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Stator assembly and method of assembling stator assembly

Abstract

A coil conductor of each of a U-phase, a V-phase, and a W-phase is provided with a configuration in which a terminal wiring conductor, a first tooth conductor wound around a first tooth, a bridging line conductor, a second tooth conductor wound around a second tooth, and a neutral-point connection conductor are connected in this order. The terminal wiring conductor is connected to the first tooth conductor at an upper side of an insulator. The bridging line conductor is disposed on an upper side of the insulator disposed on a stator core and along an outer side portion of a tooth of another phase. The neutral-point connection conductor is connected to the second tooth conductor at a lower side of the insulator.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of PCT Application No. PCT/JP2021/028087, filed Jul. 29, 2021, which claims priority to Japanese Patent Application No. 2020-191334, filed Nov. 18, 2020, the entire contents of each of which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

(1) The present invention relates to a stator assembly for a three-phase brushless motor.

BACKGROUND

(2) Japanese Unexamined Patent Application Publication No. 2012-253978 (hereinafter "Patent Document 1" describes a structure of a stator for a three-phase motor. The stator described therein includes twelve teeth arranged at predetermined angular intervals (30°). The twelve teeth are used in four for a U-phase, four for a V-phase, and four for a W-phase. Then, a U1 tooth for the U-phase, a U2 tooth for the U-phase, a V1 tooth for the V-phase, a V2 tooth for the V-phase, a W1 tooth for the W-phase, a W2 tooth for the W-phase, a U3 tooth for the U-phase, a U4 tooth for the U-phase, a V3 tooth for the V-phase, a V4 tooth for the V-phase, a W3 tooth for the W-phase, and a W4 tooth for the W-phase are arranged annularly (counterclockwise, for example) in this order.

(3) Moreover, a wire conductor for the U-phase is wound around a tooth constituting the U-phase, a wire conductor for the V-phase is wound around a tooth constituting the V-phase, and a wire conductor for the W-phase is wound around a tooth constituting the W-phase.

(4) The U-phase conductors for teeth not adjacent to each other among multiple teeth constituting the U-phase are connected by a U-phase bridging line (conductor), the V-phase linear conductors for teeth not adjacent to each other among teeth constituting the V-phase are connected by a V-phase bridging line (conductor), and the W-phase linear conductors for teeth not adjacent to each other among teeth constituting the W-phase are connected by a W-phase bridging line (conductor). Then, the U-phase conductor, the V-phase conductor, and the W-phase conductor each are connected to a neutral-point at a predetermined position of an annular structural body in which the multiple teeth are arranged.

(5) In addition, the bridging line of each layer is tied to multiple pins provided on the structural body that are shaped to protrude from a top surface of the structural body and are arranged and spaced apart from each other along the annular shape.

(6) However, in the configuration described in Patent Document 1, there exists inevitably a place where conductors having an electric potential difference cross, for example, where a W-phase bridging line (conductor) and a conductor connecting the V-phase conductor to the neutral-point cross, or the like. As a result, the insulation reliability of the stator decreases. Further, since a pin for tying a winding line is required, it is hard to reduce in height.

SUMMARY OF THE INVENTION

(7) Accordingly, it is an object of the present invention to provide a stator assembly that is thin and has high insulation reliability.

(8) In an exemplary aspect, a stator assembly is provided that includes a stator core including a back yoke disposed in an annular shape and multiple teeth extending toward a central axis of the annular shape. Moreover, an insulator made of an insulation material is disposed to sandwich the stator core from above and below, and a coil conductor is wound around portions of the insulator covering the multiple teeth.

(9) In an exemplary aspect, the multiple teeth include a first tooth and a second tooth for each of the U-phase, the V-phase, and the W-phase, and the teeth of each phase are repeatedly arranged in order along an annular shape.

(10) In an exemplary aspect, the coil conductor further includes a coil conductor for each of the U-phase, the V-phase, and the W-phase. The coil conductor for each phase is connected in the order of a terminal wiring conductor, a first tooth conductor wound around the first tooth, a bridging line conductor, a second tooth conductor wound around the second tooth, and a neutral-point connection conductor.

(11) In another exemplary aspect, the terminal wiring conductor is connected to the first tooth conductor at an upper side of the insulator. Moreover, the bridging line conductor is disposed on an upper side of the insulator disposed on the stator core and is disposed along an outer side portion of

