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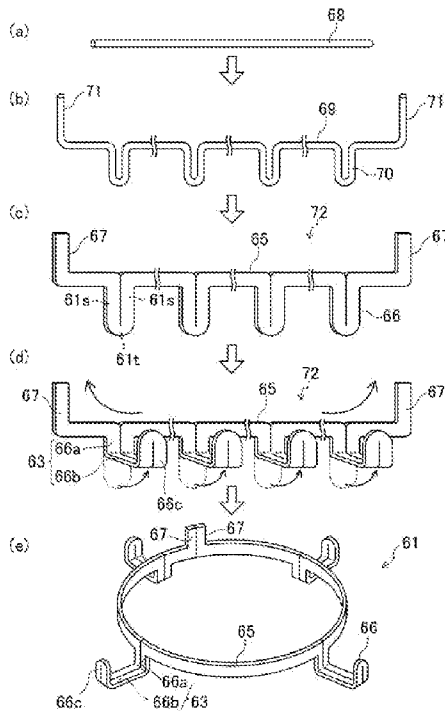
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[Continued on next page]

(54) Title: BUS BAR, MOTOR, AND PROCESS FOR PRODUCING THESE

[Fig. 6]



(57) Abstract: The present invention relates to a method for manufacturing a bus bar which electrically connects the end parts of a plurality of conductive lines. An intermediate region of a single wire rod is folded to form a plurality of terminal forming parts extending to a lateral direction of the wire rod. The whole wire rod including the terminal forming part is rolled. The rolled wire rod is bent into a certain shape.

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Description

Title of Invention: BUS BAR, MOTOR, AND PROCESS FOR PRODUCING THESE

Technical Field

[0001] The present invention relates to a bus bar for electrically connecting with the end part of a plurality of conductive lines led out from a coil, and a process for producing the same.

Background Art

[0002] A press-molded, strip-shaped conductor is commonly used for the present type of a bus bar. A strip-shaped conductor is usually formed by punching a metal plate into an intermediate member with a certain shape laying out a strip-shaped conductor, and then bending a certain portion of said intermediate member e.g. JP-A 2000-333400.

[0003] Further, in addition to the strip-shaped conductor, a rotating electrical machine is disclosed JP-B 3650372, which intactly uses a conductive line as a connecting conductor bus bar. The connecting conductor disclosed in JP-B 3650372 is formed by bending a conductive line with a circular or rectangular cross section into a certain shape. Specifically, a ring-shaped receiving part, and a terminal part for coil connection protruding from four places of said receiving part toward the external diameter direction in a radial shape are formed by bending a single conductive line having a circular cross section.

[0004] The terminal part for coil connection is formed by bending and folding the conductive line by 180 degrees at a front end. In order to prevent the folded conductive line from being spread again, the base of the terminal part for coil connection is joined by TIG welding. On the front end of the terminal part for coil connection, a ring-shaped part is formed for inserting a lead line of the coil. Also, a connecting conductor formed by levelling the receiving section in the diameter direction into a flat shape is disclosed as well.

[0005] In the rotating electrical machine, three connecting conductors in such form are received in a ring-shaped holder. The holder has three receiving grooves with different depths, arranged in a concentrically circular form, where receiving parts of each connecting conductor are respectively received.

[0006] Generally, a bus bar has protruding terminals formed on multiple places, and therefore its layout form is complicated. Accordingly, when a bus bar is formed by punching a metal plate into an intermediate member to produce a strip-shaped conductor, metal scraps are generated after the punching process and causes a decrease in the yield rate. Various studies regarding the shape of the bus bar or the positioning

of the intermediate member when punching the metal plate are being conducted in order to improve the yield rate; however, the current situation is that several tens percent of metal plate are being wasted.

[0007] In such regard, when producing a connecting conductor by using a conductive line as in JP-B 3650372, metal scraps are not generated and the problem of yield rate as in the strip-shaped conductor does not occur.

Citation List

Patent Literature

[0008] PTL 1: JP-A 2000-333400

PTL 2: JP-B 3650372

Summary of Invention

Technical Problem

[0009] However, since the connecting conductor in JP-B 3650372 forms the terminal part for coil connection only by folding the conductive line, it requires welding of the base part, which is a disadvantage in workability. Also, the connecting conductor is difficult to be received in the holder due to the thickness of the terminal part for coil connection, which makes it difficult to handle compared to the strip-shaped conductor. Further, in the terminal part for coil connection of JP-B 3650372, a plurality of coil lead lines are simultaneously inserted to the end part for coil connection, either caulking or welding is required, and manual operations or arrangements of complex manufacturing devices or processes are required.

Solution to Problem

[0010] The first embodiment of the present invention is a method for manufacturing a bus bar which electrically connects end parts of a plurality of conductive lines. The method comprises a step of forming a plurality of terminal forming parts, a step of rolling the whole wire rod, and a step of bending the wire rod into a certain shape. In the step of forming a plurality of terminal forming parts, the intermediate portion of a single wire rod is folded to form a plurality of terminal forming parts which protrude toward a lateral direction of the wire rod. In the step of rolling the whole wire rod, the whole wire rod is rolled including the terminal forming part. In the step of bending the wire rod into a certain shape, the rolled wire rod is bent into a certain shape.

[0011] The bus bar according to the second embodiment of the present invention comprises a body part in a plate-shape, and a plurality of terminal parts in a plate-shape integrally formed with the body part to correspond to the arrangement of end parts of the conductive lines. The terminal part has a terminal protrusion part comprising a pair of extending parts which protrude toward a lateral direction from the body part, facing each other, and a terminal front end extending from the terminal protrusion part.

[0012] The third embodiment of the present invention is a method for manufacturing a bus bar which electrically connects end parts of a plurality of conductive lines. The present method comprises a step of forming a plurality of terminal forming parts, a step of forming a connecting end forming part, a step of rolling the whole wire rod, and a step of bending the wire rod into a certain shape. In the step of forming a plurality of terminal forming parts, a single, linear-shaped wire rod is folded in the intermediate portion to form a plurality of terminal forming parts which protrude toward a lateral direction of the wire rod. In the step of forming a connecting end forming part, each of both ends of a wire rod is folded in the opposite direction from the terminal forming part with respect to the linear-shaped wire rod. In the step of rolling the whole wire rod, the rolling process is performed on the whole wire rod including the terminal forming part. In the step of bending the wire rod into a certain shape, the rolled wire rod is bent into a certain shape.

[0013] As explained above, the present invention provides a bus bar that can be handled easily as a strip-shaped conductor, and does not have the problem of yield rate.

Brief Description of Drawings

[0014] [fig.1]FIG. 1 is a schematic sectional view illustrating the motor according to an embodiment.

[fig.2]FIG. 2 is a schematic perspective view illustrating the divisional stator.

[fig.3]FIG. 3 is a schematic perspective view illustrating the stator and the bus bar unit.

[fig.4]FIG. 4 is a disassembled perspective view schematically illustrating the bus bar unit.

[fig.5]FIG. 5 is a schematic perspective view viewing the bus bar unit from the rear surface.

[fig.6a]FIG. 6a is a schematic view illustrating the bus bar and the manufacturing process thereof.

[fig.6b]FIG. 6b is a schematic view illustrating the bus bar and the manufacturing process thereof.

[fig.6c]FIG. 6c is a schematic view illustrating the bus bar and the manufacturing process thereof.

[fig.6d]FIG. 6d is a schematic view illustrating the bus bar and the manufacturing process thereof.

[fig.6e]FIG. 6e is a schematic view illustrating the bus bar and the manufacturing process thereof.

[fig.7]FIG. 7 is a schematic plane view viewing the bus bar unit from the rear surface.

[fig.8a]FIG. 8a is a schematic sectional view illustrating a principal part in line A-A of FIG. 7.

[fig.8b]FIG. 8b is a schematic sectional view illustrating a principal part in line B-B of FIG. 7.

[fig.8c]FIG. 8c is a schematic sectional view illustrating a principal part in line C-C of FIG. 7.

[fig.8d]FIG. 8d is a schematic sectional view illustrating a principal part in line D-D of FIG. 7.

[fig.9]FIG. 9 is a schematic plane view of the stator.

[fig.10]FIG. 10 is a schematic view illustrating a principal part of the motor.

