

## MARINE STEAM TURBINE MODULE STRUCTURE

### TECHNICAL FIELD

[0001] The present disclosure relates to a marine steam turbine module structure  
5 including a steam turbine, a generator, and a condenser.

### BACKGROUND ART

[0002] Main components necessary for a power generation facility using a steam turbine includes, for instance, a steam turbine, a generator, and a condenser. For installation of these  
10 components, generally, the steam turbine and the generator are disposed on a common base, and the condenser is disposed below the steam turbine. For instance, the condenser is independently arranged below a steam turbine floor.

[0003] Such a steam turbine power generator is typically mounted on a LNP (liquefied Natural Gas) carrier or a container ship and is installed in an engine room by the above layout.

[0004] On the other hand, in recent years, there is an increasing demand for mounting the  
15 steam turbine power generator on a deck of a ship. Although depending on the type of ships, many apparatuses are generally mounted on the deck of a ship. Thus, installment of the steam turbine power generator facility needs to be simplified, as well as the other apparatuses, to be mounted on the deck of a ship.

[0005] In the steam turbine power generator in a conventional land power generation  
20 plant, a technique for packaging a steam turbine power generation facility and a boiler is suggested to reduce an installation space (refer to Patent Document 1). In the power generation plant disclosed in Patent Document 1, the steam turbine power generation facility (steam turbine, generator, condenser) is disposed on an upper part of a base made of a  
25 structural steel plate reinforced with a steel frame, and the boiler is disposed on a lower part of the base made of a structural steel plate in a packaged manner.

### Citation List

Patent Literature

[0006]

Patent Document 1: JP2003-106110A

5 SUMMARY

Problems to be Solved

[0007] However, in the power generation plant disclosed in Patent Document 1, the steam turbine and the condenser are disposed on the upper part of the base made of a structural steel plate. Accordingly, this technique cannot be adopted to a downward exhaust type steam turbine commonly used in a marine steam turbine. Moreover, in the power generation plant disclosed in Patent Document 1, the boiler is disposed on the lower part of the base made of a structural steel plate. Unfortunately, in the marine steam turbine power generation facility, the boiler is often disposed in a different position from the steam turbine facility disposed on the deck; thus, the power generation plant disclosed in Patent Document 1 cannot be adopted to this kind of power generation plant.

[0008] The present invention was made under the above conditions in the related art, and an object of at least one embodiment of the present invention is to provide a marine steam turbine module structure which simplifies installation on a deck of a ship of a steam turbine power generation facility.

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Solution to the Problems

[0009] (1) A marine steam turbine module structure according at least one embodiment of the present invention is a marine steam turbine module structure mounted on a deck of a ship, the structure comprising: a steam turbine; a generator driven by the steam turbine; a condenser for condensing steam discharged downward from the steam turbine; and a base on which the steam turbine, the generator, and the condenser are disposed, wherein the base has a two-floor structure including an upper plate and a lower plate, and wherein the steam turbine and the generator are disposed on the upper plate, and the condenser is disposed on the lower

plate so that the steam turbine, the generator, the condenser, and the base are modularized.

[0010] In the marine steam turbine module structure described in the above (1), the steam turbine and the generator are disposed on the upper plate of the base with a two-floor structure, and the condenser is disposed on the lower plate of the base. When the steam turbine and the generator are disposed on the upper plate of the base, a connection structure between the steam turbine and the generator can be simplified; and when the condenser is disposed on the lower plate of the base, steam discharged below the steam turbine can be condensed by the condenser. Thereby, it is possible to put the steam turbine, the generator, and the condenser, which are main components of the steam turbine power generation facility, into the single base to be modularized as the steam turbine power generation facility. Thus, it is possible to achieve the marine steam turbine module structure which simplifies installation on the deck of the ship of the steam turbine power generation facility.

[0011] (2) In some embodiments, in the marine steam turbine module structure described in the above (1), the condenser is disposed on the lower plate so that a longitudinal direction of the condenser follows an axial direction of the steam turbine.

[0012] In the embodiment described in the above (2), it is possible to reduce an installation area of the base in a plan view, compared with a case where the condenser is disposed so that the longitudinal direction of the condenser is perpendicular to the axial direction of the steam turbine. Thus, it is possible to reduce an installation space of the marine steam turbine facility installed on the deck of the ship.

[0013] (3) In some embodiments, in the marine steam turbine module structure described in the above (2), the generator is disposed on the upper plate so that an axial direction of a rotational shaft of the generator is parallel to the axial direction of the steam turbine, and a body of the steam turbine is disposed in a first-side region, and a body of the generator is disposed in a second-side region, where the first-side region is on a first side, and the second-side region is on an opposite second side of a line which passes through a central position of the upper plate in the axial direction of the steam turbine and which is perpendicular to the axial direction of the steam turbine.

