A compressor housing of a supercharger includes a housing body housing an impeller therein, and having an inner circumferential recess in a recessed shape on an annular inner circumferential surface along an outer circumference of the impeller; and a sliding member in an annular shape disposed in the inner circumferential recess, an inner circumferential surface of the sliding member having a shroud surface that faces the impeller. The housing body includes a diffuser surface that is disposed circumferentially outward of the shroud surface in a manner as to be continued to the shroud surface. Joint portions in which the housing body and the sliding member are joined through a friction stir welding are provided at a boundary between an outer circumferential end of the sliding member and an inner circumferential end of the diffuser surface of the housing body.
COMPRESSOR HOUSING FOR SUPERCHARGER AND PRODUCING METHOD OF THE SAME

INCORPORATION BY REFERENCE


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention relates to a compressor housing for a supercharger and a producing method of the same.
[0004] 2. Description of Related Art
[0005] Compressors (compression machines) used in superchargers, such as turbochargers, of automobiles have compressor housings, each configured to house an impeller therein, and include: an intake port to take in air toward the impeller; a scroll chamber formed circumferentially outward of the impeller in a circumferential direction so as to introduce the air discharged from the impeller; and a shroud surface facing the impeller.
[0006] In the above configured compressor, a gap between impeller blades and the shroud surface of the compressor housing is set to be as small as possible, thereby enhancing compression efficiency of the compressor. However, if the gap is too small, damages might be caused to the impeller if the impeller blades come into contact with the shroud surface of the compressor housing due to vibrations, run-out of a rotational axis of the impeller, or the like, for example.
[0007] To counter this, there has conventionally been proposed a structure of providing a sliding member made of a softer resin or the like than impeller blades to a portion where a shroud surface of a compressor housing is formed (Japanese Patent Application Publication No. 9-170442). According to this, even if the impeller blades come into contact with the shroud surface of the compressor housing due to vibrations, run-out of the impeller rotation axis, or the like, only the sliding member provided to the portion where the shroud surface is formed becomes cut; therefore, no damage is caused to the impeller, and a gap between the impeller blades and the shroud surface of the compressor housing is maintained to be small.
[0008] Unfortunately, in JP 9-170442 A, in order to fix the sliding member to the shroud, the sliding member is enlarged to a diffuser that does not face the impeller. The sliding member is fasteningly fixed to a main body of the compressor housing (housing body) via screw through-holes formed in the enlarged part with screw members. Hence, the sliding member is increased in dimension by the above enlarged part. In general, it is necessary to use a more expensive material for the sliding member than a material for the housing body, thus causing increase in cost of the entire compressor housing due to increase in dimension of the sliding member.
[0009] As with the configuration of JP 9-170442 A, using the screw members causes not only increase in number of components, but also makes it necessary to carry out machining for screw-holes formed in the housing body, and machining for screw through-holes formed in the sliding member. In light of this point, it is likely to increase the production cost.

SUMMARY OF THE INVENTION

[0010] The present invention has been made in light of the above background, and provides a compressor housing for a supercharger and a producing method of the compressor housing capable of reducing the number of components and the cost.
[0011] According to one aspect of the present invention, there is provided a compressor housing for a supercharger including: a housing body; and a sliding member. The housing body is configured to house an impeller therein, and has an inner circumferential recess in a recessed shape on an annular inner circumferential surface along an outer circumferential of the impeller. The sliding member has an annular shape, the sliding member is disposed in the inner circumferential recess, and an inner circumferential surface of the sliding member has a shroud surface that faces the impeller. The housing body includes a diffuser surface disposed circumferentially outward of the shroud surface in a manner as to be continued to the shroud surface, and joint portions are provided at a boundary between an outer circumferential end of the sliding member and an inner circumferential end of the diffuser surface of the housing body. In the joint portions the housing body and the sliding member are joined through a friction stir welding (FSW).
[0012] In the above compressor housing, each of the joint portion may be disposed in a part of the boundary, and a center of each of the joint portion in a radial direction of the housing body may be located circumferentially outward of the boundary.
[0013] According to another aspect of the present invention, there is provided a producing method of the above compressor housing for a supercharger. The producing method includes an assembling step, a friction stir welding step, and a cutting step. In the assembling step, the sliding member is assembled into the inner circumferential recess of the housing body. Subsequently, in the friction stir welding step, the friction stir welding is carried out at the boundary between the outer circumferential end of the sliding member and the inner circumferential end of the diffuser surface of the housing body so as to provide each of the joint portion. Subsequently, in the cutting step, the sliding member and the housing body are subjected to cutting so as to provide the shroud surface and the diffuser surface. In the cutting step, a surface of each of the joint portion is cut so as to be smoothly continued to the diffuser surface and the shroud surface.
[0014] In the producing method of the compressor housing, in the friction stir welding step, when a rotating tool is pushed against a processing target at the boundary, the friction stir welding may be carried out such that a center of the rotating tool is located circumferentially outward of the boundary.
[0015] In the compressor housing for a supercharger produced with the above producing method of the compressor housing for a supercharger, each of the joint portion is provided at the boundary between the outer circumferential end of the sliding member and the inner circumferential end of the diffuser surface of the housing body. In other words, the housing body and the sliding member are joined through the friction stir welding. Hence, it is unnecessary to provide the sliding member with portions to be engaged with fixing members, such as screw members, thus promoting reduction in dimension of the sliding member. Specifically, reduction in dimension of the sliding member for which material is
likely to be relatively expensive can realize cost reduction. Through the friction stir welding, no fixing member to fix the housing body and the sliding member to each other is necessary; thus reducing the number of components.

