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(54) ROTATING ELECTRIC MACHINE

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H02K 3/34 (2006.01)
H02K 11/25 (2006.01)

(52) **U.S. Cl.**
CPC ***H02K 3/28*** (2013.01); ***H02K 1/16*** (2013.01); ***H02K 11/25*** (2016.01); ***H02K 3/34*** (2013.01); ***H02K 3/14*** (2013.01)

(57) **ABSTRACT**

Provided is an excellent insulating rotating electric machine having a small axial size and a small number of components. In the rotating electric machine according to the present invention, radially outer-side terminals and radially inner-side terminals extend from slots while a circumferential bending direction is alternately changed for each group of n radially outer-side terminals or n radially inner-side terminals after the extension thereof from the slots. A first angle formed between at least one of an oblique-side portion of each of the n radially inner-side terminals, which are continuous in the circumferential direction of the stator core and are bent in the same circumferential bending direction, and an oblique-side portion of each of the n radially outer-side terminals, which are continuous in the circumferential direction and are bent the same circumferential bending direction, and an end surface of a stator core monotonously decreases in the circumferential bending direction.

100

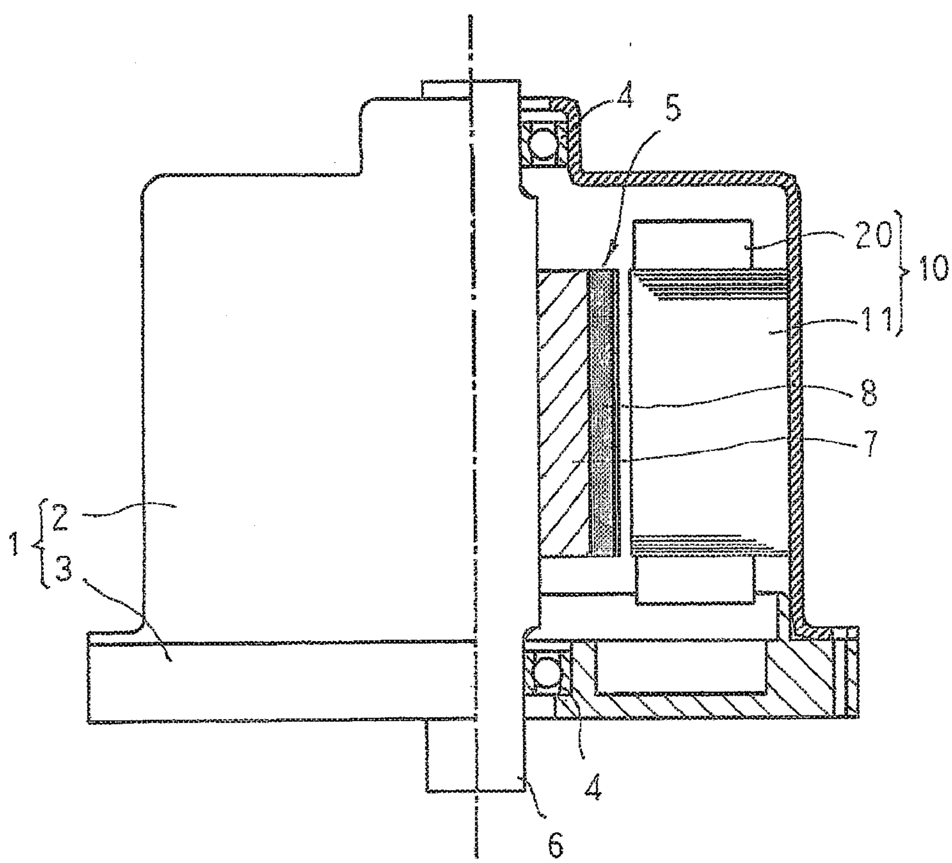


FIG. 1

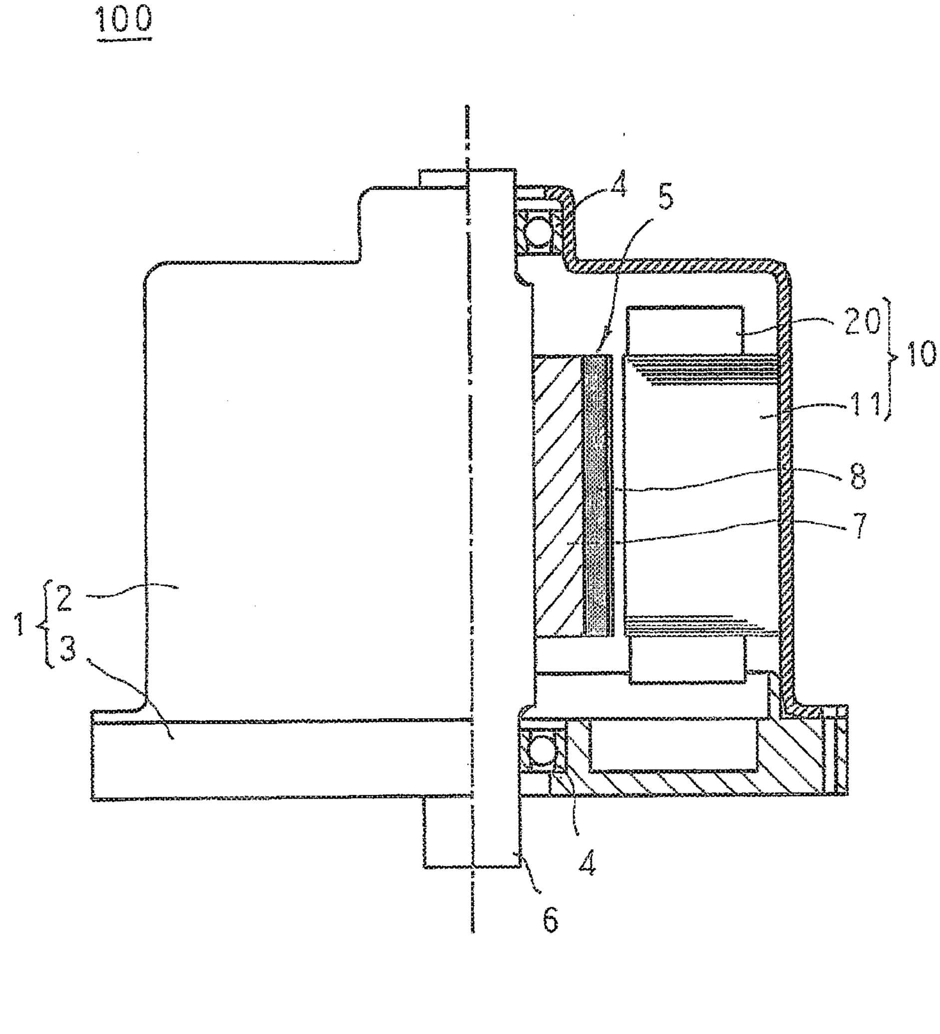


FIG. 2

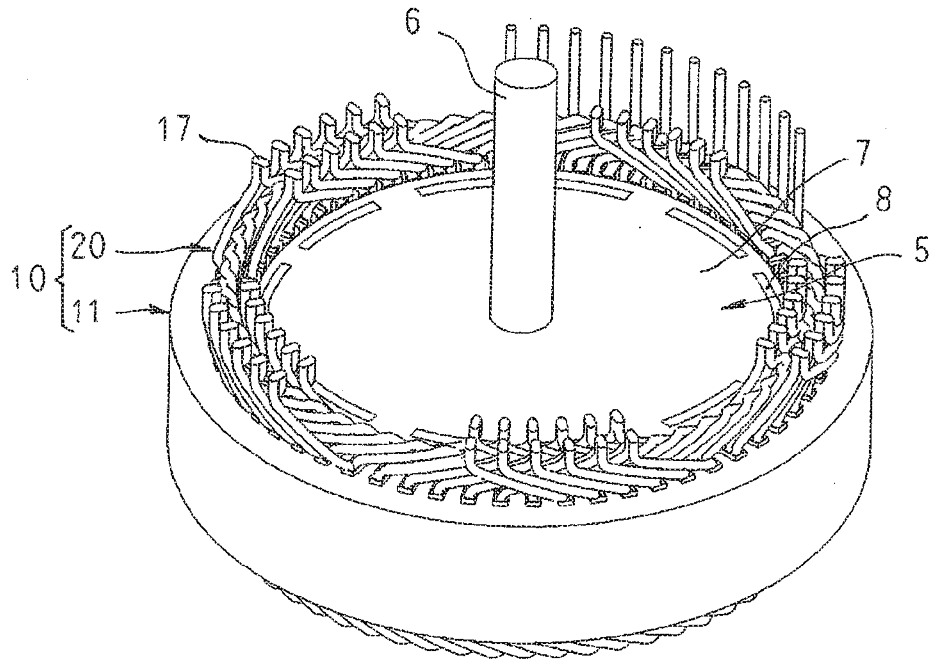


FIG. 3

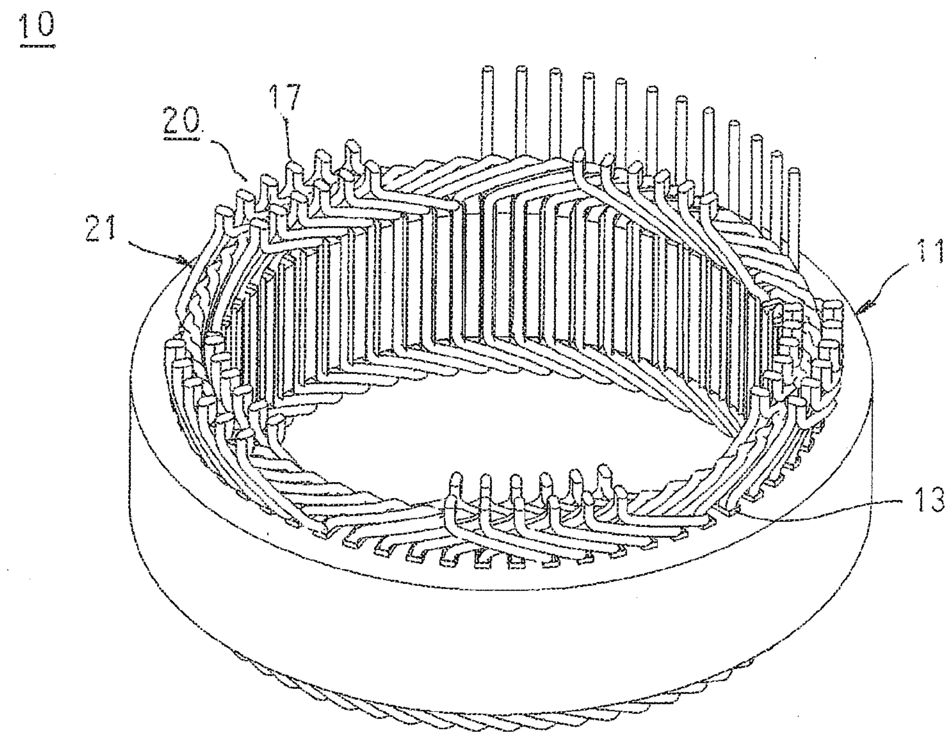


FIG. 4

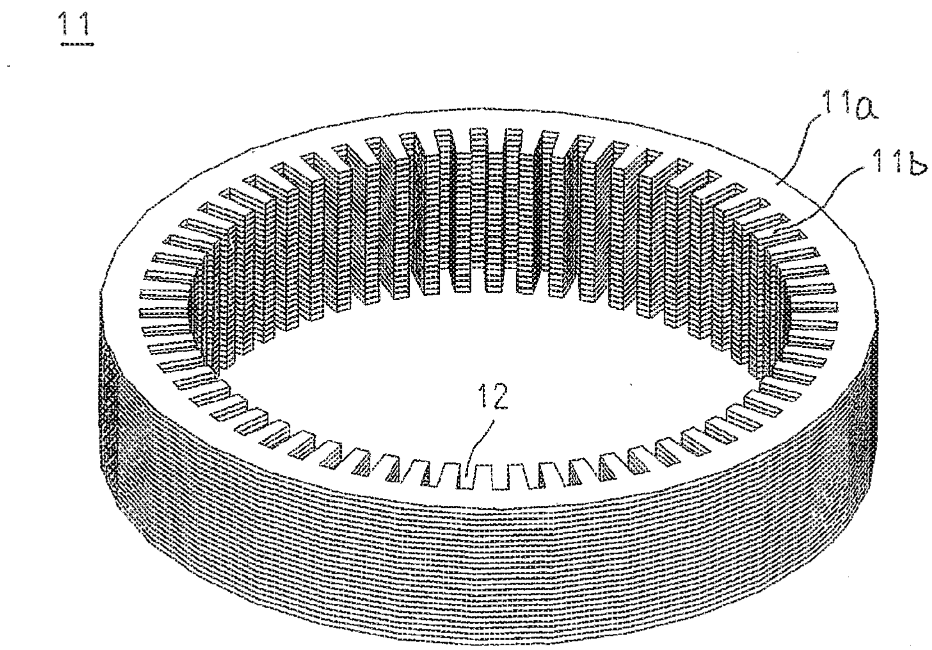


FIG. 5

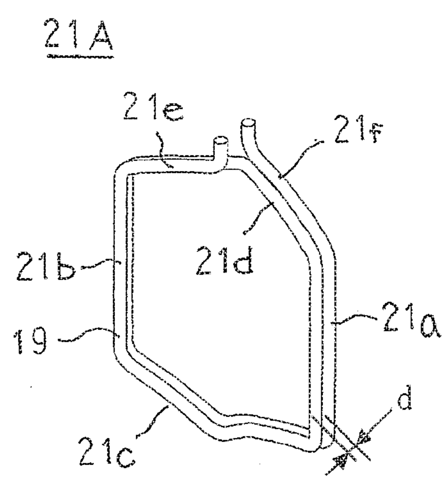


FIG. 6

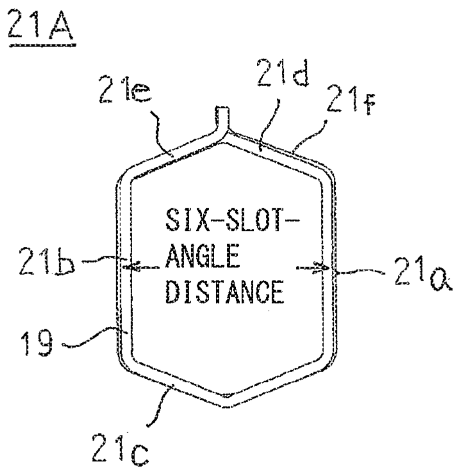

21A
21e
21d
21f
SIX-SLOT-
ANGLE
DISTANCE
21b
21a
19
21c

FIG. 7

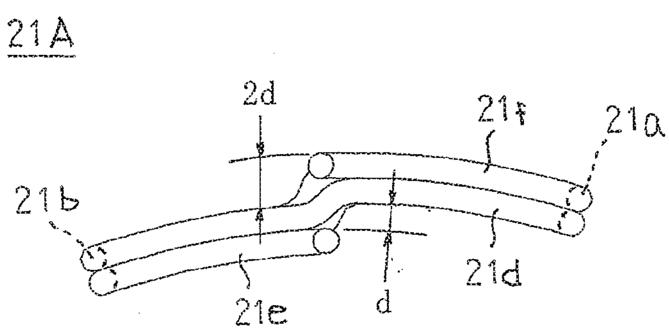

21A
2d
21f
21a
21b
21d
21e
d

FIG. 8

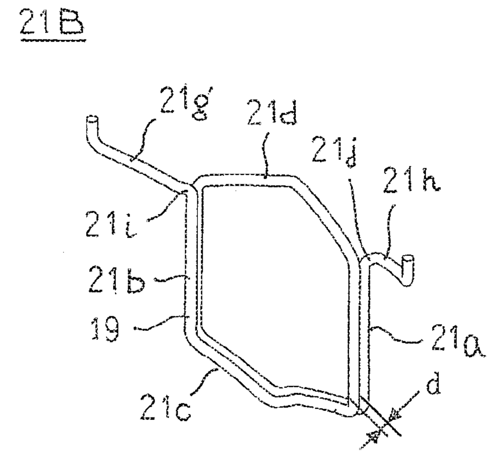

21B
21g
21d
21j
21h
21i