[0014] In the embodiment described in the above (3), in a plan view, the generator is oriented along the longitudinal direction of the steam turbine. Thus, it is possible to reduce a width between an end of the steam turbine on a first side in the transverse direction and an end of the generator on a second side in the transverse direction. Although the steam turbine and the generator are heavy, when the body of the steam turbine is disposed in the first-side region of the line passing through the central position of the upper plate while the generator is disposed in the second-side region, it becomes easy to balance the weight of the steam turbine and the generator across the central position of the upper plate. Thus, it is possible to bring the center of gravity of the entire marine steam turbine module structure closer to the central position of the upper plate in a plan view, and it is possible to improve installment performance when the marine steam turbine module structure is lifted and mounted on the deck of the ship.

[0015] (4) In some embodiments, in the marine steam turbine module structure described in the above (3), a turbine shaft of the steam turbine and the rotational shaft of the generator are coupled via a speed-reduction device, and a combined center of gravity obtained by combining respective centers of gravity of the steam turbine, the generator, and the speed-reduction device is located in the second-side region (E2).

[0016] The body of the condenser is disposed below the body of the steam turbine. Accordingly, the center of gravity on the lower plate side of the base is located in the first-side region where the body of the steam turbine is disposed, with respect to the central position of the upper plate. For this reason, if the combined center on the upper plate side is located in the first-side region, the center of gravity of the entire marine steam turbine module structure is biased on the first side with respect to the central position of the upper plate, in association with the center of gravity of the condenser. In view of this, when the combined center of gravity on the upper plate side is located in the second-side region as in the embodiment described in the above (4), it is possible to prevent loss of weight balance of the entire marine steam turbine module structure.

[0017] (5) In some embodiments, the marine steam turbine module structure described in

any one of the above (2) to (4) further comprises a steam inlet duct for introducing steam discharged from a steam discharge port of the steam turbine to a steam inlet of the condenser, wherein an inlet of the steam inlet duct has a shape with a longitudinal direction perpendicular to the axial direction of the steam turbine, and wherein an outlet of the steam inlet duct has a circular shape.

[0018] In the embodiment described in the above (5), when the steam discharge port of the steam turbine extends perpendicular to the axial direction of the steam turbine, the longitudinal direction of the outlet of the steam inlet duct coincides with that of the steam discharge port of the steam turbine. This enables the steam discharged from the steam discharge port to smoothly flow into the inlet of the steam inlet duct. Further, when the outlet of the steam inlet duct is circular, it is possible to improve workability when the outlet is connected to a connection duct to the condenser.

[0019] (6) In some embodiments, the marine steam turbine module structure described in the above (5) further comprises a connection duct connecting the outlet of the steam inlet duct to the steam inlet of the condenser, wherein the connection duct is expandable in an axial direction and in a radial direction of the connection duct.

[0020] The temperature of the steam discharged from the steam turbine varies depending on operation conditions of the steam turbine. Further, the steam turbine can vibrate depending on operation conditions of the steam turbine. In view of this, in the embodiment described in the above (6), the connection duct which is expandable in the axial direction and in the radial direction is disposed between the steam inlet duct and the condenser. Thereby, it is possible to absorb expansion and contraction of the steam inlet duct in the axial direction due to temperature change of the steam by the connection duct, and it is also possible to absorb vibration from the steam turbine by the connection duct.

[0021] (7) In some embodiments, the marine steam turbine module structure described in any one of the above (1) to (6) further comprises a gland condenser for condensing gland steam of the steam turbine, wherein the gland condenser is disposed on the upper plate so that a longitudinal direction of the gland condenser follows an axial direction of the steam turbine.

[0022] In the embodiment described in the above (7), the gland condenser is disposed on the upper plate so that the longitudinal direction of the gland condenser follows the axial direction of the steam turbine in a plan view. Thereby, it is possible to arrange the gland condenser along the longitudinal direction of the steam turbine. Thus, it is possible to reduce a width between an end of the steam turbine on the second side in the transverse direction and an end of the gland condenser on the first side in the transverse direction, and it is possible to reduce an installation area of the base.

#### Advantageous Effects

[0023] According to at least one embodiment of the present invention, there is provided a marine steam turbine module structure which simplifies installation on a deck of a ship of a steam turbine power generation facility.

#### BRIEF DESCRIPTION OF DRAWINGS

[0024] FIG. 1 is a front perspective view of a marine steam turbine module structure according to an embodiment of the present invention.

