mechanism by which angles of attack are varied among positions such as an upwind position and a downwind position. However, the gyromill-type windmill requires an adjustment made according to the direction of the wind and the relationship between the rotation speed and the wind speed. Moreover, the lift-type windmills have such a drawback that the mechanism is mounted at a position beyond the reach, and hence the maintenance of the mechanism is difficult in offshore. An approach has been put to practical use in which the insufficiency in self-starting force is supplemented by employing a Darrieus windmill as a main rotor, and in combination a Savonius windmill, which has a low efficiency but has a good starting characteristic, or the like is disposed inside the Darrieus windmill. However, this approach has such a drawback that the Savonius windmill disturbs the wind flow blowing to the Darrieus windmill and decreases the efficiency. In the present invention, for example, a Darrieus windmill is used, and the Darrieus windmill can be started by using a Savonius water wheel for the tidal flow force under the water surface. With this configuration, the Savonius water wheel does not disturb the fluid flow blowing to the Darrieus windmill.

[0039]

Moreover, a configuration may be employed in which the force-receiving part includes a lift-type vertical-axis windmill and a drag-type vertical-axis water wheel, the vertical-axis water wheel is connected to the vertical-axis windmill with a step-up device provided therebetween, and the step-up device transmits rotation of the vertical-axis ~~windmill~~ water wheel to the vertical-axis windmill when a rotation speed of the

vertical-axis windmill ~~after stepping up~~ is not higher than the rotation speed of the vertical-axis water wheel after stepping up, but does not transmit the rotation of the vertical-axis ~~windmill~~ water wheel to the vertical-axis ~~water wheel~~ windmill when the rotation speed of the vertical-axis windmill ~~after stepping up~~ is higher than the rotation speed of the vertical-axis water wheel after stepping up.

[0040]

According to this configuration, the rotation of the vertical-axis water wheel is transmitted to the vertical-axis windmill when the rotation speed of the vertical-axis windmill ~~after stepping up~~ is not higher than the rotation speed of the vertical-axis water wheel after stepping up. Hence, the activation property of the lift-type vertical-axis windmill can be enhanced. Meanwhile, the rotation of the vertical-axis ~~windmill~~ water wheel is not transmitted to the vertical-axis ~~water wheel~~ windmill, when the rotation speed of the vertical-axis windmill ~~after stepping up~~ is higher than the rotation speed of the vertical-axis water wheel after stepping up. Hence, the vertical-axis water wheel does not act as a resistance.

[0041]

More specifically, in general, the design speed of tidal flow is greatly lower than the design wind speed of wind. Moreover, a Savonius rotor is efficient when the peripheral speed of a maximum diameter part of the rotor is about equal to the fluid speed, whereas a Darrieus rotor is efficient when the peripheral speed is about 4 to 6 times the wind speed. Hence, the axial rotation of the Savonius water wheel is preferably transmitted to the axial rotation of the Darrieus windmill after

stepped up. Meanwhile, when the wind speed increases, it is preferable that the axial rotation of the windmill be separated from the rotation transmission, so that the water wheel does

fluid dynamic force. Also in this case, it is possible to achieve such an effect that the floating structure is not inclined and retains stability moment.

[0061]

Moreover, according to the present invention, since it is unnecessary to dispose guy-wires, the upsizing of the floating structure can be suppressed. Moreover, whichever the windmill is of a horizontal-axis type or a vertical-axis type, most of the major devices such as a gear box, a turntable, and a power generator can be disposed on the floating structure. This facilitates inspection and maintenance, and moreover can reduce work at height using a crane required for installation and operation periods as much as possible.

[0062]

In addition, since a system which is self-supported and stable even without mooring can be achieved, the system can be towed after being assembled in a quayside. Hence, the installation costs can be greatly reduced. Moreover, by utilizing this characteristic, the present invention can achieve such an effect that a highly efficient and large wind-propelled vessel can be achieved which is provided with a force-receiving facility receiving a buoyancy enough to be a major part of the propulsion and which can sail straight ahead without roll or side slip even in a crosswind.