a tooth of another phase.
(12) In an exemplary aspect, the neutral-point connection conductor is connected to the second tooth conductor at a lower side of the insulator.
(13) In the configurations of the exemplary aspects described above, a portion of the coil conductor of each phase on a side of a control signal application terminal (e.g., a side opposite to the neutral-point) and a portion connecting the coil conductors wound around the multiple teeth are separated from a portion of the coil conductor of each phase on a side connected to the neutral-point, sandwiching the stator core and the insulator. This configuration suppresses arrangement of conductors having a large electric potential difference in proximity to each other.
(14) According to exemplary aspects of the present invention, a stator assembly is provided that has high insulation reliability.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** is an equivalent circuit diagram of a motor including a stator assembly according to a first exemplary embodiment.
(2) FIG. **2** is a perspective view of the stator assembly according to the first exemplary embodiment.
(3) FIG. **3** is a top view of the stator assembly according to the first exemplary embodiment.
(4) FIG. **4** is a bottom view of the stator assembly according to the first exemplary embodiment.
(5) FIG. **5** is a developed side view of the stator assembly according to the first embodiment.
(6) FIG. **6**(A), FIG. **6**(B), FIG. **6**(C), and FIG. **6**(D) are top views illustrating respective states in a manufacturing process of the stator assembly according to the first exemplary embodiment.
(7) FIG. **7** is a perspective view of a stator assembly according to a second exemplary embodiment.
DETAILED DESCRIPTION OF EMBODIMENTS
First Exemplary Embodiment
(8) A stator assembly according to a first exemplary embodiment of the present invention will be described with reference to the drawings.
(9) (Circuit Configuration of Motor Including Stator Assembly)
(10) FIG. **1** is an equivalent circuit diagram of a motor including a stator assembly according to a first exemplary embodiment.
(11) As illustrated in FIG. **1**, the motor including a stator assembly **10** according to the first embodiment is a three-phase AC motor (e.g., a brushless motor) having a U-phase, a V-phase, and a W-phase. The motor includes a U-phase coil **101**U, a V-phase coil **101**V, and a W-phase coil **101**W.
(12) One end of the U-phase coil **101**U is connected to an input terminal **102**U for a U-phase AC. One end of the V-phase coil **101**V is connected to an input terminal **102**V for a V-phase AC. One end of the W-phase coil **101**W is connected to an input terminal **102**W for a W-phase AC.
(13) The other end of each of the U-phase coil **101**U, the V-phase coil **101**V, and the W-phase coil **101**W are connected to a neutral-point **103**.
(14) With the circuit configuration above, the motor realizes a Y-connection (e.g., a star connection).
(15) (Structure of Stator Assembly)
(16) FIG. **2** is a perspective view of the stator assembly according to the first exemplary embodiment. FIG. **3** is a top view of the stator assembly according to the first embodiment. FIG. **4** is a bottom view of the stator assembly according to the first embodiment. FIG. **5** is a developed side view of the stator assembly according to the first embodiment.
(17) As illustrated in FIG. **2**, FIG. **3**, FIG. **4**, and FIG. **5**, the stator assembly **10** includes a stator core **21**, an insulator **30**, a busbar conductor **70**, and multiple coil conductors (e.g., coil conductor

410, coil conductor **510**, and coil conductor **610**). In general, the terms “multiple” and “plurality of” are used interchangeably for purposes of this disclosure.

(18) The stator core **21** includes a back yoke and multiple teeth (e.g., tooth **221**, tooth **222**, tooth **223**, tooth **224**, tooth **225**, and tooth **226**).

(19) In an exemplary aspect, the back yoke is a magnetic body. For example, specifically, the back yoke is formed by laminating multiple electromagnetic steel sheets being a soft magnetic material. Moreover, the back yoke has an annular shape having a predetermined width and height.

(20) The multiple teeth (e.g., tooth **221**, tooth **222**, tooth **223**, tooth **224**, tooth **225**, and tooth **226**) are magnetic bodies that are arranged on an inner side of the back yoke, that is, on a side of a central axis of the annular shape formed by the back yoke. In the exemplary aspect, the multiple teeth are columnar bodies extending from an inner wall surface of the back yoke toward the central axis. The multiple teeth are arranged at predetermined angular intervals. More specifically, as illustrated in FIG. **3** and FIG. **4**, tooth **221**, tooth **222**, tooth **223**, tooth **224**, tooth **225**, and tooth **226** are arranged in this order at angular intervals of approximately 60° counterclockwise in top view and clockwise in bottom view. The multiple teeth are formed of the same material as the back yoke, for example.

(21) As a result, the stator core **21** is formed by the back yoke and the multiple teeth formed of the same material.

(22) The insulator **30** is made of an insulation material and is disposed to sandwich the stator core **21** from above and below (i.e., from the top and bottom thereof). More specifically, the insulator **30** includes an upper cover **31** and a lower cover **33**. The upper cover **31** covers the stator core **21** from a side of a top surface to a predetermined height of a side surface. The lower cover **33** covers the stator core **21** from a side of a bottom surface to a predetermined height of the side surface.

(23) In the exemplary aspect, the insulator **30** includes multiple flanges. More specifically, the upper cover **31** of the insulator **30** includes the multiple flanges (e.g., flange **311**, flange **312**, flange **313**, flange **314**, flange **315**, and flange **316**). Each of the multiple flanges (e.g., flange **311**, flange **312**, flange **313**, flange **314**, flange **315**, and flange **316**) is arranged at a portion, which overlaps with the back yoke of the stator core **21**, of the upper cover **31**.

