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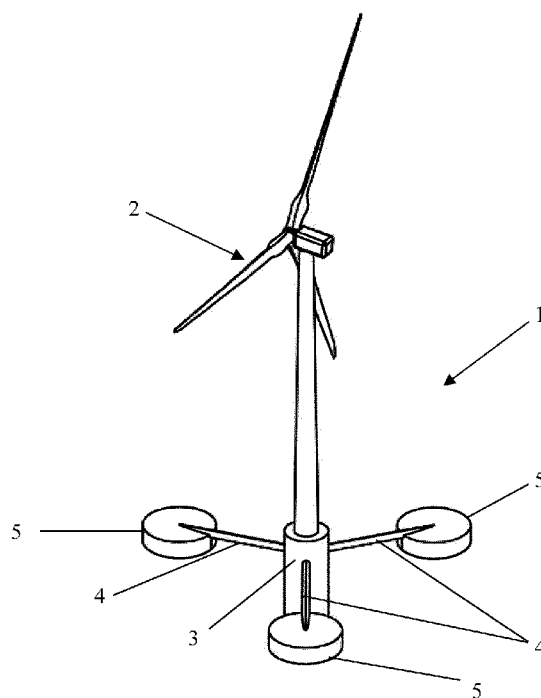


Fig. 1

(57) Abstract: It is about a hybrid platform (1) for extracting wind and wave energy, comprising at least one wind turbine (2), which provides for the fact that said wind turbine (2) is installed on a central structure (3) placed at the base of said turbine, it being provided that at least one arm (4) is hinged to said central structure (3) at a first end thereof and that it is fixed at the second end thereof to at least one float (5); It is further provided that the floating features of the at least one float (5) and its geometric arrangement around the central structure (3) confer hydrostatic and dynamic stability to the hybrid platform (1) and that there are, for the at least one arm (4), means for converting mechanical energy into electrical energy, to transform the movement due to the wave motion of the at least one float (5) into electrical energy.

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DESCRIPTION

of the invention ENTITLED “Hybrid platform for extracting wind and wave energy ”
in the name of Politecnico di Torino.

The present invention concerns a hybrid platform for extracting wind and wave energy,
5 comprising at least one wind turbine.

Renewable energies have an increasingly important role in counteracting the
consequences of climate change and in having a more sustainable impact on the
environment. The potential of wave energy and offshore wind energy is very high and
the exploitation of one of these two resources would be sufficient to balance the global
10 demand for electrical energy. To counteract the intermittent nature of the renewable
energy sources, which are difficult to predict, it is essential to diversify and build a
heterogeneous energy mix, in order to balance the energy produced by each source.

The invention proposes a hybrid device for extracting wave motion and wind energy.
The combination of offshore wind and wave energy offers numerous advantages: in
15 addition to the energy balance of the two sources, it allows sharing the same
substructure, the mooring system and the electrical system, including the submarine
cable and a reduction in maintenance costs.

In addition, the integration of the wave energy devices in the invention allows to reduce
the costs of the substructure of a floating wind turbine. In fact, these devices, located
20 around the central structure of the floating platform, contribute to the hydrostatic and
dynamic balance of the platform and their control can be constructed in such a way as
to optimize the amount of material necessary for the structure. The control of the
movement of these devices is in fact designed to increase the stability of the platform
and best cope with the operating conditions, as well as to withstand extreme events.
25 Compared to a traditional wind platform, there is also the advantage of having an

additional electrical energy production deriving from the wave energy devices, often unrelated to wind production. As a result, the overall productivity, deriving from the exploitation of the wind and wave motion resources, allows for a more constant production of energy and therefore more suitable for the introduction into the grid.

5 Floating wind is a recent technology born to exploit the wind potential present in deeper seas, where the wind speeds are higher if compared to those on land or near the coast. There are three main types of floating platforms based on the physical principle with which the platform reaches stability: “semi-submerged”, “spar” and “Tension Leg Platform or TLP”. These three types of platforms take advantage of the stability of
10 shape, of weight and of the one due to the mooring, respectively. However, these technologies have a still high energy cost and cannot be compared with that of the foundations of the bottom fixed or pile-driven type.

In the first type, stability is reached with very deep substructures and by lowering the position of the centre of gravity. In the second type, very wide substructures are used,
15 by increasing the second order pitch moment of inertia of the floating surface. The third type uses mooring systems with very taut cables, thereby reducing the motion of the platform.

The combination of the floating wind with the wave motion technology represents a cutting-edge solution and there are few examples in this regard. In fact, this hybrid
20 combination has not yet been developed commercially, since the wave motion technologies are at a less advanced state of technological development than offshore wind (low Technology Readiness Level).