[0062a]

In view of the above, according to a first aspect of the present invention, there is provided a floating structure fluid dynamic force use system comprising: an assembly for extracting energy from wind or water; and a floating structure supporting the assembly, wherein the assembly includes a force-receiving

part for receiving fluid dynamic force and a support column supporting the force-receiving part, and the assembly has a center of gravity set below water, wherein the assembly is supported rotatably around a center axis of the support column with respect to the floating structure, at least wind force is used as the fluid energy, the force-receiving part includes a wind-receiving part for receiving the wind force in the air, the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water, and the upper support column and the lower support column are connected to each other coaxially rotatably relative to each other in a rigid state with respect to a center axis of the support column with a bearing provided therebetween.

[0062b]

According to a second aspect of the present invention, there is provided a wind-propelled vessel comprising: the floating structure fluid dynamic force use system according to the first aspect of the invention, wherein the floating structure is a hull, the force-receiving part includes a wind-receiving part for receiving wind force in the air, the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water, and the wind-propelled vessel includes a propeller which is set below water and which is rotated by the wind force received by the wind-receiving part substantially around a horizontal axis, and the wind force is used as at least part of energy for rotating the propeller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0063]

[Fig. 1] Fig. 1 schematically shows a relationship between inclination and stability moment in a case where a vertical-axis windmill is titlably supported by a floating structure in a floating structure fluid dynamic force use system according to

CLAIMS

[Claim 1] A floating structure fluid dynamic force use system comprising:

an assembly for extracting energy from wind or water; and

a floating structure supporting the assembly, wherein

the assembly includes a force-receiving part for receiving fluid dynamic force and a support column supporting the force-receiving part, and

the assembly has a center of gravity set below water, wherein

the assembly is supported rotatably around a center axis of the support column with respect to the floating structure,

at least wind force is used as the fluid energy,

the force-receiving part includes a wind-receiving part for receiving the wind force in the air,

the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water, and

the upper support column and the lower support column are connected to each other coaxially rotatably relative to each other in a rigid state with respect to a center axis of the support column with a bearing provided therebetween.

[Claim 2]

The floating structure fluid dynamic force use system according to claim 1, wherein

the assembly is supported tiltably with respect to the floating structure with any one of a pin joint, a universal joint, a pillow ball-type spherical bearing, and an elastic body support mechanism provided therebetween.

[Claim 3] The floating structure fluid dynamic force use system according to claim 1, wherein

the force-receiving part includes a horizontal-axis windmill or a vertical-axis windmill.

[Claim 4] The floating structure fluid dynamic force use system according to claim 1, wherein

the force-receiving part includes a horizontal-axis water wheel or a vertical-axis water wheel, and

the horizontal-axis water wheel or the vertical-axis water wheel is set below water and functions as a ballast or part of a ballast.

[Claim 5] The floating structure fluid dynamic force use system according to claim 1, wherein

the upper support column and the lower support column are connected to each other with a gear system provided therebetween so as to coaxially rotate while keeping a predetermined relative rotational relationship, and are supported rotatably and swingably relative to the floating structure.

[Claim 6] The floating structure fluid dynamic force use system according to claim 1, wherein

the upper support column and the lower support column have a mechanism by which rotation of one of the upper support column and the lower support column is transmitted to the other under a predetermined condition, while rotation of one of the upper support column and the lower support column is not transmitted to the other under another condition.

[Claim 7] The floating structure fluid dynamic force use system according to claim 1, wherein

the assembly includes a rotation energy extraction part for extracting rotation energy from rotation of the force-receiving part,

the upper support column and the lower support column are configured to rotate coaxially with each other in directions opposite from each other, and

the rotation energy extraction part is set so as to enable torques generated upon extraction of rotation energies from the upper support column and the lower support column to cancel each other.

[Claim 8] The floating structure fluid dynamic force use system according to claim 7, wherein

the rotation energy extraction part is a power generator including a rotor and a stator,

the rotor is connected to any one of the upper support column and the lower support column, while the stator is connected to the other, and

the power generator generates electric power based on differential motion between the rotor and the stator.

[Claim 9] The floating structure fluid dynamic force use system according to claim 1, wherein

the force-receiving part includes a lift-type vertical-axis windmill and a drag-type vertical-axis water wheel, and

the vertical-axis windmill is activated by rotation of the vertical-axis water wheel.

[Claim 10] The floating structure fluid dynamic force use system according to claim 9, wherein

the force-receiving part includes the lift-type vertical-axis windmill and the drag-type vertical-axis water wheel,

the vertical-axis water wheel is connected to the vertical-axis windmill with a step-up device provided therebetween, and

the step-up device transmits rotation of the vertical-axis water wheel to the vertical-axis windmill when a rotation speed of the vertical-axis windmill is not higher than a rotation speed of the vertical-axis water wheel after stepping up, but does not transmit the rotation of the vertical-axis water wheel to the vertical-axis windmill when the rotation speed of the vertical-axis windmill is higher than the rotation speed of the vertical-axis water wheel after stepping up.

