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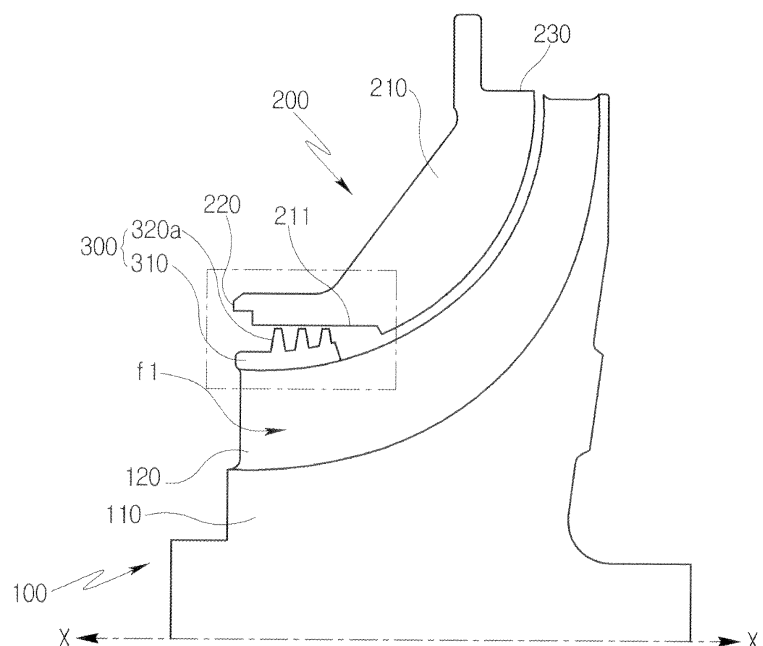
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(54) **Centrifugal compressor**

(57) Disclosed is a centrifugal compressor capable of minimizing leakage of fluid while realizing high aerodynamic performance in the process of compressing the fluid. The centrifugal compressor includes an impeller (100) having blades (120), a housing (200) formed with an inlet (220) and an outlet (230), a sealing unit (300)

disposed adjacent to one of the inlet (220) and the outlet (230), and a partial shroud (310) disposed adjacent to the sealing unit (300) and formed at one of the inlet (220) and the outlet (230) to partially surround outer peripheral portions of outer ends of the blades (120).

Fig.3



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Description

BACKGROUND

[0001] Aspects of the present inventive concept relate to a centrifugal compressor, and more particularly, to a centrifugal compressor capable of minimizing leakage of a fluid in the process of compressing the fluid and having high aerodynamic performance.

[0002] In general, a centrifugal compressor signifies a device for compressing a fluid by converting kinetic energy into pressure energy through a centrifugal force by sucking the fluid in a rotational axis direction of a high-speed rotor or an impeller and circumferentially exhausting the fluid.

[0003] The centrifugal compressor has been extensively applied to various industrial fields such as various types of air conditioning facilities and gas turbine systems.

[0004] As shown in FIG. 1A, a general centrifugal compressor includes an impeller 10 having a rotary hub 11 connected to a driving shaft 40 and a plurality of blades 12 radially provided about a rotational axis X-X' of the rotary hub 11.

[0005] In addition, the centrifugal compressor includes a housing 20 formed with an inlet into which a fluid to be compressed is introduced and an outlet through which the compressed fluid is discharged and provided with an inner surface 21 fixedly adjacent to the blades 12 and a diffuser 30 that reduces a dynamic pressure component of a voltage component increased due to force received from the impeller 10 and increases a static pressure component thereof.

[0006] An impeller used for the general centrifugal compressor constructed as described above is classified into an open impeller and a shroud impeller according to the capacity and performance thereof.

[0007] That is, as shown in FIG. 11B, an impeller where outer ends of the blades 12 are open may be called an open impeller 10 or an unshrouded impeller having no shrouds.

[0008] Since the outer ends of the blades 12 are open in the open impeller 10, mechanical processing is possible so that the open impeller 10 can be easily manufactured. In addition, precise profile tolerance may be ensured so that a structure of the open impeller 10 is stable and a manufacturing cost of the open impeller 10 is relatively low.

[0009] However, since the outer ends of the blades are open in the open impeller 10, some of a compressed fluid is leaked through a gap formed between an outer end of the blade and an inner surface of the housing so that flow loss occurs. In addition, the flow loss is significantly increased due to leakage in an inlet A and an outlet B of the housing 20.

[0010] Meanwhile, as shown in FIGs. 2A and 2B, the shroud impeller 10 includes a shroud 13 that connects outer ends of a plurality of blades 12 provided in the rotary

hub 11 to each other while surrounding the outer ends of the blades 12.

[0011] In the shroud impeller 10, a closed fluid path for a fluid to be compressed is formed by adjacent blades 12 and the shroud 13 so that flow loss may be reduced as compared with that of the open impeller, thereby representing higher compression efficiency.

[0012] Further, the shroud 13 serves as a reinforcing structure connecting the blades 12 to each other so that the shroud impeller 10 has strength higher than that of the open impeller.

[0013] However, in order to form a path of a fluid to be compressed inside the shroud, the shroud impeller has a very complicated three-dimensional structure and thus processing is not easy and a manufacturing cost is considerably increased.

[0014] As a related art of the shroud impeller, FIG. 2B shows a method of mechanically processing a monolithic rotor having a disc shape by a cutting tool 50 controlled using a numerical control tool, which is disclosed in U.S. Patent No. 7,305,762. However, the above patent may not be compatible with a complicated inner fluid path due to the structural problem, and there is a limitation in processing due to a shape of the cutting tool and the manufacturing cost is increased.

[0015] Further, FIG. 2B shows a method of manufacturing an impeller by bonding an upstream impeller member and a downstream impeller member to each other after the upstream impeller member and the downstream impeller member are separately processed, which is disclosed in Japanese unexamined patent publication No. 2010-121612.

[0016] However, an error may occur when bonding a plurality of members which are separately processed and it is difficult to maintain accurate shapes of a blade and a shroud.

[0017] In addition, strength of a bonding part is so low that the above method is not suitable for a compressor of a gas turbine which is rotated at a high speed.

[0018] In order to solve the above problem, as disclosed in U.S. patent publication No. 2011-0318183 (hereinafter, referred to as patent document 1), a technology of forming an integral shroud in a blade, and forming a partially divided shroud, and bonding the blade to the integral shroud by brazing welding, stick welding, ultrasonic welding, or electron beam welding has been suggested.

[0019] In addition, Korean patent registration No. 10-0745507 (hereinafter, referred to as patent document 2) discloses a technology for providing a partial shroud at an outlet of an impeller.

[0020] However, in the case of the patent document 1, although strength may be improved by divided shrouds bonded to an integral shroud, processing of the divided shroud is complicated and a bonding work is significantly complicated and inconvenient.

[0021] Furthermore, if the divided shrouds are not precisely and accurately bonded and an error occurs, dan-

gerous situation may be caused when the impeller is used for a gas turbine rotated at a high speed.

[0022] In addition, in the case of the patent document 2, since the partial shroud is formed at a region where compressed gas is exhausted, the problems occurring in the art may not be solved, that is, some of a compressed fluid is leaked through a gap formed between an outer end of the blade and an inner surface of the housing and thus flow loss occurs and the flow loss is significantly increased due to leakage in an inlet of the housing.

SUMMARY

[0023] Exemplary embodiment have been made in an effort to solve the above-described problems, and an aspect of the present inventive concept provides a centrifugal compressor capable of minimizing leakage of a fluid in the process of compressing the fluid and having high aerodynamic performance by providing a sealing unit between an impeller and an inner surface of a housing.

[0024] According to another aspect of the present inventive concept, there is provided a centrifugal compressor having higher strength as compared with an open impeller and superior workability as compared with a shroud impeller.

[0025] According to an exemplary embodiment, there is provided a centrifugal compressor including an impeller including a plurality of blades radially disposed about a rotational axis; a housing formed with an inlet into which a fluid to be compressed by the impeller is introduced and an outlet through which a compressed fluid is discharged and having an inner surface adjacent to the blades; a sealing unit disposed adjacent to one of the inlet and the outlet and configured to seal between outer ends of the blades and the inner surface; and a partial shroud disposed adjacent to the sealing unit and formed at one of the inlet and the outlet and configured to partially surround outer peripheral portions of the outer ends of the blades.

[0026] The sealing unit may include a first sealing unit disposed adjacent to the inlet and the first sealing unit includes a first partial shroud disposed adjacent to the inlet and configured to partially surround the outer peripheral portions of the outer ends of the blades.

[0027] The first sealing unit may include at least one first sealing protrusion protruding toward the inner surface from the first partial shroud, a rear end of the first sealing protrusion is fixed to the first partial shroud, and a front end of the first sealing protrusion is spaced apart from the inner surface by a predetermined interval.

[0028] The first sealing protrusion may be integrally formed with the first partial shroud.

[0029] The centrifugal compressor may further include a first sealing pad on the inner surface adjacent to the first sealing protrusion, wherein the first sealing pad may include a material having hardness lower than hardness of the first sealing protrusion.

[0030] The first sealing pad may be formed with a first sealing groove having a shape corresponding to a shape of the first sealing protrusion, and a front end of the first sealing protrusion is inserted into the first sealing groove.

[0031] The first sealing unit may include a second sealing protrusion protruding toward the first partial shroud from the inner surface, a rear end of the second sealing protrusion is fixed to the inner surface, and a front end of the second sealing protrusion is spaced apart from the first partial shroud by a predetermined interval.

[0032] The second sealing protrusion may be integrally formed with the housing.

[0033] The first sealing unit may further include a first support member having one surface attached to the inner surface and an opposite surface formed with the second sealing protrusion.

[0034] The second sealing protrusion may be integrally formed with the first support member.

[0035] The centrifugal compressor may further include a second sealing pad on an outer surface of the first partial shroud adjacent to the second sealing protrusion, wherein the second sealing pad may include a material having hardness lower than hardness of the second sealing protrusion.

[0036] The second sealing pad may be formed with a second sealing groove having a shape corresponding to a shape of the second sealing protrusion, and a front end of the second sealing protrusion is inserted into the second sealing groove.

[0037] The sealing unit may include a second sealing unit disposed adjacent to the outlet and the second sealing unit includes a second partial shroud disposed adjacent to the outlet to partially surround the outer peripheral portions of the outer ends of the blades.

[0038] The second sealing unit may further include a third sealing protrusion protruding toward the inner surface from the second partial shroud, a rear end of the third sealing protrusion is fixed to the second partial shroud, and a front end of the third sealing protrusion is spaced apart from the inner surface by a predetermined interval.

[0039] The third sealing protrusion may be integrally formed with the second partial shroud.

[0040] The centrifugal compressor may further include a third sealing pad on the inner surface adjacent to the third sealing protrusion, wherein the third sealing pad may include a material having hardness lower than hardness of the third sealing protrusion.

[0041] The third sealing pad may be formed with a third sealing groove having a shape corresponding to a shape of the third sealing protrusion, and a front end of the third sealing protrusion is inserted into the third sealing groove.

[0042] The second sealing unit may further include a fourth sealing protrusion protruding toward the second partial shroud from the inner surface, a rear end of the fourth sealing protrusion is fixed to the inner surface, and a front end of the fourth sealing protrusion is spaced apart

from the second partial shroud by a predetermined interval.

[0043] The fourth sealing protrusion may be integrally formed with the housing.

[0044] The second sealing unit may further include a second support member having one surface attached to the inner surface and an opposite surface formed with the fourth sealing protrusion.

[0045] The fourth sealing protrusion may be integrally formed with the second support member.

[0046] The centrifugal compressor may further include a fourth sealing pad on an outer surface of the second partial shroud adjacent to the fourth sealing protrusion, wherein the fourth sealing pad may include a material having hardness lower than hardness of the fourth sealing protrusion.

[0047] The fourth sealing pad may be formed with a fourth sealing groove having a shape corresponding to a shape of the fourth sealing protrusion, and a front end of the fourth sealing protrusion is inserted into the fourth sealing groove.

[0048] The sealing unit may include a first sealing unit disposed adjacent to the inlet and a second sealing unit disposed adjacent to the outlet, the first sealing unit may include a first partial shroud disposed adjacent to the inlet to partially surround the outer peripheral portions of the outer ends of the blades, and the second sealing unit may include a second partial shroud disposed adjacent to the outlet to partially surround the outer peripheral portions of the outer ends of the blades.