[fig.11]FIG. 11 is a schematic view viewed from the direction of Arrow E illustrated in FIG. 10.

[fig.12]FIG. 12 is a schematic view for explaining the connection between the end part and the wire end.

[fig.13a]FIG. 13a is a schematic side view illustrating the region where the end part and the wire end are joined.

[fig.13b]FIG. 13b is a schematic front view illustrating the region where the end part and the wire end are joined.

[fig.14]FIG. 14 is a schematic sectional view illustrating the motor according to another embodiment.

[fig.15]FIG. 15 is a schematic perspective view illustrating the bus bar unit according to another embodiment. Parts of the bus bar unit are omitted in order to show the inner structure.

[fig.16a]FIG. 16a is a schematic view illustrating the bus bar and the manufacturing process thereof in another embodiment.

[fig.16b]FIG. 16b is a schematic view illustrating the bus bar and the manufacturing process thereof in another embodiment.

[fig.16c]FIG. 16c is a schematic view illustrating the bus bar and the manufacturing process thereof in another embodiment.

[fig.16d]FIG. 16d is a schematic view illustrating the bus bar and the manufacturing process thereof in another embodiment.

[fig.17]FIG. 17 is a schematic view illustrating a modified embodiment of the motor.

[fig.18a]FIG. 18a is a schematic view illustrating a modified embodiment of the bus bar and the manufacturing process thereof.

[fig.18b]FIG. 18b is a schematic view illustrating a modified embodiment of the bus bar and the manufacturing process thereof.

[fig.18c]FIG. 18c is a schematic view illustrating a modified embodiment of the bus bar and the manufacturing process thereof.

Examples

[0015] Set forth below are detailed descriptions of embodiments of the present invention

based on the drawings. Yet, the descriptions below are substantially examples, and they do not necessarily imply any limitations on the present invention, where it is applied to or how it is used.

[0016] FIG. 1 illustrates the motor according to the present embodiment. The motor 1 is an inner-rotor type brushless motor. The motor 1 comprises a casing 2, a shaft 3, a rotor 4, a stator 5, a bus bar unit 6, and a rotation angle sensor 7. The centers of the rotor 4, the stator 5, and the bus bar unit 6 are positioned so that they all approximately coincide with the central axis A.

[0017] The casing 2 comprises a cylindrical casing 11 having an opening at one end, and a disc-shaped cover 12. Around the opening end of the casing 11, a flange 11a is protruded. The cover 12 is fixedly joined to the flange 11a. A shaft window 12a is opened on the center portion of the cover 12. A bearing part 11b is formed on the bottom surface of the casing 11 to be opposed to the shaft window 12a. The shaft 3 is provided inside the casing 11 closed by the cover 12.

[0018] A bearing 8 is provided in each inside of the bearing part 11b and the shaft window 12a. The shaft 3 is rotatably supported with respect to the casing 2 through the bearings 8, 8. One end part of the shaft 3 is protruded toward the outside of the cover 12 through the shaft window 12a. The rotation driving power of the motor 1 is outputted through the end part.

On the center portion of the shaft 3, a rotor 4 is fixed in a concentric manner. The rotor 4 comprises a cylindrical rotor core 41 and a magnet 42. The magnet 42 is provided on the outer circumferential surface of the rotor core 41. The magnetic poles of the magnet 42 are arranged so that the N-pole and the S-pole is alternatively disposed in a circumferential direction. A cylindrical stator 5 is arranged on the circumference of the rotor 4. The stator 5 is fixed on the inside of the casing 11. The inner circumferential surface of the stator 5 is disposed to face the outer circumferential surface of the rotor 4 with a slight interval therebetween.

[0019] The stator 5 is formed by connecting a plurality of 12 in the present embodiment divisional stators 50. As illustrated in FIG. 2, the divisional stator 50 comprises a divisional core 51, an insulator 52, a coil 53, and a resin layer 54. Specifically, the divisional core 51 is formed by layering a plurality of approximately T-shaped steel sheets. The divisional core 51 comprises a core back 51a and a teeth 51b extending toward the center of a diameter direction from the center portion of the core back 51a, the both of which are connected to each other. An insulator 52 having an insulating property is installed on the divisional core 51.

[0020] The coil 53 is formed by winding a conductive line such as copper wire with enamel coating onto each teeth 51b provided with an insulator 52. Accordingly, in the present embodiment, 12 coils 53 are provided. Two end parts of the conductive line [wire end

55] wound around the teeth 51b are both led out from one end part of the divisional stator 50. These wire ends 55 become parallel to the shaft 3 when installed in the motor 1. Also, since the wire end 55 is led out from every divisional stator 50, 24 wire ends 55 are led out from the stator 5 in the present embodiment.

[0021] The coil 53 is molded by a resin layer 54 except for the front ends of the two wire ends 55. Since the base end of the wire end 55 is molded with the resin layer 54, the wire end 55 is positioned at a certain location. Also, by molding the base end with the resin layer 54, the front end of the wire end 55 protruded from the resin layer 54 becomes difficult to be bent, which makes it possible to stably keep the front end of the wire end 55 in a straight line. Further, since the wire end 55 is molded in a fixed state by a jig, the positioning accuracy of the protruding part of the wire end 55 increases more, in comparison to an unmolded wire end. Therefore, the connecting process of the wire end 55 and a terminal part 66 described later can be easily performed. The arrangement of the wire end 55 will be further described later.

[0022] As illustrated in FIG. 3, a bus bar unit 6 is attached to one end end part at the opening side and the output side of the casing 11 of the stator 5 where the wire ends 55 are led out.

[0023] As illustrated in FIG. 4 and FIG. 5, the bus bar unit 6 comprises a plurality 4 in the present embodiment of bus bars 61, and an insulating adapter 62 supporting the bus bars 61.

bus bar

[0024] The bus bar 61 according to the present embodiment comprises three phase bus bars 61u, 61v, 61w respectively connected to U-phase, V-phase, W-phase of the stator 5, and one common bus bar 61x connected to a neutral point. That is, each coil 53 of the present embodiment is arranged in Y-connection.

[0025] The bus bar 61 is a strip-shaped conductor having approximately same thickness along the length. The bus bar 61 comprises a body part 65 in a strip plate shape curved into a ring around the central axis A, and a plurality of terminal parts 66 in a strip plate shape are integrally formed with the body part 65. The body part 65 and the terminal part 66 are made of one member. In the present embodiment, 4 pieces of terminal parts 66u, 66v, 66w are formed on each of the body parts 65u, 65v, 65w of the phase bus bars 61u, 61v, 61w. Also, 12 pieces of terminal part 66x are formed on the body part 65x of the common bus bar 61x. Hereinafter, when there is no need to identify the U-phase, V-phase, W-phase, and common phase, they will be referred as the bus bar 61 without specifying u, v, w, and x.

[0026] Also, each of the phase bus bars 61u, 61v, 61w has two connecting end parts 67u, 67v, 67w in a strip plate shape in some cases, one connecting end part by joining each other integrally formed with the body part 65. The connecting end parts 67u, 67v, 67w

are made of one member together with the body part 65 and the terminal part 66. The connecting end part 67 is preferably formed in a rectangular shape, and is extended toward an axial direction from each of both ends of the body part 65. Further, an axial direction refers to the direction along the central axis A, hereinafter, will be referred to as the axial direction. The connecting end part 67 is formed to be opposed to the terminal part 66 in the axial direction with the body part 65 therebetween. Each of the terminal part [6666u, 66v, 66w, 66x] is preferably formed with a hook shape, and arranged in a certain position at the lateral end of the body part 65. The terminal part 66 has a terminal protrusion part 63 protruded toward a lateral direction from an intermediate region of the body part 65 in the length direction, and a terminal front end 66c extending from the front end of the terminal protrusion part 63. Specifically, the terminal protrusion part 63 has a terminal base 66a and a terminal intermediate 66b. The terminal base 66a having a short length, protrudes toward a lateral direction from a certain position of the lateral end of the body part 65 and extends toward a direction approximately orthogonal to the body part 65. The terminal intermediate 66b extends from the front end of the terminal base 66a, and bends to the radial direction of the body part 65 to extend toward a direction approximately orthogonal to the terminal base 66a. The terminal front end 66c extends from the terminal intermediate 66b, bends to be opposed to the body part 65, and to extend toward a direction approximately orthogonal to the terminal intermediate 66b.

manufacturing method of a bus bar

[0027] A bus bar 61 is formed by processing a single bare wire e.g. bare copper wire 68 without insulated coating.