An example of technology featuring the hybrid combination between offshore wind and wave motion provides that the energy of the wave motion is extracted from the
25 movement of two floats, connected with an arm to a central structure. In this device the

central structure would be pile-driven, that is, it would have its own foundations at the bottom of the body of water on which it is installed and would be exploitable for sea depths not exceeding 50 m.

It is therefore clear that the free application of the known technologies is limited by the ratio between the costs of construction of the hybrid platform and the extracted energy since, in order to exploit the areas where the winds and the wave motion carry more energy, it is necessary to install pile-driven platforms, whose cost is extremely high and which, in any case, cannot be built in areas with too deep sea beds, limiting even more the areas suitable for their installation.

- 10 The most important document of the state of the art is constituted by the publication WO2013/150320 A2, in which a hybrid platform for extracting wind and wave energy is described (the references in brackets concern this document), comprising at least one wind turbine, wherein said wind turbine is installed on a central structure placed at the base of said turbine, it being provided that at least one arm (4) is hinged to said central structure at a first end thereof and that it is fixed at the second end thereof to at least one float (2); it being further provided that there are, for the at least one arm (3, 20), means for converting mechanical energy into electrical energy, to transform into electrical energy the movement due to the wave motion of the at least one float (p. 4, lines 36-38; p. 5, line 43 – p. 6, line 6).
- 20 Other state-of-the-art documents are Chinese patents CN 113 202 699 A and CN 105 781 899 A.

Aim of the present invention is to provide a hybrid platform for extracting wind and wave energy that can be low cost and can be installed in every body of water, even the deepest ones, in order to be able to exploit in the best way the areas where the winds and the wave motions are the strongest.

25

The solution described here consists of a hybrid platform for extracting wind and wave energy of the floating type, whose hydrostatic and dynamic stability is guaranteed directly by the floats that allow the extraction of energy from the wave motion.

In this way, unlike to what is known in the art, the floats also have a structural function,
5 instead of only an energy extracting function.

Unlike to what is described in the documents relating to the state of the art mentioned above, therefore, the hydrostatic and dynamic stability of the hybrid platform is not only conferred by the central structure, but also by the floats thanks to their conformation and to their arrangement. This allows to reduce the overall construction
10 costs and to achieve a more efficient solution.

It is important to point out that the floats have a fundamental function for the verification of the hydrostatic stability of the platform of which an important parameter to characterize it is the metacentric height. The floats contribute to the shape stability of the substructure as the second order pitch moment of inertia of the floating surface
15 of the hybrid system increased as a result of their floating surface and distance from the central structure. In addition, the possibility of controlling the rotary motion of each arm through a hydraulic system allows to increase the effectiveness of the floats to maintain the stability of the structure even under dynamic conditions.

The proposed type of platform has the advantage of being easily adaptable for different
20 types and power sizes of wind turbines, by suitably designing the design parameters of the platform. The energy cost is reduced thanks to the dual function of the wave-motion converters, that is, the floats, which, in addition to the energetic production, contribute substantially to the stability of the platform, allowing a more compact design and without having to resort to the use of large amounts of ballast to stabilize the system.

The design of a floating hybrid platform referred to in the present invention also allows its assembly directly at the port and not necessarily in the open sea. The platform can then be towed to the final installation site.

The present invention will now be illustrated and described in detail, with reference to
5 a particular embodiment thereof, made by way of non-limiting example, with the aid of the accompanying drawing tables, where:

- Fig. 1 shows a hybrid platform referred to in the invention in a configuration with three floats;
- Fig. 2 shows a hybrid platform referred to in the invention in a configuration with
10 four floats;
- Fig. 3 shows an embodiment of means for converting wave energy into electrical energy which are present in a hybrid platform referred to in the invention;
- Figs. 4a-b show exemplary embodiments of configurations of connection between a central structure of the hybrid platform and the respective floats;
- 15 - Fig. 5 shows three optimal design solutions of a float included in a hybrid platform referred to in the invention;
- Figs. 6, 7 and 8 show three exemplary embodiments of a hybrid platform referred to in the invention provided with ballast;
- Fig. 9 shows an embodiment of an exemplary hydraulic system for extracting the
20 wave motion energy by means of ballast;
- Figs. 10a and 10b show two schematic embodiments of the connection between a floating cable and the hydraulic system on a ballast;
- Fig. 11 shows an embodiment of a locking system by interlocking.

As exemplarily illustrated in Figs. 1 and 2, this invention concerns a floating hybrid
25 device for extracting wave and wind energy in the form of a hybrid platform 1

comprising at least one wind turbine 2, preferably horizontal to them, installed on a central structure 3 placed at the base of said turbine. The central structure 3 may advantageously be floating. Therefore, the floating contribution of the central structure 3 is not fundamental for the platform 1.

- 5 To integrate the electrical energy produced by the wind turbine 2, in the illustrated embodiment, a plurality of arms 4 is hinged to said central structure 3 at a first end thereof and each of them is hinged at the second end thereof to a float 5.

