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ELECTRIC MOTOR

The present invention relates to an electric motor having a stator core on which a coil is wound.

In the accompanying drawings, Figure 15 shows a conventional electric motor of the sort described in Japanese Utility Model Examined Publication No. 37407/1987. In Fig. 15, reference numeral 1 denotes a stator core fabricated by uniting numerous silicon steel sheets. The stator core 1 has a number of slots 2 in its inner peripheral portion and insulating paper 3 is put through each slot 2, which also houses a coil 4 via the insulating paper 3. Reference numerals 5, 6 denote a pair of insulating covers for covering the ends 4a, 4b of the coil 4 jutting out on both sides of the stator core 1, the insulating covers 5, 6 being made of insulating material such as plastics. The insulating cover 5 is formed with a combination of inner and outer tubular portions 7, 9 whose respective one sides are coupled together by an annular side plate 11, whereas the insulating cover 6 is formed with a combination of inner and outer tubular portions 8, 10 whose respective one sides are coupled together by an annular side plate 12, whereby a closed-end annular space 13 for housing the coil is formed in between both the tubular portions.

Further, reference numerals 9a, 10a denote flat portions formed alternately on the outer peripheral faces of



the outer tubular portions 9, 10 of the insulating covers 5, 6, respectively. Reference numeral 15 denotes pawls equivalent to mating parts, each of the mating pawls being integrally formed on and protruded from the flat portion 9a on the outer tubular portion 9 of the insulating cover 5. Reference numeral 16 denotes a plurality of frame-like coupling pieces equivalent to those to be mated and each of the frame-like coupling pieces is extended integrally on the flat portion 10a of the outer tubular portion 10 of the insulating cover 6, the frame-like coupling pieces corresponding to the respective mating pawls 15.

The aforementioned conventional electric motor is assembled through the steps of covering the stator core 1 with the insulating covers 5, 6 from both sides in such a way as to house the ends 4a, 4b of the coil 4 in the space 13 formed with the insulating covers 5, 6, fitting the outer tubular portions 9, 10 over the peripheral face of the stator core 1, and abutting the leading ends of the inner tubular portions 7, 8 against the end faces of the stator core 1. Then the frame-like coupling pieces 16 are made to catch the respective mating pawls 15 so as to couple the insulating covers 5, 6 together. With the coil ends 4a, 4b covered with the insulating covers 5, 6, the whole body is dipped into, for example, a varnish bath to varnish it.

However, the conventional electric motor thus fabricated poses the following problems.



1. The perimeter of the coil tends to become greater and this results in a rise in production cost as the amount of coil for use increases.

The perimeter of the coil inevitably increases because the insulating paper 3 is inserted in the slots 2 through which the coil 4 is wound. As a result, the material and assembly costs increase.

2. The use of the insulating paper 3 makes the electric motor costly.

3. The electrical characteristics are poor.

Since the perimeter of the coil is lengthy, the increased magnetic flux density lowers the operating efficiency, thus reducing its rotational and torque characteristics, for example.

4. The necessity of varnishing makes assembly mechanization less feasible.

Since both the insulating covers 5, 6 are varnished by dipping them into the varnish bath before being coupled together, assembly mechanization becomes infeasible.

An object of the present invention is to solve the foregoing problems.

An electric motor according to the present invention comprising a stator core having a plurality of slots, a coil wound through the slots of the stator core, and tubular coil covers having inner and outer peripheral portions for covering the coil ends, is characterised by insulating the slots and end faces of the stator core with insulating material, winding an autohesion wire through the slots, and covering the coil ends with the coil covers whose inner walls are substantially similar in configuration to the coil ends.

1. Lower production cost resulting from the reduced perimeter of the coil, that is, the reduced amount of coil for use;

2. No insulating paper required;
3. Excellent electrical characteristics;
4. No varnish treatment required; and
5. Feasibility of assembly mechanisation.

The upper and lower end faces of the stator core may be protruded from the respective sides of the stator core to make each end face a portion mating with the coil cover, which is provided with pawls respectively mating with the portions.

The stator core may be a laminated core and holes be bored through the stator core in the direction of lamination.

In yet another form of the invention, a tubular portion may protrude from the outer periphery of the stator core and notches be provided therein.

Recessed openings may be provided in the inner periphery of the insulating core and opposite to the respective slots.



insulating cover and opposite to the respective slots.

According to the invention, the autohesion wire as a coil is wound through the slots of the stator core, the slots and end faces thereof being insulated with insulating material. While the ends of the coil are being shaped inside the coil covers, that is, the coil is being tightly held between the coil covers by pressing the coil covers against the stator core, the coil covers are fitted to the stator core.

In a feature of the invention, the coil covers are fitted to the stator core by mating the pawls of the coil covers with the respective mating portions protruded from the upper and lower end faces of the stator core.

