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SPECIFICATIONTitle of the Invention

Method for electrostatic coating a metallic cylindrical body ✓

Field of the Invention

The present invention relates to a method for electrostatic coating a metallic cylindrical body having a substantially cylindrical shape, formed by laminating metal plates, more particularly an electrostatic coating method suitable for insulation coating of cores of rotors or stators used for rotary electrical apparatuses such as motors or generators.

Background of the Invention

Cores of rotors or stators used for rotary electrical apparatuses such as motors or generators, are formed by laminating plural sheets of magnetic metal pieces of e.g. silicon steel plates. In the case of cores of rotors, slots for inserting coils are formed on its outside, and in the case of cores of stators, slots for inserting coils are formed on its inside.

Fig. 13 shows an example of a core of a rotor. The core 1 of the rotor is formed by laminating plural sheets of magnetic metal pieces 60. The core 1 has an axial hole 2 at

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its central portion and, on its periphery or outer surface 3, slots 4 spaced circumferentially in a constant distance are formed along the axial direction. Between the slots 4, external teeth 61 around which coils are wound, are formed. In this figure, the numeral 47 denotes an internal edge of an end face.

As a method for coating the metallic cylindrical body formed by laminating the metal plate, like this core of a rotor, an electro-deposition method and an electrostatic coating method have been known. However, the electro-deposition method has a problem that the equipment is substantially large, the maintenance of machines is problematic and the production cost is totally high.

On the other hand, the electrostatic coating method uses an electrostatic coating machine which has a fluidized bed having an opening at its upper part and a porous plate at its lower part, electrodes disposed in the porous plate, and a pressure equalization chamber which surrounds the space below the fluidized bed. In this machine, a resin powder is supplied to the fluidized bed, and a compressed air is introduced into the pressure equalization chamber and ejected through the porous plate to fluidize the resin powder in the fluidized bed. At the same time, to the electrodes, positive or negative static electricity is applied to electrostatically charge the resin powder, and a

body to be coated to which static electricity opposite to the electrodes is applied, is supported at the upper portion of the fluidized bed and the resin powder is caused to stick or attach to the surface of the body to be coated, and then the body is heated for fusion-bonding of the resin powder to form a coating film.

However, when the entire surface of the metallic cylindrical body formed by laminating the metal plates, is coated by electrostatic coating, there have been the following problems.

(1) Since heating is needed for the fusion-bonding of the resin powder for the formation of the coating film, the air between the laminated metal plates is expanded, and holes are formed on the surface of the coating film to permit the expanded air to escape, whereby withstand voltage and rust prevention can not be ensured.

(2) The resin powder deposits thick on the outer surface 3 and the end face 5, but does not sufficiently deposit on the inner surfaces of the axial hole 2 and the slot 4, whereby unevenness is seen in the thickness of the finally formed coating film.

Summary of the Invention

Accordingly, it is an object of the present invention to provide a method for electrostatic coating a metallic

cylindrical body having a substantially cylindrical shape, formed by laminating metal plates, such as a core of a rotor or a stator, by which no pinholes, etc. is formed on the coating film and the outer and inner surfaces can be coated uniformly.

To accomplish the above object, the present invention provides a method for electrostatic coating a metallic cylindrical body having a substantially cylindrical shape formed by laminating metal plates, which comprises a first coating step of inserting a supporting rod into an axial hole of the metallic cylindrical body, making the supporting rod abut on an inner surface of the axial hole along the axial direction to support the metallic cylindrical body, and electrostatically attaching a resin powder to a surface of the metallic cylindrical body while placing the metallic cylindrical body at the upper portion of the fluidized bed for the resin powder and rotating the metallic cylindrical body, followed by fusion-bonding of the attached resin powder by heating to form a coating film, and a second coating step of coating a cold-setting type resin composition on an uncoated portion of the inner surface of the metallic cylindrical body on which the supporting rod abuts to form a coating film.

According to the present invention, when the electrostatic coating is made on the metallic cylindrical

body in the first coating step, by rotating the metallic cylindrical body, the resin powder can be attached uniformly. Further, since no resin powder attaches to a portion of the inner surface of the metallic cylindrical body on which the supporting rod abuts, when the stuck resin powder is fusion-bonded by heating for the formation of a coating film, the uncoated portion acts as a passage of the expanded air between the laminated plates, whereby the formation of holes on the surface of the coating film can be prevented.

Then, as the second coating step, by coating a colt-setting type resin composition on the uncoated portion of the inner surface of the metallic cylindrical body and curing it at room temperature to form a coating film, a coating film can be formed on the entire surface of the metallic cylindrical body.

