US 20250266730A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2025/0266730 A1

ISHIHARA (43) Pub. Date: Aug. 21, 2025

(54) **STATOR AND METHOD FOR PRODUCING STATOR**

(71) Applicants: **AutoNetworks Technologies, Ltd.**, Yokkaichi-Shi, Mie (JP); **Sumitomo Wiring Systems, Ltd.**, Yokkaichi-Shi, Mie (JP); **Sumitomo Electric Industries, Ltd.**, Osaka-Shi, Osaka (JP)

(72) Inventor: **Kanzo ISHIHARA**, Osaka-Shi, Osaka (JP)

(73) Assignees: **AutoNetworks Technologies, Ltd.**, Yokkaichi-Shi, Mie (JP); **Sumitomo Wiring Systems, Ltd.**, Yokkaichi-Shi, Mie (JP); **Sumitomo Electric Industries, Ltd.**, Osaka-Shi, Osaka (JP)

(21) Appl. No.: **18/859,267**

(22) PCT Filed: **Apr. 5, 2023**

(86) PCT No.: **PCT/JP2023/014124**

§ 371 (c)(1),
(2) Date: **Oct. 23, 2024**

(30) **Foreign Application Priority Data**

Apr. 26, 2022 (JP) 2022-072387

Publication Classification

(51) **Int. Cl.**

H02K 3/48	(2006.01)
H02K 1/16	(2006.01)
H02K 3/34	(2006.01)
H02K 15/064	(2025.01)
H02K 15/122	(2025.01)

(52) **U.S. Cl.**

CPC ***H02K 3/48*** (2013.01); ***H02K 1/16*** (2013.01); ***H02K 3/34*** (2013.01); ***H02K 15/064*** (2013.01); ***H02K 15/122*** (2025.01); *H02K 2215/00* (2021.08)

(57) **ABSTRACT**

A stator includes an annular stator core, a coil, an insulating resin, and a positioning component (first positioning component). The stator core includes a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction. The coil includes an insertion portion that passes through the slots. The insulating resin includes a continuous filling portion that is located in a center portion in the axial direction inside a slot of the plurality of slots and that continuously fills a space between an inner wall of the slot and the insertion portion. The positioning component (first positioning component) positions the insertion portion in a state where, on one side in the axial direction with respect to the continuous filling portion, at least a portion of the positioning component enters between the inner wall of the slot and the insertion portion.