[0049] The first sealing unit may include a first sealing protrusion protruding toward the inner surface from the first partial shroud, and the second sealing unit may include a third sealing protrusion protruding toward the inner surface from the second partial shroud.

[0050] A rear end of the first sealing protrusion may be fixed to the first partial shroud, a front end of the first sealing protrusion may be spaced apart from the inner surface by a predetermined interval, a rear end of the third sealing protrusion may be fixed to the second partial shroud, and a front end of the third sealing protrusion may be spaced apart from the inner surface by a predetermined interval.

[0051] The first sealing unit may include a second sealing protrusion protruding toward the first partial shroud from the inner surface, and the second sealing unit may include a fourth sealing protrusion protruding toward the second partial shroud from the inner surface.

[0052] A rear end of the second sealing protrusion may be fixed to the inner surface, a front end of the first sealing protrusion may be spaced apart from the first partial shroud by a predetermined interval, a rear end of the fourth sealing protrusion may be fixed to the inner surface, and a front end of the fourth sealing protrusion may be spaced apart from the second partial shroud by a predetermined interval.

[0053] The centrifugal compressor according to the present inventive concept includes the sealing unit to seal

the gap formed between the impeller and the inner surface of the housing, so the leakage of fluid to be compressed can be prevented at the fluid inlet and the fluid outlet, thereby maximizing the compression efficiency.

[0054] In addition, the partial shroud is provided at a portion of the impeller adjacent to the fluid inlet or the fluid outlet, so the centrifugal compressor may have higher strength suitable for high-speed rotation as compared with the open impeller and may have superior workability as compared with the shroud impeller. In addition, the centrifugal compressor according to the present inventive concept may have the precise profile tolerance and can be manufactured at a lower cost while ensuring the structural stability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055]

FIGs. 1A and 1B show a sectional view illustrating a centrifugal compressor including an open impeller and a perspective view illustrating the open impeller according to the related art;

FIGs. 2A and 2B show a perspective view and a sectional view illustrating a method of processing a shroud impeller according to the related art, respectively;

FIG. 3 is an axial cross-sectional view showing a centrifugal compressor according to a first embodiment of the present inventive concept;

FIGs. 4 and 5 are partially enlarged views of a centrifugal compressor shown in FIG. 3;

FIG. 6 is an axial cross-sectional view showing a centrifugal compressor according to a second exemplary embodiment of the present inventive concept; FIGs. 7 to 9 are partially enlarged views of a centrifugal compressor shown in FIG. 6;

FIG. 10 is an axial cross-sectional view showing a centrifugal compressor according to a third exemplary embodiment of the present inventive concept; FIGs. 11 and 12 are partially enlarged views of a centrifugal compressor shown in FIG. 10;

FIG. 13 is an axial cross-sectional view showing a centrifugal compressor according to a fourth exemplary embodiment of the present inventive concept; FIGs. 14 to 16 are partially enlarged views of a centrifugal compressor shown in FIG. 13;

FIG. 17 is an axial cross-sectional view showing a centrifugal compressor according to a fifth exemplary embodiment of the present inventive concept; and FIG. 18 is an axial cross-sectional view showing a centrifugal compressor according to a sixth exemplary embodiment of the present inventive concept.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0056] Hereinafter, exemplary embodiments of the

present inventive concept will be described in detail with reference to the accompanying drawings, but the present inventive concept will not be limited to the following embodiments.

[0057] FIG. 3 is an axial cross-sectional view showing a centrifugal compressor according to a first exemplary embodiment of the present inventive concept and FIGS. 4 and 5 are partially enlarged views of the centrifugal compressor shown in FIG. 3.

[0058] As shown in the drawings, the centrifugal compressor according to the first exemplary embodiment includes an impeller 100 and a housing 200. The impeller 100 includes a rotary hub 110 rotating about a rotational axis X-X' by receiving power from a driving shaft (not shown) and a plurality of blades 120 radially provided on the rotary hub 110 about the rotational axis X-X'. The housing 200 receives the impeller 100 therein and is formed with an inner surface 211 adjacent to the blades 120.

[0059] The rotary hub 110 is connected to the driving shaft (not shown) and receives rotating force from the driving shaft. The rotary hub 110 may be made from a material having predetermined strength suitable for high speed. In addition, the rotary hub 110 may be fabricated by heat-treating chromium-molybdenum steel, nickel chromium-molybdenum steel, or stainless steel.

[0060] Further, the rotary hub 110 may have a conical shape having a sectional area gradually reduced in the direction of the rotational axis X-X'. In this case, a front center portion of the conical shape in the direction of the rotational axis X-X' becomes an inlet 220 of a fluid, and a rear peripheral portion of the conical shape in the radial direction becomes an outlet of the fluid. Although an inclined surface of a peripheral side in the conical shape of the rotary hub is illustrated as a curve surface having a predetermined curvature in FIG. 3, the present inventive concept is not limited thereto.

[0061] The blades 120 are radially disposed on the inclined surface of the rotary hub 110 while being spaced apart from each other by a predetermined interval. The blades 120 may have a three-dimensional curved shape by taking specifications of a compressor, such as application purpose, compression capacity and flow velocity, into consideration. The blades 120 may be integrally formed with the rotary hub 110. It is also possible to bond the blade to the rotary hub 110 through a welding scheme after processing the blade by using a material the same as that of the rotary hub 110.

[0062] In addition, the welding scheme may not provide sufficient strength required for the high-speed impeller 100. However, as will be described later, since the strength of the impeller 100 according to the present inventive concept can be reinforced by a first partial shroud 310 or a second partial, the impeller 100 may have the condition applicable for the high-rotation compressor.

[0063] The housing 200 has an internal space for receiving the impeller 100 and is configured to serve as a stator to rotatably support the impeller 100.

[0064] Further, the housing 200 includes a cover member 210, which forms the inlet 220 of a fluid to be compressed and the outlet 230 of the compressed fluid and has an inner surface 211 adjacent to the blades 120.

[0065] Meanwhile, the centrifugal compressor according to the first exemplary embodiment includes a first sealing unit 300 disposed adjacent to the inlet 220 to seal a gap formed between outer ends of the blades 120 and the inner surface 211.

[0066] In detail, as described above, the centrifugal compressor according to the first exemplary embodiment includes the first sealing unit 300 to prevent the leakage of fluid to be compressed at the inlet 220.

[0067] The first sealing unit 300 is a non-contact type sealing unit, for instance, a labyrinth sealing unit. In order to implement the labyrinth sealing unit, there is provided a first partial shroud 310 having an annular shape and disposed adjacent to the inlet to partially surround the outer ends of the blades 120 and at least one first sealing protrusion 320a protruding toward the inner surface 211 from the first partial shroud 310.

[0068] The first partial shroud 310 has a cylindrical shape configured to partially surround outer ends of the blades 120 adjacent to the inlet 220. The first partial shroud 310 may be integrally formed with the blades 120 or may be fabricated separately from the blades 120 and bonded to the outer ends of the blades 120 through a welding scheme.

[0069] As described above, since the first partial shroud 310 partially surrounds the outer ends of the blades 120 adjacent to the inlet 220, the fluid introduced into the inlet 220 can be prevented from being leaked through a gap between the blades 120 and the inner surface 211 of the housing 200.

[0070] In addition, since the outer ends of the blades 120 adjacent to the inlet 220 can be securely fixed by the first partial shroud 310, the centrifugal compressor may have higher strength as compared with the open impeller 100 and may have the simple structure.

[0071] The first sealing unit 320a seals a gap formed between the first partial shroud 310 and the inner surface 211 through the labyrinth sealing scheme. That is, the first sealing unit 320a may allow a flow f1 of the fluid that has passed through the inlet 220 of the housing 200 to be introduced toward the blades 120 of the impeller 100 and prevent the fluid introduced into the blades 120 from flowing back to the inlet 220 through the gap formed between the blades 120 and the inner surface 211, so that the compression efficiency can be improved approximate to the compression efficiency of the shroud impeller.

[0072] The sealing protrusion 320a has a rear end 320a-1 fixed to the first partial shroud 310 and a front end 320a-2 protruding toward the inner surface 211 so that a predetermined gap is formed between the front end 320a-2 and the inner surface 211 (see, C in FIG. 4).

[0073] The first sealing protrusion 320a may be separately fabricated as an individual member and the rear end 320a-1 of the first sealing protrusion 320a may be

bonded to the first partial shroud 310 through the welding scheme, or the first sealing protrusion 320a may be integrally formed with the first partial shroud 310. In this case, the first partial shroud 310 may serve as a support member for the first sealing protrusion 320a.

[0074] As described above, the first sealing protrusion 320a prevents the fluid from flowing rearward or forward in the axial direction and it is preferable to provide a plurality of first sealing protrusions 320a as shown in FIG. 3.

[0075] The number of the first sealing protrusion is not limited, but may be variously adjusted by taking specifications of a compressor, such as application purpose, compression capacity and flow velocity, into consideration.

[0076] In the first embodiment shown in FIG. 3, the first sealing protrusion 320a may serve as a rotator and the inner surface 211 of the housing 200 may serve as a stator in labyrinth sealing.

[0077] Meanwhile, as shown in FIG. 4, the centrifugal compressor according to the first exemplary embodiment may further include a first sealing pad 330a having an annular shape. The first sealing pad 330a has hardness lower than the first sealing protrusion 320a and is provided on the inner surface 211 in opposition to the first sealing protrusion 320a.

[0078] In other words, since the first sealing unit 300 adopts the labyrinth sealing scheme, the first sealing protrusion 320a serves as the rotator and the inner surface 211 of the housing 200 serves as the stator so that vibration may occur in the direction perpendicular to the rotating axis due to the rotation of the impeller 100 when the centrifugal compressor is operated. As a result, the first sealing protrusion 320a serving as the rotator may interfere with the inner surface 211 serving as the stator, and thus the inner surface 211 may be worn or the first sealing protrusion 320a may be deformed.

[0079] If the wear or deformation occurs, the gap for maintaining the labyrinth sealing may be excessively enlarged, thereby deteriorating the sealing performance.

[0080] For this reason, the exemplary embodiment provides the first sealing pad 330a to prevent the wear or deformation. In order to prevent the wear of the inner surface 211, the first sealing pad 330a is formed on the inner surface 211 of the housing 200 corresponding to the first sealing protrusion 320a by using a material having low plastic deformation and predetermined elasticity, such as a resin, a coating, a honeycomb or a light-weight material.

[0081] In addition, in order to prevent the deformation of the first sealing protrusion 320a, the first sealing pad 330a may be fabricated by using a material having hardness lower than that of the first sealing protrusion 320a.

[0082] Since the first sealing pad 330a is fabricated by using the material described above, the predetermined gap C can be ensured between the front end 320a-2 of the first sealing protrusion 320a and the first sealing pad 330a so that the high sealing performance can be achieved.

[0083] Meanwhile, as shown in FIG. 5, the sealing pad 330a of the centrifugal compressor according to the first exemplary embodiment is formed with a first sealing groove 340 having a shape corresponding to a shape of the first sealing protrusion 320a and the front end 320a-2 of the first sealing protrusion 320a may be fitted into the first sealing groove 340.

[0084] In addition, a diameter of the impeller 110 rotating at a high speed during the operation of the centrifugal compressor may be enlarged due to centrifugal force and heat and the first sealing protrusion 320a may penetrate into the first sealing pad 330a. For this reason, the first sealing pad 330a may be made from a material having hardness lower than that of the first sealing protrusion 320a. The sealing protrusion and sealing pad according to other embodiments of the present inventive concept also may have the above feature.

[0085] In this manner, since the first sealing groove 340, into which the front end 320a-2 of the first sealing protrusion 320a is partially inserted, is formed in the first sealing pad 330a, a sealing area between the front end 320a-2 of the first sealing protrusion 320a and the first sealing pad 330a can be increased, so that the sealing efficiency can be improved. In addition, the wear and deformation caused by the vibration of the impeller 100 can be diminished and the higher sealing performance can be ensured.

[0086] FIG. 6 is an axial cross-sectional view showing a centrifugal compressor according to a second exemplary embodiment of the present inventive concept, and FIGS. 7 to 9 are partially enlarged views of the centrifugal compressor shown in FIG. 6. In the following description of the second exemplary embodiment, the description about the elements and structures that have been described in the first exemplary embodiment will be omitted in order to avoid redundancy.