Brief Description of the Drawings

Fig. 1 is a front sectional view showing an electrostatic coating machine used for the first embodiment of the electrostatic coating method of the present invention.

Fig. 2 is a perspective view of a main part of Fig. 1.

Fig. 3 is a front sectional view showing an electrostatic coating machine used for the second embodiment

of the electrostatic coating method of the present invention.

Fig. 4 is a view taken in the direction of arrows along the X-X line of Fig. 3.

Fig. 5 is a perspective view showing a main part of Fig. 3.

Fig. 6 is a front sectional view showing an electrostatic coating machine used for the third embodiment of the electrostatic coating method of the present invention.

Fig. 7 is a perspective view showing the fourth embodiment of the electrostatic coating method of the present invention.

Fig. 8 is a front sectional view showing an electrostatic coating machine used for the fifth embodiment of the electrostatic coating method of the present invention.

Fig. 9 is a front sectional view showing an electrostatic coating machine used for the sixth embodiment of the electrostatic coating method of the present invention.

Fig. 10 is a diagrammatic explanatory view showing an example of the second coating step of the electrostatic coating method of the present invention.

Fig. 11 is an enlarged sectional view of a main part

showing a state in the second coating step of the electrostatic coating method of the present invention, wherein the resin composition is coated.

Fig. 12 is a plane view showing an example of the second coating step of the electrostatic coating method of the present invention, wherein the coating is conducted on the cylindrical body having slots on its inner surface.

Fig. 13 is a perspective view showing a core of a rotor as an example of the metallic cylindrical body formed by laminating metal plates.

Fig. 14 is a sectional view showing a state where a cold-setting type liquid resin is coated on the inner surface of a metallic cylindrical body by a conventional method.

Fig. 15 is a sectional view showing a state where a cold-setting type liquid resin is coated on the inner surface of the metallic cylindrical body having slots on its inner surface by a conventional method.

Description of Preferred Embodiments

Hereinafter, the present invention will be described in further detail with reference to preferred embodiments.

As mentioned above, in the electrostatic coating method of the present invention, the first coating step comprises inserting a supporting rod into an axial hole of a

metallic cylindrical body, making the supporting rod abut on an inner surface of the axial hole along the axial direction to support the metallic cylindrical body, and electrostatically attaching a resin powder to a surface of the metallic cylindrical body while placing the metallic cylindrical body at the upper portion of the fluidized bed for the resin powder and rotating the metallic cylindrical body, followed by fusion-bonding of the attached resin powder by heating to form a coating film. Then, the second coating step comprises coating a cold-setting type resin composition on an uncoated portion of the inner surface of the metallic cylindrical body on which the supporting rod abuts, to form a coating film.

According to the preferred embodiment of the present invention, in the first coating step, when the metallic cylindrical body is supported at the upper portion of the fluidized bed for the resin powder, ring-like baffle plates are disposed with a predetermined distance from the end face of the metallic cylindrical body, and the resin powder is stuck while rotating the metallic cylindrical body.

By disposing the baffle plates, with respect to the resin powder flowing from the fluidized bed, the ones which flow between the baffle plate and the end face of the metallic cylindrical body, attach to the end face of the metallic cylindrical body, but the ones which flow outside

of the baffle plate, are prevented by the baffle plate from attaching to the end face of the metallic cylindrical body. On the other hand, not only the ones which flow between the baffle plate and the end face of the metallic cylindrical body, but also the ones which flow outside of the baffle plate, flow into the axial hole of the metallic cylindrical body through a central hole of the baffle plate, whereby the amounts of the resin powder flowing into the axial hole can be relatively increase. Further, with respect to the resin powder, the ones which flow between the baffle plate and the end face of the metallic cylindrical body, are prevented from scattering by the baffle plate, whereby they can easily enter the inside of the each slot from the end face of the metallic cylindrical body. As a result, the thickness of the resin powder attached to the end face or the outer surface of the metallic cylindrical body, and the thickness of the resin powder attached to the axial hole or the inner surface of the slot, can be equalized, whereby the thickness of the finally obtained coating film can be made uniform.

According to the preferred embodiment of the present invention, at the upper portion of the fluidized bed, a cover plate having a cross-shaped opening is disposed. When the metallic cylindrical body is supported above the opening, the metallic cylindrical body is arranged so that the axial direction of the metallic cylindrical body would

extend along one direction of the cross-shaped opening. A part of the cross-shaped opening extending along the axial direction of the metallic cylindrical body, has a width narrower than the outer diameter of the metallic cylindrical body and a length longer than the distance between the baffle plates. A part of the cross-shaped opening extending along the direction perpendicular to the axial direction of the metallic cylindrical body, has a width shorter than the axial length of the metallic cylindrical body and a length longer than the outer diameter of the metallic cylindrical body.