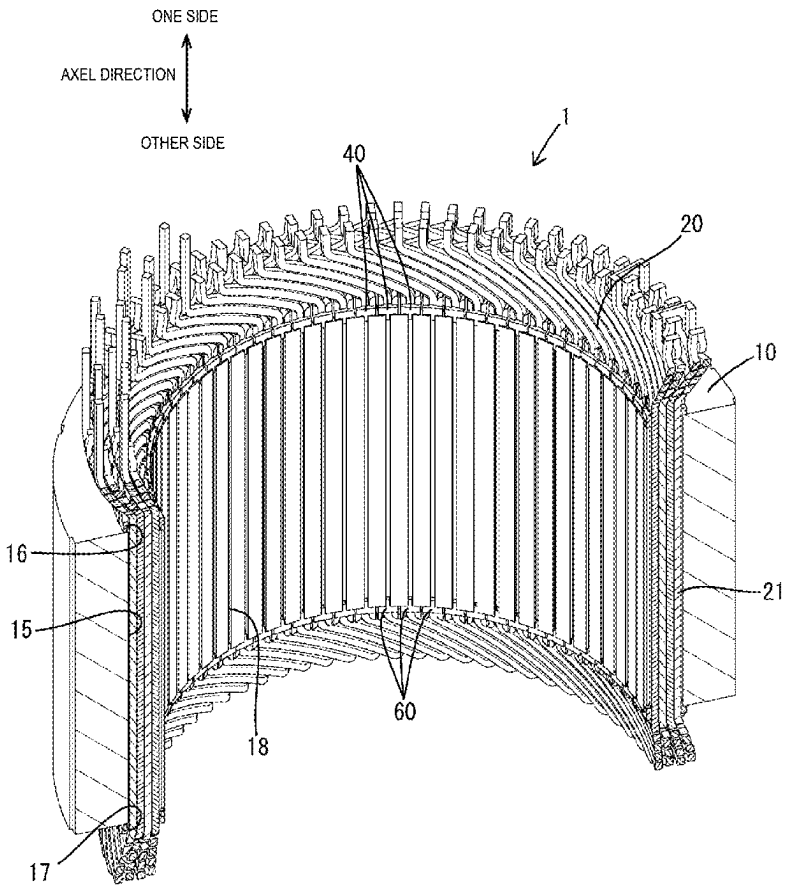


FIG. 1

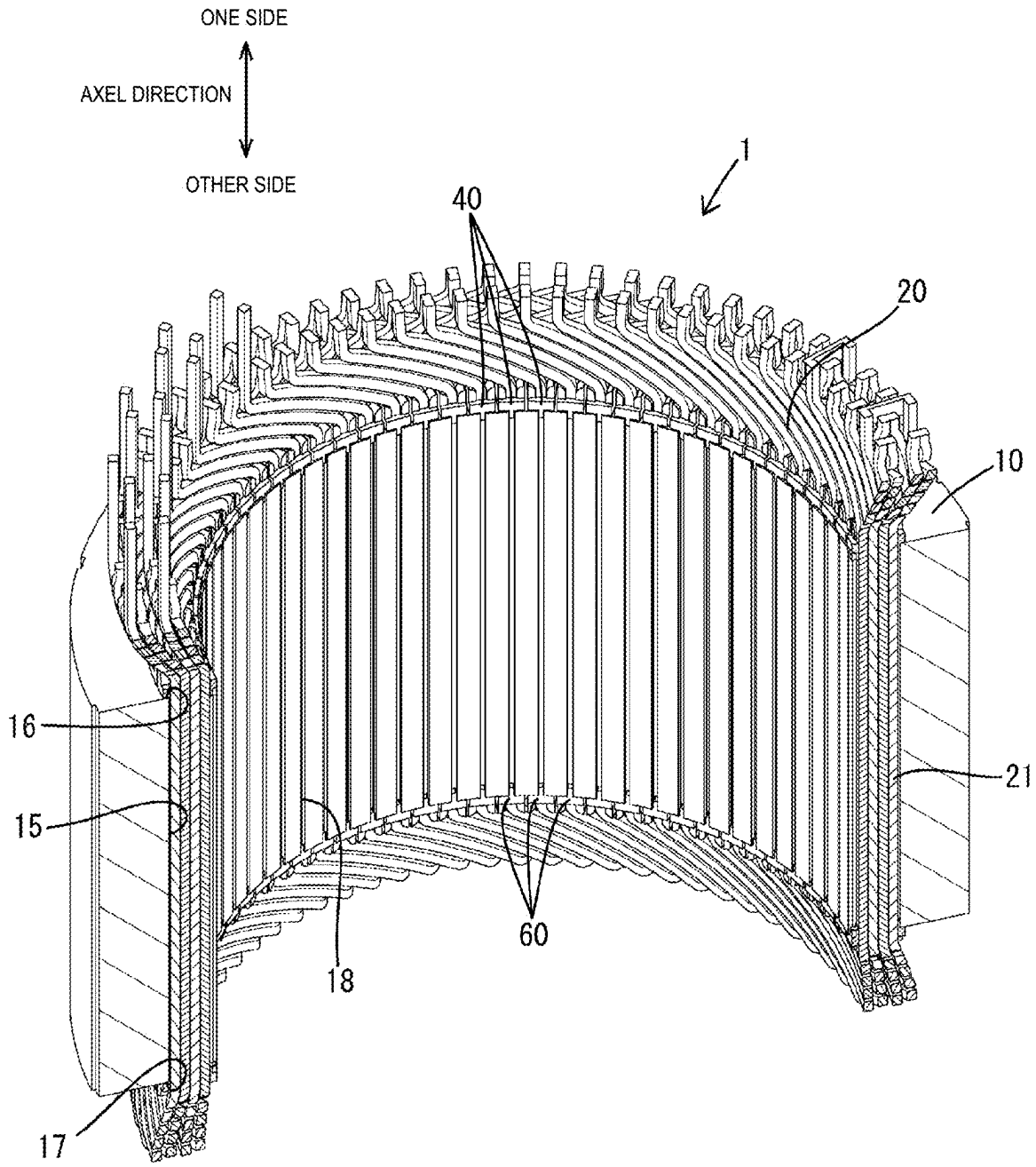


FIG. 2

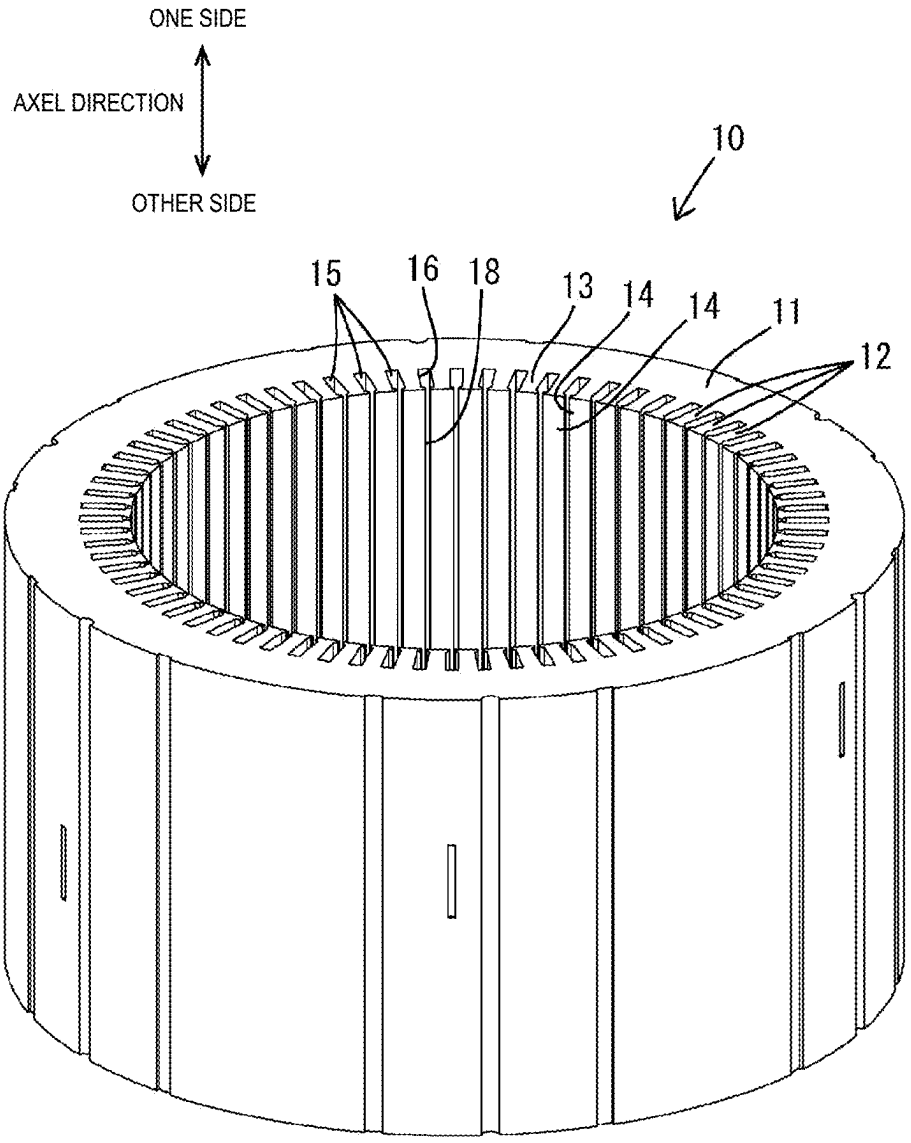


FIG. 3

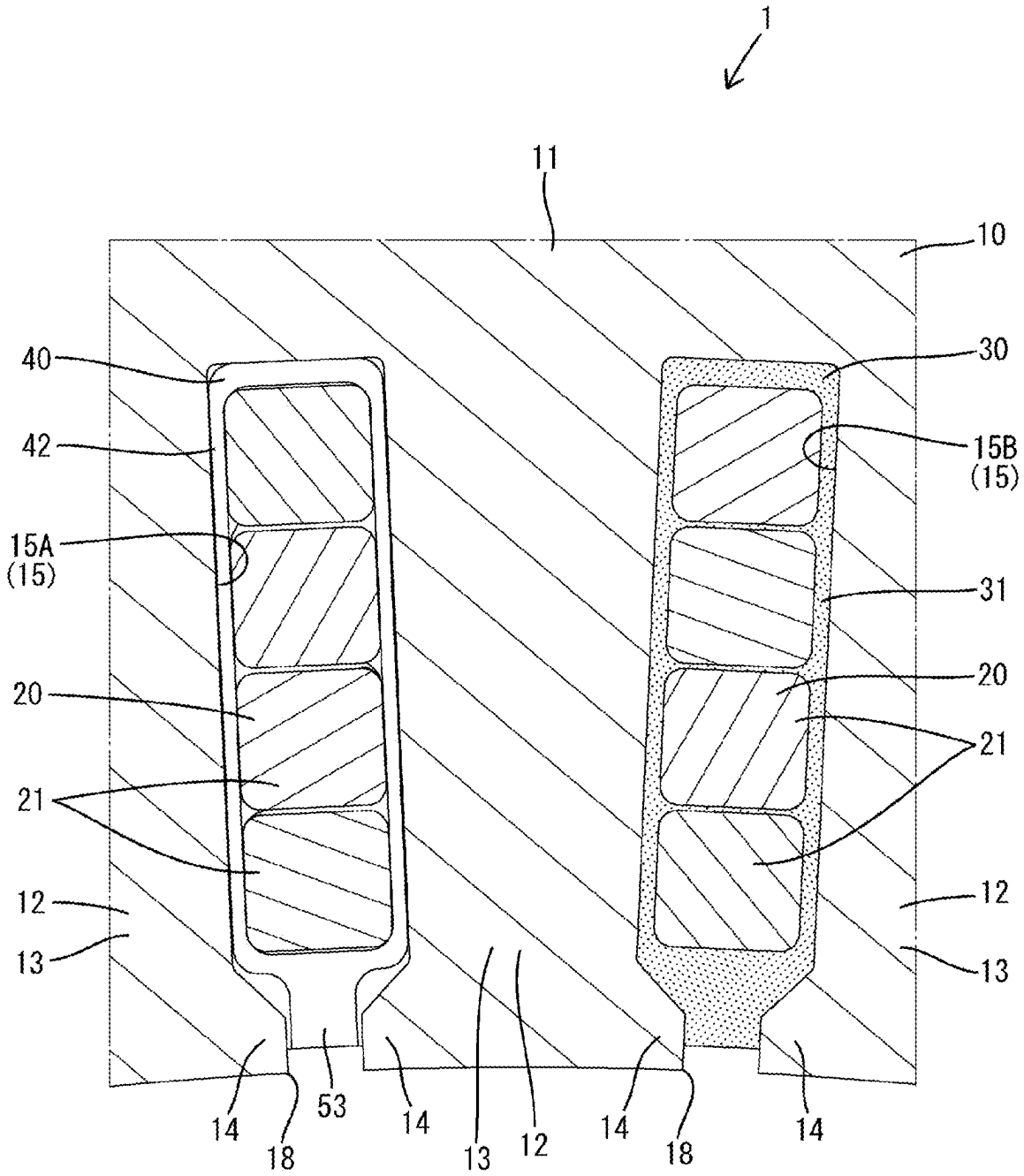

1
11
10
40
30
42
15B
(15)
15A
(15)
31
20
20
21
21
12
12
13
13
14
18
53
14
13
12
14
18
14

FIG. 4

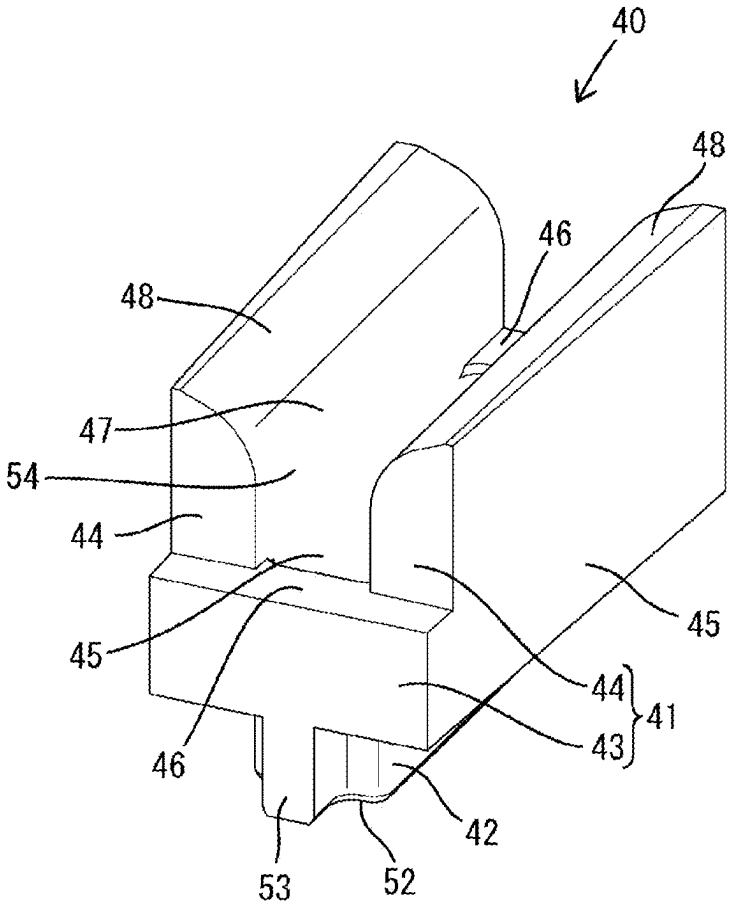
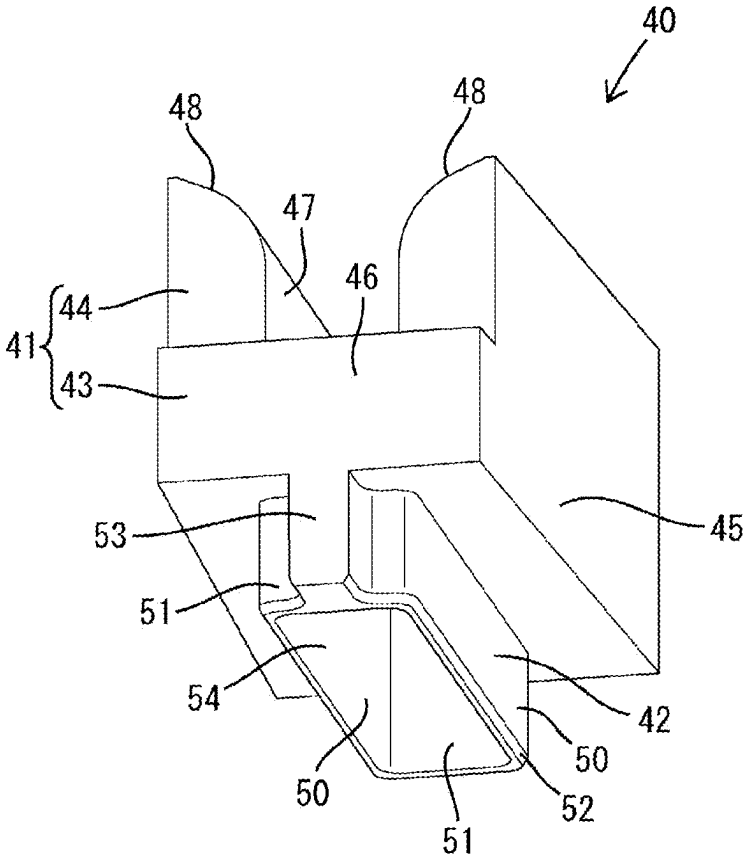