FIG. 2 is a back partial perspective view of a marine steam turbine module structure according to an embodiment of the present invention.

FIG. 3 is a front view of a steam turbine module structure according to an embodiment of the present invention.

FIG. 4 is a plan view of a marine steam turbine module structure according to another embodiment of the present invention.

FIG. 5 is a plan view of a marine steam turbine module structure, taken along line III-III in FIG. 3.

FIG. 6A is a plan view of a steam inlet duct; FIG. 6B is a front view of the steam inlet duct; FIG. 6C is a bottom view of the steam inlet duct; and FIG. 6D is a side view of the steam inlet duct.

DETAILED DESCRIPTION

[0025] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings. It is intended, however, that unless particularly identified, dimensions, materials, shapes, relative positions and the like of components described in the embodiments shall be interpreted as illustrative only and not intended to limit the scope of the present invention. For instance, an expression of relative or absolute arrangement such as “in a direction”, “along a direction”, “parallel”, “orthogonal”, “centered”, “concentric” and “coaxial” shall not be construed as indicating only the arrangement in a strict literal sense, but also includes a state where the arrangement is relatively displaced by a tolerance, or by an angle or a distance whereby it is possible to achieve the same function. For instance, an expression of an equal state such as “same” “equal” and “uniform” shall not be construed as indicating only the state in which the feature is strictly equal, but also includes a state in which there is a tolerance or a difference that can still achieve the same function. Further, for instance, an expression of a shape such as a rectangular shape or a cylindrical shape shall not be construed as only the geometrically strict shape, but also includes a shape with unevenness or chamfered corners within the range in which the same effect can be achieved. On the other hand, an expression such as “comprise”, “include”, “have”, “contain” and “constitute” are not intended to be exclusive of other components. Further, in the description below, some the same features are associated with the same reference numerals and not described again.

[0026] FIG. 1 is a front perspective view of a marine steam turbine module structure according to an embodiment of the present invention. FIG. 2 is a back partial perspective view of a marine steam turbine module structure according to an embodiment of the present invention. FIG. 3 is a front view of a steam turbine module structure according to an embodiment of the present invention. FIG. 4 is a plan view of a marine steam turbine module structure according to another embodiment of the present invention. FIG. 5 is a plan view of a marine steam turbine module structure, taken along line III-III in FIG. 3.

[0027] A marine steam turbine module structure 1 according to an embodiment of the

present invention is a marine steam turbine module structure 1 mounted on a deck 70a of a ship 70. As shown in FIGs. 1 and 2, the marine steam turbine module structure 1 includes a steam turbine 5, a generator 10 driven by the steam turbine 5, a condenser 15 configured to condense steam discharged downward from the steam turbine 5, and a base 20 on which the steam turbine 5, the generator 10, and the condenser 15 are disposed.

[0028] The marine steam turbine module structure 1 according to the illustrated embodiment may be used, for instance, in a steam turbine power generation facility of a ship such as FPSO (Floating Production, Storage and Offloading system) or FLNG (Floating LNG) ship.

[0029] The base 20 has a two-floor structure including an upper plate 21 and a lower plate 23. In the illustrated embodiment, the base 20 is formed in a flame shape by combining steel members. The base 20 is composed of a foundation 30 composed of a plurality of steel members 25 connected in a rectangle shape in a plan view, a plurality of steel struts 32 connected to the foundation 30 and extending upward, and steel beams 35 connected between upper ends of the plurality of steel struts 32 and having a rectangular shape in a plan view.

[0030] The lower plate 23, which is rectangular in a plan view, is disposed inside the foundation 30. The lower plate 23 is integrally connected to the foundation 30. The upper plate 21, which is rectangular in a plan view, is disposed inside the steel beams 35. The upper plate 21 is integrally connected to the plurality of steel beams 35. That is, the upper plate 21 is disposed parallel to the lower plate 23, above the lower plate 23.

[0031] The steel struts 32 are disposed at the four corners of the foundation 30 and also disposed at positions on the foundation 30 along its circumference at a certain distance. Additionally, a reinforcement strut 37 for reinforcing support of the upper plate 21 is connected on one side in a transverse direction of the foundation, between a pair of steel struts 32 disposed on each of both longitudinal ends of the foundation 30. A lower end of the reinforcement strut 37 is connected to the foundation 30, and an upper end of the reinforcement strut 37 is connected to the upper plate 21. Additionally, a plurality of reinforcement struts 38 is further disposed on the lower plate 23 on an inner side of the

foundation 30 with respect to the steel struts 32 disposed on both longitudinal ends of the foundation 30, at a certain distance in a longitudinal direction of the foundation 30.