According to this embodiment, since the part of the cross-shaped opening along the axial direction of the metallic cylindrical body extends outside of the baffle plates, the resin powder flows even outside of the baffle plates, and such resin powder flows into the axial hole of the metallic cylindrical body through the central hole of the baffle plate, whereby the amount of the resin powder attached to the inner surface of the axial hole can be relatively increased. Further, since the part of the cross-shaped opening along the axial direction of the metallic cylindrical body has a width narrower than the outer diameter of the metallic cylindrical body, when a metallic cylindrical body having slots at its outer surface as shown in, for example, Fig. 13, by decreasing the amount of the

resin powder which raises at such an angle that it hardly enter the slots of the metallic cylindrical body, and by relatively increasing the amount of the resin powder which raises at such an angle that it easily enter the slots of the metallic cylindrical body, thereby further equalizing the amounts of the resin powders which attach to the outer surface of the metallic cylindrical body or the inner surface of the slots. Further, since the part of the cross-shaped opening extending along the direction perpendicular to the axial direction of the metallic cylindrical body, has the width shorter than the axial length of the metallic cylindrical body and the length longer than the outer diameter of the metallic cylindrical body, it is possible to relatively decrease the amount of the resin powder which flows near the end face of the metallic cylindrical body and further equalize the amount of the resin powder attached to the surface of the metallic cylindrical body.

According to the most preferred embodiment of the present invention, the metallic cylindrical body is disposed above the fluidized bed, and at the same time, suction means are disposed at the upper portion and/or the side portion of the metallic cylindrical body, whereby a flow of the resin powder is formed by the suction means.

According to this embodiment, by forming the flow of the resin powder by the suction means, it is possible to

easily attach the resin powder to desired portions. Particularly, in the case where the suction means are disposed at the upper portion and the side portion of the metallic cylindrical body, when the suction means at the upper portion is actuated, a flow in the upper portion can be formed, whereby the resin powder can easily enter the slots and it is possible to make the resin powder attached to the end face further uniform. Further, when the suction means at the side portion is actuated, a strong flow toward the horizontal direction can be formed, whereby the resin powder can easily enter the axial hole and the slots.

According to further preferred embodiment of the present invention, a scraping member is disposed near the outer surface of the metallic cylindrical body, and the thickness of the resin powder attached to the outer surface of the metallic cylindrical body can thereby be controlled.

Even if the above various means are provided, the amount of the resin powder attached to the outer surface of the metallic cylindrical body tends to increase relatively, i.e. the resin powder coating film tends to be relatively thick. Accordingly, by forcedly scraping the excess parts of the resin powder attached to the outer surface by disposing the scraping member, the attached amount of the resin powder can be equalized.

According to another preferred embodiment of the

present invention, in the second step, a cold-setting type liquid resin composition is coated on a part of the inner surface of the metallic cylindrical body on which the supporting rod abuts and which is uncoated, and a gas is blown to the inner surface of the metallic cylindrical body to extend uniformly the liquid resin composition attached to the inner surface of the metallic cylindrical body, and then the liquid resin composition is cured to form a coating film..

According to this embodiment, by blowing a gas to extend the liquid resin composition uniformly, sag of the coating and unevenness of the coating film can be prevented, whereby a coating film having a uniform thickness can be formed.

According to still another preferred embodiment of the present invention, in the second coating step, the metallic cylindrical body is supported by clamping the both end faces of the metallic cylindrical body with a pair of jigs each having an opening which fits to the inner surface of the metallic cylindrical body, and while rotating the metallic cylindrical body together with the jigs, the liquid resin composition is coated on the inner surface of the metallic cylindrical body and the gas is blown to the inner surface of the metallic cylindrical body.

Such operation gives the following effects. It is

possible to prevent extra attachment of the coating to the end faces of the metallic cylindrical body. The jig at the upper side ensures the film thickness of the internal edge of the upper end face of the metallic cylindrical body, and the jig at the lower side solves a problem of liquid reservoir at the lower portion of the inner surface of the metallic cylindrical body.

Further, it is preferred to use an ultraviolet-setting type resin composition as the liquid resin composition, and to coat this ultraviolet-setting type resin composition on the uncoated part of the inner surface of the metallic cylindrical body, blow the gas and then irradiate ultraviolet rays on the inner surface of the metallic cylindrical body to cure the ultraviolet-setting type resin composition.

By such operation, no heating is needed at the time of curing the resin, and the resin composition coated on the inner surface of the metallic cylindrical body can be cured spontaneously and uniformly.