[0028] FIG. 6 illustrates the manufacturing process of a bus bar 61. First of all, as illustrated in FIG. 6a, a single bare copper wire 68 wire rod having a certain length is prepared. The bare copper wire 68 can be a commercial product, for example, having a diameter of about 2mm. Subsequently, as illustrated in FIG. 6b, by folding the bare copper wire 68, a body forming part 69 to form the body part 65, a terminal forming part 70 to form the terminal part 66, and a connecting end forming part 71 to form the connecting end part 67 are formed. Specifically, when forming the terminal forming part 70, a certain position at the intermediate region of the bare copper wire 68 is bent, and then the parts of the bare copper wire 68 extending from the bent point and opposing each other are made to get closer to be substantially parallel. The bare copper wire 68 is bent at a certain position by approximately 90 degrees to the opposite direction of the front end of the bent bare copper wire 68.

[0029] By repeating this procedure, a plurality of terminal forming parts 70 protruding approximately orthogonally to the body forming part 69 extending in a straight line in the lateral direction are formed. 4 terminal forming parts 70 are formed in the phase bus

bar 61, and 12 terminal forming parts 70 are formed in the common bus bar 61x. All terminal forming parts 70 are arranged on the same side of the body forming part 69. The connecting end forming part 71 is formed by bending each of both ends of the bare copper wire 68 by approximately 90 degrees to the opposite side of the terminal forming part 70 with respect to the body forming part 69. The terminal forming part 70 and the connecting end forming part 71 are formed on the same plane in a parallel position from each other. Since the common bus bar 61x does not have a connecting end part 67, connecting end forming part 71 is not formed in the common bus bar 61x.

[0030] Subsequently, as illustrated in FIG. 6c, the intermediate member 72 is formed by rolling the whole bare copper wire 68 where the terminal forming part 70 is formed, in a direction orthogonal to the bending direction. By rolling the whole bare copper wire 68, the intermediate member 72 is formed in a shape of spread strip plate. If such intermediate member 72 is formed by punching a metal plate, a great quantity of metal scrap is generated after the punching process; however, the present manufacturing method does not produce any metal scraps. Accordingly, manufacturing an intermediate member 72 with a 100% yield rate can be realized.

The body forming part 69 and the connecting end forming part 71 are respectively rolled to form a body part 65 and a connecting end part 67 in a strip plate shape having approximately the same width. In the terminal forming part 70, a terminal part 66 having a larger width is formed by rolling and integrating the parts of the bare copper wire 68 extending from the bent point in parallel opposing each other.

[0031] Specifically, a pair of a strip plate shaped parts extended part 61s rolled into approximately identical width to the body part 54 is protruded facing each other from the body part 65 in the lateral direction. Each of a pair of the extended parts 61s is extended to and integrally formed with a front end portion front end 61t formed in a U-shape by rolling the bent part of the bare copper wire 68. The pair of extended parts 61s or the front end 61t may be integrally formed by transformation by the rolling process. A terminal protrusion part 63 is formed by the pair of extended parts 61s described above, and a terminal front end 66c is formed by the front end 61t described above.

[0032] Finally, as illustrated in FIG. 6d, by bending a certain region of the intermediate member 72, the bus bar is completed. Specifically, a terminal base 66a is formed by bending the base portion of each terminal part 66 by approximately 90 degrees. Further, the intermediate portion of each terminal part 66 is folded by approximately 90 degrees to form a terminal intermediate 66b and a terminal front end 66c. Then, the body part 65 is folded in the thickness direction so that the connecting end parts 67 face each other in a common bus bar 61x, the end parts of the body part 65 will face each other, to form into a ring shape as illustrated in FIG. 6e.

- [0033] The terminal forming part 70 of each phase bus bar 61 is formed with a different length to one another. Each terminal base 66a of the phase bus bar 61 is formed with the same length. Accordingly, each terminal intermediate 66b of the phase bus bar 61 is formed to have a different length. Further, the body forming part 69 of each phase bus bar 61 of each phase is formed with a different length. Accordingly, the body part 65 of each phase bus bar 61 is formed with a different diameter to one another.
- [0034] The terminal forming part 70 of the common bus bar 61x according to the present embodiment is formed with a shorter length than the phase bus bar 61. The length of the terminal base 66a and the length of the terminal front end 66c are the same for the phase bus bar 61 and the common bus bar 61x, and the length of the terminal intermediate 66b is shorter for the common bus bar 61x than the phase bus bar 61. Although the common bus bar 61x has more number of terminal parts 66 than the phase bus bar 61, it is possible to reduce the consumed amount of bare copper wire 68 by making the size of the terminal part 66 relatively shorter.
- [0035] adapter
- The adapter 62 is an injection molding product of a resin. The adapter 62 according to the present embodiment is formed with a circular ring shape in accordance with the shape of the stator 5. The cross section of the adapter 62 is rectangular.
- [0036] As illustrated in FIG. 3 or FIG 5, the adapter 62 comprises a inner circumferential surface 62a and a outer circumferential surface 62b shaping a concentric circle and facing each other, and a pair of top end surface 62c and rear end surface 62d, extending from each rim of the inner circumferential surface 62a and the outer circumferential surface 62b and facing each other. The top end surface 62c of an adapter 62 has three openings of a terminal hole 73. The connecting end part 67 of each phase bus bar 61 is protruded through these terminal holes 73. The rear end surface 62d of the adapter 62 has a plurality in the present embodiment, 4 of body supporting grooves 74, and a plurality in the present embodiment, 24 of terminal supporting grooves 75.
- [0037] As illustrated in FIG. 7 or FIG. 8, the body supporting groove 74 is a circular ring shaped groove, and is formed multiply in a concentrical shape. The body supporting groove 74 has a little larger width than the thickness of the body part 65 of the bus bar. According to the present embodiment, three body supporting grooves 74u, 74v, 74w, a first body supporting groove ~ a third body supporting groove, are arranged on the inside of the radial direction, which receives the body part 65 of the phase bus bar 61, and a fourth body supporting groove 74x is arranged on the most outside, which receives the body part 65x of the common bus bar 61x. The depths of the first body supporting groove ~ the fourth body supporting groove 74 are all the same.
- [0038] The terminal supporting groove 75 is a groove extending in a radial direction to cross the body supporting groove 74. Each of the terminal supporting groove 75 is arranged

radially. The width of the terminal supporting groove 75 is set to be a little larger than that of the terminal part 66 of the bus bar. The terminal supporting groove 75 is formed in equal intervals at 24 places in a circumferential direction. The terminal supporting groove 75 according to the present embodiment consists of a first terminal supporting groove ~ a fourth terminal supporting groove 75u, 75v, 75w, 75x which respectively extends to the first ~ the fourth body supporting grooves 74 see FIG. 4.

- [0039] The fourth terminal supporting groove 75x is arranged in equal intervals at 12 places in a circumferential direction. The first ~ the third terminal supporting grooves 75 are arranged one by one between the fourth terminal supporting groove 75x, for example, in a counterclockwise direction, in the order of the first terminal supporting groove 75u, the second terminal supporting groove 75v, and the third terminal supporting groove 75w. The depths of the first ~ the fourth terminal supporting grooves 75 are all the same.
- [0040] Each of the first ~ the fourth terminal supporting groove 75 has a different length. Specifically, each of one ends of the first ~ fourth terminal supporting groove 75 is open onto the outer circumferential surface 62b of the adapter 62. Further, the other end of the fourth terminal supporting groove 75x is open onto the fourth body supporting groove 74x, and likewise, the other ends of the first ~ the third terminal supporting groove 75 are respectively open onto the first ~ third body supporting groove 74.
- [0041] A plurality of body parts 65 and a plurality of terminal bases 66a extending from the body part 65 are respectively received in the body supporting groove 74, and they are arranged telescopically. A plurality of terminal intermediates 66b are respectively received in the terminal supporting groove 75. At this point, since the terminal front end 66c is located to oppose to the body part 65, it becomes to oppose the outer circumferential surface 62b of the adapter 62.
- [0042] As illustrated in FIG. 8a, the depth D2 of the terminal supporting groove 75 is set to be larger than the thickness t of the terminal part 66. Accordingly, when the terminal part 66 is inserted into the adapter 62, the bus bar 61 does not protrude to the rear end surface 62d of the adapter 62, which makes it possible for the bus bar 61 to avoid any contact with other members.
- [0043] The depth D1 of the body supporting groove 74 is set to be larger than the depth D2 of the terminal supporting groove 75. Further, the difference between the depth D1 of body supporting groove 74 and the depth D2 of the terminal supporting groove 75 is set to be larger than the width W of the body part 65. The movement of the bus bar 61 received in the body supporting groove 74 is restricted by devices such as a snap fit provided onto the body supporting groove 74. Accordingly, when a bus bar 61 is received in the adapter 62, the terminal part 66 of one bus bar 61 spreading across the

body part 65 of the other bus bar 61 is restricted by the terminal supporting groove 75, which ensures to avoid any contact with the body part 54 of the other bus bar 61.