[0032] Additionally, obliquely extending braces 39 are disposed between the steel struts 32 which are circumferentially adjacent to each other between the foundation 30 and the steel beam 35. These braces 39 suppress deformation of the base 20 due to horizontal load. The base 20 has an opening 41 allowing the condenser 15 to pass on both longitudinal sides. In the illustrated embodiment, the opening 41 is surrounded by the steel strut 32, the reinforcement strut 37, the foundation 30, and the steel beam 35, in a side view along a transverse direction of the base 20. The lower plate 23 is so large that the condenser 15 can be mounted thereon.

[0033] A projection 35a is formed at a base-longitudinal middle portion of the steel beam 35 on one side in the transverse direction, as shown in FIG. 4. The projection 35a has a rectangular shape in a plan view. The upper plate 21 extends on an inner side of the projection 35a. That is, the upper plate 21 has an extension part 21a which extends at the base-longitudinal middle portion on one side in the transverse direction. The extension part 21a has a rectangular shape whose longitudinal direction follows the longitudinal direction of the base in a plan view. The steel beam 35 forming the projection 35a is supported via a support strut 43 connected between the steel strut 32 and the steel beam 35 which are adjacent to each other (see FIG. 2). On an upper surface of the steel beam 35, a rail 45 is disposed so as to surround the upper plate 21. On both longitudinal ends of the base 20, a step 37 extending vertically is disposed. At the four corners of the foundation 30, a hanging plate 49 having a hole for hooking a hook, a rope, or the like is disposed.

[0034] As described above, the steam turbine 5 and the generator 10 are disposed on the upper plate 21, and the condenser 15 is disposed on the lower plate 23 of the base 20 with a two-floor structure. When the steam turbine 5 and the generator 10 are disposed on the upper plate 21 of the base 20, the generator 10 can be driven by power of the steam turbine 5; and when the condenser 15 is disposed on the lower plate 23 of the base 20, the steam discharged below the steam turbine 5 can be condensed by the condenser 15. Thereby, it is

possible to put the steam turbine 5, the generator 10, and the condenser 15, which are main components of the steam turbine power generation facility, into the single base 20 to be modularized as the steam turbine power generation facility. Thus, it is possible to achieve the marine steam turbine module structure 1 which simplifies installation on the deck 70a of the ship 70 of the steam turbine power generation facility.

[0035] In some embodiments, as shown in FIGs. 3, 4, and 5, the condenser 15 is disposed on the lower plate 23 so that a longitudinal direction of the condenser 15 follows an axial direction of the steam turbine 5. In the illustrated embodiment, the steam turbine 5 is disposed on the left side with respect to a longitudinal direction on the upper plate 21 while the axial direction of the steam turbine 5 is parallel to the longitudinal direction of the upper plate 21. Additionally, the condenser 15 is positioned substantially directly under the steam turbine 5 while the longitudinal direction of the condenser 15 is parallel to the axial direction of the steam turbine 5. The condenser 15 includes a condenser body 16 for condensing the steam discharged from the steam turbine 5. To one longitudinal end of the condenser body 16, a cooling-water pipe 17, through which cooling water flows for cooling the steam, is connected. The cooling-water pipe 17 is connected to the longitudinal end of the condenser body 16 on one side and extends toward a longitudinal end of the base 20 along a longitudinal direction of the condenser 15 on an opposite side.

[0036] In this embodiment, since the condenser 15 is disposed on the lower plate 23 so that the longitudinal direction of the condenser 15 follows the axial direction of the steam turbine 5, it is possible to reduce an installation area of the base 20 in a plan view, compared with a case where the condenser 15 is disposed so that the longitudinal direction of the condenser 15 is perpendicular to the axial direction of the steam turbine 5. Thus, it is possible to reduce an installation space of the marine steam turbine facility installed on the deck 70a of the ship 70. Further, when the condenser 15 is parallel to a front-back direction of the ship, it is possible to reduce an influence of the inclination of the ship, and it is possible to reduce an influence on the condenser water level control.

[0037] In the above embodiment, the condenser 15 is disposed so that the longitudinal

direction of the condenser is parallel to the axial direction of the steam turbine 5. However, the present invention is not limited thereto. At least a case where an angle between the longitudinal direction of the condenser 15 and the axial direction of the steam turbine 5 is less than  $30^{\circ}$  is included in the definition of “the longitudinal direction of the condenser 15 follows the axial direction of the steam turbine 5”.