[0016] As aforementioned, according to the present invention, it is possible to provide a compressor housing for a supercharger and a producing method of the compressor housing capable of reducing the number of components and the cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

[0018] FIG. 1 is a sectional view of a turbocharger including a compressor housing for a supercharger in Embodiment 1 of the present invention, and is a sectional view taken along line I-I of FIG. 4;

[0019] FIG. 2 is an enlarged sectional view of a vicinity of a shroud surface of the compressor housing in Embodiment 1, and is a partially enlarged sectional view of FIG. 1;

[0020] FIG. 3 is an enlarged sectional view of the vicinity of the shroud surface of the compressor housing in Embodi- ment 1, and is a sectional view taken along line of FIG. 4.

[0021] FIG. 4 is a plan view of a part of the compressor housing as viewed from a diffuser surface in Embodiment 1;

[0022] FIG. 5 is an enlarged plan view of a joint portion as viewed from the diffuser surface in Embodiment 1;

[0023] FIG. 6 is an explanatory sectional view showing a state immediately before assembly of a housing body and a sliding member in Embodiment 1;

[0024] FIG. 7 is an explanatory sectional view showing a sub-assembly formed by assembling the housing body and the sliding member in Embodiment 1;

[0025] FIG. 8 is an enlarged sectional view of a boundary, and an explanatory view of a rotating tool in Embodiment 1.

[0026] FIG. 9 is an enlarged sectional view showing a state immediately after a friction stir welding step in Embodiment 1.

DETAILED DESCRIPTION OF EMBODIMENTS

[0027] As an example of the present invention, a compressor housing for a supercharger and a producing method of the compressor housing according to Embodiment 1 will be described with reference to FIG. 1 to FIG. 9. The compressor housing 1 for a supercharger of the present embodiment includes a housing body 20 and a sliding member 30, as shown in FIG. 1.

[0028] The housing body 20 is configured to house an impeller 10 therein, and includes an inner circumferential recess 21 in a recessed shape on an annular inner circumferential surface along an outer circumference of the impeller 10. The sliding member 30 is an annular member disposed in the inner circumferential recess 21 of the housing body 20, and an inner circumferential surface of the sliding member 30 forms a shroud surface 31 that faces the impeller 10.

[0029] The housing body 20 includes a diffuser surface 24 formed circumferentially outward of the shroud surface 31 in a manner as to be continued to the shroud surface 31. As shown in FIG. 1, FIG. 2, FIG. 4, and FIG. 5, joint portions 4 where the housing body 20 and the sliding member 30 are joined through a friction stir welding are formed at a boundary 101 (see FIG. 3) between an outer circumferential end of the sliding member 30 and an inner circumferential end of the diffuser surface 24 of the housing body 20. The friction stir welding will be described later.

[0030] As shown in FIG. 1, the compressor housing 1 forms an outer shell of a compressor (compression machine) used in a turbocharger (supercharger) of an automobile. The housing body 20 is made of a gravity casting of aluminum, for example, and includes an intake port 11, an intake passage 12, and a scroll chamber 13, as shown in FIG. 1. The intake port 11 and the intake passage 12 are formed by a cylindrical portion 23 in a cylindrical shape. The scroll chamber 13 is formed circumferentially outward of the impeller 10 in the circumferential direction, and isconfigured to introduce the air discharged from the impeller 10.