[0044] A junction surface 76 is formed on the radially outward side of the terminal front end 66c of the bus bar 61. Each of the junction surface 76 is disposed to contact a first virtual circle 77 with a center being the central axis A of the adapter 62 bus bar unit 6 in the radially inward side, when each of the junction surface 76 is installed to the adapter 62 see FIG. 7. The wire end 55 is joined to these junction surfaces 76 when the bus bar unit 6 is installed to the stator 5.

[0045] As illustrated in FIG. 3, when the bus bar unit 6 is installed to the stator 5, the rear end surface 62d of the adapter 62 is facing the output side end part 5a of the stator 5. With such configuration, it is possible to prevent the bus bar from being separated from the adapter 62. It is also possible to prevent dust from entering the body supporting groove 74.

[0046] As illustrated in FIG. 9, the wire end 55 is arranged in equal intervals in a circumferential direction of the stator 5. In the present embodiment, the central angle formed by two adjacent wire ends 55 is 15 degrees, since the wire end 55 is provided at 24 places. Further, the terminal part 66 of the bus bar unit 6 is provided in accordance with the number or the location of the wire end 55.

[0047] The wire end 55 is disposed to contact a second virtual circle 78 with a center being the central axis A of the stator 5 in the radially outward side. The second virtual circle 78 is set to have the same diameter with the first virtual circle 77.

[0048] Accordingly, as illustrated in FIG. 10, when the bus bar unit 6 is installed to the stator 5 to overlap each of central axis A, and the wire end 55 and the terminal part 66 are aligned in a circumferential direction, the wire end 55 contacts the junction surface 76 of the terminal part 66 at the radially outward side. It is more preferable to arrange the wire end 55 and the junction surface 76 to face each other with a small interval without making contact.

[0049] As illustrated in FIG. 11, since the junction surface 76 broadens toward a circumferential direction, the wire end 55 is disposed to face the junction surface 76 even if the location of the wire end 55 is somewhat dislocated or curved. Accordingly, the wire end 55 and the terminal part 66 can be stably joined, and also the process can be easily automatized.

[0050] When manufacturing a motor 1, a series of processes for installing the bus bar unit 6 to the stator 5 can be mechanized. For example, after assembling the bus bar unit 6 by installing each bus bar 61 to the adapter 62, the bus bar unit 6 is installed to the stator 5 by using a certain assembling device illustration omitted at a location where the junction surface 76 faces the wire end 55 location determining process. For example, after overlapping each of central axis A, the bus bar unit 6 is brought closer to the

output side end part 5a of the stator 5 along the central axis A. Then, the bus bar unit 6 and the stator 5 are rotated with respect to each other in order to determine the location of the wire end 55 and the terminal part 66 in a circumferential direction. By performing such procedure, all wire ends 55 can simply contact with the terminal part 66.

- [0051] Further, as illustrated in FIG. 12, after inserting each terminal front end 66c and each wire end 55 from radially inward and outward side by using an assembling device 101, the wire end 55 is pressured onto the junction surface 76. After this process, it is preferable to weld the wire end 55 and the terminal part 66 by using methods such as resistance welding, TIG welding, ultrasonic welding, etc. welding process. Since all wire ends 55 can be processed integrally, the number of processes can be reduced, and it is possible to obtain excellent productivity.
- [0052] In the present embodiment, the wire end 55 and the terminal part 66 are joined by ultrasonic welding, using the interval 56 formed between the terminal part 66 and the adapter 62. Specifically, a bonding device 101 comprises a first pressure bonding part 101a and a second pressure bonding part 101b located at an outer side than the first pressure bonding part 101a and facing the first pressure bonding part 101a.
- [0053] The terminal part 66 faces the adapter 62 with an interval 56 in a diameter direction. The first pressure bonding part 101a is received in the interval 56. Further, as indicated by the arrow in FIG. 12, the wire end 55 and the terminal part 66, which are in contact with each other, are pressured in a diameter direction by the first pressure bonding part 101a and the second pressure bonding part 101b, and the wire end 55 and the terminal part 66 are joined by applying ultrasonic vibration.
- [0054] FIG. 13 illustrates a specific example of the region where the wire end 55 and the terminal part 66 are joined. According to the present embodiment, the joined region of the wire end 55 and the terminal part 66 has an inclined surface 55a.
- [0055] Specifically, the inclined surface 55a is formed so that the thickness in the diameter direction of the wire end 55 becomes gradually thinner toward the front end side of the wire end 55 in the axial direction. By performing ultrasonic welding to form the inclined surface 55a in the joined region of the wire end 55, the front end of the wire end 55 is joined with the terminal part 66, the front end being spread out. As a result, the wire end 55 and the terminal part 66 can be joined more strongly and firmly. Since the joining strength between the wire end 55 and the terminal part 66 gradually becomes stronger toward the front end side, a stable connection having a strong durability against vibration, etc. can be realized.
- another embodiment
- [0056] FIG. 14 illustrates a motor according to another embodiment. The motor 1A according to the present embodiment has a bus bar unit 6 with a different configuration

from that described above in the motor 1 of the previous embodiment. Hereinafter, the constitution that has an identical function as the motor 1 according to the previous embodiment will be referred to as identical symbols, without detailed explanation. Only the differences will be specifically explained.

[0057] FIG. 15 illustrates the bus bar unit 6A according to the present embodiment. The bus bar unit 6A comprises a plurality in this embodiment, 4 of bus bar 81, and an insulating adapter 82 which supports these bus bars 81. The bus bar 81 according to the present embodiment also comprises three phase bus bars 81u, 81v, 81w that are respectively connected to the U-phase, V-phase, W-phase of the stator 5, and a common bus bar 81x that is connected to a neutral point.

[0058] As illustrated in FIG. 16d, the body part 65 of the bus bar 81 of the present embodiment is curved into a ring shape not in the thickness direction, but in the width direction. The terminal part 66 comprises a terminal protrusion part 83 and a terminal front end 66c. The terminal protrusion part 83 protrudes from the lateral end of the outer circumferential side of the body part 65 to the radially outward side and extends to be approximately parallel to the body part 65. The terminal front end 66c extends from the terminal protrusion part 83 to be approximately parallel to the terminal protrusion part 83. These bus bars are also formed by processing a single bare copper wire 68.

[0059] When manufacturing the bus bar according to the present embodiment, a single bare copper wire 68 is prepared as illustrated in FIG. 16a. Then, as illustrated in FIG. 16b, the bare copper wire 68 is bent to form a body forming part 69 to form the body part 65, a terminal forming part 70 to form the terminal part 66, and a connecting end forming part 71 to form the connecting end part 67.

[0060] Specifically, a plurality of terminal forming parts 70 are formed by the same process as the previous embodiment. 4 terminal forming parts 70 is formed for a phase bus bar 81, and 12 for a common bus bar 81x. The body forming part 69 is formed by bending the bare copper wire 68 into a ring shape. All terminal forming parts 70 are disposed on the radially outward side of the body forming part 69. The connecting end forming part 71 is disposed on the opposite side of the terminal forming part 70, that is, on the radially inward side of the body forming part 69.