FIG. 5



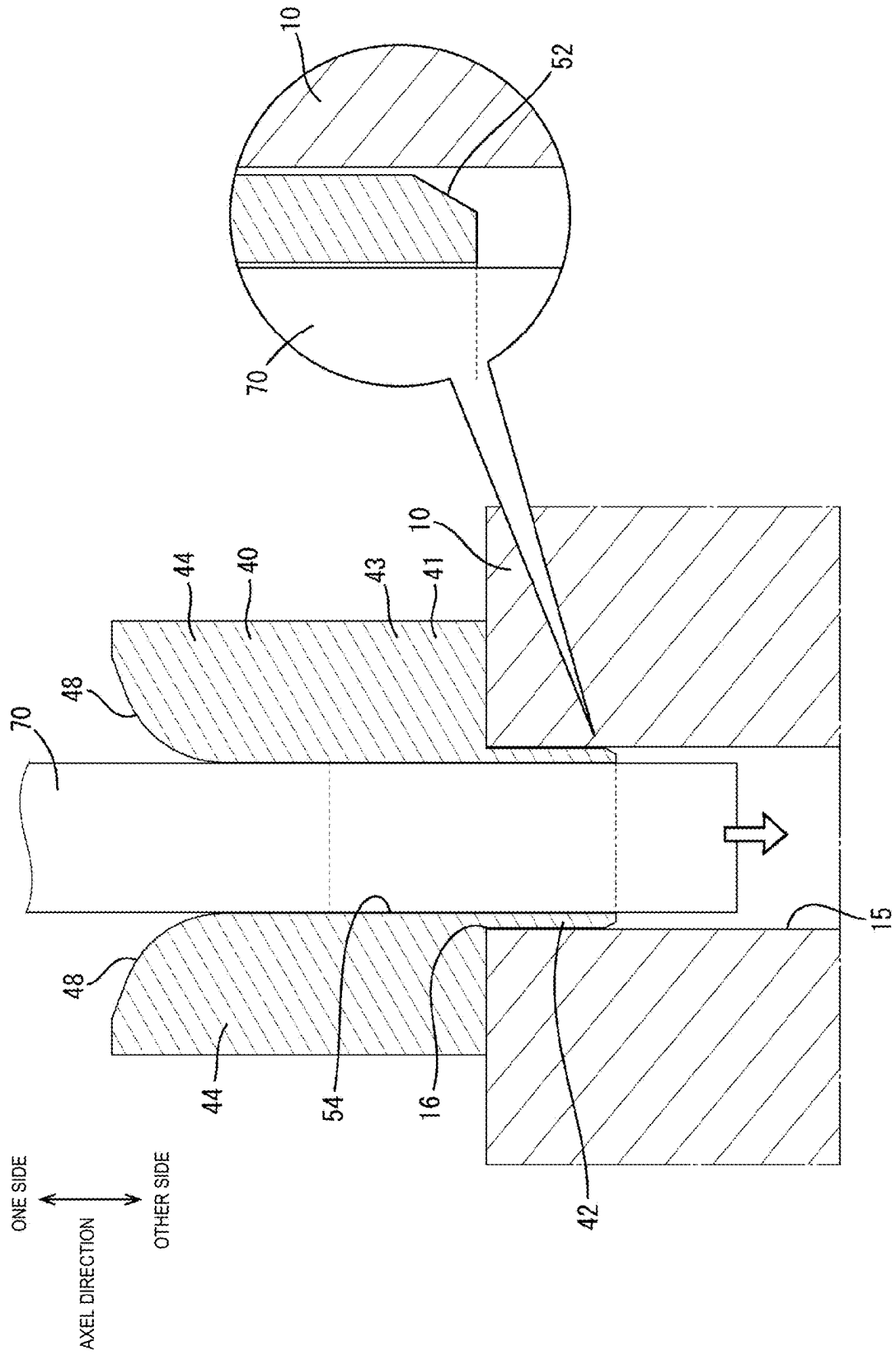

10
52
70
10
44
40
43
41
48
70
48
44
54
16
42
15
ONE SIDE
AXEL DIRECTION
OTHER SIDE

FIG. 6

FIG. 7

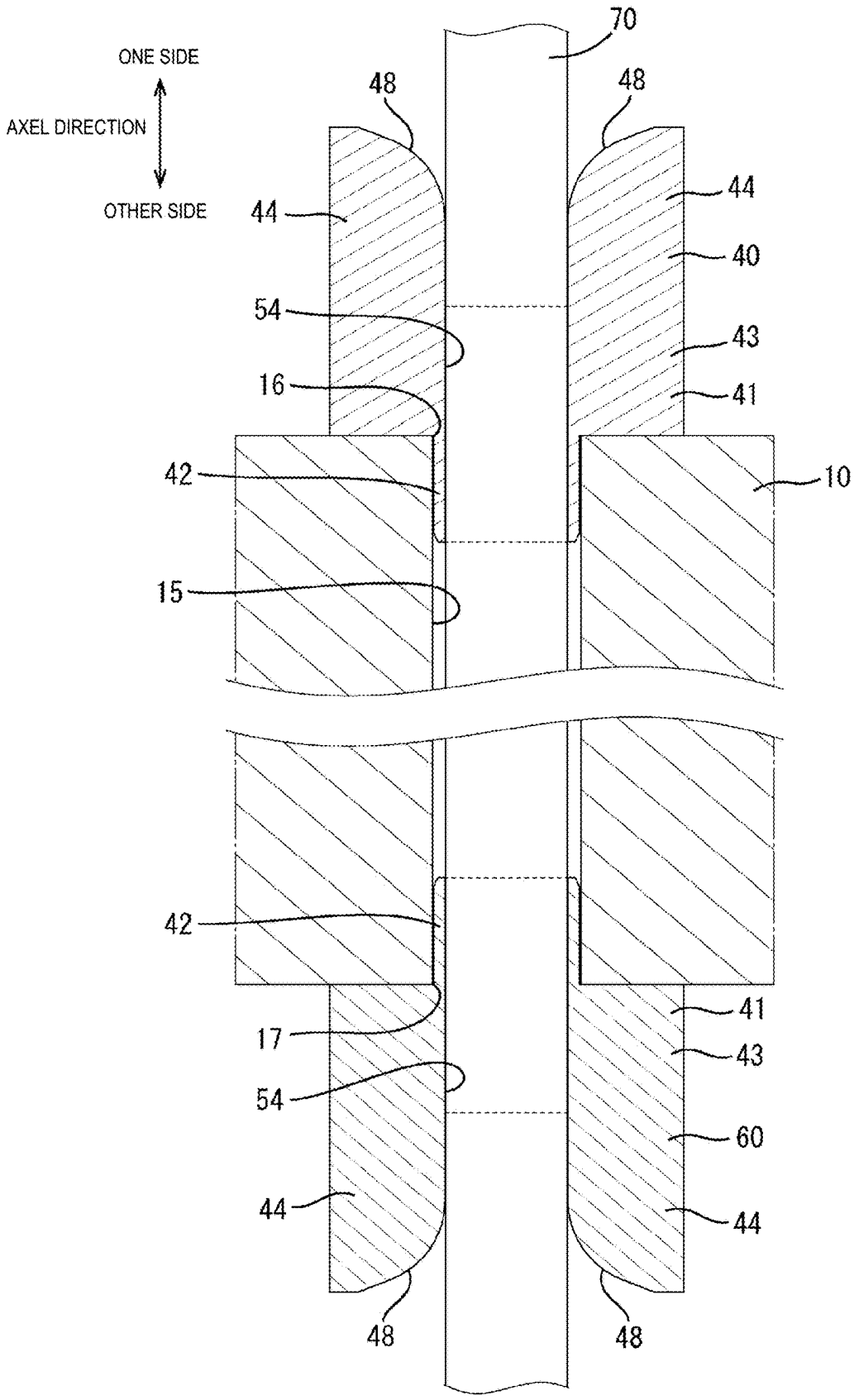
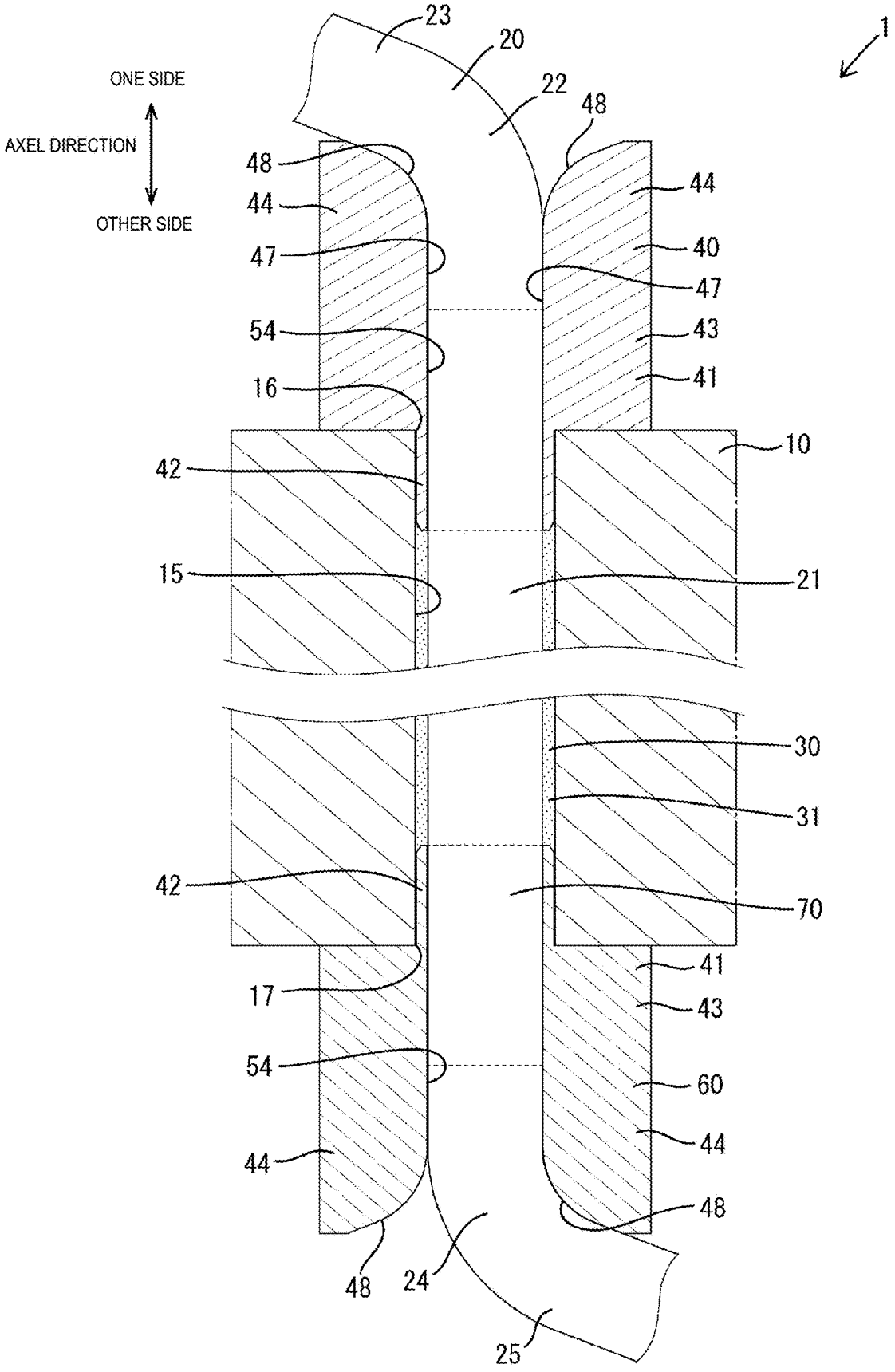

