the container 2 and the supporting platform 5 and is connected to the bottom wall 22 of the cup-shaped member 16 thereby communicating with the lower accumulator and diffuser cavity 20. Gas line 21 is adapted to be connected to a suitable gas storage tank 23 by means of suitable control valve 24 (FIG. 2).

A downwardly inclined rim or deflector member 25 is mounted on the upper end 14 of the conduit member 6 and the heated stator core member 27 which is to have the integral insulation applied thereto is positioned on the deflector member 25 as shown so that one of its ends 28 and its winding slots 29 communicate with the interior of the conduit 6. A suitable plug member 30, preferably formed of metal such as aluminum, is arranged to be inserted in the bore 31 of the core member 27 and to be moved downwardly therethrough into the conduit member 6 in the direction of the arrow 32 into the position shown by the dashed lines 33.

In operation, a suitable gas, such as nitrogen or air, is fed from the tank 23 under pressure through the line 21 into the accumulator and diffuser cavity 20 of the cup-shaped member 22. The velocity of the gas escaping upwardly through the porous diffuser member 18 into the powdered material in the upper cavity 19 increases the volume of the mass of powdered material causing it to rise in the upper or expansion portion 34 of conduit member 6 to the level shown by the dashed line 35.

In order to apply a coating of the resinous material on the winding slots 29 and one end 28 of the heated stator core member 27, the fluidized powdered material in the expansion portion 34 of conduit 6 is caused to rise from the normal level 35 to the top 36 of the core 27 and maintained at this level a sufficient length of time to form the desired coating; in practice, the stator member 27 will be placed with one end 28 facing downwardly and maintained in position a sufficient length of time to form a coating on the walls of the winding slots 29 approximately one-half the desired final coating and is then reversed with the other end 36 facing downwardly for the remaining slot wall coating to be applied; in this manner, not only are the walls of the winding slots 29 coated, but the coating is also applied on both ends 28 and 36. Any surplus fluidized material which flows over the upper surface 36 of the stator member 27 is deflected

downwardly by the deflector member 25 back into the container 2.

The fluidized resinous material in the expansion portion 34 of conduit 6 may be caused to rise in several different ways. Referring again to FIG. 1, the plug member 30, when moved downwardly in the direction shown by the arrow 32 into the position shown by the dashed lines 33, has sufficient volume thereby to displace the fluidized resinous material and to force it upwardly into contact with the end 28 and into the slots 29 of the stator member 27. Alternatively, the pressure of the air or gas from the supply tank 23 may be increased by suitable adjustment of the valve 24, thereby effectively to raise the level 35 responsive to the increased gas pressure and thus force the fluidized resinous material upwardly into the winding slots 29.

Referring now to FIG. 4 there is shown a modified form of our invention in which the conduit member 6 is formed of resilient material, such as rubber, with an inflatable portion 38 surrounding the wall portion 39 of conduit member 6 adjacent the cup-shaped member 16. A suitable source of air under pressure is connected to the inflatable member 38 by means of line 40. Thus, when it is desired to cause the fluidized material in the expansion portion 34 of the conduit 6 to rise above the normal level 35, air under pressure is fed to the inflatable member 38 which thereby contracts the wall portion 39 of the conduit member 6 around the cup-shaped member 16, as shown by the dashed lines 41, thereby displacing the fluidized material upwardly into contact with the ends and winding slots of the core member 27.

Referring now to FIG. 5 in which another embodiment of our invention is shown, an inflatable member 42, in the nature of a balloon, is positioned within the expansion cavity 34 of the conduit member 6 and may be supported therein by means of a suitable screen 43. The inflatable member 42 is connected to a suitable source of air under pressure by means of a line 44 and thus again, when it is desired to raise the fluidized powdered resinous material in the expansion portion 34 of the conduit member 6 above the normal level 35, the air under pressure is fed to the inflatable member 42 by line 44 thus causing it to expand, as shown by the dashed lines 45, thus again displacing the fluidized material upwardly into contact with the end 28 and walls of the winding slots 29 of the hot core member 27.

It may be found desirable to agitate the admixed powdered resinous material 9 and pellets 10 in the container 2 in order to prevent compacting of the fine mesh powdered resin and thus, the supporting platform 5 may be resiliently mounted on a frame assembly 46 by means of suitable springs 47. A conventional motor 48 may then be mounted on the supporting platform 5 in any suitable manner and provided with an eccentric flywheel 49 on a shaft 50. The resultant vibration caused by the high speed rotation of the eccentric flywheel 49 will in turn cause vibration of the supporting platform 5 of the container 2 on the springs 47 thus in turn agitating the admixed powdered resinous material 9 and the pellets 10 in the container 2. It will be readily apparent that other suitable means of vibrating the container 2, if necessary, may be provided and the arrangement shown is for illustrative purposes only.

It has been found that our improved fluidized bed method and apparatus provides superior coatings on the ends and winding slot walls of dynamoelectric machine core members; while our method and apparatus has particular utility in the applying of integral insulation to dynamoelectric machine core members; it will be readily apparent that it is not limited thereto and may be employed in applying coatings to the surfaces of other members. It will be readily seen that our method and apparatus eliminates the necessity for emerging and subsequently removing the article to be coated from the fluidized material which were required in the prior meth-

ods and apparatus for performing the fluidized bed process.