In a feature of the invention, the insulating material is allowed to flow through holes toward the opposite side of a gate for insulating resin, so that the insulating material also flows to the opposite side thereof.

In a feature of the invention, the coil cover can be fitted while the coil end is kept being pressed inward by inserting through the notch a jig for pressing the coil end on the tubular portion.

In a feature of the invention, the coil cover can be fitted while the coil end is kept being pressed outward by

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inserting through the opening the jig for pressing the coil end on the tubular portion.

The invention will be further described by way of non-limitative example, with reference to the accompanying drawings, in which:-

Figure 1 is a perspective assembly drawing of an electric motor embodying the present invention.

Figure 2 is a perspective assembly drawing of the electric motor of Fig. 1.

Figure 3 is a top view of a stator core embodying the present invention.

Figure 4 is a sectional view of the stator core of Fig. 3.

Figure 5 is a top view of the stator core covered with insulating material according to the present invention.

Figure 6 is a sectional view of the stator core covered with insulating material of Fig. 5.

Figure 7 is a top view of the stator core fitted with an insulating cover according to the present invention.

Figure 8 is a sectional view of the stator core fitted with the coil cover according to the present invention.

Figure 9 is a bottom view of the stator core fitted with the coil cover according to the present invention.

Figure 10 is a partial sectional view of the stator core with the wedge fixed according to the present invention.

Figure 11(a) is a top view of an upper coil cover according to the present invention and Figure 11(b) is a



partial sectional view of a projection according to the present invention.

Figure 12 a side view of the upper coil cover including its partial sectional view according to the present invention.

Figure 13 is a top view of a lower coil cover according to the present invention.

Figure 14 is a side view of the lower coil cover including its partial sectional view according to the present invention.

Figure 15 is a perspective exploded view of a conventional electric motor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figs. 1 - 14, an embodiment of the present invention will subsequently be described. Reference numeral 20 denotes a stator core, which is formed with a high-speed automatic press (not shown) for use in blanking stator core plates with rotors separately located on the respective inner peripheral sides 21 of the stator core plates out of an electric steel sheet wound like a hoop and simultaneously these plates are united by caulking to required thickness. Reference numeral 22 denotes mating portions formed by sticking out the upper and lower end faces 22a from the respective sides of the stator core 20 when the plates are formed into a laminated core; a plurality of such portions are provided so that the end portions of coil



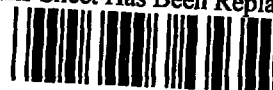
covers, which will be described later, may mate with the portions thus stuck out. When steel sheets, for example, 0.35 mm or 0.5 mm thick are united in the die (not shown) of the high-speed automatic press, two kinds of them different in configuration are manufactured by taking in and out the punch in the die (not shown) to effect thickness or lamination control so as to make more than one sheet stick out from each of the upper and lower end faces. Reference numeral 23 denotes a plurality of slots provided at equal intervals and extended from the inner peripheral side 21 toward the outer periphery of the stator core 20, each pole piece 24 being formed between the slots.

Further, reference numeral 25 denotes a plurality of holes provided in the outer periphery of the stator core 20 at equal intervals and passed therethrough in the direction of lamination outside the slots 23. Like the slots 23, these holes are formed simultaneously with the stator core 20. Reference numeral 26 denotes an insulating portion formed by, for example, injection molding in such a way as to cover the stator core 20 and caused to stick to the slots 23, the upper and lower end faces 22a. Reference numeral 27 denotes a coil guard including a tubular chimney-shaped portion 28 projecting in combination with the insulating portion 26 of the stator core 20 on the outer periphery thereof, the leading end of the coil guard having notches 29 in a plurality of places. The coil guard 27 is used to prevent a



coil from coming apart after the coil is wound through the slots 23 of the stator core 20 as will become apparent later. Moreover, the notches 29 are used as spaces where the coil is pressed toward the center of the stator core 20 by means of a coil-pressing jig when the coil covers are fitted to the stator core 20.

Further, reference numeral 30 denotes a coil cover, and 31 an upper coil cover for a terminal table as what forms the coil cover on one side, the coil cover 31 being formed of insulating resin by injection molding into a disc covering the upper end face 22a of the stator core 20. Reference numeral 32 denotes projections formed on the upper coil cover, the leading end of the projection being L-shaped so as to fix a terminal, which will become apparent later in Fig. 11, 33 pins also provided on the upper coil cover 31 likewise and used to fix a temperature fuse (not shown) and a jumper wire as will become apparent later, and 34 a first groove formed with a side wall A35 enclosing the inner peripheral side of the upper coil cover 31 and used for lead-wiring as will also be described later. Reference numeral 36 denotes a plurality of openings made in the inner peripheral wall of the upper coil cover 31 and these openings having the same width as the slots 23 are respectively set opposite to the slots 23 when the upper coil cover 31 is fitted to the stator core 20. Each of these openings 36 is used as a space for use in pressing the coil against the outside of the stator



core 20 by means of the coil-pressing jig when the upper coil cover 31 is fitted to the stator core 20. Reference numeral 34a denotes a plurality of second grooves, each of which is formed in the upper periphery of the upper coil cover 31, set wider than the diameter of a magnet wire and used for positioning the coil.