(24) Each of the multiple flanges (e.g., flange **311**, flange **312**, flange **313**, flange **314**, flange **315**, and flange **316**) has a shape protruding from a top surface (e.g., a surface on a side opposite to a surface in contact with the back yoke of the stator core **21**) of the upper cover **31**, and has a plate shape extending along an inner peripheral end of the back yoke of the stator core **21**.

(25) The multiple flanges are arranged at a portion of the stator core **21** where the back yoke and each of the multiple teeth are connected. More specifically, the flange **311** is disposed at a portion where the back yoke and the tooth **221** are connected, the flange **312** is disposed at a portion where the back yoke and the tooth **222** are connected, and the flange **313** is disposed at a portion where the back yoke and the tooth **223** are connected. The flange **314** is disposed at a portion where the back yoke and the tooth **224** are connected, the flange **315** is disposed at a portion where the back yoke and the tooth **225** are connected, and the flange **316** is disposed at a portion where the back yoke and the tooth **226** are connected.

(26) As further shown, the flange **311** has a recess **3110** that divides the flange **311** into two, the flange **312** has a recess **3120** that divides the flange **312** into two, and the flange **313** has a recess **3130** that divides the flange **313** into two. The flange **314** has a recess **3140** that divides the flange **314** into two, the flange **315** has a recess **3150** that divides the flange **315** into two, and the flange **316** has a recess **3160** that divides the flange **316** into two.

(27) According to the exemplary aspect, the insulator **30** includes multiple protrusions. More specifically, the upper cover **31** of the insulator **30** includes multiple protrusions (e.g., protrusion **321**, protrusion **322**, protrusion **323**, protrusion **324**, protrusion **325**, and protrusion **326**) that each has a shape protruding from the top surface of the upper cover **31** (e.g., the surface on the side opposite to the surface in contact with the back yoke of the stator core **21**). The multiple

protrusions are arranged outward of the multiple flanges.
(28) In side view of the insulator **30**, the multiple protrusions are arranged to overlap with part of the recess of each of the multiple flanges. More specifically, the protrusion **321** overlaps with part of the recess **3110** of the flange **311**, the protrusion **322** overlaps with part of the recess **3120** of the flange **312**, and the protrusion **323** overlaps with part of the recess **3130** of the flange **313**. The protrusion **324** overlaps with part of the recess **3140** of the flange **314**, the protrusion **325** overlaps with part of the recess **3150** of the flange **315**, and the protrusion **326** overlaps with part of the recess **3160** of the flange **316**.
(29) As illustrated in FIG. **3** and FIG. **4**, the insulator **30** has a plurality of through-holes, for example, a through-hole **391**, a through-hole **392**, and a through-hole **393**. Each of the through-hole **391**, the through-hole **392**, and the through-hole **393** passes through the insulator **30** (e.g., the upper cover **31** and lower cover **33**) from the top surface to the bottom surface.
(30) A hollow **290** is formed outside a portion of the stator core **21** where the back yoke and each of the multiple teeth are connected, and each of the through-hole **391**, the through-hole **392**, and the through-hole **393** is formed in a portion disposed in the hollow **290** of the insulator **30**. More specifically, the through-hole **391** is formed in the insulator **30** at the hollow **290** in a portion of the stator core **21** where the back yoke and the tooth **221** are connected, the through-hole **392** is formed in the insulator **30** at the hollow **290** in a portion of the stator core **21** where the back yoke and the tooth **222** are connected, and the through-hole **393** is formed in the insulator **30** at the hollow **290** in a portion of the stator core **21** where the back yoke and the tooth **223** are connected.
(31) As further shown in FIG. **4**, for example, the busbar conductor **70** is an annular flat plate having a predetermined width. The busbar conductor **70** overlaps with the back yoke of the stator core **21** in top view or bottom view. The busbar conductor **70** is disposed on a surface of the lower cover **33** of the insulator **30**, that is, on a surface opposite to a side where the insulator **30** is in contact with the back yoke of the stator core **21**.
(32) Each of the multiple coil conductors is formed of a single conductor, and the single conductor is formed of a terminal wiring conductor, multiple tooth conductors, a bridging line conductor, and a neutral-point connection conductor.
(33) More specifically, the coil conductor **410** is formed of a single conductor, and as a functional portion, the single conductor is formed of a terminal wiring conductor **411**, a first tooth conductor **41**, a bridging line conductor **412**, a second tooth conductor **42**, and a neutral-point connection conductor **413**. The coil conductor **510** is formed of a single conductor, and as a functional portion, the single conductor is formed of a terminal wiring conductor **511**, a first tooth conductor **51**, a bridging line conductor **512**, a second tooth conductor **52**, and a neutral-point connection conductor **513**. The coil conductor **610** is formed of a single conductor, and as a functional portion, the single conductor is formed of a terminal wiring conductor **611**, a first tooth conductor **61**, a bridging line conductor **612**, a second tooth conductor **62**, and a neutral-point connection conductor **613**.
(34) (Specific Arrangement (Routing) of Coil Conductor **410**)
(35) According to an exemplary aspect, the coil conductor **410** is disposed as follows.
(36) The terminal wiring conductor **411** is inserted through the through-hole **391** and routed from a lower side to an upper side of the back yoke of the stator core **21**. Furthermore, the terminal wiring conductor **411** passes over the top surface of a portion of the insulator **30** that overlaps with the back yoke of the stator core **21**, passes through the recess **3110**, is led to a side of the tooth **222** of the tooth **221**, and is connected to the first tooth conductor **41**.
(37) The first tooth conductor **41** is wound around the tooth **221** with the insulator **30** interposed therebetween. An end portion of the first tooth conductor **41**, on a side opposite to a side connected to the terminal wiring conductor **411**, is routed to a side of a top surface of a portion where the insulator **30** overlaps with the back yoke of the stator core **21**, along a side end of the flange **311** on a side of the tooth **226**. The end portion above is connected to the bridging line conductor **412**.
(38) As further shown, the bridging line conductor **412** is routed to the side of the tooth **222**

