A joining structure of a rotation part of a rotary machine, where the rotation part including blades and a shroud, includes a welded part made up of a solidified melted part of the blades and the shroud, and a brazed part disposed at a junction part of the blades and the shroud.
FIG. 2
FIG. 5

1. Prepare a blade and a shroud
2. Dispose the blade in contact with a surface of the shroud
3. Dispose a filler metal at a junction part of the blade and the shroud
4. Form a brazed part by melting the filler metal by using heat generated by an electric beam or laser beam
5. Form a welded part by melting the blade and the shroud
FIG. 6

FIG. 7
FIG. 10

1. Prepare a blade and a shroud
2. Dispose the blade in contact with a surface of the shroud
3. Form a welded part by melting the blade and the shroud
4. Dispose a filler metal at a junction part of the blade and the shroud
5. Form a brazed part by melting the filler metal using a furnace
JOINING STRUCTURE OF ROTATION PART OF ROTARY MACHINE AND METHOD OF JOINING ROTATION PART OF ROTARY MACHINE

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims priority from Korean Patent Application No. 10-2011-0097570, filed on Sep. 27, 2011, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field

[0003] Apparatuses and methods consistent with exemplary embodiments relate to a joining structure of a rotation part of a rotary machine and methods of joining a rotation part of a rotary machine, and more particularly, to a joining structure of a rotation part of a rotary machine and methods of joining a rotation part of a rotary machine such as a compressor or a pump.

[0004] 2. Description of the Related Art

[0005] A compressor or a pump is a rotary machine whose main element is a rotation part.

[0006] In general, a rotary machine includes an impeller as a rotation part which increases the pressure of a fluid by transferring rotational kinetic energy to the fluid. For this, the impeller includes a plurality of blades for guiding the flow of the fluid and transferring energy to the fluid.

[0007] Meanwhile, a shroud is disposed outside the impeller and forms fluid passages together with the blades.

[0008] Since the efficiency of a compressor mostly increases if the distance between blades and a shroud decreases, a method of maximizing the efficiency of a compressor by combining a shroud with the blades of an impeller has been suggested.

SUMMARY

[0009] One or more exemplary embodiments may overcome the above disadvantages and other disadvantages not described above. However, it is understood that one or more exemplary embodiment are not required to overcome the disadvantages described above, and may not overcome any of the problems described above.

[0010] One or more exemplary embodiments provide a joining structure of a rotation part of a rotary machine, the joining structure having sufficient strength and reliability, and methods thereof of joining the rotation part.

[0011] According to an aspect of an exemplary embodiment, there is provided a joining structure of a rotation part of a rotary machine, the rotation part including blades and a shroud, and the joining structure including a welded part formed by solidifying a melted part of the blade and the shroud; and a brazed part formed at a junction part of the blade and the shroud.

[0012] The rotary machine may be a compressor or a pump.

[0013] The brazed part may include a fillet part formed at the junction part; and a clearance bonding part formed at the junction part between the blade and the shroud.

[0014] According to another aspect of an exemplary embodiment, there is provided a method of joining a rotation part of a rotary machine, the rotation part including blades and a shroud, and the method including: preparing the blade and the shroud; disposing the blade on one surface of the shroud; disposing a filler metal for a brazing process at a junction part of the blade and the shroud; performing the brazing process by irradiating an electron beam or a laser beam onto a portion of another surface of the shroud, which is opposite to a portion of the one surface of the shroud where the blade is disposed, and melting the filler metal by using heat generated by the electron beam or the laser beam; and welding the blade and the shroud by irradiating the electron beam or the laser beam onto the portion of the another surface of the shroud, which corresponds to the portion of the one surface of the shroud where the blade is disposed, and melting the blade and the shroud so as to form a melted part.

[0015] The rotary machine may be a compressor or a pump.

[0016] The filler metal may be in the form of a paste.

[0017] The performing of the brazing process may include forming a fillet part at the junction part; and forming a clearance bonding part at the junction part between the blade and the shroud by using the melted filler metal.