[0038] In some embodiments, the generator 10 is disposed on the upper plate 21 so that an axial direction of a rotational shaft 10a of the generator 10 is parallel to the axial direction of the steam turbine 5. Also, a body 5a of the steam turbine 5 is disposed in a first-side region E1, and a body 10b of the generator 10 is disposed in a second-side region E2, where the first-side region E1 is on a first side, and the second-side region E2 is on an opposite second side with respect to a line L which passes through a central position of the upper plate 21 in the axial direction of the steam turbine 5 and is perpendicular to the axial direction of the steam turbine 5.

[0039] In the illustrated embodiment, as shown in FIG. 4, in a plan view, the generator 10 is disposed, on the upper plate 21, adjacent to an end of the base 20 in the longitudinal direction on the second side, opposite to the steam turbine 5; and the rotational shaft 10a of the generator 10 is disposed so as to be shifted from a turbine shaft 5b toward an end of the base 20 on a second side in the transverse direction.

[0040] Here, the steam turbine 5 includes the body 5a having a hollow casing 5a1 and a rotor 5a2 rotatably supported within the casing 5a1, and the turbine shaft 5b disposed coaxially about a rotational center axis of the rotor 5a2 and connected to the rotor 5a2.

[0041] Further, the generator 10 includes the body 10b having a hollow casing 10b1 and a rotor 10b2 rotatably supported within the casing 10b1, and the rotational shaft 10a disposed coaxially about a rotational center axis of the rotor 10b2 and connected to both sides of the rotor 10b2.

[0042] In the illustrated embodiment, the body 5a of the steam turbine 5 is disposed in the first-side region E1 on the first side of the line L, which passes through a central position of the upper plate 21 in the axial direction of the steam turbine 5 and is perpendicular to the axial

direction of the steam turbine 5; and the body 10b of the generator 10 is disposed in the second-side region E2 on the second side of the line L.

[0043] In this embodiment, in a plan view, the generator 10 is disposed along the longitudinal direction of the steam turbine 5. Thus, it is possible to reduce a width L1  
5 between an end of the steam turbine 5 on a first side in the transverse direction and an end of the generator 10 on a second side in the transverse direction. Although the steam turbine 5 and the generator 10 are heavy, when the body 5a of the steam turbine 5 is disposed in the first-side region E1 of the line L passing through the central position of the upper plate 21 and the generator 10 is disposed in the second-side region E2, it becomes easy to balance the  
10 weight of the steam turbine 5 and the generator 10 on the central position of the upper plate 21. Thus, it is possible to bring the center of gravity of the entire marine steam turbine module structure closer to the central position of the upper plate 21, and it is possible to improve installment performance when the marine steam turbine module structure 1 is lifted and mounted on the deck 70a of the ship 70.

[0044] In some embodiments, the turbine shaft 5b of the steam turbine 5 and the rotational shaft 10a of the generator 10 are coupled with a speed-reduction device 51. In the illustrated embodiment, the speed-reduction device 51 is connected between a tip end of the turbine shaft 5b connected to the rotor 5a2 of the steam turbine 5 and a tip end of the rotational shaft 10a of the generator 10. The speed-reduction device 51 is constructed by, for  
15 instance, meshing a plurality of gears. Thereby, it is possible to adjust the rotational speed of the generator in accordance with a ship frequency.

[0045] In some embodiments, a combined center of gravity G1 obtained by combining respective centers of gravity of the steam turbine 5, the generator 10, and the speed-reduction device 51 is located at a position deviated from the line L toward the second-side region E2.  
20 In the illustrated embodiment, as shown in FIG. 4, the combined center of gravity G1 is deviated from the line L toward the second-side region E2. Further, as shown in FIG. 3, the combined center of gravity G1 is located above the base 20 in a side view of the marine steam turbine module structure 1. On the other hand, as shown in FIGs. 4 and 5, the condenser

body 16 of the condenser 15 is disposed substantially directly under the body 5a of the steam turbine 5. The cooling-water pipe 17 extending along the longitudinal direction of the condenser 15 is connected to a longitudinal end of the condenser body 16 of the condenser 15 on the second side. The center of gravity G2a of the condenser body 16 in a plan view is located in the first-side region E1 with respect to the line L, and the center of gravity G2b of the cooling-water pipe 17 in a plan view is located in the second-side region E2 with respect to the line L. Since the condenser body 16 is heavier than the cooling-water pipe 17, a combined center of gravity combining the center of gravity G2a of the condenser body 16 with the center of gravity G2b of the cooling-water pipe 17 is located at a position deviated from the line L toward the first-side region E1. Further, as shown in FIG. 3, the combined center of gravity G2 is located below the base 20 in a side view of the marine steam turbine module structure 1. Accordingly, the total combined center of gravity G3 of components disposed below the base 20 and components disposed above the base 20 is located adjacent to the line L. Thus, it is possible to prevent loss of weight balance of the entire marine steam turbine module structure 1.