through the outer surface of the flange **311** and above a top surface of the protrusion **321**. The bridging line conductor **412** is routed to a portion of the flange **314** on a side of the flange **313** along outer surfaces of the flange **312** and the flange **313**, in substantially an arc shape as same as a shape of the back yoke of the stator core **21**. The bridging line conductor **412** passes through the recess **3140** from an outer surface of a portion of the flange **314** on the side of the flange **313**, is led to the tooth **224** on a side of the tooth **225**, and is connected to the second tooth conductor **42**.
(39) The second tooth conductor **42** is wound around the tooth **224** with the insulator **30** interposed therebetween. An end portion of the second tooth conductor **42**, on a side opposite to a side connected to the bridging line conductor **412**, is drawn out to a lower side of the tooth **224**, and is connected to the neutral-point connection conductor **413**.
(40) The neutral-point connection conductor **413** is routed to a position of the busbar conductor **70** between the tooth **224** and the tooth **225**, and is connected to the busbar conductor **70** by a conductive bonding material or the like.
(41) (Specific Arrangement (Routing) of Coil Conductor **510**)
(42) According to an exemplary aspect, the coil conductor **510** is disposed as follows.
(43) The terminal wiring conductor **511** is inserted through the through-hole **392** and routed from the lower side to the upper side of the back yoke of the stator core **21**. Furthermore, the terminal wiring conductor **511** passes over the top surface of a portion of the insulator **30** that overlaps with the back yoke of the stator core **21**, passes through the recess **3120**, is led to a side of the tooth **223** of the tooth **222**, and is connected to the first tooth conductor **51**.
(44) The first tooth conductor **51** is wound around the tooth **222** with the insulator **30** interposed therebetween. An end portion of the first tooth conductor **51**, on a side opposite to a side connected to the terminal wiring conductor **511**, is routed to the side of the top surface of the portion where the insulator **30** overlaps with the back yoke of the stator core **21**, along a side end of the flange **312** on a side of the tooth **221**. The end portion above is connected to the bridging line conductor **512**.
(45) The bridging line conductor **512** is routed to the side of the tooth **223** through the outer surface of the flange **312** and above a top surface of the protrusion **322**. The bridging line conductor **512** is routed to a portion of the flange **315** on a side of the flange **314** along outer surfaces of the flange **313** and the flange **314**, in substantially an arc shape as same as the shape of the back yoke of the stator core **21**. The bridging line conductor **512** passes through the recess **3150** from the outer surface of a portion of the flange **315** on the side of the flange **314**, is led to the tooth **225** on the side of the tooth **226**, and is connected to the second tooth conductor **52**.
(46) Moreover, the second tooth conductor **52** is wound around the tooth **225** with the insulator **30** interposed therebetween. An end portion of the second tooth conductor **52**, on a side opposite to a side connected to the bridging line conductor **512**, is drawn out to a lower side of the tooth **225**, and is connected to the neutral-point connection conductor **513**.
(47) The neutral-point connection conductor **513** is routed to a position of the busbar conductor **70** between the tooth **225** and the tooth **226**, and is connected to the busbar conductor **70** by a conductive bonding material or the like.
(48) (Specific Arrangement (Routing) of Coil Conductor **610**)
(49) According to an exemplary aspect, the coil conductor **610** is disposed as follows.
(50) The terminal wiring conductor **611** is inserted through the through-hole **393** and routed from the lower side to the upper side of the back yoke of the stator core **21**. Furthermore, the terminal wiring conductor **611** passes over the top surface of a portion of the insulator **30** that overlaps with the back yoke of the stator core **21**, passes through the recess **3130**, is led to a side of the tooth **224** of the tooth **223**, and is connected to the first tooth conductor **61**.
(51) The first tooth conductor **61** is wound around the tooth **223** with the insulator **30** interposed therebetween. An end portion of the first tooth conductor **61**, on a side opposite to a side connected to the terminal wiring conductor **611**, is routed to the side of the top surface of the portion where

the insulator **30** overlaps with the back yoke of the stator core **21**, along a side end of the flange **313** on the side of the tooth **222**. The end portion above is connected to the bridging line conductor **612**.