[0087] As shown in the drawings, the centrifugal compressor according to the second exemplary embodiment includes at least one second sealing protrusion 320b protruding toward the first partial shroud 310 from the inner surface 211 of the housing 200. The second sealing protrusion 320b includes a rear end 320b-1 fixed to the inner surface 211 and a front end 320b-2 spaced apart from the first partial shroud 310 by a predetermined distance C.

[0088] That is, different from the first exemplary embodiment, the sealing protrusion constituting the first sealing unit 300 protrudes toward the first partial shroud 310 from the inner surface 211 of the housing 200.

[0089] As shown in FIG. 6, the second sealing protrusion 320b may be integrally formed with the housing 200. In addition, as shown in FIG. 7, the second sealing protrusion 320b may be attached to an inner surface of a first support member 350 having an annular shape and inserted into the inner surface 211 of the housing 200. Further, the second sealing protrusion 320b may be separately prepared as an individual member such that the rear end 320b-1 of the second sealing protrusion 320b

can be attached to the inner surface of the first support member 350 through a welding scheme or the second sealing protrusion 320b may be integrally formed with the inner surface of the first support member 350.

[0090] In this manner, since the second sealing protrusion 320b is provided at the inner surface 211 of the housing 200, other than the first partial shroud 310, the manufacturing cost for the first partial shroud 310 and the impeller 100, which are relatively expensive and complicate in shapes, can be reduced.

[0091] Meanwhile, according to the second exemplary embodiment, the second sealing protrusion 320b serves as a stator and the first partial shroud 310 may serve as a rotator.

[0092] Therefore, as shown in FIG. 8, a second sealing pad 330b can be formed on an outer surface of the first partial shroud 310 to prevent the sealing protrusion from being worn and deformed. The second sealing pad 330b is also formed by using a material having low plastic deformation and predetermined elasticity as well as hardness lower than that of the second sealing protrusion 320b.

[0093] In addition, similar to the first exemplary embodiment, the second sealing pad 330b is formed with a second sealing groove 340 having a shape corresponding to a shape of the second sealing protrusion 320b as shown in FIG. 9. The front end 320b-2 of the second sealing protrusion 320b may be inserted into the second sealing groove 340.

[0094] FIG. 10 is an axial cross-sectional view showing a centrifugal compressor according to a third exemplary embodiment of the present inventive concept and FIGS. 11 and 12 are partially enlarged views of the centrifugal compressor shown in FIG. 10. In the following description of the third exemplary embodiment, the description about the elements and structures that have been described in the first and second exemplary embodiments will be omitted in order to avoid redundancy.

[0095] As shown in the drawings, the centrifugal compressor according to the third exemplary embodiment includes a second sealing unit 400 adjacent to the outlet 230 of the housing 200.

[0096] In detail, the centrifugal compressor according to the third exemplary embodiment includes the second sealing unit 400 to prevent the leakage of the fluid flow f2 at the outlet 230 of the compressed fluid.

[0097] The second sealing unit 400 includes a second partial shroud 410 having an annular shape and disposed adjacent to the outlet 230 to partially surround the outer ends of the blades 120 and at least one third sealing protrusion 420a protruding toward the inner surface 211 from the second partial shroud 410.

[0098] Similar to the first exemplary embodiment described above, a rear end 420a-1 of the third sealing protrusion 420a is fixed to the second partial shroud 410 and a front end 420a-2 of the third sealing protrusion 420a is spaced apart from the inner surface 211 by a predetermined distance (see C of FIG. 11) such that the third

sealing protrusion 420a serves as a rotator and the inner surface 211 of the housing 200 serves as a stator, thereby implementing the labyrinth sealing.

[0099] The second partial shroud 410 has a hollow disc shape corresponding to a shape of the blades 120 adjacent to the outlet 230 of the fluid. The second partial shroud 410 partially surrounds the outer ends of the blades 120 to serve as a support member for the third sealing protrusion 420a. Thus, the outer ends of the blades adjacent to the outlet 230 of the fluid can be securely fixed by the second partial shroud 410, thereby implementing a high-strength structure.

[0100] Similar to the first partial shroud, the second partial shroud 410 may be integrally formed with the blades 120 or may be separately prepared and attached to the outer ends of the blades 120 through a welding scheme.

[0101] Meanwhile, similar to the first exemplary embodiment, the third sealing protrusion 420a may be prepared as an individual member. In this case, the rear end 420a-1 of the third sealing protrusion 420a may be attached to the second partial shroud 410 through a welding scheme or may be integrally formed with the first partial shroud.

[0102] In addition, as shown in FIG. 11, the centrifugal compressor according to the third exemplary embodiment may further include a third sealing pad 430a provided at the inner surface 211 in opposition to the third sealing protrusion 420a and having an annular shape. The third sealing pad 420a may have hardness lower than that of the third sealing protrusion 420a and may be formed by using a material having low plastic deformation and predetermined elasticity.

[0103] Further, as shown in FIG. 12, the third sealing pad 430a is formed with a third sealing groove 440 having a shape corresponding to a shape of the third sealing protrusion 420a. The front end 420a-2 of the third sealing protrusion 420a may be inserted into the third sealing groove 440.

[0104] FIG. 13 is an axial cross-sectional view showing a centrifugal compressor according to a fourth exemplary embodiment of the present inventive concept, and FIGS. 14 to 16 are partially enlarged views of a centrifugal compressor shown in FIG. 13. In the following description of the fourth exemplary embodiment, the description about the elements and structures that have been described in the first to third exemplary embodiments will be omitted in order to avoid redundancy.

[0105] As shown in the drawings, the centrifugal compressor according to the fourth embodiment of the present inventive concept includes a second sealing unit 400 having at least one fourth sealing protrusion 420b protruding toward the second partial shroud 410 from the inner surface 211 of the housing. The fourth sealing protrusion 420b includes a rear end 420b-1 fixed to the inner surface 211 and a front end 420b-2 spaced part from the second partial shroud 410 by a predetermined distance C.

[0106] In detail, different from the third exemplary embodiment, according to the fourth exemplary embodiment, the sealing protrusion constituting the second sealing unit 400 protrudes toward the second partial shroud 410 from the inner surface 211 of the housing 200.

[0107] That is, similar to the second exemplary embodiment, the fourth sealing protrusion 420b may be integrally formed with the housing 200 as shown in FIG. 13. In addition, as shown in FIG. 14, the fourth sealing protrusion 420b may be attached to an inner surface of a second support member 450 having an annular shape and inserted into the inner surface 211 of the housing 200.

[0108] Further, the fourth sealing protrusion 420b may be separately prepared as an individual member. In this case, the rear end 420b-1 of the fourth sealing protrusion 420b may be attached to the inner surface of the second support member 450 through a welding scheme or may be integrally formed with the inner surface of the second support member 450.

[0109] In addition, similar to the second exemplary embodiment, a fourth sealing pad 430b may be provided to prevent the wear and deformation of the sealing protrusion. As shown in FIG. 15, the fourth sealing pad 430b may be formed on the outer surface of the second partial shroud 410. The fourth sealing pad 430b may be formed by using a material having low plastic deformation and predetermined elasticity as well as hardness lower than that of the second sealing protrusion.

[0110] Further, as shown in FIG. 16, the fourth sealing pad 430b is formed with a fourth sealing groove 440 having a shape corresponding to a shape of the fourth sealing protrusion 420b. The front end 420b-2 of the fourth sealing protrusion 420b may be inserted into the fourth sealing groove 440.

[0111] FIG. 17 is an axial cross-sectional view showing a centrifugal compressor according to a fifth exemplary embodiment of the present inventive concept.

[0112] As shown in FIG. 17, the centrifugal compressor according to the fifth exemplary embodiment includes a first sealing unit 300 adjacent to the inlet 220 of the housing 200 and a second sealing unit 400 adjacent to the outlet 230 of the housing 200.

[0113] In detail, the centrifugal compressor according to the fifth embodiment of the present inventive concept includes the first sealing unit 300 according to the first embodiment and the second sealing unit 400 according to the third embodiment. In more detail, the centrifugal compressor according to the fifth exemplary embodiment includes the first sealing unit 300 having a first partial shroud 310 and a first sealing protrusion 320a and the second sealing unit 400 having a second partial shroud 410 and a third sealing protrusion 420a.

[0114] Since both of the first and second units 300 and 400 are provided, the fluid leakage can be effectively prevented at the inlet 220 and the outlet 230 of the housing 200, so that the efficiency of the impeller 100 can be upgraded to the level of the typical shroud impeller.

[0115] Further, the blades 120 adjacent to the inlet 220 of the housing 200 can be reinforced by the first partial shroud 310 and the blades adjacent to the outlet 230 of the housing 200 can be reinforced by the second partial shroud 410 so that the strength of the impeller 100 can be improved to the level of the typical shroud impeller.

[0116] In addition, although not shown in the drawing, the technical features of the first sealing pad and the first sealing groove according to the first exemplary embodiment and the technical features of the third sealing pad and the third sealing groove according to the third exemplary embodiment can be adopted in the fifth exemplary embodiment illustrated in FIG. 17.

[0117] FIG. 18 is an axial cross-sectional view showing the centrifugal compressor according to a sixth exemplary embodiment of the present inventive concept.

[0118] As shown in FIG. 18, the centrifugal compressor according to the sixth exemplary embodiment includes a first sealing unit 300 adjacent to the inlet 220 of the housing 200 and a second sealing unit 400 adjacent to the outlet 230 of the housing 200. The first sealing unit 300 includes at least one second sealing protrusion 320b protruding toward the first partial shroud 310 from the inner surface 211 of the housing 200 and the second sealing unit 400 includes at least one fourth sealing protrusion 420b protruding toward the second partial shroud 410 from the inner surface 211 of the housing 200.

[0119] In detail, the centrifugal compressor according to the sixth exemplary embodiment includes the first sealing unit 300 according to the second exemplary embodiment and the second sealing unit 400 according to the fourth embodiment. In more detail, the centrifugal compressor according to the sixth exemplary embodiment includes the first sealing unit 300 having the first partial shroud 310 and the second sealing protrusion 320b and the second sealing unit 400 having the second partial shroud 410 and the fourth sealing protrusion 420b.

[0120] Although not shown in the drawing, the technical features of the second sealing pad and the second sealing groove according to the second exemplary embodiment and the technical features of the fourth sealing pad and the fourth sealing groove according to the fourth exemplary embodiment can be adopted in the sixth embodiment illustrated in FIG. 18.

[0121] In addition, although not shown in the drawing, the technical features of the first sealing unit 300 according to the first exemplary embodiment and the second sealing unit 400 according to the fourth exemplary embodiment and the technical features of the first sealing unit 300 according to the second exemplary embodiment and the second sealing unit 400 according to the third exemplary embodiment can be adopted in the sixth exemplary embodiment without departing from the scope of the present inventive concept.

[0122] Although various examples have been illustrated and described, the present disclosure is not limited to the above-mentioned examples and various modifications can be made by those skilled in the art without de-

parting from the scope of the appended claims. In addition, these modified examples should not be appreciated separately from technical spirits or prospects.

Claims

1. A centrifugal compressor comprising:

an impeller comprising a plurality of blades radially disposed about a rotational axis;
a housing comprising an inlet into which a fluid to be compressed by the impeller is introduced, an outlet through which the compressed fluid is discharged, and an inner surface adjacent to the plurality of blades;
a sealing unit disposed adjacent to one of the inlet and the outlet to seal a space between outer ends of the plurality of blades and the inner surface; and
a partial shroud disposed adjacent to the sealing unit and disposed at one of the inlet and the outlet to partially surround outer peripheral portions of the outer ends of the plurality of blades.

2. The centrifugal compressor of claim 1, wherein the sealing unit comprises a first sealing unit disposed adjacent to the inlet and the first sealing unit comprises a first partial shroud disposed adjacent to the inlet to partially surround the outer peripheral portions of the outer ends of the plurality of blades.

3. The centrifugal compressor of claim 2, wherein the first sealing unit comprises at least one first sealing protrusion protruding toward the inner surface from the first partial shroud, a rear end of the first sealing protrusion is fixed to the first partial shroud, and a front end of the first sealing protrusion is spaced apart from the inner surface by a predetermined interval.

4. The centrifugal compressor of claim 3, further comprising a first sealing pad on the inner surface adjacent to the first sealing protrusion, wherein the first sealing pad comprises a material having a hardness lower than a hardness of the first sealing protrusion.