21b
19
21a
21c
d

FIG. 9

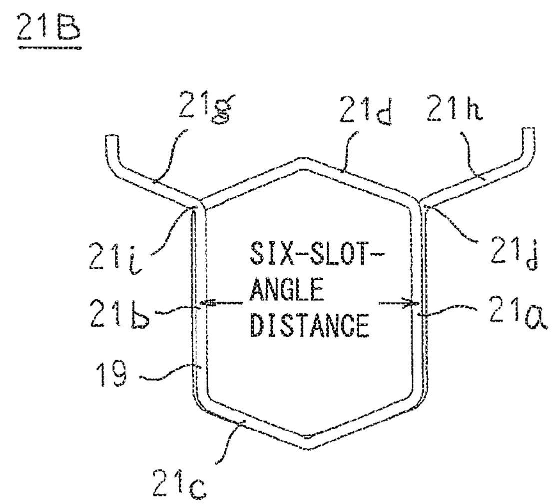

21B
21g
21d
21h
21i
21j
SIX-SLOT-
ANGLE
DISTANCE
21b
21a
19
21c

FIG. 10

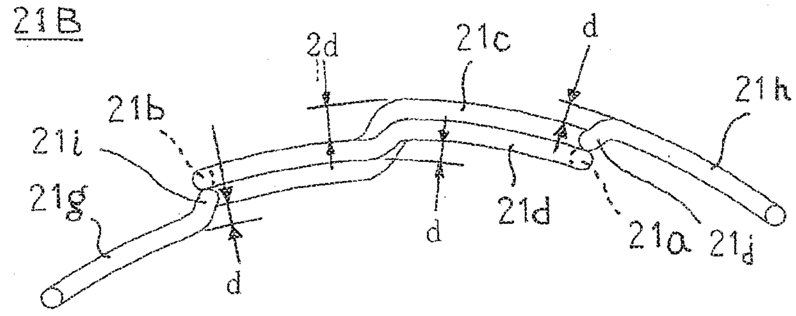


FIG. 11

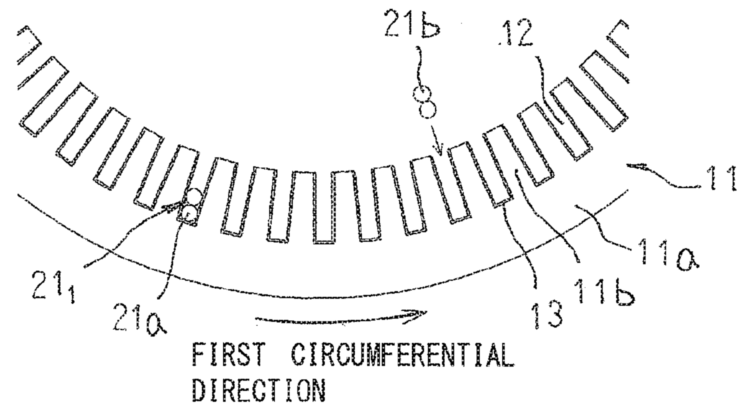


FIG. 12

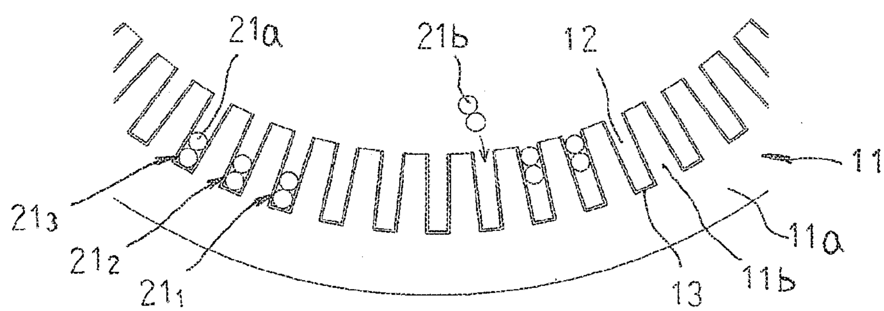


FIG. 13

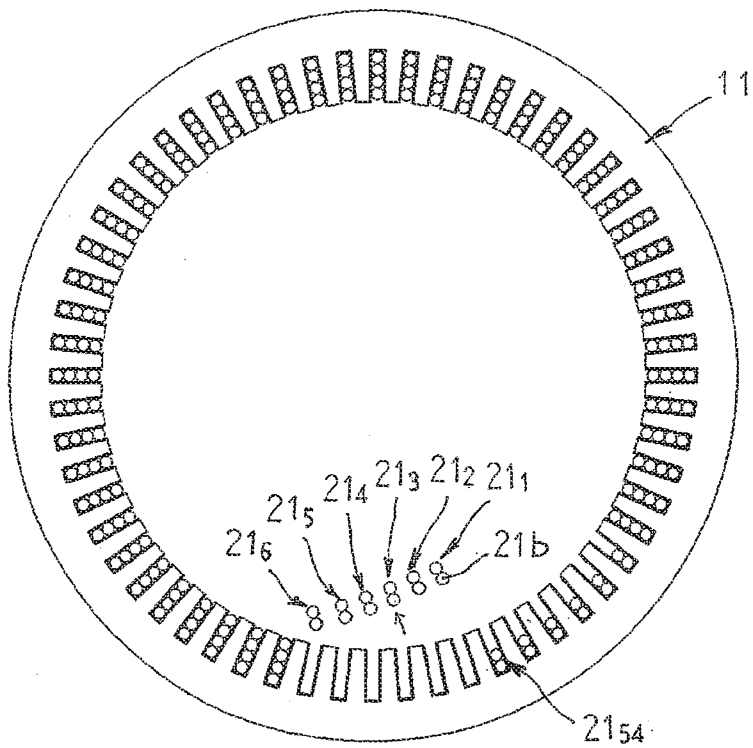


FIG. 14

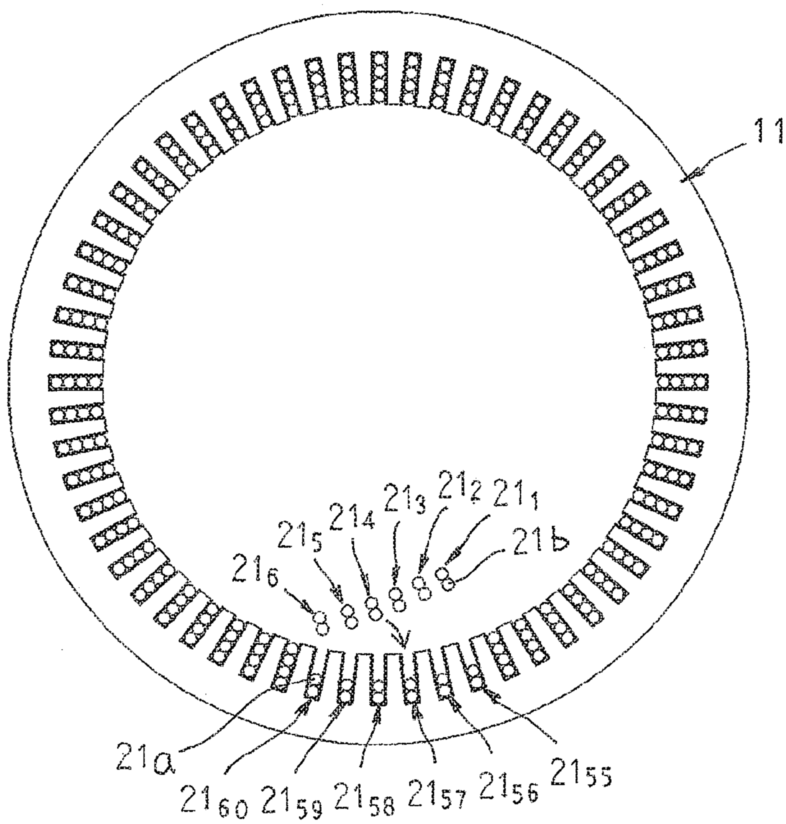

11
21b
21₁
21₂
21₃
21₄
21₅
21₆
21a
21₆₀
21₅₉
21₅₈
21₅₇
21₅₆
21₅₅

FIG. 15

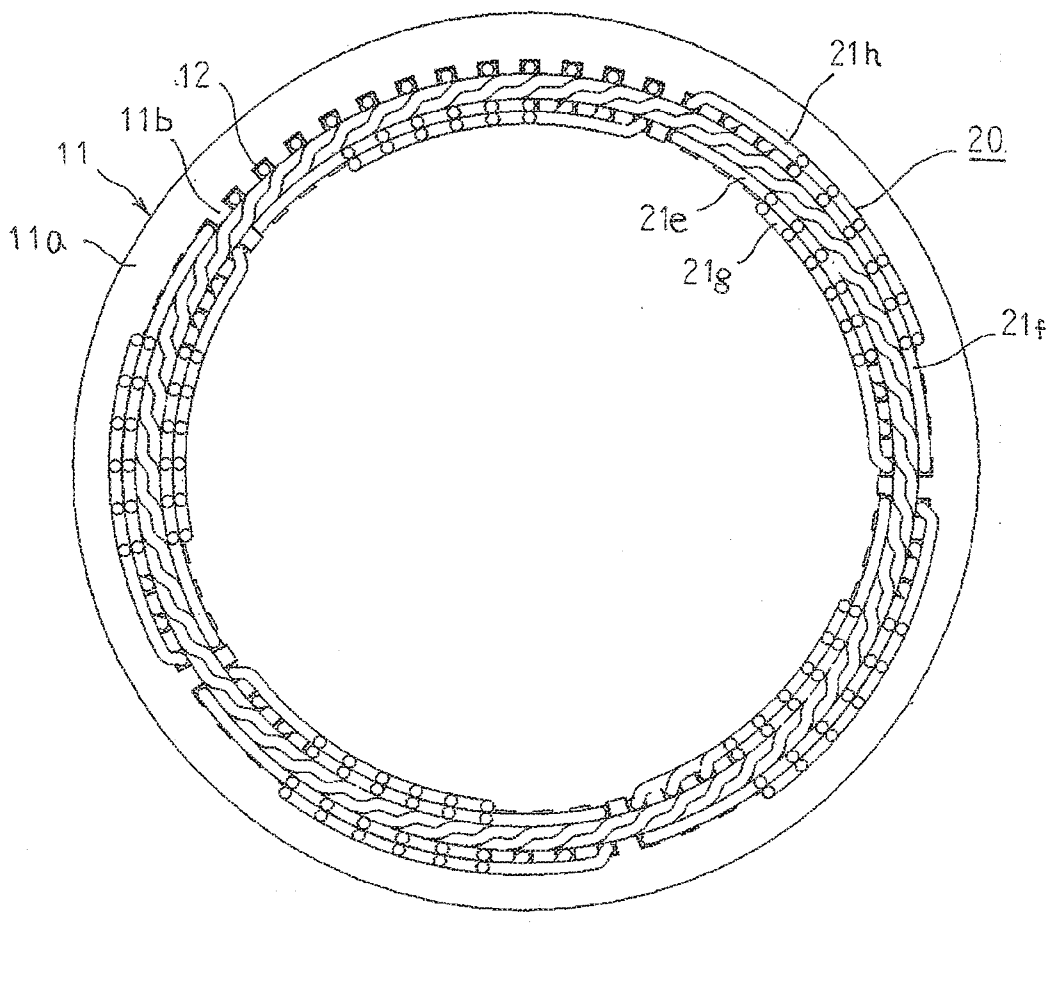


FIG. 16

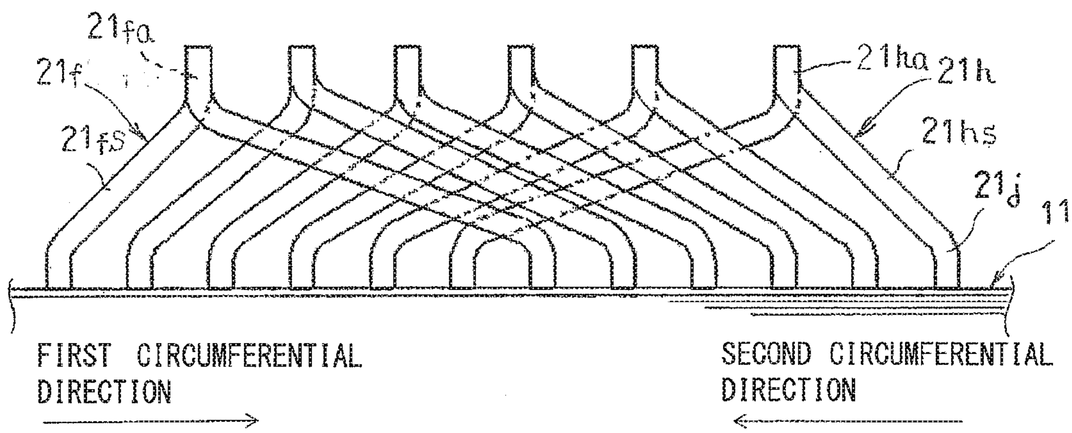

21fa
21f
21fs
21ha
21h
21hs
21j
11
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 17

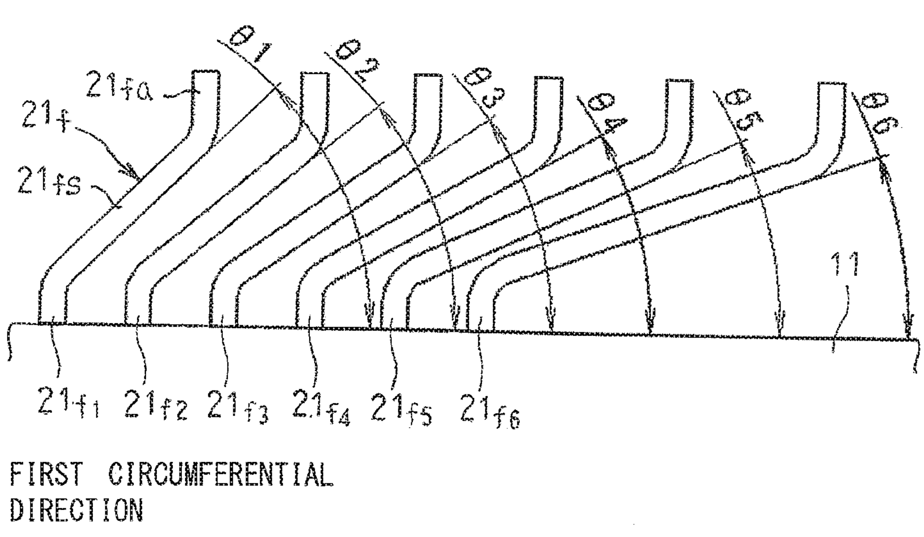

21fa
21f
21fs
θ1
θ2
θ3
θ4
θ5
θ6
11
21f1
21f2
21f3
21f4
21f5
21f6
FIRST CIRCUMFERENTIAL DIRECTION

FIG. 18

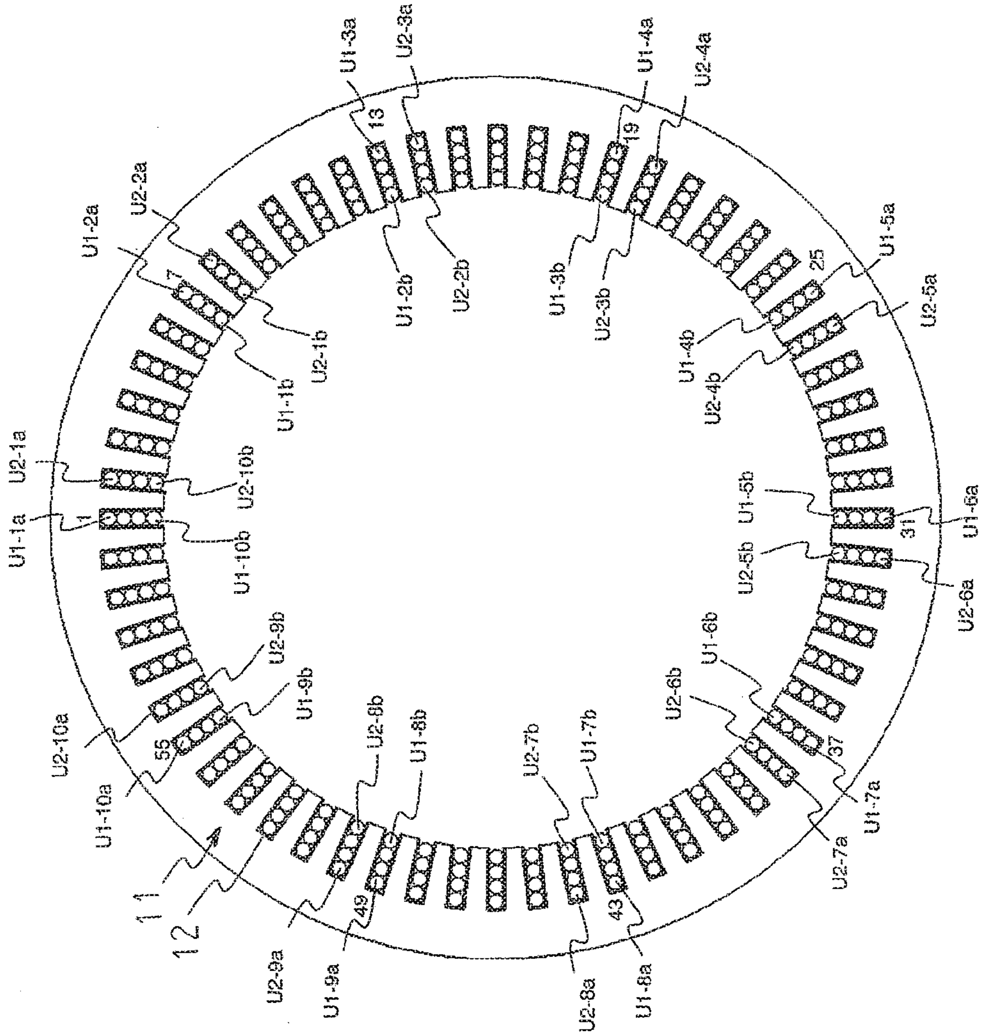

U1-1a
U2-1a
U1-1b
U2-1b
U1-2a
U2-2a
U1-2b
U2-2b
U1-3a
U2-3a
U1-3b
U2-3b
U1-4a
U2-4a
U1-4b
U2-4b
U1-5a
U2-5a
U1-5b
U2-5b
U1-6a
U2-6a
U1-6b
U2-6b
U1-7a
U2-7a
U1-7b
U2-7b
U1-8a
U2-8a
U1-8b
U2-8b
U1-9a
U2-9a
U1-9b
U2-9b
U1-10a
U2-10a
U1-10b
U2-10b
1
7
13
19
25
31
37
43
49
55
11
12

FIG. 19A

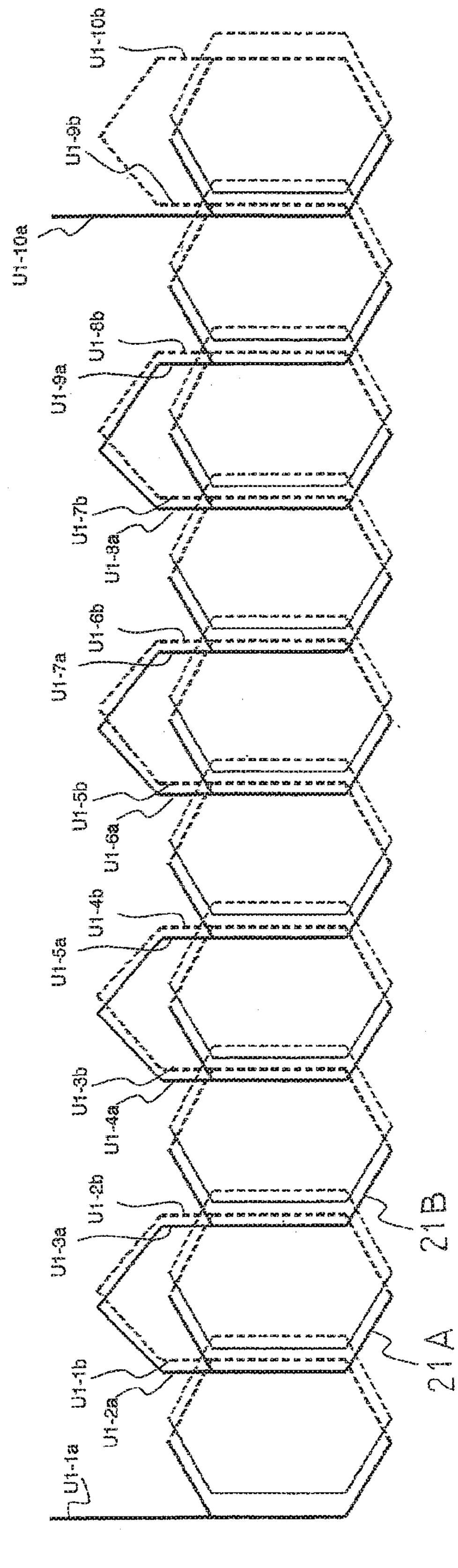
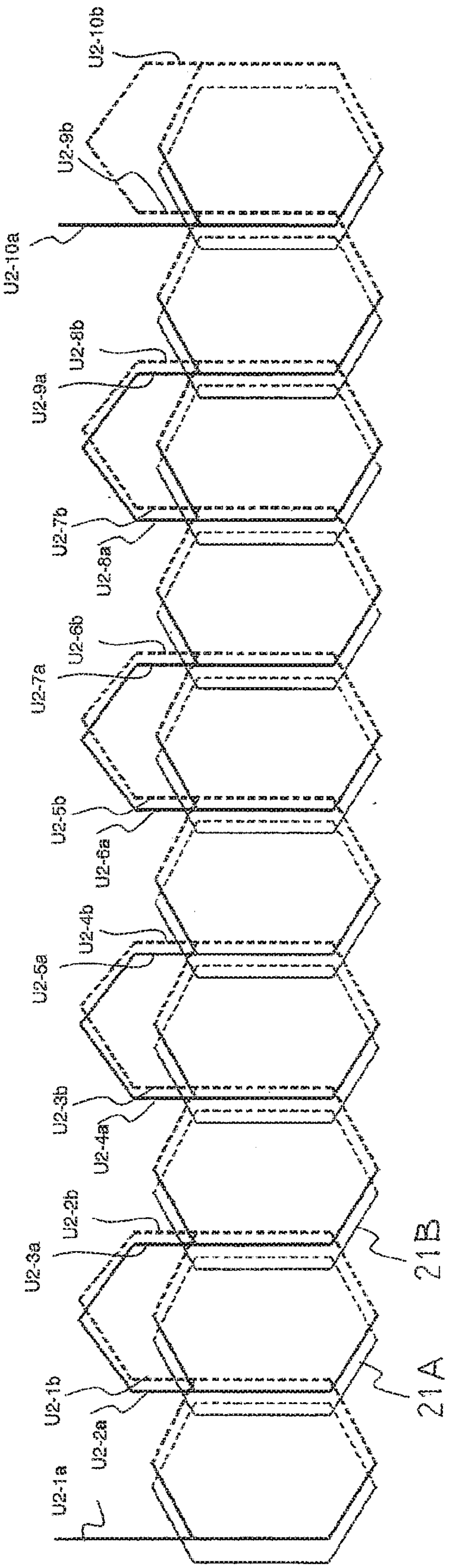

U1-10b
U1-9b
U1-10a
U1-8b
U1-9a
U1-7b
U1-8a
U1-6b
U1-7a
U1-5b
U1-6a
U1-4b
U1-5a
U1-3b
U1-4a
U1-2b
U1-3a
21B
21A
U1-1b
U1-2a
U1-1a

FIG. 19B



U2-1a
U2-2a
U2-1b
U2-3a
U2-2b
U2-4a
U2-3b
U2-5a
U2-4b
U2-6a
U2-5b
U2-7a
U2-6b
U2-8a
U2-7b
U2-9a
U2-8b
U2-10a
U2-9b
U2-10b
21A
21B

FIG. 20

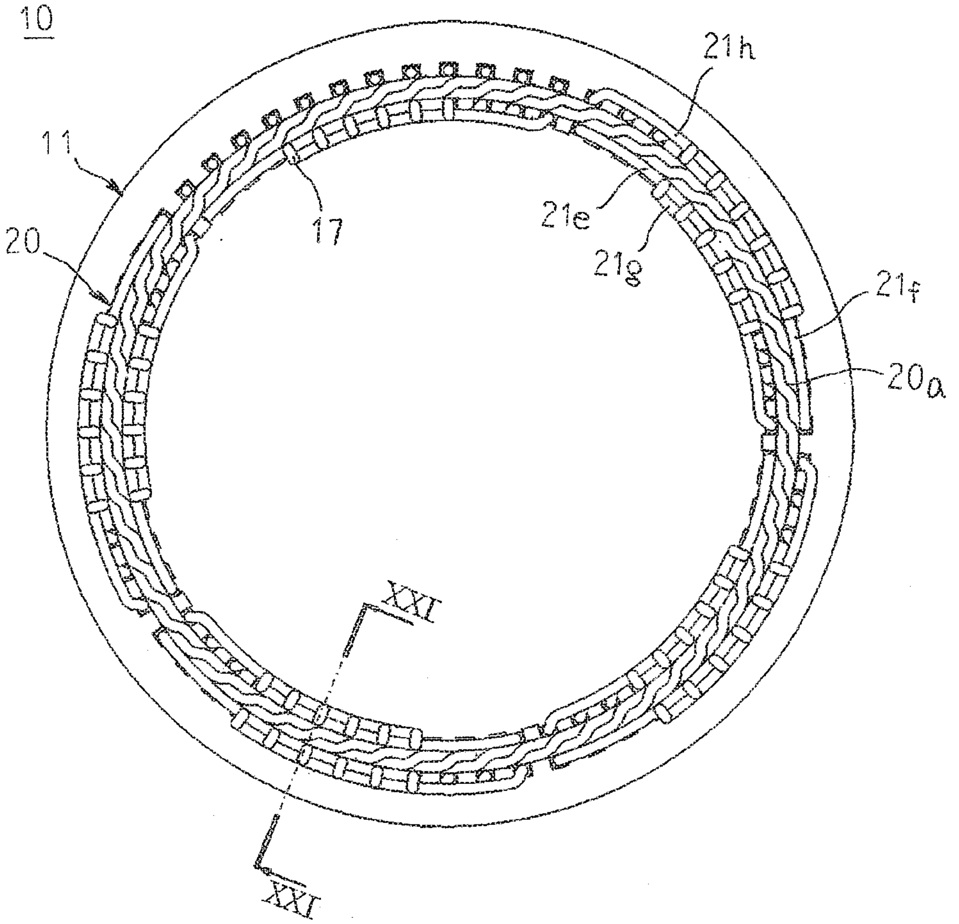

10
11
20
17
21h
21e
21g
21f
20a
XXI
XXI

FIG. 21

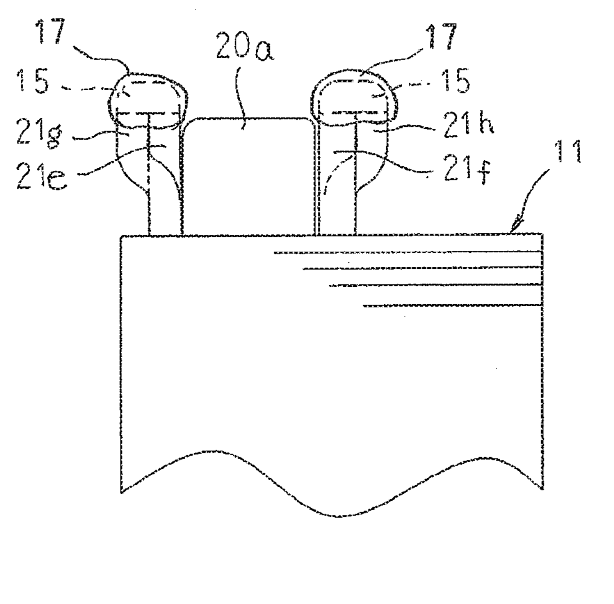

17
15
21g
21e
20a
17
15
21h
21f
11

FIG. 22

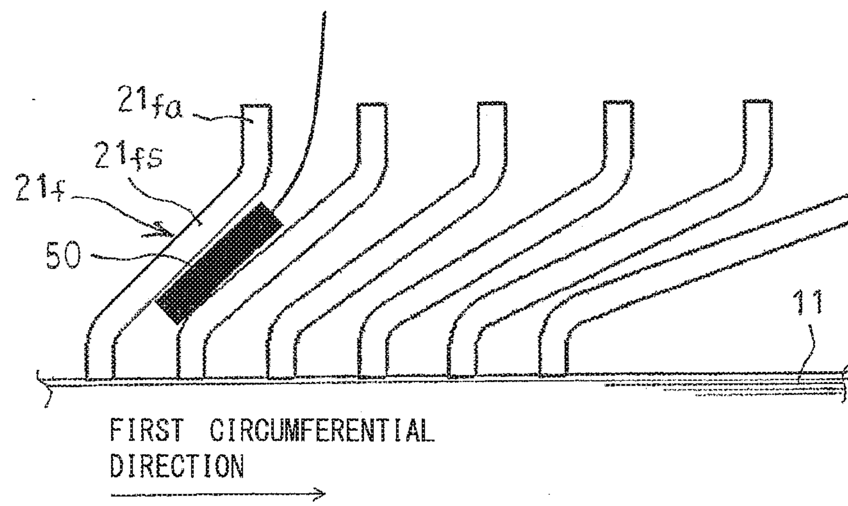

21fa
21fs
21f
50
11
FIRST CIRCUMFERENTIAL DIRECTION

FIG. 23

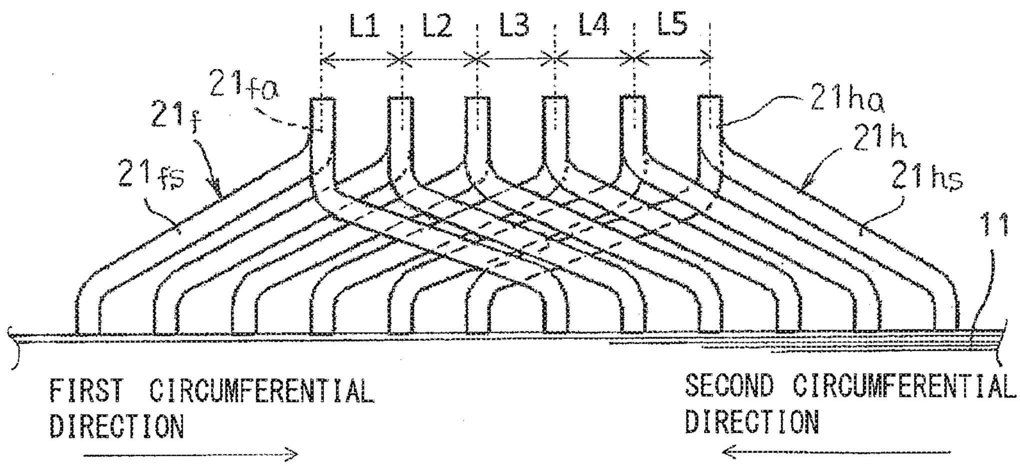

L1
L2
L3
L4
L5
21fa
21f
21fs
21ha
21h
21hs
11
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 24