[0031] The inner circumferential recess 21 is formed on the inner circumferential surface of the housing body 20 in a manner as to correspond to the outer circumference of the sliding member 30. The inner circumferential recess 21 includes: a first cylindrical recess 210 formed in a recess shape in a manner as to correspond to a cylindrical sliding member body 310 in the sliding member 30 described later, and a second cylindrical recess 220 formed in a recess shape disposed further circumferentially outward of the first recess 210 in a manner as to correspond to an enlarged-diameter portion 311 of the sliding member 30. This configuration enables the sliding member 30 to be installed in the inner circumferential recess 21.

[0032] The sliding member 30 may be formed of an elastically deformable thermoplastic member. For example, the sliding member 30 is formed of a thermoplastic polyimide resin. An example of the thermoplastic polyimide resin includes Arulum (registered trademark) manufactured by Mitsui Chemicals, Inc., for example. A formation material of the sliding member 30 is not limited to this, and the TP-series of Vespel (registered trademark) manufactured by DuPont or the like may also be employed, for example.

[0033] As shown in FIG. 4, the sliding member 30 is formed in an annular shape, and the entire inner circumference thereof forms the shroud surface 31 in a manner as to face the impeller 10 (FIG. 1). As shown in FIG. 1 to FIG. 3, the sliding member 30 includes: the sliding member body 310 in a cylindrical shape; and the enlarged-diameter portion 311 of which diameter is enlarged radially outward on an opposite side to the intake port 11 in the sliding member body 310. The enlarged-diameter portion 311 is formed on an entire circumference of the sliding member 30. The sliding member 30 is disposed in the inner circumferential recess 21 such that the sliding member body 310 is located in the first recess 210 of the inner circumferential recess 21, and the enlarged-diameter portion 311 is located in the second recess 220.

[0034] The sliding member 30 is press-fitted in the inner circumferential recess 21 while the outer circumferential surface of the enlarged-diameter portion 311 is pressed in contact with the inner circumferential surface of the second recess 220. An outer diameter of the sliding member body 310 is smaller than an inner diameter of the first recess 210, and the outer circumferential surface of the sliding member body 310 is out of contact with the inner circumferential surface of the first recess 210.
As shown in FIG. 4, if the compressor housing 1 is viewed from the diffuser surface 24 in an axial direction X, the boundary 101 between the housing body 20 and the sliding member 30, that is, the boundary 101 between the diffuser surface 24 and the shroud surface 31 is formed in a circular shape. Each joint portion 4 is formed in a part of the boundary 101. As shown in FIG. 2 and FIG. 5, a center of each joint portion 4 is located circumferentially outward of the boundary 101. The center of the joint portion 4 denotes a center of the joint portion 4 in a radial direction of the compressor housing 1. Specifically, with reference to the boundary 101, the joint portion 4 has a dimension b protruding toward the housing body 20 (the diffuser surface 24 side: the circumferentially outward side) greater than a dimension a protruding toward the sliding member 30 (the inner circumference side).

In the present embodiment, as shown in FIG. 4, the joint portions 4 are formed at four positions on the boundary 101 in a circular shape. The joint portions 4 are arranged with equal intervals. The number of the joint portions 4 is not limited to specific one. The joint portions 4 may be arranged around the entire circumference of the boundary 101.

As shown in FIG. 1, if the turbocharger is configured by using the compressor housing 1, a bearing housing of the impeller 10 or an end surface 70 of a back plate is located on an opposite side to the intake port 11 of the housing body 20. A diffuser 14 serving as a fluid passage extending from the impeller 10 to the scroll chamber 13 is formed between the end surface 70 and the diffuser surface 24 of the housing body 20.

As shown in FIG. 1, the impeller 10 is disposed on the inner circumferential surface (shroud surface 31) side of the sliding member 30 of the housing body 20, and is rotatably fixed around a rotation shaft 15. The impeller 10 includes a hub 16 and plural blades 17 projectingly arranged in a circumferential direction from the outer circumferential surface of the hub 16. The plural blades 17 are so arranged as to face the shroud surface 31 of the sliding member 30.

As shown in FIG. 1, in the compressor including the compressor housing 1 for a supercharger of the present embodiment, the air taken in by the rotation of the impeller 10 from the intake port 11 through the intake passage 12 is accelerated by the blades 17 of the impeller 10 to be sent to the diffuser 14. The pressure of the air is increased in the diffuser 14, and is sent to the scroll chamber 13.