(52) The bridging line conductor **612** is routed to the side of the tooth **224** through the outer surface of the flange **313** and above a top surface of the protrusion **323**. The bridging line conductor **612** is routed to a portion of the flange **316** on a side of the flange **315** along outer surfaces of the flange **314** and the flange **315**, in substantially an arc shape as same as the shape of the back yoke of the stator core **21**. The bridging line conductor **612** passes through the recess **3160** from the outer surface of a portion of the flange **316** on the side of the flange **315**, is led to the tooth **226** on the side of the tooth **221**, and is connected to the second tooth conductor **62**.

(53) The second tooth conductor **62** is wound around the tooth **226** with the insulator **30** interposed therebetween. An end portion of the second tooth conductor **62**, on a side opposite to a side connected to the bridging line conductor **612**, is drawn out to a lower side of the tooth **226**, and is connected to the neutral-point connection conductor **613**.

(54) The neutral-point connection conductor **613** is routed to a position of the busbar conductor **70** between the tooth **226** and the tooth **221**, and is connected to the busbar conductor **70** by a conductive bonding material or the like.

(55) In the configuration above, tooth **221** and tooth **224** are designated as U-phase teeth, and the coil conductor **410** is designated as a U-phase coil conductor, for example. Moreover, tooth **222** and tooth **225** are designated as V-phase teeth, and the coil conductor **510** is designated as a V-phase coil conductor. Finally, tooth **223** and tooth **226** are designated as W-phase teeth, and the coil conductor **610** is designated as a W-phase coil conductor. As a result, the stator assembly **10** provides the circuit connection illustrated in FIG. **1** described above. It should be appreciate that while only one pair of teeth is shown for each of the three phases, the number of teeth for each phase can be any number n of teeth, with n being a number greater than or equal to two according to alternative exemplary embodiments.

(56) Moreover, in the configuration above, portions of multiple coil conductors to be made bridge between multiple teeth are routed to a side of a top surface of the back yoke of the stator core **21** and the insulator **30**, and portions to connect teeth to a neutral-point are routed from the teeth through an inside of the back yoke to a side of a bottom surface of the back yoke of the stator core **21** and the insulator **30**. Further, portions of the multiple coil conductors from terminals to the teeth are arranged routing from an outer surface to the top surface of the insulator **30**. This configuration suppresses arrangement of portions of multiple coil conductors having a large electric potential difference in proximity to each other. Accordingly, the stator assembly **10** provides high insulation reliability.

(57) Further, in the configuration above, since the bridging line conductor **412** passes through a side of a top surface of the protrusion **321** and the terminal wiring conductor **411** passes through a side of a side surface of the protrusion **321**, the bridging line conductor **412** and the terminal wiring conductor **411** may be separated from each other with a predetermined distance. Since the bridging line conductor **512** passes through a side of a top surface of the protrusion **322** and the terminal wiring conductor **511** passes through a side of a side surface of the protrusion **322**, the bridging line conductor **512** and the terminal wiring conductor **511** may be separated from each other with a predetermined distance. Since the bridging line conductor **612** passes through a side of a top surface of the protrusion **323** and the terminal wiring conductor **611** passes through a side of a side surface of the protrusion **323**, the bridging line conductor **612** and the terminal wiring conductor **611** may be separated from each other with a predetermined distance.

(58) As a result, both ends of the first tooth conductor **41** do not come into contact with each other when they cross, and arrangement in proximity may be suppressed. Similarly, both ends of the first tooth conductor **51** do not come into contact with each other when they cross, and arrangement in proximity may be suppressed. Further, both ends of the first tooth conductor **61** do not come into

contact with each other when they cross, and arrangement in proximity may be suppressed. Accordingly, the stator assembly **10** achieves higher insulation reliability.

(59) Further, in the configuration above, the bridging line conductor **412** and the bridging line conductor **512** are arranged parallel to each other in a section from the flange **312** to an end portion of the flange **313** on a side of the flange **312**. The bridging line conductor **412**, the bridging line conductor **512**, and the bridging line conductor **612** are arranged parallel to each other in a section from the flange **313** to a portion of the flange **314** on the side of the flange **313**. The bridging line conductor **512** and the bridging line conductor **612** are arranged parallel to each other in a section from a portion of the flange **314** on the side of the flange **315** to a portion of the flange **315** on the side of the flange **314**. As described above, the multiple coil conductors that form the different phases are routed in parallel with each other, and all the multiple coil conductors are ending terminals of the tooth conductors. The electric potential difference between the ending terminals of the tooth conductors is smaller than the electric potential difference between a starting terminal and the ending terminal of each tooth conductor. Accordingly, even when there is a portion where the tooth conductors are arranged in parallel with each other, problem in insulation does not occur. As a result, the stator assembly **10** achieves higher insulation reliability.