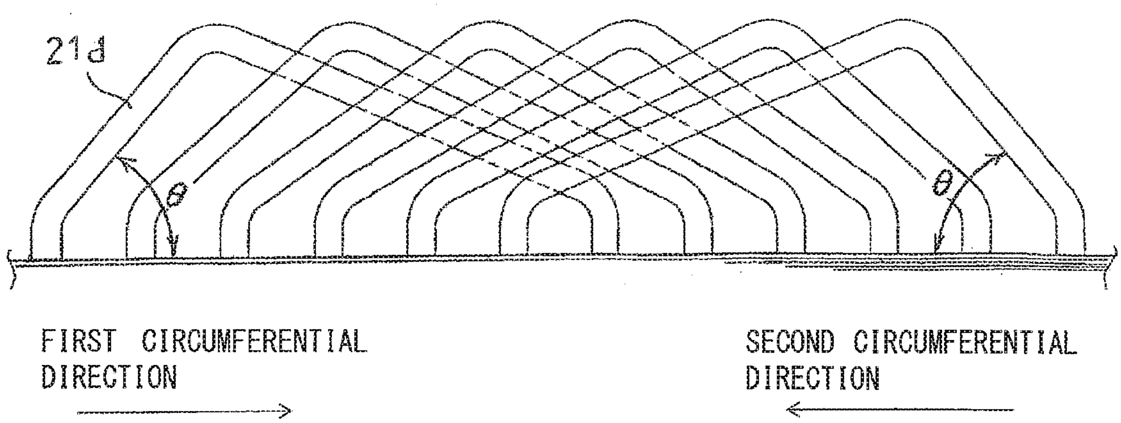

21d
θ
θ
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 25A

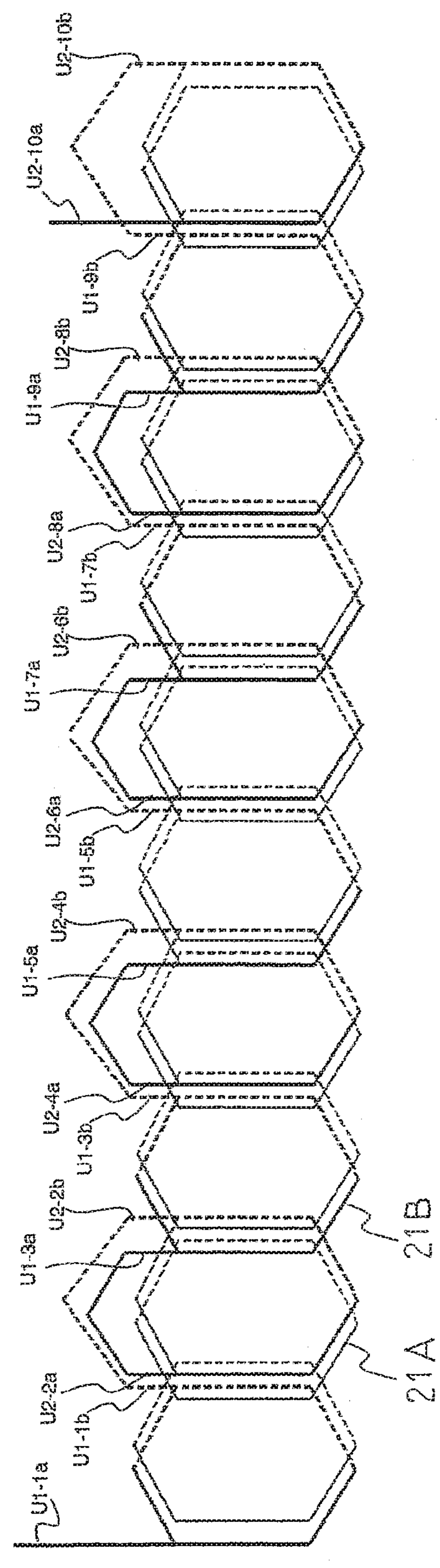

U1-1a
U1-1b
U2-2a
U1-3a
U2-2b
U1-3b
U2-4a
U1-5a
U2-4b
U1-5b
U2-6a
U1-7a
U2-6b
U1-7b
U2-8a
U1-9a
U2-8b
U1-9b
U2-10a
U2-10b
21A
21B

FIG. 25B

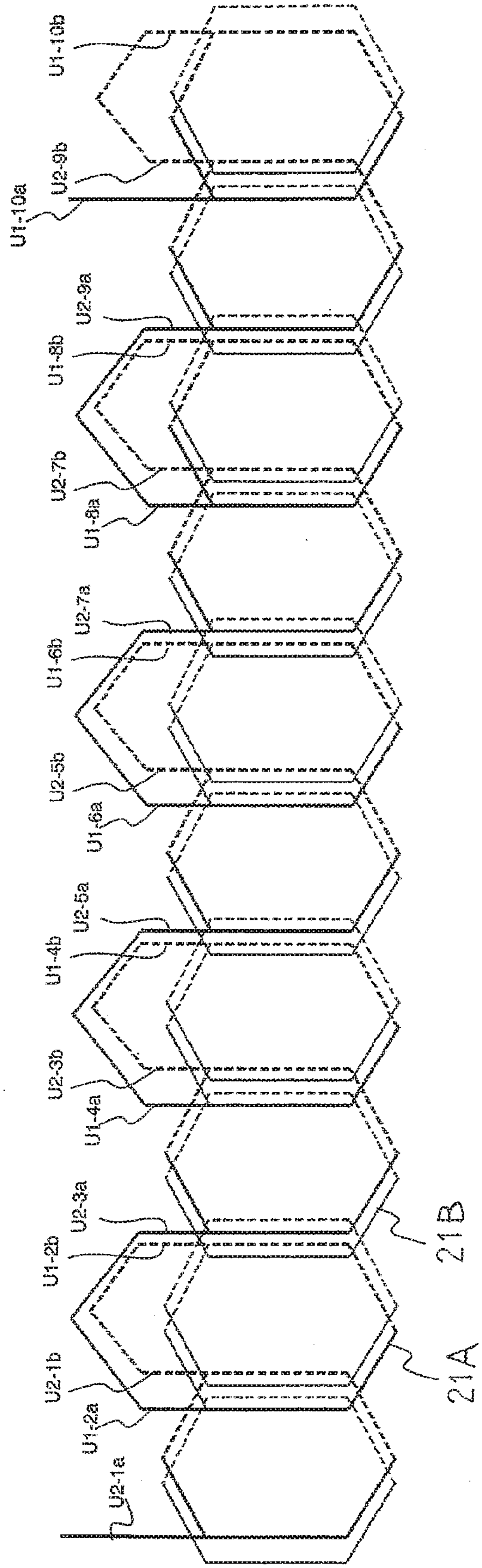

U1-10b
U2-9b
U1-10a
U2-9a
U1-8b
U2-7b
U1-8a
U2-7a
U1-6b
U2-5b
U1-6a
U2-5a
U1-4b
U2-3b
U1-4a
U2-3a
U1-2b
U2-1b
U1-2a
U2-1a
21B
21A

FIG. 26

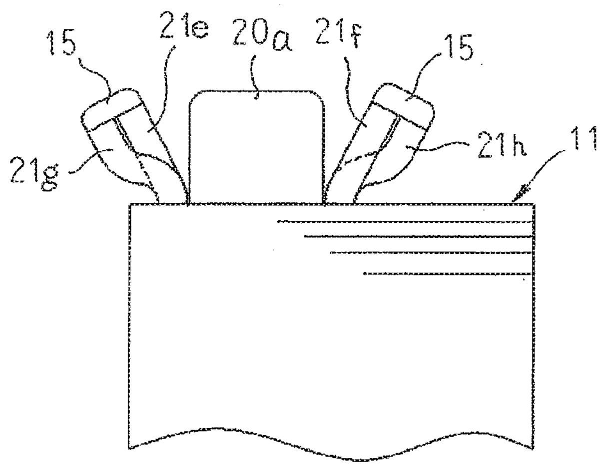


FIG. 27

(a)

(b)

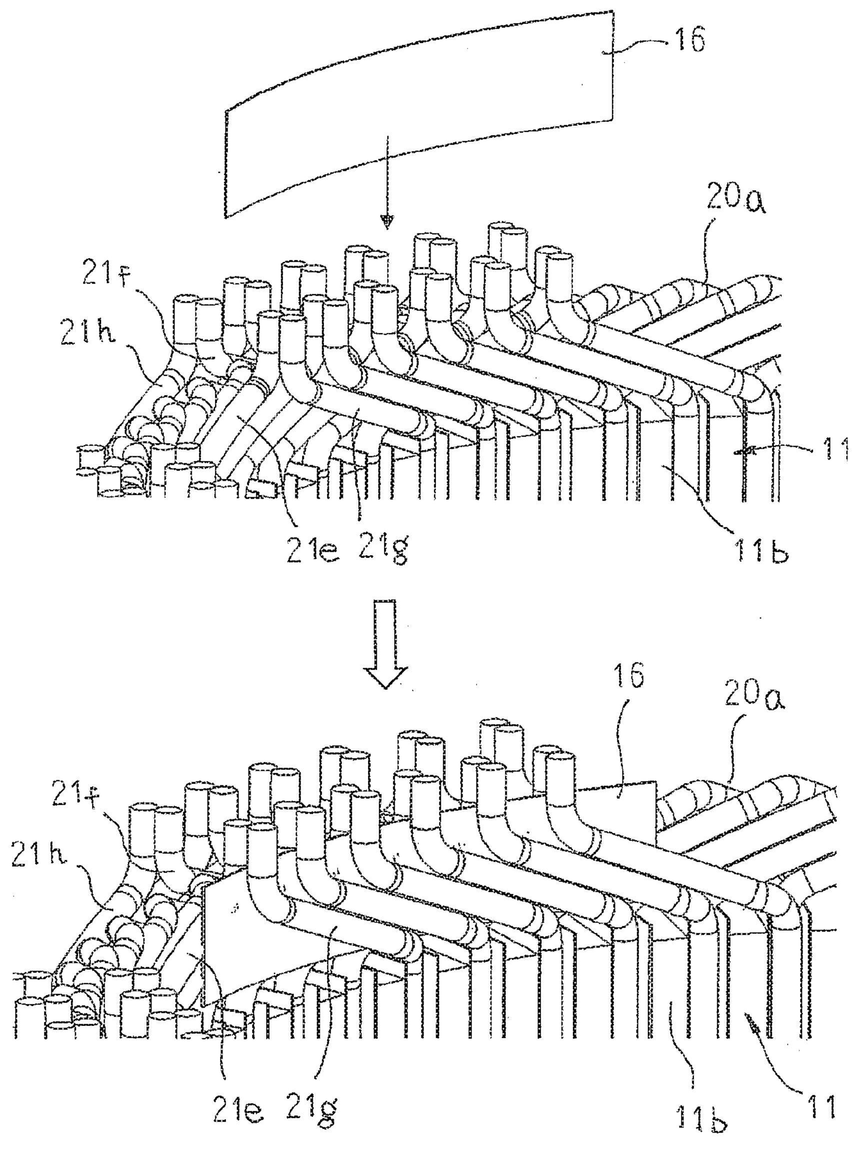


FIG. 28

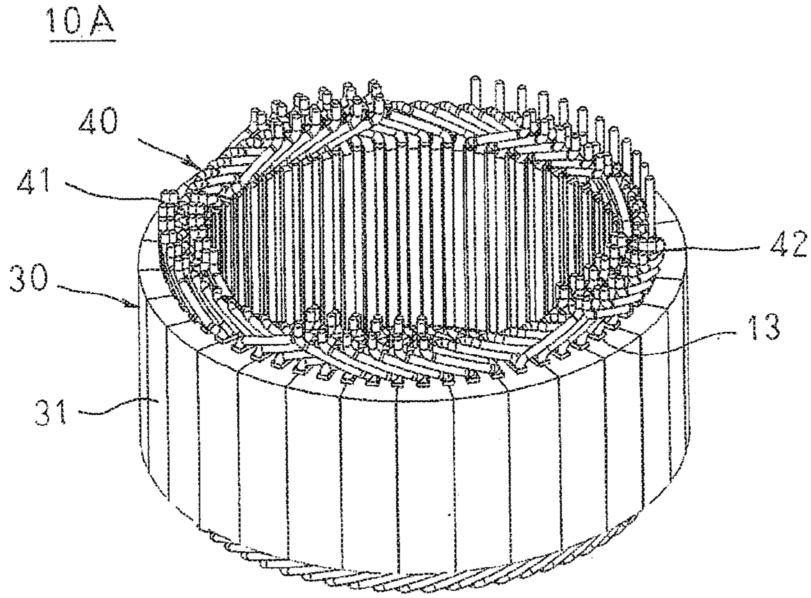


FIG. 29

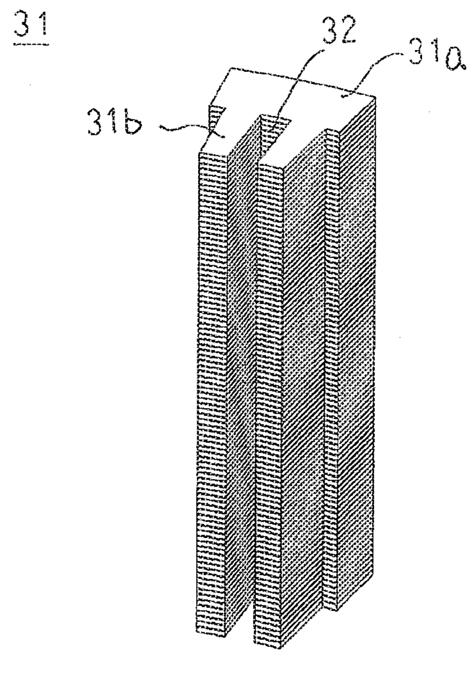


FIG. 30

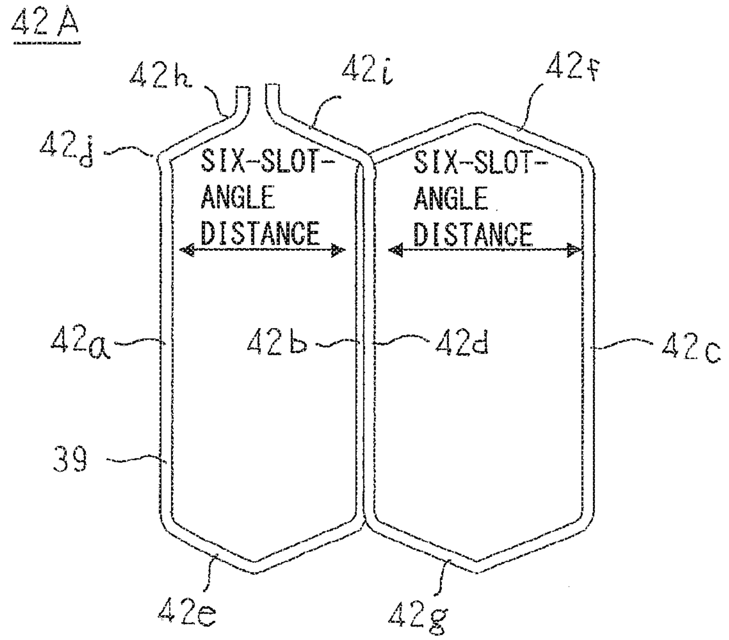

42A
42h
42i
42f
42j
SIX-SLOT-ANGLE DISTANCE
SIX-SLOT-ANGLE DISTANCE
42a
42b
42d
42c
39
42e
42g

FIG. 31

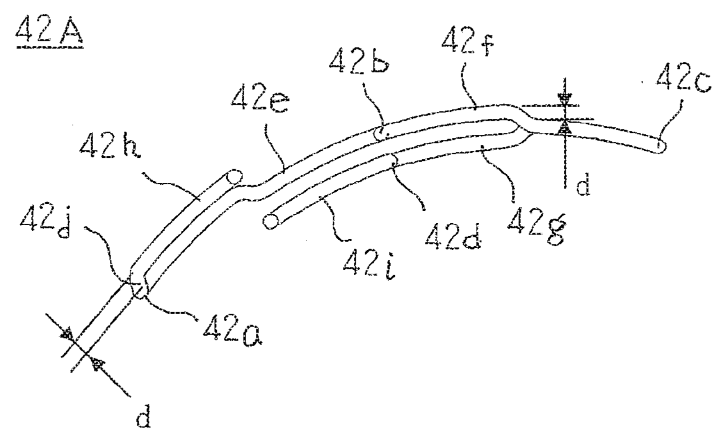

42A
42f
42b
42c
42e
42h
d
42j
42d
42g
42i
42a
d

FIG. 32

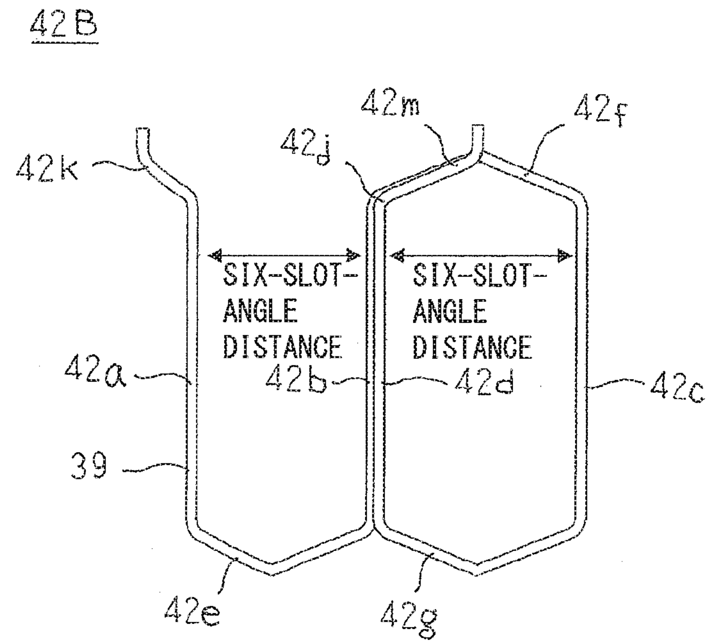

42B
42m
42f
42j
42k
SIX-SLOT-ANGLE DISTANCE
SIX-SLOT-ANGLE DISTANCE
42a
42b
42d
42c
39
42e
42g

FIG. 33

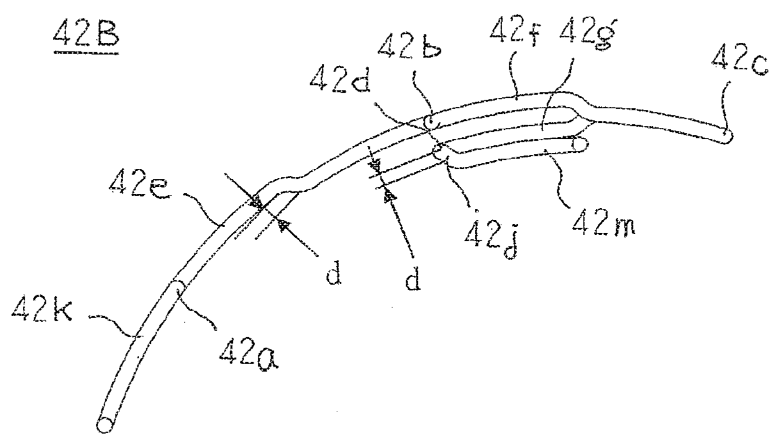

42B
42f
42g
42b
42c
42d
42e
42j
42m
d
d
42k
42a

FIG. 34

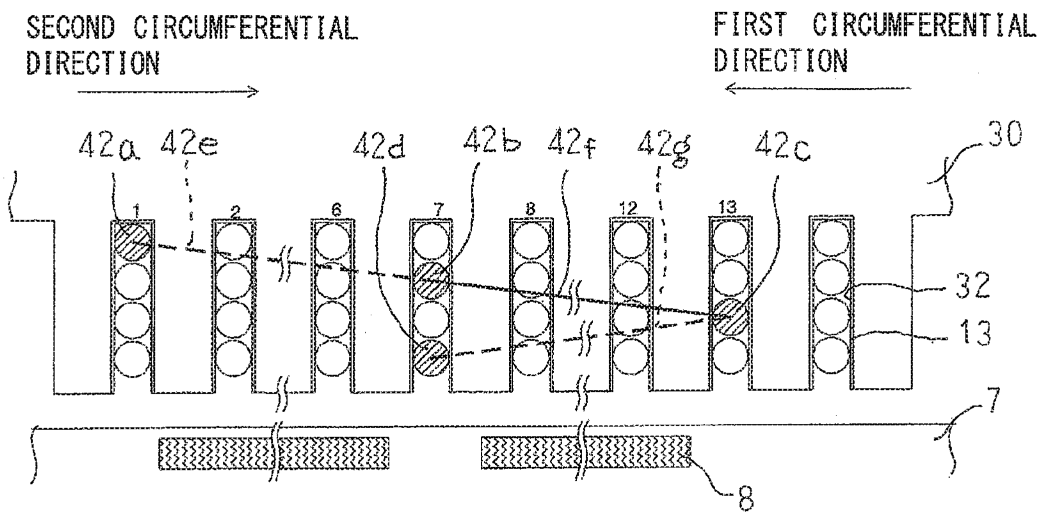

SECOND CIRCUMFERENTIAL DIRECTION
FIRST CIRCUMFERENTIAL DIRECTION
42a
42e
42d
42b
42f
42g
42c
30
1
2
6
7
8
12
13
32
13
7
8