Further, the metallic cylindrical body is preferably a core of a stator or a core of a rotor used for a rotary electrical apparatus. Since such a core is made of a laminated metal plates and demanded to have more complete insulation and rust prevention, the merit of applying the method of the present invention is particularly high.

Figs. 1 and 2 show the first embodiment of the electrostatic coating method of the present invention. Fig. 1 is a front sectional view showing an electrostatic coating machine used for this method. Fig. 2 is a perspective view of a main part of Fig. 1.

This electrostatic coating machine has a frame member 11 having an opening at its upper portion, a porous plate 13 covering the lower portion of the frame member, and a housing 14 disposed below the porous plate 13. By the frame member 11 and the porous plate 13, a fluidized bed 12 on which the resin powder P is supplied and packed, is formed. By the porous plate 13 and the housing 14, a pressure equalization chamber 15 is formed. At the side portion of the pressure equalization chamber 15, an air-supplying port 16 for introducing a compressed air AR into the pressure equalization chamber 15 is provided. To the porous plate 13, a plurality of electrodes 17 are provided to apply positive or negative static electricity to the resin powder P.

The metallic cylindrical body CL as the material to be coated (specifically, a laminated core 1) is disposed at the upper portion of the fluidized bed 12 so that its axis faces horizontally, and supported by a pair of electrode shafts 18 inserted into the axial hole 2. The electrode shafts 18 are applied with voltages opposite to the electrodes 17 of the

porous plate 13, and attached to a rotating body 19 which rotates by a driving source not shown. The electrode shafts 18 linearly abut on the inner surface of the axial hole 2 of the metallic cylindrical body CL in the axial direction, and act as the supporting rods of the present invention.

Further, to control the flow of the resin powder P from the fluidized bed 12 to the right and left end faces 5, 5' of the metallic cylindrical body CL, baffle plates 20, 21 are disposed a little, for example, a few mm away from the right and left end faces 5, 5' in the direction of an axial core C. The baffle plates 20, 21 are formed into a ring-like shape having a hole 20b or 21b at the center, and have a tapered hole 20a or 21a, respectively, through which the electrode shaft 18 passes.

The electrode shaft 18 has a stewed portion 18a which engages with the end face of the metallic cylindrical body CL, a stepped portion 18b which engages with the tapered hole 20a of the baffle plate 20, and a stepped portion 18c which engages with the tapered hole 21a of the baffle plate 21. By these stepped portions, the movement of the metallic cylindrical body CL and the baffle plates 20, 21 in the axial direction is controlled.

In the above structure, a compressed air AR is supplied from the air-supplying port 16 to the fluidized bed 12 via the porous plate 13 to introduce the compressed air

AR into the pressure equalization chamber 15 and eject it from the porous plate 13, whereby the resin powder P in the fluidized bed 12 is fluidized. Further, a rotary 19 is rotated to slowly rotate the metallic cylindrical body CL together with the electrode shafts 18.

Under such conditions, when a predetermined voltage is applied between the electrodes 17 and the electrode shafts 18, the resin powder P is positively or negatively charged by the electrodes 17, and electrostatically attached to the metallic cylindrical body CL to which opposite voltage is applied.

In this case, the resin powder P rising from the fluidized bed 12 and fluidizing upward, is classified into (1) ones which attach to the outer surface 3 of the metallic cylindrical body CL and the inside of the slots 4, (2) ones which enter the space between the right or left end face 5 or 5' of the metallic cylindrical body CL and the baffle plate 20 or 21, and attach to the right or left end face 5 or 5', and (3) ones which enter the axial hole 2 of the metallic cylindrical body CL and attach to the inner surface thereof.

However, by disposing the baffle plates 20, 21, the resin powder P flowing outside of the baffle plate 20 or 21, is prevented from attaching to the right or left end face 5 or 5' of the metallic cylindrical body CL, whereby the

amount of the resin powder P attached to the right or left end face 5 or 5' becomes less than that when the baffle plates 20, 21 are not disposed.

On the other hand, not only the ones which flow into the space between the right or left end face 5 or 5' of the metallic cylindrical body CL and the baffle plate 20 or 21, but also the ones which flow outside of the baffle plates 20, 21 and pass through the holes 20b of the baffle plate 20 or the holes 21b of the baffle plate 21, flow into the axial hole 2 of the metallic cylindrical body CL, whereby the amount of the resin powder attached to the right or left end face 5 or 5' does not decrease so much as compared with the case where the baffle plates 20, 21 are not disposed.

Furthermore, a part of the resin powder P which flows into the space between the right or left end face 5 or 5' of the metallic cylindrical body CL and the baffle plate 20 or 21, is reflected at the inner surface of the baffle plates 20 or 21, and enter into each slot 4 from the end face side of the metallic cylindrical body CL.