ONE SIDE
AXEL DIRECTION
OTHER SIDE
70
48
48
44
44
40
54
43
16
41
42
10
15
42
41
17
43
54
60
44
44
48
48

FIG. 8


ONE SIDE
AXEL DIRECTION
OTHER SIDE
1
23
20
22
48
48
44
44
47
40
47
54
43
16
41
10
42
15
21
30
31
42
70
41
17
43
54
60
44
44
48
48
24
25

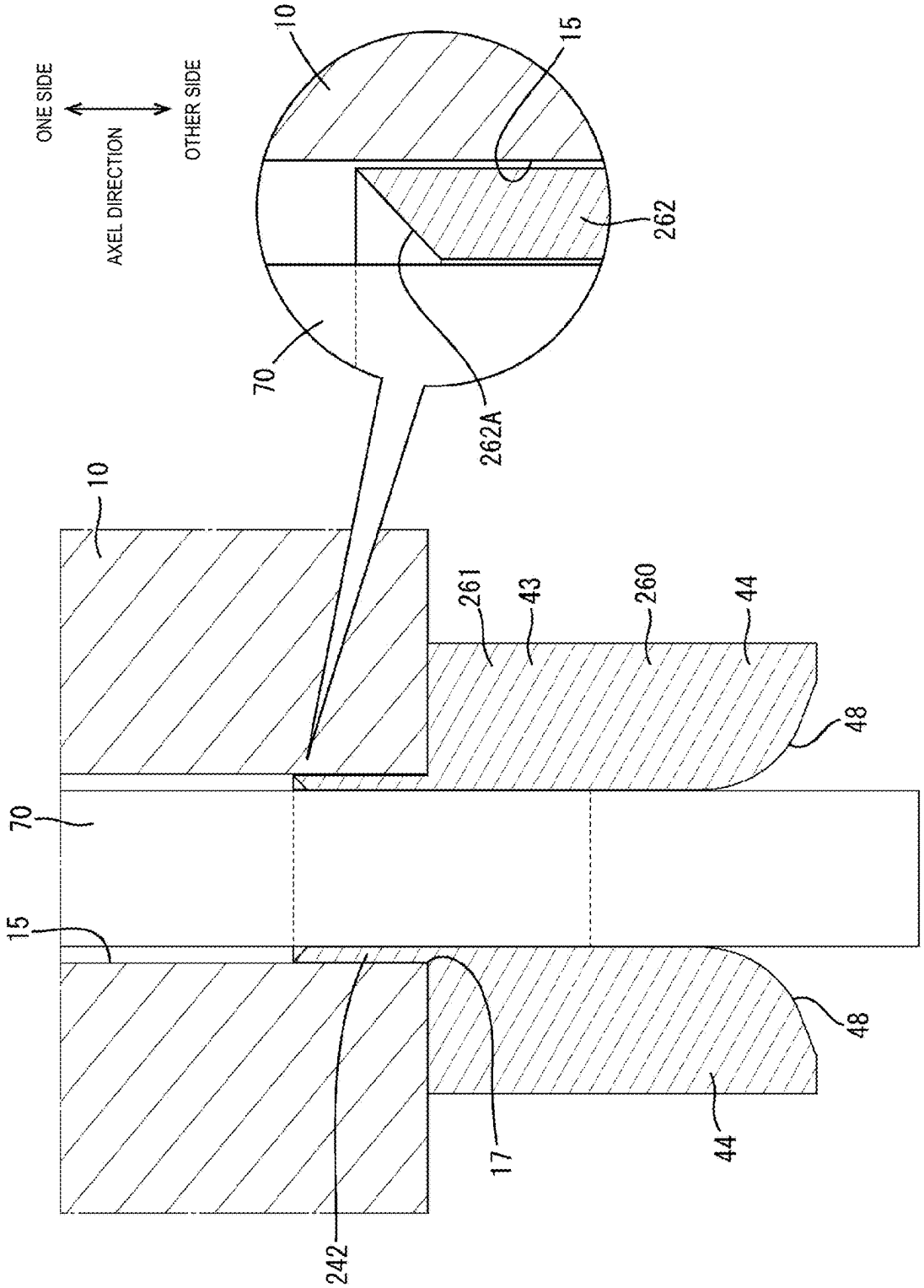

ONE SIDE
AXEL DIRECTION
OTHER SIDE
10
15
262
70
262A
10
261
43
260
44
48
70
15
48
44
17
242

FIG. 9

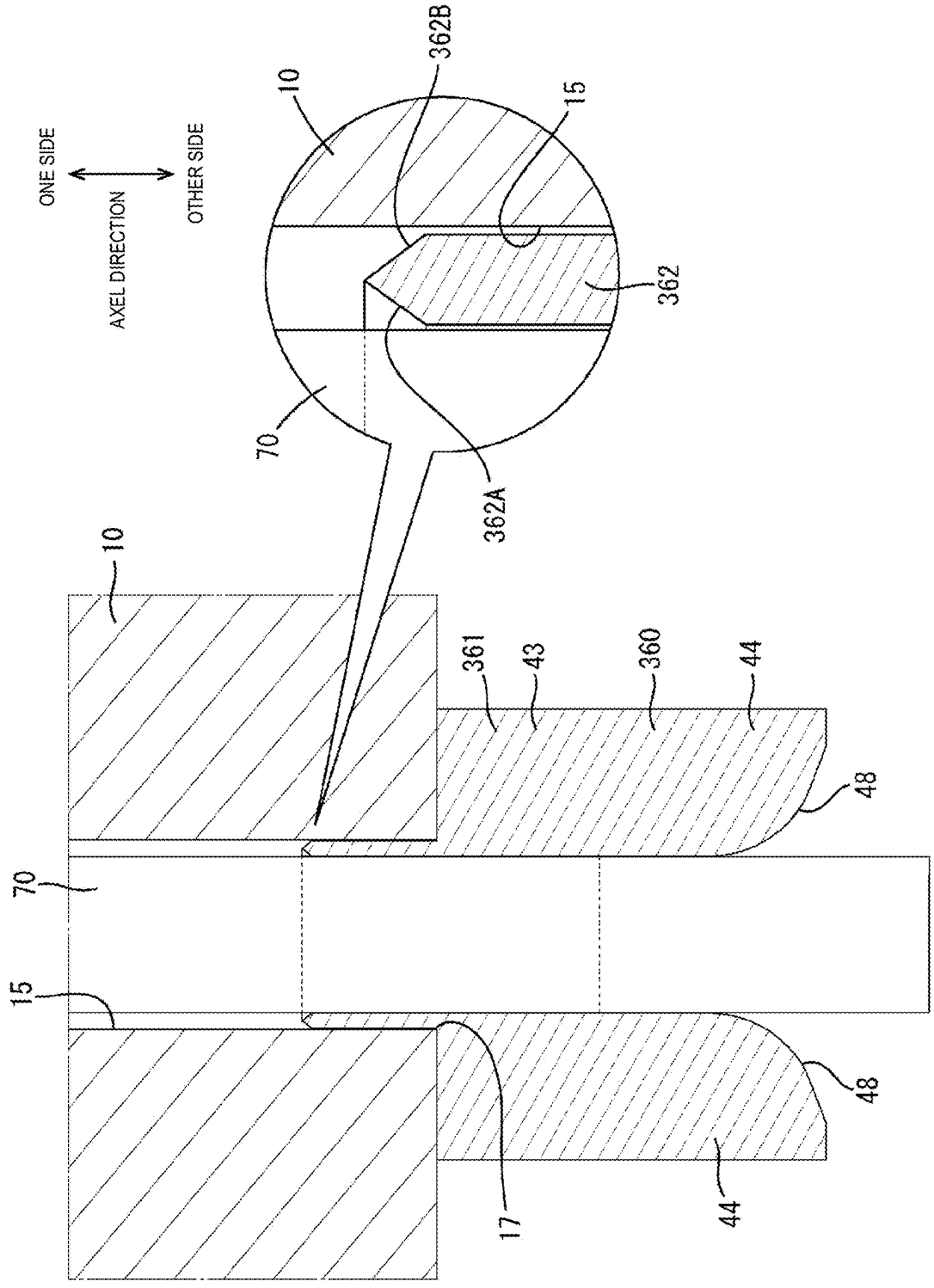

ONE SIDE
AXEL DIRECTION
OTHER SIDE
10
362B
15
362
70
362A
10
361
43
360
44
48
70
15
48
17
44

FIG. 10

STATOR AND METHOD FOR PRODUCING STATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is the U.S. national stage of PCT/JP2023/014124 filed on Apr. 5, 2023, which claims priority of Japanese Patent Application No. JP 2022-072387 filed on Apr. 26, 2022, the contents of which are incorporated herein.