(60) Further, in the configuration above, the terminal wiring conductor **411**, the terminal wiring conductor **511**, and the terminal wiring conductor **611** each are routed from a side of a top surface to a side of a bottom surface of the stator core **21** and the insulator **30** through the through-hole **391**, the through-hole **392**, and the through-hole **393** of the insulator **30**. As a result, a drive signal application terminal may be disposed on a side of a bottom surface of the stator assembly **10**. Accordingly, the drive signal application terminal can be disposed to be separated from the bridging line conductor of each of the multiple coil conductors.

(61) At this time, in the stator assembly **10**, a short circuit may be suppressed between the stator core **21** and each of the terminal wiring conductor **411**, the terminal wiring conductor **511**, and the terminal wiring conductor **611** by insertion of the wiring conductors into the through-hole **391**, the through-hole **392**, and the through-hole **393**.

(62) (Method for Assembling Stator Assembly **10**)

(63) The stator assembly **10** having the above-described configuration is assembled as follows, for example. FIG. **6**(A), FIG. **6**(B), FIG. **6**(C), and FIG. **6**(D) are top views illustrating respective states in a manufacturing process of the stator assembly according to the first embodiment. Note that, in FIG. **6**(A), FIG. **6**(B), FIG. **6**(C), and FIG. **6**(D), reference signs are omitted as appropriate to facilitate viewing drawings, and reference signs not illustrated in FIG. **6**(A), FIG. **6**(B), FIG. **6**(C), and FIG. **6**(D) will be described with reference to FIG. **4**.

(64) The stator core **21** including a back yoke and multiple teeth is prepared, and the insulator **30** is attached to the core.

(65) As illustrated in FIG. **6**(A), the coil conductor **610** (i.e., terminal wiring conductor **611**) is inserted into the through-hole **393**, is passed through the recess **3130**, and is led to the tooth **223**. The coil conductor **610** (i.e., first tooth conductor **61**) is wound around the tooth **223** with the insulator **30** interposed therebetween.

(66) As illustrated in FIG. **6**(B), the coil conductor **610** (i.e., bridging line conductor **612**) is wired along the flange **313**, the flange **314**, the flange **315**, and a portion of the flange **316** on the side of the flange **315**, is passed through the recess **3160**, and is led to the tooth **226**. The coil conductor **610** (i.e., second tooth conductor **62**) is wound around the tooth **226** with the insulator **30** interposed therebetween. The coil conductor **610** (i.e., neutral-point connection conductor **613**) is drawn out to a lower side of the tooth **226**.

(67) The coil conductor **510** is wound around the tooth **222**, adjacent to the tooth **223** around which the coil conductor **610** is wound, on a side opposite to a side from which the bridging line conductor **612** is drawn out. Specifically, as illustrated in FIG. **6**(C), the coil conductor **510** (i.e., terminal wiring conductor **511**) is inserted into the through-hole **392**, is passed through the recess

3120, and is led to the tooth **222**. The coil conductor **510** (i.e., first tooth conductor **51**) is wound around the tooth **222** with the insulator **30** interposed therebetween.
(68) As illustrated in FIG. **6**(C), the coil conductor **510** (i.e., bridging line conductor **512**) is wired along the flange **312**, the flange **313**, the flange **314**, and a portion of the flange **315** on the side of the flange **314**, is passed through the recess **3150**, and is led to the tooth **225**. The coil conductor **510** (i.e., second tooth conductor **52**) is wound around the tooth **225** with the insulator **30** interposed therebetween. The coil conductor **510** (i.e., neutral-point connection conductor **513**) is drawn out to a lower side of the tooth **225**.
(69) The coil conductor **410** is wound around the tooth **221**, adjacent to the tooth **222** around which the coil conductor **510** is wound, on a side opposite to a side from which the bridging line conductor **512** is drawn out. Specifically, as illustrated in FIG. **6**(D), the coil conductor **410** (i.e., terminal wiring conductor **411**) is inserted into the through-hole **391**, is passed through the recess **3110**, and is led to the tooth **221**. The coil conductor **410** (i.e., first tooth conductor **41**) is wound around the tooth **221** with the insulator **30** interposed therebetween.
(70) As illustrated in FIG. **6**(D), the coil conductor **410** (i.e., bridging line conductor **412**) is wired along the flange **311**, the flange **312**, the flange **313**, and a portion of the flange **314** on the side of the flange **313**, is passed through the recess **3140**, and is led to the tooth **224**. The coil conductor **410** (i.e., second tooth conductor **42**) is wound around the tooth **224** with the insulator **30** interposed therebetween. The coil conductor **410** (i.e., neutral-point connection conductor **413**) is drawn out to a lower side of the tooth **224**.
(71) The coil conductor **410** (i.e., neutral-point connection conductor **413**), the coil conductor **510** (i.e., neutral-point connection conductor **513**), and the coil conductor **610** (i.e., neutral-point connection conductor **613**) each are connected to the busbar conductor **70**.
(72) That is, each of the coil conductor **410**, the coil conductor **510**, and the coil conductor **610** forming each phase is wound in order in an annular shape. At this time, as a tooth around which a first tooth conductor is wound in a coil conductor of each phase, there is used a tooth, with respect to a tooth around which an already wound first tooth conductor of a different phase is wound, on a side opposite to a side at which a bridging line conductor is wired from the first tooth conductor to a second tooth conductor of the different phase. As a result, with the configuration above, even in a configuration in which the bridging line conductors of the respective phases are arranged in parallel and the tooth conductors of the respective phases are arranged in order in an annular shape, the coil conductors of the respective phases may easily and reliably be wound.
(73) By using the assembling method above, the stator assembly **10** having the above-described configuration may easily be assembled.

