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[54] **STATOR FOR AN ELECTRIC MOTOR**

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[30] **Foreign Application Priority Data**

Sep. 24, 1992 [JP] Japan 4-254321

[51] **Int. Cl.**^{6} **H02K 1/16**

[52] **U.S. Cl.** **310/258**; 310/179; 310/254; 310/42; 310/217

[58] **Field of Search** 310/217, 254, 310/258, 179, 216, 218, 42

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Attorney, Agent, or Firm—Watson Cole Stevens Davis, P.L.L.C.

[57] **ABSTRACT**

In a stator for an electric motor, insulating members are formed on laminated iron cores divided for each pole-tooth unit in the direction of the output shaft and windings are applied perpendicularly to the pole-tooth portions in a high-density alignment. After a predetermined number of the laminated iron cores are combined so as to form a cylindrical configuration, they are welded at the outer end portions of the dividing surfaces in the direction of lamination so as to construct an integral structure stator with rigidity, thereby enabling high densification of the windings (conductor space factor of 70%) and space-savings in the winding end portions. Further, as any joint portions between the pole-tooth portions are not necessary, reduction (5 to 10%) in motor efficiency due to such joint portions can be prevented, and, as any integrally forming by resinous members is not necessary, inter-winding short-circuiting is not caused. Welding may be replaced by adhesive bonding. Otherwise, an annular member may be employed to form an integral structure of the divided iron core lamination.