FIG. 35

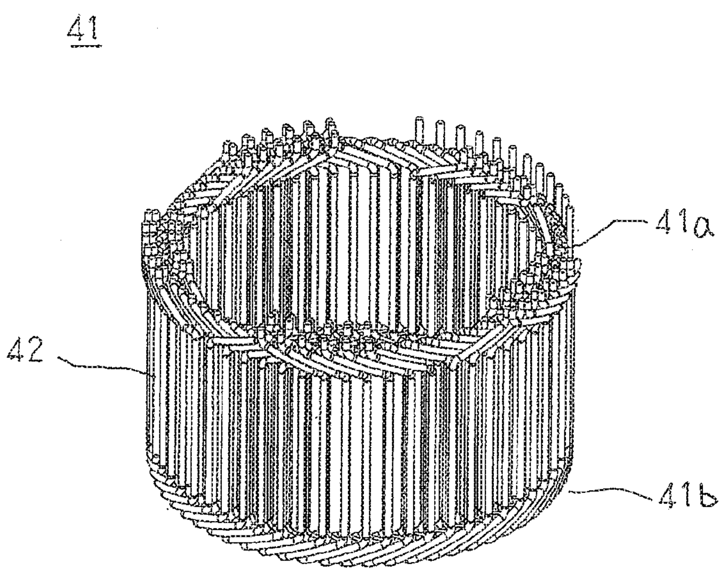

41
41a
42
41b

FIG. 36

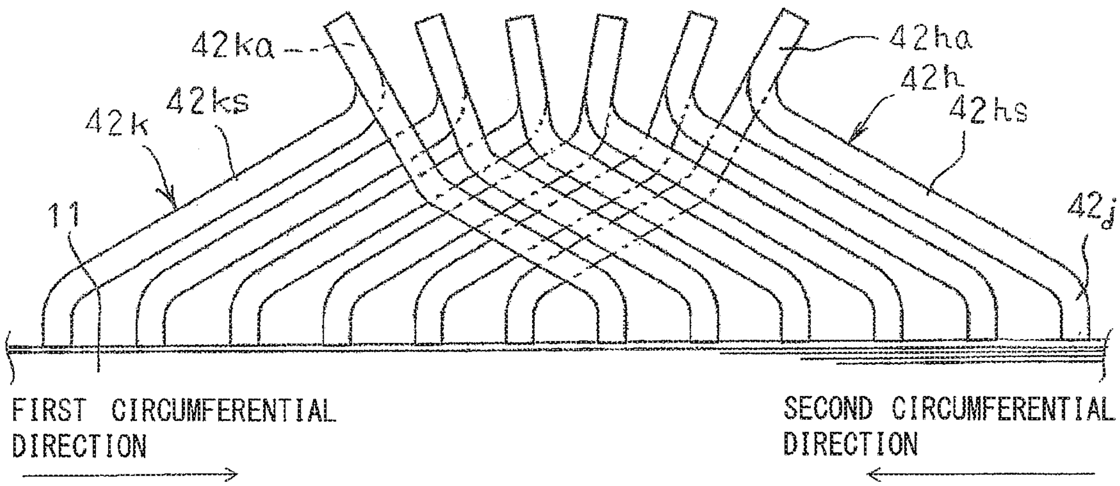

42ka
42ks
42k
11
42ha
42h
42hs
42j
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 37

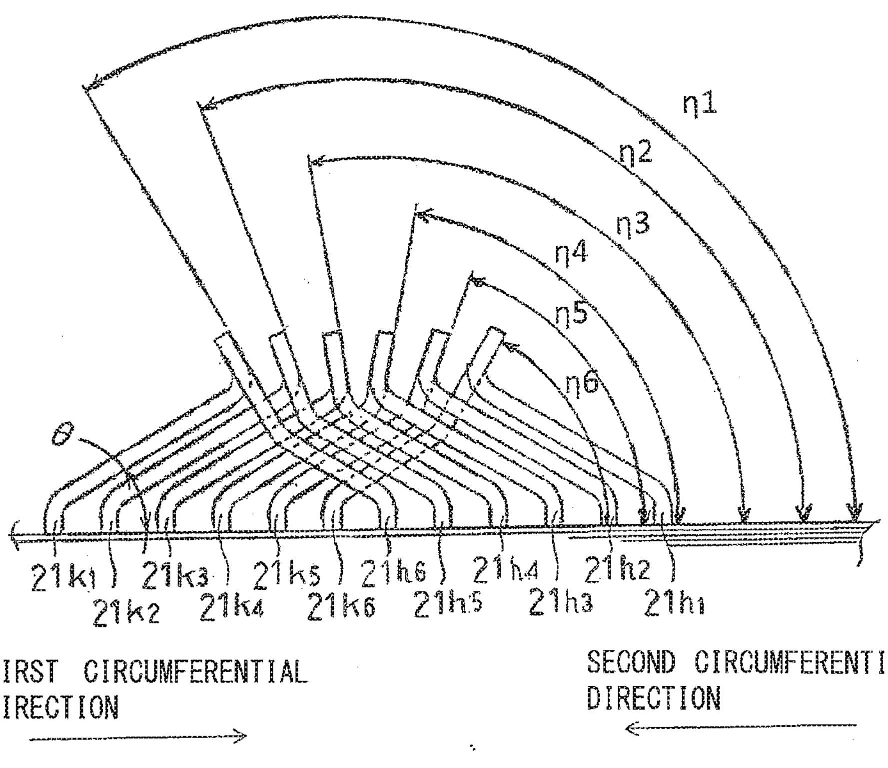

η1
η2
η3
η4
η5
η6
θ
21k1
21k2
21k3
21k4
21k5
21k6
21h6
21h5
21h4
21h3
21h2
21h1
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 38

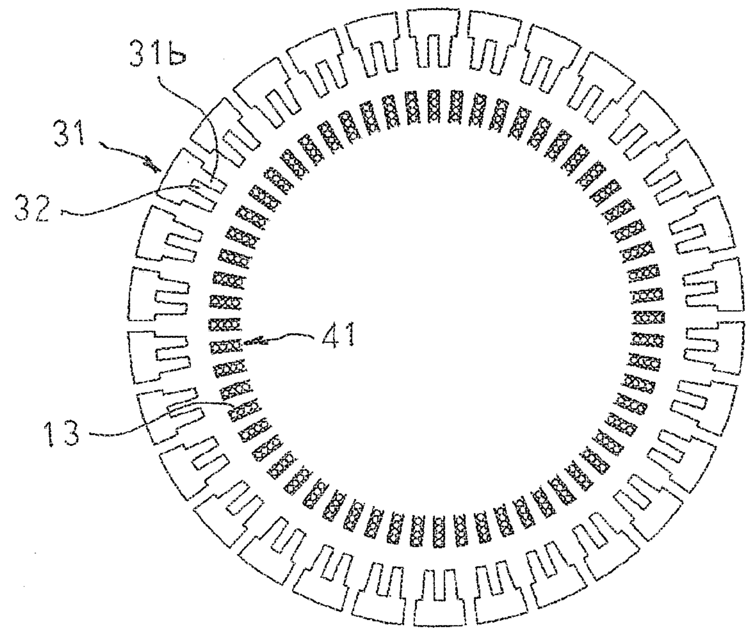


FIG. 39

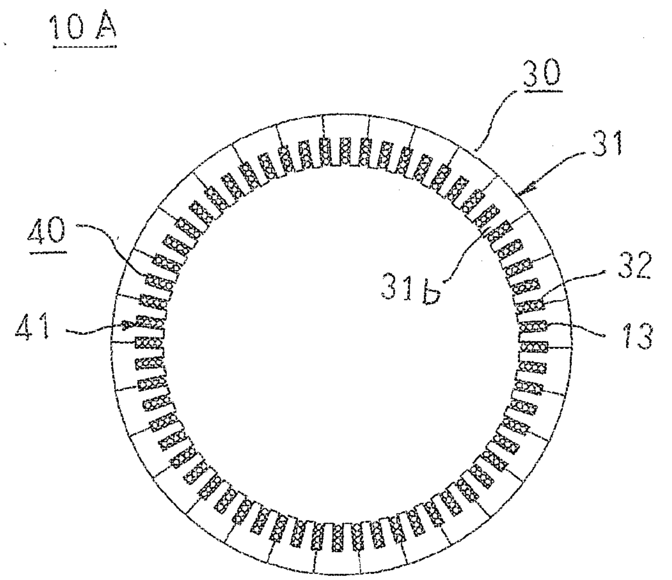


FIG. 40

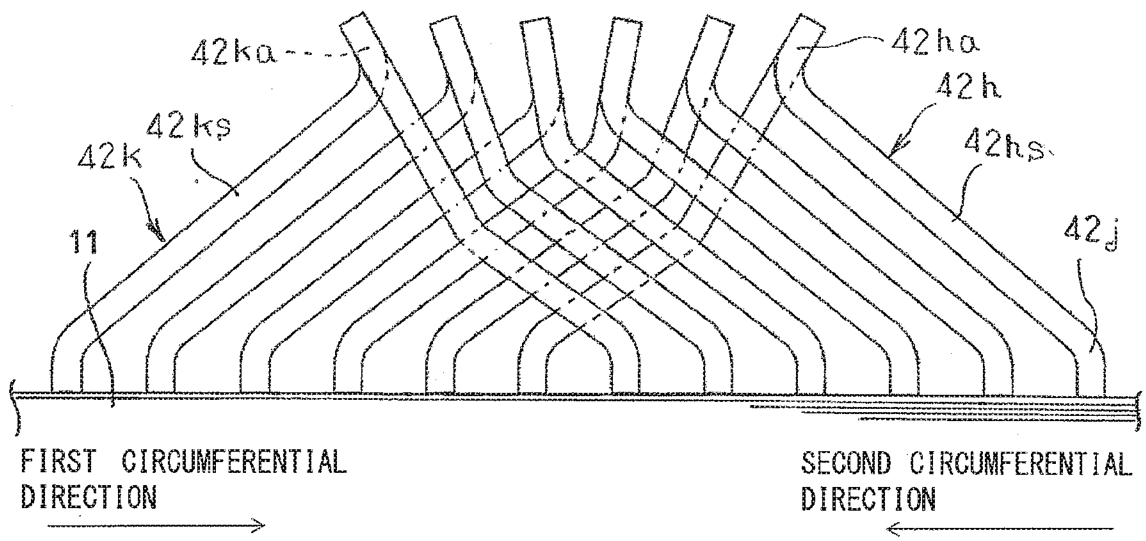
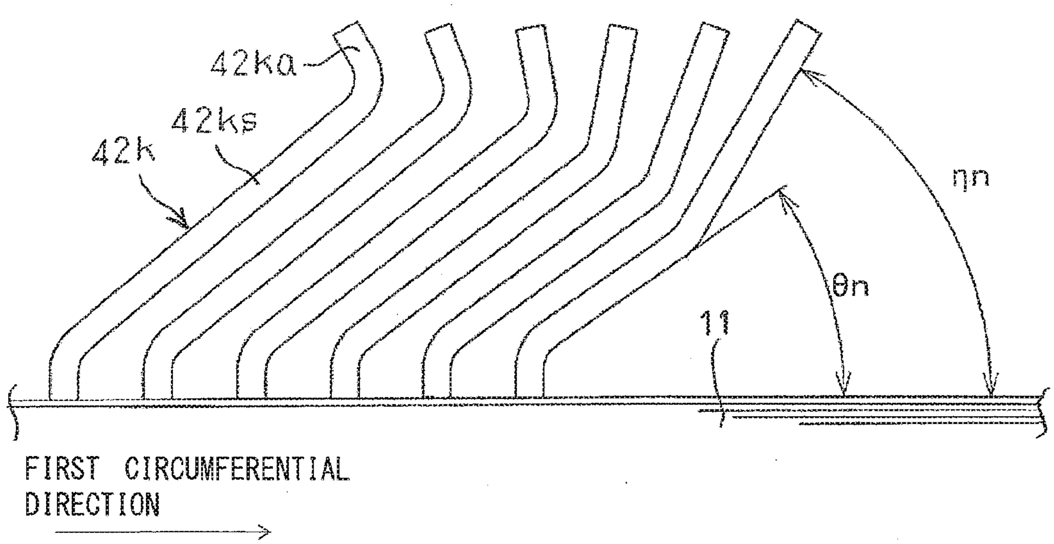

42ka
42ha
42h
42hs
42ks
42k
42j
11
FIRST CIRCUMFERENTIAL DIRECTION
SECOND CIRCUMFERENTIAL DIRECTION

FIG. 41


42ka
42ks
42k
ηn
θn
11
FIRST CIRCUMFERENTIAL DIRECTION

ROTATING ELECTRIC MACHINE

TECHNICAL FIELD

[0001] The present invention relates to a rotating electric machine, for example, an electric motor or a power generator, and more particularly, to a structure of a stator winding.

BACKGROUND ART

[0002] In recent years, for a rotating electric machine such as an electric motor or a power generator, a small size with a high output and high quality are demanded. Further, in order to achieve a higher output, there has been used a stator of a distributed winding type. In the stator of a distributed winding type, thick conductor wires are used to cause a large current to flow through a stator winding, and the conductor wires are arranged in slots.

[0003] However, when the winding of the distributed winding type formed of the thick conductor wires is used, there arise problems in that, as compared to a case in which a winding of a concentrated winding type is used, an axial length of the stator becomes longer, and the number of components increases.

[0004] In view of the circumstances described above, in a related-art rotating electric machine described in Patent Literature 1, a terminal wire extending from a radially innermost position is connected to a terminal wire being a target to be connected, which extends from a radially outermost position, across a coil end. A connected portion thereof is bent so as to be brought closer to the coil end to project radially outward. In this manner, the axial length of the stator is shortened, and the number of components is reduced.

CITATION LIST

Patent Literature

[0005] [PTL 1] JP 2013-150548 A

SUMMARY OF INVENTION

Technical Problem

[0006] In Patent Literature 1, it is difficult to define a sufficient distance between terminal wires adjacent to each other, and hence there arises a problem in that quality in terms of an insulating property is lowered.

[0007] The present invention has been made to solve the problems described above, and has an object to provide a rotating electric machine, which has a small size with a small number of components and high quality in terms of an insulating property.

Solution to Problem

[0008] According to one embodiment of the present invention, there is provided a rotating electric machine, including a stator including: a stator core having an annular shape, which includes slots arranged in a circumferential direction of the stator core; and a stator winding mounted to the stator core. The stator winding includes a plurality of winding bodies formed by distributed winding, each being formed by winding a conductor wire a plurality of turns, which are inserted into a plurality of the slots to be mounted to the stator core. Each of the winding bodies includes a radially inner-side terminal extending from a radially innermost position in a corresponding one of the slots to one axial side of the stator core and a radially outer-side terminal extending from a radially outermost position in a corresponding one of the slots to the one axial side of the stator core. Each of the radially inner-side terminals for forming each of phase windings of the stator winding among the radially inner-side terminals extends from a radially innermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially inner-side terminal from the corresponding slot is changed alternately for each group of n radially inner-side terminals (in which n is a natural number equal to or larger than 2). Each of the radially outer-side terminals for forming each of the phase windings of the stator winding among the radially outer-side terminals extends from a radially outermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially outer-side terminal from the corresponding slot is changed alternately for a group of n radially outer-side terminals. Each of the phase windings is formed by directly joining distal end portions of the radially inner-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other and directly joining distal end portions of the radially outer-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other. A first angle formed between at least one of an oblique-side portion of each of the n radially inner-side terminals, which are continuous in the circumferential direction and are bent in the same circumferential bending direction, and an oblique-side portion of each of the n radially outer-side terminals, which are continuous in the circumferential direction and are bent in the circumferential bending direction, and an end surface of the stator core monotonously decreases in the circumferential bending direction.

Advantageous Effects of Invention

[0009] According to one embodiment of the present invention, the phase winding is formed by directly joining the distal end portions of the radially inner-side terminals, which extend from the slots being separate from each other by the n slots and are bent so as to be brought closer to each other, and directly joining the distal end portions of the radially outer-side terminals respectively extending from the slots being separate from each other by the n slots to be bent so as to be brought closer to each other. In this manner, the radially inner-side terminals and the radially outer-side terminals are not required to be caused to pass on an axially outer side of a coil end group, thereby being capable of reducing an axial dimension of the stator. Further, another component such as a bus bar for connecting the terminals of the winding bodies is not required, thereby being capable of reducing the number of components of the stator.

[0010] Further, the first angle formed between at least one of the oblique-side portion of each of the n radially inner-side terminals, which are continuous in the circumferential direction and are bent in the same circumferential bending direction, and the oblique-side portion of each of the n radially outer-side terminals, which are continuous in the circumferential direction and are bent in the same circumferential bending direction, and the end surface of the stator core monotonously decreases in the circumferential bending direction. Thus, a distance between the oblique-side portions adjacent to each other in the circumferential direction increases, thereby enhancing the insulating property.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. **1** is a half sectional view for illustrating a rotating electric machine according to a first embodiment of the present invention.

[0012] FIG. **2** is a perspective view for illustrating a main part of the rotating electric machine according to the first embodiment of the present invention.

[0013] FIG. **3** is a perspective view for illustrating a stator to be applied to the rotating electric machine according to the first embodiment of the present invention.

[0014] FIG. **4** is a perspective view for illustrating a stator core to be applied to the rotating electric machine according to the first embodiment of the present invention.

[0015] FIG. **5** is a perspective view for illustrating a first winding body for forming a stator winding of the stator to be applied to the rotating electric machine according to the first embodiment of the present invention.

[0016] FIG. **6** is a front view for illustrating the first winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention.

[0017] FIG. **7** is an end view for illustrating the first winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention.

[0018] FIG. **8** is a perspective view for illustrating a second winding body for forming the stator winding of the stator to be applied to the rotating electric machine according to the first embodiment of the present invention.

[0019] FIG. **9** is a front view for illustrating the second winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention.

[0020] FIG. **10** is an end view for illustrating the second winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention.

[0021] FIG. **11** is an end view of a main part, for illustrating a method of mounting the winding body, which is the first one to be mounted, to the stator core in the rotating electric machine according to the first embodiment of the present invention.

[0022] FIG. **12** is an end view of the main part, for illustrating a method of mounting the winding body, which is the third one to be mounted, to the stator core in the rotating electric machine according to the first embodiment of the present invention.

[0023] FIG. **13** is an end view for illustrating a method of mounting last six winding bodies to the stator core in the rotating electric machine according to the first embodiment of the present invention.

[0024] FIG. **14** is an end view for illustrating the method of mounting the last six winding bodies to the stator core in the rotating electric machine according to the first embodiment of the present invention.

[0025] FIG. **15** is an end view for illustrating the stator core to which the winding bodies are mounted in the rotating electric machine according to the first embodiment of the present invention.

[0026] FIG. **16** is a side view of a main part, for illustrating the stator in the rotating electric machine according to the first embodiment of the present invention when viewed from a radially outer side.

[0027] FIG. **17** is a view for illustrating bending shapes of radially outer-side terminals of the stator winding in the rotating electric machine according to the first embodiment of the present invention.

[0028] FIG. **18** is an end view of the stator in the rotating electric machine according to the first embodiment of the present invention when viewed from an axial direction of the stator.

[0029] FIG. **19**A is a view for illustrating wire connection of the stator winding in the rotating electric machine according to the first embodiment of the present invention.

[0030] FIG. **19**B is a view for illustrating wire connection of the stator winding in the rotating electric machine according to the first embodiment of the present invention.

[0031] FIG. **20** is an end view for illustrating the stator in the rotating electric machine according to the first embodiment of the present invention.

[0032] FIG. **21** is a sectional view taken along the line XXI-XXI of FIG. **20** when viewed in the direction indicated by the arrows.

[0033] FIG. **22** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a second embodiment of the present invention when viewed from a radially outer side.

[0034] FIG. **23** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a third embodiment of the present invention when viewed from a radially outer side.

[0035] FIG. **24** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a fourth embodiment of the present invention when viewed from a radially outer side.

[0036] FIG. **25**A is a view for illustrating wire connection of a stator winding in a rotating electric machine according to a fifth embodiment of the present invention.

[0037] FIG. **25**B is a view for illustrating wire connection of the stator winding in the rotating electric machine according to the fifth embodiment of the present invention.

[0038] FIG. **26** is a sectional view of a main part, for illustrating a periphery of a coil end group of a stator in a rotating electric machine according to a sixth embodiment of the present invention.

[0039] FIG. **27** is a view for illustrating a phase-to-phase insulation method for a stator winding in a rotating electric machine according to a seventh embodiment of the present invention.

[0040] FIG. **28** is a perspective view for illustrating a stator to be applied to a rotating electric machine according to an eighth embodiment of the present invention.

[0041] FIG. **29** is a perspective view for illustrating a core block for forming a stator core to be applied to the rotating electric machine according to the eighth embodiment of the present invention.

[0042] FIG. **30** is a front view for illustrating a first winding body for forming a stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0043] FIG. **31** is a plan view for illustrating the first winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0044] FIG. **32** is a front view for illustrating a second winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0045] FIG. **33** is a plan view for illustrating the second winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0046] FIG. **34** is a sectional view of a main part, for schematically illustrating a state in which winding bodies are accommodated in slots in the rotating electric machine according to the eighth embodiment of the present invention.

[0047] FIG. **35** is a perspective view for illustrating a winding assembly for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0048] FIG. **36** is a side view of a main part, for illustrating the stator in the rotating electric machine according to the eighth embodiment of the present invention when viewed from a radially outer side.

[0049] FIG. **37** is a view for illustrating bending shapes of radially outer-side terminals of the stator winding in the rotating electric machine according to the eighth embodiment of the present invention.

[0050] FIG. **38** is a view for illustrating a method of assembling the stator in the rotating electric machine according to the eighth embodiment of the present invention.

[0051] FIG. **39** is a view for illustrating the method of assembling the stator in the rotating electric machine according to the eighth embodiment of the present invention.

[0052] FIG. **40** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a ninth embodiment of the present invention when viewed from a radially outer side.

[0053] FIG. **41** is a view for illustrating bending shapes of radially outer-side terminals of a stator winding in the rotating electric machine according to the ninth embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0054] Now, with reference to the drawings, a rotating electric machine according to exemplary embodiments of the present invention is described.

First Embodiment

[0055] FIG. **1** is a half sectional view for illustrating a rotating electric machine according to a first embodiment of the present invention. FIG. **2** is a perspective view for illustrating a main part of the rotating electric machine according to the first embodiment of the present invention. FIG. **3** is a perspective view for illustrating a stator to be applied to the rotating electric machine according to the first embodiment of the present invention. FIG. **4** is a perspective view for illustrating a stator core to be applied to the rotating electric machine according to the first embodiment of the present invention. FIG. **5** is a perspective view for illustrating a first winding body for forming a stator winding of the stator to be applied to the rotating electric machine according to the first embodiment of the present invention. FIG. **6** is a front view for illustrating the first winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention. FIG. **7** is an end view for illustrating the first winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention. FIG. **8** is a perspective view for illustrating a second winding body for forming the stator winding of the stator to be applied to the rotating electric machine according to the first embodiment of the present invention. FIG. **9** is a front view for illustrating the second winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention. FIG. **10** is an end view for illustrating the second winding body for forming the stator winding of the stator in the rotating electric machine according to the first embodiment of the present invention.