A producing method of the compressor housing 1 of the present embodiment will be described, hereinafter. As shown in FIG. 6 and FIG. 7, in the producing method, an assembling step of assembling the sliding member 30 into the inner circumferential recess 21 of the housing body 20, and subsequently, a friction stir welding step and a cutting step are respectively carried out as follows. In the friction stir welding step, as shown in FIG. 8 and FIG. 9, the friction stir welding is carried out at the boundary 101 between the outer circumferential end of the sliding member 30 and the inner circumferential end of the diffuser surface 24 of the housing body 20. Through this welding, joint portions 4 are formed.

In the cutting step, subsequent to the friction stir welding step, the sliding member 30 and the housing body 20 are cut so as to form the shroud surface 31 and the diffuser surface 24 as shown in FIG. 2. In the cutting step, a surface of each joint portion 4 is cut along with the formation of the shroud surface 31 and the diffuser surface 24 so as to machine this surface to be smoothly continued to the diffuser surface 24 and the shroud surface 31.

In the stage before the above cutting step, the sliding member 30 does not have the shroud surface 31 (see FIG. 1 to FIG. 3), and as shown in FIG. 6 to FIG. 9, an inner circumferential surface 32 is evenly formed across the entire axial direction X. The sliding member 30 having such a shape is fitted into the inner circumferential recess 21 of the housing body 20 in the assembling step, thereby producing a sub-assembly 100 in which the housing body 20 and the sliding member 30 are assembled to each other, as shown in FIG. 7.

In the assembling step, an outer circumferential surface of the enlarged-diameter portion 311 of the sliding member 30 is pressed into the inner circumferential recess 21 while the outer circumferential surface of the enlarged-diameter portion 311 is pressed in contact with the inner circumferential surface of the second recess 220 in the inner circumferential recess 21 of the housing body 20. Specifically, the inner circumferential end of the diffuser surface 24 of the housing body 20 and the outer circumferential end of the sliding member 30 are in contact with each other. This contact portion is the boundary 101, and in the friction stir welding step, each joint portion 4 is formed in a manner as to extend through the boundary 101.

The friction stir welding (FSW) is carried out in such a manner that a rotating tool 5 rotating on its own axis at a high speed is pushed against the vicinity of the boundary 101 (processing target) between the sliding member 30 and the housing body 20, and the rotating tool 5 is moved along the boundary 101, thereby welding the sliding member 30 and the housing body 20. As shown in FIG. 8, the rotating tool 5 includes a shoulder 51 in a cylindrical shape, and a cylindrical probe 52 that has a smaller diameter, and projects from a front end surface of the shoulder 51.

Friction heat generated while the rotating tool 5 rotating at a high speed is pushed against the processing target as shown by an arrow F of FIG. 8 causes a plastic flow in the materials of the sliding member 30 and the housing body 20 (e.g., a polyamide resin and an aluminum alloy). Specifically, the materials of the sliding member 30 and the housing body 20 are stirred by the probe 52 pushed into a predetermined depth in the processing target, and are flown out to the surface. At the same time, the flown materials of the sliding member 30 and the housing body 20 are pushed and stirred by the front end surface of the shoulder 51. Consequently, the plastically flown materials are mixed with each other, and thereafter, become solidified, thereby forming the joint portion 4 in which the sliding member 30 and the housing body 20 are joined to each other.

In the friction stir welding step, the friction stir welding is carried out in such a manner that the center of the rotating tool 5 pushed against the processing target is located circumferentially outward of the boundary 101. This configuration makes it possible to locate the center of each joint portion 4 circumferentially outward of the boundary 101. This means that a portion coming from the housing body 20 before the friction stir welding is friction-stir welded in a wider range than that of a portion coming from the sliding member 30 before the friction stir welding. As shown in FIG. 9, the surface of the joint portion 4 produced in the friction stir welding step is not in a smooth state.
[0047] In the cutting step, in the sub-assembly 100, a region from the inner circumferential surface 52 of the sliding member 30 to the diffusor surface 24 of the housing body 20 is subject to cutting so as to form the shroud surface 31 as shown in FIG. 2, and the surface of the joint portion 4 is also subjected to cutting. The surface of the joint portion 4 is finished into a smooth surface continued to the diffusor surface 24 and the shroud surface 31. In this manner, as shown in FIG. 1, there is produced the compressor housing 1 in which the sliding member 30 is fixed to the housing body 20.