[0018] According to another aspect of an exemplary embodiment, there is provided a method of joining a rotation part of a rotary machine, the rotation part including blades and a shroud, and the method including: preparing the blade and the shroud; disposing the blade on one surface of the shroud; welding the blade and the shroud by irradiating an electron beam or a laser beam onto a portion of another surface of the shroud, which is opposite to a portion of the one surface of the shroud where the blade is disposed, and melting the blade and the shroud so as to form a melted part; disposing a filler metal for a brazing process at a junction part of the blade and the shroud; and performing the brazing process by applying heat to the junction part and melting the disposed filler metal.

[0019] The rotary machine may be a compressor or a pump.

[0020] The filler metal may be in the form of a paste.

[0021] The performing of the brazing process may include forming a fillet part at the junction part; and forming a clearance bonding part at the junction part between the blade and the shroud by using the melted filler metal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The above and other aspects will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings, in which:

[0023] FIG. 1 is a perspective view of a rotation part of a rotary machine, according to an exemplary embodiment;

[0024] FIG. 2 is a cross-sectional view of FIG. 1 as viewed at II-II;

[0025] FIG. 3 is a cross-sectional view of a joining structure of the rotation part illustrated in FIG. 1, according to an exemplary embodiment;

[0026] FIG. 4 is a magnified cross-sectional view of portion A illustrated in FIG. 3;

[0027] FIG. 5 is a flowchart which illustrates a process used to form a joining structure of a rotation part of a rotary machine, according to an exemplary embodiment.

[0028] FIGS. 6-9 are cross-sectional views showing sequential processes of a method of joining the rotation part illustrated in FIG. 1, according to an exemplary embodiment.

[0029] FIG. 10 is a flowchart which illustrates a process used to form a joining structure of a rotation part of a rotary machine, according to another exemplary embodiment.
FIGS. 11-13 are cross-sectional views showing sequential processes of a method of joining the rotation part illustrated in FIG. 1, according to another exemplary embodiment.

DETAILED DESCRIPTION

Hereinafter, exemplary embodiments will be described in detail with reference to the attached drawings. Like reference numerals in the drawings denote like elements, and thus, repeated descriptions will be omitted.

FIG. 1 is a perspective view of a rotation part 100 of a rotary machine, according to an exemplary embodiment. FIG. 2 is a cross-sectional view of FIG. 1 as viewed at II-II. FIG. 3 is a cross-sectional view of a joining structure of the rotation part 100 illustrated in FIG. 1, according to an exemplary embodiment. FIG. 4 is a magnified cross-sectional view of portion A illustrated in FIG. 3.

The rotary machine according to the current embodiment is a compressor, and as illustrated in FIGS. 1 and 2, the rotation part 100 of the rotary machine includes an impeller 110 and a shroud 120.

The rotary machine is not limited to a compressor and may be any device capable of changing the pressure and speed of a fluid due to a rotary motion of the rotation part. For example, the rotary machine may be a pump or an air blower.

The impeller 110 includes an inner core 111, a base unit 112, and a plurality of blades 113.

The inner core 111 has a cylindrical shape.

A mounting hole 111a is formed in the center of the inner core 111. Since a rotation shaft (not shown) is fitted into the mounting hole 111a in an assembling process, the inner core 111 transfers power from the rotation shaft to the impeller 110.

The base unit 112 is disposed outside the inner core 111. Since a surface 112a of the base unit 112 is inclined and curved to form bottom surfaces of fluid channels, a fluid may flow smoothly and maximum energy may be transferred to the fluid.

The blades 113 are formed on the surface 112a of the base unit 112, guide the flow of the fluid, and transfer kinetic energy of the impeller 110 to the fluid.

Meanwhile, the shroud 120 is joined onto the blades 113, has a lamp shade shape with concave curvatures whose central portion is open, and covers upper portions of the blades 113.

The shroud 120 forms ceiling surfaces of the fluid channels, and also forms passages of the fluid together with the base unit 112 and the blades 113.