The floats 5 have the dual function of extracting wave energy and of maintaining the platform 1 in hydrostatic and dynamic stability.

- 10 A float 5 can have any shape suitable for the purpose and the cylindrical shape that guarantees a higher floating force, optimal for balancing the weight of the turbine 2, is preferable. However, other designs are also possible; for example, a hemisphere may be provided on the lower end of each float 5 to reduce the viscous effects and thus optimize the power produced and the amount of material used. Some optimal
15 embodiments are illustrated in Fig. 5; the spherical, semi-spherical and cylindrical solutions are particularly suitable for the present application.

The arms 4 are hinged on the central structure 3, so as to leave their movement free along the axis of the hinge and the same applies to the hinge provided between the arms 4 and the floats 5 which can thus move on a substantially vertical plane.

- 20 This relative movement between the arms 4 and the central structure 3 is converted into hydraulic energy through means for converting mechanical energy into electrical energy 6, such as hydraulic pistons, as shown in Figure 3, where a piston is connected to both an arm 4 and to the central structure 3 so that their relative movement causes the piston to elongate and shorten, generating hydraulic energy.

Said means, when in the form of hydraulic pistons or in general hydraulic conversion means, first convert the kinetic energy of the movement of the arm 4 and of the float 5 into hydraulic energy by means of a high-pressure fluid; subsequently said energy is converted into mechanical energy by means of a hydraulic turbine and into electrical energy by means of an electric generator.

By using this technology it is possible to accumulate energy through special high-pressure and low-pressure fluid accumulators to have a more constant production of electrical energy. The hydraulic system also allows to have floats 5 with non-zero hydrostatic balance. If the weight and the floating force of a float 5 are not balanced, a static moment may be applied to the arm to maintain the position of the arm in the design condition.

The hydrostatic and dynamic stability of the platform 1 is obtained by the position of the floats around the central structure and by their floating features as a function of their shape and of their density. The sizing and the arrangement of the floats 5 around the structure 3 can be designed so as to make sure that the sum of the moments of the gravitational and hydrostatic forces of the arm and float around each hinge is cancelled to reduce costs due to an auxiliary hydraulic system for maintaining the position of the float under static conditions. In this way the mass of the float is determined by the hydrostatic balance as follows:

$$F_{NBarm} \cdot x_{arm} + F_{NBfloat} \cdot x_{float} = (B_{arm} - M_{arm} g) \cdot x_{arm} + (B_{float} - M_{float} g) \cdot x_{float} = 0$$

where F_{NBarm} and $F_{NBfloat}$ are the net hydrostatic loads of each arm 4 and float 5, M_{arm} and M_{float} are the masses of the arm 4 and of the float 5, B_{arm} and B_{float} are the floating forces of the arm 4 and of the float 5, x_{arm} and x_{float} are the distances

between the hinge and the hydrostatic and gravitational loads of the arm 4 and of the float 5, respectively.

For example, the standard *DNVGL-ST-0119 - Floating wind turbine structures* and the scientific publication *An efficient optimisation tool for floating offshore wind support structures - E. Faraggiana *, M. Sirigu, A. Ghigo, G. Bracco, G. Mattiazzo – Elsevier – Energy Reports 8 (2022) 9104–9118* are cited which provide information on the calculation of the hydrostatic and dynamic balance of systems of this type.

The number of arms 4 and floats 5 is not defined and is a parameter to be optimized during the design phase of a platform 1 as a function of the installation site to minimize the energy cost. A single float 5 connected to at least one arm 4 may also be sufficient although it is preferable that at least three floats 5 are present to ensure compliance with the hydrostatic constraints of the platform 1 and at the same time to reduce the structural costs as a result of the small number of floats 5.

In the configuration with three floats, the arms of the floats are arranged at 120° with respect to each other along the horizontal plane as the structure has greater hydrostatic and dynamic stability in all directions. A cylindrical geometry of the floats 5 is preferred as it represents one of the simplest solutions in terms of construction. An example of configuration with three floats is illustrated in Figure 1. By way of example, an optimal design has a limited draft of the structure (less than 10 m) to reduce costs during the phase of installation at sea. In this way the hybrid platform 1 is assembled in a dry dock making it competitive with respect to the spar and TLP type structures where the assembly of the complete system is provided at sea.

A greater stability of the platform 1 is obtained by increasing the diameter of the floats 5 and the length of the arms 4 whilst a reduction in the costs due to the structure requires minimum values of the diameters of the floats 5 and of the length of the arms 4. For an

optimal solution and by way of example, it is mentioned that the hydrostatic verification requires that the metacentre is located above the centre of gravity by at least 1 m and that the hydrostatic curve observes, for example, the requirements of the DNV-ST0119 standard.