[0046] FIG. 6A is a plan view of a steam inlet duct; FIG. 6B is a front view of the steam inlet duct; FIG. 6C is a bottom view of the steam inlet duct; and FIG. 6D is a side view of the steam inlet duct.

[0047] In some embodiments, as shown in FIGs. 3, 6A, 6B, 6C, and 6D, the steam inlet duct 53 for introducing the steam discharged from a steam discharge port 5c of the steam turbine 5 to a steam inlet 15a of the condenser 15 is further provided. An inlet 53a of the steam inlet duct 53 has a shape with a longitudinal direction perpendicular to the axial direction of the steam turbine 5. An outlet 53b of the steam inlet duct 53 has a circular shape.

[0048] In the illustrated embodiment, the steam inlet duct 53 includes an inlet duct body portion 54 having a rectangular tubular shape with a vertical through hole 54a, an inlet transition portion 55 connected to an upper part of the inlet duct body portion 54 and forming the inlet 53a into which the steam discharged from the steam discharge port 5c of the steam turbine 5 flows, and an outlet transition portion 56 connected to a lower part of the inlet duct

body portion 54 and forming the outlet 53b through which the steam discharged from the steam turbine 5 flows out.

[0049] The inlet duct body portion 54 has a rectangular tubular shape with a front surface 54b and a back surface 54c each shaped in a trapezoid in which an upper edge is longer than a lower edge in a front view, and a pair of right and left side surfaces 54d shaped in a trapezoid in which an upper edge is shorter than a lower edge in a side view. The front surface 54b and the back surface 54c, as well as the pair of right and left side surfaces 54d, have the same shape. The inlet transition portion 55 has a rectangular tubular shape with a rectangular front surface 55a extending in a lateral direction in a front view and a rectangular side surface 55b extending in a lateral direction in a side view. On an upper end of the inlet transition portion 55, a flange part 55c protruding outward is formed. The inlet transition portion 55 is provided with the inlet 53a opening rectangularly in a plan view.

[0050] The outlet transition portion 56 has a rectangular tubular shape with a rectangular front surface 56a extending in a lateral direction in a front view and a rectangular side surface 56b extending in a lateral direction in a side view. On a lower end of the outlet transition portion 56, a flange part 56c protruding outward is formed. The outlet transition portion 56 is provided with the outlet 53b opening circularly in a bottom view.

[0051] Hereinafter, the steam discharge port 5c of the steam discharged from the steam turbine 5 will be described. In the illustrated embodiment, as shown in FIG. 4, the steam discharge port 5c has a rectangular shape and extends perpendicular to the axial direction of the steam turbine 5 in a plan view. This steam discharge port 5c and the inlet 53a of the inlet transition portion 55 have substantially the same shape.

[0052] In this embodiment, when the steam discharge port 5c of the steam turbine 5 extends perpendicular to the axial direction of the steam turbine 5, the longitudinal direction of the inlet 53a of the steam inlet duct 53 coincides with the longitudinal direction of the steam discharge port 5c of the steam turbine 5. This enables the steam discharged from the steam discharge port 5c to smoothly flow into the outlet 53b of the steam inlet duct 53. Further, when the outlet 53b of the steam inlet duct 53 is circular, it is possible to improve

workability when the outlet 53b is connected via a connection duct 60 to the condenser 15.

[0053] In some embodiments, as shown in FIG. 3, a connection duct 60 connecting the outlet 53b (see FIG. 6C) of the steam inlet duct 53 with the steam inlet 15a (see FIG. 5) of the condenser 15 is further provided. The connection duct 60 is expandable in an axial direction and in a radial direction of the connection duct 60.

[0054] In the illustrated embodiment, the connection duct 60 includes a bellows 60a which is expandable in the axial direction and in the radial direction. The bellows 60a has a cylindrical shape and has a hole penetrating its interior vertically. Upper and lower ends of the bellows 60a have an upper connection part 60b connected to the steam inlet duct 53 and a lower connection part 60c connected to the condenser 15. An inner diameter of the hole of the bellows 60a is substantially the same as an inner diameter of the outlet 53b. On an upper surface of the condenser body 16 of the condenser 15, the steam inlet 15a is formed to introduce the steam (see FIG. 5). This steam inlet 15a has a circular shape. An inner diameter of the steam inlet 15a is substantially the same as an inner diameter of the bellows 60a.