As a result, as compared with the case where the baffle plates 20, 21 are not provided, the amounts of the resin powder P which enter the axial hole 2 and the slots 4 tend to relatively increase, whereby it becomes possible to attach the resin powder P more uniformly to the surface of the metallic cylindrical body CL.

After the resin powder P is thus attached to the surface of the metallic cylindrical body CL, the metallic cylindrical body CL is detached from the electrode shaft 18 or, while supporting the metallic cylindrical body CL by the electrode shafts 18, the metallic cylindrical body CL is placed in a high frequency heating furnace or a hot blast drying furnace to heat it for fusion-bonding of the resin powder P to the metallic cylindrical body CL, forming a coating film.

Since the metallic cylindrical body CL is supported by the electrode shaft 18 inserted into the axial hole 2, the resin powder P does not attach to a portion of the axial hole 2 in contact with the electrode shaft 18. At the time of heating, the air between the laminated iron plates is expanded, and forms bubbles to flow out. However, in the present invention, the expanded air is permitted to escape from the portion to which the resin powder P does not attach, whereby the formation of pin holes in the coating film can be prevented. Further, at the portion with which the electrode shaft 18 is in contact and on which a coating film is not formed, a cold-setting type resin such as an ultraviolet-setting type resin is coated and cured, whereby coating films can be formed over the entire surface without causing the problems of pin holes due to the expansion of the air between the laminated iron plates.

In the present invention, as the resin powder P, for example, conventional ones for powder coating, for example, a polyester type or an epoxy type may be used.

Figs. 3 and 5 show the second embodiment of the electrostatic coating method of the present invention, wherein Fig. 3 is a front sectional view showing an electrostatic coating machine used for the second embodiment of this method, Fig. 4 is a view taken in the direction of arrows along the X-X line of Fig. 3, and Fig. 5 is a perspective view showing a main part of Fig. 3. The portions substantially same as the ones in the first embodiment, are indicated by the same numerals and their explanations will be omitted.

In the second embodiment as well, similarly as the first embodiment, the metallic cylindrical body CL is supported by a pair of electrode shafts 18, and baffle plates 20, 21 are disposed in the vicinity of the right and left end faces 5, 5' of the metallic cylindrical body CL to introduce the flow of the resin powder P.

Then, the feature of the second embodiment resides in that a cover plate 31 having an opening portion H of a cross-shaped form in a plane view, is disposed. The opening portion H has a part A along the axial direction of the metallic cylindrical body CL and a part B along the direction perpendicular to the axial direction. With

respect to the part A along the axial direction, the width W_1 is smaller than the outer diameter W of the metallic cylindrical body CL and the length L_1 is longer than the distance LL between the disposed right and left baffle plates 20, 21. With respect to the part B along the direction perpendicular to the axial direction, the width W_2 is shorter than the axial length L of the metallic cylindrical body CL and the length L_2 is longer than the outer diameter W of the metallic cylindrical body CL.

Accordingly, in the second embodiment, since the part A of the opening portion H of a cross-shaped form along the axial direction of the metallic cylindrical body CL, extends outside of the baffle plates 20, 21, the resin powder P flows outside of the baffle plates 20, 21 as well and such resin powder P flows into the axial hole 2 of the metallic cylindrical body CL through the central holes 20b, 21b of the baffle plates 20, 21, whereby the attached amount of the resin powder P to the inner surface of the axial hole 2 can be relatively increased.

Further, since the part A of the opening portion H of a cross-shaped form along the axial direction of the metallic cylindrical body CL, has a width shorter than the outer diameter W of the metallic cylindrical body CL, it is possible to decrease the amount of the resin powder rising at such an angle that the resin powder can hardly enter the

slots 4 of the metallic cylindrical body CL (as the resin powder becomes more distant from the center of the metallic cylindrical body CL, it becomes difficult to enter the slot 4), and it is possible to relatively increase the amount of the resin powder rising at such an angle that the resin powder can easily enter the slots 4 of the metallic cylindrical body CL, whereby the amount of the resin powder attached to the outer surface 3 and the slots 4 of the metallic cylindrical body CL can further be equalized.

Furthermore, with respect to the part B along the direction perpendicular to the axial direction of the metallic cylindrical body CL, since the width W2 is shorter than the axial length L of the metallic cylindrical body CL and the length L2 is longer than the outer diameter W of the metallic cylindrical body CL, it is possible to relatively decrease the amount of the resin powder P flowing in the vicinity of the right and left end faces 5, 5' of the metallic cylindrical body CL to decrease the amount of the resin powder attached to the right and left end faces 5, 5' of the metallic cylindrical body CL, whereby the attached amount of the resin powder P can be entirely equalized.