- 5 The righting moment (M_R) is a function of the inclination angle (α) of the structure and is defined as:

$$M_R(\alpha) = \rho_w g V GZ(\alpha)$$

where ρ_w is the density of the water, V is the volume of the submerged platform and GZ is the arm of the righting pair. The DNV standard requires that the integral of the
10 righting moment up to the second intercept with the overturning moment of the turbine is 30% greater than the integral of the overturning moment up to the same intercept.

The optimal design of the floating-arm system must verify the hydrostatic constraints just described, minimizing the structural costs and maximizing the power produced by wave motion. In particular, an optimal production of power from wave motion requires
15 the resonance of the floating-arm system with the design sea states. It is in fact known that the response of the system of a wave motion generator (RAO) is influenced by the frequency of the incident wave and has a peak for a specific frequency. The optimal design is therefore determined by a detailed cost of energy (LCOE) calculation that takes into account both the cost and the energy produced by the wave-motion
20 converters and wind turbine.

From comparisons carried out with a simple floating turbine, it was evaluated how, for example, a potential reduction in the energy cost of up to 11% can be obtained with the solution of the present invention.

Always by way of example, it was found that the contribution of generation of power
25 from the wave-motion converters was expected to be around 7-8% compared to the

total power generated by a hybrid device with a 5 MW turbine, but the contribution could also be greater with control systems like the “Model predictive control”.

The purpose of the design of the floats 5 is to guarantee stability to the platform 1, to maximise the power produced, but also to minimise the structural costs. A greater
5 stability of the platform is achieved by increasing the diameter of the floats 5 and the length of the arms 4.

In one embodiment, the optimization of the power produced also requires the resonance of the arm 4 + float 5 system with the most energetic sea states. By sea it is meant any body of water on which the platform 1 is installed.

10 Figs. 4a, 4b schematically illustrate particular embodiments of ways for fixing a float 5 to the central structure 3.

In particular, as can be seen in Fig. 4a, the float 5 is connected to the central structure 3 by means of an arm 4 which is constituted by a hydraulic piston. This solution makes it possible to unify the function of the means for converting the energy generated by
15 the wave motion into electrical energy to the function of fixing the float 5 to the central structure 3.

Fig. 4b, in addition to what has already been described for Fig. 4a, between the structure 3 and the float 5 there are support axes 7 in an articulated quadrilateral configuration in which the arm 4 constitutes a diagonal of said quadrilateral. This makes the
20 connection of the float 5 to the central structure 3 more resistant.

A hybrid platform 1 may include different types of turbines with a different number of blades, for example, for micro-wind turbines, or vertical axis turbines.

The central structure 3 may provide for the use of ballast in the lower area thereof to increase the stability of the platform 1. The transport of the platform 1 from the port to
25 the place chosen for installation and subsequent energy production could involve the

use of additional ballast to maintain the relative position of the platform 1 with the surface of the water.

Obviously once a hybrid platform 1 is brought from the port to the place of final installation it is necessary to use suitable moorings to keep the structure in place. The number of provided mooring lines may vary based on the depth of the seabed, extreme weather-sea conditions expected at the installation site and the number of wave energy devices. A greater number of floats 5 is expected to improve the stability of the platform 1. However, mooring plays a key role in balancing the thrust effect generated on the rotor of the turbine and the drift caused by the waves.

10 The presence of one or more ballasts may advantageously be provided. The ballast allows to move the position of the centre of gravity of the structure further down, contributing to making it more stable. This solution therefore results in a more efficient use of the amount of material of the structure, allowing to reduce the costs. It is important to point out the fact that the hybrid platform, in this way, would exploit two
15 fundamental principles for the stability of the floating structure already known by the various designers of floating turbines: an increase in the depth of the centre of gravity (typical for the spar-type substructures) and an increase in the second order moment of the floating surface (typical for the submerged-type substructures). Various embodiments can be provided integrating the ballast mentioned herein by way of
20 example and not with limiting purpose.

The first two embodiments are illustrated in Figs. 6 and 7. In general, a ballast 8 can be connected to one or more floats 5 by means of suitable cables 9. The position of the ballast 8 can be adjusted through special winches 10 present on the floats 5. The winches can also be placed directly on the ballast 8 or on the central structure 3. The
25 adjustment of the position of the ballast 8 is particularly important as it allows to

manage the operation of transport at sea more easily by reducing the depth of the ballasts 8 if necessary.

Advantageously in the embodiment of Fig. 7, the position of the ballast 8 is central (below the central structure 3) and is anchored through the cables 9 to the various floats
5 5 of the substructure. Advantageously, in this case a single float 5 can rotate around the hinge placed on the central structure 3 to maximize the power extracted from the wave motion. The other floats 5 are instead fixed.