5. The centrifugal compressor of claim 4, wherein the first sealing pad comprises a first sealing groove comprising a shape corresponding to a shape of the first sealing protrusion, and a front end of the first sealing protrusion is inserted into the first sealing groove.

6. The centrifugal compressor of claim 2, wherein the first sealing unit comprises a second sealing protrusion protruding toward the first partial shroud from the inner surface, a rear end of the second sealing

protrusion is fixed to the inner surface, and a front end of the second sealing protrusion is spaced apart from the first partial shroud by a predetermined interval.

7. The centrifugal compressor of claim 6, wherein the first sealing unit further comprises a first support member comprising one surface attached to the inner surface and an opposite surface formed with the second sealing protrusion.

8. The centrifugal compressor of claim 6, further comprising a second sealing pad on an outer surface of the first partial shroud adjacent to the second sealing protrusion, wherein the second sealing pad comprises a material having a hardness lower than a hardness of the second sealing protrusion.

9. The centrifugal compressor of claim 8, wherein the second sealing pad comprises a second sealing groove comprising a shape corresponding to a shape of the second sealing protrusion, and a front end of the second sealing protrusion is inserted into the second sealing groove.

10. The centrifugal compressor of claim 1, wherein the sealing unit comprises a second sealing unit disposed adjacent to the outlet and the second sealing unit comprises a second partial shroud disposed adjacent to the outlet to partially surround the outer peripheral portions of the outer ends of the plurality of blades.

11. The centrifugal compressor of claim 10, wherein the second sealing unit further comprises a third sealing protrusion protruding toward the inner surface from the second partial shroud, a rear end of the third sealing protrusion is fixed to the second partial shroud, and a front end of the third sealing protrusion is spaced apart from the inner surface by a predetermined interval.

12. The centrifugal compressor of claim 11, further comprising a third sealing pad on the inner surface adjacent to the third sealing protrusion, wherein the third sealing pad comprises a material having a hardness lower than a hardness of the third sealing protrusion.

13. The centrifugal compressor of claim 12, wherein the third sealing pad comprises a third sealing groove comprising a shape corresponding to a shape of the third sealing protrusion, and a front end of the third sealing protrusion is inserted into the third sealing groove.

14. The centrifugal compressor of claim 10, wherein the second sealing unit further comprises a fourth seal-

ing protrusion protruding toward the second partial shroud from the inner surface, a rear end of the fourth sealing protrusion is fixed to the inner surface, and a front end of the fourth sealing protrusion is spaced apart from the second partial shroud by a predetermined interval. 5

15. The centrifugal compressor of claim 14, wherein the second sealing unit further comprises a second support member comprising one surface attached to the inner surface and an opposite surface formed with the fourth sealing protrusion. 10

16. The centrifugal compressor of claim 14, further comprising a fourth sealing pad on an outer surface of the second partial shroud adjacent to the fourth sealing protrusion, wherein the fourth sealing pad comprises a material having a hardness lower than a hardness of the fourth sealing protrusion. 15

17. The centrifugal compressor of claim 16, wherein the fourth sealing pad is formed with a fourth sealing groove comprising a shape corresponding to a shape of the fourth sealing protrusion, and a front end of the fourth sealing protrusion is inserted into the fourth sealing groove. 20 25

18. The centrifugal compressor of claim 1, wherein the sealing unit comprises a first sealing unit disposed adjacent to the inlet and a second sealing unit disposed adjacent to the outlet, the first sealing unit comprising a first partial shroud disposed adjacent to the inlet to partially surround the outer peripheral portions of the outer ends of the plurality of blades, and the second sealing unit comprising a second partial shroud disposed adjacent to the outlet to partially surround the outer peripheral portions of the outer ends of the plurality of blades. 30 35

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Fig.1A (Related Art)

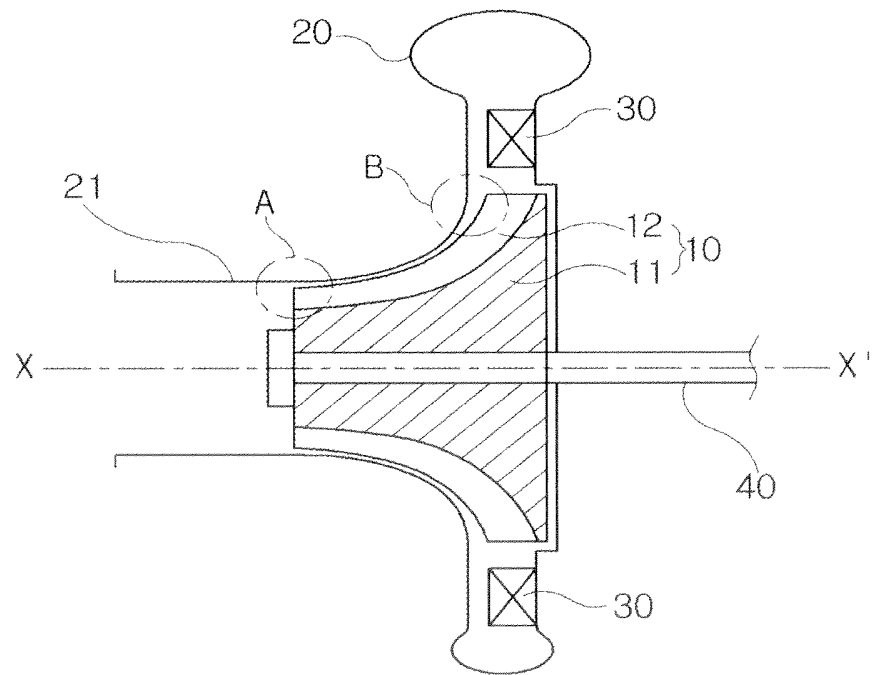


Fig.1B (Related Art)

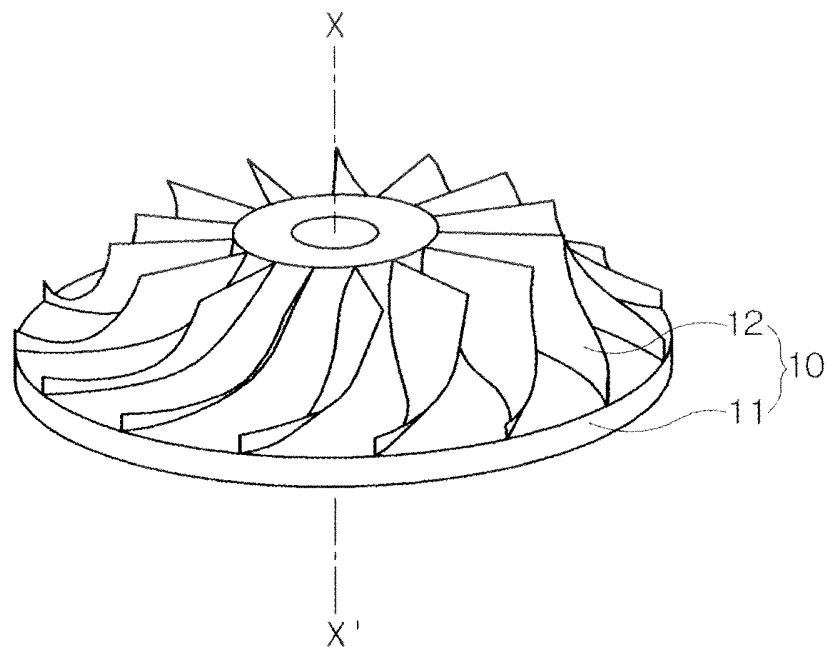


Fig.2A (Related Art)

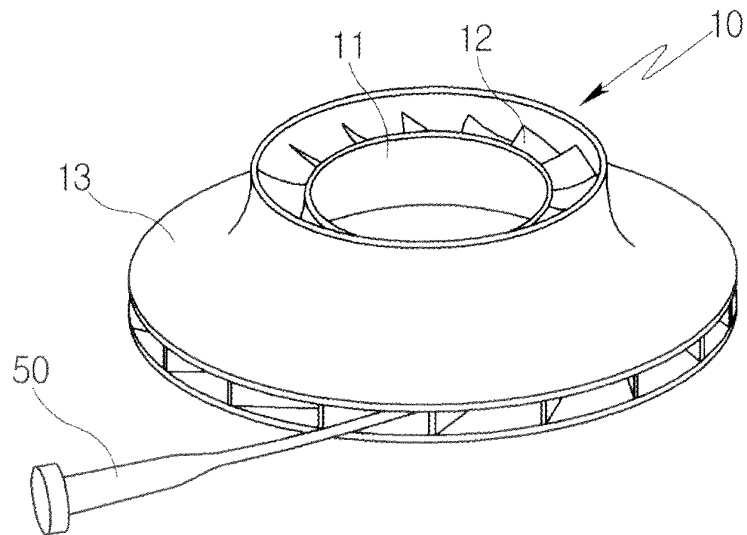


Fig.2B (Related Art)