TECHNICAL FIELD

[0002] The present disclosure relates to a stator and a method for producing a stator.

BACKGROUND

[0003] JP 2013-62911A and JP 2020-33433A disclose a stator. In this stator, a coil is fixed to a stator core via an insulating paper.

[0004] In the above-described stator, it is desired that heat dissipation of a coil is improved.

[0005] In view of this, an object of the present disclosure is to provide a technique which can improve heat dissipation of a coil.

SUMMARY

[0006] A stator according to the present disclosure is a stator including: an annular stator core; a coil; an insulating resin; and a positioning component, in which the stator core includes a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the coil includes an insertion portion that passes through a slot of the plurality of slots, the insulating resin includes a continuous filling portion located in a center portion in the axial direction inside the slot, and that continuously fills a space between an inner wall of the slot and the insertion portion, and the positioning component positions the insertion portion in a state where, on one side in the axial direction with respect to the continuous filling portion, at least a portion of the positioning component enters between the inner wall of the slot and the insertion portion.

[0007] A method for producing a stator according to the present disclosure is a method for producing a stator including: an annular stator core and a coil segment, the stator core having a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the method including: a placement step of placing a jig so as to cover at least a portion of an opening edge on one side in the axial direction of a slot of the plurality of slots; an insertion step of inserting the coil segment in the slot from the one side in the axial direction after placing the jig, and a filling step of continuously filling a space between an inner wall of the slot and the coil segment in a center portion in the axial direction inside the slot, with an insulating resin.

Advantageous Effects

[0008] According to the present disclosure, heat dissipation of a coil can be improved.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. **1** is a perspective view of a state in which a stator according to a first embodiment has been cut along the axial direction.

[0010] FIG. **2** is a perspective view of a stator core.

[0011] FIG. **3** is a cross-sectional view showing a portion of a cross-section of the stator taken along a direction orthogonal to the axial direction, as viewed from another side in the axial direction.

[0012] FIG. **4** is a perspective view of a first positioning component as viewed from one side in the axial direction.

[0013] FIG. **5** is a perspective view of the first positioning component as viewed from the other side in the axial direction.

[0014] FIG. **6** is a cross-sectional view showing how a coil segment is inserted into a slot.

[0015] FIG. **7** is a cross-sectional view showing a state in which the coil segment is positioned by the first positioning component and a second positioning component.

[0016] FIG. **8** is a cross-sectional view showing a state where the coil segment has been bent along an inclined surface.

[0017] FIG. **9** is an illustrative view for illustrating a first alternative embodiment of the second positioning component.

[0018] FIG. **10** is an illustrative view for illustrating a second alternative embodiment of the second positioning component.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] Hereinafter, embodiments of the present disclosure will be listed and described.

[0020] In a first aspect, a stator according to the present disclosure is a stator including: an annular stator core; a coil; an insulating resin; and a positioning component, wherein the stator core includes a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the coil includes an insertion portion that passes through a slot of the plurality of slots, the insulating resin includes a continuous filling portion located in a center portion in the axial direction inside the slot, and that continuously fills a space between an inner wall of the slot and the insertion portion, and the positioning component positions the insertion portion in a state where, on one side in the axial direction with respect to the continuous filling portion, at least a portion of the positioning component enters between the inner wall of the slot and the insertion portion.

[0021] With this configuration, since the insulating paper is not interposed between the inner wall of the slot and the insertion portion in the continuous filling portion, the heat of the coil is easily dissipated. Further, since the insertion portion is positioned in the state where at least a portion of the positioning component enters between the inner wall of the slot and the insertion portion, the position of the insertion portion in the slot is easily stabilized, and as a result, heat dissipation performance of the insertion portion via the insulating resin is easily stabilized.

[0022] In a second aspect, the stator according to the first aspect, In which the positioning component is disposed so as

to extend in the axial direction inside and outside of the slot, and positions the insertion portion on both the inside and outside of the slot.

[0023] With this configuration, since the insertion portion is positioned on the inside and outside of the slot, the position of the insertion portion is more easily stabilized.

[0024] In a third aspect, the stator according to the first or the second aspects, further including a second positioning component that positions the insertion portion in a state where, on the other side in the axial direction with respect to the continuous filling portion, at least a portion of the second positioning component enters between the inner wall of the slot and the insertion portion, and the insertion portions are positioned by the positioning component and the second positioning component.

[0025] With this configuration, since the insertion portion is positioned on both sides in the axial direction, the position of the insertion portion is more easily stabilized.

[0026] In a fourth aspect, the stator according to the third aspect, wherein the coil has an extended portion that extends from one end of the insertion portion via a bent portion, and the positioning component has an inclined surface that extends along the extended portion.

[0027] With this configuration, since the displacement of the extended portion is restricted by the inclined surface, the orientation of the coil is more easily stabilized.

[0028] In a fifth aspect, a method for producing a stator including an annular stator core and a coil segment, the stator core having a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the method including: a placement step of placing a jig so as to cover at least a portion of an opening edge on one side in the axial direction of a slot of the plurality of slots; an insertion step of inserting the coil segment in the slot from the one side in the axial direction after placing the jig, and a filling step of continuously filling a space between an inner wall of the slot and the coil segment in a center portion in the axial direction inside the slot, with an insulating resin.

[0029] With this configuration, the coil segment is easily inserted into the slot so as not to come into contact with the stator core. Further, since the insulating resin continuously fills the space between the inner wall of the slot and the coil segment, the heat of the coil segment is easily dissipated via the insulating resin, and as a result, heat dissipation of the coil can be improved.

[0030] In a sixth aspect, the method for producing a stator according to the fifth aspect, wherein in the filling step, the slot is filled with the insulating resin while an opening on the one side in the axial direction of the slot is closed by the jig.

[0031] With this configuration, leakage of the insulating resin through the opening on the one side in the axial direction of the slot to the outside is easily prevented by the jig.

[0032] In a seventh aspect, the method for producing a stator according to the fifth or the sixth aspects, wherein the jig includes a base portion disposed at an end portion on the one side in the axial direction of the stator core and a protrusion that protrudes in a tubular shape from the base portion and through which the coil segment is passed, an outer peripheral surface of the protrusion includes an outer peripheral tapered surface that is tapered toward a protruding end of the protrusion, and in the placement step, the jig is disposed by inserting the protrusion into the slot from the protruding end side.

[0033] With this configuration, since the outer peripheral tapered surface is formed on the protruding end side of the protrusion, even if the coil segment deviates slightly when the coil segment is inserted into the protrusion, the outer peripheral tapered surface guides the coil segment into the protrusion. Accordingly, with this configuration, the protrusion of the jig is easily inserted into the slot.

[0034] In an eighth aspect, the method for producing a stator according to any one of the fifth through the seventh aspects, further including: an attachment step of attaching a second jig to the coil segment that has been inserted into the slot in the insertion step, from the other side in the axial direction, wherein, in the filling step, the slot is filled with the insulating resin while an opening on the one side in the axial direction of the slot is closed by the jig and an opening on the other side in the axial direction is closed by the second jig, the second jig includes a second base portion disposed at an end portion on the other side in the axial direction of the stator core, and a second protrusion that protrudes in a tubular shape from the second base portion, an inner peripheral surface of the second protrusion includes an inner peripheral tapered surface formed such that a hole in the second protrusion widens toward the protruding end, and in the attachment step, the second jig is attached to the coil segment by inserting the coil segment into the second jig from the protruding end side of the second protrusion.

[0035] With this configuration, leakage of the insulating resin to the outside of the slot on both sides in the axial direction is easily prevented by the jig. Further, since the inner peripheral tapered surface is included in the inner peripheral surface of the second protrusion, even if the coil segment deviates slightly when the coil segment is inserted into the second protrusion, the inner peripheral tapered surface guides the coil segment to the inside of the second protrusion. Accordingly, with this configuration, the second jig is easily attached to the coil segment.

[0036] In a ninth aspect, the method for producing a stator according to the eighth aspect, wherein an outer peripheral surface of the second protrusion has a second outer peripheral tapered surface that is tapered toward the protruding end, the method further including a second placement step of placing the second jig at the end portion on the other side in the axial direction of the stator core by inserting the second protrusion into the slot from the protruding end side.

[0037] With this configuration, since the second outer peripheral tapered surface is formed on the protruding end side of the second protrusion, even if the second protrusion deviates slightly when the second protrusion is inserted into the slot from the protruding end side, the second outer peripheral tapered surface guides the second protrusion into the slot. Accordingly, this configuration makes it easy for the second jig to be inserted into the slot. That is, since the inner peripheral tapered surface and the second outer peripheral tapered surface are formed on the protruding end side of the second protrusion, the second jig is easily attached to the coil segment and inserted into the slot.

[0038] In a tenth aspect, the method for producing a stator according to any one of the fifth through the ninth aspects, wherein the base portion of the jig includes an inclined surface that guides the coil segment into the protrusion, and

in the placement step, the jig is placed such that the inclined surface is placed on the one side in the axial direction with respect to the protrusion.

[0039] With this configuration, even if the coil segment deviates slightly when the coil segment is inserted into the protrusion from the one side in the axial direction, the inclined surface guides the coil segment into the protrusion. Accordingly, this configuration makes it easy for the coil segment to be inserted into the protrusion from the one side in the axial direction.

[0040] In an eleventh aspect, the method for producing a stator according to the tenth aspect, further including a bending step of bending the coil segment along the inclined surface.