A design with ballast 8 allows to reduce the cost of the float 5 and the economic advantage is still increased by the fact that the mass of the ballast 8 can be obtained
10 with cheaper materials than, for example, cement and steel which are usually used for the floats 5.

The third embodiment is illustrated in Figure 8. This solution differs substantially from the first two in that the power extracted by the system of the arms 4 joined to the floats 5 no longer takes place using a hydraulic system composed of a hydraulic piston on the
15 arms 4 of each float, but it is extracted on the ballast 8, through motion transmission cables of the floats 5. In particular, the energy conversion means on the ballast 8 are constituted by a drum 30 on which the cables are wound during the movement of each float 5 and by an electric generator or hydraulic system 31. A hydraulic system is generally chosen because it interfaces better with high low-frequency loads typical of
20 the wave-motion converters. A typical example of hydraulic system present in the literature includes a hydraulic pump rigidly connected to the drum, control valves, high and low pressure accumulators, a hydraulic motor and a hydraulic generator. An example of hydraulic system is provided in Figure 9.

An intermediate pulley 33 between the drum and the float 5 can be added on the ballast 8 if a cost reduction is envisaged during the sizing. The two options, with or without pulley are shown in Figures 10a and 10b.

In Fig. 10a it is exemplified the fact that the cable is connected to the pulley 33 at point
5 X, while in Fig. 10b the cable is connected directly to the drum at point Y. Obviously these are non-limiting schematic exemplifications.

The ballast 8, and the floats 5 as well, can be moored to the seabed.

The depth of the ballast 8 can be adjusted similarly to the first two embodiments to facilitate transport of the platform 1 at sea by controlling the moments generated by the
10 hydraulic system on each drum. In addition, the ballast 8 can be brought closer to the surface during maintenance phases to facilitate access for the operators. The ballast 8 can be connected through central cables 11 to the central structure in such a way as to discharge its hydrostatic load and not affect the design of the hydraulic system.

The ballast 8 hung through cables to the floats 5 or to the central structure 3 (see Fig.
15 8) can be added to the hybrid system to reduce the position of the centre of gravity. In particular, the position of the centre of gravity is influenced by the position and by the mass of the ballast 8. The position of the ballast 8 is limited by the depth of the sea in the chosen location and is determined by technical-economic analyses concerning the mass of the ballast 8 and the length of the cables. Advantageously, the material chosen
20 for the ballast is a material having a high specific density to minimize the volumes required and at the same time it can be an economical material. Some possible materials are magnetite, sand, concrete, water and gravel.

The mooring of the hybrid platform 1 is anchored to the central structure 3 along the outer surface with a number of mooring lines advantageously equal to three. The
25 optimal type of mooring is the catenary, which provides for reduced installation costs

compared, for example, to the type of taut mooring cables. In the third embodiment described above, it is also provided that the ballast 8 is connected to the sea soil through a catenary mooring to reduce its motion and increase the reliability and safety of the hybrid platform 1. In the event that a hydraulic system is provided on the ballast 8, it is
5 optimal to reduce the motion of the ballast 8 as much as possible, especially in anticipation of maintenance operations.

The cables chosen to connect the ballast 8 with the floats 5 and/or with the central structure 3 can advantageously be stainless steel wire ropes that lend themselves well to the high stresses and loads during the operating conditions. The number of cables
10 required will be decided while designing the hybrid system as a function of the mass of the ballast 8 and of the dynamic stresses. In particular, it is optimal for the cables to be always taut to avoid slack line phenomena in which the stresses are considerably greater. Advantageously, the mass of the ballast 8 must, for this reason, be heavy enough to avoid phenomena of this type.

15 Further aspects of the invention include extreme wave and wind conditions in which a safety configuration of the platform is required. In this case, a suitable locking system by interlocking 20 is provided for each float 5 to prevent its relative motion with respect to the central structure 3. This locking system 20 can be generated for example by one or more bars 21 activated by a control system and locked together with the arm 4 of
20 each float, as visible in Fig. 11. The locking system 20 may be based on the operating conditions of the structure and meteorological data measured for example using accelerometers and by LiDAR type sensors. The bars 21 under the operating conditions of energy production can be vertical along the central structure 3, while during the emergency mode they are activated for example by an electric motor that makes them

rotate around hinges. A suitable interlocking area is provided between each bar 21 and the corresponding arm 4.

From the above it can be seen how a hybrid platform 1 according to the invention allows to offer a solution to the problems known in the art, by providing an economical
5 and easily installable structure in any type of body of water, regardless of the depth thereof, thanks to its floating features. In this way, the hybrid platform 1 is able to extract wind and wave energy in an optimal way, best exploiting the environments most suitable for the purpose.

