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(54) **TURBINE NOZZLE SUPPORT DEVICE AND STEAM TURBINE**

(57) A steam turbine includes a turbine casing, a turbine rotor disposed in the turbine casing, a plurality of turbine stages, a cylinder substantially coaxial with the turbine casing, and a fixing partition plate having an outer edge fixed to the turbine casing and an inner edge fixed to an outer circumferential portion of the cylinder. In a turbine nozzle support holder of such the steam turbine, the turbine stages each includes turbine movable blades

disposed circumferentially around the turbine rotor and turbine nozzles paired with the turbine movable blades and disposed upstream of the turbine movable blades. The turbine nozzles of the turbine stages are arranged inside the cylinder in an axial direction and are engaged with and fixed to the cylinder. The fixing partition plate is disposed downstream of the center of the cylinder in the axial direction to separate an upstream atmosphere and a downstream atmosphere.

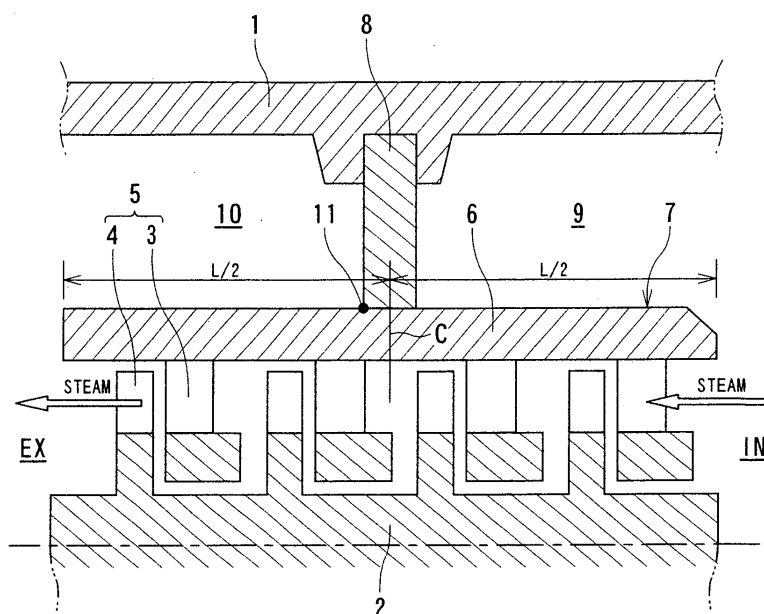


FIG. 1

Description

Technical Field

[0001] The present invention relates to a turbine nozzle (stationary blade) holder for a steam turbine and a steam turbine which include the holder, and particularly relates to a turbine nozzle holder having a structure for supporting the turbine nozzle and fixing a turbine casing.

Background Art

[0002] A steam turbine has turbine stages, each including turbine movable blades (turbine buckets) and turbine nozzles (stationary blades) paired with the turbine movable blades. The turbine movable blades are disposed circumferentially around a turbine rotor (rotating shaft) inside a turbine casing. The turbine nozzles are disposed upstream of the turbine movable blades in the circumferential direction of the turbine rotor.

[0003] The turbine nozzles (stationary blades) are held between inner and outer nozzle diaphragm rings. The outer nozzle diaphragm ring is supported by the turbine casing so as to fix the turbine nozzles inside the casing.

[0004] In addition, a support structure is used in which turbine nozzles of turbine pressure stages are supported by a single holder, called a turbine nozzle holder, which is supported by a turbine casing.

[0005] An example of a known turbine nozzle holder will be described hereunder with reference to Fig. 11.

[0006] Fig. 11 is a sectional view of the upper half part of the known turbine nozzle holder. In Fig. 11, a turbine nozzle holder 57 includes a cylinder 56 extending axially substantially in parallel with a turbine rotor 52 and a support flange 58 engaged with a turbine casing 51 to support the cylinder 56. An outer nozzle diaphragm ring, not shown, is engaged with grooves provided in an inner surface of the cylinder 56. The number of grooves corresponds to the number of nozzle plates 53 supported (four grooves in the example of Fig. 11). The cylinder 56 has a separate structure including two semicylindrical portions for ease of assembly. These semicylindrical portions are mechanically joined at joint portions, such as flanges, disposed along separate surfaces by means of bolts, for example.

[0007] The turbine nozzle holder 57 having the structure described above is engaged and supported at a relatively upstream position on the turbine casing 51 for easy assembling, for example, for easy positioning of the support flange 58 and the turbine casing 51.

[0008] A high-temperature, high-pressure steam passing through pressure stages 55 in the turbine nozzle holder 57 feeds a torque to movable blades 54 and flows toward the downstream side while decreasing in pressure and temperature. The upstream side of a space defined between the turbine casing 51 and the turbine nozzle holder 57 (outside the cylinder 56) is filled with the high-pressure steam to be supplied to the turbine stages

while the downstream side of the space is filled with the low-pressure steam that has lost its pressure after passing through all stages. The support flange 58 also serves as a pressure barrier to prevent communication between the steams with different pressures.

[0009] Fig. 12 shows pressure distribution inside and outside the turbine nozzle holder 57 and on the front and rear sides of the support flange 58. A curve indicated by the dotted line P1 represents the pressure distribution of the steam passing through the pressure stages inside the turbine nozzle holder 57. This curve shows that the pressure decreases gradually as the steam passes through the pressure stages. The solid line P2a represents the pressure of an atmosphere 59 upstream of the support flange 58, which also serves as a pressure barrier. The solid line P2b represents the pressure of an atmosphere 60 downstream of the support flange 58. The hatched parts (areas) represent pressures applied to the turbine nozzle holder 57 (cylinder 56) as a result of a pressure difference between the inside and outside of the turbine nozzle holder 57. In the hatched area A1, the pressure outside the cylinder 56 is larger than the pressure inside the cylinder 56, and thus, the cylinder 56 receives an external pressure. In the hatched area A2, on the other hand, the pressure inside the cylinder 56 is larger than the pressure outside the cylinder 56, and thus, the cylinder 56 receives an internal pressure. In this case, the turbine nozzle holder 57 is required to support a net internal pressure because the hatched area A2 is much larger than the hatched area A1.

[0010] An example of a steam turbine includes a turbine nozzle holder supported on a casing by a pressure difference between the upstream and downstream sides of the turbine nozzle holder (for example, see Japanese Unexamined Patent Application Publication No. 10-103009). According to this publication, the turbine nozzle holder is supported by fitting or engaging a rib protruding from an inner surface of the turbine casing to a groove provided on an outer circumferential portion of the turbine nozzle holder. A side surface of the groove of the turbine nozzle holder is pressed against and fixed to a side surface of the rib of the turbine casing by a thrust force resulting from a pressure difference between the front and rear sides of the rib.

[0011] With reference to Fig. 11, the turbine nozzle holder 57, specifically, the cylinder 56, involves several matters to be solved, including leakage of steam passing through the cylinder (i.e., through the stages).

[0012] As described above, the turbine nozzle holder 57 (cylinder 56) constantly supports an internal pressure. This pressure is generally supported by the fastening bolts attached to the joint portions (joint flanges) provided along the joint surfaces of the cylinder 56, which has a separate structure. During the operation of the steam turbine, the temperature of the fastening bolts reaches substantially the same temperature as that of the steam passing through the turbine stages. For the latest models of steam turbines, the steam temperature (entrance tem-

perature) reaches about 600°C. After extended operation, therefore, the fastening bolts undergo gradual creep deformation. Such fastening bolts fail to maintain the initial fastening force and thus cause steam leakage.

[0013] In addition, the turbine nozzle holder 57 becomes longer in the axial direction if the number of the turbine nozzles 53 supported by the turbine nozzle holder 57 is increased. In that case, a uniform fastening force is difficult to achieve over the entire joint surfaces of the cylinder 56 because of complicated factors, including the creep deformation of the fastening bolts, the thermal expansion and the deformation of the turbine nozzle holder 57 due to the temperature distribution thereof, the pressure distribution of the steam passing through the turbine stages 55, and the number of fastening bolts. As a result, the turbine nozzle holder 57 cannot avoid slight steam leakage.

[0014] One of the possible measures to avoid such leakage is to increase the diameter of the fastening bolts or the area of the joint portions (joint flanges) of the cylinder 56. Such measures, however, contribute to an increase in the size of the turbine nozzle holder 57 and thus to an increase in the volume of the turbine casing 51. This undesirably causes problems such as increases in the cost and installation area of the steam turbine.