7 Claims, 3 Drawing Sheets

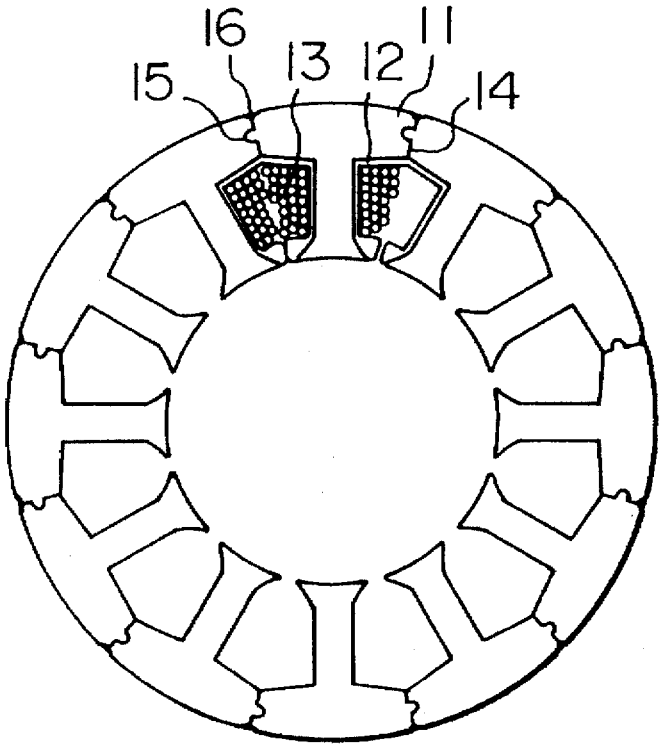


FIG. 1

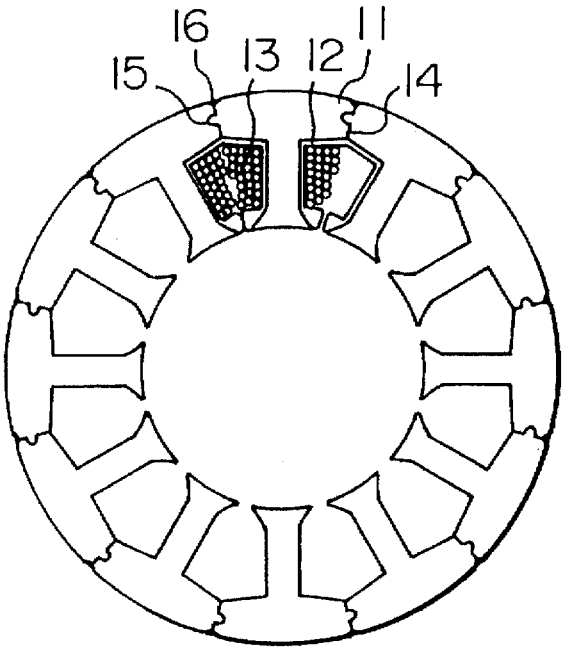


FIG. 2

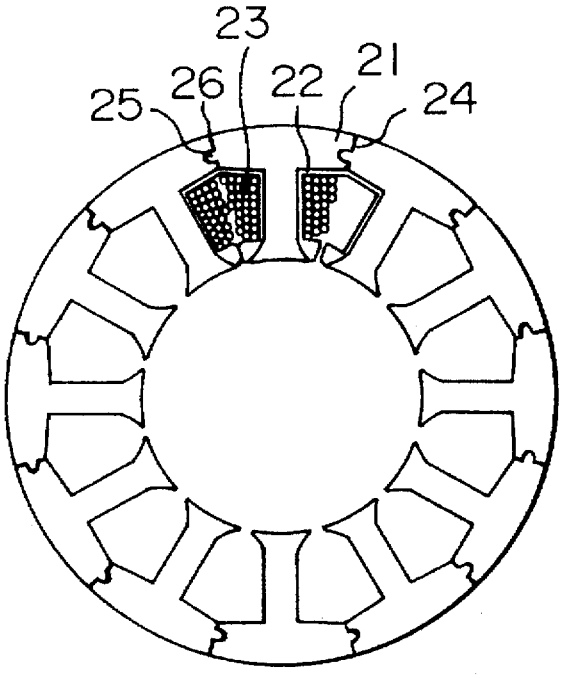


FIG. 3

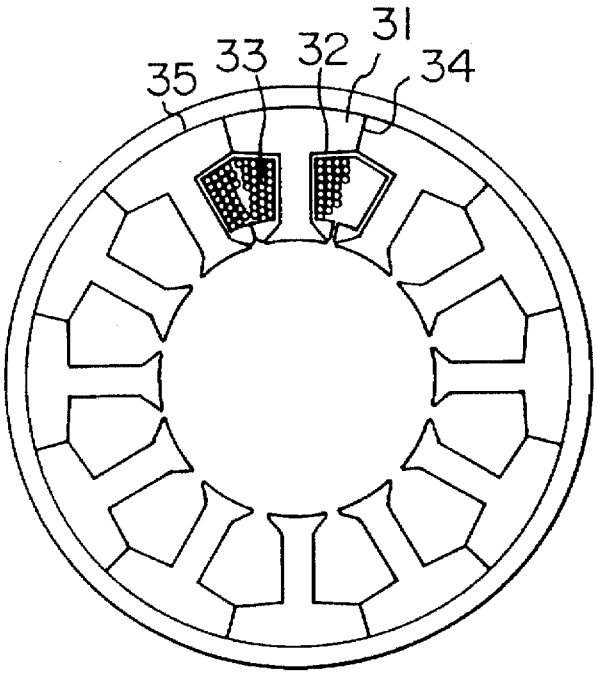


FIG. 4 PRIOR ART

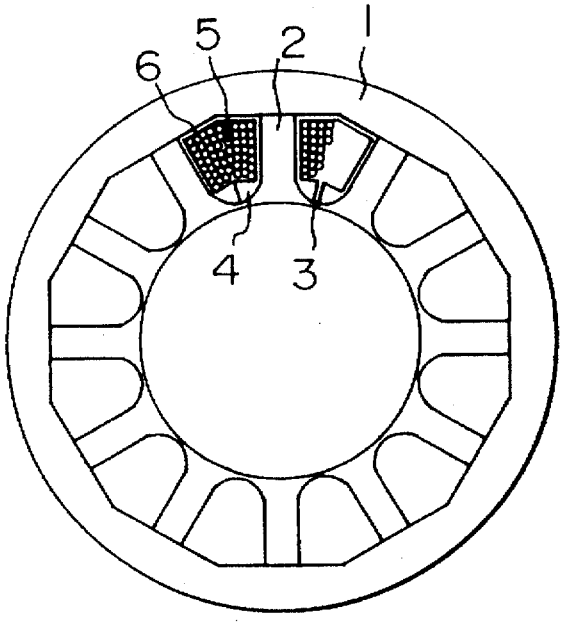


FIG. 5A PRIOR ART

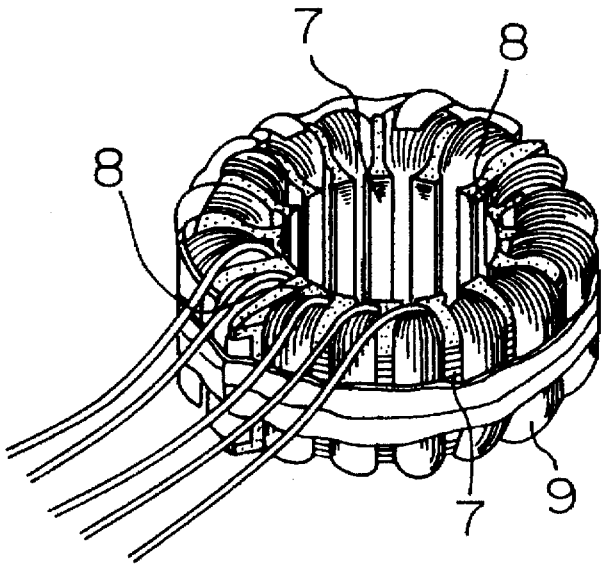
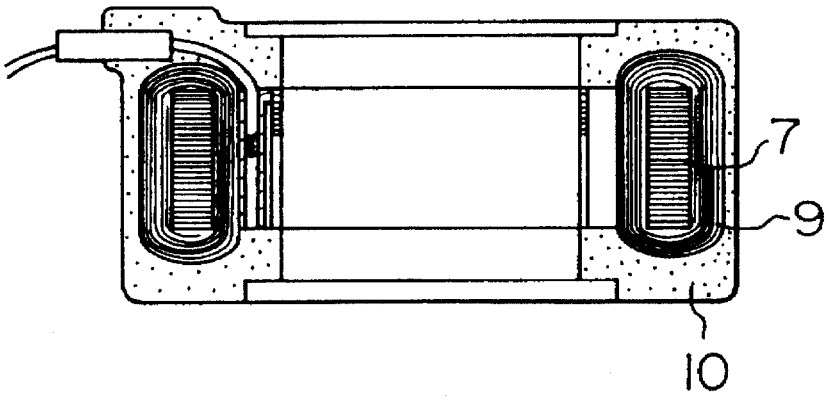


FIG. 5B PRIOR ART



STATOR FOR AN ELECTRIC MOTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field to which the present invention relates is generally a stator for an electric motor.

In recent years, for the purposes of rendering an electric motor compact and highly efficient, a need of rendering stator windings highly densified and saving space for winding end portions has been increasingly arising. In particular, in a servo-motor used in industrial robots and others, in order to meet the recent demand for achieving a high-speed robotic operation, saving space and obtaining an increased output, it has become necessary that a magnet of an extremely high magnetic flux density be employed for a rotor, that the winding density of the stator reach a conductor space factor of 70% which represents the theoretical limit value of aligning windings, and that space for the winding end portions be made to minimum. While there has hitherto been an inserter winding as a winding technique for attaining high densification, it entails the problem of causing the space for the winding end portions to be extremely large. Accordingly, it is the recent trend to seek to enable simultaneously the windings of an increased density and the space-saving for the winding end portions to be achieved by dividing the iron core and effecting the windings in alignment at an outside place.

2. Description of the Prior Art

The constructions of conventional stators will now be described below.

FIG. **4** shows the construction of a stator aimed to highly densify its windings and to save the space for the winding end portions. In FIG. **4**, numeral **1** designates a first iron core member constituting the outer part of an iron core whereas numeral **2** designates a second iron core member constituting the inner part of the iron core. Numeral **3** designates a joint portion connecting adjacent pole-tooth portions of the second iron core member. Numeral **4** designates an insulator, numeral **5** designates windings and numeral **6** denotes a resinous part.