CLAIMS

1. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, comprising at least one wind turbine (2), installed on a central structure (3) placed at the base of said turbine, it being provided that at least one arm (4) is hinged to said central structure (3) at a first end thereof and that it is fixed at the second end thereof to at least one float (5); it being provided that there are means for converting mechanical energy into electrical energy (6), to convert the energy from wave motion into electrical energy following the movement of the float (5) caused by the wave motion, **characterized in that** the floating features of the at least one float (5) and its geometric arrangement around the central structure (3) confer hydrostatic and dynamic stability to the hybrid platform (1).
2. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to claim 1, **characterized by** comprising at least one ballast (8) connected to one or more floats (5) and/or to the central structure (3) by means of cables (9); it being provided that the position of the ballast (8) is susceptible to be adjusted through winches adapted to wind and/or unwind the cables (9).
3. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, **characterized in that** the means for converting mechanical energy into electrical energy (6) comprise at least one hydraulic piston having one end connected to an arm (4) and the other end connected to the central structure (3).
4. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to claim 2, **characterized in that** the means for converting mechanical energy into electrical energy (6) comprise at least one drum (30), on which the cables

(9) are wound during the movement of the floats (5) involved, and an electric generator/hydraulic system (31) driven by the movement of said drum (30).

5 5. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, characterized in that there are at least three arms (4) to each of which a float (5) is connected.

6. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to claim 5, **characterized in that** there is provided an intermediate pulley (33) for pulling the cables (5) between the drum (30) and the float (5).

10 7. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, characterized in that the central structure (3) is floating.

8. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, **characterized in that** the at least one float (5) has a non-zero hydrostatic balance.

15 9. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, **characterized in that** each pair of arm (4) with the relative float (5) has the same resonance frequency as the most energetic states of the body of water on which the hybrid platform (1) is adapted to be installed.

20 10. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, **characterized in that** the arm (4) consists of a hydraulic piston.

11. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to claim 10, **characterized in that** between the floating structure (3) and the float (5) there are support axes (7) with an articulated quadrilateral configuration, in
25 which the arm (4) constitutes a diagonal of said quadrilateral.

12. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY, according to any one of the preceding claims, **characterized by** comprising at least one locking system (20) for locking the movement of the arms (4).

13. HYBRID PLATFORM (1) FOR EXTRACTING WIND AND WAVE ENERGY,
5 according to claim 12, **characterized in that** the locking system (20) comprises at least one bar (21) hinged to the central structure (3) and adapted, if necessary, to interlock in an interlocking area on the relative arm (4) to lock the movement thereof.