[0015] Furthermore, many fastening bolts are firmly fixed only to the joint portions (joint flanges) of the cylinder 56, and thus, for example, deformation due to internal pressure and thermal expansion can be concentrated in the portions of the cylinder 56 other than the joint portions, that is, in less rigid portions. Such uneven deformation varies, for example, gaps between seal fins provided on a ground portion of the turbine casing 51, gaps between seal fins provided between the turbine nozzles 53 and the turbine rotor 52, and gaps between seal fins provided between the leading ends of the turbine movable blades 54 and the turbine nozzle holder 57. If the gaps are narrowed, rubbing (contact) occurs and the operation must be stopped. If, on the other hand, the gaps are widened, steam leakage occurs more significantly and the internal efficiency of the turbine decreases.

[0016] As described above, steam leakage due to the deformation of a turbine nozzle holder decreases the internal efficiency of the turbine. On the other hand, the above measures for preventing the steam leakage involve an increase in the size of the fastening bolts and cause a problem such as an increase in the size of a turbine casing engaged with the turbine nozzle holder.

Disclosure of The Invention

[0017] An object of the present invention is to eliminate the defects of the known art described above by providing a turbine nozzle holder having joint portions (joint flanges) closely fastened without depending on the fastening force of fastening bolts to reduce steam leakage and achieve uniform rigidity in a circumferential direction and by providing a steam turbine including the holder.

[0018] To achieve the above object, a turbine nozzle holder for a steam turbine according to the present invention which includes a turbine casing, a turbine rotor disposed in the turbine casing, a plurality of turbine stages, a cylinder substantially coaxial with the turbine casing, and a fixing partition plate having an outer edge fixed to the turbine casing and an inner edge fixed to an outer circumferential portion of the cylinder, wherein the turbine stages each includes turbine movable blades disposed circumferentially around the turbine rotor and turbine nozzles paired with the turbine movable blades and disposed upstream of the turbine movable blades. The turbine nozzles of the turbine stages are arranged inside the cylinder in an axial direction and are engaged with and fixed to the cylinder. The fixing partition is disposed downstream of the center of the cylinder in the axial direction to separate an upstream atmosphere and a downstream atmosphere with respect to the partition plate.

[0019] In the turbine nozzle holder for a steam turbine, the cylinder may be separated in two portions in the axial direction, and the turbine nozzle holder further includes joint flanges disposed along opposing separate surfaces and fastening bolts fastening the joint flanges.

[0020] The turbine nozzle holder may further include dummy flanges protruding from the outer circumferential portion of the cylinder in addition to the joint flanges disposed along the separate surfaces.

[0021] The dummy flanges may be preferably regularly arranged between the two joint flanges disposed on the cylinder. In particular, the dummy flanges are preferably regularly arranged at intervals of 45° or 60° between the two joint flanges disposed on the cylinder.

[0022] The dummy flanges preferably have substantially the same shape as the joint flanges.

[0023] The cylinder preferably may have a cross-sectional shape symmetrical with respect to the axis thereof.

[0024] To achieve the above object, additionally, there is also provided a steam turbine according to the present invention comprising a turbine casing, a turbine rotor disposed in the turbine casing, a plurality of turbine stages, a cylinder substantially coaxial with the turbine casing, and a fixing partition plate having an outer edge fixed to the turbine casing and an inner edge fixed to an outer circumferential portion of the cylinder, wherein the turbine stages each includes turbine movable blades disposed circumferentially around the turbine rotor and turbine nozzles paired with the turbine movable blades and disposed upstream of the turbine movable blades, the turbine nozzles of the turbine stages are arranged inside the cylinder in an axial direction and are engaged with and fixed to the cylinder, and the fixing partition plate is disposed downstream of the center of the cylinder in the axial direction to separate an upstream atmosphere and a downstream atmosphere with respect to the partition plate.

[0025] For the turbine nozzle holder and the steam turbine having the features described above according to the present invention, the size or number of fastening

bolts used to fasten the separate surfaces can be reduced, and the separate surfaces are firmly fastened by a steam pressure difference between the inside and outside of the turbine nozzle holder. The turbine nozzle holder and the steam turbine can therefore reduce leakage of steam passing through the stages to further enhance the internal efficiency of the turbine.

Brief Description of The Drawings

[0026]

Fig. 1 is a schematic partial sectional view of a turbine nozzle holder and a steam turbine according to a first embodiment of the present invention.

Fig. 2 is a graph showing pressure distribution inside and outside the turbine nozzle holder according to the first embodiment of the present invention.

Fig. 3A is a front vertical sectional view of a known turbine nozzle holder and steam turbine for comparison with the turbine nozzle holder and the steam turbine according to the present invention.

Fig. 3B is a front vertical sectional view of the turbine nozzle holder and the steam turbine according to the present invention.

Fig. 4 is a schematic sectional view of a turbine nozzle holder according to a modification of the first embodiment of the present invention.

Fig. 5 is a schematic sectional view of a turbine nozzle holder according to a second embodiment of the present invention.

Fig. 6 is a sectional view taken along line VI-VI of Fig. 5.

Fig. 7 is a sectional view of a turbine nozzle holder having no dummy flanges and a steam turbine.

Fig. 8 is a sectional view of a turbine nozzle holder having dummy flanges and a steam turbine.

Fig. 9 is a schematic sectional view of a turbine nozzle holder and a steam turbine according to a modification of the second embodiment of the present invention.

Fig. 10 is a schematic sectional view of a turbine nozzle holder and a steam turbine according to another modification of the second embodiment of the present invention.

Fig. 11 is a schematic partial sectional view of a known turbine nozzle holder and steam turbine.

Fig. 12 is a graph showing pressure distribution inside and outside the known turbine nozzle holder.

Fig. 13 is a schematic axial sectional view of a steam turbine according to the present invention, and a circled portion thereof corresponds to the view of Fig. 1 in an enlarged scale.

Best Mode for Embodying The Invention

[0027] A turbine nozzle holder and a steam turbine according to an embodiment of the present invention will

be described hereunder with reference to the accompanying drawings and the reference numerals used therein.

[0028] Fig. 13 is a schematic longitudinal sectional view of the steam turbine according to this embodiment.

5 The steam turbine generally includes three pressure sections of a high-pressure turbine, an intermediate pressure turbine, and a low-pressure turbine. Among the three pressure sections, Fig. 13 illustrates the high-pressure turbine section and the intermediate pressure turbine section. In Fig. 13, the high-pressure turbine and the intermediate pressure turbine are integrally provided inside a single turbine casing 1 among the pressure sections of the steam turbine. The high-pressure turbine and the intermediate pressure turbine each have turbine stages 10 15 20 25 30 35 40 45 50 55

[0029] In Fig. 13, reference numerals 1' to 14' denote the individual stages of the high-pressure turbine. A main steam flows in the order of the stages 1' to 14' to rotate the movable blades before being discharged. Reference numerals 15' to 22' denote the individual stages of the intermediate pressure turbine. A boiler, not shown, reheats the steam discharged from the high-pressure turbine, and the reheated steam flows in the order of the stages 15' to 22' to rotate the movable blades before being discharged.

[0030] The turbine nozzles 4 of, for example, the turbine stages of the intermediate pressure turbine are held between inner and outer nozzle diaphragm rings. The outer nozzle diaphragm ring is supported by the turbine casing 1 to fix the turbine nozzles inside the casing 1.

[0031] The high-pressure turbine has a support structure, particularly on the downstream side thereof, in which the turbine nozzles 4 of the turbine stages are supported by a single holder, called a turbine nozzle holder, which is supported by the turbine casing 1.

[0032] Fig. 1 is a schematic diagram of the turbine nozzle holder according to the first embodiment of the present invention, showing an enlarged view of the circled portion of the steam turbine shown in Fig. 13. Fig. 1 illustrates the upper half of the turbine nozzle holder and the steam turbine along a horizontal plane in the axial direction.

[0033] It should be noted in the description of embodiments of the present invention that terms relating to directions and positions, such as "upper", "lower", "left", and "right", are based on the drawings or the horizontal plane in the axial direction of the steam turbine.

[0034] As described with reference to Fig. 13, the steam turbine includes the pressure sections (generally, a high-pressure section, an intermediate pressure section, and/or a low-pressure section). These pressure sections each has the turbine stages 5 inside the turbine

casing 1, each including the turbine movable blades 4 and the turbine nozzles (stationary blades) 3 paired with the turbine movable blades 4. The turbine movable blades 4 are disposed circumferentially around the turbine rotor (rotating shaft) 2. The turbine nozzles are disposed upstream of the turbine movable blades 4 in the circumferential direction of the turbine rotor 2.