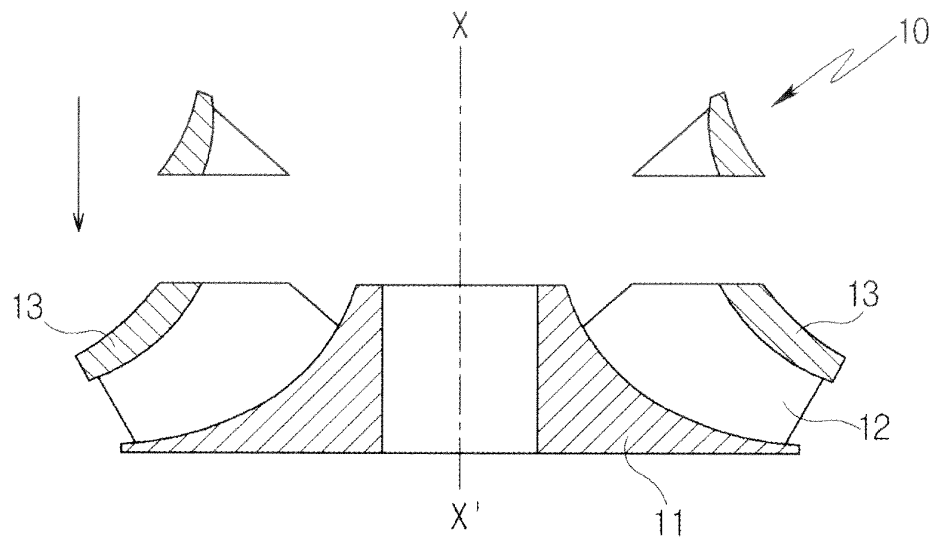


Fig.3

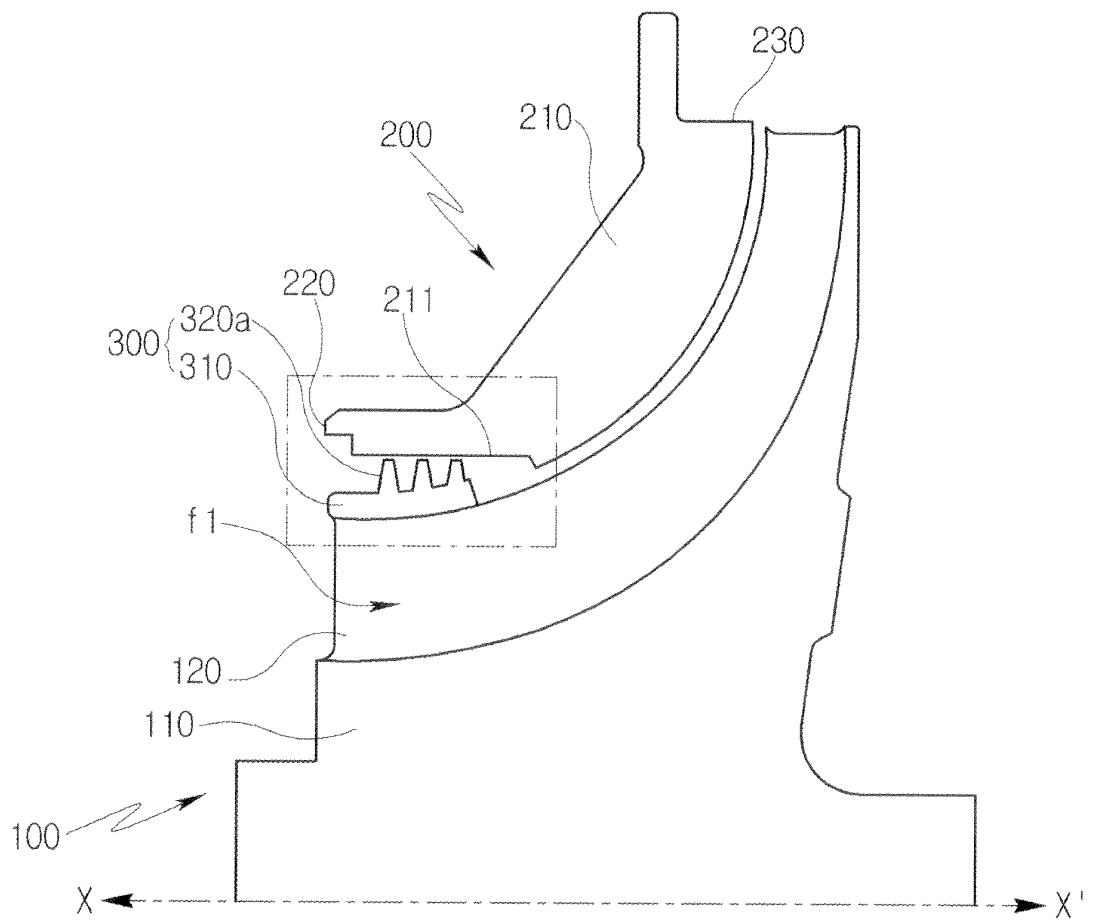


Fig.4

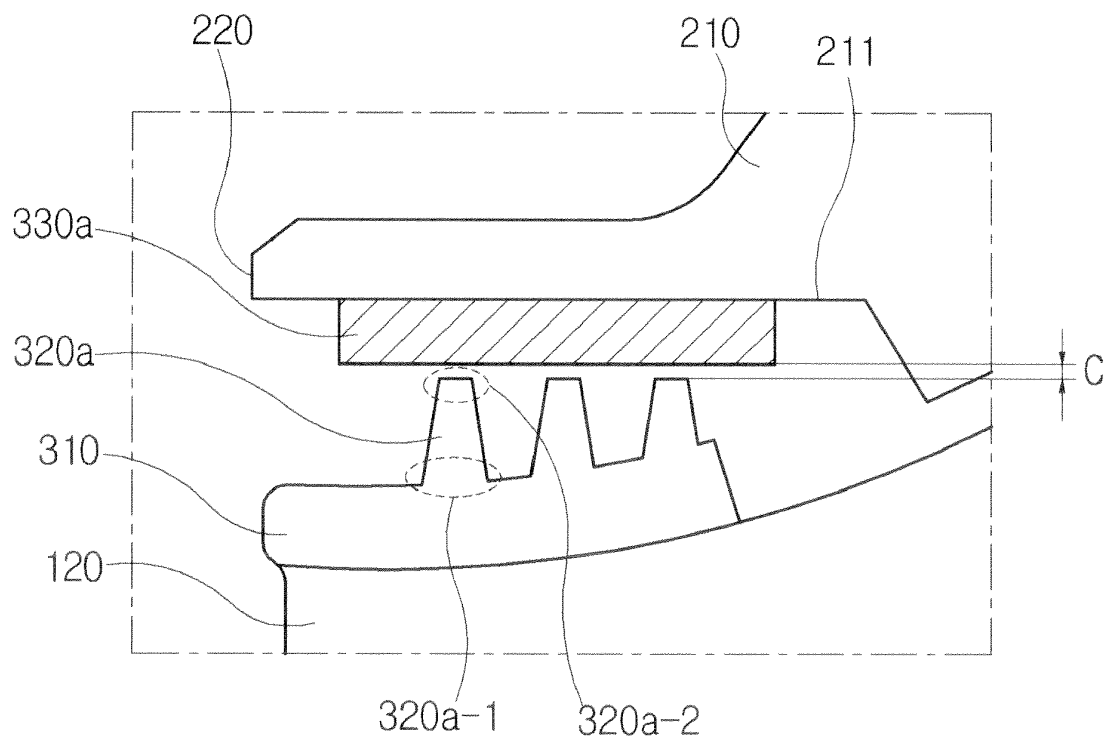


Fig.5

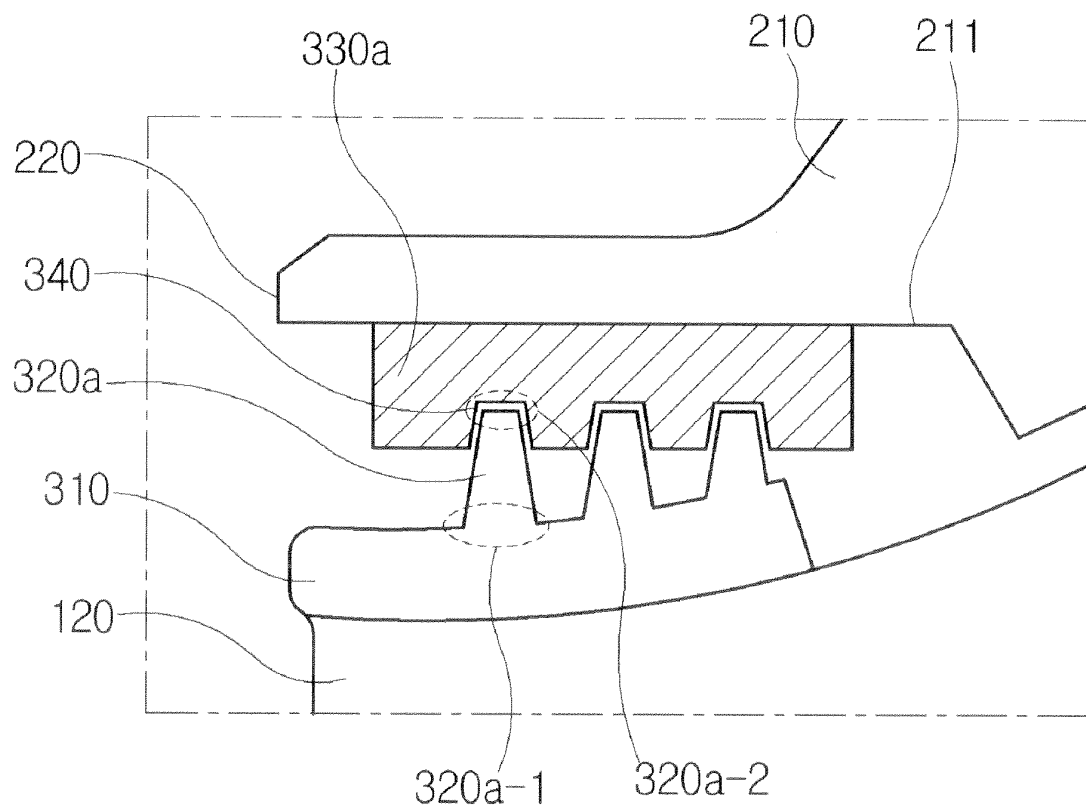


Fig.6

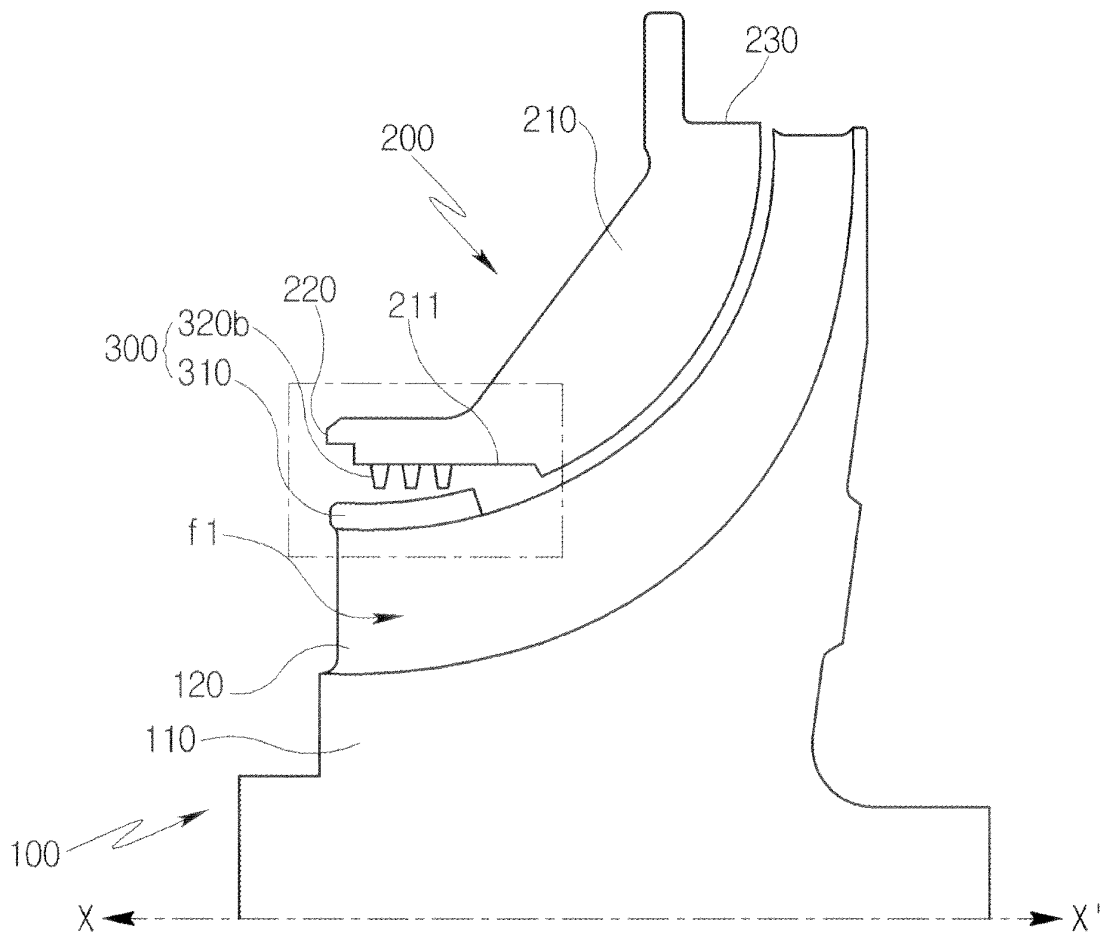