[Claim 11] The floating structure fluid dynamic force use system according to claim 1, wherein

the assembly has a buoyancy about equal to own weight of the assembly and is supported vertically movably with respect to the floating structure, and

a vertical-movement energy extraction part is provided for extracting energy from relative vertical movement between the assembly and the floating structure.

[Claim 12] The floating structure fluid dynamic force use system according to claim 11, wherein

the vertical-movement energy extraction part is a linear generator including a translator and a stator,

the translator is connected to any one of the assembly and the floating structure, while the stator is connected to the other, and

the linear generator generates electric power based on differential motion between the translator and the stator.

[Claim 13] The floating structure fluid dynamic force use system according to claim 11, wherein

the vertical-movement energy extraction part includes a rotation force conversion mechanism including any one of a ball screw, a rack and pinion, a connecting rod-crank mechanism, and a gyro.

[Claim 14] The floating structure fluid dynamic force use system according to claim 13, wherein

the force-receiving part includes at least any one of a lift-type vertical-axis windmill and a lift-type vertical-axis water wheel, and is activated by rotation force obtained by the rotation force conversion mechanism.

[Claim 15] A wind-propelled vessel comprising:

the floating structure fluid dynamic force use system according to any one of claims 1 to 14, wherein

the floating structure is a hull,

the force-receiving part includes a wind-receiving part for receiving wind force in the air,

the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water, and

the wind-propelled vessel includes a propeller which is set below water and which is rotated by the wind force received by the wind-receiving part substantially around a horizontal axis, and

the wind force is used as at least part of energy for rotating the propeller.

[Claim 16] The wind-propelled vessel according to claim 15, wherein

the propeller is disposed in the ballast.

[Claim 17] The wind-propelled vessel according to claim 15, wherein

the ballast or the lower support column functions as a lift-type keel.

[Claim 18] The wind-propelled vessel according to claim 17, wherein

the wind-propelled vessel includes two assemblies, each of which is the assembly, set in a front and a rear of the hull, and

the two keels rotate to have angles of attack in the same direction during sailing straight ahead in a crosswind, while the keel in a front end and the keel in a rear end rotate to have angles of attack in directions opposite form each other during turning.

CLAIMS

[Claim 1] A floating structure fluid dynamic force use system comprising:

an assembly for extracting energy from wind or water; and

a floating structure supporting the assembly, wherein

the assembly includes a force-receiving part for receiving fluid dynamic force and a support column supporting the force-receiving part, and

the assembly has a center of gravity set below water and is supported tiltably in any direction with respect to the floating structure.

[Claim 2]

The floating structure fluid dynamic force use system according to claim 1, wherein

the assembly is supported tiltably with respect to the floating structure with any one of a pin joint, a universal joint, a pillow ball-type spherical bearing, and an elastic body support mechanism provided therebetween.

[Claim 3] The floating structure fluid dynamic force use system according to claim 1, wherein

the assembly is supported rotatably around a center axis of the support column with respect to the floating structure.

[Claim 4] The floating structure fluid dynamic force use system according to claim 3, wherein

at least wind force is used as the fluid energy,

the force-receiving part includes a wind-receiving part for receiving the wind force in the air, and

the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water.

[Claim 5] The floating structure fluid dynamic force use system according to claim 4, wherein

the upper support column and the lower support column are connected to each other coaxially rotatably relative to each other in a rigid state with respect to a center axis of the support column with a bearing provided therebetween.

[Claim 6] The floating structure fluid dynamic force use system according to claim 4, wherein

the force-receiving part includes a horizontal-axis windmill or a vertical-axis windmill.

[Claim 7] The floating structure fluid dynamic force use system according to claim 4, wherein

the force-receiving part includes a horizontal-axis water wheel or a vertical-axis water wheel, and

the horizontal-axis water wheel or the vertical-axis water wheel is set below water and functions as a ballast or part of a ballast.

[Claim 8] The floating structure fluid dynamic force use system according to claim 4, wherein

the upper support column and the lower support column are connected to each other with a gear system provided therebetween so as to coaxially rotate while keeping a predetermined relative rotational relationship, and are supported rotatably and

swingably relative to the floating structure.