In the above construction, the windings **5** are wound perpendicularly around the insulator **4** in a high density in alignment at an outside place, and a predetermined number of such windings **5** are inserted on the pole-tooth portions of the second iron core member **2**. Thereafter, the second iron core member **2** is inserted into the first iron core member **1** to constitute the stator iron core. In addition, the resinous part is formed by molding or the like to complete the integral structure of the stator.

Next, FIGS. **5**A and **5**B show the construction of another conventional and typical stator in which a laminated iron core is divided in the direction of its output shaft. In FIG. **5**A, numeral **7** designates a laminated iron core which is divided into two by a dividing surface **8**. Numeral **9** designates windings. In FIG. **5**B, numeral **10** designates a resinous part.

In the above construction, the windings **9** are perpendicularly wound around the outer periphery of the laminated iron core **7** divided into the two parts. Thereafter, the laminated iron core **7** is matched at the dividing surfaces **8** and is made integral with the resinous part **10**.

The foregoing first conventional constructions, however, involves the following problems:

(1) Due to the fact that the iron core constituting the stator is divided at the outer circumferential surfaces of the pole-tooth portions, the joint portions **3** connecting the pole-tooth portions at their inner parts are indispensable in order to structure and maintain the second iron core member **2**.

(2) In the joint portions **3** indispensable as abovesaid, magnetic leakage occurs between the pole-teeth, causing a problem that the motor efficiency drops by 5 to 10%, and this requires the joint portions **3** to be formed as thinly as possible.

(3) Therefore a need arises so as to form the resinous part **6** in order for the rigidity of the stator structure to be properly given; however, a problem arrises that an inter-winding short-circuiting tends to be caused as a result of a damage of the insulating sheathes of the windings **5** at the time of forming such resinous part **6**.

(4) Besides, the inconvenience arises that, following the necessity of a larger iron core, a larger press equipment and molding apparatus become necessary, and productive efficiency is reduced.

Furthermore, in the foregoing second conventional construction, the perpendicular winding of the windings **9** around the outer periphery of the laminated iron core **7** renders the windings not in alignment and does impose the limitation of conductor space factor at 52 to 55%. Moreover, while space-saving for the winding end portion is possible, the dimension increases as the windings extend over in the direction of the outer diameter.

SUMMARY OF THE INVENTION

The present invention has for its object to solve the foregoing conventional problems and provides a stator for an electric motor which, while maintaining the construction which enables high-density aligning winding to be carried out at an outside place, is designed to effect space-saving for the winding end portions, eliminates such joint portions between the pole-teeth which tend to reduce the motor efficiency, also eliminates forming of such resinous part hitherto required to ensure the stator rigidity, and yet has a divided construction which enables a large-sized iron core to be produced with a small-sized press equipment.

In order to achieve this object, a stator for an electric motor according to the present invention comprises laminated iron cores divided for each pole-tooth unit and windings wound perpendicularly to the pole-tooth portions of the laminated iron cores, wherein a predetermined number of the laminated iron cores are combined so as to form a cylindrical form and thereafter the laminated iron cores are made integral by welding, bonding or applying an annular member.

By virtue of this construction,

(1) As the iron cores are divided for pole-tooth unit, it becomes possible to wind up the windings perpendicularly around the pole-tooth portion in a high density in alignment (a conductor space factor of 70%) at an outside place for an individual set of the laminated cores, and space-saving in the winding end portions is performed.

(2) As it is possible to obtain the necessary rigidity of the stator by welding, bonding or applying an annular member after a predetermined number of the iron core are combined so as to form a cylindrical form, such resinous part becomes unnecessary and such inter-winding short-circuiting is prevented from occurring. Further, since such joint portions for the pole-teeth portions to construct and maintain the integral iron core are made unnecessary, it is possible to prevent a reduction in motor efficiency by 5 to 10% due to such joint portions.

(3) As the laminated iron core is divided for pole-tooth unit, even a large-sized iron core can be produced with a

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