Fig.7

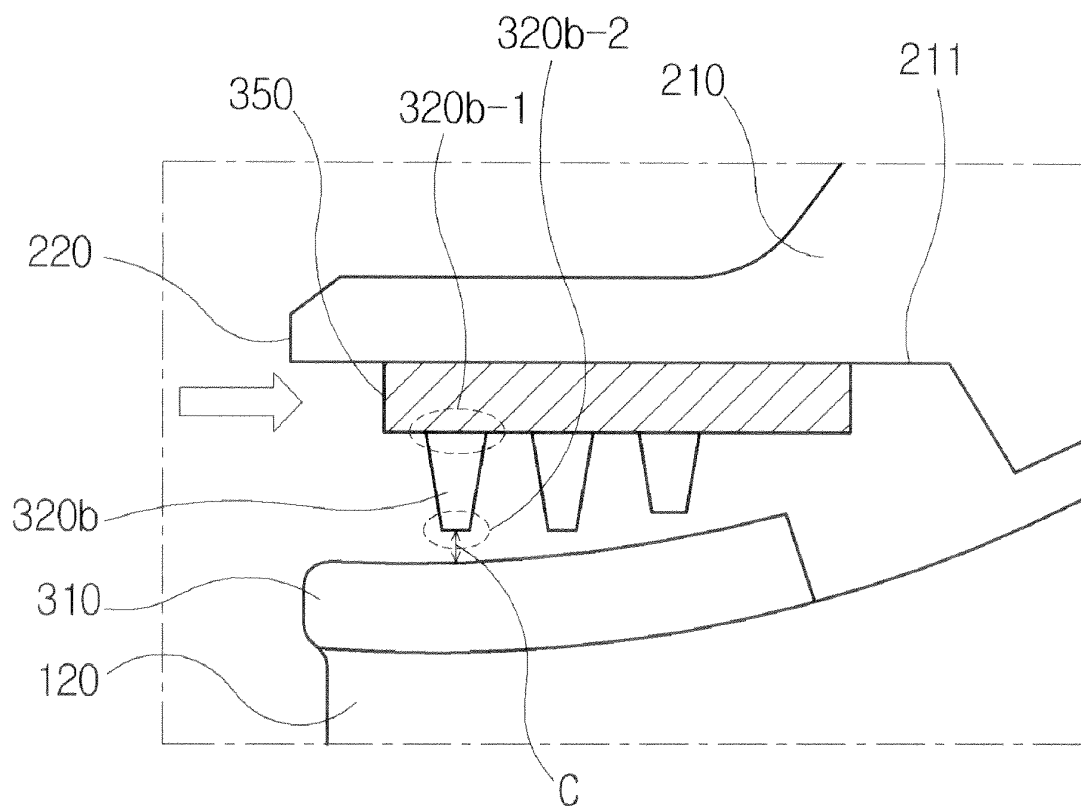


Fig.8

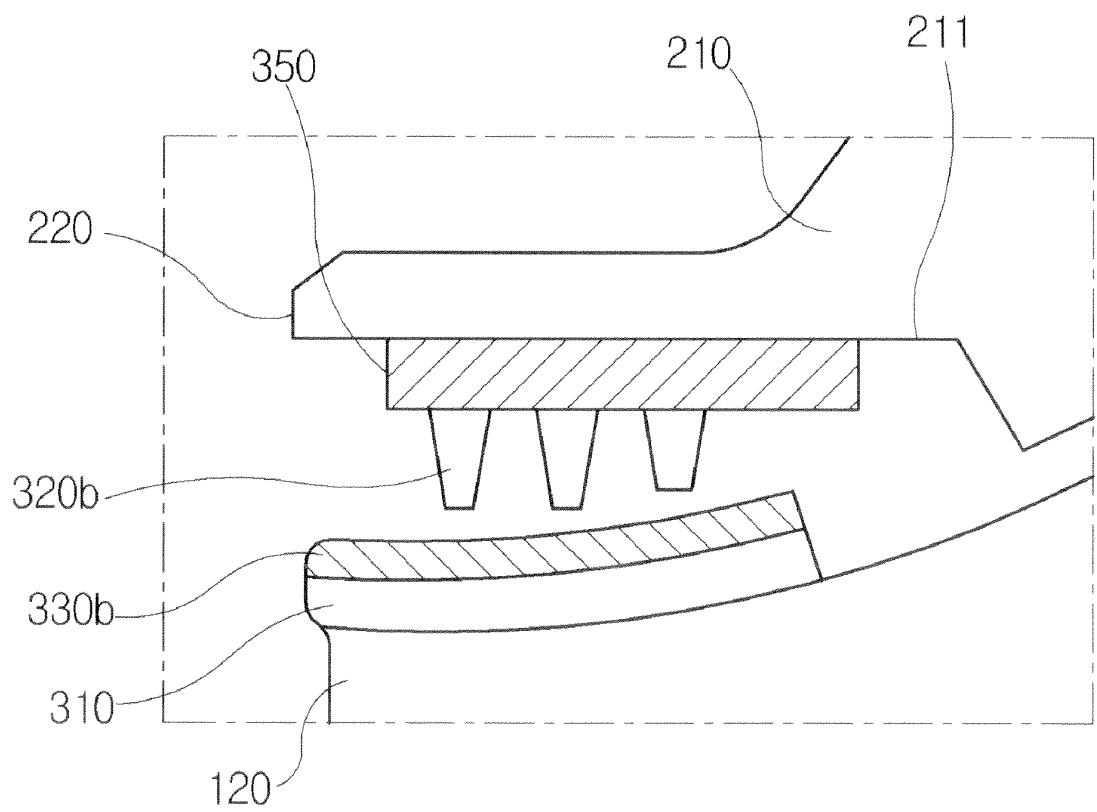


Fig.9

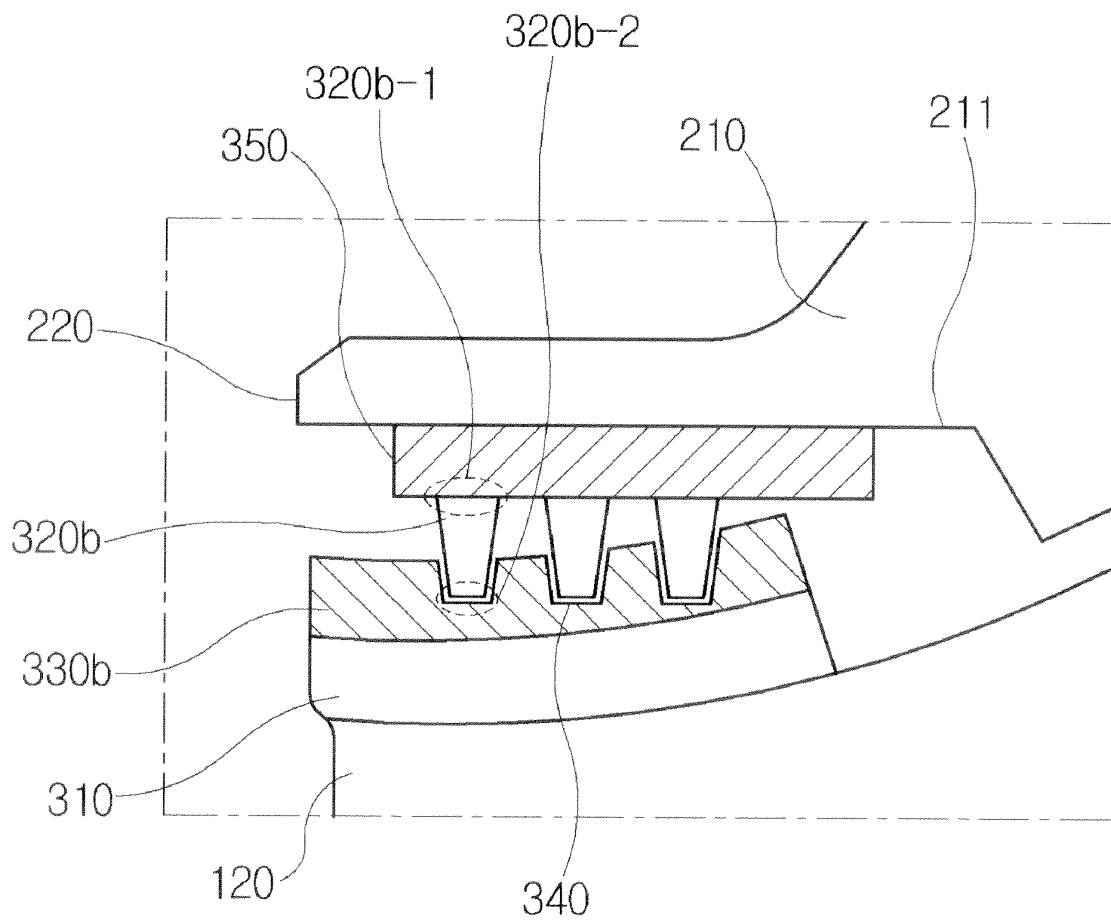


Fig.10

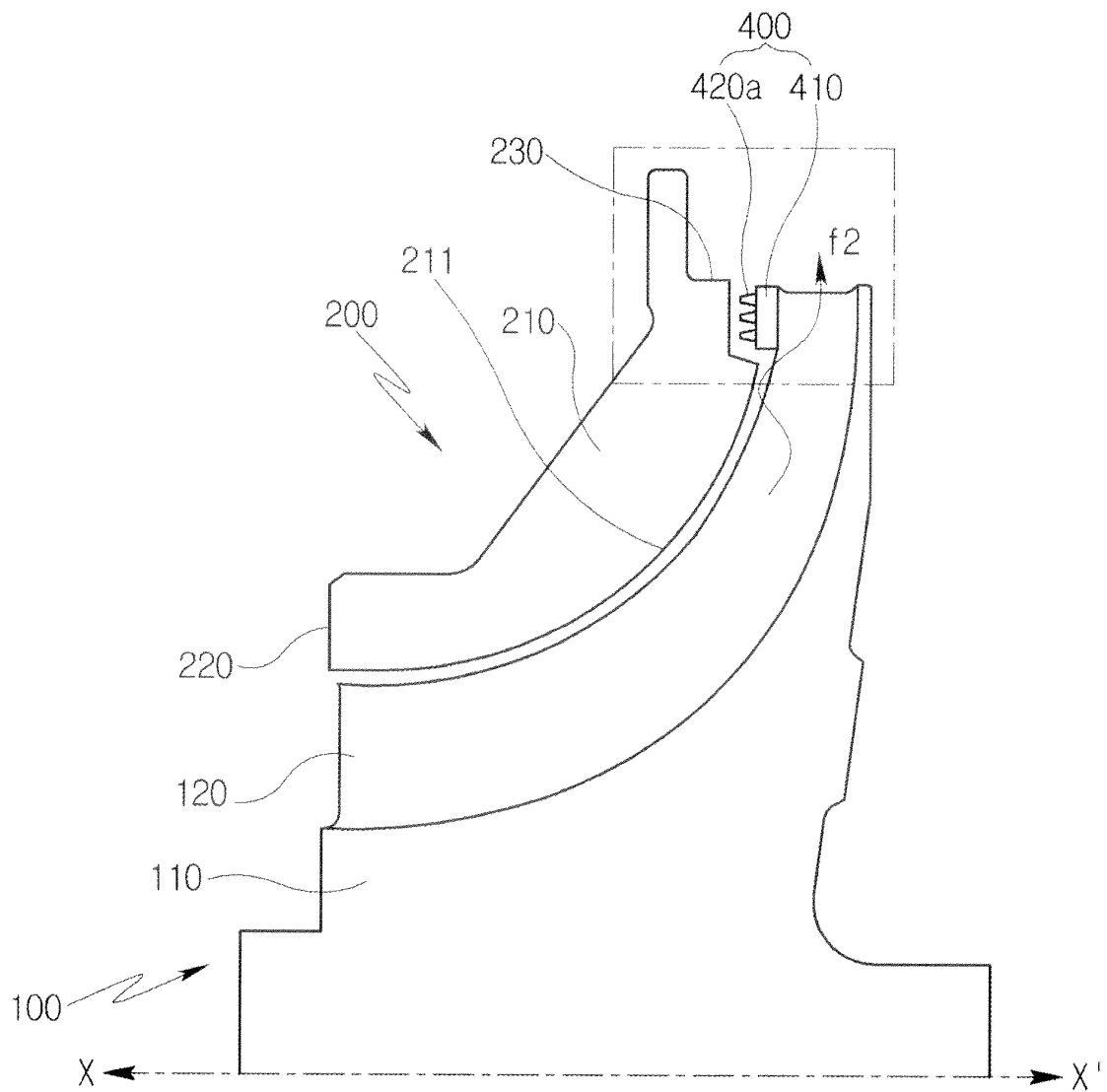


Fig.11