[Claim 9] The floating structure fluid dynamic force use system according to claim 4, wherein

the upper support column and the lower support column have a mechanism by which rotation of one of the upper support column and the lower support column is transmitted to the other under a predetermined condition, while rotation of one of the upper support column and the lower support column is not transmitted to the other under another condition.

[Claim 10] The floating structure fluid dynamic force use system according to claim 4, wherein

the assembly includes a rotation energy extraction part for extracting rotation energy from rotation of the force-receiving part,

the upper support column and the lower support column are configured to rotate coaxially with each other in directions opposite from each other, and

the rotation energy extraction part is set so as to enable torques generated upon extraction of rotation energies from the upper support column and the lower support column to cancel each other.

[Claim 11] The floating structure fluid dynamic force use system according to claim 10, wherein

the rotation energy extraction part is a power generator including a rotor and a stator,

the rotor is connected to any one of the upper support column and the lower support column, while the stator is

connected to the other, and

the power generator generates electric power based on differential motion between the rotor and the stator.

[Claim 12] The floating structure fluid dynamic force use system according to claim 4, wherein

the force-receiving part includes a lift-type vertical-axis windmill and a drag-type vertical-axis water wheel, and

the vertical-axis windmill is activated by rotation of the vertical-axis water wheel.

[Claim 13] The floating structure fluid dynamic force use system according to claim 12, wherein

the force-receiving part includes the lift-type vertical-axis windmill and the drag-type vertical-axis water wheel,

the vertical-axis water wheel is connected to the vertical-axis windmill with a step-up device provided therebetween, and

the step-up device transmits rotation of the vertical-axis windmill to the vertical-axis windmill when a rotation speed of the vertical-axis windmill after stepping up is not higher than a rotation speed of the vertical-axis water wheel, but does not transmit the rotation of the vertical-axis windmill to the vertical-axis water wheel when the rotation speed of the vertical-axis windmill after stepping up is higher than the rotation speed of the vertical-axis water wheel.

[Claim 14] The floating structure fluid dynamic force use

system according to claim 1, wherein

the assembly has a buoyancy about equal to own weight of the assembly and is supported vertically movably with respect to the floating structure, and

a vertical-movement energy extraction part is provided for extracting energy from relative vertical movement between the assembly and the floating structure.

[Claim 15] The floating structure fluid dynamic force use system according to claim 14, wherein

the vertical-movement energy extraction part is a linear generator including a translator and a stator,

the translator is connected to any one of the assembly and the floating structure, while the stator is connected to the other, and

the linear generator generates electric power based on differential motion between the translator and the stator.

[Claim 16] The floating structure fluid dynamic force use system according to claim 14, wherein

the vertical-movement energy extraction part includes a rotation force conversion mechanism including any one of a ball screw, a rack and pinion, a connecting rod-crank mechanism, and a gyro.

[Claim 17] The floating structure fluid dynamic force use system according to claim 16, wherein

the force-receiving part includes at least any one of a lift-type vertical-axis windmill and a lift-type vertical-axis water wheel, and is activated by rotation force obtained by the

rotation force conversion mechanism.

[Claim 18] A wind-propelled vessel comprising:

the floating structure fluid dynamic force use system according to any one of claims 1 to 17, wherein

the floating structure is a hull,

the force-receiving part includes a wind-receiving part for receiving wind force in the air,

the support column includes an upper support column supporting the wind-receiving part and a lower support column supporting a ballast set below water, and

the wind-propelled vessel includes a propeller which is set below water and which is rotated by the wind force received by the wind-receiving part substantially around a horizontal axis, and

the wind force is used as at least part of energy for rotating the propeller.

[Claim 19] The wind-propelled vessel according to claim 18, wherein

the propeller is disposed in the ballast.

[Claim 20] The wind-propelled vessel according to claim 18, wherein

the ballast or the lower support column functions as a lift-type keel.

[Claim 21] The wind-propelled vessel according to claim 20, wherein

the wind-propelled vessel includes two assemblies, each

of which is the assembly, set in a front and a rear of the hull, and

the two keels rotate to have angles of attack in the same direction during sailing straight ahead in a crosswind, while the keel in a front end and the keel in a rear end rotate to have angles of attack in directions opposite form each other during turning.