A process of transferring energy to a fluid due to a rotary motion of the above-described rotation part 100 will now be described.

When the rotation shaft rotates, the impeller 110 and the shroud 120 also rotate.

A fluid flows into inlets 100a of the rotation part 100 in the directions indicated by arrows in FIG. 2, receives rotational kinetic energy of the rotation part 100, and then flows out of outlets 100b in a high-pressure state. Subsequently, the fluid passes through a diffuser (not shown), the fluid speed is reduced, and the fluid pressure is increased to a desired level. A detailed description thereof is not provided.

A joining structure of the rotation part 100, according to an exemplary embodiment, will now be described with reference to FIGS. 3 and 4.

The joining structure of the rotation part 100 mainly includes a welded part 121 and a brazed part 122. The welded part 121 is formed by irradiating an electron beam or a laser beam, melting the blade 113 and the shroud 120 so as to form a melted part, and solidifying the melted part.

The brazed part 122 is formed at a junction part J of the blade 113 and the shroud 120, and includes a fillet part 122a and a clearance bonding part 122b.

The fillet part 122a is formed at the junction part J and the clearance bonding part 122b is formed at a clearance of the junction part J between the blade 113 and the shroud 120.

The brazed part 122 is formed by disposing a filler metal for a brazing process at the junction part J of the blade 113 and the shroud 120 and then performing the brazing process by applying heat. The brazing process will be described in detail below.

Since the joining structure of the rotation part 100 includes the brazed part 122 as well as the welded part 121, a joining force and a joining reliability may be improved between the blade 113 and the shroud 120. This is because the melted filler metal forms the fillet part 122a, and evenly spreads into a minute clearance of the junction part J between the blade 113 and the shroud 120 so as to form the clearance bonding part 122b.

FIG. 5 is a flowchart which illustrates processes used to form a joining structure of a rotation part of a rotary machine, according to an exemplary embodiment, and FIGS. 6 through 9 are cross-sectional views showing the sequential processes of a method of joining the rotation part 100 illustrated in FIG. 1, according to an exemplary embodiment.

Initially, a user prepares the blade 113 and the shroud 120 formed of metal (operation S101). In operation S101, the blade 113 is already mounted on the surface 112a of the base unit 112 and a joining process between the blade 113 and the shroud 120 is ready. However, the exemplary embodiment is not limited thereto. For example, the blade 113 may be joined to the shroud 120 first and then may be mounted on the base unit 112.

The blade 113 and the shroud 120 may be formed of carbon steel having a light weight, or may be formed of nonferrous metal such as aluminum. That is, the blade 113 and the shroud 120 are not particularly limited to any material as long as they are formed of metal.

Then, as illustrated in FIG. 6, the user disposes the blade 113 in such a way that at least a portion of the blade 113 contacts one surface 120a of the shroud 120 (operation S102).

Then, as illustrated in FIG. 7, the user disposes a filler metal 130 for a brazing process at the junction part J of the blade 113 and the shroud 120 (operation S103).

The filler metal 130 may have various types and forms according to a base material, i.e., the material of the blade 113 and the shroud 120. In general, the filler metal 130 may be tin solder, silver solder, brass solder, nickel-silver, copper, silicon, or another well-known filler metal in terms of its type, and may be powder, paste, or a solution in terms of its form.

The filler metal 130 may be any appropriate filler metal according to the material of the blade 113 and the shroud 120 and may be in the form of a paste including the filler metal. However, the filler metal 130 is not particularly limited to the above-mentioned types and forms.
[0060] Then, as illustrated in FIG. 8, the user forms the brazed part 122 by irradiating an electron beam or a laser beam onto a portion of another surface 120b of the shroud 120, which is opposite to a portion of the one surface 120a of the shroud 120 where the blade 113 is disposed, and melting the filler metal 130 by using heat generated by the electron beam or the laser beam (operation S104). As mentioned above, the portion onto which the electron beam or the laser beam is irradiated is a portion of the other surface 120b of the shroud 120.

