The invention relates to coating techniques and particularly to improved apparatus and methods for coating apparatus components with an insulating layer of resin. The invention provides a method for coating selected surfaces of apparatus components, particularly electric motor stators, with insulation without the necessity for specially masking those surfaces of the component desirably not coated. Thus the invention provides a mass production technique for appropriately coating stators or the like with a minimum of procedural steps.

Hereof the coating of apparatus components such as stators with resin insulating coatings has necessarily involved preliminary masking of parts of the component which must remain uncoated or essentially free of any significant thickness of coating. Specifically, the surface of the internal bore of stators as well as the surface of the outer periphery of stators generally must remain unchanged during the step of coating the slots and outer laminations with insulating material. After appropriate masking of a stator, it may be coated in limited areas by using prior art techniques such as dipping the partially masked stator in a liquid bath of coating resin or in a fluidized bed of particles of fusible resin material. In the event of the fluidized bed technique for coating is used, the stator itself must, of course, be elevated in temperature appropriately to cause pick-up of fusible resin particles which are then coated in the fluidized bed.

Conventional prior art practice using techniques such as noted have involved complicated jigging, masking and dipping equipment. Even so, the coatings produced have not always been uniform and the processes employed have been difficult to completely automate.

The practice of the instant invention, it is possible to achieve remarkably uniform coating of insulating material upon selected areas of motor parts by using very simple equipment. The special coating technique hereof is such that the internal bore and outer periphery of a stator remain essentially free of the coating material, as is desired.

The invention will be described by reference to a drawing wherein:

FIGURE 1 is a perspective view of one embodiment of my coating apparatus;

FIGURES 2, 3 and 4 are partial perspective views of alternative embodiments of my coating apparatus; and

FIGURE 5 is a perspective view of an expandable mandrel such as employed in the arrangement of elements illustrated in FIGURE 4.

As illustrated in FIGURE 1, my coating apparatus is contained within a chamber 10 having an exit duct 11 for air and excess powder removal. A stator 12 to be coated is supported within chamber 10 by means of, as illustrated in FIGURE 1, two rotatable rollers 13 and 14. One or both of these rollers is rotated by means of a suitable power source such as motor 15. Rotation of stator 13 is simply accomplished by friction engagement of the outer periphery of the stator against rollers 13 and 14.

In the event the outer periphery of the stator is hexagonal or otherwise irregularly shaped, suitable rotation of it for coating may be accomplished by using an expandable mandrel support 16 as illustrated in FIGURES 4 and 5, or by means of a small support roller placed within the space of internal bore of the stator (not illustrated in the drawings).

Also mounted within coating chamber 10 is at least one pair of oppositely disposed spray nozzles 17 and 18 which are fed with powdered heat-fusible insulating material through conduits 19 and 20 from any suitable source (not shown). Particles of heat-fusible material are blown from these spray nozzles under pressure during coating. It is of utmost importance that at least one pair of spray nozzles for the coating operation be oppositely disposed, such that powder particles emerging from one nozzle of the pair is met by the stream of powder particles emerging from the other or opposite nozzle of the pair. Further, the pair of nozzles are so disposed in relation to a stator to be coated (or, stated another way, in relation to the support means for a stator to be coated) such that the slots 21 of a rotating stator to be coated move in sequence past the pair of nozzles and are each subjected in sequence to the spray from each nozzle of the pair. Because of this relationship turbulence of powdered heat-fusible material is created within each slot of the stator as the coating operation progresses.

It is, of course, of critical importance, in the coating operations here discussed to pre-heat the object to be coated to a temperature at least sufficiently high to cause particles of the heat-fusible material employed in coating to stick upon the surfaces of the article contacted by the particles during the spray operation. And, of course, the pre-heating temperature employed will not be sufficient to cause the heat-fusible material to degrade or decompose sufficiently to no longer function for its intended purpose. Thus the pre-heat temperature employed will be insufficient to destroy the electrical insulation qualities of coating material applied to the stator.

While the portions of an object to be coated are being rotated through sprayed material emerging from sources 17 and 18, excess sprayed material is removed from the locus of the coating operation by a stream of air flowing approximately transverse to the axis of rotation of the object being coated. Suitably this is accomplished by withdrawing air by means of an exhaust fan, a dust collector, or the like (not shown in the drawing) from duct 11, and by allowing air to enter the coating duct 13 through some suitable open port such as an opening 22 located generally in an upward direction in relation to the coating operation.

Surprisingly, it has been found that sprayed material emerging from slots 21 of a large stator being coated is taken up by the stream of air past the stator (and moving turbulently through the core of the stator) such that the internal diameter surfaces 23 of the core of the stator as well as the outer diameter or periphery 24 of the stator remains essentially free of coating material. The surfaces of outer laminations 25 are of course subjected directly to the sprayed coating material, and thus also become coated particularly in areas near the terminus of slots 21, as is desired.

Where small stators are being coated, it is desirable to insure more positive removal of excess sprayed powder from the internal bore of the stator. This may be done (see FIGURE 2) by using a vacuum head 26 connected through duct 27 to a vacuum or exhaust fan source (not shown). Another suitable modification of apparatus to accomplish this result is illustrated in FIGURE 3. As there illustrated, an air nozzle 28 is used to blow excess sprayed particles, as they emerge from slots 21, from the internal bore of the stator.