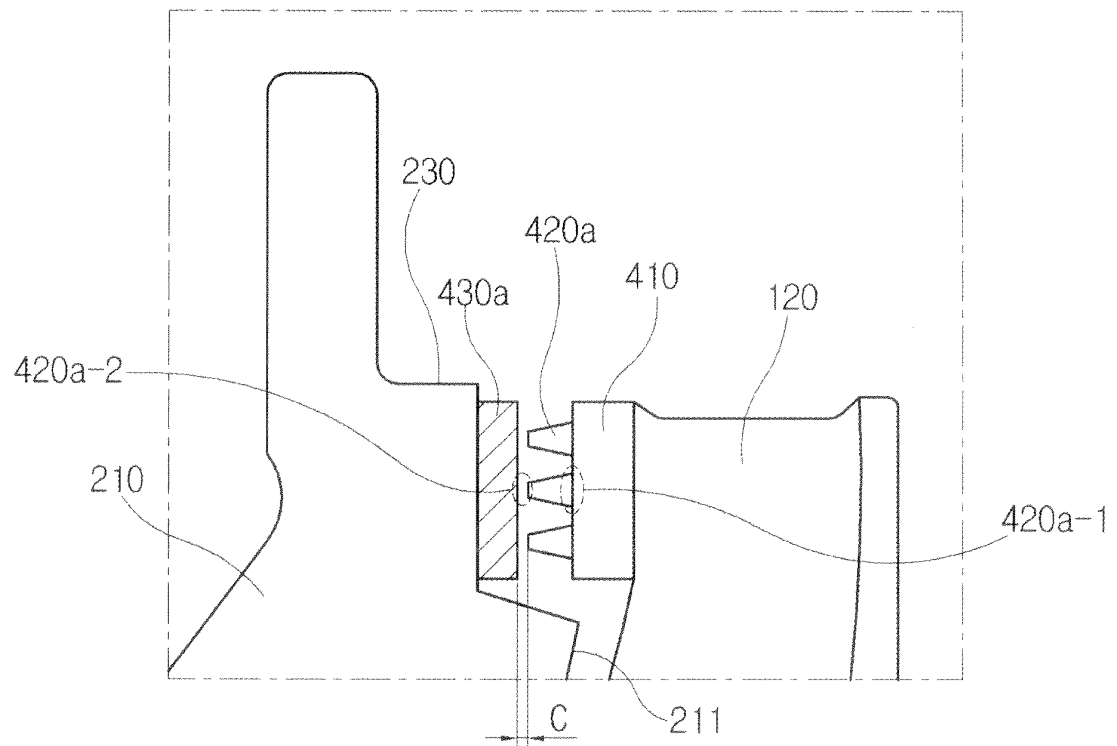


Fig.12

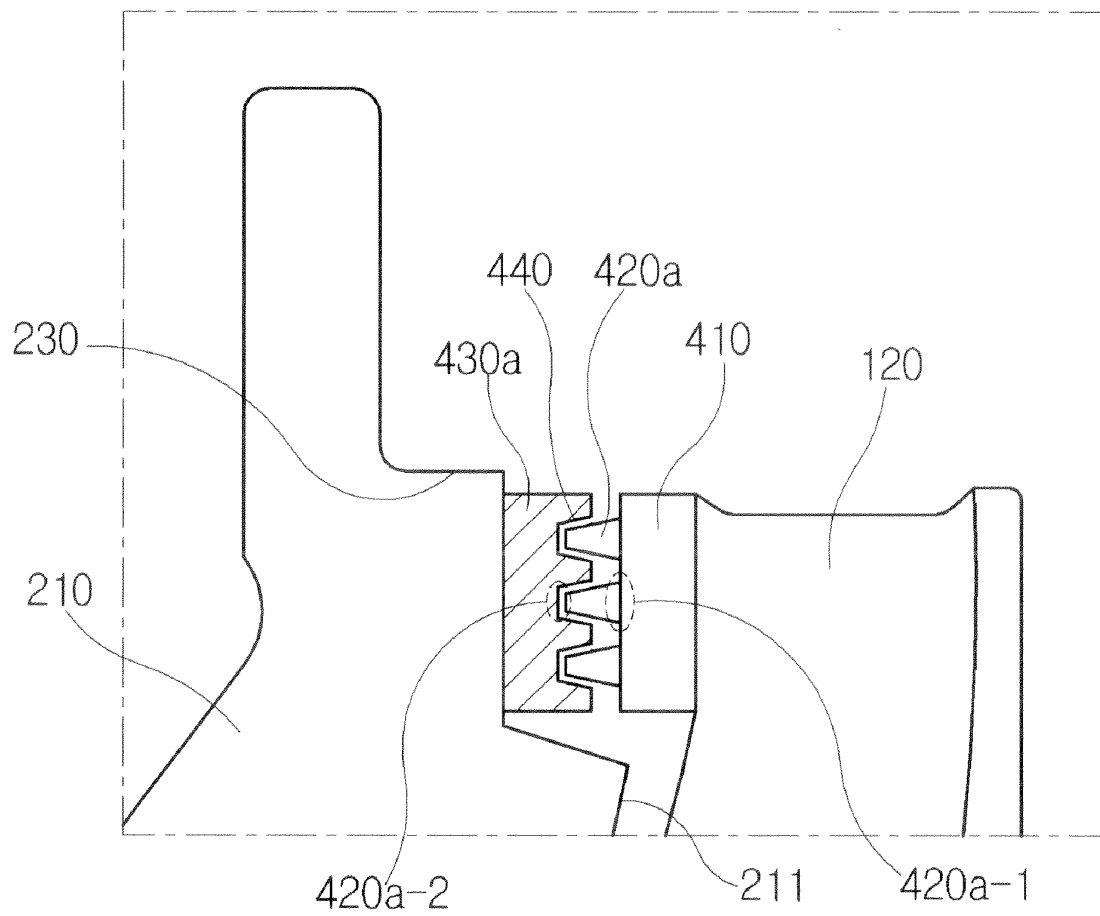


Fig.13

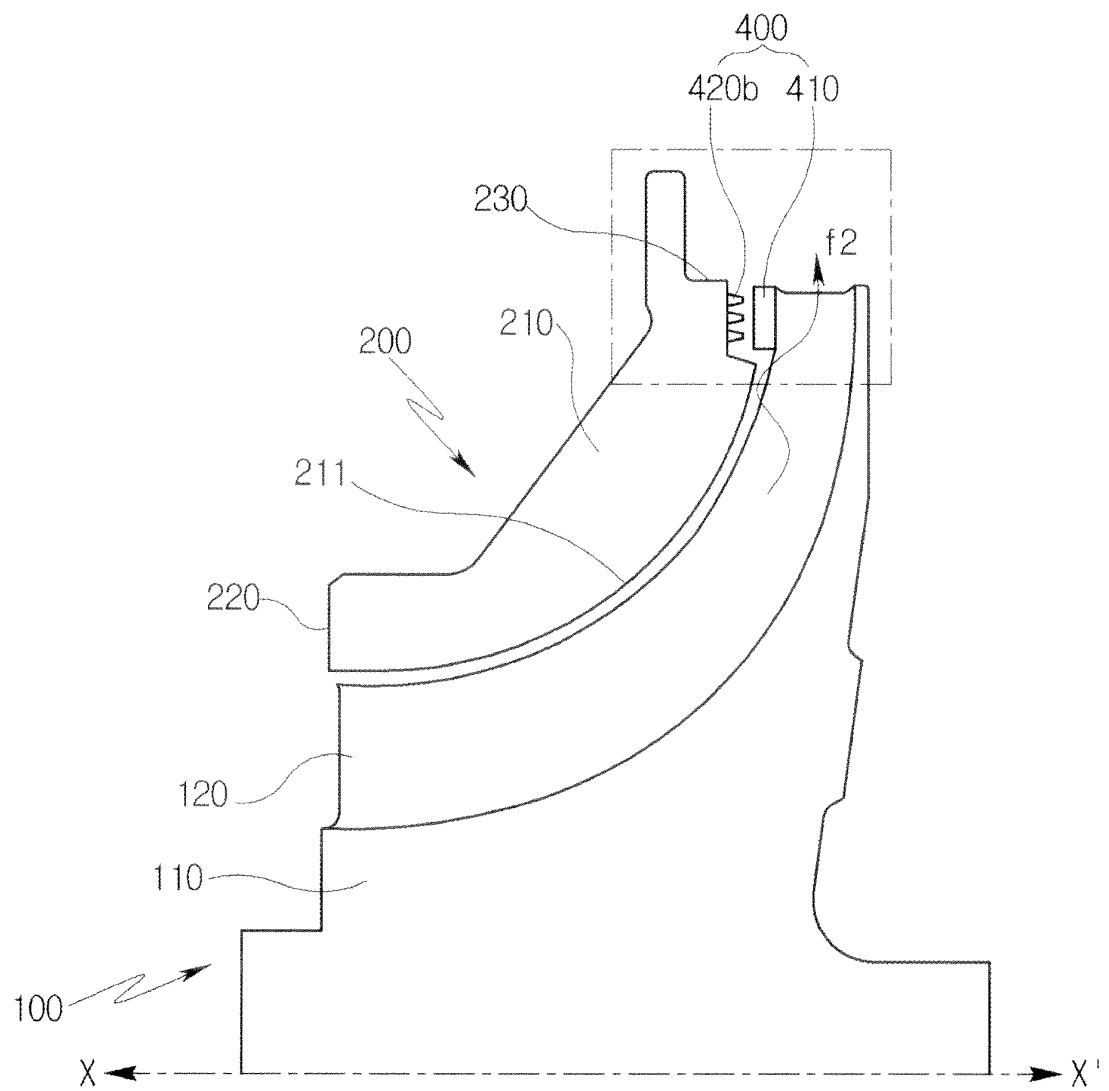


Fig.14

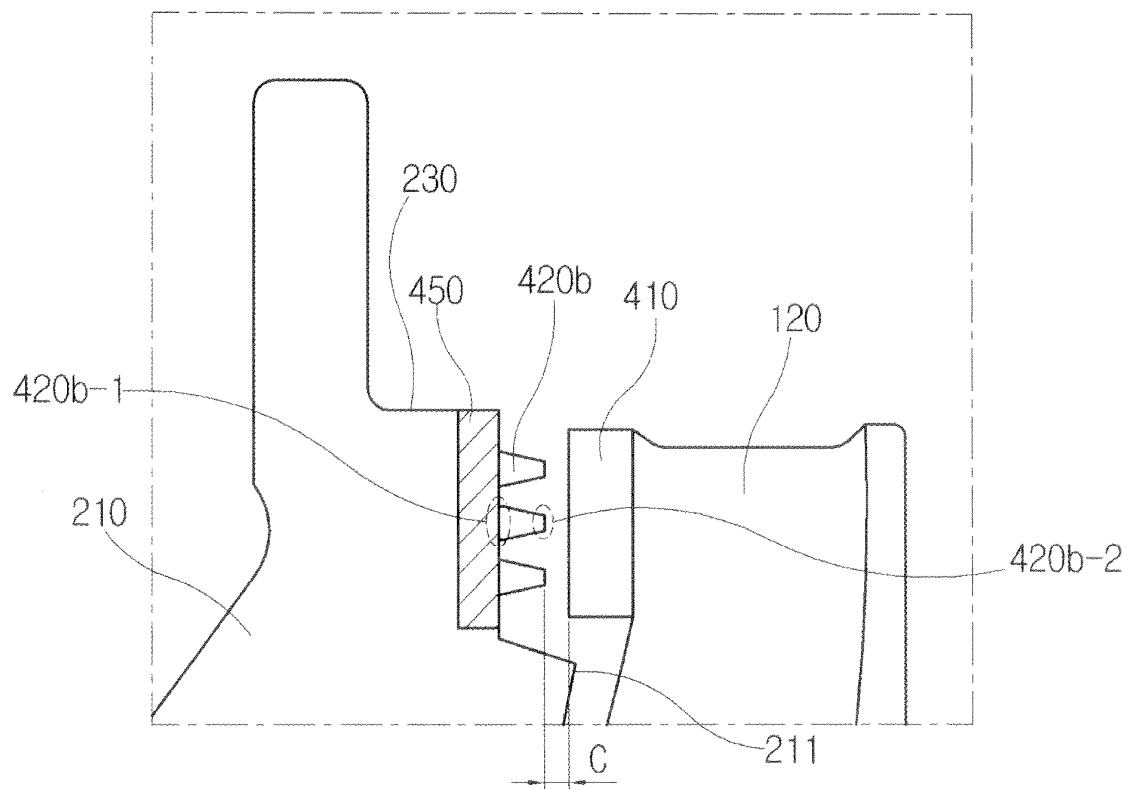


Fig.15

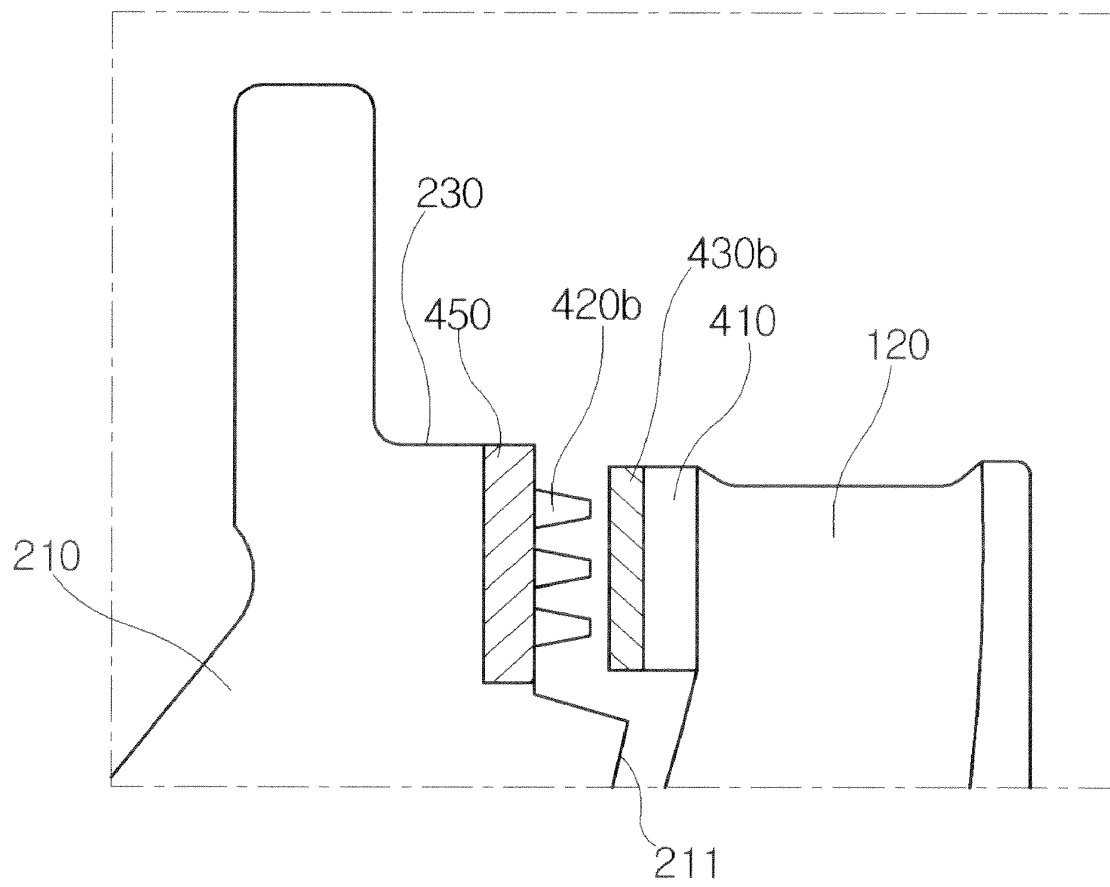


Fig.16