[0061] In general, electron beam welding is performed by using a principle of transforming kinetic energy of electrons into thermal energy. In the current exemplary embodiment, the electron beam may be irradiated by an electron beam generator used in a common electron beam welding system.

[0062] In general, laser beam welding is performed by using a principle of transforming energy of a laser into thermal energy. In the exemplary embodiment, the laser beam may be irradiated by a laser beam generator used in a common laser beam welding system.

[0063] In more detail, when the electron beam or the laser beam starts to be irradiated, heat is generated and thus the temperature of the shroud 120 is increased. The heat is transferred from a portion where the electron beam or the laser beam is irradiated, reaches the junction part J, and thus is transferred to the filler metal 130.

[0064] Due to brazing characteristics, since a melting temperature of the filler metal 130 is lower than the melting temperature of a base material (here, the melting temperature of the blade 113 and the shroud 120), the filler metal 130 is melted first. When the filler metal 130 starts to melt, the melted filler metal 130 evenly spreads at the junction part J. In the current embodiment, due to a capillary phenomenon, the melted filler metal 130 also spreads into a minute clearance between the blade 113 and the shroud 120. Consequently, as illustrated in FIGS. 3, 4, and 8, the brazed part 122 including the fillet part 122a and the clearance bonding part 122b are formed.

[0065] The size of the fillet part 122a is predetermined in a designing process by, for example, calculating the strength of the fillet part 122a and, in order to grow the fillet part 122a to the determined size, the amount of the filler metal 130, and an irradiation intensity and an irradiation time of the electron beam or the laser beam are adjusted.

[0066] Subsequently, as illustrated in FIG. 9, the user forms the welded part 121 by sufficiently irradiating the electron beam or the laser beam onto the portion of the other surface 120b of the shroud 120, which is opposite to the portion of the one surface 120a of the shroud 120 where the blade 113 is disposed, melting the blade 113 and the shroud 120 to form a melted part 121, and solidifying the melted part 121 (operation S105). As mentioned above, the portion onto which the electron beam or the laser beam is irradiated is the portion of the other surface 120b of the shroud 120.

[0067] It should be noted in operation S105 that the region, intensity, and time for irradiating the electron beam or the laser beam have to be appropriately determined in order to minimize damages the brazed part 122 formed in operation S104 as much as possible.

[0068] If the electron beam or the laser beam is sufficiently irradiated in operation S105, a portion of the shroud 120 is melted by using heat generated due to the irradiating and the melted portion is gradually grown to reach the blade 113 and is mixed with a melted portion of the blade 113, thereby forming the melted part 121.

[0069] FIG. 9 shows that the melted part 121' is grown to join the blade 113 and the shroud 120 with a sufficient joining force. If the melted part 121' is sufficiently grown as illustrated in FIG. 9, the user stops irradiating the electron beam or the laser beam, cools the melted part 121' so as to form the welded part 121 as illustrated in FIG. 3, and thus completing the joining operation. In addition, as illustrated in FIG. 9, due to the above joining operation, a heat affected zone (HAZ) is generated.

[0070] Although operation S105 is performed immediately after operation S104 is performed in the above description, the current embodiment is not limited thereto. That is, if necessary, the user may perform operation S105 after operation S104 is completely performed, a sufficient cooling time has passed, and thus the brazed part 122 is completely formed.

[0071] As described above, according to the current embodiment, since a joining operation is performed by performing a welding process for melting the blade 113 and the shroud 120 corresponding to a base material after performing a brazing process using the filler metal 130, a joining structure of the rotation part 100 may have less work deformation and may achieve an excellent joining force between the blade 113 and the shroud 120.

[0072] Furthermore, according to characteristics of the brazing process, since the melted filler metal 130 evenly spreads into a minute clearance between the blade 113 and the shroud 120 due to a capillary phenomenon, cracks of the junction part J may be prevented and thus a joining reliability may be increased.