[0041] With this configuration, the inclined surface that guides the coil segment can be used to bend the coil segment.

First Embodiment

Configuration of Stator **1**

[0042] A stator **1** of the first embodiment is used as a component of a rotating electrical device (specifically, a motor). As shown in FIG. **1**, the stator **1** has an annular shape, and more specifically, a circular ring shape. The stator **1** includes a stator core **10**, a coil **20**, an insulating resin **30** (see FIG. **3**), a first positioning component **40**, and a second positioning component **60**. Note that the insulating resin **30** is not shown in FIG. **1**.

[0043] As shown in FIG. **2**, the stator core **10** has an annular shape, more specifically, a ring shape. Hereinafter, the radial direction of the stator core **10** is referred to as a "radial direction", the axial direction of the stator core **10** is referred to as an "axial direction", and the circumferential direction of the stator core **10** is referred to as a "circumferential direction".

[0044] As shown in FIGS. **2** and **3**, the stator core **10** includes a yoke portion **11** and teeth portions **12**. The yoke portion **11** has an annular shape, more specifically, a ring shape. The plurality of teeth portions **12** are arranged in an annular shape along the inner peripheral surface of the yoke portion **11**. The teeth portions **12** are disposed at intervals in the circumferential direction. The teeth portions **12** protrude radially inward from the inner peripheral surface of the yoke portion **11**. The teeth portions **12** each have a wall shape extending along the radial direction and the axial direction. The teeth portions **12** each have a teeth body **13** having a wall shape extending along the radial direction and the axial direction, and teeth projections **14** that project from the distal end portion of the teeth body **13** (i.e., radially inner end portion) to both sides in the circumferential direction.

[0045] The stator core **10** may be a laminated steel plate manufactured by laminating a plurality of magnetic steel plates (e.g., silicon steel plates) in the thickness direction, or a powder magnetic core formed by press-molding insulation-coated magnetic particles.

[0046] The stator core **10** includes a plurality of slots **15** as shown in FIG. **2**. The slots **15** are arranged side by side in an annular shape. The slots **15** extend through the stator core **10** in the axial direction. As shown in FIGS. **2** and **8**, the slots **15** each have a first opening **16**, a second opening **17**, and a third opening **18**. The first opening **16** is formed in a surface on the one side in the axial direction of the stator core **10**. The second opening **17** is formed in a surface on the other side in the axial direction of the stator core **10**. The third opening **18** is formed in a surface on the radially inner side of the stator core **10**. The third opening **18** is continuous with the first opening **16** and the second opening **17**. As shown in FIG. **3**, the slots **15** are each formed by two adjacent teeth portions **12**. The two sides in the circumferential direction of each slot **15** are defined by the teeth portions **12**, and the outer surface in the radial direction of each slot **15** is defined by the yoke portion **11**.

[0047] The coil **20** may be a distributed winding or a concentrated winding. As shown in FIG. **1**, the coil **20** is wrapped around the teeth portions **12** through the slots **15**. The coil **20** has a rectangular cross section taken along the direction orthogonal to the length direction. The coil **20** includes a core wire that forms a conductive path and a coating portion that coats the core wire. The core wire is a conductor. The core wire is a rectangular wire, and has a rectangular cross section taken along a direction orthogonal to the length direction. The coating portion forms an insulation layer. The material for the coating portion is not particularly limited. In the present embodiment, the coating portion is a low dielectric constant enamel with a low dielectric constant. The coating portion may be mainly composed of a thermosetting resin such as polyvinyl formal, thermosetting polyurethane, thermosetting acrylic, epoxy, thermosetting polyester, thermosetting polyesterimide, aromatic polyamide, thermosetting polyamideimide, or thermosetting polyimide. Further, the coating portion may be mainly composed of a thermoplastic resin such as polyetherimide, polyphenylene ether, polyether sulfone, polyphenylene sulfide, polyether ether ketone, or thermoplastic polyimide. Here, the "main component" is the component with the highest content, for example, the component contained in an amount of 50% by mass or more.

[0048] As shown in FIG. **8**, the coil **20** includes an insertion portion **21** passing through the slot **15**. The coil **20** includes a first extended portion **23** that extends from one end of the insertion portion **21** via a first bent portion **22**, and a second extended portion **25** that extends from the other end of the insertion portion **21** via a second bent portion **24**. The first bent portion **22** corresponds to an example of a "bent portion". The first extended portion **23** corresponds to an example of an "extended portion".

[0049] The insulating resin **30** fills the inside of the slots **15**. In FIG. **3**, a slot **15**A and a slot **15**B are illustrated as the slots **15**. The insulating resin **30** is not shown in the slot **15**A. The slot **15**B filled with the insulating resin **30** is shown. The insulating resin **30** includes a continuous filling portion **31** that continuously fills a space between the inner wall of the slot **15**B (slot **15**) and the insertion portions **21** at the center portion in the axial direction of the stator core **10**. The continuous filling portion **31** continuously fills the slot **15**B (slot **15**) except for both end portions in the axial direction. According to this configuration, since the insulating paper is not interposed between the inner wall of the slot **15** and the insertion portions **21** in each continuous filling portion **31**, the heat of the coil **20** is easily dissipated.

[0050] The first positioning component **40** corresponds to an example of a "positioning component" and an example of a "jig". The first positioning component **40** has insulating properties, and is formed by a material such as resin or ceramic. As shown in FIGS. **4** and **5**, the first positioning

component **40** has an annular shape. The first positioning component **40** includes a base portion **41** and a protrusion **42**.

[0051] The base portion **41** includes an annular base portion **43** and projections **44**. The annular base portion **43** has an annular shape. The annular base portion **43** includes a pair of long portions **45** and a pair of short portions **46**. The pair of long portions **45** extend linearly in parallel with each other. The pair of long portions **45** extend along the radial direction. The short portions **46** are shorter than the long portions **45**. The pair of short portions **46** extend linearly in parallel with each other. The pair of short portions **46** extend along a direction orthogonal to the long portions **45**. The pair of short portions **46** extend along the circumferential direction. The pair of long portions **45** and the pair of short portions **46** form an annular shape as a whole.

[0052] The projections **44** project from the base portion **41** toward one side in the axial direction. The projections **44** respectively project from the pair of long portions **45** toward one side in the axial direction. That is, the projections **44** are provided in a pair. The pair of projections **44** respectively have facing surfaces **47** that face each other and inclined surfaces **48** that face each other. The pair of facing surfaces **47** face each other in the circumferential direction. The facing surfaces **47** are surfaces extending along the axial direction and the radial direction. At least a portion of the facing surfaces **47** is flush with an inner peripheral surface of the annular base portion **43** (more specifically, surfaces of the pair of long portions **45** that face each other). The pair of inclined surfaces **48** are inclined such that the distance from each other increases toward the projecting side (the one side in the axial direction) of the projections **44**. Radially inner end portions of the pair of projections **44** are disposed radially inward of the inner peripheral surface of the annular base portion **43** and radially inward of the inner peripheral surface of the protrusion **42**. Radially outer end portions of the pair of projections **44** are disposed radially outward of the inner peripheral surface of the annular base portion **43**, and radially outward of the inner peripheral surface of the protrusion **42**. The radially inner end portions of the pair of facing surfaces **47** and the pair of inclined surfaces **48** are disposed radially inward of the inner peripheral surface of the annular base portion **43** and radially inward of the inner peripheral surface of the protrusion **42**. The radially outer end portions of the pair of facing surfaces **47** and the pair of inclined surfaces **48** are disposed radially outward of the inner peripheral surface of the annular base portion **43**, and radially outward of the inner peripheral surface of the protrusion **42**.

[0053] The protrusion **42** protrudes in a tubular shape from the base portion **41** toward the opposite side to the projections **44** side (the other side in the axial direction). The protrusion **42** protrudes in a tubular shape from the inner periphery of the tubular base portion **41**. The protrusion **42** has a quadrangular tube shape. The protrusion **42** includes a pair of long plate portions **50** and a pair of short plate portions **51**. The pair of long plate portions **50** extend linearly in parallel with each other. The pair of long plate portions **50** extend along a radial direction. The short plate portions **51** are shorter than the long plate portions **50**. The pair of short plate portions **51** extend linearly in parallel with each other. The pair of short plate portions **51** extend in a direction orthogonal to the long plate portions **50**. The pair of short plate portions **51** extend along the circumferential direction. The pair of long portions **50** and the pair of short portions **51** form a tube shape (more specifically, a quadrangular tube shape) as a whole.

[0054] The inner peripheral surface of the protrusion **42** is continuous with the inner peripheral surface of the base portion **41** (annular base portion **43**) without a stepped portion. The outer peripheral surface of the protrusion **42** includes an outer peripheral tapered surface **52** that is tapered toward the protruding end.

[0055] The first positioning component **40** includes an inner protrusion **53** protruding radially inward from the outer peripheral surface of the protrusion **42**. As shown in FIG. **3**, the inner protrusion **53** is disposed in a gap between the teeth projections **14** in the circumferential direction.

[0056] As shown in FIGS. **4** and **5**, the first positioning component **40** has a pair of positioning surfaces **54**. The pair of positioning surfaces **54** position the insertion portions **21** in the circumferential direction. The pair of positioning surfaces **54** are constituted by the pair of facing surfaces **47**, the inner peripheral surface of the annular base portion **43** (more specifically, the surfaces of the pair of long portions **45** that face each other), and the inner peripheral surface of the protrusion **42** (more specifically, the surfaces of the pair of long plate portions **50** that face each other).

[0057] The second positioning component **60** corresponds to an example of a "second jig". In the present embodiment, the second positioning component **60** has the same form as the first positioning component **40**, and thus a detailed description thereof will be omitted.