If desired, flared spray nozzles 29 and 30 may be used in the spray operation, as illustrated in FIGURE 4. Also,
where desired, one may support a stator for rotation and simultaneously positively protect the internal diameter surfaces of the stator against coating by using an expandable mandrel 16, suitably of a silicone or other rubbery covering capable of being expanded by injecting air under pressure therewith or by screwing an expandable mechanism therewithin by means of handle 31.

In other embodiments of coating apparatus illustrated, the air flow approximately transverse to the axis of rotation of a stator serves to remove particles of heat-fusible coating material rapidly from the locus of coating so as to essentially prevent any thickness of coating material from accumulating upon the internal diameter and outer diameter or periphery of the stator. Of course, a slight coating of material on the internal and outer diameter of a stator is usually permissible so long as the thickness of it is insignificant, say below one mill; thus such thin coatings are negligible and the part is considered essentially free of coating in such areas.

Suitable heat-fusible powderly material for use in coating as here discussed may be selected from thermoplastic as well as thermosetting classes of organic resins. Indeed, where insulation is not a primary requirement, materials other than those of organic character may be used. Of course, some heat-fusible inorganic or ceramic-type materials may indeed possess satisfactory insulating character. A preferred type of heat-fusible and yet thermosetable resin powder for use in forming insulating coatings comprises epoxy resin. Wear U.S. Patent No. 2,847,395 contains several formulations of epoxy resin-hardener mixtures, with and without latent heat-activatable accelerators for the reaction between epoxy resin and a hardener reactive therewith; and the disclosure of that Wear patent is here incorporated by reference. When using such resin mixtures, pre-heat temperatures for the part may be as high as 400°F., or even higher, but below the temperature of substantial degradation of the resin mixture.

Surprisingly, the technique of coating here described causes substantially uniform deposition of material on the surfaces of slots. In achieving this result, it is preferable to spray powdery material at substantially the same velocity from each nozzle of the pair, so as to create turbulence in the slot and thereby cause particles of coating material to strike the internal surfaces of the slot and adhere and coalesce thereupon.

If desired, several pairs of spray nozzles may be employed in the apparatus. Also, if desired special cooling means may be employed in conjunction with holding means such as illustrated in FIGURES 4 and 5.

Depending upon the thickness of coating desired, the part to be coated may be rotated through the opposing spray sources one or more times. Usually one complete revolution will be sufficient to build up a coating thickness (e.g., 5 to 15 mils) satisfactory for insulating slots of a stator.

It will be appreciated that the coating techniques hereof are useful for coating stators of a shape other than cylindrical. For example, a hexagonal stator may be coated using support means such as illustrated in FIGURES 4 and 5. Stators having skewed or angular slots, or slots located on their outer periphery, may also be coated using, for example, such support means as illustrated in FIGURES 4 and 5. Objects presenting coating problems substantially similar or equivalent to those discussed in the coating of stators may also wisely be coated in an automatic manner using the principles hereof.

That which is claimed is:

1. A method for providing an insulating coating on parts of a stator, specifically on the internal surfaces of slots and on the external surface of outer laminations while maintaining the internal diameter and outer diameter of said stator substantially free of said insulating coating, comprising (1) mounting said stator on a rotatable support, (2) rotating the supported stator on its axis while said stator is at a temperature sufficiently high to effect fusion of particles of heat-fusible insulating material which may be deposited thereupon, (3) depositing particles of heat-fusible insulating material upon the internal surfaces of slots and on the external surface of outer laminations of said stator by directing said particles toward said surfaces from opposing spray sources located adjacent the outer laminations of said rotating stator in a manner such that opposing flow of said particles is effected from said spray sources through each slot of said stator in sequence during rotation of said stator, said opposing flow of said particles within each slot of said stator being such as to create turbulence therewithin and thereby effect deposition of said particles upon the internal surfaces of each said slot, and (4) simultaneously removing particles of said insulating material from the locus of the coating operation by means including at least one air stream flowing approximately transverse to the axis of rotation of the stator, such that the internal diameter and outer diameter of said stator is maintained substantially free of said insulating material.

2. The method of claim 1 wherein the particles of heat-fusible insulating material include heat-fusible epoxy resin particles.

3. Apparatus for coating stators comprising (1) means to support a stator for rotation, (2) opposing spray nozzles spaced from each other sufficiently to accommodate said stator therewith and adapted to spray material from opposite directions into slots of said stator sequentially during rotation of the same, (3) means to create an air flow transverse to the axis of rotation of said stator rotated by said first means and (4) means to force air into the internal bore of said stator.

4. The apparatus of claim 3 where the means to hold and rotate the stator comprises at least two support rollers spaced apart, with at least one connected to means to rotate the same.

5. The apparatus of claim 3 where the means to hold and rotate the stator comprises at least one support roller adapted to be inserted within the internal bore of a stator.

6. The apparatus of claim 3 where the means to hold and rotate the stator comprises an expandable mandrel.

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JOSEPH B. SPENCER, Primary Examiner.
RICHARD D. NEVIUS, Examiner.