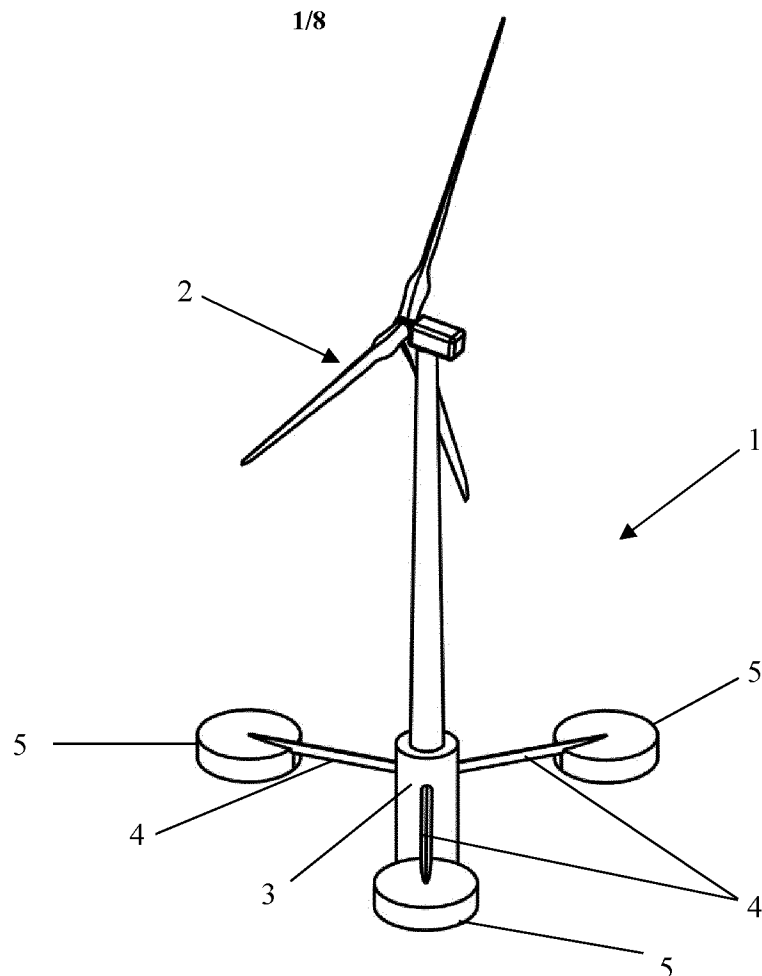


Fig. 1

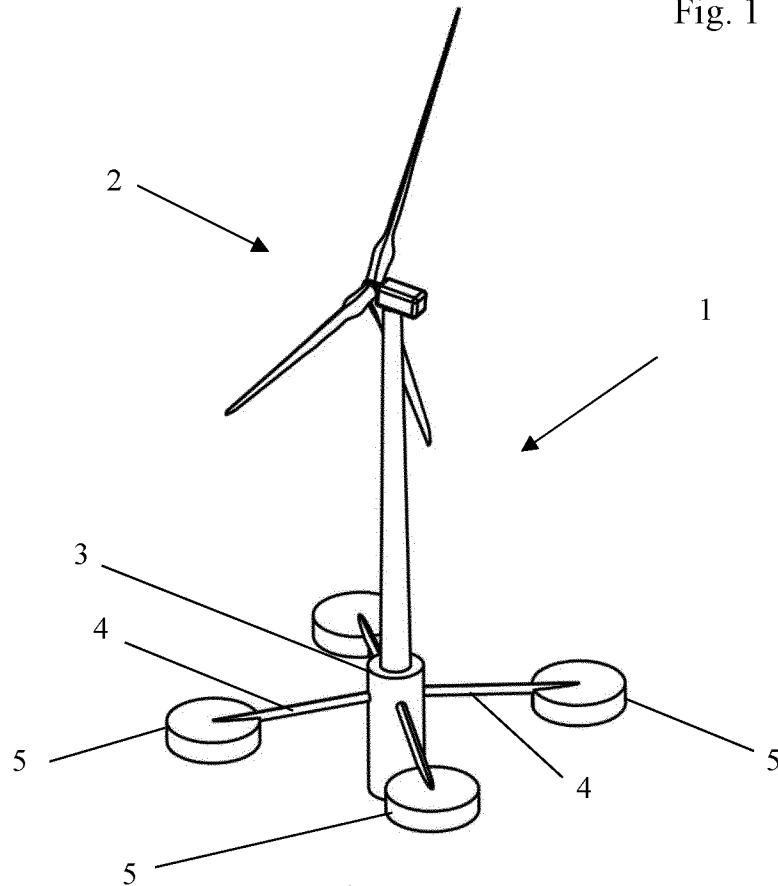


Fig. 2

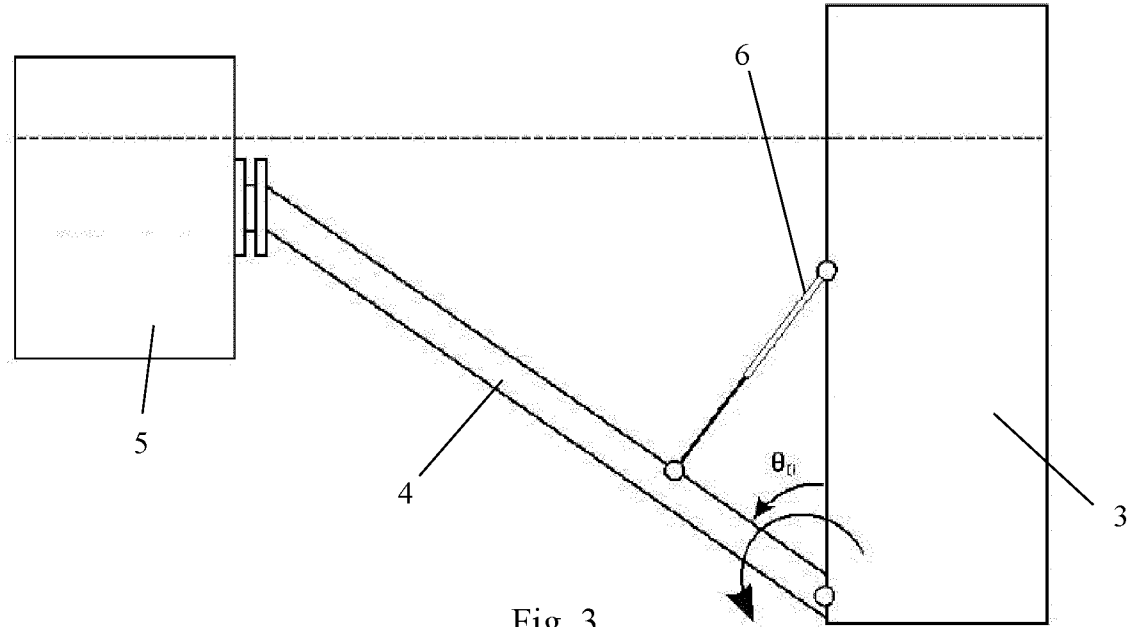