Further, reference numeral 37 denotes a stepped portion provided beneath the inner peripheral wall of the upper coil cover 31 and fixed to the stator core 20 while its recessed surface is used to press a wedge as will become apparent later, and 38 a plurality of coupling pieces provided at equal intervals and each coupling piece is extended down the external peripheral wall of the upper coil cover 31 and has a L-shaped mating pawl 39 at its leading end. Incidentally, the interior of the upper coil cover 31 is, as will become apparent later, U-shaped in section so as to form the coil end. Reference numeral 40 denotes a lower coil cover forming the counter part of the coil cover 30, the coil cover 31 being formed of insulating resin by injection molding into a disc covering the lower end face 22a of the stator core 20. The lower coil cover is U-shaped in section like the upper coil cover 31. Reference numeral 41 denotes a plurality of holes formed in the lower insulating cover 30 at equal intervals and used as those for confirming the coil condition.



Like the upper coil cover 31, the lower coil cover 40 is also provided with openings 36, coupling pieces 38 and a stepped portion 37. Reference numeral 42 denotes a coil which is a magnet wire coated with, for example, autohesion material, and wound through the slots 23 of the stator core 20 whose slots and end faces are insulated with the insulating material. While the coil end is formed inside the coil cover 30, the coil 42 is held by pressing the coil cover 30 against the stator core 20, so that the coil cover 30 is fitted to the stator core 20. Reference numeral 43 denotes the coil end, and 44 the wedge inserted in the slot 23. The wedge is pressed and vertically secured by the respective stepped portions of the covers 31, 40 when the coil cover 30 is fitted to the stator core 20. Reference numeral 45 denotes rotors provided inside the stator core 20 with the rotary shaft 46 passed through the center thereof, and 47 a bearing, for example, a ball bearing embracing the rotary shaft.

Reference numeral 48 denotes an outer case, 49 a frame forming one side of the outer case, and having a rotary shaft hole (not shown) bored in the center and a coupling brim 50 on the periphery of the frame. Reference numeral 51 denotes a bracket forming the other side of the outer case 48 having the coupling brim 50 on the periphery, a cord hole 52 being bored in the inner side of the coupling brim 50. Reference numeral 53 denotes a power supply lead which is,



for example, a heat-resistant vinyl wire, 54 an insulating tube for protecting the lead, the tube being made of flexible insulating material, for example, polyethylene. Reference numeral 55 denotes a plastic cord bush which is embraced with an insulating tube and fitted in the cord hole 52, 56 a jumper line which is, for example, a single conductor for connecting terminals 57 secured between the projections 32, and 58 leads formed with the beginning and end of winding.

The aforementioned electric motor is assembled through the steps of forming the stator core 20 and the rotor 45 by blanking and caulking to required thickness with a high-speed automatic press from an electric steel sheet wound like a hoop. Subsequently, the stator core 20 is rinsed to remove oil and heated up to about 150 °C using a heating medium. Then an injection molding machine (not shown) is used to mold the insulating portion 26 formed of the insulating material integrally on the upper and lower end faces 22a and in the slots 23. After the insulating portion 26 is thus formed, the parting portion is trimmed and a rust preventive is applied to the inner periphery.

Further, a coil winding machine (not shown) is used to wind the coil 42 on a winding jig (not shown) and the coil 42 is fitted in the slots 23 together with the wedge 44 being inserted in the slot 23. Then the intermediate forming of the coil end 43 is conducted and the stator core 20 having the coil 42 is fitted to an assembly pallet (not shown) to



fasten the leads 58 of the coil 42 temporarily. Then the upper coil cover 31 is secured to the stator core 20 by engaging the portions 22 with the pawls 39. Then the terminals 57 is fitted to the upper coil cover 31 and the leads 58 are fixedly connected to the terminals 57 before the ends of the leads 58 are cut and removed.

Subsequently, the lower coil cover 40 is fitted to the lower end face of the stator core 20 as in the case of the upper coil cover 31 and electrical inspection is made by abutting contacts (not shown) on the terminals 57. Then prescribed voltage is applied across a predetermine position of the terminals 57 to supply power to the coil 42 and the heat generated thereby causes the autohesion varnish sticking to the surface of the magnet wire to melt, so that the coil 42 is anchored.