[0048] Operation and effect of the present embodiment will be described, hereinafter. In the aforementioned compressor housing 1 for a supercharger, the joint portions 4 are formed at the boundary 101 between the outer circumferential end of the sliding member 30 and the inner circumferential end of the diffusor surface 24 of the housing body 20. In other words, the housing body 20 and the sliding member 30 are joined through the friction stir welding. Hence, it is unnecessary to provide the sliding member 30 with portions to be engaged with fixing members, such as screw members, thus promoting reduction in dimension of the sliding member 30. In other words, reduction in dimension of the sliding member 30 for which material is likely to be relatively expensive can realize cost reduction. In the friction stir welding, a stir margin is required in the sliding member 30, but this stir margin can be sufficiently smaller than a width of the portions for engagement with the fixing members. This friction stir welding eliminates fixing members used for fixing the housing body 20 and the sliding member 30 to each other, thus reducing the number of components.

[0049] As aforementioned, the friction stir welding utilizes friction heat between the rotating tool 5 and the processing target, but required energy is smaller than that required in a laser welding for non-porous formation, for example. Hence, it is possible to sufficiently suppress the production cost. The smoothing of the surface of the joint portion 4 can be carried out together with the formation of the shroud surface 31 and the diffusor surface 24 in the cutting step; therefore, it is possible to suppress the production cost.

[0050] The center of the joint portion 4 is located circumferentially outward of the boundary 101. This configuration makes it possible to further promote reduction in dimension of the sliding member 30. Specifically, in the case of carrying out the friction stir welding, the joint portions 4 are also provided at parts of the sliding member 30, and thus it is necessary to form the joint portions 4 at positions that do not face the impeller 10. Hence, it is required to secure a so-called stir margin used for forming the joint portions 4 at the outer circumferential end of the sliding member 30. Setting this stir margin to be as small as possible can minimize the outer diameter of the sliding member 30. Meanwhile, the width of each joint portion 4 (dimension of the joint portion 4 in the radial direction of the compressor housing 1) depends on the diameter of the rotating tool 5; therefore, the rotating tool 5 is required to have a moderate diameter, otherwise, it makes it difficult to appropriately carry out the friction stir welding.

[0051] To cope with this, in order to secure the width of each joint portion 4, and reduce the stir margin of the sliding member 30, it is configured to locate the center of each joint portion 4 circumferentially outward of the boundary 101. Through this configuration, it is possible to further reduce the dimension of the sliding member 30, thereby producing the compressor housing 1 with lower cost.

[0052] In order to readily realize this, in the friction stir welding step in the aforementioned producing method, the friction stir welding is carried out such that the center of the rotating tool 5 is pushed against the processing target is located circumferentially outward of the boundary 101. This means that a portion of the material (e.g., an aluminum alloy) of the housing body 20 is friction-stir welded in a wider range than that of a portion of the material (e.g., a polyamide resin) of the sliding member 30, thereby reducing the cost for the relatively expensive material of the sliding member 30.

[0053] As aforementioned, in the present embodiment, it is possible to provide the compressor housing for a supercharger and the producing method of the compressor housing capable of reducing the number of components and the cost.

What is claimed is:

1. A compressor housing for a supercharger, the compressor housing comprising:
   a housing body housing an impeller, and having an inner circumferential recess in a recessed shape on an annular inner circumferential surface along an outer circumferential surface of the impeller; and
   a sliding member having an annular shape, being disposed in the inner circumferential recess, and an inner circumferential surface of the sliding member having a shroud surface that faces the impeller;
   wherein the housing body includes a diffusor surface that is disposed circumferentially outward of the shroud surface in a manner as to be continued to the shroud surface, and
   joint portions are provided at a boundary between an outer circumferential end of the sliding member and an inner circumferential end of the diffusor surface of the housing body, the housing body and the sliding member being joined through a friction stir welding in the joint portions.

2. The compressor housing according to claim 1, wherein each of the joint portions is disposed in a part of the boundary, and
   a center of each of the joint portion in a radial direction of the housing body is located circumferentially outward of the boundary.

3. A producing method of the compressor housing for a supercharger according to claim 1, the method comprising:
   an assembling step of assembling the sliding member into the inner circumferential recess of the housing body; a friction stir welding step of carrying out the friction stir welding at the boundary between the outer circumferential end of the sliding member and the inner circumferential end of the diffusor surface of the housing body, and providing each of the joint portion; and
   a cutting step of cutting the sliding member and the housing body so as to provide the shroud surface and the diffusor surface, and cutting a surface of each of the joint portion so as to smoothen the surface to be continued to the diffusor surface and the shroud surface.

4. The producing method according to claim 3, wherein in the friction stir welding step, the friction stir welding is carried out such that a center of a rotating tool is located
circumferentially outward of the boundary when the rotating tool is pushed against a processing target at the boundary.