[0073] FIG. 10 is a flowchart which illustrates a process used to form a joining structure of a rotation part of a rotary machine, according to another exemplary embodiment, and FIGS. 11 through 13 are cross-sectional views showing sequential processes of a method of joining the rotation part 100 illustrated in FIG. 1, according to another exemplary embodiment.

[0074] Initially, a user prepares the blade 113 and the shroud 120 formed of metal (operation S201) and, as illustrated in FIG. 6, disposes the blade 113 in such a way that at least a portion of the blade 113 contacts one surface 120a of the shroud 120 (operation S202). Operations S201 and S202 are the same as those described above with reference to operations S101 and S102 and FIG. 6.

[0075] Subsequently, as illustrated in FIG. 11, the user forms the welded part 121 by sufficiently irradiating an electron beam or a laser beam on a portion of the other surface 120b of the shroud 120, which is opposite to a portion of the one surface 120a of the shroud 120 where the blade 113 is disposed, melting the blade 113 and the shroud 120 to form a melted part 121', and solidifying the melted part 121' (operation S203). As mentioned above, the portion onto which the electron beam or the laser beam is irradiated is the portion of the other surface 120b of the shroud 120.

[0076] If the electron beam or the laser beam is sufficiently irradiated in operation S203, a portion of the shroud 120 is melted by using heat generated due to the irradiating and the melted portion is gradually grown to reach the blade 113 and is mixed with a melted portion of the blade 113, thereby forming the melted part 121'.
FIG. 11 shows that the melted part 121' is grown to join the blade 113 and the shroud 120 with a sufficient joining force. If the melted part 121' is sufficiently grown as illustrated in FIG. 11, the user stops irradiating the electron beam or the laser beam, cools the melted part 121' so as to form the welded part 121, and thus completing a welding process.

Subsequently, as illustrated in FIG. 12, the user disposes the filler metal 130 for a brazing process at the junction part J of the blade 113 and the shroud 120 (operation S204). The filler metal 130 may have various types and forms according to a base material, i.e., the material of the blade 113 and the shroud 120. In general, the filler metal 130 may be tin solder, silver solder, brass solder, nickel-silver, copper, sintering, or other well-known filler metal in terms of its type, and may be a powder, paste, or a solution in terms of its form.

The filler metal 130 may be any appropriate filler metal according to the material of the blade 113 and the shroud 120 and may be in the form of paste including the filler metal. However, the filler metal 130 is not particularly limited to the above-mentioned types and forms.

Then, as illustrated in FIG. 13, the user disposes the rotation part 100 in a furnace 140 and applies heat to the junction part J by operating the furnace 140. If heat is applied to the junction part J, the filler metal 130 is melted to form the brazed part 122 (operation S205).

When the filler metal 130 starts to melt, the melted filler metal 130 evenly spreads at the junction part J between the blade 113 and the shroud 120. In this case, due to a capillary phenomenon, the melted filler metal 130 also spreads into a minute clearance between the blade 113 and the shroud 120. Consequently, as illustrated in FIGS. 3 and 4, the brazed part 122 including the fillet part 122a and the clearance bonding part 122b is formed.

The size of the fillet part 122a is previously determined in a designing process by, for example, calculating the strength of the fillet part 122a and, in order to grow the fillet part 122a to the determined size, the amount of the filler metal 130, and an irradiation intensity and an irradiation time of the electron beam or the laser beam are adjusted.

Although the brazing process is performed by using the furnace 140 in the above description, the current embodiment is not limited to the above brazing method. That is, the brazing method is not particularly limited as long as the brazing process may be performed by applying heat to the junction part J. For example, various brazing methods such as torch brazing, induction brazing, dip brazing, salt-bath brazing, and resistance brazing may be used.

As described above, according to the current embodiment, since the joining operation is executed by performing a brazing process using the filler metal 130 after performing a welding process for melting the blade 113 and the shroud 120 corresponding to a base material, the joining structure of the rotation part 100 may have less work deformation and may achieve an excellent joining force between the blade 113 and the shroud 120.