[0055] The temperature of the steam discharged from the steam turbine 5 varies depending on operation conditions of the steam turbine 5. Further, the steam turbine 5 can vibrate depending on operation conditions of the steam turbine 5. In view of this, in the above-described embodiment, the connection duct 60 which is expandable in the axial direction and in the radial direction is disposed between the steam inlet duct 53 and the condenser 15, whereby it is possible to absorb expansion and contraction of the steam inlet duct 53 in the axial direction due to temperature change of the steam by the connection duct 60, and it is also possible to absorb vibration from the steam turbine 5 by the connection duct 60.

[0056] In some embodiments, a gland condenser 61 for condensing gland steam of the steam turbine 5 is further provided. The gland condenser 61 is disposed on the upper plate 21 so that a longitudinal direction of the gland condenser 61 follows the axial direction of the steam turbine 5.

[0057] In the illustrate embodiment, the gland condenser 61 is disposed on the above-described extension part 21a of the upper plate 21 disposed inside the projection 35a of the steel beam 35. As shown in FIG. 4, the center of gravity G4 of the gland condenser 61 is located at a position adjacent to the line L, which passes through the central position of the upper plate 21 in the axial direction of the steam turbine 5 and is perpendicular to the axial direction of the steam turbine 5.

[0058] In this embodiment, since the gland condenser 61 is disposed on the upper plate 21 so that the longitudinal direction of the gland condenser 61 follows the axial direction of the steam turbine 5, it is possible to arrange the gland condenser 61 along the longitudinal direction of the steam turbine 5 in a plan view. Thus, it is possible to reduce a width L2 between an end of the steam turbine 5 on the second side in the transverse direction and an end of the gland condenser 61 on the first side in the transverse direction, and it is possible to reduce an installation area of the base 20.

[0059] The embodiments of the present invention have been described above. However, the present invention is not limited thereto, and various modifications may be applied as long as they do not depart from the object of the present invention.

#### Reference Signs List

|        |           |                                       |
|--------|-----------|---------------------------------------|
| [0060] |           |                                       |
| 20     | 1         | Marine steam turbine module structure |
|        | 5         | Steam turbine                         |
|        | 5a, 10b   | Body                                  |
|        | 5a1, 10b1 | Casing                                |
|        | 5a2       | Rotor                                 |
| 25     | 5b, 10a   | Rotational shaft                      |
|        | 5c        | Steam discharge port                  |
|        | 10        | Generator                             |
|        | 10b2      | Rotor                                 |

# 16-730PCT\_specification

|    |               |                         |
|----|---------------|-------------------------|
|    | 15            | Condenser               |
|    | 15a           | Steam inlet             |
|    | 16            | Condenser body (Body)   |
|    | 17            | Cooling-water pipe      |
| 5  | 20            | Base                    |
|    | 21            | Upper plate             |
|    | 21a           | Extension part          |
|    | 23            | Lower plate             |
|    | 25            | Steel member            |
| 10 | 30            | Foundation              |
|    | 32            | Steel strut             |
|    | 35            | Steel beam              |
|    | 35a           | Projection              |
|    | 37, 38        | Reinforcement strut     |
| 15 | 39            | Brace                   |
|    | 41            | Opening                 |
|    | 43            | Support strut           |
|    | 45            | Rail                    |
|    | 47            | Step                    |
| 20 | 49            | Hanging plate           |
|    | 51            | Speed-reduction device  |
|    | 53            | Steam inlet duct        |
|    | 53a           | Inlet                   |
|    | 53b           | Outlet                  |
| 25 | 54            | Inlet duct body portion |
|    | 54a           | Hole                    |
|    | 54b, 55a, 56a | Front surface           |
|    | 54c           | Back surface            |

## 16-730PCT\_specification

|    |               |                           |
|----|---------------|---------------------------|
|    | 54d, 55b, 56b | Side surface              |
|    | 55            | Inlet transition portion  |
|    | 55c, 56c      | Flange part               |
|    | 56            | Outlet transition portion |
| 5  | 60            | Connection duct           |
|    | 60a           | Bellows                   |
|    | 61            | Gland condenser           |
|    | 70            | Ship                      |
|    | 70a           | Deck                      |
| 10 | E1            | First-side region         |
|    | E2            | Second-side region        |
|    | G1, G2        | Center of gravity         |