Subsequently, as illustrated in FIG. 16c, the whole bare copper wire 68, where the terminal forming part 70 is formed, is rolled to form a strip plate shaped intermediate member 72. As illustrated in FIG. 16d, a certain region of the intermediate member 72 is bent. Specifically, the intermediate portion of each terminal part 66 is bent by approximately 90 degrees to form the terminal protrusion part 83 and the terminal front end 66c. In the present embodiment, the terminal protrusion part 83 corresponds to the terminal protrusion part 63 a pair of extending parts 66s.

- [0061] The terminal forming part 70 in each bus bar 81 is respectively set to have a different length. In the present embodiment, the terminal protrusion part 83 is formed to have the same length, and the terminal front end 66c in each bus bar is formed to have a different length. Also, all the body forming parts 69 in each bus bar according to the present embodiment are formed to have the same length. Accordingly, the body part 65 in each bus bar 81 is respectively formed to have the same diameter.
- [0062] The terminal forming part 70 of the common bus bar 81x according to the present embodiment is formed to be longer than that of the phase bus bar 81. Accordingly, the terminal front end 66c of the common bus bar 81x is set to be longer than that of the phase bus bar 81. The terminal forming part 70 of a common bus bar 81x may be formed to be shorter than that of the phase bus bar 81. By such configuration, although the common bus bar 81x has more number of terminal parts 66 than the phase bus bars 61, it becomes possible to reduce the consumed amount of the bare copper wire 68 by making the size of terminal parts 66 relatively shorter.
- [0063] In the present embodiment, the bus bar 81 is integrally formed with the adapter 82. Specifically, the body part 65 of the bus bar 81 is layered inside the adapter 82 with a resin layer interposing between the adjacent bus bars 81 without making contact with the adjacent bus bar. The terminal front end 66c of each bus bar 81 is formed to have a different length in accordance with the layered position. Accordingly, the portion of each terminal front end 66c protruding from the top end surface 62c of the adapter 82 is set to be approximately identical. Further, the portion of each terminal front end 66c protruding from an outer circumferential surface 62b of the adapter 82 is set to be identical. By such configuration, a junction surface 76 is in contact with a first virtual circle 77.
- [0064] Also, the bus bar according to the present embodiment is not limited by the described example, and further comprises other various modifications. For example, most of the stators 5 of the motor according to the above embodiment are embedded in a resin layer 54 by a molding process. However, as illustrated in FIG. 17, the present invention is applicable to motors without a resin layer 54.
- [0065] Further, some configuration of the terminal part 66 of the bus bar 61 can be appropriately modified if necessary. FIG. 18c illustrates the bus bar 91 according to a modified embodiment. The terminal part 92 of the bus bar 91 is formed so that a wire end 55 can be pressured and joined thereto. That is, the terminal part 92 comprises a terminal base 92a extending from the body part 65 and protruding toward a lateral direction, and a pair of terminal arm part 92b protruding toward a lateral direction from each side of the front end of the terminal base 92a. The terminal part 92 and the wire end 55 are joined by wrapping the wire end 55 between these terminal arm parts 92b and by winding and tightening the terminal arm part 92b.

[0066] For producing the terminal part 92, for example, a terminal forming part 70 is formed by bending the bare copper wire 68 into an approximately T-shape, as illustrated in FIG. 18a. After that, by performing a rolling process, an intermediate body having a layout shape of the terminal part 92 can be obtained as illustrated in FIG. 18b. Afterward, a certain region of the intermediate body is bent.

The connection of each coil is not limited to a Y-connection, and the connection can be a delta connection. Also, it can be applied to a series connection which connects the coil to each phase in series, or a series parallel connection which further connects a group of coils that are series-connected to each phase in parallel.

The material of a bus bar wire rod is not limited to a copper wire if the material is conductive. For example, since an aluminum wire is lighter and more inexpensive than a copper wire, it can be effectively applied. Especially, when the same material used in the conductive line of the coil is employed, the quality of connection can be enhanced since the property between the two materials is identical.

The shape of the adapter or the body part of the bus bar is not limited to a ring shape. The shape can be a circular arc, a polygon, or an indeterminate form.

[0067] The bus bar or the motor of the present invention can be used in a vehicle on-board motor, and for example, is suitable for a vehicle on-board electromotive power steering device.

Reference Signs List

- [0068] 1: motor
2: casing
3: shaft
4: rotor
5: stator
6: bus bar unit
51: divisional core
52: insulator
53: coil
54: resin layer
55: wire end end part of a conductive line
56: interval
61: bus bar
62: adapter
65: body part
66: terminal part
66s: extending part

66t: front end part
67: connecting end part
68: bare copper wire wire rod
69: body forming part
70: terminal forming part
74: body supporting groove
75: terminal supporting groove
76: junction surface
77: a first virtual circle
78: a second virtual circle
A: center axis of rotation

Claims

- [Claim 1] A method for manufacturing a bus bar which electrically connects with end parts of a plurality of conductive lines, comprising the steps of:
folding an intermediate region of a single wire rod to form a plurality of terminal forming parts which protrude toward a lateral direction of the wire rod;
rolling the whole wire rod including the terminal forming part; and
bending the rolled wire rod into a certain shape.
- [Claim 2] A bus bar manufactured by the method according to Claim 1, comprising:
a body part in a plate shape; and
a plurality of terminal parts in a plate shape integrally formed with the body part, to correspond to the arrangement of the end parts of the conductive lines,
wherein the terminal part comprises
a terminal protrusion part constituted by a pair of extending parts which protrude in a lateral direction from the body part, facing each other; and
a terminal front end extending from the terminal protrusion part.
- [Claim 3] A motor equipped with the bus bar according to Claim 2, comprising:
a rotably supported shaft;
a rotor integrally formed with the shaft; and
a stator arranged around the rotor, the stator having a coil formed by winding the conductive line,
wherein the bus bar is installed to one end of the stator;
the end parts of the conductive lines is led out approximately in parallel to the shaft through the one end of the stator,
the terminal part has a junction surface parallel to the shaft, and
the end part of the conductive line is joined to the junction surface.
- [Claim 4] The motor according to Claim 3, comprising:
a plurality of bus bars; and
an insulating adapter which is attached to the one end side of the stator and supports each bus bar,
wherein the body part is folded in a thickness direction to correspond to the shape of the adapter,
the terminal protrusion part comprises a terminal intermediate approximately orthogonal to the body part,
the terminal front end comprises a part approximately orthogonal to the

terminal protrusion part, and
the plurality of body parts are arranged inside the adapter telescopically.

[Claim 5] The motor according to Claim 4,
wherein a plurality of body supporting grooves which respectively receive the plurality of body parts, and a plurality of terminal supporting grooves which respectively receive the plurality of terminal intermediates are formed on one end surface of the adapter,
the body supporting groove is multiply formed around the shaft,
the terminal supporting groove crosses the body supporting groove, and
the depth of the body supporting groove is deeper than the depth of the body supporting groove, and the difference of depth is larger than the width of the body part.

[Claim 6] The motor according to Claim 5,
wherein the terminal front end is located on the opposite side of the body part, and
the adapter is attached to the stator, with the end surface to face the one end of the stator.

[Claim 7] The motor according to Claim 3, comprising:
a plurality of bus bars; and
an insulating adapter which is attached to the one end side of the stator and supports each bus bars,
wherein the body part is folded in a width direction to correspond to the shape of the adapter,
the terminal protrusion part comprises a part extending approximately in parallel to the body part,
the terminal front end comprises a part approximately orthogonal to the terminal protrusion part, and
the plurality of body parts are layered inside the adapter, without making contact with each other.

[Claim 8] The motor according to any one of Claims 4 to 7,
wherein the stator is formed in a cylindrical shape,
the end parts of the conductive lines are arranged in a circumferential direction,
the adapter and the body part are formed in a circular ring or a circular arc shape,
the terminal part is arranged correspondingly to the location of the end parts of the conductive lines.