Furthermore, according to characteristics of the brazing process, since the melted filler metal 130 evenly spreads into a minute clearance between the blade 113 and the shroud 120 due to a capillary phenomenon, cracks of the junction part J may be prevented from appearing, and thus, a joining reliability may be increased.

In addition, since the welding process is performed at a relatively high temperature and then the brazing process is performed at a relatively low temperature, damage of the brazed part 122 due to high temperature may be prevented. That is, since the brazing process using the filler metal 130 is performed after the melted part 121' formed in the welding process is sufficiently cooled to form the welded part 121, the brazed part 122 may not be damaged.

According to the current exemplary embodiment, the strength and reliability of a joining structure between blades and a shroud may be increased.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims. The exemplary embodiments should be considered in a descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A joining structure of a rotation part of a rotary machine, the rotation part comprising blades and a shroud, and the joining structure comprising:
   a welded part comprising a solidified melted part of each blade and the shroud; and
   a brazed part disposed at a junction part.

2. The joining structure of claim 1, wherein the rotary machine is a compressor or a pump.

3. The joining structure of claim 1, wherein the brazed part comprises:
   a fillet part formed at the junction part; and
   a clearance bonding part formed at a minute clearance of the junction part between the blade and the shroud.

4. A method of joining a rotation part of a rotary machine, the method comprising:
   preparing a blade and a shroud;
   disposing the blade on one surface of the shroud;
   disposing a filler metal at a junction part of the blade and the shroud;
   performing a brazing process; and
   performing a welding process on the blade and the shroud after performing the brazing process.

5. The method of claim 4, wherein the rotary machine is a compressor or a pump.

6. The method of claim 4, wherein the filler metal is in the form of a paste.

7. The method of claim 4, wherein the performing of the brazing process comprises:
   irradiating an electron beam or a laser beam onto a portion of another surface of the shroud, which is opposite to a portion of the one surface of the shroud where the blade is disposed; and
   melting the filler metal by using heat generated by the electron beam or the laser beam.

8. The method of claim 7, wherein the performing of the brazing process further comprises:
   forming a fillet part at the junction part; and
   forming a clearance bonding part at a minute clearance of the junction part between the blade and the shroud by using the melted filler metal.

9. The method of claim 4, wherein the performing of the welding process comprises:
   irradiating the electron beam or the laser beam onto the portion of the another surface of the shroud, which is opposite to the portion of the one surface of the shroud where the blade is disposed; and
   melting the blade and the shroud to form a melted part.
10. The method of claim 9, wherein the performing of the welding process further comprises solidifying the melted part.

11. The method of claim 4 further comprises attaching the blade to a base unit of an impeller.

12. A method of joining a rotation part of a rotary machine, the method comprising:
preparing a blade and a shroud;
disposing the blade on one surface of the shroud;
performing a welding process on the blade and the shroud;
disposing a filler metal at a junction part of the blade and the shroud; and
performing a brazing process by applying heat to the junction part and melting the disposed filler metal after performing the welding process.

13. The method of claim 12, wherein the performing of the welding process comprises:
irradiating the electron beam or the laser beam onto the portion of the another surface of the shroud, which is opposite to the portion of the one surface of the shroud where the blade is disposed; and
melting the blade and the shroud to form a melted part.

14. The method of claim 13, wherein the performing of the welding process further comprises solidifying the melted part.

15. The method of claim 12, wherein the performing of the brazing process comprises disposing the rotational part in a furnace.

16. The method of claim 12, wherein the performing of the brazing process comprises performing one of torch brazing, induction brazing, dip brazing, salt-bath brazing, or resistance brazing.

17. The method of claim 12, wherein the rotary machine is a compressor or a pump.

18. The method of claim 12, wherein the filler metal is in the form of paste.

19. The method of claim 12, wherein the performing of the brazing process comprises:
forming a fillet part at the junction part; and
forming a clearance bonding part at a clearance between the blade and the shroud by using the melted filler metal.

20. The method of claim 12 further comprises attaching the blade to a base unit of an impeller.