In the second embodiment, as the metallic cylindrical body CL, a laminated core having an outer diameter W of 20.3 mm, an axial length L of 8.8 mm and an inner diameter of the axial hole 2 of 15 mm, was used for test. It was found that

the coating film thickness was from 25 to 30 μm at the axial hole 2, 40 μm at the outer surface 3, from 36 to 40 μm at the inside of the slot 4 and 50 μm at the right and left end faces 5, 5', and that the coating film thickness at the axial hole 2 and the inside of the slot 4 to which the resin powder P can hardly attach, can be sufficiently equalized as compared with the conventional electrostatic coating method wherein no baffle plates 20, 21 nor cover plate 31 is disposed.

Fig. 6 is a front sectional view showing an electrostatic coating machine used for the third embodiment of the electrostatic coating method of the present invention. The portions substantially same as the ones in the first and second embodiments, are indicated by the same numerals and their explanations will be omitted.

In the third embodiment as well, similarly as the second embodiment, the metallic cylindrical body CL is supported by a pair of electrode shafts 18, baffle plates 20, 21 are disposed in the vicinity of the right and left end faces 5, 5' of the metallic cylindrical body CL to introduce the flow of the resin powder P, and a cover plate 31 having an opening portion H of a cross-shaped form is disposed above the fluidized bed 12.

Then, the feature of the third embodiment resides in that suction means 32, 33 are disposed by which the flow of

the resin powder P toward the metallic cylindrical body CL from the fluidized bed 12 is forcedly formed in the desired direction. Suction means 32 is disposed above the metallic cylindrical body CL, and another suction means 33 is disposed at one side of the metallic cylindrical body CL. In this embodiment, each of the suction means 32, 33 is composed of a suction cylinder connected to a suction pump not shown wherein any one of the suction means 32, 33 is selectively actuated by a change valve disposed in the suction cylinder.

Accordingly, when the suction means 32 disposed above the metallic cylindrical body CL is actuated, a strong flow is formed straight upward from the fluidized bed 12, and the resin powder P tends to enter easily the slot 4 at the lower part of the metallic cylindrical body CL, whereby the amount of the resin powder P attached to the inside of the slot 4 increases, and at the same time, the flow rate of the resin powder P flowing near the right and left end faces 5, 5' of the metallic cylindrical body CL is increased, and the amount of the resin powder P attached to the right and left end faces 5, 5' is decreased, thereby attaching the resin powder P in a uniform thickness.

Further, when the suction means 33 disposed at the side portion of the metallic cylindrical body CL is actuated, the resin powder P rising from the fluidized bed

12 flows toward such a side portion along the axial direction of the metallic cylindrical body CL, whereby the resin powder P tends to enter the axial hole 2 and the slot 4 easily, and the amount of the resin powder P attached to the axial hole 2 and the slot 4 can be increased. In this case, by moving the metallic cylindrical body CL relative to the fluidized bed 12 or moving the opening portion H of the cover plate 31 so as to move the position of the metallic cylindrical body CL relatively toward the suction means 33, it is possible to form the above flow effectively.

Fig. 7 is a perspective view showing an electrostatic coating machine used for the fourth embodiment of the electrostatic coating method of the present invention. The portions substantially same as the ones in the first to third embodiments, are indicated by the same numerals and their explanations will be omitted.

The feature of the fourth embodiment resides in that a scraping means 34 of the resin powder P is disposed near the outer surface 3 of the metallic cylindrical body CL supported by a pair of electrode shafts 18. As the scraping means 34, a spatula-shaped plate of a synthetic resin is employed in this embodiment, but it may be, for example, a roller or a brush. The space T between the scraping means 34 and the outer surface 3 of the metallic cylindrical body CL may suitably be arranged depending upon the thickness of

the attached resin powder P, but in general, preferably about a few times the coating film thickness to be desired.

In this embodiment, when the resin powder P is attached in an excess thickness on the outer surface 3 of the metallic cylindrical body CL, the excess resin powder P is scraped by the scraping means 34, whereby the resin powder P can usually be attached in an appropriate thickness on the outer surface 3 of the metallic cylindrical body CL. In this embodiment, the terminal end 34a of the scraping means 34 is in contact with the outer surface of the baffle plates 20, 21 to adjust the space T between the scraping means 34 and the outer surface 3 of the metallic cylindrical body CL.

Fig. 8 is a front sectional view showing an electrostatic coating machine used for the fifth embodiment of the electrostatic coating method of the present invention. The portions substantially same as the ones in the first to fourth embodiments, are indicated by the same numerals and their explanations will be omitted.