[0056] In FIG. **1** and FIG. **2**, a rotating electric machine **100** includes a housing **1**, a stator **10**, and a rotor **5**. The housing **1** includes a frame **2** and an end plate **3**. The frame **2** has a bottomed cylindrical shape. The end plate **3** is configured to close an opening of the frame **2**. The stator **10** is firmly fixed to a cylindrical portion of the frame **2** in an internally fitted state. The rotor **5** is firmly fixed to a rotary shaft **6** rotatably supported in a bottom of the frame **2** and the end plate **3** through intermediation of bearings **4**, and is rotatably disposed on an inner peripheral side of the stator **10**.

[0057] The rotor **5** is a permanent magnet rotor including a rotor core **7** and permanent magnets **8**. The rotor core **7** is firmly fixed to the rotary shaft **6** inserted therethrough at an axial center position. The permanent magnets **8** are embedded in the stator core **7** on an outer peripheral surface side of the stator core **7** and are arranged at equal pitches in a circumferential direction of the rotor **5** to form magnetic poles. The rotor **5** is not limited to the permanent magnet rotor, and may be a squirrel-cage rotor in which an uninsulated rotor conductor is accommodated in slots of the rotor core and both sides thereof are short-circuited with use of a short-circuit ring or a winding rotor in which an insulated conductor wire is mounted to the slots of the rotor core.

[0058] Next, a configuration of the stator **10** is specifically described with reference to FIG. **3** to FIG. **10**.

[0059] The stator **10** includes, as illustrated in FIG. **3**, a stator core **11**, a stator winding **20**, and slot cells **13**. The stator winding **20** is mounted to the stator core **11**. The slot cells **13** are mounted to slots **12** of the stator core **11**. The stator winding **20** is formed by connecting a plurality of winding bodies **21** mounted to the stator core **11**. Each of the slot cells **13** is formed by bending, for example, a rectangular sheet formed of a polyimide film sandwiched between meta-aramid fibers into a U shape. The slot cells **13** are inserted into the slots **12** to electrically separate the stator core **11** and the stator winding **20** from each other.

[0060] For convenience of the description, a pole number p of the rotor **5** is set to 10, a slot number S of the stator core **11** is set to 60, and the stator winding **20** is set to a three-phase winding. Specifically, the slots **12** are formed in the stator core **11** in a proportion of two slots per phase for each pole. In FIG. **3**, for clear illustration of a wire connection state of radially inner-side terminals and radially outer-side terminals, the radially inner-side terminals and the radially outer-side terminals are illustrated in an exaggerated manner as projecting axially outward from a coil end group. However, in reality, as illustrated in FIG. **20**, the radially inner-side terminals and the radially outer-side terminals have an axial height equal to that of the coil end group.

[0061] The stator core **11** is formed by, as illustrated in FIG. **4**, laminating and integrating thin electromagnetic steel sheets. The stator core **11** includes a core back **11***a* having an annular shape and a plurality of teeth **11***b*. The plurality of teeth **11***b* are arranged in a circumferential direction of the stator **10** so as to project radially inward from an inner peripheral wall surface of the core back **11***a*. Spaces surrounded by the core back **11***a* and the teeth **11***b* correspond to the slots **12**. Each of the teeth **11***b* is formed into a tapered shape having a circumferential width gradually decreasing toward a radially inner side. A cross section of each of the slots **12**, which is orthogonal to an axial center of the stator core **11**, has a rectangular shape.

[0062] The winding bodies **21** for forming the stator core **20** include first winding bodies **21**A and second winding bodies **21***b*. The first winding body **21**A and the second winding body **21**B have different directions in which terminals extend. Each of the first winding body **21**A and the second winding body **21**B is a hexagonal coil formed by helically winding a conductor wire **19** having a circular cross section with a diameter d two turns into an approximately hexagonal shape. The conductor wire **19** is formed of, for example, a copper wire or an aluminum wire, which is continuous without a connecting portion and is insulation-coated with an enamel resin. Specifically, each of the first winding body **21**A and the second winding body **21**B is a winding body formed by distributed winding and lap winding. Each of the winding bodies **21** may be formed of a conductor wire having a rectangular cross section in place of the conductor wire **19** having the circular cross section.

[0063] The first winding body **21**A includes, as illustrated in FIG. **5** to FIG. **7**, a first straight portion **21***a*, a second straight portion **21***b*, a first coil end **21***c*, a second coil end **21***d*, a radially inner-side terminal **21***e*, and a radially outer-side terminal **21***f*. The first straight portion **21***a* and the second straight portion **21***b* are arranged in two rows so as to be separate from each other by a six-slot-angle distance. In each of the row of the first straight portion **21***a* and the row of the second straight portion **21***b*, two conductor wires are arranged so as to be held in contact with each other in a radial direction. The first coil end **21***c* couples one longitudinal end of the first straight portion **21***a* and one longitudinal end of the second straight portion **21***b* to each other, and the second coil end **21***d* couples another longitudinal end of the first straight portion **21***a* and another longitudinal end of the second straight portion **21***b* to each other between the rows of the first straight portion **21***a* and the second straight portion **21***b* so as to alternate the rows. The "six-slot-angle distance" is a distance between slot centers of the slots **12** located on both sides of continuous six teeth **11***b* and corresponds to one magnetic-pole pitch. The "radial direction" corresponds to a radial direction of the stator core **11**.

[0064] The first coil end **21***c* extends outward in a length direction of the first straight portion **21***a* and the second straight portion **21***b* from one end of the first straight portion **21***a* in one of the rows toward the second straight portion **21***b* in another one of the rows, is bent at the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to be displaced radially inward by 2d, and is then bent to extend inward in the length direction of the first straight portion **21***a* and the second straight portion **21***b* toward the second straight portion **21***b* in the another one of the rows to be connected to one end of the second straight portion **21***b* in the another one of the rows.

[0065] Similarly, the second coil end **21***d* extends outward in a length direction of the first straight portion **21***a* and the second straight portion **21***b* from another end of the second straight portion **21***b* in another one of the rows toward the first straight portion **21***a* in another one of the rows, is bent at the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to be displaced radially outward by d, and is then bent to extend inward in the length direction of the first straight portion **21***a* and the second straight portion **21***b* toward the first straight portion **21***a* in one of the rows to be connected to another end of the first straight portion **21***a* in one of the rows.

[0066] The radially inner-side terminal **21***e* extends from the another end of the second straight portion **21***b*, which is located on the radially inner side, toward the first straight portion **21***a* in the one row so as to be approximately parallel to the second coil end **21***d*, is bent at the approximate center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to extend outward in the length direction of the first straight portion **21***a* and the second straight portion **21***b*. The radially-outer terminal **21***f* extends from the another end of the first straight portion **21***a*, which is located on the radially outer side, toward the second straight portion **21***b* in the another one of the rows so as to be approximately parallel to the second coil end **21***d* and is bent at the approximate center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to extend outward in the length direction of the first straight portion **21***a* and the second straight portion **21***b*.

[0067] The first winding body **21***a* having the configuration described above is accommodated in a first layer and a second layer from the radially outer side in one slot **12**, and the second straight portion **21***b* is accommodated in a third layer and a fourth layer from the radially outer side in the slot **12**, which is separate from the one slot **12** by the six-slot-angle distance. The radially outer-side terminal **21***f* extends to a vicinity of top of the second coil end **21***d* while maintaining the same radial position as that of the first straight portion **21***a* accommodated in the first layer from the radially outer side in the one slot **12**. The radially inner-side terminal **21***e* extends to the vicinity of the top of the second coil end **21***d* while maintaining the same radial position as that of the second straight portion **21***b* accommodated in the fourth layer from the radially outer side in the slot **12**, which is separate from the one slot **12** by the six-slot-angle distance.

[0068] The second winding body **21**B includes, as illustrated in FIG. **8** to FIG. **10**, a first straight portion **21***a*, a second straight portion **21***b*, a first coil end **21***c*, a second coil end **21***d*, a radially inner-side terminal **21**g, and a radially outer-side terminal **21***h*. The first straight portion **21***a* and the second straight portion **21***b* are arranged in two rows so as to be separate from each other by a six-slot-angle distance. In each of the row of the first straight portion **21***a* and the row of the second straight portion **21***b*, two conductor wires are arranged so as to be held in contact with each other in a radial direction. The first coil end **21***c* couples one longitudinal end of the first straight portion **21***a* and one longitudinal end of the second straight portion **21***b* to each other, and the second coil end **21***d* couples another longitudinal end of the first straight portion **21***a* and another longitudinal end of the second straight portion **21***b* to each other between the rows of the first straight portion **21***a* and the second straight portion **21***b* so as to alternate the rows.

[0069] The first coil end **21***c* extends outward in a length direction of the first straight portion **21***a* and the second straight portion **21***b* from one end of the first straight portion **21***a* in one of the rows toward the second straight portion **21***b* in another one of the rows, is bent at the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to be displaced radially inward by 2d, and is then bent to extend inward in the length direction of the first straight portion **21***a* and the second straight portion **21***b* toward the second straight portion **21***b* in the another one of the rows to be connected to one end of the second straight portion **21***b* in the another one of the rows.

[0070] Similarly, the second coil end **21***d* extends outward in a length direction of the first straight portion **21***a* and the second straight portion **21***b* from another end of the second straight portion **21***b* in another one of the rows toward the first straight portion **21***a* in one of the rows, is bent at the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b* to be displaced radially outward by d, and is then bent to extend inward in the length direction of the first straight portion **21***a* and the second straight portion **21***b* toward the first straight portion **21***a* in the one of the rows to be connected to another end of the first straight portion **21***a* in the one of the rows.

[0071] After the radially inner-side terminal **21***g* is bent at a displacement portion **21***i* extending from the another end of the second straight portion **21***b* located on the radially inner side to be displaced radially inward by d, the radially inner-side terminal **21***g* extends approximately in parallel to a portion of the second coil end **21***d*, which extends from the another end of the first straight portion **21***a* to the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b*. After that, the radially inner-side terminal **21***g* is bent to extend outward in the length direction of the first straight portion **21***a* and the second straight portion **21***b*. After the radially outer-side terminal **21***h* is bent at a displacement portion **21***j* extending from the another end of the first straight portion **21***a* located on the radially outer side to be displaced radially outward by d, the radially outer-side terminal **21***h* extends approximately in parallel to a portion of the second coil end **21***d*, which extends from the another end of the second straight portion **21***b* to the center between the row of the first straight portion **21***a* and the row of the second straight portion **21***b*. After that, the radially outer-side terminal **21***h* is bent to extend outward in the length direction of the first straight portion **21***a* and the second straight portion **21***b*.

[0072] In the second winding body **21**B having the configuration described above, the first straight portion **21***a* is accommodated in a first layer and a second layer from the radially outer side in one slot **12**, and the second straight portion **21***b* is accommodated in a third layer and a fourth layer from the radially outer side in the slot **12**, which is separate from the one slot **12** by the six-slot-angle distance. After the radially outer-side terminal **21***h* is displaced radially outward by d at the displacement portion **21***j* with respect to the first straight portion **21***a* accommodated in the first layer from the radially outer side in the one slot **12**, the radially outer-side terminal **21***h* extends outward in a circumferential direction of the second winding body **21**B. After the radially inner-side terminal **21***g* is displaced radially inward by d at the displacement portion **21***i* with respect to the second straight portion **21***b* accommodated in the fourth layer from the radially outer side in the slot **12**, which is separate from the one slot by the six-slot angle distance, the radially inner-side terminal **21***g* extends outward in the circumferential direction of the second winding body **21**B.

[0073] Next, a method of mounting the first winding bodies **21**A and the second winding bodies **21**B to the stator core **11** is described with reference to FIG. **11** to FIG. **15**. FIG. **11** is an end view of a main part, for illustrating a method of mounting the winding body, which is the first one to be mounted, to the stator core in the rotating electric machine according to the first embodiment of the present invention. FIG. **12** is an end view of a main part, for illustrating a method of mounting the winding body, which is the third one to be mounted, to the stator core in the rotating electric machine according to the first embodiment of the present invention. FIG. **13** is an end view for illustrating a method of mounting last six mounting bodies to the stator core in the rotating electric machine according to the first embodiment of the present invention. FIG. **14** is an end view for illustrating the method of mounting the last six winding bodies to the stator core in the rotating electric machine according to the first embodiment of the present invention. FIG. **15** is an end view for illustrating the stator core to which the winding bodies are mounted in the rotating electric machine according to the first embodiment of the present invention. FIG. **16** is a side view of a main part, for illustrating the stator in the rotating electric machine according to the first embodiment of the present invention when viewed from the radially outer side. FIG. **17** is a view for illustrating bending shapes of the radially outer-side terminals of the stator winding in the rotating electric machine according to the first embodiment of the present invention. In FIG. **11** to FIG. **14**, the winding bodies are representatively illustrated as the first straight portions and the second straight portions. In FIG. **16** and FIG. **17**, only the radially outer-side terminals are illustrated.

[0074] First, the winding body **21** is formed by helically winding the conductor wire **19** two turns. For convenience of the description, the winding bodies **21** are denoted as a winding body $\mathbf{21}_1$, a winding body $\mathbf{21}_2$, a winding body $\mathbf{21}_3$ . . . a winding body $\mathbf{21}_{59}$, and a winding body $\mathbf{21}_{60}$ in the order of assembly.

[0075] Then, as illustrated in FIG. **11**, the first winding body $\mathbf{21}_1$ is inserted into a pair of the slots **12** of the stator core **11**, which are separate from each other by the six-slot-angle distance, from the radially inner side. Similarly, the second winding body $\mathbf{21}_2$ is inserted into a pair of the slots **12**, which are shifted by one slot pitch to one side in a circumferential direction (hereinafter referred to as "first circumferential direction"), from the radially inner side. Subsequently, as illustrated in FIG. **12**, the third winding body $\mathbf{21}_3$ is inserted into a pair of the slots **12**, which are shifted by one slot pitch in the first circumferential direction, from the radially inner side. The above-mentioned procedure is repeated so as to complete mounting of the winding bodies up to a fifty-fourth winding body $\mathbf{21}_{54}$ to the stator core **11**.

[0076] Subsequently, as illustrated in FIG. **13**, the second straight portions **21***b* of the first to sixth winding bodies **21**

(from the first winding body 21_1 to the sixth winding body 21_6), which are each accommodated in the third layer and the fourth layer from the radially outer side in the slot **12**, are drawn out radially inward from the slots **12**. Subsequently, in a similar manner, a fifty-fifth winding body 21_{55}, a fifty-sixth winding body 21_{56}, a fifth-seventh winding body 21_{57} . . . and a sixtieth winding body 21_{60} are mounted one by one into the stator core **11** in the stated order. Then, as illustrated in FIG. **14**, the second straight portions **21***b* of the first to sixth winding bodies (from the first winding body 21_1 to the sixth winding body 21_6) are inserted to the third layer and the fourth layer in the slots **12** from the radially outer side to thereby complete the mounting of the sixty winding bodies **21** to the stator core **11**.

[0077] The first winding bodies **21**A are used for first to sixth, thirteenth to eighteenth, twenty-fifth to thirtieth, thirty-seventh to forty-second, and fourth-ninth to fifty-fourth windings **21**, and the second winding bodies **21**B are used for seventh to twelfth, nineteenth to twenty-fourth, thirty-first to thirty-sixth, forty-third to forty-eighth, and fifty-fifth to sixtieth winding bodies **21**.

[0078] As described above, sets of six first winding bodies **21**A and sets of six second winding bodies **21**B are alternately mounted to the stator core **11**. The radially inner-side terminal **21***e* of each of the first winding bodies **21**A maintains a fourth radial position from the radially outer side in the slot **12**, whereas the radially outer-side terminal **21***f* maintains a first radial position from the radially outer side in the slot **12**. Further, the radially inner-side terminal **21***g* of each of the second winding bodies **21**B is displaced radially inward from the fourth radial position from the radially outer side in the slot **12** by the width d of the conductor **19**, whereas the radially outer-side terminal **21***h* is displaced radially outward from the first radial position from the radially outer side in the slot **12** by the width d of the conductor **19**.

[0079] In the manner described above, the radially inner-side terminals **21***e* and **21***g* project toward a radially inner side of a coil end group **20***a*, whereas the radially outer-side terminals **21***f* and **21***h* project toward a radially outer side of the coil end group **20***a*. As illustrated in FIG. **15**, each terminal pair includes the first winding body **21**A and the second winding body **21**B, which are separate from each other by 180 degrees in electrical angle so that a distal end portion of the radially inner-side terminal **21***e* of the first winding body **21**A and a distal end portion of the radially inner-side terminal **21***g* of the second winding body **21**B are held in contact with each other in the radial direction. Six terminal pairs described above are arranged in the circumferential direction as one set. Five sets described above are arranged so as to be separate from each other in the circumferential direction. Further, each terminal pair includes the first winding body **21**A and the second winding body **21**B, which are separate from each other by 180 degrees in electrical angle so that a distal end portion of the radially outer-side terminal **21***f* of the first winding body **21**A and a distal end portion of the radially outer-side terminal **21***h* of the second winding body **21**B are held in contact with each other in the radial direction. Six terminal pairs described above are arranged in the circumferential direction as one set. Four sets described above are arranged so as to be separate from each other in the circumferential direction. Twelve radially-outer side terminals **21***f* and **21***h* are arranged between the sets of terminal pairs at one-slot pitches.

[0080] In the set of six terminal pairs arranged in the circumferential direction, in which the distal end portions of the radially outer-side terminals **21***f* of the first winding bodies **21**A and the distal end portions of the radially outer-side terminals **21***h* of the second winding bodies **21**B, which are separate from each other by 180 degrees in electrical angle, are arranged so as to be held in contact with each other in the radial direction, as illustrated in FIG. **16**, an oblique-side portion **21***fs* of each of the radially outer-side terminals **21***f* and an oblique-side portion **21***hs* of a corresponding one of the radially outer-side terminals **21***h* cross each other when viewed from the radially outer side. Specifically, the oblique-side portions **21***fs* of the radially outer-side terminals **21***f* of the first winding bodies **21**A, which extend from the slots, are bent in the first circumferential direction. Meanwhile, the oblique-side portions **21***hs* of the radially outer-side terminals **21***h* of the second winding bodies **21**B, which extend from the slots, are bent in a second circumferential direction, which is a direction opposite to the first circumferential direction.

[0081] More specifically, as illustrated in FIG. **17**, when six radially outer-side terminals **21***f* are denoted for convenience as a radially outer-side terminal $21f_1$, a radially outer-side terminal $21f_2$, a radially outer-side terminal $21f_3$ . . . , and a radially outer-side terminal $21f_6$ in the order of arrangement in the first circumferential direction, first angles θ**1**, θ**2**, θ**3** . . . , and θ**6**, each being formed between a surface of the oblique-side portion **21***fs* of the radially outer-side terminal $21f_1$, $21f_2$, $21f_3$ . . . $21f_6$, which is oriented forward in the first circumferential direction, and an end surface of the stator core **11** have a relationship of: $\theta 1 > \theta 2 > \theta 3 \ldots > \theta 6$. Specifically, the first angle θ gradually decreases in the first circumferential direction, which is a bending direction of the oblique-side portions **21***fs* of the radially outer-side terminals **21***f*.

[0082] Meanwhile, when six radially outer-side terminals **21***h* are denoted for convenience as a radially outer-side terminal $21h_1$, a radially outer-side terminal $21h_2$, a radially outer-side terminal $21h_3$ . . . , and a radially outer-side terminal $21h_6$ in the order of arrangement in the first circumferential direction, the first angle θ formed between a surface of the oblique-side portion **21***hs* of the radially outer-side terminal $21h_1$, $21h_2$, $21h_3$ . . . $21h_6$, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is a bending direction of the oblique-side portions **21***hs* of the radially outer-side terminals **21***h*.

[0083] A distal end portion **21***fa* of the radially outer-side terminal **21***f* and a distal end portion **21***ha* of the radially outer-side terminal **21***h*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0084] Although not illustrated, even in the sets, each including six terminal pairs arranged in the circumferential direction so that the distal end portion of the radially inner-side terminal **21***e* of the first winding body **21**A and the distal end portion of the radially inner-side terminal **21***g* of the second winding body **21**B of each terminal pair, which are separate from each other by 180 degrees in electrical angle, are held in contact with each other in the radial direction, an oblique-side portion of each of the radially inner-side terminals **21***e* and an oblique-side portion of a corresponding one of the radially inner-side terminals **21***g* cross each other when viewed from the radially inner side.

[0085] Meanwhile, when six radially inner-side terminals **21***e* are denoted for convenience as a radially inner-side terminal $21e_1$, a radially inner-side terminal $21e_2$, a radially inner-side terminal $21e_3$ . . . , and a radially inner-side terminal $21e_6$ in the order of arrangement in the second circumferential direction, the first angle θ formed between a surface of the oblique-side portion of the radially inner-side terminal $21e_1$, $21e_2$, $21e_3$ . . . $21e_6$, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is a bending direction of the oblique-side portions of the radially inner-side terminals **21***e*. Further, when six radially inner-side terminals **21***g* are denoted for convenience as a radially inner-side terminal $21g_1$, a radially inner-side terminal $21g_2$, a radially inner-side terminal **21***g***3** . . . , and a radially inner-side terminal $21g_6$ in the order of arrangement in the first circumferential direction, the first angle θ formed between a surface of the oblique-side portion **21***gs* of the radially inner-side terminal $21gg_1$, $21g_2$, $21g_3$ . . . $21g_6$, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction, which is a bending direction of the oblique-side portions of the radially outer-side terminals **21***g*. A distal end portion of the radially inner-side terminal **21***e* and a distal end portion of the radially inner-side terminal **21***g*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0086] Next, a wire connection method for the stator winding **20** is described with reference to FIG. **18**, FIG. **19**A, and FIG. **19**B. FIG. **18** is an end view of the stator in the rotating electric machine according to the first embodiment of the present invention when viewed from the axial direction. FIG. **19**A is a view for illustrating wire connection of a U**1**-phase winding of the stator winding in the rotating electric machine according to the first embodiment of the present invention. FIG. **19**B is a view for illustrating wire connection of a U**2**-phase winding of the stator winding in the rotating electric machine according to the first embodiment of the present invention. In FIG. **18**, the winding bodies **21** are representatively illustrated as the first straight portions and the second straight portions.

[0087] In FIG. **18**, slot numbers **1**, **7**, **13** . . . **49**, and **55** are sequentially allocated to the slots **12** in the circumferential direction. Numbers U**1**-*la*, U-**2***a* . . . , and U**1**-**10***a* and U**1**-**1***b*, U**1**-**2***b* . . . , and U**1**-**10***b* denote the first straight portions **21***a*, which are continuous with the radially outer-side terminals **21***f* and **21***h* of the winding bodies **21** that form the U**1**-phase winding mounted to a group of the slots **12** with the slot numbers (**1**+**6***n*) (in which n is a natural number including 0). Numbers U**2**-**1***a*, U**2**-**2***a* . . . , and U**2**-**10***a* and U**2**-**1***b*, U**2**-**2***b* . . . , and U**2**-**10***b* denote the second straight portions **21***b*, which are continuous with the radially inner-side terminals **21***e* and **21***g* of the winding bodies **21** that form the U**2**-phase winding mounted to a group of the slots **12** with the slot numbers (**2**+**6***n*).