- [Claim 9] The motor according to Claim 8,
wherein each of the end parts of the conductive lines is arranged in location to contact with a first virtual circle,
each of the junction surface is arranged in a location to contact with a second virtual circle, and
the first virtual circle and the second circle coincide when the bus bar and the adapter are installed to the stator.
- [Claim 10] A method for manufacturing the motor according to any one of Claims 3 to 9, comprising the steps of:
determining the location of the bus bar in the stator so that the junction surface is arranged to face the end part of the conductive line; and
welding the end part of the conductive line and the terminal part by pressuring the end part of the conductive line onto the junction surface,
wherein the location determining step and the welding step are automated.
- [Claim 11] The motor according to Claim 3,
wherein the conductive line is joined to the junction surface of the terminal part by ultrasonic welding.
- [Claim 12] The motor according to Claim 11,
wherein an inclined surface is formed on the joined region in the end part of the conductive line, and the thickness in the diameter direction of the conductive line becomes thinner as the inclined surface proceeds to one end side in an axial direction of the conductive line.
- [Claim 13] The motor according to Claim 11,
wherein the junction surface is broadened toward a circumferential direction.
- [Claim 14] The motor according to Claim 3,
wherein the coil is embedded in a resin; and
the end part of the conductive line is led out toward the outside of the resin.
- [Claim 15] The bus bar according to Claim 2, comprising:
a connecting end part which extends from each of both ends of the body part and oppose the terminal part, with the body part therebetween.
- [Claim 16] The motor according to Claim 3,
wherein the extending direction of the terminal front end is a direction extending from one end to the other end of the stator.
- [Claim 17] A bus bar comprising:

a body part in a plate shape; and
a plurality of terminal parts in a plate shape integrally formed with the body part, to correspond to the arrangement of the end parts of conductive lines,

wherein the terminal part comprises:

a terminal protrusion part constituted by a pair of extending parts which protrude in a lateral direction from the body part, facing each other; and
a terminal front end extending from the terminal protrusion part.

[Claim 18]

A motor equipped with the bus bar according to Claim 17, comprising a rotably supported shaft;

a rotor integrally formed with the shaft; and

a stator arranged around the rotor, the stator having a coil formed by winding the conductive line,

wherein the bus bar is installed to one end of the stator;

the end part of the conductive line is led out approximately in parallel to the shaft through the one end of the stator,

the terminal part has a junction surface parallel to the shaft, and

the end parts of the conductive lines is joined to the junction surface.

[Claim 19]

The motor according to Claim 18, comprising:

a plurality of bus bars; and

an insulating adapter which is attached to the one end side of the stator and supports each bus bar,

wherein the body part is folded in a thickness direction to correspond to the shape of the adapter,

the terminal protrusion part comprises a terminal intermediate approximately orthogonal to the body part,

the terminal front end comprises a part approximately orthogonal to the terminal protrusion part, and

the plurality of body parts are arranged inside the adapter telescopically.

[Claim 20]

The motor according to Claim 19,

wherein a plurality of body supporting grooves which respectively receive the plurality of body parts, and a plurality of terminal supporting grooves which respectively receive the plurality of terminal intermediates are formed on one end surface of the adapter,

the body supporting groove is multiply formed around the shaft,

the terminal supporting groove crosses the body supporting groove, and

the depth of the body supporting groove is deeper than the depth of the

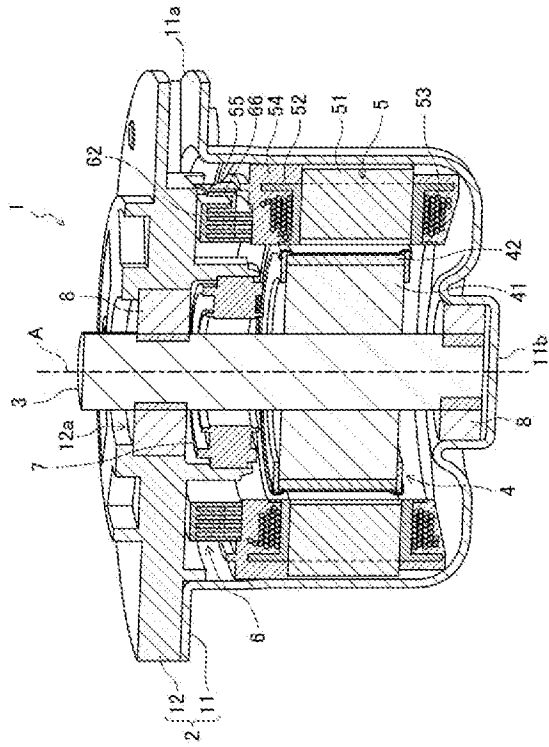
- body supporting groove, and the difference of depth is larger than the width of the body part.
- [Claim 21] The motor according to Claim 20, wherein the terminal front end is located on the opposite side of the body part, and the adapter is attached to the stator, with the end surface to face the one end of the stator.
- [Claim 22] The motor according to Claim 18, a plurality of bus bars; and an insulating adapter which is attached to the one end side of the stator and supports each bus bars, wherein the body part is folded in a width direction to correspond to the shape of the adapter, the terminal protrusion part comprises a part extending approximately in parallel to the body part, the terminal front end comprises a part approximately orthogonal to the terminal protrusion part, and the plurality of body parts are layered inside the adapter without making contact with each other.
- [Claim 23] The motor according to any one of Claims 19 to 22, wherein the stator is in a cylindrical shape; the end part of the conductive line is arranged in a circumferential direction; the adapter and the body part are in a circular ring or a circular arc shape; and the terminal part is arranged correspondingly to the location of the end parts of the conductive lines.
- [Claim 24] The motor according to Claim 23, wherein each of the end parts of the conductive lines is arranged in location to contact with a first virtual circle, each of the junction surface is arranged in a location to contact with a second virtual circle, and the first virtual circle and the second coincide when the bus bar and the adapter are installed to the stator.
- [Claim 25] A method for manufacturing the motor according to any one of Claims 18 to 24, comprising the steps of: determining the location of the bus bar in the stator so that the junction surface is arranged to face the end part of the conductive line; and

welding the end part of the conductive line and the terminal part by pressuring the end part of the conductive line onto the junction surface, wherein the location determining step and the welding step are automated.

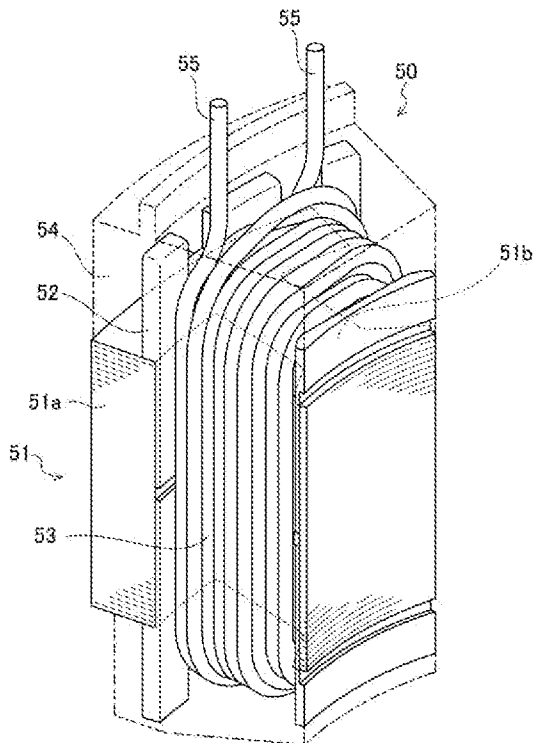
- [Claim 26] The motor according to Claim 18, wherein the conductive line is joined to the junction surface of the terminal part by ultrasonic welding.
- [Claim 27] The motor according to Claim 26, wherein an inclined surface is formed on the joined region in the end part of the conductive line, and the thickness in the diameter direction of the conductive line becomes thinner as the inclined surface proceeds to one end side in an axial direction of the conductive line.
- [Claim 28] The motor according to Claim 26, wherein the junction surface is broadened toward a circumferential direction.
- [Claim 29] The motor according to Claim 18, wherein the coil is embedded in a resin; and the end part of the conductive line is led out toward the outside of the resin.
- [Claim 30] The bus bar according to Claim 17, comprising a connecting end part extends from each of both ends of the body part and oppose the terminal part, with the body part therebetween.
- [Claim 31] The motor according to Claim 18, wherein the extending direction of the terminal front end is a direction extending from one end to the other end of the stator.
- [Claim 32] A method for manufacturing a bus bar which electrically connects with end parts of a plurality of conductive lines, comprising the steps of: folding an intermediate region of a linear-shaped single wire rod to form a plurality of terminal forming parts which protrude toward a lateral direction of the wire rod; folding both ends of the wire rod toward the opposite side of the terminal forming part with respect to the linear-shaped wire rod to form a connecting end forming part; rolling the whole wire rod including the terminal forming part; and bending the rolled wire rod into a certain shape.
- [Claim 33] The method for manufacturing the bus bar according to Claim 32, comprising the step of: bending the rolled wire rod in a thickness direction to bring the two of

rolled connecting end forming parts into contact with each other and to form the wire rod in a circular ring or a circular arc shape.