[0058] As shown in FIG. **8**, the first positioning component **40** positions the insertion portions **21** in a state where the protrusion **42** enters between the inner wall of the slot **15** and the insertion portions **21** on the one side in the axial direction with respect to the continuous filling portion **31**. In the circumferential direction, the protrusion **42** positions the insertion portions **21** in a state where the protrusions **42** enter between the inner wall of the slot **15** and the insertion portions **21**, on both sides of each insertion portion **21**. In the radial direction, the protrusion **42** positions the insertion portions **21** in a state where the protrusion **42** enters between the inner wall of the slot **15** and the innermost insertion portion **21** and the outermost insertion portion **21** among the plurality of insertion portions **21** radially arranged side by side. According to this configuration, since the protrusion **42** of the first positioning component **40** positions the insertion portions **21** in a state where the protrusion **42** enters between the inner wall of the slot **15** and the insertion portions **21**, the positions of the insertion portions **21** in the slot **15** are easily stabilized, and as a result, the heat dissipation performance of the insertion portion **21** via the insulating resin **30** is easily stabilized. The first positioning component **40** is disposed so as to extend in the axial direction inside and outside of each slot **15**, and positions the insertion portions **21** on both the inside and outside of the slot **15**. More specifically, the inner peripheral surface of the protrusion **42** of the first positioning component **40** positions the insertion portions **21** inside the slot **15**, and the inner peripheral surface of the annular base portion **43** and the pair of facing surfaces **47** of the pair of projections **44** position the insertion portions **21** outside of the slot **15**. According to this configuration, since the insertion portions **21** are positioned on the inside and outside of the slot **15**, the positions of the insertion portions **21** are more easily stabilized.

[0059] As shown in FIG. **8**, on the other side in the axial direction with respect to the continuous filling portion **31**, similarly to the first positioning component **40**, the second positioning component **60** positions the insertion portions **21** in a state where the protrusion **42** enters between the inner wall of the slot **15** and the insertion portions **21**.

[0060] As shown in FIG. **8**, the insertion portions **21** are positioned by the first positioning component **40** and the second positioning component **60**. According to this configuration, since the insertion portions **21** are positioned on both sides in the axial direction, the position of the insertion portion **21** is more easily stabilized.

[0061] As shown in FIG. **8**, the inclined surfaces **48** of the first positioning component **40** are disposed along the first extended portions **23** of the coil **20**. The inclined surfaces **48** of the second positioning component **60** are disposed along the second extended portions **25** of the coil **20**. According to this configuration, displacement of the first extended portions **23** is restricted by the inclined surfaces **48** of the first positioning component **40**, and displacement of the second extended portions **25** is restricted by the inclined surfaces **48** of the second positioning component **60**. Accordingly, the orientation of the coil **20** is more easily stabilized.

[0062] As shown in FIG. **3**, a plurality (in the present embodiment, four) of insertion portions **21** are disposed in one slot **15**. The plurality of insertion portions **21** are radially arranged in a row in one slot **15**.

Method for Producing Stator **1**

[0063] The method for producing a stator **1** includes a first placement step, an insertion step, an attachment step, a second placement step, a filling step, a bending step, and a welding step.

[0064] In the first placement step, the first positioning component **40** is placed so as to cover at least a portion of the opening edge on the one side in the axial direction of the slot **15** (see FIG. **6**). The first positioning component **40** is inserted into the slot **15** from the protruding end side of the protrusion **42**. The outer peripheral tapered surface **52** is formed on the protruding end side of the protrusion **42**. Accordingly, even if the protrusion **42** deviates slightly when inserted into the slot **15**, the protrusion **42** is guided into the slot **15**. Accordingly, with this configuration, the protrusion **42** of the first positioning component **40** is easily inserted into the slot **15**. The base portion **41** of the first positioning component **40** is placed on the one end portion in the axial direction of the stator core **10**. The first positioning component **40** is placed so as to close the opening on the one side in the axial direction (the first opening **16**) of the slot **15**. The pair of inclined surfaces **48** of the first positioning component **40** are placed on the one side in the axial direction with respect to the protrusion **42**. According to this configuration, even if the coil segment **70** deviates slightly when inserted into the protrusion **42** from the one side in the axial direction, the coil segment **70** is guided into the protrusion **42** by the inclined surfaces **48**. Accordingly, with this configuration, the coil segment **70** is easily inserted into the protrusion **42** from the one side in the axial direction. Note that the coil segment **70** is a component that is included in the coil **20**. The coil segment **70** has a linear shape.

[0065] In the insertion step, after the first positioning component **40** is placed, the coil segment **70** is inserted into the slot **15** from one side in the axial direction (see FIG. **6**). With this configuration, the coil segment **70** is easily inserted into the slot **15** so as not to come into contact with the stator core **10**. Accordingly, even if there is a burr at an opening end of the slot **15**, the case where the coating portion of the insertion portion **21** is caught by the burr and peeled off is easily prevented. The coil segment **70** is passed through the tubular protrusion **42** from the one side in the axial direction to be inserted into the slot **15**. The coil segment **70** is passed between the pair of inclined surfaces **48** to be inserted into the tubular base portion **41**. The pair of inclined surfaces **48** are inclined so that the distance from each other increases toward the one side in the axial direction. According to this configuration, even if the coil segment **70** deviates slightly in the circumferential direction when inserted into the base portion **41**, the coil segment **70** is guided into the base portion **41** by the pair of inclined surfaces **48**. Accordingly, with this configuration, the coil segment **70** is easily inserted into the protrusion **42** from the one side in the axial direction.

[0066] In the attachment step, the second positioning component **60** is attached to the coil segment **70**, which has been inserted into the slot **15** in the insertion step, from the other side in the axial direction (see FIG. **7**). That is, in the attachment step, the second positioning component **60** is attached to the coil segment **70** that extends from the opening (the second opening **17**) on the other side in the axial direction of the slot **15**. In the attachment step, the coil segment **70** is inserted into the tubular protrusion **42** of the second positioning component **60**. The second positioning component **60** is attached to the coil segment **70** in an orientation opposite to that of the first positioning component **40**.

[0067] In the second placement step, the second positioning component **60** is placed so as to cover at least a portion of an opening edge on the other side in the axial direction of the slot **15** (see FIG. **7**). The second positioning component **60** is inserted into the slot **15** from the protruding end side of the protrusion **42**. The outer tapered surface **52** is formed on the protruding end side of the protrusion **42**. Accordingly, even if the protrusion **42** deviates slightly when inserted into the slot **15**, the protrusion **42** is guided into the slot **15**. Accordingly, with this configuration, the protrusion **42** of the second positioning component **60** is easily inserted into the slot **15**. The base portion **41** of the second positioning component **60** is placed at the other end portion in the axial direction of the stator core **10**. The second positioning component **60** is placed so as to cover the opening (the second opening **17**) on the other side in the axial direction of the slot **15**. The pair of inclined surfaces **48** of the second positioning component **60** are placed on the other side in the axial direction with respect to the protrusion **42**.

[0068] In the filling step, a gap between the inner wall of the slot **15** and the coil segment **70** in the center portion in the axial direction of the slot **15** is continuously filled with an insulating resin **30** (see FIG. **8**). Since the gap between the inner wall of the slot **15** and the coil segment **70** is continuously filled with the insulating resin **30**, the heat of the coil segment **70** is easily dissipated via the insulating resin **30**, and as a result, heat dissipation of the coil **20** can be improved. When filling with the insulating resin **30**, the opening on the one side in the axial direction of the slot **15** (the first opening **16**) is closed by the first positioning component **40**. The opening on the other side in the axial direction of the slot **15** (the second opening **17**) is closed by the second positioning component **60**. The opening on the

radially inner side of the slot **15** (the third opening **18**) is closed by another member except for the resin injection portion. Then, the slot **15** is filled with the insulating resin **30** through the third opening **18**. With this configuration, leakage of the insulating resin **30** from both sides in the axial direction of the slot **15** is easily prevented by the first positioning component **40** and the second positioning component **60**. The filling step is performed in the state where the coil segment **70** is positioned by the first positioning component **40** and the second positioning component **60**. With this configuration, when the insulating resin **30** is solidified, the coil segment **70** is easily placed at an appropriate position.

[0069] In the bending step, the one end side of the coil segment **70** is bent along the inclined surfaces **48** of the first positioning component **40** (see FIG. **8**). The first extended portion **23** is thus formed. With this configuration, the inclined surfaces **48** that guide the coil segment **70** can be used to bend the coil segment **70**. In the bending step, the other end side of the coil segment **70** is bent along the inclined surfaces **48** of the second positioning component **60**. The second extended portion **25** is thus formed.

[0070] In the welding step, the first extended portion **23** of the coil segment **70** is welded to another coil component (e.g., a first extended portion **23** of another coil segment **70**). Also, in the welding step, the second extended portion **25** of the coil segment **70** is welded to another coil component (e.g., a second extended portion **25** of another coil segment **70**). The stator **1** is produced through these steps.

Second Embodiment

[0071] In a second embodiment, a first alternative embodiment of the second positioning component will be described. In the following description, configurations that are the same as in the first embodiment are denoted by the same reference signs, and redundant description thereof is omitted.

[0072] A second positioning component **260** of the second embodiment corresponds to the "second jig". The second positioning component **260** has insulating properties and is made of resin or ceramic, for example. The second positioning component **260** has an annular shape. As shown in FIG. **9**, the second positioning component **260** includes a second base portion **261** that is disposed at the other end portion of the stator core **10**, and a second protrusion **262** that protrudes in a tubular shape from the second base portion **261**. The second base portion **261** has the same form as the base portion **41** of the first embodiment.

[0073] The second protrusion **262** protrudes in a tubular shape from the second base portion **261** to the opposite side to the projection **44** side (the other side in the axial direction). The second protrusion **262** protrudes in a tubular shape from the inner periphery of the tubular second base portion **261**. The second protrusion **262** has a quadrangular tube shape.

[0074] The inner peripheral surface of the second protrusion **262** is continuous with the inner peripheral surface of the second base portion **261** (annular base portion **43**) without a stepped portion. The inner peripheral surface of the second protrusion **262** has an inner peripheral tapered surface **262**A formed such that a hole in the second protrusion **262** widens toward the protruding end.