[0088] The winding bodies **21** are mounted to a group of slots with slot numbers (**3**+**6***n*) to form a V**1**-phase winding. The winding bodies **21** are mounted to a group of slots with slot numbers (**4**+**6***n*) to form a V**2**-phase winding. The winding bodies **21** are mounted to a group of slots with slot numbers (**5**+**6***n*) to form a W**1**-phase winding. The winding bodies **21** are mounted to a group of slots with slot numbers (**6**+**6***n*) to form a W**2**-phase winding. The wire connection is performed in the same manner for the U-phase winding, the V-phase winding, and the W-phase winding. Thus, the wire connection method is described only for the U-phase winding.

[0089] First, as illustrated in FIG. **19**A, connection between U**1**-**1***b* and U**1**-**2***b*, U**1**-**2***a* and U**1**-**3***a*, U**1**-**3***b* and U**1**-**4***b*, U**1**-**4***a* and U**1**-**5***a*, U**1**-**5***b* and U**1**-**6***b*, U**1**-**6***a* and U**1**-**7***a*, U**1**-**7***b* and U**1**-**8***b*, U**1**-**8***a* and U**1**-**9***a*, and U**1**-**9***b* and U**1**-**10***b*, which are separate from each other in each set by one magnetic-pole pitch in the circumferential direction, is performed by, for example, welding to form the U**1**-phase winding. The connection between U**1**-**1***b* and U**1**-**2***b* corresponds to connection between the radially outer-side terminal **21***f* extending from the first straight portion **21***a* denoted by U**1**-**1***b* and the radially outer-side terminal **21***h* extending from the first straight portion **21***a* denoted by U**1**-**2***b* to each other.

[0090] Next, as illustrated in FIG. **19**B, connection between U**2**-**1***b* and U**2**-**2***b*, U**2**-**2***a* and U**2**-**3***a*, U**2**-**3***b* and U**2**-**4***b*, U**2**-**4***a* and U**2**-**5***a*, U**2**-**5***b* and U**2**-**6***b*, U**2**-**6***a* and U**2**-**7***a*, U**2**-**7***b* and U**2**-**8***b*, U**2**-**8***a* and U**2**-**9***a*, and U**2**-**9***b* and U**2**-**10***b*, which are separate from each other in each set by one magnetic-pole pitch in the circumferential direction, is performed by, for example, welding to form the U**2**-phase winding. Subsequently, U**1**-**10***a* and U**2**-*la* are connected by, for example, welding to connect the U**1**-phase winding and the U**2**-phase winding in series. As a result, the U-phase winding having U**1**-*la* as a feeding terminal and U**2**-**10***a* as a neutral point is formed.

[0091] The V-phase winding and the W-phase winding are formed in a similar manner. The neutral points are wire-connected to obtain the stator winding **20** formed as a three-phase AC winding in which the U-phase winding, the V-phase winding, and the W-phase winding are wire-connected in a Y-connection configuration.

[0092] A wire connection state of the stator winding **20** of the stator **10**, which is formed as described above, is described with reference to FIG. **20** and FIG. **21**. FIG. **20** is an end view for illustrating the stator in the rotating electric machine according to the first embodiment of the present invention, and FIG. **21** is a sectional view taken along the line XXI-XXI of FIG. **20** when viewed in the direction indicated by the arrows.

[0093] In the stator **10**, as illustrated in FIG. **20** and FIG. **21**, six terminal pairs, each including the radially inner-side terminals **21***e* and **21***g* being held with each other in the radial direction, are arranged in the circumferential direction on the radially inner side of the coil end group **20***a* to form a group of terminal pairs. Five groups of the six terminal pairs are formed so as to be separate from each other in the circumferential direction. Six terminal pairs, each including the radially outer-side terminals **21***f* and **21***h* being held in contact with each other in the radial direction, are arranged in the circumferential direction on the radially outer side of the coil end group **20***a* to form a group of terminal pairs. Four groups of six terminal pairs are formed so as to be separate from each other in the circumferential direction. Each of beads **15** obtained by joining distal end portions of the pair of the radially inner-side terminals **21***e* and **21***g* to each other and distal end portions of the pair of the radially outer-side terminals **21***f* and **21***h* to each other by, for example, welding, is coated with an insulating member **17** such as an insulating tape, cap, or powder so as to be insulated. At this time, the insulating coating is released from a distal end portion of each of the terminals so that the distal end portions of the terminals are joined to each other. Thus, a portion of the distal end portion of each of the terminals at the periphery of the bead **15**, from which the insulating coating is released, is coated and insulated with the insulating member **17** at the same time. The bead **15** and a portion of the distal end portions connected to each other, which is at the periphery of the bead **15**, form a connecting portion.

[0094] The rotating electric machine **100** using the stator **10** obtained by the wire connection described above operates as a 10-pole, 60-slot inner rotor three-phase motor with AC power fed to the stator winding **20**.

[0095] As described above, according to the first embodiment, sixty (the same number as a total number of slots) winding bodies **21** formed by distributed winding and lap winding are mounted to the stator core **11** at one-slot pitches. Then, the winding bodies **21** are formed so that the radially inner-side terminals **21***e* and **21***g*, each being one end of the conductor **19**, extend from a radially innermost position in the slot **12** toward the one axial side of the stator core **11** and the radially outer-side terminals **21***f* and **21***h*, each being another end of the conductor **19**, extend from a radially outermost position in the slot **12** toward the one axial side of the stator core **11**. Further, each phase winding of the stator winding **20** is formed by directly joining the radially inner-side terminals **21***e* and **21***g* of the winding bodies **21** for forming the same phase to each other and directly joining the radially outer-side terminals **21***f* and **21***h* thereof to each other.

[0096] Thus, the radially inner-side terminals **21***e* and **21***g* and the radially outer-side terminals **21***f* and **21***h* are not required to be caused to pass on an axially outer side of the coil end group **20***a*. Thus, an axial dimension of the stator **10** can be reduced. Further, another component such as a bus bar, which is configured to connect the terminals of the winding bodies **21** to each other, is not required. Thus, the number of components of the stator **10** can be reduced.

[0097] The radially inner-side terminal **21***e* of the first winding body **21**A maintains the fourth radial position in the slot **12** from the radially outer side, and the radially outer-side terminal **21***f* maintains the first radial position in the slot **12** from the radially outer side. The radially inner-side terminal **21***g* of the second winding body **21**B is displaced radially inward from the fourth radial position in the slot **12** from the radially outer side by the width d of the conductor wire **19**, and the radially outer-side terminal **21***h* thereof is displaced radially outward from the first radial position in the slot **12** from the radially outer side by the width d of the conductor wire **19**. In this manner, the radially inner-side terminal **21***g* can be led in the circumferential direction without interference with the radially inner-side terminal **21***e* so that an end of the radially inner-side terminal **21***g* is joined to an end of the radially inner-side terminal **21***e*, which is a target to be joined. Further, the radially outer-side terminal **21***h* can be led in the circumferential direction without interference with the radially outer-side terminal **21***f* so that an end of the radially outer-side terminal **21***h* is joined to an end of the radially outer-side terminal **21***f*, which is a target to be joined. Thus, radial projection of the coil end group **20***a* can be reduced.

[0098] Six radially outer-side terminals **21***f* and six radially outer-side terminal **21***h*, which extend from the radially outermost position in the slots **12**, are arranged so that a group of the six radially outer-side terminals **21***f* and a group of the six radially outer-side terminals **21***h* are arranged alternately in the circumferential direction. The six radially outer-side terminals **21***f* extend from the slots **12** and are then bent in the first circumferential direction. The six radially outer-side terminals **21***h* extend from the slots **12** and are then bent in the second circumferential direction so as to be brought closer to the radially outer-side terminals **21***f* being targets to be connected, which are separate from the radially outer-side terminals **21***h* by six slots, to be connected to the radially outer-side terminals **21***f* being the targets to be connected. Specifically, the radially outer-side terminals **21***f* and **21***h* are bent in the different circumferential directions for every six slots. In the set of six radially outer-side terminals **21***f* and six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, each of the radially outer-side terminals **21***f* and a corresponding one of the radially outer-side terminals **21***h* are bent so as to be brought closer to each other. Further, in the set of the six radially outer-side terminals **21***f* and the six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, the first angle θ formed between the surface of the oblique-side portion **21***fs* of the radially outer-side terminal **21***f*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. Further, the first angle θ formed between the surface of the oblique-side portion **21***hs* of the radially outer-side terminal **21***h*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. As a result, a distance between the oblique-side portions **21***fs* of the radially outer-side terminals **21***f* adjacent to each other and a distance between the oblique-side portions **21***hs* of the radially outer-side terminals **21***h* adjacent to each other can be increased. Hence, an insulating property can be improved. Further, a distance between the connecting portions, each being formed between the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h*, which are adjacent to each other, can be increased. Hence, the insulating property can be improved.

[0099] Six radially inner-side terminals **21***e* and six radially inner-side terminal **21***g*, which extend from the radially innermost position in the slots **12**, are arranged so that a group of the six radially inner-side terminals **21***e* and a group of the six radially inner-side terminals **21***g* are arranged alternately in the circumferential direction. The six radially inner-side terminals **21***e* extend from the slots **12** and are then bent in the second circumferential direction. The six radially inner-side terminals **21***g* extend from the slots **12** and are then bent in the first circumferential direction so as to be brought closer to the radially inner-side terminals **21***e* being targets to be connected, which are separate from the radially inner-side terminals **21***g* by six slots, to be connected to the radially inner-side terminals **21***e* being the targets to be connected. Specifically, the radially inner-side terminals **21***e* and **21***g* are bent in the different circumferential directions for every six slots. In the set of six radially inner-side terminals **21***e* and six radially inner-side terminals **21***g* in which the group of the six radially inner-side terminals **21***e* and the group of the six radially inner-side terminals **21***g* are adjacent to each other in the circumferential direction, each of the radially inner-side terminals **21***e* and a corresponding one of the radially inner-side terminals **21***g* are bent so as to be brought closer to each other. Further, in the set of the six radially inner-side terminals **21***e* and the six radially inner-side terminals **21***g* in which the group of the six radially inner-side terminals **21***e* and the group of the six radially inner-side terminals **21***g* are adjacent to each other in the circumferential direction, the first angle θ formed between the surface of the oblique-side portion **21***fs* of the radially inner-side terminal **21***e*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. Further, the first angle θ formed between the surface of the oblique-side portion **21***hs* of the radially inner-side terminal **21***g*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. As a result, a distance between the oblique-side portions of the radially inner-side terminals **21***e* adjacent to each other and a distance between the oblique-side portions of the radially inner-side terminals **21***g* adjacent to each other can be increased. Hence, an insulating property can be improved. Further, a distance between the connecting portions, each being formed between the distal end portion of the radially inner-side terminal **21***e* and the distal end portion of the radially inner-side terminal **21***g*, which are adjacent to each other, can be increased. Hence, the insulating property can be improved.

[0100] In the first embodiment described above, the first angle θ formed between the oblique-side portion of the radially outer-side terminal and the end surface of the stator core and between the oblique-side portion of the radially inner-side terminal and the end surface of the stator core gradually decreases in a direction of being brought closer to the terminal to be joined. When insulating performance has a margin, the first angle θ may be the same for a plurality of the oblique-side portions as long as the first angle θ monotonously decreases in the direction of being brought closer to the terminal to be joined. For example, in FIG. **17**, the first angles θ**1** to θ**6** may have a relationship of: $\theta 1 = \theta 2 > \theta 3 > \theta 4 > \theta 5 > \theta 6$. Further, a potential difference between the terminals of the same phase is small. Thus, in a portion in which the terminals of the same phase are adjacent to each other in the circumferential direction, the first angle θ may be set to the same angle.

Second Embodiment

[0101] FIG. **22** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a second embodiment of the present invention when viewed from a radially outer side. In FIG. **22**, only radially outer-side terminals are illustrated.

[0102] In FIG. **22**, a thermistor **50** serving as a temperature detector is disposed between the oblique-side portions **21***fs* of the radially outer-side terminals **21***f* adjacent to each other in the circumferential direction.

[0103] Other configurations are the same as those of the first embodiment described above.

[0104] Even in the second embodiment, the first angle θ formed between the surface of the oblique-side portion **21***fs* of the radially outer-side terminal **21***f*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11**, gradually decreases in the first circumferential direction, and a distance between the oblique-side portions **21***fs* of the radially outer-side terminals **21***f* adjacent to each other increases. Thus, the thermistor **50** can be stably installed under a state of being held in contact with the oblique-side portion **21***fs* of the radially outer-side terminal **21***f*. At the same time, a temperature of a coil end can be precisely measured.

Third Embodiment

[0105] FIG. **23** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a third embodiment of the present invention when viewed from a radially outer side. In FIG. **23**, only radially outer-side terminals are illustrated.

[0106] In FIG. **23**, the distal end portion **21***fa* of the radially outer-side terminal **21***f* is bent at an end of the oblique-side portion **21***fs*, and the distal end portion **21***ha* of the radially outer-side terminal **21***h* is bent at an end of the oblique-side portions **21***hs* to extend axially outward. In the set of six radially outer-side terminals **21***f* and six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, distances L**1**, L**2**, L**3**, L**4**, and L**5** between the pairs of the distal end portions, each including the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h*, are the same. Height positions of the distal end portions **21***fa* of the radially outer-side terminals **21***f* and the distal end portions **21***ha* of the radially outer-side terminals **21***h* from the end surface of the stator core **11** are the same.

[0107] Other configurations are the same as those of the first embodiment described above.

[0108] According to the third embodiment, the distances L**1**, L**2**, L**3**, L**4**, and L**5** between the pairs of the distal end portions, each including the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h*, are the same, and the height positions of the distal end portions **21***fa* of the radially outer-side terminals **21***f* and the distal end portions **21***ha* of the radially outer-side terminals **21***h* from the end surface of the stator core **11** are the same for the pairs. Thus, a step of connecting the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h* is simplified. At the same time, stable joint strength can be obtained.

[0109] In the third embodiment, in the set of the six radially outer-side terminals **21***f* and the six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, the first angle θ formed between the surface of the oblique-side portion **21***fs* of the radially outer-side terminal **21***f*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. Further, the first angle θ formed between the surface of the oblique-side portion **21***hs* of the radially outer-side terminal **21***h*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. Thus, a height position of a bent portion of the oblique-side portion **21***fs*, at which the distal end portion **21***fa* of the radially outer-side terminal **21***f* is defined, from the end surface of the stator core **11** is gradually decreased in the first circumferential direction. Further, a height position of a bent portion of the oblique-side portion **21***hs*, at which the distal end portion **21***ha* of the radially outer-side terminal **21***h* is defined, from the end surface of the stator core **11** is gradually decreased in the second circumferential direction. In this manner, the height positions of the connecting portions, each being formed between the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h*, are set to be the same. Further, the distances between the pairs, each including the distal end portion **21***fa* of the radially outer-side terminal **21***f* and the distal end portion **21***ha* of the radially outer-side terminal **21***h*, are set to be the same.

[0110] The radially outer-side terminals **21***f* and **21***h* have been described. However, the radially inner-side terminals **21***e* and **21***g* are formed in a similar manner.

[0111] In the third embodiment, the configuration applied to the rotating electric machine according to the first embodiment has been described. However, the configuration may be applied to a rotating electric machine according to other embodiments.

Fourth Embodiment

[0112] FIG. **24** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a fourth embodiment of the present invention when viewed from a radially outer side. In FIG. **24**, only the second coil end **21***d* is illustrated.

[0113] In FIG. **24**, in a set of six second coil ends **21***d* arranged in the circumferential direction, for the second coil end **21***d* having an oblique-side portion bent in the first circumferential direction, the first angle θ formed between a surface of the oblique-side portion of the second coil end **21***d*, which is oriented forward in the first circumferential direction, and the end surface of the stator core monotonously decreases in the first circumferential direction. For the second coil end **21***d* having an oblique-side portion bent in the second circumferential direction, the first angle θ formed between a surface of the oblique-side portion of the second coil end **21***d*, which is oriented forward in the second circumferential direction, and the end surface of the stator core monotonously decreases in the second circumferential direction. The oblique-side portion is bent in the second circumferential direction. Height positions of tops of the second coil ends **21***d* from the end surface of the stator core **11** are constant.

[0114] Other configurations are the same as those of the first embodiment described above.

[0115] According to the fourth embodiment, a distance between the oblique-side portions of the second coil ends **21***d* adjacent to each other in the circumferential direction is increased. Hence, the insulating property can be improved.

[0116] The second coil ends **21***d* have been described. However, even for a first angle formed between each of a pair of oblique-side portions through top of a first coil end **21***c* therebetween and the end surface of the stator core, similarly to the second coil end **21***d*, the first angle formed between the surface oriented forward in a bending direction of the oblique-side portion and the end surface of the stator core monotonously decreases in the bending direction.

[0117] In the fourth embodiment, the configuration applied to the rotating electric machine according to the first embodiment has been described. However, the configuration may be applied to a rotating electric machine according to other embodiments.

Fifth Embodiment

[0118] FIG. **25**A is a view for illustrating wire connection of a stator winding in a rotating electric machine according to a second embodiment of the present invention, and FIG. **25**B is a view for illustrating wire connection of the stator winding in the rotating electric machine according to the second embodiment of the present invention.

[0119] The third embodiment has the same configuration as that of the first embodiment described above except for a difference in the wire connection method for the stator winding.

[0120] First, as illustrated in FIG. **25**A, connection between U**1**-**1***b* and U**2**-**2***b*, U**2**-**2***a* and U**1**-**3***a*, U**1**-**3***b* and U**2**-**4***b*, U**2**-**4***a* and U**1**-**5***a*, U**1**-**5***b* and U**2**-**6***b*, U**2**-**6***a* and U**1**-**7***a*, U**1**-**7***b* and U**2**-**8***b*, U**2**-**8***a* and U**1**-**9***a*, and U**1**-**9***b* and U**2**-**10***b* is performed by, for example, welding to form the U**1**-phase winding.

[0121] Further, as illustrated in FIG. **25**B, connection between U**2**-**1***b* and U**1**-**2***b*, U**1**-**2***a* and U**2**-**3***a*, U**2**-**3***b* and U**1**-**4***b*, U**1**-**4***a* and U**2**-**5***a*, U**2**-**5***b* and U**1**-**6***b*, U**1**-**6***a* and U**2**-**7***a*, U**2**-**7***b* and U**1**-**8***b*, U**1**-**8***a* and U**2**-**9***a*, and U**2**-**9***b* and U**1**-**10***b* is performed by, for example, welding to form the U**2**-phase winding. Subsequently, U**2**-**10***a* and U**2**-*la* are connected by, for example, welding to connect the U**1**-phase winding and the U**2**-phase winding in series. As a result, the U-phase winding having U**1**-*la* as a feeding terminal and U**1**-**10***a* as a neutral point is formed.

[0122] The V-phase winding and the W-phase winding are formed in a similar manner. The neutral points are wire-connected to obtain the stator winding formed as a three-phase AC winding in which the U-phase winding, the V-phase winding, and the W-phase winding are wire-connected in a Y-connection configuration.

[0123] Even in the fifth embodiment, the winding bodies **21** are mounted to the stator core at one-slot pitches so that the radially inner-side terminals **21***e* and **21***g* of the winding bodies **21** project toward the radially inner side of the coil end group **20***a* and the radially outer-side terminals **21***f* and **21***h* of the radially outer-side terminals **21***f* and **21***h* project toward the radially outer side of the coil end group **20***a*. Then, the radially inner-side terminals **21***e* and **21***g* of the winding bodies **21** for forming the same phase are directly joined to each other and the radially outer-side terminals **21***f* and **21***h* thereof are directly joined to each other to form each phase winding.

[0124] The radially outer-side terminals **21***f* and **21***h* are bent in the different circumferential directions for every six slots. In the set of six radially outer-side terminals **21***f* and six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, each of the radially outer-side terminals **21***f* and a corresponding one of the radially outer-side terminals **21***h* are bent so as to be brought closer to each other. Further, in the set of the six radially outer-side terminals **21***f* and the six radially outer-side terminals **21***h* in which the group of the six radially outer-side terminals **21***f* and the group of the six radially outer-side terminals **21***h* are adjacent to each other in the circumferential direction, the first angle θ formed between the surface of the oblique-side portion of the radially outer-side terminal **21***f*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. Further, the first angle θ formed between the surface of the oblique-side portion of the radially outer-side terminal **21***h*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction.

[0125] The radially inner-side terminals **21***e* and **21***g* are bent in the different circumferential directions for every six slots. In the set of six radially inner-side terminals **21***e* and six radially inner-side terminals **21***g* in which the group of the six radially inner-side terminals **21***e* and the group of the six radially inner-side terminals **21***g* are adjacent to each other in the circumferential direction, each of the radially inner-side terminals **21***e* and a corresponding one of the radially inner-side terminals **21***g* are bent so as to be brought closer to each other. Further, in the set of the six radially inner-side terminals **21***e* and the six radially inner-side terminals **21***g* in which the group of the six radially inner-side terminals **21***e* and the group of the six radially inner-side terminals **21***g* are adjacent to each other in the circumferential direction, the first angle θ formed between the surface of the oblique-side portion of the radially inner-side terminal **21***e*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. Further, the first angle θ formed between the surface of the oblique-side portion **21***hs* of the radially inner-side terminal **21***g*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction.

[0126] Accordingly, even in the fifth embodiment, the same effects as those of the first embodiment described above are obtained.

Sixth Embodiment

[0127] FIG. **26** is a sectional view of a main part, for illustrating a periphery of a coil end group of a stator in a rotating electric machine according to a sixth embodiment of the present invention.

[0128] In FIG. **26**, a pair of the radially inner-side terminals **21***e* and **21***g*, which are held in contact with each other in the radial direction, are inclined to the radially inner side, and hence the bead **15** is separated from the coil end group **20***a* to the radially inner side. A pair of the radially outer-side terminals **21***f* and **21***h*, which are held in contact with each other in the radial direction, are inclined to the radially outer side, and hence the bead **15** is separated from the coil end group **20***a* to the radially outer side.

[0129] Other configurations are the same as those of the first embodiment described above.

[0130] According to the sixth embodiment, the radially inner-side terminals **21***e* and **21***g* are inclined to the radially inner side, and hence the bead **15** serving as the connecting portion for the pair of the radially inner-side terminals **21***e* and **21***g* is separated from the coil end group **20***a* to the radially inner side. The radially outer-side terminals **21***f* and **21***h* are inclined to the radially outer side, and hence the bead **15** serving as the connecting portion for the pair of the radially outer-side terminals **21***f* and **21***h* is separated from the coil end group **20***a* to the radially outer side. With the configuration described above, the axial height of the terminals of the winding bodies **21** can be reduced. Further, generation of damage of the insulating coating for the conductor wire for forming the coil ends, which may be caused by fire of a torch or sputtering at the time of joint between the pair of the radially outer-side terminals **21***f* and **21***h*, can be suppressed.

[0131] In the sixth embodiment, the configuration applied to the rotating electric machine according to the first embodiment has been described. However, the configuration may be applied to a rotating electric machine according to other embodiments.