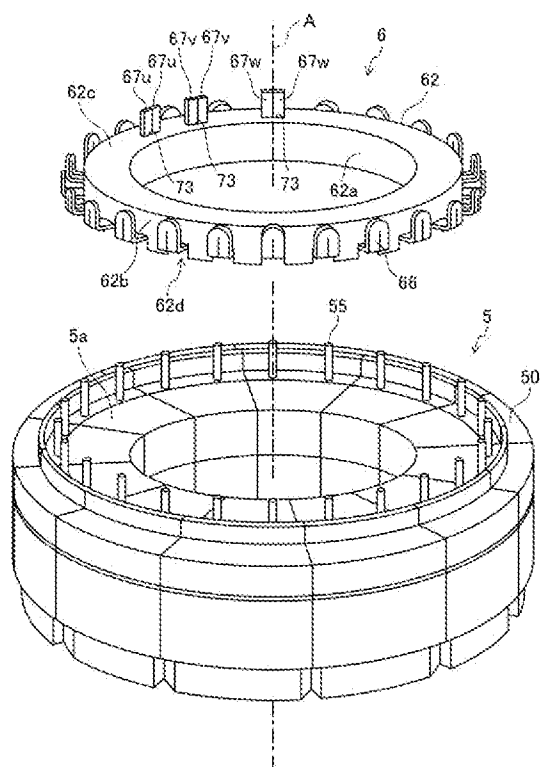
[Fig. 1]



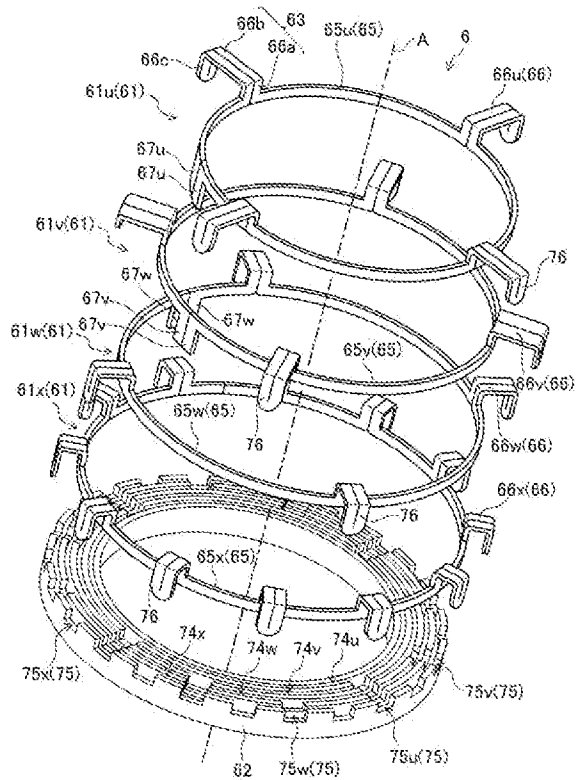
[Fig. 2]



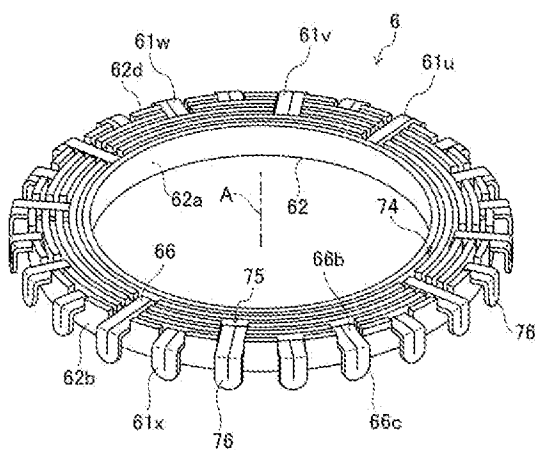
[Fig. 3]



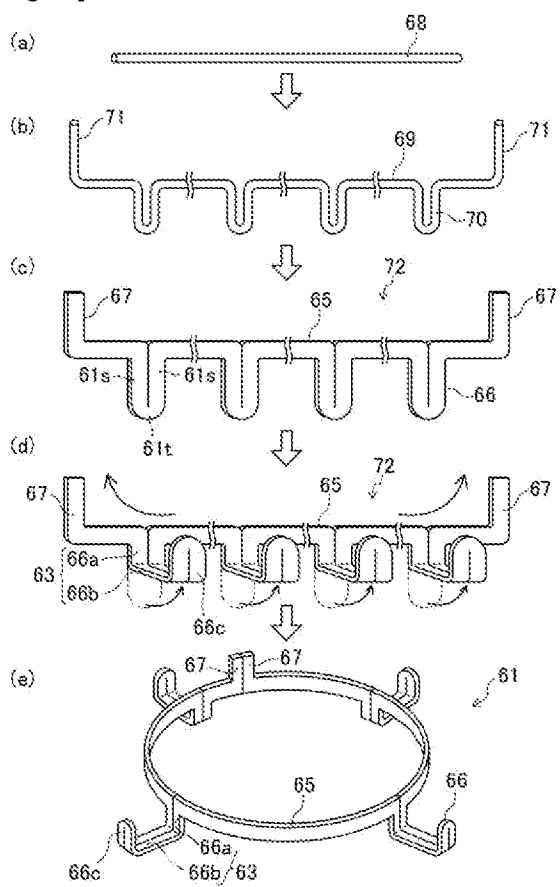
[Fig. 4]



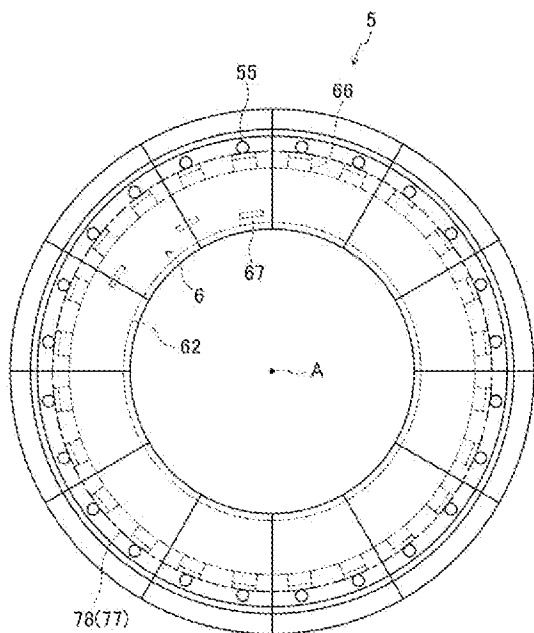
[Fig. 5]



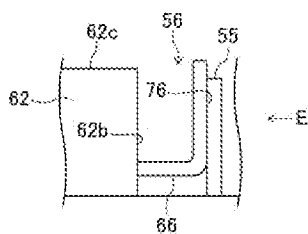
[Fig. 6]



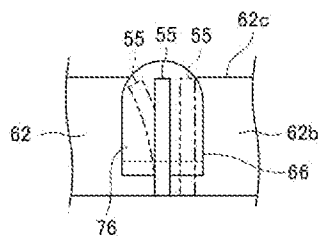
[Fig. 9]



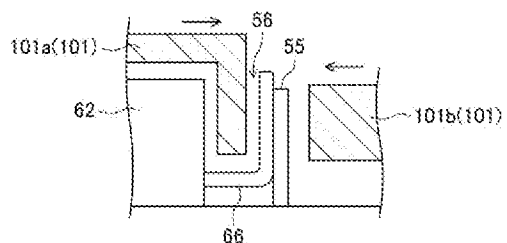
[Fig. 10]