## CLAIMS

1. A marine steam turbine module structure mounted on a deck of a ship, comprising:  
a steam turbine; a generator driven by the steam turbine; a condenser for condensing steam discharged downward from the steam turbine; and a base on which the steam turbine, the generator, and the condenser are disposed,  
wherein the base has a two-floor structure including an upper plate and a lower plate,  
wherein the steam turbine and the generator are disposed on the upper plate, and the condenser is disposed on the lower plate so that the steam turbine, the generator, the condenser, and the base are modularized,  
wherein the base includes a foundation composed of a plurality of steel members connected in a rectangular shape in a plan view, a plurality of steel struts connected to the foundation and extending upward, and a plurality of steel beams connected between upper ends of the plurality of steel struts and having a rectangular shape in a plan view,  
wherein the upper plate is integrally connected to the plurality of beams,  
wherein the lower plate is integrally connected to the foundation,  
wherein the plurality of steel struts at least includes a first steel strut disposed at four corners of the foundation,  
wherein a reinforcement strut for reinforcing support of the upper plate is connected on one side in a transverse direction of the foundation, between a pair of the first steel struts disposed on each of both longitudinal ends of the foundation, and  
wherein the base has an opening in a longitudinal direction, the opening is surrounded by the first steel strut, the reinforcement strut, the foundation, and at least one of the steel beams, and the opening allows the condenser to pass therethrough.
2. The marine steam turbine module structure according to claim 1,  
wherein the condenser is disposed on the lower plate so that a longitudinal direction of the condenser follows an axial direction of the steam turbine.
3. The marine steam turbine module structure according to claim 2,  
wherein the generator is disposed on the upper plate so that an axial direction of a rotational shaft of the generator is parallel to the axial direction of the steam turbine, and  
wherein a body of the steam turbine is disposed in a first-side region, and a body of the generator is disposed in a second-side region, where the first-side region is on a first side, and the second-side region is on an opposite second side with respect to a line which passes through a central position of the upper plate in the axial direction of the steam turbine and which is perpendicular to the axial direction of the steam turbine.
4. The marine steam turbine module structure according to claim 3,  
wherein a turbine shaft of the steam turbine and the rotational shaft of the generator are coupled via a speed-reduction device, and  
wherein a combined center of gravity obtained by combining respective centers of gravity of the steam turbine, the generator, and the speed-reduction device is located in the second-side region.
5. A marine steam turbine module structure mounted on a deck of a ship, comprising:  
a steam turbine; a generator driven by the steam turbine; a condenser for condensing steam discharged downward from the steam turbine; and a base on which the steam turbine, the generator, and the condenser are disposed,  
wherein the base has a two-floor structure including an upper plate and a lower plate,

wherein the steam turbine and the generator are disposed on the upper plate, and the condenser is disposed on the lower plate so that the steam turbine, the generator, the condenser, and the base are modularized,

wherein the condenser is disposed on the lower plate so that a longitudinal direction of the condenser follows an axial direction of the steam turbine,

wherein the marine steam turbine module structure further comprises a steam inlet duct for introducing steam discharged from a steam discharge port of the steam turbine to a steam inlet of the condenser,

wherein the steam inlet duct includes

an inlet duct body portion having a rectangular tubular shape with a vertical through hole,

an inlet transition portion connected to an upper part of the inlet duct body portion and forming an inlet having a rectangular shape with a longitudinal direction perpendicular to the axial direction of the steam turbine, and

an outlet transition portion connected to a lower part of the inlet duct body portion and forming an outlet having a circular shape.

6. The marine steam turbine module structure according to claim 5, further comprising a connection duct connecting the outlet of the steam inlet duct to the steam inlet of the condenser,

wherein the connection duct is expandable in an axial direction and in a radial direction of the connection duct.

7. The marine steam turbine module structure according to claim 1 or 5, further comprising a gland condenser for condensing gland steam of the steam turbine,

wherein the gland condenser is disposed on the upper plate so that a longitudinal direction of the gland condenser follows an axial direction of the steam turbine.

8. The marine steam turbine module structure according to any one of claims 1 to 7, wherein the condenser is disposed on the lower plate so that a longitudinal direction of the condenser is parallel to a front-back direction of the ship.

9. The marine steam turbine module structure according to claim 1, wherein the plurality of steel struts further includes, besides the first steel strut, a second steel strut disposed at positions on the foundation circumferentially at a certain distance, and

wherein an obliquely extending brace is disposed between the first steel strut and the second steel strut which are circumferentially adjacent between the foundation and the steel beams.

10. The marine steam turbine module structure according to claim 5, wherein the inlet duct body portion include

a front surface and a back surface each shaped in a trapezoid in which an upper edge is longer than a lower edge in a front view taken from a direction perpendicular to a longitudinal direction of the inlet, and

a pair of side surfaces shaped in a trapezoid in which an upper edge is shorter than a lower edge in a side view taken from the longitudinal direction of the inlet.