While we have illustrated and described specific embodiments of our invention, further modifications and improvements will occur to those skilled in the art and we desired therefore in the appended claims to cover all modifications which do not depart from the spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. The method of applying an insulating coating to the walls of the winding slots and the end faces of a preheated dynamoelectric machine stator core member having a bore extending therethrough, without applying an insulating coating to the exterior surface of said stator core member, comprising the steps of: positioning said core member with one face and said slots exposed to the upper end of a conduit member containing a powdered, resin containing, insulating coating material adapted to adhere to said preheated core member; fluidizing said material to form an agitated bed having an upper level maintained below said upper end of said conduit member by passing a stream of gas upwardly therethrough; and inserting a plug member having a diameter less than the bore diameter of said core member and less than the diameter of said conduit member into said conduit member through the bore of said core member while fluidizing said material thereby to displace said fluidized material upwardly into contact with said one face and the walls of said slots without moving said conduit member in an upward direction.

2. Apparatus for applying a coating on a surface of a solid article comprising: an upwardly extending open ended container; an upwardly extending frusto-conical conduit in said container having its larger end seated on the bottom thereof; a quantity of coating material in powdered form admixed with relatively larger solid pellets in said container in the space between the wall thereof and said conduit; said conduit extending above the level of said admixed powdered material and pellets and having a plurality of openings formed in its wall below said level, said openings being smaller than said pellets for admitting only said powdered material to said conduit; a cup-shaped member positioned in said conduit and spaced from the bottom of said container with its open end below said level of said admixed powdered material and pellets and facing upwardly; a porous member extending across said cup-shaped member and spaced from said open end thereof for supporting a quantity of said powdered material thereon; said porous member defining a diffuser cavity with the bottom of said cup-shaped member; a gas line communicating with said cavity and extending out of said bottom of said container for admitting gas to said cavity whereby the same passes upwardly through said porous member and powdered material thereon thereby to fluidize the same, said gas line supporting said cup-shaped member from said container bottom; the smaller end of said conduit being adapted to support said article and having a downwardly inclined rim portion formed therearound; and means for forcing said fluidized material upwardly in said conduit and into contact with said article thereby to coat said surface.

3. Apparatus for applying a coating on a surface of a solid article comprising: a container for powdered coating material and relatively larger solid pellets; upwardly extending flexible conduit means positioned in said container, said conduit means having openings for admission of said powdered coating material thereto but not said pellets; means for supporting said article adjacent the upper end of said conduit means; means in said conduit means for fluidizing the powdered material therein; and means for contracting said conduit means thereby to reduce the volume of said conduit means while the powder is being fluidized therein for displacing said fluidized ma-

terial whereby the same is forced upwardly in said conduit means and into contact with said article thereby to coat said surface.

4. Apparatus for applying a coating on a surface of a solid article comprising: a container for powdered coating material and relatively larger solid pellets; means for vibrating said container to prevent compacting of said powdered material therein; upwardly extending conduit means positioned in said container, said conduit means having openings for admission of said powdered coating material thereto but not said pellets; means for supporting said article adjacent the upper end of said conduit means; a cup-shaped member in said conduit means with its open end facing upwardly to form a diffuser cavity and having a gas supply line connected thereto for passing a stream of gas upwardly through said diffuser cavity and said powdered material thereby to fluidize the same; said conduit means having at least a portion of its wall adjacent said cup-shaped member formed of resilient material; and means for contracting said wall portion around said cup-shaped member thereby to displace said fluidized material whereby the same is forced upwardly in said conduit means and into contact with said article thereby to coat said surface.

5. Apparatus for applying a coating on a surface of a solid article comprising: a container for powdered coating material and relatively larger solid pellets; upwardly extending conduit means positioned in said container, said conduit means having openings for admission of said powdered coating material thereto but not said pellets; means for supporting said article adjacent the upper end of said conduit means; a cup-shaped member in said conduit means with its open end facing upwardly to form a diffuser cavity and having a gas supply line connected thereto for passing a stream of gas upwardly through said powdered material thereby to fluidize the same; said conduit means having at least a circumferential portion of its wall adjacent said cup-shaped member formed of resilient material; and an inflatable member embracing said wall portion and adapted to be inflated thereby to contract said wall portion around said cup-shaped member to displace said fluidized material whereby the same is forced upwardly in said conduit means and into contact with said article thereby to coat said surface.

6. Apparatus for applying integral insulation on the winding slots and ends of a dynamoelectric machine core member by means of the fluidized bed process comprising: an upwardly extending open ended container; an upwardly extending frusto-conical conduit in said container having its larger end seated on the bottom thereof; a quantity of coating material in powdered form admixed with relatively larger solid pellets in said container in the space between the wall thereof and said conduit; said conduit extending above the level of said admixed powdered material and pellets and having a plurality of openings formed in its wall below said level, said openings being smaller than said pellets for admitting only said powdered material to said conduit; a cup-shaped member positioned in said conduit and spaced from the bottom of said container with its open end below said level of said admixed powdered material and pellets and facing upwardly a diffuser cavity; a porous member extending across said cup-shaped member and defining upper and lower cavities, said porous member supporting a quantity of said powdered material in said upper cavity; a gas line communicating with said lower cavity of said cup-shaped member and extending out of said bottom of said container for admitting gas to said lower cavity whereby the same passed upwardly through said porous member and powdered material thereon thereby to fluidize the same, said gas line supporting said cup-shaped member from said container bottom; the smaller end of said conduit being adapted to support a heated stator core member with one end thereof and the winding slots therein communicating with said conduit, said smaller end of

said conduit having a downwardly inclined rim portion formed therearound; a plug member adapted to be inserted in the bore of said core member and to be moved downwardly into said conduit member thereby to displace said fluidized material causing the same to rise upwardly into contact with said core member end and the walls of said core member slots; and means for vibrating said container thereby to prevent compacting of said powdered material therein.

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