[0035] In Fig. 1, a turbine nozzle holder 7 according to this embodiment includes a cylinder 6 extending axially substantially in parallel with the turbine rotor 2 and a fixing partition 8 engaged with the turbine casing 1 so as to support the cylinder 6. The fixing partition 8 also serves to divide the atmosphere of a space defined between the turbine casing 1 and the cylinder 6 into an upstream atmosphere 9 and a downstream atmosphere 10. Grooves (not shown) for engagement with the turbine nozzles 3 are formed in an inner surface of the cylinder 6. The number of grooves corresponds to the number of the turbine nozzles 3 supported (four grooves in the example of Fig. 1).

[0036] A high-temperature and high-pressure steam passes through the stages 5 from the upstream side to the downstream side in the axial direction of the steam turbine (that is, in the direction from right (IN) to left (EX) in Fig. 1 and from 1' to 14' in Fig. 13). The movable blades convert the energy of the steam into rotational energy as the steam passes through the stages 5. The steam itself is discharged from the steam turbine with decreased pressure and temperature.

[0037] In the steam turbine having the structure described above according to this embodiment, as shown in Fig. 1, the fixing partition 8 is engaged with the turbine casing 1 so as to fix and support the turbine nozzle holder 7. The fixing partition 8 is positioned downstream of the central position C of the turbine nozzle holder 7 (cylinder 6) in the axial direction (a position corresponding to a length of $L/2$ where L is the full length of the turbine nozzle holder 7). More specifically, as shown in Fig. 1, a rear joint end 11 of a portion of the fixing partition 8 joined to the cylinder 6 on the downstream side is positioned downstream of the central position C of the turbine nozzle holder 7 (cylinder 6) in the axial direction.

[0038] Fig. 2 shows a graph representing internal and external steam pressures applied to the turbine nozzle holder 7 with the fixing partition 8 disposed at the position described above.

[0039] A curve indicated by the dotted line P1 represents the pressure distribution of the steam passing through the stages inside the turbine nozzle holder 7. This curve shows the fact that the pressure decreases gradually as the steam passes through the stages. The solid lines P2a and P2b represent the pressures of the upstream atmosphere 9 and the downstream atmosphere 10, respectively, separated by the fixing partition 8 (rear joint end 11) inside the space defined between the turbine casing 1 and the cylinder 6. The hatched portions represent pressures applied to the turbine nozzle holder 7 (cylinder 6) as a result of a pressure difference

between the inside and outside of the turbine nozzle holder 7.

[0040] In the hatched portion A1 on the upstream side of the fixing partition 8, more specifically, upstream side of the rear joint end 11, the pressure outside the cylinder 6, represented by the solid line P2a, is larger than the pressure inside the cylinder 6, represented by the dotted line. This means that the cylinder 6 receives an external pressure in this portion. In the hatched portion A2 on the downstream side of the fixing partition 8 (rear joint end 11), on the other hand, the pressure inside the cylinder 6, represented by the dotted line, is larger than the pressure outside the cylinder 6, represented by the solid line P2b. This means that the cylinder 6 receives an internal pressure in this portion. A comparison of the areas of the upstream hatched portions A1 and A2 reveals that the turbine nozzle holder 7 receives a net external pressure because the area of the upstream hatched portion A1 is larger than that of the downstream hatched portion A2.

[0041] The net external pressure applied to the turbine nozzle holder 7 eliminates the need to use fasteners, such as bolts, for fastening the separate structure of the turbine nozzle holder 7 if the separate surfaces are accurately aligned.

[0042] The embodiment based on the mechanism described above is specifically illustrated in Fig. 3B, where the cylinder 6 of the turbine nozzle holder 7 is separated in two parts along a horizontal plane HL in the axial direction. This structure does not require, for example, flanges or fastening bolts.

[0043] Fig. 3A illustrates a known turbine nozzle holder 57 including a cylinder 56 having the same diameter as that of the cylinder 6 of the turbine nozzle holder 7 according to this embodiment. The cylinder 56 has joint flanges 63a and 63b and fastening bolts 64 along the horizontal separating plane HL. A comparison of the turbine nozzle holders 7 and 57 clearly shows that the turbine casing 51 requires a diameter larger than the turbine casing 1 according to this embodiment because the turbine casing 51 accommodates the joint flanges 63a and 63b and the fastening bolts 64.

[0044] That is, the external pressure is smaller than the internal pressure in the example of Fig. 3A, while the external pressure is larger than the internal pressure in the example of Fig. 3B.

[0045] According to this embodiment, as described above, the rear joint end 11 of the fixing partition 8 is positioned on the downstream side of the central position C of the turbine nozzle holder 7 in the axial direction so that the external pressure applied to the turbine nozzle holder 7 is larger than the internal pressure applied thereto. This structure eliminates the need to use flanges or fastening bolts for the separate structure of the turbine nozzle holder and, because of no fastening bolts used, prevents steam leakage from the separate surfaces due to the creep deformation of bolts after extended exposure to elevated temperature. The steam turbine can therefore constantly maintain the high internal efficiency over an

extended period of time.

[0046] In this embodiment, the cylinder 6 of the turbine nozzle holder 7 has a separate structure, that is, separated in two parts along the horizontal plane HL in the axial direction, and no flanges or fastening bolts are provided along the separate surfaces. As shown in Fig. 2, the external-pressure region (the length of the portion of the cylinder 6 upstream of the rear joint end 11) does not necessarily have a sufficient area. Hence, steam leakage may be possible from the separate surfaces of the cylinder 6 on the downstream side of the rear joint end 11, at which the cylinder 6 receives an internal pressure, depending on steam conditions. Accordingly, a combination of joint flanges and fastening bolts may be optionally used to prevent leakage as in the known art. In addition, fixed joint flanges may be coupled to each other with fastening bolts so as to prevent the misalignment of the separate surfaces of the cylinder 6 due to, for example, the steam vibration. In that case, the sizes, diameters, and numbers of joint flanges and the fastening bolts used may be reduced relative to those of the known art.

[0047] Fig. 4 is a schematic sectional view of a turbine nozzle holder and a steam turbine according to a modification of the first embodiment of the present invention, in which the same components as those used in the first embodiment are indicated by the same reference numerals.

[0048] In Fig. 4, the fixing partition 8 is engaged with the turbine casing 1 to fix and support the turbine nozzle holder 7. In this modification, the fixing partition 8 is largely shifted from the central position C of the turbine nozzle holder 7 (cylinder 6) in the axial direction (i.e., a position corresponding to a length of $L/2$ where L is the full length of the turbine nozzle holder 7) to the downstream side (to the left in Fig. 4, for example, to a position corresponding to a length of $3L/4$ where L is the full length of the turbine nozzle holder 7).

[0049] If the fixing partition 8 is disposed at such a position, the area of the hatched portion A1 on the upstream side of the fixing partition 8 (rear joint end 11) in Fig. 2 is significantly increased, and the area of the downstream hatched portion A2 is decreased accordingly. As a result, the turbine nozzle holder 7 receives a net external pressure larger than that of the first embodiment. As in the first embodiment, therefore, the net external pressure eliminates the need to use joint flanges or fastening bolts for preventing the leakage.

[0050] According to this modification, as described above, the rear joint end 11 of the fixing partition 8 is largely shifted from the central position C of the turbine nozzle holder 7 in the axial direction to the downstream side so that the external pressure applied to the turbine nozzle holder 7 is larger than the internal pressure applied thereto. This structure eliminates the need to use flanges or fastening bolts for the separate structure of the turbine nozzle holder and, because of no fastening bolts used, reduces the steam leakage from the separate surfaces due to the creep deformation of the bolts after

the extended exposure to elevated temperature. The steam turbine can therefore constantly maintain high internal efficiency over an extended period of time.

[0051] The position of the fixing partition 8 relative to the turbine nozzle holder 7 is specifically determined according to, for example, the steam conditions and operating conditions of the steam turbine used and the number of turbine nozzles supported by the turbine nozzle holder 7.

[0052] In this modification, as in the first embodiment, joint flanges and fastening bolts may be used to prevent misalignment of the separate surfaces due to, for example, the steam vibration.

[0053] Figs. 5 and 6 are sectional views of a turbine nozzle holder and a steam turbine according to a second embodiment of the present invention.

[0054] In the second embodiment, the turbine nozzles 3 are engaged with and supported by the cylinder 6, and the turbine nozzle holder 7 has joint flanges 13a and 13b and dummy flanges 15 disposed on the outer circumferential portion of the cylinder 6 along the separate surfaces thereof.

[0055] Figs. 7 and 8 are views for explaining the effect of the dummy flange 15 of the steam turbine, graphically showing the amount of deformation. Fig. 7 is a sectional view of a known steam turbine including a turbine nozzle holder having no dummy flanges. Fig. 8 is a sectional view of the steam turbine including the turbine nozzle holder 7 having the dummy flanges according to the second embodiment. The cylinder 6 shown in Fig. 8 has the same diameter as that shown in Fig. 7.