Further, the stator core 20 fitted with the coil cover 30 is forced into the frame 49 and the rotor 45 fitted with the bearing 47 is fitted in the stator core 20. Various kinds of inspection are made after a washer (not shown) is fitted to the rotary shaft 46 of the rotor 45. Subsequently, the jumper wire 56 and the temperature fuse are fitted to the upper coil cover 31 and the lead including the power supply lead 53 is connected to the terminals 57. Each charging parts are then insulated with patty (not shown). Then the bracket 51 is fitted to the stator core 20 and by caulking the brim 50 of the frame 49, the frame 49 and the bracket 51



are combined and fixed. The lead 53 is then passed through the insulating tube 54, which together with the cord bush 55 is fitted to the bracket 51.

As set forth above, the steps of treating the slot cells with varnish and shaping the coil end 43 can be dispensed with by insulating the end faces of the stator core 20 and slots 23, winding the autohesion wire thereon, and fitting the upper and lower coil covers 31, 40 to the stator core 20. Moreover, assembly mechanization ultimately becomes feasible as it is possible to decrease the perimeter of the coil 42, thus facilitating the fixing of the coil 42. Further, the stator core 20 is readily fitted to the coil cover 30 by means of the mating portions of the stator core 20 and the pawls 39 of the coil cover 30, and this makes it simpler to lock the coil cover 30. Since the resin as the insulating material is allowed to flow through the holes of the stator core 20, it is caused to flow toward the opposite gate more efficiently than to flow on the surface of each slot of the stator core 20, whereby the flow characteristics thereof are improvable. In addition, not only moldability at low pressures but also freedom from burr renders thin-wall molding possible.

The provision of the first groove 34 and the projections 32 for the upper coil cover 31 allows the lead 53 and the terminals 57 to be positioned properly. Assembly mechanization is also facilitated. The provision of the



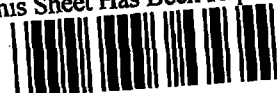
second grooves 34a, moreover, facilitates the positioning of the magnet wire end and this also contributes to the assembly mechanization. Further, the wedge 44 can be held by the stepped portion 37 between the coil covers 31, 40.

The present invention thus constituted has the following effect:

According to the arrangement of the invention wherein an electric motor is made up of: a stator core having a plurality of slots, a coil wound through the slots of the stator core, and tubular coil covers having inner and outer peripheral portions for covering the coil ends, and is characterized by the production steps of insulating the slots and end faces of the stator core with insulating material, winding an autohesion wire through the slots, and covering the coil ends with the coil covers whose inner walls are substantially similar in configuration to the coil ends, assembly mechanization is made possible by pressing the coil end against the stator core while forming it inside the coil cover to tightly hold and form the coil.

According to the preferable form of the invention wherein the upper and lower end faces of the stator core are protruded from the sides of the stator core to make each end face a portion mating with the coil cover, which is provided with pawls respectively mating with the mating portions, the mating pawls can simply be shaped as the coil cover is

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readily fitted to the stator core by engaging the mating portions and the pawls.

According to the preferable form of the invention wherein the stator core is a laminated core and wherein holes are bored in the stator core in the direction of lamination, the stator core is uniformly covered with a thin layer of resin as the insulating material since the flow of the resin is facilitated by the holes.

According to the preferable form of the invention wherein a tubular portion is protruded from the outer periphery of the stator core and wherein notches are provided therein, the coil cover can be fitted while the coil is pressed down from the outer periphery of the coil end, whereby the coil cover is prevented from cutting into the outer periphery of the coil end.

According to the preferable form of the invention wherein recessed openings are provided in the inner periphery of the coil cover and opposite to the respective slots, the coil cover can be fitted while the coil is pressed down from the inner periphery of the coil end, whereby the coil cover is prevented from cutting into the inner periphery of the coil end.

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C L A I M S

1. An electric motor comprising:
a stator core having a plurality of slots and end faces wherein said slots and said end faces of the stator core are insulated with insulating material;
a coil formed by winding an autohesion wire on said stator core through said slots;
at least one annular coil cover for covering one of said end face, said cover having inner and outer peripheral walls and an bottom wall substantially identical in configuration to said one of said end faces and connecting said inner and outer peripheral walls.
2. An electric motor as claimed in claim 1, wherein said one of said end faces is protruded radially outward from a peripheral surface of said stator core to provide an engagement portion engageable with a pawl formed on said coil cover.
3. An electric motor as claimed in claim 1 or 2, wherein the stator core is formed as a laminated construction and holes are bored in the stator core in the direction of lamination.
4. An electric motor as claimed in claim 1, 2 or 3, wherein a tubular portion is protruded from the outer periphery of said one of said end faces, and notches are provided in said tubular portion.





5. An electric motor as claimed in claim 1, 2, 3 or 4, wherein recessed openings are formed in said bottom wall of said coil cover so as to face said slots, respectively.

- 5 6. An electric motor constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 14 of the accompanying drawings.

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