[0075] The second positioning component **260** differs from the second positioning component **60** (first positioning component **40**) of the first embodiment in that the inner peripheral tapered surface **262**A is provided and the outer peripheral tapered surface **52** is not provided, and is the same in other aspects.

[0076] Similarly to the method for producing the stator **1** of the first embodiment, the method for producing the stator of the second embodiment includes the first placement step, the insertion step, the attachment step, the second placement step, the filling step, the bending step and the welding step.

[0077] That is, in the attachment step, the second positioning component **260** is attached from the other side in the axial direction to the coil segment **70** that has been inserted into the slot **15** in the insertion step. In the attachment step, the second positioning component **260** is attached to the coil segment **70** by inserting the coil segment **70** into the second positioning component **260** from the protruding end side of the second protrusion **262**.

[0078] According to this configuration, since the inner peripheral surface of the second protrusion **262** has the inner peripheral tapered surface **262**A, even if the coil segment **70** deviates slightly when passed into the second protrusion **262**, the coil segment **70** is guided into the second protrusion **262** by the inner peripheral tapered surface **262**A. Accordingly, with this configuration, the second positioning component **260** is easily attached to the coil segment **70**.

Third Embodiment

[0079] In a third embodiment, a second alternative embodiment of the second positioning component will be described. The second positioning component of the third embodiment differs from the positioning component of the second embodiment in that a second outer peripheral tapered surface is provided in addition to the inner peripheral tapered surface, and is the same in other aspects. In the following description, configurations that are the same as in the first embodiment are denoted by the same reference signs, and redundant description thereof is omitted.

[0080] A second positioning component **360** of the third embodiment corresponds to an example of the "second jig". The second positioning component **360** has insulating properties, and is made of resin or ceramic, for example. The second positioning component **360** has an annular shape. As shown in FIG. **10**, the second positioning component **360** includes a second base portion **361** that is disposed at the other end portion of the stator core **10**, and a second protrusion **362** that protrudes in a tubular shape from the second base portion **361**. The second base portion **361** has the same form as the base portion **41** of the first embodiment.

[0081] The second protrusion **362** protrudes in a tubular shape from the second base portion **361** to the opposite side to the projections **44** side (the other side in the axial direction). The second protrusion **362** protrudes in a tubular shape from the inner periphery of the tubular second base portion **361**. The second protrusion **362** has a quadrangular tube shape.

[0082] The inner peripheral surface of the second protrusion **362** is continuous with the inner peripheral surface of the second base portion **361** (annular base portion **43**) without a stepped portion. The inner peripheral surface of the second protrusion **362** has an inner peripheral tapered surface **362**A formed such that a hole in the second protrusion **362** widens toward the protruding end.

[0083] The outer peripheral surface of the second protrusion **362** includes a second outer peripheral tapered surface **362**B that is tapered toward the protruding end.

[0084] The second positioning component **360** differs from the second positioning component **60** (first positioning component **40**) of the first embodiment in that the inner peripheral tapered surface **362**A is provided and the second outer peripheral tapered surface **362**B is provided instead of the outer peripheral tapered surface **52**, and is the same in other aspects.

[0085] Similarly to the method for producing the stator **1** of the first embodiment, the method for producing the stator of the third embodiment includes the first placement step, the insertion step, the attachment step, the second placement step, the filling step, the bending step, and the welding step.

[0086] Specifically, in the second placement step, by inserting the second protrusion **362** into the slot **15** from the protruding end side, the second positioning component **360** is placed at the end portion on the other side in the axial direction of the stator core **10**.

[0087] According to this configuration, since the second outer peripheral tapered surface **362**B is formed on the protruding end side of the second protrusion **362**, even if the second protrusion **362** deviates slightly when inserted into the slot **15** from the protruding end side, the second protrusion **362** is guided into the slot **15** by the second outer peripheral tapered surface **362**B. Accordingly, with this configuration, the second positioning component **360** is easily inserted into the slot **15**. That is, since the inner peripheral tapered surface **362**A and the second outer peripheral tapered surface **362**B are formed on the protruding end side of the second protrusion **362**, the second positioning component **360** is easily attached to the coil segment **70** and inserted into the slot **15**.

OTHER EMBODIMENTS

[0088] The present disclosure is not limited to the embodiments described by way of the above descriptions and figures. For example, the features of the embodiments described above and below can be combined in any way as long as no contradiction arises. Also, any feature of the above embodiments can also be omitted unless otherwise specified as essential.

[0089] In the above embodiments, the first positioning component that is one component of the stator is used as the first jig, and the second positioning component is used as the second jig. However, a jig that is not a component of the stator can be used to produce a stator.

[0090] In the second embodiment, the first positioning component may have the same form as the second positioning component.

[0091] In the third embodiment, the first positioning component may have the same form as the second positioning component.

[0092] The embodiment disclosed here is to be considered in all respects as illustrative and not limiting. The scope of the present disclosure is not intended to be limited to the embodiments disclosed herein, but rather is indicated by the scope of the claims, and is intended to include all modifications within the meaning and scope of equivalents of the scope of the claims.

1. A stator comprising:
an annular stator core;
a coil;
an insulating resin; and
a positioning component,
wherein the stator core includes a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction,
the coil includes an insertion portion that passes through a slot of the plurality of slots,
the insulating resin includes a continuous filling portion located in a center portion in the axial direction inside the slot, and that continuously fills a space between an inner wall of the slot and the insertion portion,
the positioning component positions the insertion portion in a state where, on one side in the axial direction with respect to the continuous filling portion, at least a portion of the positioning component enters between the inner wall of the slot and the insertion portion,
the positioning component has a pair of positioning surfaces, and
the pair of positioning surface are disposed so as to be continuous inside and outside of the slot in the axial direction without a stepped portion, and position the insertion portion on both the inside and outside of the slot.

2. (canceled)

3. The stator according to claim **1**, further including;
a second positioning component that positions the insertion portion in a state where, on the other side in the axial direction with respect to the continuous filling portion, at least a portion of the second positioning component enters between the inner wall of the slot and the insertion portion, and
the insertion portions are positioned by the positioning component and the second positioning component.

4. The stator according to claim **1**,
wherein the coil has an extended portion that extends from one end of the insertion portion via a bent portion, and
the positioning component has an inclined surface that extends along the extended portion.

5. (canceled)

6. A method for producing a stator including an annular stator core and a coil segment, the stator core having a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the method comprising:
a placement step of placing a jig so as to cover at least a portion of an opening edge on one side in the axial direction of a slot of the plurality of slots, and such that a pair of positioning surfaces included in the jig are continuous inside and outside of the slot without a stepped portion;
an insertion step of inserting the coil segment in the slot from the one side in the axial direction after placing the jig, and
a filling step of continuously filling a space between an inner wall of the slot and the coil segment in a center portion in the axial direction inside the slot, with an insulating resin.

7. The method for producing a stator according to claim **6**, wherein in the filling step, the slot is filled with the insulating resin while an opening on the one side in the axial direction of the slot is closed by the jig.

8. The method for producing a stator according to claim **6**,
wherein the jig includes a base portion disposed at an end portion on the one side in the axial direction of the

stator core and a protrusion that protrudes in a tubular shape from the base portion and through which the coil segment is passed,

an outer peripheral surface of the protrusion includes an outer peripheral tapered surface that is tapered toward a protruding end of the protrusion, and

in the placement step, the jig is disposed by inserting the protrusion into the slot from the protruding end side.

9. A method for producing a stator including an annular stator core and a coil segment, the stator core having a plurality of slots that are arranged in an annular shape and extend through the stator core in an axial direction, the method comprising:

a placement step of placing a jig so as to cover at least a portion of an opening edge on one side in the axial direction of a slot of the plurality of slots;

an insertion step of inserting the coil segment in the slot from the one side in the axial direction after placing the jig;

an attachment step of attaching a second jig to the coil segment that has been inserted into the slot in the insertion step, from the other side in the axial direction, and

a filling step of continuously filling a space between an inner wall of the slot and the coil segment in a center portion in the axial direction inside the slot, with an insulating resin,

wherein, in the filling step, the slot is filled with the insulating resin while an opening on the one side in the axial direction of the slot is closed by the jig and an opening on the other side in the axial direction is closed by the second jig,

the second jig includes a second base portion disposed at an end portion on the other side in the axial direction of the stator core, and a second protrusion that protrudes in a tubular shape from the second base portion,

an inner peripheral surface of the second protrusion is continuous with an inner peripheral surface of the second base portion, without a stepped portion,

the inner peripheral surface of the second protrusion includes an inner peripheral tapered surface formed such that a hole in the second protrusion widens toward the protruding end, and

in the attachment step, the second jig is attached to the coil segment by inserting the coil segment into the second jig from the protruding end side of the second protrusion.

10. The method for producing a stator according to claim **9**,

wherein an outer peripheral surface of the second protrusion has a second outer peripheral tapered surface that is tapered toward the protruding end,

the method further comprising

a second placement step of placing the second jig at the end portion on the other side in the axial direction of the stator core by inserting the second protrusion into the slot from the protruding end side.

11. The method for producing a stator according to claim **8**,

wherein the base portion of the jig includes an inclined surface that guides the coil segment into the protrusion, and

in the placement step, the jig is placed such that the inclined surface is placed on the one side in the axial direction with respect to the protrusion.

12. The method for producing a stator according to claim **11**, further including;

a bending step of bending the coil segment along the inclined surface.

13. The stator according to claim **3**,

wherein the coil has an extended portion that extends from one end of the insertion portion via a bent portion, and

the positioning component has an inclined surface that extends along the extended portion.

14. The method for producing a stator according to claim **7**,

wherein the jig includes a base portion disposed at an end portion on the one side in the axial direction of the stator core and a protrusion that protrudes in a tubular shape from the base portion and through which the coil segment is passed,

an outer peripheral surface of the protrusion includes an outer peripheral tapered surface that is tapered toward a protruding end of the protrusion, and

in the placement step, the jig is disposed by inserting the protrusion into the slot from the protruding end side.

* * * * *