[0056] For the known steam turbine shown in Fig. 7, the joint flanges 13a and 13b are firmly fastened with the fastening bolts 14. For example, an internal pressure tends to expand the cylinder 6 by exerting a uniform force on the entire cylinder 6 in directions in which the diameter thereof uniformly increases, that is, perpendicularly to the inner circumferential surface of the cylinder 6. However, the joint flanges 13a and 13b restrain deformation of the cylinder 6 in the direction along the joint surfaces (HL line). Portions of the cylinder 6 around the joint flanges 13a and 13b have a rigidity higher than other portions because of the thickness of the joint flanges and the fastening force of the fastening bolts. Accordingly, the internal pressure deforms a less rigid portion more significantly, for example, in the vertical direction of Fig. 7. As a result, the entire cylinder 6 can be deformed to an oval shape.

[0057] According to the embodiment of the present invention shown in Fig. 8, the dummy flanges 15, which have substantially the same shape as the joint flanges 13a and 13b, are provided on the less rigid portion to ensure the rigidity thereof, thus realizing the substantially uniform amount of deformation.

[0058] That is, the cylinder 6 shown in Fig. 7 is less rigid and more susceptible to the deformation in the vertical direction and is more rigid and less susceptible to the deformation in the horizontal direction, as indicated

by the bidirectional arrows. In contrast, the cylinder 6 shown in Fig. 8 is more rigid and less susceptible to the deformation in both directions.

[0059] This embodiment is based on the phenomenon mentioned above, and as shown in Fig. 6, specifically, the cylinder 6 is separated along the horizontal plane HL in the axial direction, and the joint flanges 13a and 13b and the fastening bolts 14 are provided along the separate surfaces. In addition, the dummy flanges 15 are provided at the positions farthest away from the joint flanges 13a and 13b so as to further enhance the rigidity of the turbine nozzle holder 7 (cylinder 6).

[0060] The turbine nozzle holder 7 including the cylinder 6 having the dummy flanges 15 can be used for a steam turbine, as shown in Fig. 5. Gaps 16a between seal fins 16 disposed at the leading ends of the movable blades 4 and gaps 17a between seal fins 17 disposed inside the turbine nozzles 4 can be uniformly maintained irrespective of the operating conditions of the steam turbine (the extent of variations in pressure difference between the inside and outside of the turbine nozzle holder).

[0061] According to this embodiment, as described above, the turbine nozzle holder 7 has the dummy flanges 15 in addition to the joint flanges 13a and 13b to achieve and realize the rigidity sufficient to substantially uniformly maintain the distances of the gaps 16a between the seal fins 16 disposed at the leading ends of the movable blades 4 and the gaps 17a between the seal fins 17 disposed inside the turbine nozzles 3. The turbine nozzle holder 7 can therefore reduce the steam leakage through the seal fins 16 of the movable blades 4 and the seal fins 17 of the turbine nozzles 3 to enhance the internal efficiency of the turbine.

[0062] Although it is preferred that the dummy flanges 15 have substantially the same shape as the joint flanges 13a and 13b, as described above, the dummy flanges 15 may have any other shape that allows the cylinder 6 to be deformed uniformly. Such a shape may be determined by analyzing the deformation of the turbine nozzle holder 7 (cylinder 6). In addition, the dummy flanges 15 are not necessarily provided over the full length of the turbine nozzle holder 7 (cylinder 6) in the axial direction, and may be only partially provided thereon with consideration given to the amount of the deformation in the longitudinal direction.

[0063] Although the turbine nozzle holder 7 (cylinder 6) is separated along the horizontal plane HL in the axial direction with the joint flanges 13a and 13b disposed along the separate surfaces in this embodiment, the turbine nozzle holder 7 (cylinder 6) may also be separated along a vertical plane (perpendicular to the horizontal plane in the axial direction).

[0064] Figs. 9 and 10 are schematic views of turbine nozzle holders and steam turbines according to modifications of the second embodiment of the present invention.

[0065] In the modification shown in Fig. 9, the turbine nozzle holder 7 includes the joint flanges 13a and 13b

and the fastening bolts 14 along the separate surfaces in the horizontal plane HL in the axial direction and dummy flanges 15a, 15b, 15c, ... regularly arranged at intervals of 45° from the horizontal plane HL.

[0066] In this modification, as described above, the turbine nozzle holder 7 includes the dummy flanges 15a, 15b, 15c, ... in addition to the joint flanges 13a and 13b and the fastening bolts 14. The dummy flanges 15a, 15b, 15c, ... are regularly arranged at intervals of 45° from the horizontal plane HL to further reduce the amount of the deformation due to, for example, a pressure difference between the inside and outside of the turbine nozzle holder 7. The turbine nozzle holder 7 can therefore inhibit the steam leakage through, for example, the seal fins of the movable blades and the turbine nozzles so that the steam turbine can maintain high internal efficiency.

[0067] In Fig. 10, on the other hand, the turbine nozzle holder 7 is separated along a vertical cross section VL in the axial direction. The joint flanges 13a and 13b and the fastening bolts 14 are disposed along the separate surfaces of the turbine nozzle holder 7. The dummy flanges 15a, 15b, 15c, ... are regularly arranged at intervals of 60° from the vertical cross section VL.

[0068] In these modifications, any other structure may be used in which the dummy flanges 15a, 15b, 15c ... are arranged so that the entire cross-sectional shape of the turbine nozzle holder 7 (cylinder 6) is symmetrical with respect to the axis of the cylinder 6.

[0069] The same advantages as those attained by the embodiments described hereinbefore can also be achieved in these modifications. The present invention is not limited to the embodiments described above, and other embodiments and modifications may be permitted without departing from the scopes of the appended claims.

Claims

1. A turbine nozzle holder for a steam turbine which comprises: a turbine casing; a turbine rotor disposed in the turbine casing; a plurality of turbine stages, each including turbine movable blades disposed circumferentially around the turbine rotor and turbine nozzles paired with the turbine movable blades and disposed on an upstream side of the turbine movable blades; a cylinder substantially coaxial with the turbine casing, the turbine nozzles of the turbine stages being arranged inside the cylinder in an axial direction and being engaged with and fixed to the cylinder; and a fixing partition plate having an outer edge fixed to the turbine casing and an inner edge fixed to an outer circumferential portion of the cylinder, wherein the fixing partition plate is disposed on a downstream side of the center of the cylinder in the axial direction so as to separate an upstream atmosphere and a downstream atmosphere with respect to the fixing partition plate.

2. The turbine nozzle holder according to claim 1, wherein the cylinder is separated in two portions in the axial direction.
3. The turbine nozzle holder according to claim 1, wherein the cylinder is separated in two portions in the axial direction, and the turbine nozzle holder further includes joint flanges disposed along opposing separate surfaces and fastening bolts fastening the joint flanges.
4. The turbine nozzle holder according to claim 3, further comprising dummy flanges protruding from the outer circumferential portion of the cylinder in addition to the joint flanges disposed along the separate surfaces.
5. The turbine nozzle holder according to claim 4, wherein the dummy flanges are regularly arranged between the two joint flanges disposed on the cylinder.
6. The turbine nozzle holder according to claim 5, wherein the dummy flanges are regularly arranged at intervals of 45° between the two joint flanges disposed on the cylinder.
7. The turbine nozzle holder according to claim 5, wherein the dummy flanges are regularly arranged at intervals of 60° between the two joint flanges disposed on the cylinder.
8. The turbine nozzle holder according to claim 4, wherein the dummy flanges have substantially the same shape as that of the joint flanges.
9. The turbine nozzle holder according to claim 8, wherein the cylinder has a cross-sectional shape symmetrical with respect to the axis thereof.
10. A steam turbine comprising:
 - a turbine casing;
 - a turbine rotor disposed in the turbine casing;
 - a plurality of turbine stages, each including turbine movable blades disposed circumferentially around the turbine rotor and turbine nozzles paired with the turbine movable blades and disposed upstream of the turbine movable blades;
 - a cylinder substantially coaxial with the turbine casing, the turbine nozzles of the turbine stages being arranged inside the cylinder in an axial direction and being engaged with and fixed to the cylinder; and
 - a fixing partition plate having an outer edge fixed to the turbine casing and an inner edge fixed to an outer circumferential portion of the cylinder, the fixing partition plate being disposed down-

stream of the center of the cylinder in the axial direction to separate an upstream atmosphere and a downstream atmosphere with respect to the fixing partition plate.