In the fifth embodiment, as shown in Fig. 3, the metallic cylindrical body CL is supported so that its axial direction would be laid horizontally, and the resin powder P is attached in the same manner as in the above-mentioned embodiments, and then as shown in Fig. 8, the supporting angle is changed so that the axial direction of the metallic

cylindrical body CL would be vertical.

Namely, when the metallic cylindrical body CL is supported so that its axial direction would be vertical, the resin powder P rising from the fluidized bed 12 can easily enter the axial hole 2 and the slot 4 of the metallic cylindrical body CL, whereby the coating film thickness of the axial hole 2 and the slot 4 can be made thicker.

Figs. 9 to 12 show the sixth embodiment of the electrostatic coating method of the present invention. Fig. 9 is a front sectional view showing an electrostatic coating machine used for this method. Fig. 10 is a diagrammatic explanatory view showing the second coating step of this method. Fig. 11 is an enlarged sectional view of a main part showing the state where the resin composition is coated in the second coating step. The portions substantially same as the ones in the first to fifth embodiments, are indicated by the same numerals and their explanations will be omitted.

In the sixth embodiment, the metallic cylindrical body CL as the material to be coated is supported by an electrode shaft 18 which fits to the inner surface of the axial hole 2. With respect to the metallic cylindrical body CL, its one end face engages with a stepped portion 18d of the electrode shaft 18 and another end face is pressed by a cap 22 and fixed to the electrode shaft 18. In this embodiment, the axial hole of the metallic cylindrical body CL is

covered with the electrode shaft 18 and the cap 22 and the resin powder thereby hardly enter thereinto, whereby no baffle plates like the above embodiments is needed.

Then, the resin powder P is attached thereto while rotating the metallic cylindrical body as described above, and at this time, a scraping means of the resin powder may be disposed near the outer surface of the metallic cylindrical body CL to scrape excess resin powder P attached to the outer surface of the metallic cylindrical body CL, whereby the resin powder P in an appropriate thickness is usually attached to the outer surface of the metallic cylindrical body CL. After the resin powder P is attached to the surface of the metallic cylindrical body CL as above, the metallic cylindrical body CL is detached from the electrode shaft 18 or, while supporting the metallic cylindrical body CL by the electrode shaft 18, the metallic cylindrical body CL is placed in a high frequency heating furnace or a hot blast drying furnace and heated for fusion-bonding of the resin powder, thereby forming a coating film.

Then, the second coating step will be described. In this step, a cold-setting type liquid resin composition is coated on a part on the inner surface of the axial hole on which the supporting rod abut in the above first coating step and which is uncoated.

At this time, as shown in Fig. 14, when the viscosity

of the cold-setting type liquid resin composition 42 is low, the film thickness at the internal edge portion 47 of the upper end face of the metallic cylindrical body CL may sometimes be thin or a liquid may sometimes retain at the lower portion of the inner surface. Further, when the viscosity is contrarily high, as shown in Fig. 15, when a groove 51, etc. is formed on the inner surface of the metallic cylindrical body CL, the groove may sometimes be plugged, whereby uniform coating can not be made.

Accordingly, as shown in Fig. 10(a), the both end faces of the metallic cylindrical body CL on which a coating film 43 is formed at the part other than the inner surface of the axial hole in the above first coating step, are clamped and supported by a pair of jigs 41a and 41b each having an opening portion which fits to the inner surface of the metallic cylindrical body CL, and while rotating the metallic cylindrical body CL with the jigs, a nozzle 40 for supplying a coating material is inserted into the axial hole of the metallic cylindrical body CL, and then a cold-setting type liquid resin composition, in this embodiment, an ultraviolet-setting type liquid resin composition 42, is coated on its inner surface. Here, the nozzle 40 for supplying a coating material may be rotated while keeping the metallic cylindrical body CL fixed.

Then, as shown in Fig. 10(b), a gas such as air or

nitrogen, is blown to the inner surface of the metallic cylindrical body CL from the gas-supplying nozzle 44, to extend uniformly the ultraviolet-setting type liquid resin composition 42 on the inner surface.

At this time, by clamping and supporting the metallic cylindrical body CL with a pair of jigs 41a and 41b each having an opening portion which fits to the inner surface of the metallic cylindrical body CL, it is possible to prevent excess attachment of the liquid resin composition 42 to the end face of the metallic cylindrical body CL as shown in Fig. 11. Further, by disposing the jig 41a at the upper portion, the film thickness of the internal edge portion 47 of the upper end face of the metallic cylindrical body CL can be secured, and the jig 41b disposed at the lower portion brings about such an effect that the problem of the liquid reservoir at the lower inner surface of the metallic cylindrical body CL can be solved.