Second Exemplary Embodiment

(74) A stator assembly according to a second exemplary embodiment of the present invention will be described with reference to the drawing.
(75) FIG. **7** is a perspective view of the stator assembly according to the second embodiment. As illustrated in FIG. **7**, a stator assembly **10**A according to the second embodiment is different from the stator assembly **10** according to the first embodiment in that the multiple protrusions are omitted. Other configurations of the stator assembly **10**A are the same as those of the stator assembly **10**, and description of the same portions will be omitted.
(76) Even with the configuration above, the stator assembly **10**A may inhibit arrangement of the portions of the multiple coil conductors that form respective phases having the largest voltage difference in proximity to each other, thereby achieving high insulation reliability.
(77) Note that, in the description above, an aspect has been described in which teeth and coil conductors of 3 phases×2 pieces are used. However, the configuration above such as the routing of the bridging line conductor may also be applied to an aspect in which teeth and coil conductors of 3 phases×m pieces=N pieces (i.e., each of m and N being a natural number) are used.

REFERENCE SIGNS LIST

(78) **10**, **10**A STATOR ASSEMBLY **21** STATOR CORE **30** INSULATOR **31** UPPER COVER **33** LOWER COVER **41** FIRST TOOTH CONDUCTOR **42** SECOND TOOTH CONDUCTOR **51** FIRST TOOTH CONDUCTOR **52** SECOND TOOTH CONDUCTOR **61** FIRST TOOTH CONDUCTOR **62** SECOND TOOTH CONDUCTOR **70** BUSBAR CONDUCTOR **101**U U-PHASE COIL **101**V V-PHASE COIL **101**W W-PHASE COIL **102**U, **102**V, **102**W INPUT TERMINAL **103** NEUTRAL-POINT **221**, **222**, **223**, **224**, **225**, **226** TOOTH **290** HOLLOW **311**, **312**, **313**, **314**, **315**, **316** FLANGE **321**, **322**, **323**, **324**, **325**, **326** PROTRUSION **391**, **392**, **393** THROUGH-HOLE **410**, **510**, **610** COIL CONDUCTOR **411**, **511**, **611** TERMINAL WIRING CONDUCTOR **412**, **512**, **612** LINE CONDUCTOR **413**, **513**, **613** NEUTRAL-POINT CONNECTION CONDUCTOR **3110**, **3120**, **3130**, **3140**, **3150**, **3160** RECESS

Claims

1. A stator assembly, comprising: a stator core including a back yoke disposed in an annular shape and a plurality of teeth extending from the back yoke toward a central axis of the annular shape; an insulator disposed to sandwich the stator core from a top and bottom thereof; and a coil conductor wound around a portion of the insulator that covers the plurality of teeth, wherein the plurality of teeth include N teeth from a first tooth to an N-th tooth for each of a U-phase, a V-phase, and a W-phase, which are repeatedly arranged in order along the annular shape, where N is a natural number, wherein the coil conductor includes a respective coil conductor for each of the U-phase, the V-phase, and the W-phase, wherein the coil conductor in each phase has a first end configured as a terminal wiring conductor and a second end configured as a neutral-point connection conductor, and the terminal wiring conductor and the neutral-point connection conductor are connected by tooth conductors wound around teeth among the N teeth and a bridging line conductor that bridges the tooth conductors wound around the teeth, wherein the terminal wiring conductor is connected to a first tooth conductor among the N teeth at an upper side of the insulator, wherein the bridging line conductor is disposed on the upper side of the insulator disposed on the stator core and is disposed along an outer side of a tooth of a different phase, and wherein the neutral-point connection conductor is connected to an N-th tooth conductor among the N teeth at a lower side of the insulator.
2. The stator assembly according to claim 1, wherein the plurality of teeth are successively arranged in an annular shape in a top view in an order of a first U-phase tooth, a first V-phase tooth, and a first W-phase tooth to an N-th U-phase tooth, an N-th V-phase tooth, and an N-th W-phase tooth.
3. The stator assembly according to claim 2, wherein the coil conductor includes a U-phase coil conductor, a V-phase coil conductor, and a W-phase coil conductor, and wherein: the U-phase coil conductor includes a U-phase bridging line conductor that connects a 1U-phase tooth conductor wound around the first U-phase tooth to an NU-phase tooth conductor wound around the N-th U-phase tooth, the V-phase coil conductor includes a V-phase bridging line conductor that connects a 1V-phase tooth conductor wound around the first V-phase tooth to an NV-phase tooth conductor wound around the N-th V-phase tooth, and the W-phase coil conductor includes a W-phase bridging line conductor that connects a 1W-phase tooth conductor wound around the first W-phase tooth to an NW-phase tooth conductor wound around the N-th W-phase tooth.
4. The stator assembly according to claim 3, wherein the U-phase bridging line conductor, the V-phase bridging line conductor, and the W-phase bridging line conductor are routed in a direction in an order in which the N-th W-phase tooth and the N-th V-phase tooth are arranged.
5. The stator assembly according to claim 1, wherein the insulator includes a plurality of flanges that protrude from a top surface of portions overlapping with the stator core and from which the plurality of teeth protrude.
6. The stator assembly according to claim 5, wherein each of the plurality of flanges has a recess at