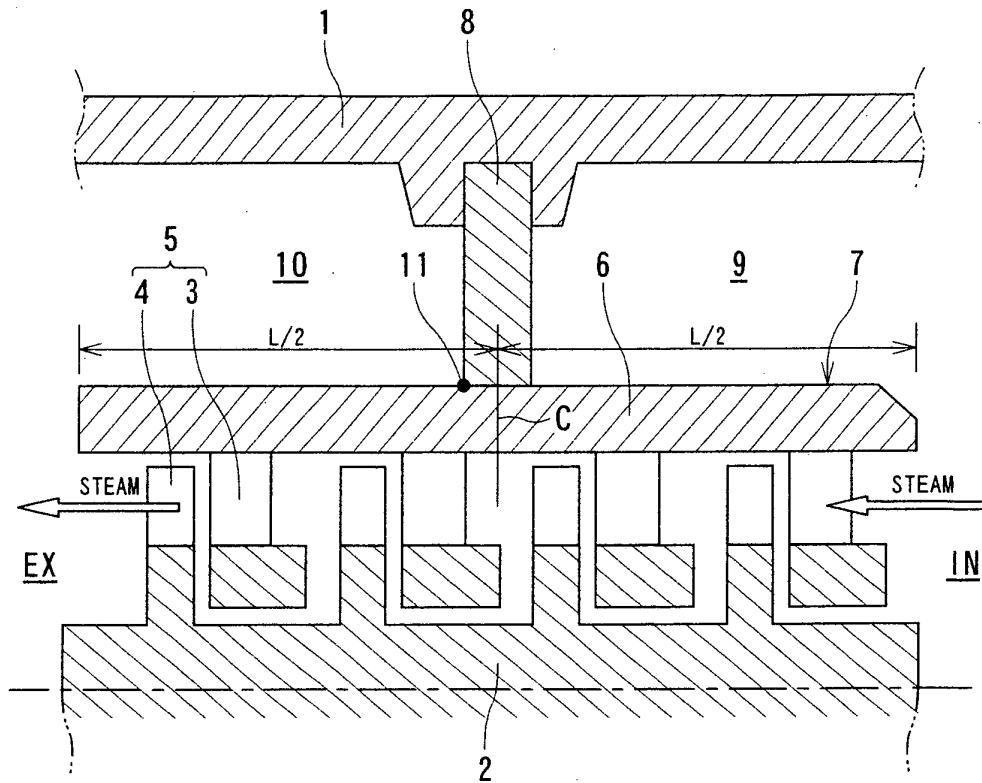


FIG. 1

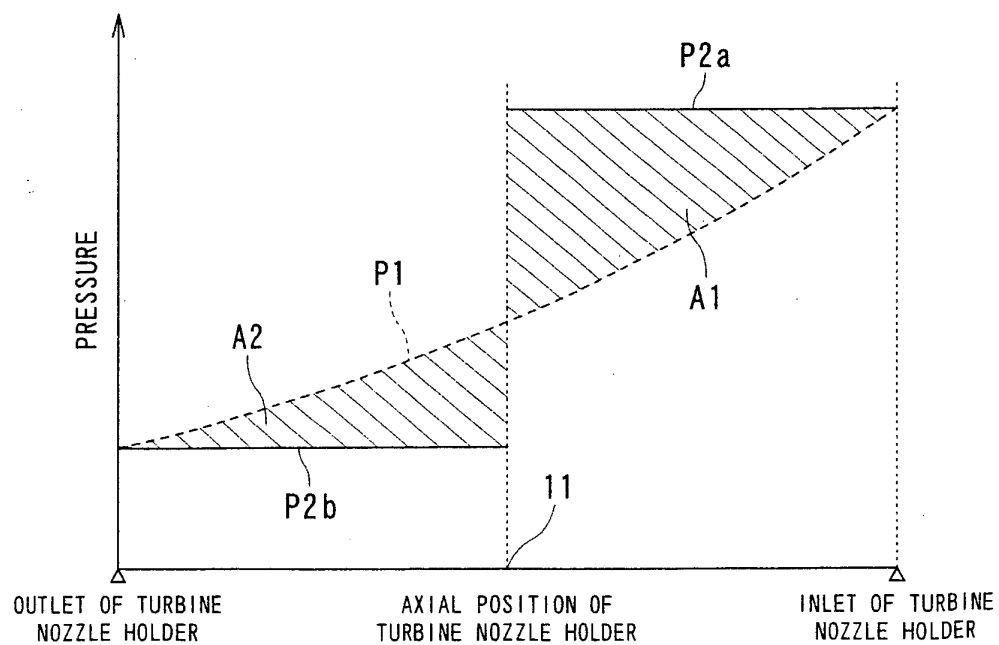


FIG. 2

FIG. 3A

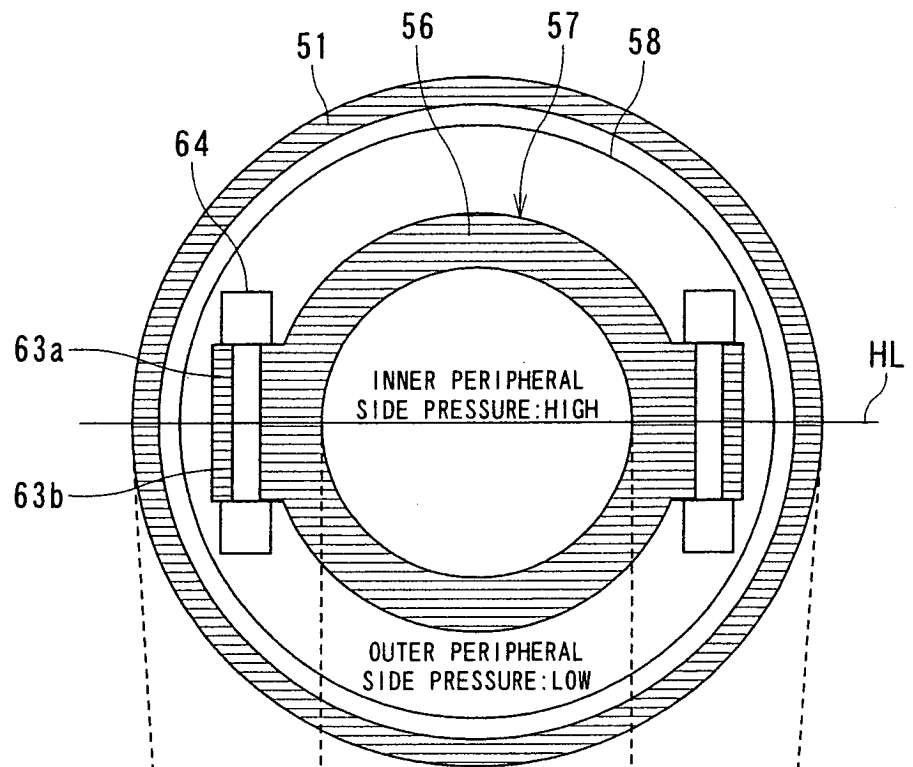
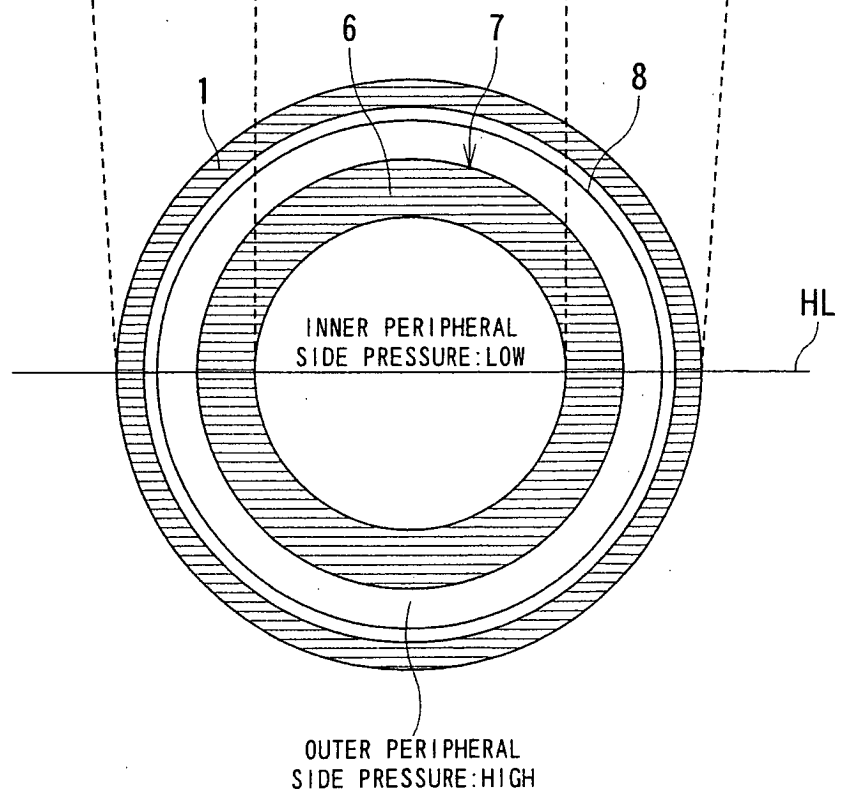