Further, by blowing a gas to the inner surface of the metallic cylindrical body CL from the gas-supplying nozzle 44, as shown in Fig. 12, even if the groove 51, etc. is formed on the inner surface of the metallic cylindrical body CL, the liquid resin composition 42 can be formed in a uniform thickness. Furthermore, by varying the gas-blowing pressure, the coating film thickness on the inner surface of the axial hole can be controlled as well.

After coating the ultraviolet-setting type liquid resin composition 42 on the inner surface of the metallic cylindrical body CL as above, as shown in Fig. 10(c), while supporting the metallic cylindrical body CL with a supporting member 46 and rotating the metallic cylindrical body CL together with the supporting member 46, the inner surface of the metallic cylindrical body CL is irradiated with ultraviolet rays by an ultraviolet ray applying device 45. By doing so, the liquid resin composition 42 coated on the inner surface of the metallic cylindrical body CL is cured and a coating film 42a of a uniform thickness can thereby be formed.

As the cold-setting type liquid resin composition, not only the ultraviolet-setting type liquid resin composition as described above, but also a solvent-type resin composition which is dried and cured at room temperature, etc. may be used.

What is claimed is:

Claim 1. A method for electrostatic coating a metallic cylindrical body having a substantially cylindrical shape formed by laminating metal plates, which comprises

a first coating step of inserting a supporting rod into an axial hole of the metallic cylindrical body, making the supporting rod abut on an inner surface of the axial hole along the axial direction to support the metallic cylindrical body, and electrostatically attaching a resin powder to a surface of the metallic cylindrical body while placing the metallic cylindrical body at the upper portion of the fluidized bed for the resin powder and rotating the metallic cylindrical body, followed by fusion-bonding of the attached resin powder by heating to form a coating film, and

a second coating step of coating a cold-setting type resin composition on an uncoated portion of the inner surface of the metallic cylindrical body on which the supporting rod abuts, followed by curing.

Claim 2. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein the metallic cylindrical body is supported at the upper portion of the fluidized bed for the resin powder, and at the same time, ring-like baffle plates are disposed with a predetermined distance from the end faces of the metallic cylindrical body, respectively, and the resin powder is



attached while rotating the metallic cylindrical body.

Claim 3. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein at the upper portion of the fluidized bed, a cover plate having a cross-shaped opening is disposed, and when the metallic cylindrical body is supported above the opening, the metallic cylindrical body is arranged so that the axial direction of the metallic cylindrical body would extend along one direction of the cross-shaped opening, wherein a part of the cross-shaped opening extending along the axial direction of the metallic cylindrical body, has a width narrower than the outer diameter of the metallic cylindrical body and a length longer than the distance between the baffle plates, and a part of the cross-shaped opening extending along the direction perpendicular to the axial direction of the metallic cylindrical body, has a width shorter than the axial length of the metallic cylindrical body and a length longer than the outer diameter of the metallic cylindrical body.

Claim 4. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein the metallic cylindrical body is disposed above the fluidized bed, and at the same time, suction means are disposed at the upper portion and/or the side portion of the metallic cylindrical body, whereby a flow of the resin powder is



formed by the suction means.

Claim 5. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein a scraping member is disposed near the outer surface of the metallic cylindrical body, and the thickness of the resin powder attached to the outer surface of the metallic cylindrical body can thereby be controlled.

Claim 6. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein in the second step, a gas is blown to the inner surface of the metallic cylindrical body, to extend uniformly the liquid resin composition attached to the inner surface of the metallic cylindrical body, and then the liquid resin composition is cured to form a coating film.

Claim 7. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein in the second coating step, the metallic cylindrical body is supported by clamping both end faces of the metallic cylindrical body with a pair of jigs each having an opening which fits to the inner surface of the metallic cylindrical body, and while rotating the metallic cylindrical body together with the jigs, the liquid resin composition is coated on the inner surface of the metallic cylindrical body and the gas is blown to the inner surface of the metallic cylindrical body.



Claim 8. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein in the second coating step, an ultraviolet-setting type resin composition is used as the liquid resin composition, and the ultraviolet-setting type resin composition is coated on the uncoated part of the inner surface of the metallic cylindrical body, the gas is blown and then the inner surface of the metallic cylindrical body is irradiated with ultraviolet rays to cure the ultraviolet-setting type resin composition.

Claim 9. The method for electrostatic coating a metallic cylindrical body according to Claim 1, wherein the metallic cylindrical body is a core of a stator or a core of a rotor used for a rotary electrical apparatus.