Seventh Embodiment

[0132] FIG. **27** is a view for illustrating a phase-to-phase insulation method for a stator winding in a rotating electric machine according to a seventh embodiment of the present invention.

[0133] In the seventh embodiment, as illustrated in part (a) of FIG. **27**, prior to a step of joining the pair of the radially inner-side terminals **21***e* and **21***g*, which are held in contact with each other in the radial direction, an insulating sheet **16** made of, for example, polyimide, aramid, polyethylene terephthalate (PET), or polyphenylene sulfide (PPS) is inserted between the radially inner-side terminals **21***e* and **21***g* that form the pair from the axially outer side. In this manner, as illustrated in part (b) of FIG. **27**, the insulating sheet **16** is arranged between the radially inner-side terminals **21***e* and **21***g*, which cross each other when viewed from the radially inner side. The insulating sheet **16** is similarly arranged between the radially outer-side terminals **21***f* and **21***h*, which cross each other when viewed from the radially outer side.

[0134] Other configurations are the same as those of the first embodiment described above.

[0135] According to the seventh embodiment, the insulating sheets **16** are arranged between the radially inner-side terminals **21***e* and **21***g* of different phases, which cross each other when viewed from the radial direction, and between the radially outer-side terminals **21***f* and **21***h* of different phases, which cross each other when viewed from the radial direction, respectively. Thus, phase-to-phase insulation is ensured, and hence the stator having a high insulating property is obtained.

[0136] In the first to seventh embodiments described above, the winding body is formed by helically winding the conductor wire two turns. However, the number of turns of the conductor wire is not limited to two, and may be any number equal to or larger than two.

[0137] In the seventh embodiment, the configuration applied to the rotating electric machine according to the first embodiment has been described. However, the configuration may be applied to a rotating electric machine according to other embodiments.

Eighth Embodiment

[0138] FIG. **28** is a perspective view for illustrating a stator to be applied to a rotating electric machine according to an eighth embodiment of the present invention. FIG. **29** is a perspective view for illustrating a core block for forming a stator core to be applied to the rotating electric machine according to the eighth embodiment of the present invention. FIG. **30** is a front view for illustrating a first winding body for forming a stator winding in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **31** is a plan view for illustrating the first winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **32** is a front view for illustrating a second winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **33** is a plan view for illustrating the second winding body for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **34** is a sectional view of a main part, for schematically illustrating a state in which the winding bodies are accommodated in slots in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **35** is a perspective view for illustrating a winding assembly for forming the stator winding in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **36** is a side view of a main part, for illustrating the stator in the rotating electric machine according to the eighth embodiment of the present invention when viewed from a radially outer side. FIG. **37** is a view for illustrating bending shapes of radially outer-side terminals of the stator winding in the rotating electric machine according to the eighth embodiment of the present invention. In FIG. **36** and FIG. **37**, only the radially outer-side terminals are illustrated.

[0139] In FIG. **28** a stator **10**A includes a stator core **30** having an annular shape, a stator winding **40** mounted to the stator core **30**, and slot cells **13**. The slot cells **13** electrically separate the stator winding **40** and the stator core **30** from each other. For convenience of the description, a pole number p is set to 10, a slot number of the stator core **30** is set to 60, and a three-phase winding is set as the stator winding **20**. Specifically, the slots are formed in the stator core **30** in a proportion of two slots per phase for each pole.

[0140] A core block **31** is obtained by, as illustrated in FIG. **29**, equally dividing the stator core **30** having the annular shape into thirty blocks in a circumferential direction of the stator core **30**. The core block **31** is formed by stacking and integrating a plurality of electromagnetic steel sheets. The core block **31** includes a core back portion **31***a* having an arc-shaped cross section and two teeth **31***b* projecting radially inward from an inner peripheral wall surface of the core back portion **31***a*. The stator core **30** is formed into the annular shape by arranging and integrating thirty core blocks **31** in the circumferential direction while the teeth **31***b* are oriented radially inward and circumferential side surfaces of the core back portions **31***a* abut against each other. Slots **32** formed between the core blocks **31** adjacent to each other in the circumferential direction are arranged at equiangular pitches in the circumferential direction so as to be open toward an inner peripheral side. Each of the teeth **31***b* is formed into a tapered shape having a circumferential width gradually decreasing to a radially inner side. A cross section of each of the slots **32**, which is orthogonal to an axial direction of the stator core **30**, is rectangular. As described above, the stator core **30** has the same configuration as that of the stator core **11** described above except that the stator core **30** is formed into the annular shape by arranging the thirty core blocks **31** in the circumferential direction.

[0141] Winding bodies **42** for forming the stator winding **40** include first winding bodies **42**A and a second winding bodies **42**B. In the first winding bodies **42** and the second winding bodies **42**B, terminals extend in different directions. Each of the first winding body **42**A and the second winding body **42**B is formed by inserting a conductor wire **39** having a circular cross section with the diameter d, which is formed of, for example, a copper wire or an aluminum wire, which is insulation-coated with an enamel resin and is continuous without any connecting portions, into a first slot, a second slot, and a third slot, which are arranged at six-slot-angle distances in the circumferential direction. The conductor wire **39** is inserted into the first slot, the second slot, the third slot, and the second slot in the started order so that an insertion direction into the first slot, the second slot, and the third slot from an axial direction are changed alternately to form each of the first winding body **42**A and the second winding body **42**B into a **6**-shaped coil pattern. The winding body **42** may also be formed with use of a conductor wire having a rectangular cross section in place of the conductor wire **39** having the circular cross section.

[0142] The first winding body **42**A includes, as illustrated in FIG. **30** and FIG. **31**, a first straight portion **42***a*, a second straight portion **42***b*, a third straight portion **42***c*, a fourth straight portion **42***d*, a first coil end **42***e*, a second coil end **42***f*, a third coil end **42***g*, a radially outer-side terminal **42***h*, and a radially inner-side terminal **42***i*. The first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d* are arranged in three rows arranged at six-slot-angle distances. The first coil end **42***e* connects one end of the first straight portion **42***a* in a length direction and one end of the second straight portion **42***b* in the length direction to each other. The second coil end **42***f* connects another end of the second straight portion **42***b* in the length direction and another end of the third straight portion **42***c* in the length direction to each other. The third coil end **42***g* connects one end of the third straight portion **42***c* in the length direction and one end of the fourth straight portion **42***d* in the length direction to each other. The radially outer-side terminal **42***h* extends from another end of the first straight portion **42***a* in the length direction. The radially inner-side terminal **42***i* extends from another end of the fourth straight portion **42***d* in the length direction. The six-slot-angle distance corresponds to one magnetic-pole pitch.

[0143] More specifically, the first winding body **42**A is formed into the **6**-shaped coil pattern in the following manner, as illustrated in FIG. **34**. The conductor wire **39** is inserted into a first layer inside a first slot **32** from one axial end side of the stator core **30**, extends from the first slot **32** to another axial side of the stator core **30** to be inserted into a second layer in a seventh slot **32**, which is separate by the six-slot-angle distance in the second circumferential direction, extends from the seventh slot **32** to the one axial end side of the stator core **30** to be inserted into a third layer in a thirteenth slot **32**, which is separate by the six-slot-angle distance in the second circumferential direction, extends from the thirteenth slot **32** to the another axial end side of the stator core **30** to be inserted into a fourth layer in the seventh slot **32**, which is separate by the six-slot-angle distance in the first circumferential direction, and extends from the seventh slot **32** to the one axial end side of the stator core **30**.

[0144] Positions of accommodation of the conductor wire **39** accommodated in the slot **32** are referred to as the first layer, the second layer, the third layer, and the fourth layer from the radially outer side for convenience. In FIG. **34**, the numbers **1**, **2** . . . **12**, and **13** are slot numbers allocated to the slots **32** in the order of arrangement in the circumferential direction.

[0145] The first straight portion **42***a* is accommodated in the first layer in the first slot **32**, the second straight portion **42***b* and the fourth straight portion **42***d* are accommodated in the second layer and the fourth layer in the seventh slot **32**, and the third straight portion **42***c* is accommodated in the third layer in the thirteenth slot **32**. Specifically, the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d* are arranged in the three rows located at the six-slot-angle distances.

[0146] The first coil end **42***e* extending from the first layer in the first slot **32** to the another axial end side of the stator core **30** extends axially outward to another circumferential side at a constant inclination while maintaining a radial position, is displaced radially inward by d at a center (top), and then extends axially inward in the second circumferential direction at an inclination in the opposite direction while maintaining the radial position to be inserted into the second layer in the seventh slot **32**.

[0147] The second coil end **42***f* extending from the second layer in the seventh slot **32** to the one axial end side of the stator core **30** extends axially outward in the second another circumferential direction at a constant inclination while maintaining a radial position, is displaced radially inward by d at a center (top), and then extends axially inward in the second circumferential direction at an inclination in the opposite direction while maintaining the radial position to be inserted into the third layer in the thirteenth slot **32**.

[0148] The third coil end **42***g* extending from the third layer in the thirteenth slot **32** to the another axial end side of the stator core **30** extends axially outward in the first circumferential direction at a constant inclination while maintaining a radial position, is displaced radially inward by d at a center (top), and then extends axially inward in the first circumferential direction at an inclination in the opposite direction while maintaining the radial position to be inserted into the fourth layer in the seventh slot **32**.

[0149] As described above, each of the first coil end **42***e*, the second coil end **42***f*, and the third coil end **42***g* has a crank portion, which is displaced in the radial direction by the radial width of the conductor wire **39**, at the top.

[0150] The radially outer-side terminal **42***h*, which extends from the first layer in the first slot **32** to the one axial end side of the stator core **30**, as illustrated in FIG. **30** and FIG. **31**, is bent at a displacement portion **42***j* to be displaced radially outward by d, then extends radially outward in the second circumferential direction at a constant inclination while maintaining a radial position, and is bent at an approximate center (top) to extend axially outward.

[0151] The radially inner-side terminal **42***i*, which extends from the fourth layer in the seventh slot **32** to the one axial end side of the stator core **30**, as illustrated in FIG. **30** and FIG. **31**, extends radially outward in the first circumferential direction at a constant inclination while maintaining a radial position, and is bent at an approximate center (top) to extend axially outward.

[0152] The second winding body **42**B includes, as illustrated in FIG. **32** and FIG. **33**, the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, the fourth straight portion **42***d*, the first coil end **42***e*, the second coil end **42***f*, the third coil end **42***g*, a radially outer-side terminal **42***k*, and a radially inner-side terminal **42***m*. The first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d* are arranged in three rows arranged at six-slot-angle distances. The first coil end **42***e* connects the one end of the first straight portion **42***a* in the length direction and the one end of the second straight portion **42***b* in the length direction to each other. The second coil end **42***f* connects the another end of the second straight portion **42***b* in the length direction and the another end of the third straight portion **42***c* in the length direction to each other. The third coil end **42***g* connects one end of the third straight portion **42***c* in the length direction and the one end of the fourth straight portion **42***d* in the length direction to each other. The radially outer-side terminal **42***k* extends from the another end of the first straight portion **42***a* in the length direction. The radially inner-side terminal **42***m* extends from the another end of the fourth straight portion **42***d* in the length direction. The second winding body **42**B is formed into a **6**-shaped coil pattern. Specifically, the second winding body **42**B is formed to have the same configuration as that of the first winding body **42**A except for the radially outer-side terminal **42***k* and the radially inner-side terminal **42***m*.

[0153] In the second winding body **42**B, similarly to the first winding body **42**A, the first straight portion **42***a* is accommodated in the first layer in the first slot **32**, the second straight portion **42***b* and the fourth straight portion **42***d* are accommodated in the second layer and the fourth layer in the seventh slot **32**, and the third straight portion **42***c* is accommodated in the third layer in the thirteenth slot **32**.

[0154] The radially outer-side terminal **42***k*, which extends from the first layer in the first slot **32** to the one axial end side of the stator core **30**, as illustrated in FIG. **32** and FIG. **33**, extends axially outward in the first circumferential direction at a constant inclination while maintaining a radial position, and is bent at an approximate center (top) to extend axially outward.

[0155] The radially inner-side terminal **42***m*, which extends from the fourth layer in the seventh slot **32** to the one axial end side of the stator core **30**, as illustrated in FIG. **32** and FIG. **33**, is bent at a displacement portion **42***j* to be displaced radially inward by d, then extends radially outward in the second circumferential direction at a constant inclination while maintaining a radial position, and is bent at an approximate center (top) to extend axially outward.

[0156] The first winding bodies **42**A and the second winding bodies **42**B, which are formed as described above, are arranged in the circumferential direction at one-slot pitches so that a group of six first winding bodies **42**A and a group of six second winding bodies **42**B are arranged alternately in the circumferential direction to thereby form a winding assembly **41** having an annular shape, which is illustrated in FIG. **35**. The winding assembly **41** includes thirty first winding bodies **42**A and thirty second winding bodies **42**B.

[0157] In the winding assembly **41** formed as described above, the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d* are arranged in one row in the radial direction, and sixty rows are arranged in the circumferential direction at one-slot pitches.

[0158] On one axial end side of the winding assembly **41**, a second coil end row formed by arranging the second coil ends **42***f* in the circumferential direction at one-slot pitches forms a first coil end group **41***a*. On another axial end side of the winding assembly **41**, a second coil end group **41***b* is formed. The second coil end group **41***b* includes a first coil end row and a third coil end row, which are two rows arranged in the radial direction. The first coil end row is formed by arranging the first coil ends **42***e* in the circumferential direction at one-slot pitches. The third coil end row is formed by arranging the third coil ends **42***g* in the circumferential direction at one-slot pitches.

[0159] Each terminal pair includes the first winding body **42**A and the second winding body **42**B, which are separate from each other by 180 degrees in electrical angle so that an end of the radially outer-side terminal **42***h* of the first winding body **42**A and an end of the radially outer-side terminal **42***k* of the second winding body **42**B are held in contact with each other in the radial direction. Four sets, each including the six terminal pairs described above arranged in the circumferential direction, are arranged on the radially outer side of the first coil end group **41***a* so as to be separate from each other in the circumferential direction. Further, each terminal pair includes the first winding body **42**A and the second winding body **42**B, which are separate from each other by 180 degrees in electrical angle so that an end of the radially inner-side terminal **42***i* of the first winding body **42**A and an end of the radially inner-side terminal **42***m* of the second winding body **42**B are held in contact with each other in the radial direction. Five sets, each including the six terminal pairs described above arranged in the circumferential direction, are arranged on the radially inner side of the first coil end group **41***a* so as to be separate from each other in the circumferential direction.

[0160] In the set of six terminal pairs arranged in the circumferential direction, in which the distal end portions of the radially outer-side terminals **42***h* of the first winding bodies **42**A and the distal end portions of the radially outer-side terminals **42***k* of the second winding bodies **42**B, which are separate from each other by 180 degrees in electrical angle, are arranged so as to be held in contact with each other in the radial direction, as illustrated in FIG. **36**, an oblique-side portion **42***hs* of each of the radially outer-side terminals **42***h* and an oblique-side portion **42***hs* of a corresponding one of the radially outer-side terminals **42***k* cross each other when viewed from the radially outer side. Specifically, the oblique-side portions **42***hs* of the radially outer-side terminals **42***h* of the first winding bodies **42**A, which extend from the slots, are bent in the second circumferential direction. Meanwhile, the oblique-side portions **42***ks* of the radially outer-side terminals **42***k* of the second winding bodies **42**B, which extend from the slots, are bent in the first circumferential direction.

[0161] More specifically, as illustrated in FIG. **37**, when six radially outer-side terminals **42***k* of each of the sets are denoted as a radially outer-side terminal $\mathbf{42}k_1$, a radially outer-side terminal $\mathbf{42}k_2$, a radially outer-side terminal $\mathbf{42}k_3$ . . . , and a radially outer-side terminal $\mathbf{42}k_6$ in the order of arrangement in the first circumferential direction for convenience, the first angle θ formed between the oblique-side portion **42***ks* of each of the radially outer-side terminals $\mathbf{42}k_1$, $\mathbf{42}k_2$, $\mathbf{42}k_3$ . . . , and $\mathbf{42}k_6$, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** is constant. Second angles η**1**, η**2**, η**3** . . . , and η**6** respectively formed between distal end portions **42***ka* of the radially outer-side terminals $\mathbf{42}k_1$, $\mathbf{42}k_2$, $\mathbf{42}k_3$ . . . , and $\mathbf{42}k_6$, which are oriented in the first circumferential direction, and the end surface of the stator core **11** have a relationship of: η**1**>η**2**>η**3** . . . >η**6**. Specifically, the second angle η gradually decreases in the first circumferential direction. A height position of a bent portion of the oblique-side portion **42***ks*, at which the distal end portion **42***ka* of the radially outer-side terminal **42***k* is defined, from the end surface of the stator core **11** is set so as to gradually decrease in the first circumferential direction.

[0162] Meanwhile, when six radially outer-side terminals **42***h* of each of the sets are denoted as a radially outer-side terminal $\mathbf{42}h_1$, a radially outer-side terminal $\mathbf{42}h_2$, a radially outer-side terminal $\mathbf{42}h_3$ . . . , and a radially outer-side terminal $\mathbf{42}h_6$ in the order of arrangement in the second circumferential direction for convenience, the first angle θ formed between the oblique-side portion **42***hs* of each of the radially outer-side terminals $\mathbf{42}h_1$, $\mathbf{42}h_2$, $\mathbf{42}h_3$ . . . , and $\mathbf{42}h_6$, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** is constant. The second angle η formed between a surface of a distal end portion **42***ha* of the radially outer-side terminal $\mathbf{42}h_1$, $\mathbf{42}h_2$, $\mathbf{42}h_3$ . . . , and $\mathbf{42}h_6$, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. A height position of a bent portion of the oblique-side portion **42***hs*, at which the distal end portion **42***ha* of the radially outer-side terminal **42***h* is defined, from the end surface of the stator core **11** is set so as to gradually decrease in the second circumferential direction.

[0163] A distal end portion **42***ha* of the radially outer-side terminal **42***k* and a distal end portion **42***ka* of the radially outer-side terminal **42***h*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0164] Although not illustrated, even in the sets, each including six terminal pairs arranged in the circumferential direction so that the distal end portion of the radially inner-side terminal **42***i* of the first winding body **42**A and the distal end portion of the radially inner-side terminal **42***m* of the second winding body **42**B of each terminal pair, which are separate from each other by 180 degrees in electrical angle, are held in contact with each other in the radial direction, an oblique-side portion of each of the radially inner-side terminals **42***i* and an oblique-side portion of a corresponding one of the radially inner-side terminals **42***m* cross each other when viewed from the radially inner side.

[0165] More specifically, although not illustrated, when six radially inner-side terminals **42***i* of each of the sets are denoted as a radially inner-side terminal $\mathbf{42}i_1$, a radially inner-side terminal $\mathbf{42}i_2$, a radially inner-side terminal $\mathbf{42}i_3$ . . . , and a radially inner-side terminal $\mathbf{42}i_6$ in the order of arrangement in the first circumferential direction for convenience, the first angle θ formed between the oblique-side portion of each of the radially inner-side terminals $\mathbf{42}i_1$, $\mathbf{42}i_2$, $\mathbf{42}i_3$ . . . , and $\mathbf{42}i_6$, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** is constant. The second angle η formed between a surface of a distal end portion of the radially outer-side terminal **42**i_1, **42**i_2, **42**i_3 . . . , and **42**i_6, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. A height position of a bent portion of the oblique-side portion, at which the distal end portion of the radially inner-side terminal **42***i* is defined, from the end surface of the stator core **11** is set so as to gradually decrease in the first circumferential direction.

[0166] More specifically, although not illustrated, when six radially inner-side terminals **42***m* of each of the sets are denoted as a radially inner-side terminal **42**m_1, a radially inner-side terminal **42**m_2, a radially inner-side terminal **42**m_3 . . . , and a radially inner-side terminal **42**m_6 in the order of arrangement in the second circumferential direction for convenience, the first angle θ formed between the oblique-side portion of each of the radially inner-side terminals **42**m_1, **42**m_2, **42**m_3 . . . , and **42**m_6, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** is constant. The second angle η formed between a surface of a distal end portion of the radially inner-side terminal **42**m_1, **42**m_2, **42**m_3 . . . , and **42**m_6, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. A height position of a bent portion of the oblique-side portion, at which the distal end portion of the radially inner-side terminal **42***m* is defined, from the end surface of the stator core **11** is set so as to gradually decrease in the second circumferential direction.

[0167] A distal end portion **21***fa* of the radially inner-side terminal **42***i* and a distal end portion **21***ha* of the radially inner-side terminal **42***m*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0168] Next, an assembly method for the stator **10**A is described with reference to FIG. **38** and FIG. **39**. FIG. **38** and FIG. **39** are views for illustrating an assembly method for the stator in the rotating electric machine according to the eighth embodiment of the present invention. FIG. **38** is an illustration of a state before assembly of the stator, and FIG. **39** is an illustration of a state after the assembly of the stator.

[0169] First, the slot cells **13** are mounted to the rows, each including the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d*, in the winding assembly **41**. Next, the thirty core blocks **31** are arranged, as illustrated in FIG. **38**, at approximately equiangular pitches in the circumferential direction so that the teeth **31***b* are arranged on the radially outer side of spaces between adjacent ones of the rows, each including the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d*, in the winding assembly **41**. Subsequently, the core blocks **31** arranged in the circumferential direction are moved radially inward. As a result, each of the teeth **31***b* of the core blocks **31** is inserted between the adjacent ones of the rows, each including the first straight portion **42***a*, the second straight portion **42***b*, the third straight portion **42***c*, and the fourth straight portion **42***d*.

[0170] The core blocks **31** arranged in the circumferential direction is moved further to the radially inner side. Then, circumferential side surfaces of adjacent ones of the core blocks **31** are brought into abutment against each other to hamper radially inward movement of the core blocks **31**. As a result, as illustrated in FIG. **39**, the winding assembly **41** is mounted to the stator core **30**. Subsequently, the insulating sheets **16** are inserted between the radially inner-side terminals **42***i* and **42***m*, which are held in contact with each other in the radial direction, and between the radially outer-side terminals **42***h* and **42***k*, which are held in contact with each other in the radial direction. Subsequently, wire connection processing is performed for the winding assembly **41** as in the case of the first embodiment described above to thereby assemble the stator **10**A.

[0171] Although not shown, a distance from an end surface of the stator core **30** to a bending start position (bending position in the circumferential direction) on the radially outer-side terminal **42***k* is longer than a distance from the end surface of the stator core **30** to a bending start position (bending position in the circumferential direction) at the displacement portion **42***j* of the radially outer-side terminal **42***h*. Further, a distance from the end surface of the stator core **30** to a bending start position (bending position in the circumferential direction) on the radially inner-side terminal **42***i* is longer than a distance from the end surface of the stator core **30** to a bending start position (bending position in the circumferential direction) at the displacement portion **42***j* of the radially inner-side terminal **42***m*.