FIG. 3B



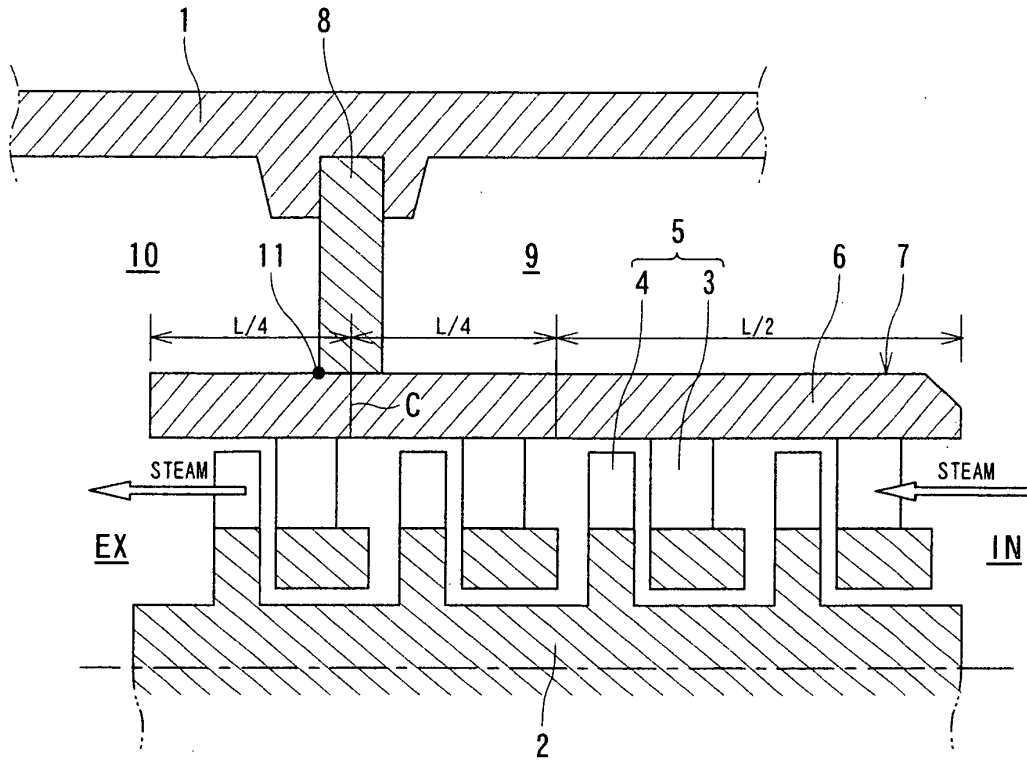


FIG. 4

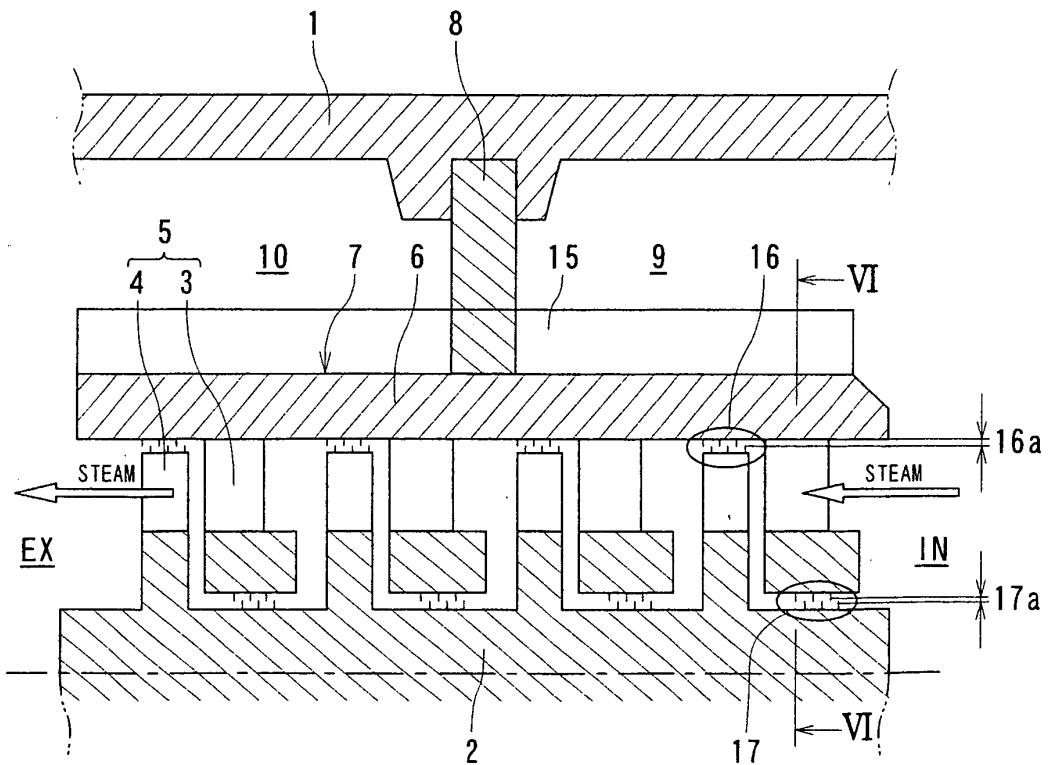


FIG. 5

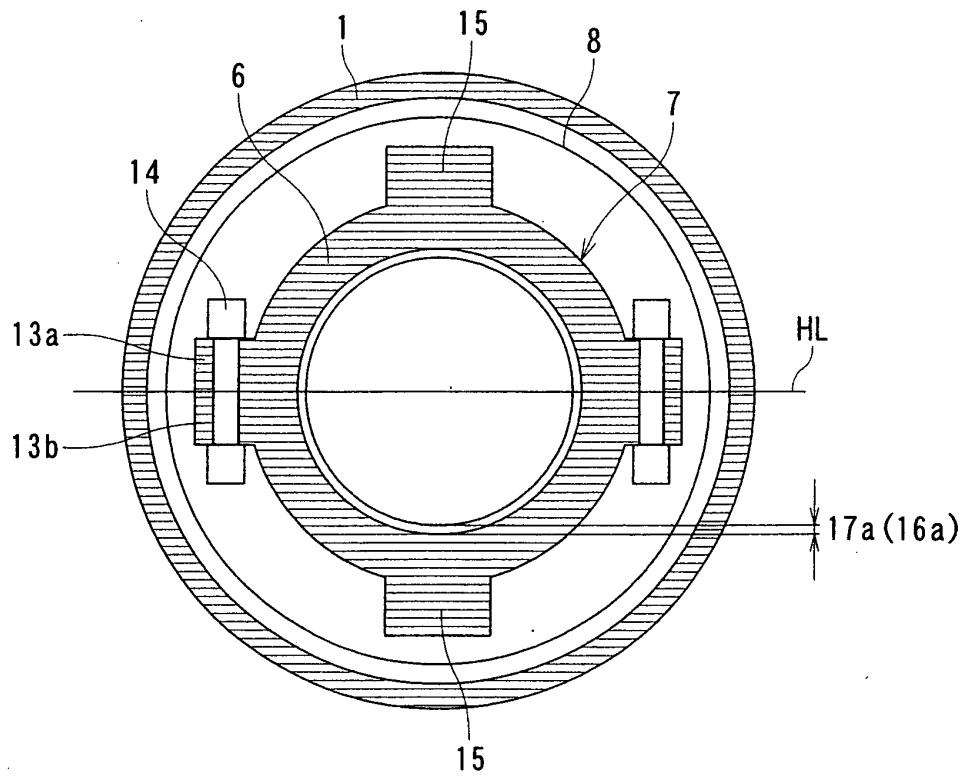


FIG. 6

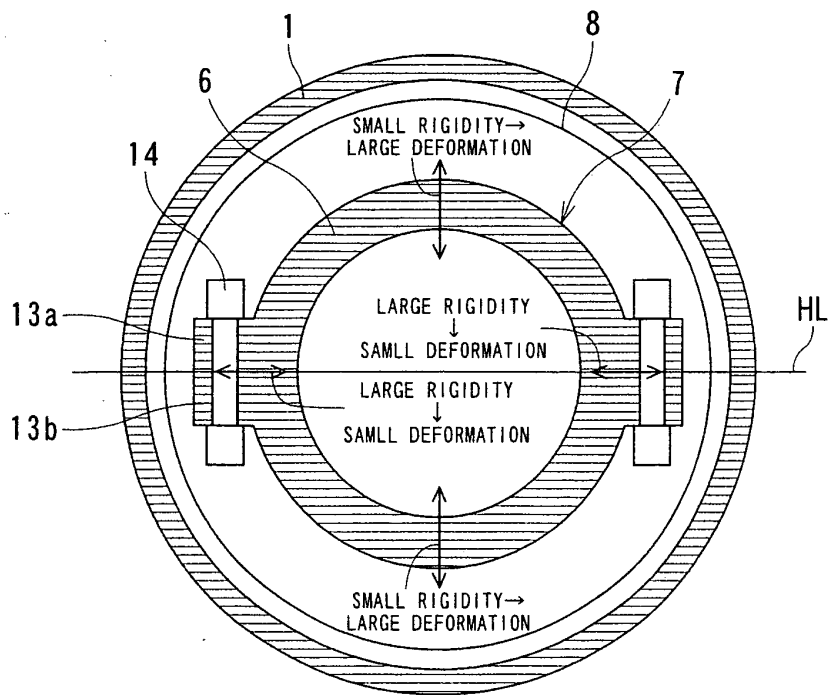


FIG. 7

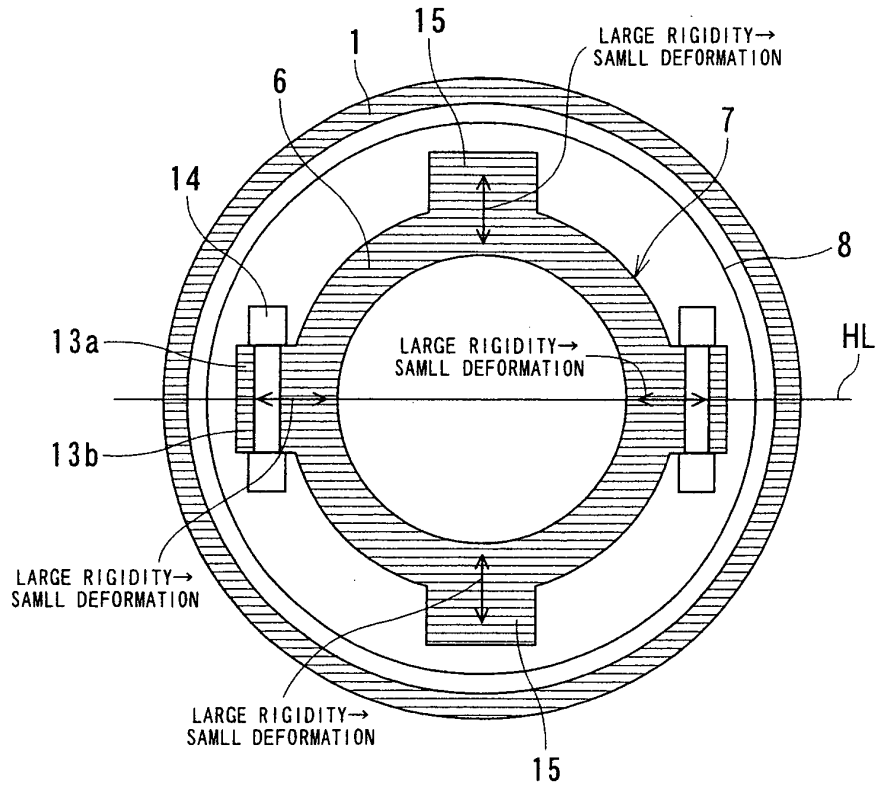


FIG. 8

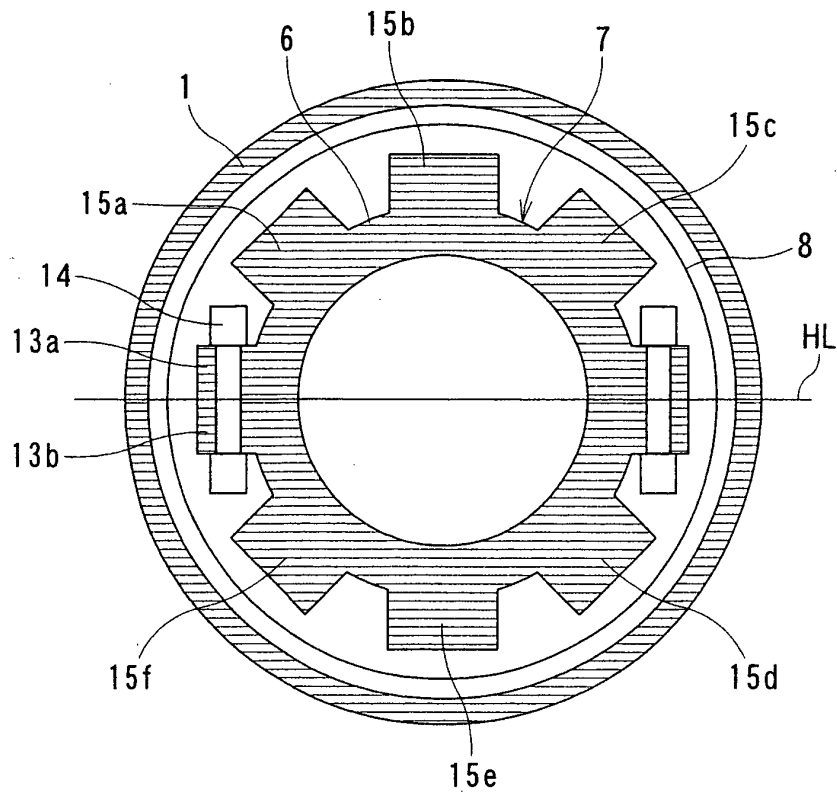


FIG. 9

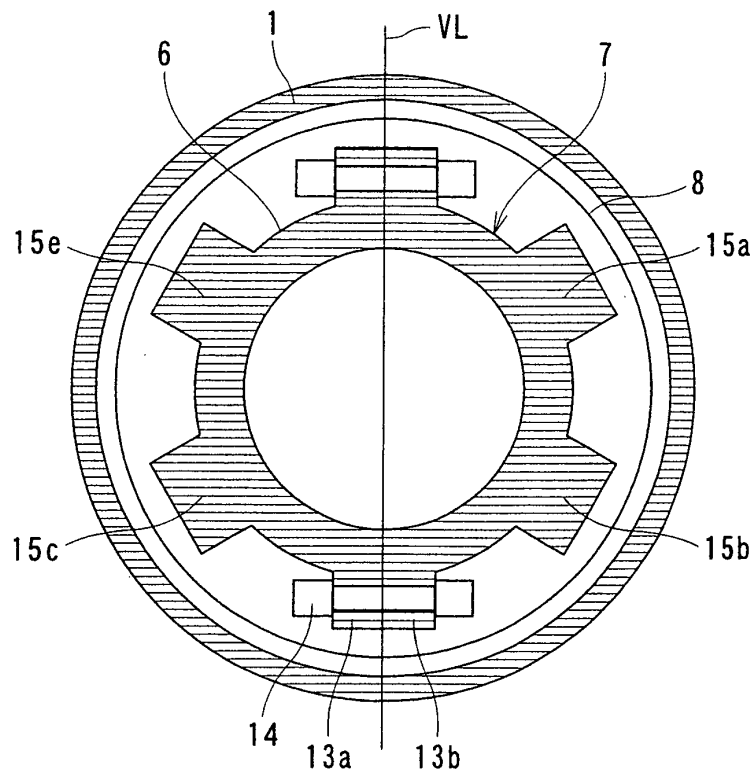


FIG. 10

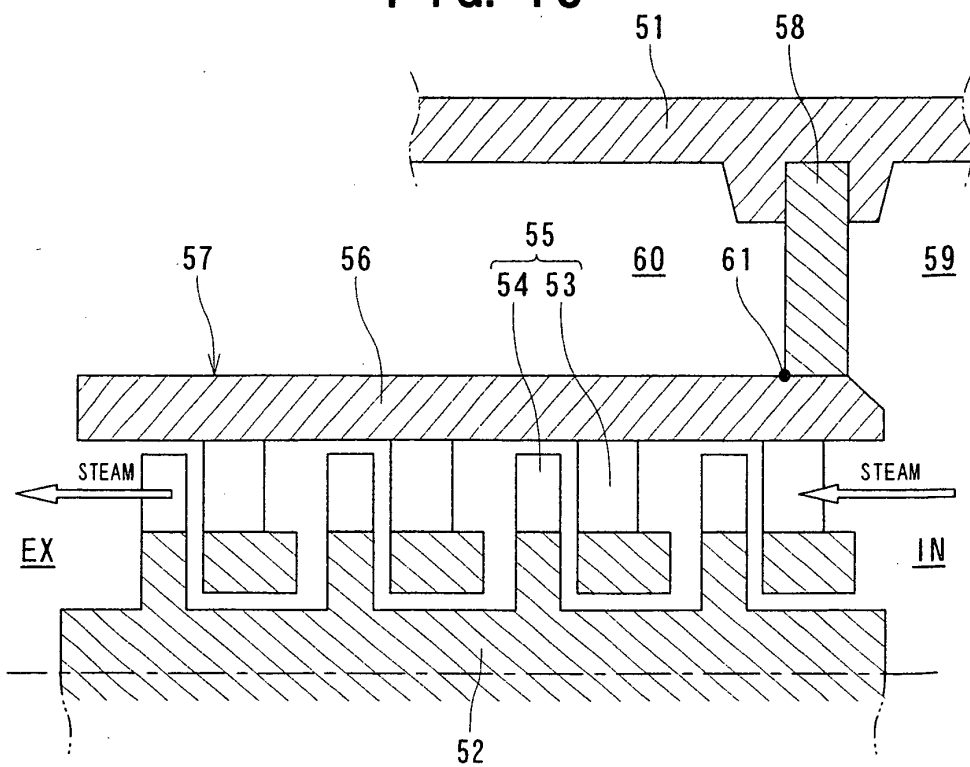


FIG. 11