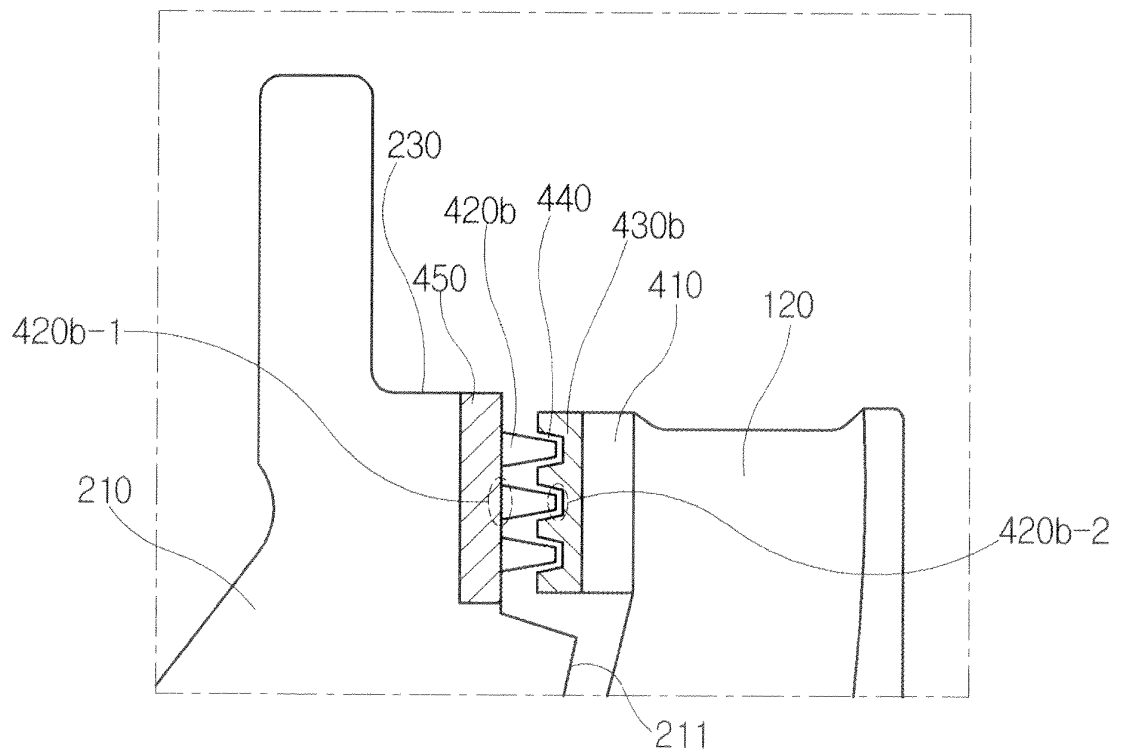


Fig.17

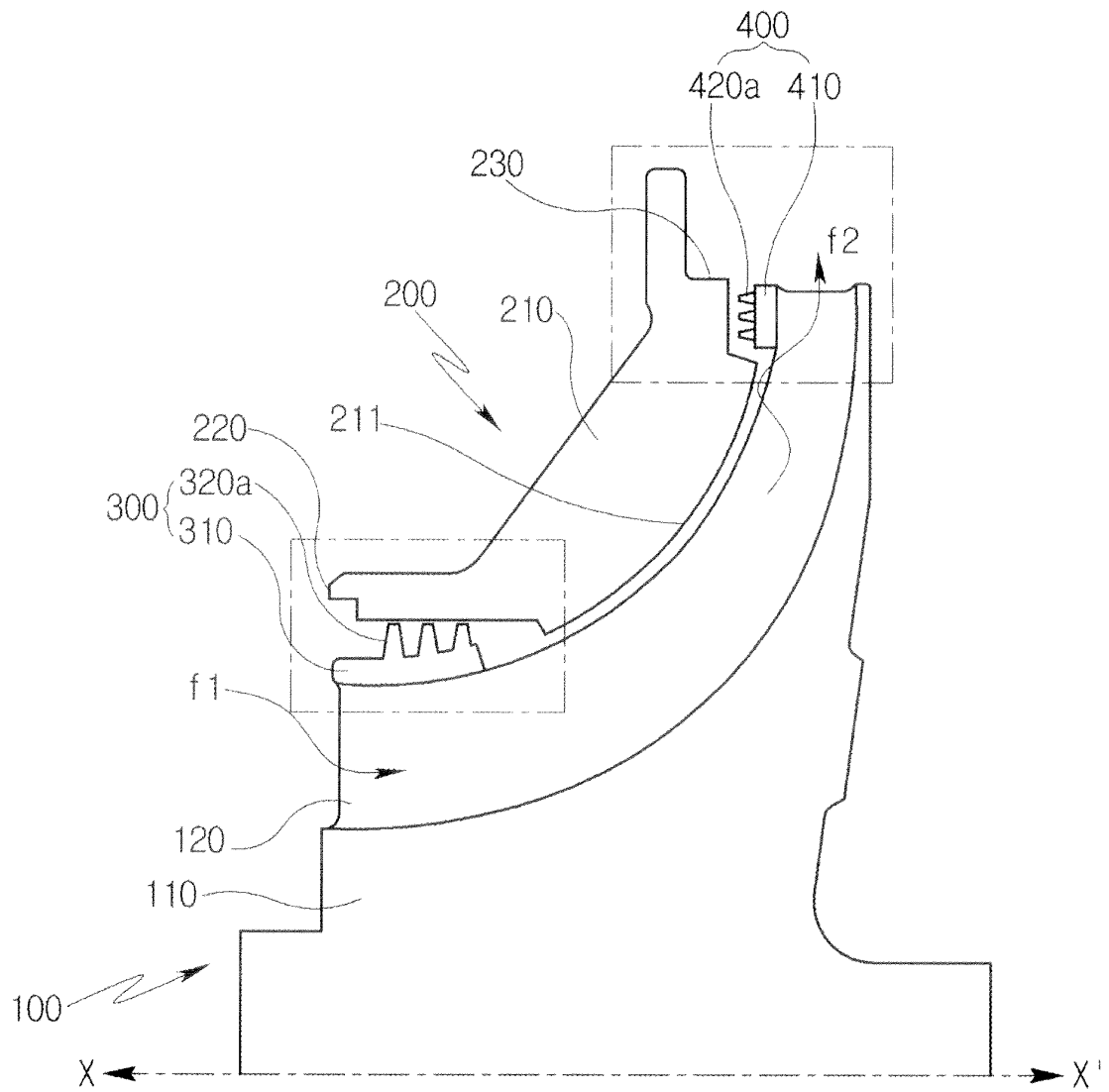
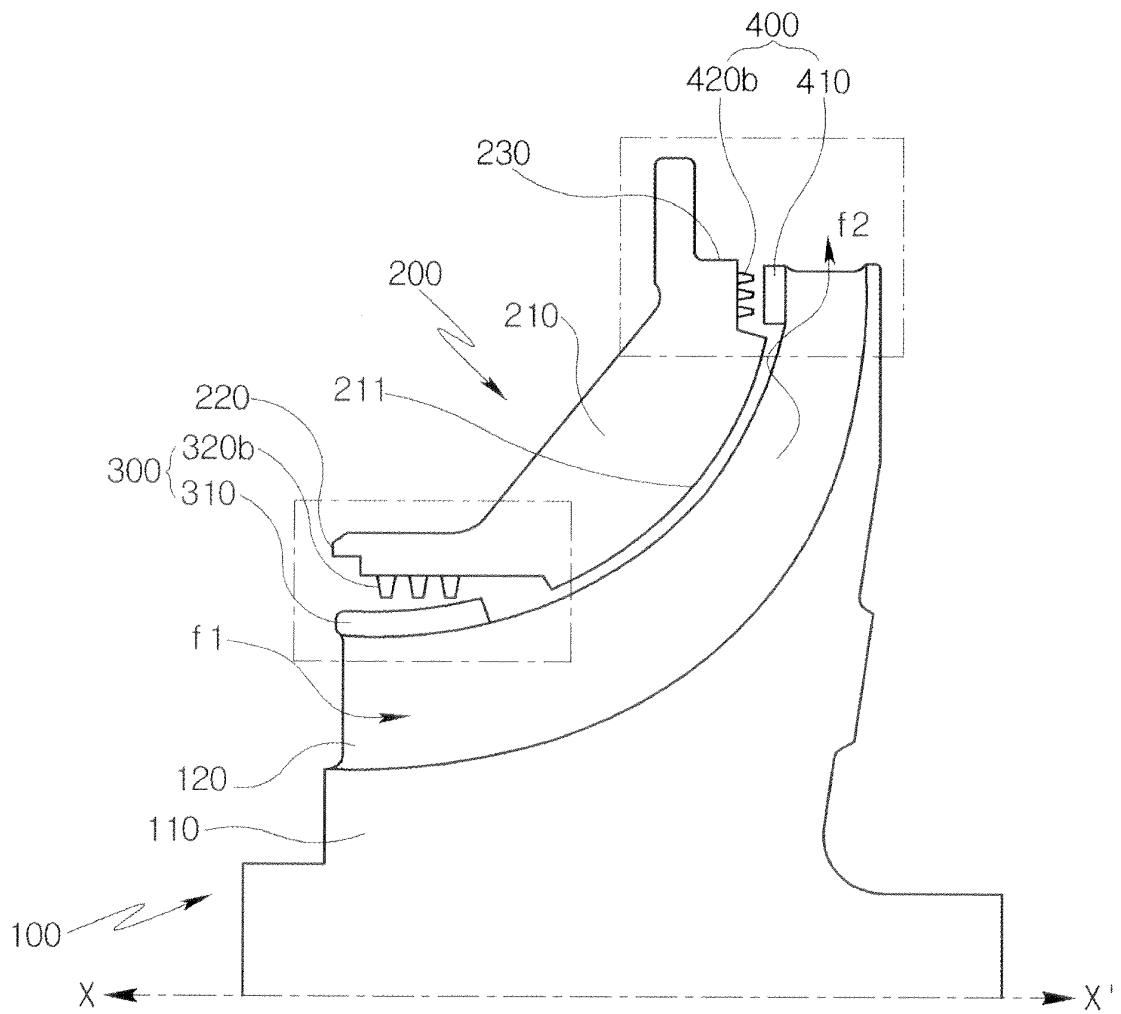


Fig.18



REFERENCES CITED IN THE DESCRIPTION

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