[0172] According to the eighth embodiment, the same number as a total number of slots winding bodies **42** formed by distributed winding are mounted in the stator core **30** at one-slot pitches. Then, the winding bodies **42** are formed so that the radially inner-side terminals **42***i* and **42***m*, each being one end of the conductor **39**, extend from a radially innermost position in the slot **32** toward the one axial side of the stator core **30** and the radially outer-side terminals **42***h* and **42***k*, each being another end of the conductor **39**, extend from a radially outermost position in the slot **32** toward the one axial side of the stator core **30**. Further, each phase winding of the stator winding **40** is formed by directly joining the radially inner-side terminals **42***i* and **42***m* of the winding bodies **42** for forming the same phase to each other and directly joining the radially outer-side terminals **42***h* and **42***k* thereof to each other.

[0173] Therefore, also in the eighth embodiment, the radially inner-side terminals **42***i* and **42***m* and the radially outer-side terminals **42***h* and **42***k* are not required to be caused to pass on an axially outer side of the first coil end group a. Thus, an axial dimension of the stator **10** can be reduced.

[0174] Further, another component such as a bus bar, which is configured to connect the terminals of the winding bodies **42** to each other, is not required. Thus, the number of components of the stator **10**A can be reduced.

[0175] Further, the radially inner-side terminal **42***i* of the first winding body **42**A maintains the fourth radial position from the radially outer side in the slot **32**, and the radially outer-side terminal **42***h* is displaced radially inward from the first radial position from the radially outer side in the slot **32** by the width d of the conductor wire **39**. The radially inner-side terminal **42***m* of the second winding body **42**B is displaced radially inward from the fourth radial position from the radially outer side in the slot **32** by the width d of the conductor **39**, and the radially outer-side terminal **42***k* maintains the first radial position from the radially outer side in the slot **32**. In this manner, the radially inner-side terminal **42***i* can be led in the circumferential direction to be joined to a corresponding one of the radially inner-side terminals

42*m* without interference of the radially inner-side terminals **42***m*. Further, the radially outer-side terminal **42***h* can be led in the circumferential direction to be joined to a corresponding one of the radially outer-side terminals **42***k* without interference of the radially outer-side terminals **42***k*. Thus, radial projection of the second coil end group **41***b* can be reduced.

[0176] Six radially outer-side terminals **42***k* and six radially outer-side terminal **42***h*, which extend from the radially outermost position in the slots **12**, are arranged so that a group of the six radially outer-side terminals **42***k* and a group of the six radially outer-side terminals **42***h* are arranged alternately in the circumferential direction. The six radially outer-side terminals **42***k* extend from the slots **12** and are then bent in the first circumferential direction. The six radially outer-side terminals **42***h* extend from the slots **12** and are then bent in the second circumferential direction so as to be brought closer to the radially outer-side terminals **42***k* being targets to be connected, which are separate from the radially outer-side terminals **42***k* by six slots, to be connected to the radially outer-side terminals **42***k* being the targets to be connected. Specifically, the radially outer-side terminals **42***k* and **42***h* are bent in the different circumferential directions for every six slots. In the set of six radially outer-side terminals **42***k* and six radially outer-side terminals **42***h* in which the group of the six radially outer-side terminals **42***k* and the group of the six radially outer-side terminals **42***h* are adjacent to each other in the circumferential direction, each of the radially outer-side terminals **42***k* and a corresponding one of the radially outer-side terminals **42***h* are bent so as to be brought closer to each other. Further, in the set of the radially outer-side terminals **42***k* and the radially outer-side terminals **42***h*, which are arranged so that a group of six radially outer-side terminals **42***k* and a group of six radially outer-side terminals **42***h* are adjacent to each other in the circumferential direction, the second angle η formed between the distal end portion **42***ka* of the radially outer-side terminal **42***k* and the end surface of the stator core **11** gradually decreases in the first circumferential direction, which is a bending direction of the oblique-side portions **42***ks* of the radially outer-side terminals **42***k*. Further, the second angle η formed between the distal end **42***ha* of the radially outer-side terminal **42***h* and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is a bending direction of the oblique-side portions **42***hs* of the radially outer-side terminals **42***h*. As a result, a distance between the connecting portions, each being formed between the distal end portion **42***ha* of the radially outer-side terminal **42***h* and the distal end portion **42***ka* of the radially outer-side terminal **42***k* adjacent to each other, which are held in contact with each other in the radial direction, can be increased. Thus, the insulating property can be improved.

[0177] Six radially inner-side terminals **42***i* and six radially inner-side terminal **42***m*, which extend from the radially innermost position in the slots **12**, are arranged so that a group of the six radially inner-side terminals **42***i* and a group of the six radially inner-side terminals **42***m* are arranged alternately in the circumferential direction. The six radially inner-side terminals **42***i* extend from the slots **12** and are then bent in the first circumferential direction. The six radially inner-side terminals **42***m* extend from the slots **12** and are then bent in the second circumferential direction so as to be brought closer to the radially inner-side terminals **42***i* being targets to be connected, to be connected to the radially inner-side terminals **42***i* being the targets to be connected. Specifically, the radially inner-side terminals **42***i* and **42***m* are bent in the different circumferential directions for every six slots. In the set of six radially inner-side terminals **42***i* and six radially inner-side terminals **42***m* in which the group of the six radially inner-side terminals **42***i* and the group of the six radially inner-side terminals **42***m* are adjacent to each other in the circumferential direction, each of the radially inner-side terminals **42***i* and a corresponding one of the radially inner-side terminals **42***m* are bent so as to be brought closer to each other. Further, in the set of the radially inner-side terminals **42***i* and the radially inner-side terminals **42***m*, which are arranged so that a group of six radially outer-side terminals **42***i* and a group of six radially outer-side terminals **42***m* are adjacent to each other in the circumferential direction, the second angle η formed between the distal end portion of the radially inner-side terminal **42***i* and the end surface of the stator core **11** gradually decreases in the first circumferential direction, which is a bending direction of the oblique-side portions of the radially inner-side terminals **42***i*. Further, the first angle θ formed between the distal end of the radially inner-side terminal **42***m* and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is a bending direction of the oblique-side portions of the radially inner-side terminals **42***m*. As a result, a distance between the connecting portions, each being formed between the distal end portion of the radially inner-side terminal **42***i* and the distal end portion of the radially inner-side terminal **42** adjacent to each other, which are held in contact with each other in the radial direction, can be increased. Thus, the insulating property can be improved.

[0178] In the eighth embodiment described above, the second angle η formed between the distal portion of the radially outer-side terminal and the end surface of the stator core and between the distal portion of the radially inner-side terminal and the end surface of the stator core gradually decreases in a direction of being brought closer to the terminal to be joined. When insulating performance has a margin, the second angle η may be the same for a plurality of the oblique-side portions as long as the second angle η monotonously decreases in the direction of being brought closer to the terminal to be joined. For example, in FIG. **37**, the second angles $\eta 1$ to $\eta 6$ may have a relationship of: $\eta 1 = \eta 2 > \eta 3 > \eta 4 > \eta 5 > \eta 6$. Further, a potential difference between the terminals of the same phase is small. Thus, in a portion in which the terminals of the same phase are adjacent to each other in the circumferential direction, the second angle η may be set to the same angle.

Ninth Embodiment

[0179] FIG. **40** is a side view of a main part, for illustrating a stator in a rotating electric machine according to a ninth embodiment of the present invention when viewed from a radially outer side. FIG. **41** is a view for illustrating bending shapes of radially outer-side terminals of a stator core in the rotating electric machine according to the ninth embodiment of the present invention. In FIG. **40** and FIG. **41**, only the radially outer-side terminal are illustrated.

[0180] In the set of six terminal pairs arranged in the circumferential direction, in which the distal end portions of the radially outer-side terminals **42***ha* of the first winding bodies **42**A and the distal end portions **42***ka* of the radially outer-side terminals **42***k* of the second winding bodies **42**B, which are separate from each other by 180 degrees in electrical angle, are arranged so as to be held in contact with each other in the radial direction, as illustrated in FIG. **40** and FIG. **41**. An oblique-side portion **42***fs* of each of the radially outer-side terminals **42***h* and an oblique-side portion **42***ks* of a corresponding one of the radially outer-side terminals **42***h* cross each other when viewed from the radially outer side. Specifically, the oblique-side portions **42***hs* of the radially outer-side terminals **42***h* of the first winding bodies **42**A, which extend from the slots, are bent in the second circumferential direction. Meanwhile, the oblique-side portions **42***ks* of the radially outer-side terminals **42***k* of the second winding bodies **42**B, which extend from the slots, are bent in a first circumferential direction.

[0181] The first angle θ formed between the surface of the oblique-side portion **42***ks* of each of the six radially outer-side terminals **42***k* of each set, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. The second angle η formed between the surface of the oblique-side portion **42***ka* of the radially outer-side terminal **42***k*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. Further, the height position of the bent portion of the oblique-side portion **42***ks*, at which the distal end portion **42***ka* of the radially outer-side terminal **42***k* is defined, from the end surface of the stator core **11** is gradually decreased in the first circumferential direction.

[0182] Meanwhile, the first angle θ formed between the surface of the oblique-side portion **42***hs* of each of the six radially outer-side terminals **42***h* of each set, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. The second angle η formed between the surface of the oblique-side portion **42***ha* of the radially outer-side terminal **42***h*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. Further, the height position of the bent portion of the oblique-side portion **42***hs*, at which the distal end portion **42***ha* of the radially outer-side terminal **42***h* is defined, from the end surface of the stator core **11** is gradually decreased in the first circumferential direction. A distal end portion **42***ka* of the radially outer-side terminal **42***k* and a distal end portion **42***ha* of the radially outer-side terminal **42***h*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0183] Although not illustrated, even in the sets, each including six terminal pairs arranged in the circumferential direction so that the distal end portion of the radially inner-side terminal **42***i* of the first winding body **42**A and the distal end portion of the radially inner-side terminal **42***m* of the second winding body **42**B of each terminal pair, which are separate from each other by 180 degrees in electrical angle, similarly, an oblique-side portion of each of the radially inner-side terminals **42***i* and an oblique-side portion of a corresponding one of the radially inner-side terminals **42***m* cross each other when viewed from the radially inner side.

[0184] The first angle θ formed between the surface of the oblique-side portion of each of the six radially outer-side terminals **42***i* of each set, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. The second angle η formed between the surface of the oblique-side portion of the radially outer-side terminal **42***i*, which is oriented forward in the first circumferential direction, and the end surface of the stator core **11** gradually decreases in the first circumferential direction. Further, the height position of the bent portion of the oblique-side portion, at which the distal end portion of the radially outer-side terminal **42***i* is defined, from the end surface of the stator core **11** is gradually decreased in the first circumferential direction.

[0185] The first angle θ formed between the surface of the oblique-side portion of each of the six radially outer-side terminals **42***m* of each set, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. The second angle η formed between the surface of the oblique-side portion of the radially outer-side terminal **42***m*, which is oriented forward in the second circumferential direction, and the end surface of the stator core **11** gradually decreases in the second circumferential direction. Further, the height position of the bent portion of the oblique-side portion, at which the distal end portion of the radially outer-side terminal **42***m* is defined, from the end surface of the stator core **11** is gradually decreased in the second circumferential direction.

[0186] Further, a distal end portion of the radially outer-side terminal **42***i* and a distal end portion of the radially outer-side terminal **42***m*, which are held in contact with each other in the radial direction, are located at the same height position from the end surface of the stator core **11**.

[0187] Other configurations are the same as those of the eighth embodiment described above.

[0188] Accordingly, even in the ninth embodiment, the same effects as those of the eighth embodiment described above are obtained.

[0189] According to the ninth embodiment, the first angle θ formed between the surface of the oblique-side portion **42***ks* of each of the six radially outer-side terminals **42***k* of each set and the end surface of the stator core **11** gradually decreases in the first circumferential direction, which is the bending direction of the oblique-side terminals **42***ks* of the radially outer-side terminals **42***k*. Thus, a distance between the oblique-side portions **42***ks* of the radially outer-side terminals **42***k* adjacent to each other is increased to improve the insulating property. Similarly, the first angle θ formed between the surface of the oblique-side portion **42***hs* of each of the six radially outer-side terminals **42***h* of each set and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is the bending direction of the oblique-side portions **42***hs* of the radially outer-side terminals **42***h*. Thus, a distance between the oblique-side portions **42***hs* of the radially outer-side terminals **42***h* adjacent to each other is increased to improve the insulating property. The first angle θ formed between the oblique-side portion of each of the six radially inner-side terminals **42***i* of each set and the end surface of the stator core **11** gradually decreases in the first circumferential direction, which is the bending direction of the oblique-side portions of the radially inner-side terminals **42***i*. Thus, a distance between the oblique-side portions of the radially inner-side terminals **42***i* adjacent to each other is increased to improve the insulating property. Similarly, the first angle θ formed between the oblique-side portion of each of the six radially inner-side terminals **42***m* of each set and the end surface of the stator core **11** gradually decreases in the second circumferential direction, which is the bending direction of the oblique-side portions of the radially inner-side terminals **42***m*. Thus, a distance between the oblique-side portions of the radially inner-side terminals **42***m* adjacent to each other is increased to improve the insulating property.

[0190] In the eighth and ninth embodiments described above, the application of the present invention to the stator using the winding bodies **42** has been described. However, the present invention may be applied to the stator using the winding bodies **21**.

[0191] In the eighth and ninth embodiments described above, each of the winding bodies **42** is formed by continuously winding the conductor wire **39** one turn into the **6**-shaped coil pattern. However, the winding body may be formed by winding the conductor wire **39** two or more turns into the **6**-shaped coil pattern. Specifically, the winding body may be formed by arranging the **6**-shaped coil patterns (winding bodies **42**) in two or more rows in the radial direction so as to be continuously formed with use of a jumper wire for connecting winding ends of the **6**-shaped coil patterns.

[0192] In each of the embodiments described above, the application of the rotating electric machine to the electric motor has been described. However, the same effects are provided even when the rotating electric machine is applied to a power generator.

[0193] Further, in each of the embodiments described above, the rotating electric machine having ten poles and sixty slots has been described above. However, the pole number p and the slot number S are not limited to ten poles and sixty slots.

[0194] In each of the embodiments described above, the slots are formed in a proportion of two slots per phase for each pole. However, a slot number q per phase for each pole is not limited to two, and may be one, or three or more. For example, the slot number q per phase for each pole is one, a distance between the row of the first straight portion and the row of the second straight portion of the winding bodies is a three-slot-angle distance (one magnetic-pole pitch). In this case, the bending direction of the radially outer-side terminal extending from the radially outermost position of the slot is different in the circumferential direction for every three slots.

[0195] In each of the embodiments described above, each of the winding bodies is formed as a winding formed by full-pitch winding. However, each of the winding bodies may be formed as a winding formed by fractional-pitch winding or long-pitch winding.

[0196] In each of the embodiments described above, the winding body is formed of one continuous conductor wire. However, the winding body may be formed with use of a plurality of conductors connected to each other as long as distributed winding is used.

[0197] Further, in each of the embodiments described above, vanish is not applied to the coil end group. However, vanish may be applied to the coil end group. As a result, firm fixation between the radially outer-side terminals, between the radially inner-side terminals, and between the radially outer-side terminals and the radially inner-side terminals, and the coil end group is achieved. Therefore, the radially outer-side terminals are not brought closer to each other and the radially inner-side terminals are not brought closer to each other due to vibration. Thus, the insulating property is improved.

REFERENCE SIGNS LIST

[0198] **10**, **10**A stator, **11**, **30** stator core, **12**, **32** slot, **15** bead (connecting portion), **16** insulating sheet, **17** insulating member, **19**, **39** conductor wire, **20**, **40** stator winding, **21**A, **21**B winding body, **21***f*, **21***h* radially outer-side terminal, **21***fa*, **21***ha* distal end portion, **21***fs*, **21***hs* oblique-side portion, **21***e*, **21***g* radially inner-side terminal, **42**A, **42**B winding body, **42***h*, **42***k* radially outer-side terminal, **21***ha*, **21***ka* distal end portion, **21***hs*, **21***ks* oblique-side portion, **42***i*, **42***m* radially inner-side terminal, **50** thermistor (temperature detector)

1. A rotating electric machine, comprising a stator including: a stator core having an annular shape, which includes slots arranged in a circumferential direction of the stator core; and a stator winding mounted to the stator core,

wherein the stator winding includes a plurality of winding bodies formed by distributed winding, each being formed by winding a conductor wire a plurality of turns, which are inserted into a plurality of the slots to be mounted to the stator core;

wherein each of the winding bodies includes a radially inner-side terminal extending from a radially innermost position in a corresponding one of the slots to one axial side of the stator core and a radially outer-side terminal extending from a radially outermost position in a corresponding one of the slots to the one axial side of the stator core,

wherein each of the radially inner-side terminals for forming each of phase windings of the stator winding among the radially inner-side terminals extends from a radially innermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially inner-side terminal from the corresponding slot is changed alternately for each group of n radially inner-side terminals (in which n is a natural number equal to or larger than 2),

wherein each of the radially outer-side terminals for forming each of the phase windings of the stator winding among the radially outer-side terminals extends from a radially outermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially outer-side terminal from the corresponding slot is changed alternately for a group of n radially outer-side terminals,

wherein each of the phase windings is formed by directly joining distal end portions of the radially inner-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other and directly joining distal end portions of the radially outer-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other, and

wherein a first angle formed between at least one of an oblique-side portion of each of the n radially inner-side terminals, which are continuous in the circumferential direction and are bent in the same circumferential bending direction, and an oblique-side portion of each of the n radially outer-side terminals, which are continuous in the circumferential direction and are bent in the circumferential bending direction, and an end surface of the stator core monotonously decreases in the circumferential bending direction.

2. The rotating electric machine according to claim **1**, wherein the first angle gradually decreases in the circumferential bending direction.

3. The rotating electric machine according to claim **1**, further comprising a temperature detector disposed between the oblique-side portions, which are adjacent to each other in the circumferential direction, among the n oblique-side portions for which the first angle monotonously decreases.

4. The rotating electric machine according to claim **1**, wherein a second angle formed between at least any one of a connecting portion between distal end portions of two of the n radially outer-side terminals, which are continuous in the circumferential direction, and a connecting portion between distal end portions of two of the n radially inner-side terminals, which are continuous in the circumferential direction, and the end surface of the stator core monotonously decreases in the circumferential bending direction.

5. The rotating electric machine according to claim **4**, wherein the second angle gradually decreases in the circumferential bending direction.

6. A rotating electric machine, comprising a stator including: a stator core having an annular shape, which includes slots arranged in a circumferential direction of the stator core; and a stator winding mounted to the stator core,

wherein the stator winding includes a plurality of winding bodies formed by distributed winding, each being formed by winding a conductor wire a plurality of turns, which are inserted into a plurality of the slots to be mounted to the stator core;

wherein each of the winding bodies includes a radially inner-side terminal extending from a radially innermost position in a corresponding one of the slots to one axial side of the stator core and a radially outer-side terminal extending from a radially outermost position in a corresponding one of the slots to the one axial side of the stator core,

wherein each of the radially inner-side terminals for forming each of phase windings of the stator winding among the radially inner-side terminals extends from a radially innermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially inner-side terminal from the corresponding slot is changed alternately for each group of n radially inner-side terminals (in which n is a natural number equal to or larger than 2),

wherein each of the radially outer-side terminals for forming each of the phase windings of the stator winding among the radially outer-side terminals extends from a radially outermost position in a corresponding one of the slots on a one-by-one basis while a circumferential bending direction after the extension of the radially outer-side terminal from the corresponding slot is changed alternately for a group of n radially outer-side terminals,

wherein each of the phase windings is formed by directly joining distal end portions of the radially inner-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other and directly joining distal end portions of the radially outer-side terminals respectively extending from the slots being separate from each other by n slots to be bent so as to be brought closer to each other, and

wherein a second angle formed between at least any one of a connecting portion between distal end portions of two of the n radially outer-side terminals, which are continuous in the circumferential direction, and a connecting portion between distal end portions of two of the n radially inner-side terminals, which are continuous in the circumferential direction, and the end surface of the stator core monotonously decreases in the circumferential bending direction.

7. The rotating electric machine according to claim **6**, wherein the second angle gradually decreases in the circumferential bending direction.

8. The rotating electric machine according to claim **1**, wherein each of a connecting portion between the radially outer-side terminals and a connecting portion between the radially inner-side terminals is coated with an insulating member.

9. The rotating electric machine according to claim **1**, wherein the radially outer-side terminals are inclined radially outward so that connecting portions between the radially outer-side terminals are separate radially outward from a coil end group of the stator winding, and the radially inner-side terminals are inclined radially inward so that connecting portions between the radially inner-side terminals are separate radially inward from the coil end group of the stator winding.

10. The rotating electric machine according to claim **1**,

wherein, in groups, each including the n radially outer-side terminals being bent so that the n radially outer-side terminals of one of the groups and the n radially outer-side terminals of another one of the groups are brought closer to each other, a radial position of each of the radially outer-side terminals bent in one circumferential bending direction is offset radially outward by a radial width of the conductor wire with respect to a radial position of each of the radially outer-side terminals bent in another circumferential bending direction, and

wherein, in groups, each including the n radially inner-side terminals being bent so that the n radially inner-side terminals of one of the groups and the n radially inner-side terminals of another one of the groups are brought closer to each other, a radial position of each of the radially inner-side terminals bent in the one circumferential bending direction is offset radially inward by the radial width of the conductor wire with respect to a radial position of each of the radially inner-side terminals bent in the another circumferential bending direction.

11. The rotating electric machine according to claim **1**, further comprising insulating sheets disposed between the radially outer-side terminals of different phases, which cross each other when viewed from a radial direction, and between the radially inner-side terminals of the different phases, which cross each other when viewed from the radial direction.

12. The rotating electric machine according to claim **6**, wherein each of a connecting portion between the radially outer-side terminals and a connecting portion between the radially inner-side terminals is coated with an insulating member.

13. The rotating electric machine according to claim **6**, wherein the radially outer-side terminals are inclined radially outward so that connecting portions between the radially outer-side terminals are separate radially outward from a coil end group of the stator winding, and the radially inner-side terminals are inclined radially inward so that connecting portions between the radially inner-side terminals are separate radially inward from the coil end group of the stator winding.

14. The rotating electric machine according to claim **6**,

wherein, in groups, each including the n radially outer-side terminals being bent so that the n radially outer-side terminals of one of the groups and the n radially outer-side terminals of another one of the groups are brought closer to each other, a radial position of each of the radially outer-side terminals bent in one circumferential bending direction is offset radially outward by a radial width of the conductor wire with respect to a radial position of each of the radially outer-side terminals bent in another circumferential bending direction, and

wherein, in groups, each including the n radially inner-side terminals being bent so that the n radially inner-side terminals of one of the groups and the n radially inner-side terminals of another one of the groups are brought closer to each other, a radial position of each of the radially inner-side terminals bent in the one circumferential bending direction is offset radially inward by the radial width of the conductor wire with respect to a radial position of each of the radially inner-side terminals bent in the another circumferential bending direction.

15. The rotating electric machine according to claim **6**, further comprising insulating sheets disposed between the radially outer-side terminals of different phases, which cross each other when viewed from a radial direction, and between the radially inner-side terminals of the different phases, which cross each other when viewed from the radial direction.

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