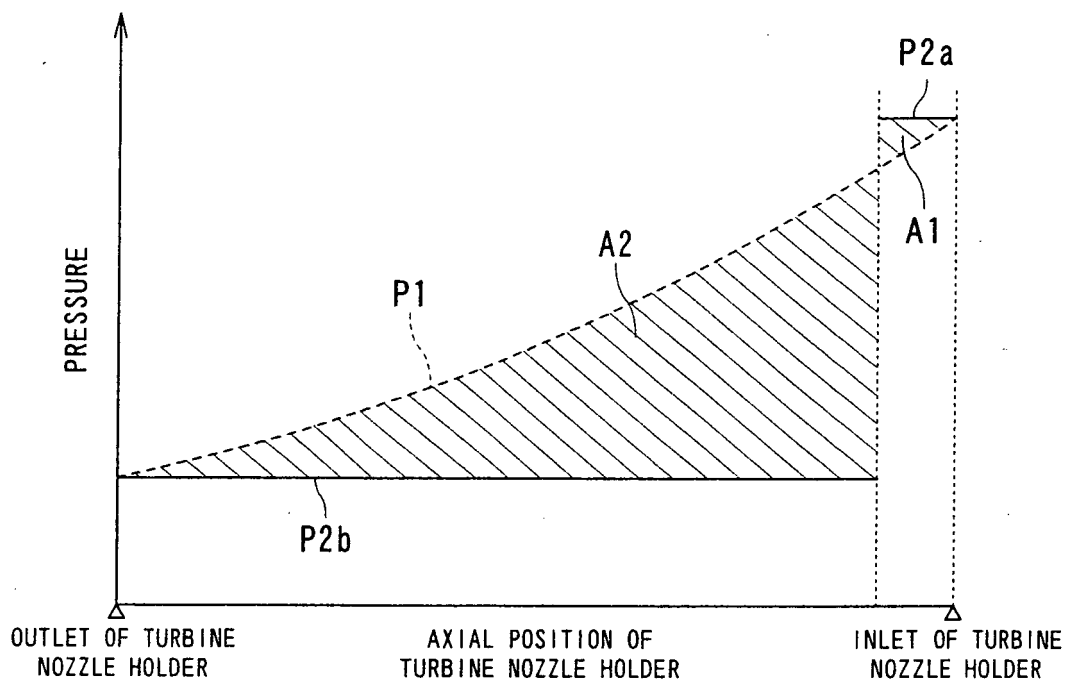
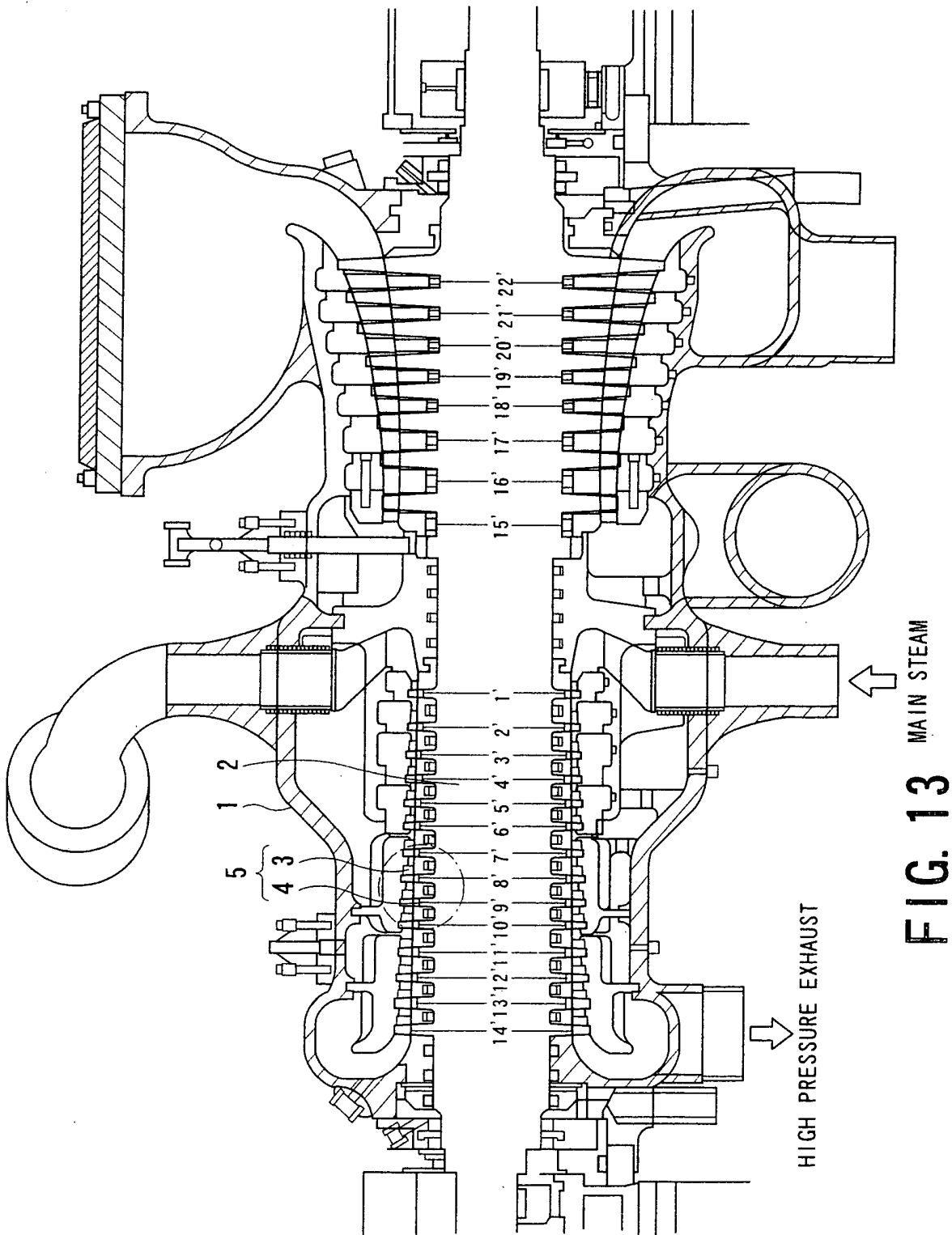


FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/011908

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F01D25/24, 9/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ F01D25/24, 9/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005 Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 9-195712 A (Mitsubishi Heavy Industries, Ltd.), 29 July, 1997 (29.07.97), Fig. 3 (Family: none)	1, 10 2-9
Y	WO 1999/051857 A (Siemens AG.), 14 October, 1999 (14.10.99), Fig. 4 & JP 2002-510768 A & US 6607352 B1	2-9
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 05 August, 2005 (05.08.05)		Date of mailing of the international search report 23 August, 2005 (23.08.05)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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