a center.
7. The stator assembly according to claim 6, wherein the terminal wiring conductor is led to a side of a tooth of the plurality of teeth through the recess.
8. The stator assembly according to claim 7, wherein the bridging line conductor is disposed along outer surfaces of the plurality of flanges.
9. The stator assembly according to claim 7, wherein: the insulator includes a protrusion lower than the flanges in part of a portion overlapping with the recess, the terminal wiring conductor is disposed on a side of a side surface of the protrusion, and the bridging line conductor is disposed on a side of a top surface of the protrusion.
10. The stator assembly according to claim 1, further comprising bridging lines of the respective phases that are arranged parallel to each other.
11. The stator assembly according to claim 1, wherein the insulator includes a through-hole extending from a top surface to a bottom surface of the insulator at a position on an outer side portion of a tooth of the plurality of teeth.
12. The stator assembly according to claim 11, wherein the terminal wiring conductor is inserted through the through-hole.
13. The stator assembly according to claim 1, further comprising a busbar conductor having an annular shape and disposed on a bottom surface of the insulator.
14. The stator assembly according to claim 13, wherein the neutral-point connection conductor is connected to the busbar conductor.
15. The stator assembly according to claim 1, wherein the back yoke is a magnetic body.
16. The stator assembly according to claim 1, wherein the plurality of teeth are columnar bodies extending from an inner wall surface of the back yoke toward the central axis of the annular shape.
17. A stator assembly, comprising: a stator core including a back yoke having an annular shape and a plurality of teeth that extend from the back yoke toward a central axis of the annular shape; an insulator that sandwiches the stator core; and a plurality of coil conductors wound around a portion of the insulator that covers the plurality of teeth, respectively, wherein the plurality of teeth include a plurality teeth having a U-phase, a plurality teeth having a V-phase, and a plurality of teeth having a W-phase, which are alternately arranged in order along the annular shape, wherein the plurality of coil conductors in each phase each have a first end configured as a terminal wiring conductor and a second end configured as a neutral-point connection conductor, and the terminal wiring conductor and the neutral-point connection conductor are connected by tooth conductors wound around respective teeth and a bridging line conductor that bridges the tooth conductors wound around the teeth, wherein the terminal wiring conductor is connected to a first tooth conductor of the plurality of teeth at an upper side of the insulator, and wherein the bridging line conductor is disposed on the upper side of the insulator disposed on the stator core and is disposed along an outer side of a tooth of a different phase.
18. The stator assembly according to claim 17, further comprising a busbar conductor having an annular shape and disposed on a bottom surface of the insulator, with the busbar conductor being connected to the neutral-point connection conductor.
19. A method for assembling a stator assembly that includes a stator core having a back yoke disposed in an annular shape and a plurality of teeth extending from the back yoke toward a central axis of the annular shape, an insulator sandwiching the stator core from a top and a bottom thereof, and a coil conductor wound around a portion of the insulator that covers the plurality of teeth, the method comprising: configuring the plurality of teeth with N teeth from a first tooth to an N-th tooth for each of a U-phase, a V-phase, and a W-phase, and arranging the teeth of each phase repeatedly in order along the annular shape, where N is a natural number; connecting a terminal wiring conductor and a neutral-point connection conductor, in which the terminal wiring conductor and the neutral-point connection conductor each are configured as a first end and a second end of the coil conductor of each of the U-phase, the V-phase, and the W-phase, by tooth conductors

wound around teeth among the N teeth and a bridging line conductor that bridges the tooth conductors wound around the teeth; connecting the terminal wiring conductor to a first tooth conductor among the N teeth at an upper side of the insulator; disposing the bridging line conductor on an upper side of the insulator disposed on the stator core, and along an outer side portion of a tooth of a different phase; and connecting the neutral-point connection conductor to an N-th tooth conductor among the N teeth at a lower side of the insulator.

20. The method for assembling a stator assembly according to claim 19, further comprising winding a first tooth conductor of a phase to be newly wound around a tooth disposed adjacent to a tooth, around which a first tooth conductor of a different phase has already been wound, on a side opposite to a side on which a bridging line conductor is wired from the first tooth conductor of the other phase to a next tooth conductor of the other phase.