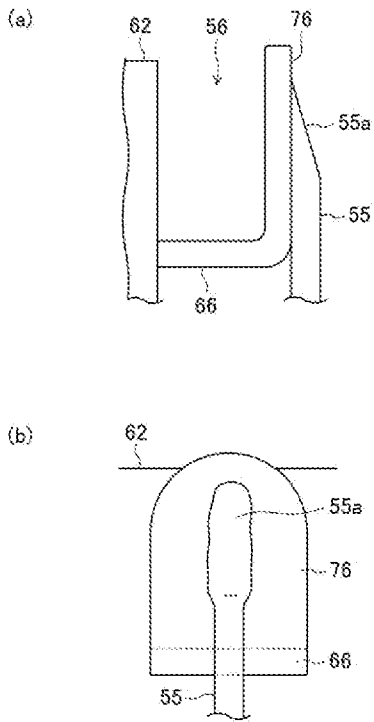
[Fig. 11]



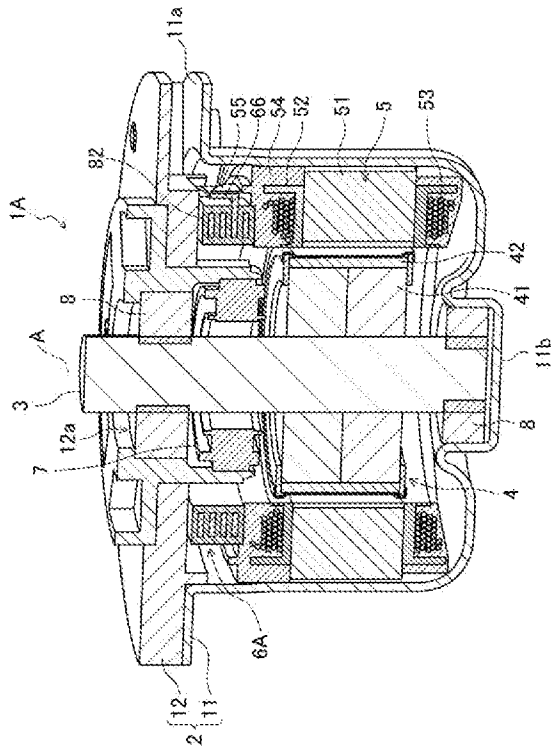
[Fig. 12]



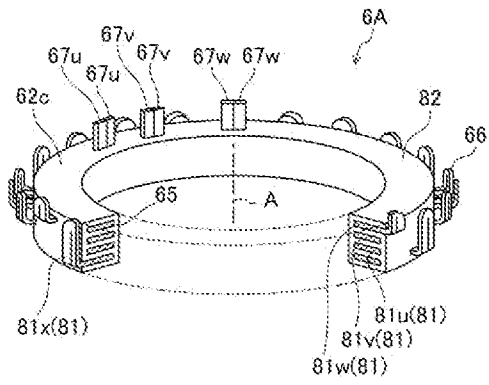
[Fig. 13]



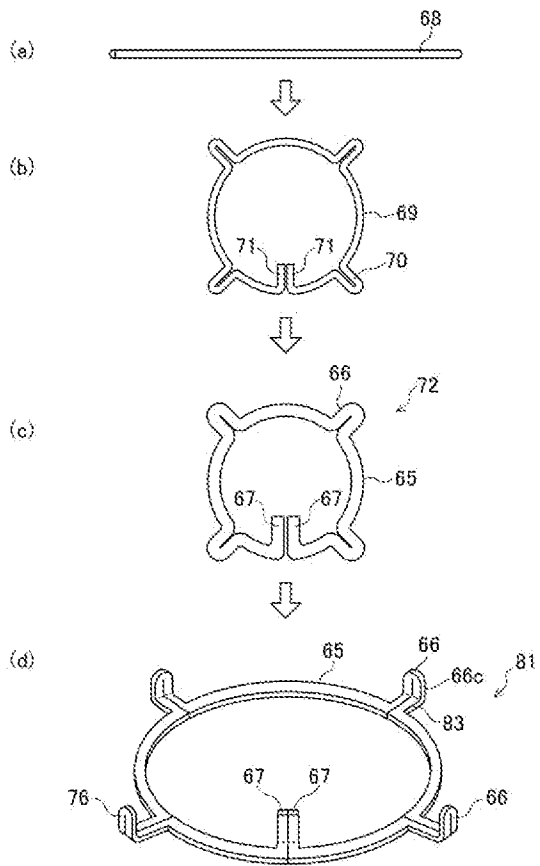
[Fig. 14]



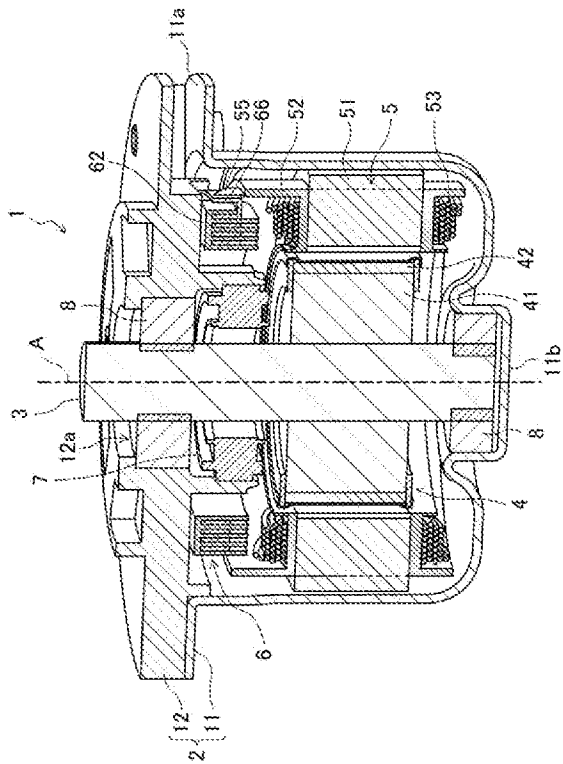
[Fig. 15]



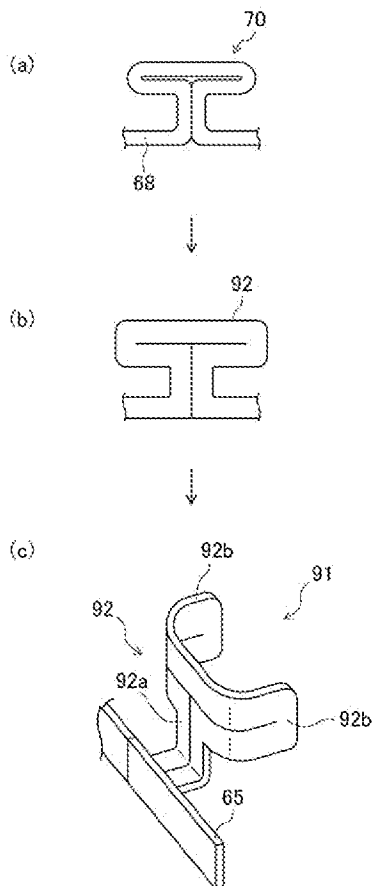
[Fig. 16]



[Fig. 17]



[Fig. 18]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/006044

A. CLASSIFICATION OF SUBJECT MATTER		
Int.Cl. H02K15/04 (2006.01) i, H02K3/52 (2006.01) i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Int.Cl. H02K15/04, H02K3/52		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2012 Registered utility model specifications of Japan 1996-2012 Published registered utility model applications of Japan 1994-2012		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-28759 A (Auto Networks Technologies, Ltd.) 2007.02.01, 【0010】 - 【0018】、Fig.1-Fig.8 Family None	1-33
Y	JP 2005-160137 A (SUMITOMO WIRING SYSTEM, LTD.) 2005.06.16, 【0004】 , 【0021】 , Fig.4, Fig.15 Family None	1-33
Y	JP 2008-259259 A (NIDEC CORPORATION) 2008.10.23, 【0026】 - 【0048】 , Fig.1-2, 4, 7 & US 2008/0242124 A1	3-33
Y	JP 6-233483 A (HONDA MOTOR CO., LTD) 1994.08.19, 【0020】 - 【0029】 , Fig.2-Fig.5 Family None	7-33
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 09.04.2012		Date of mailing of the international search report 17.04.2012
Name and mailing address of the ISA/JP Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan		Authorized officer Yasutane AMASAKA Telephone No. +81-3-3581-1101 Ext. 3358
		3V 3519

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/006044

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-180615 A (Sumitomo Electric Industries, LTD.) 2006.07.06, 【0014】 Family None	10-33