Fig. 3

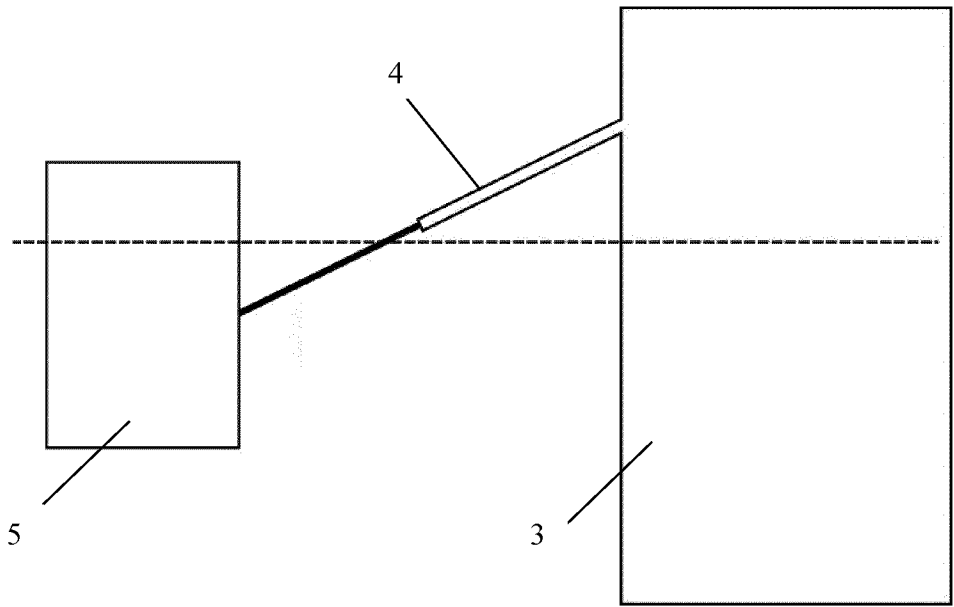


Fig. 4A

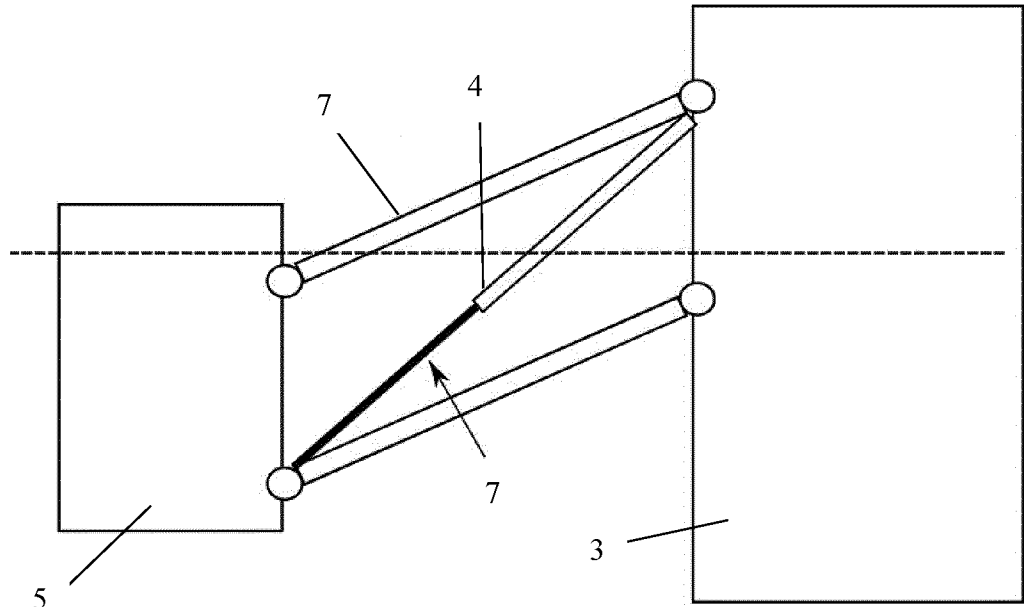


Fig. 4B

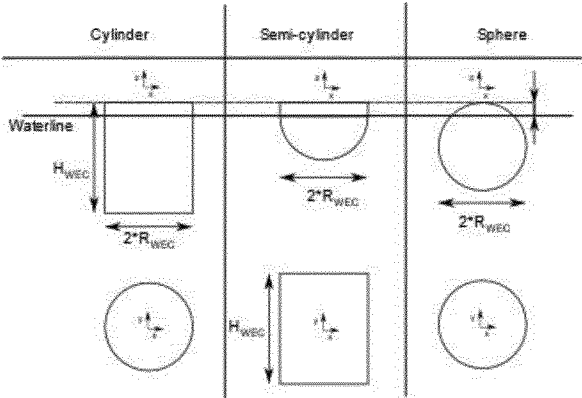
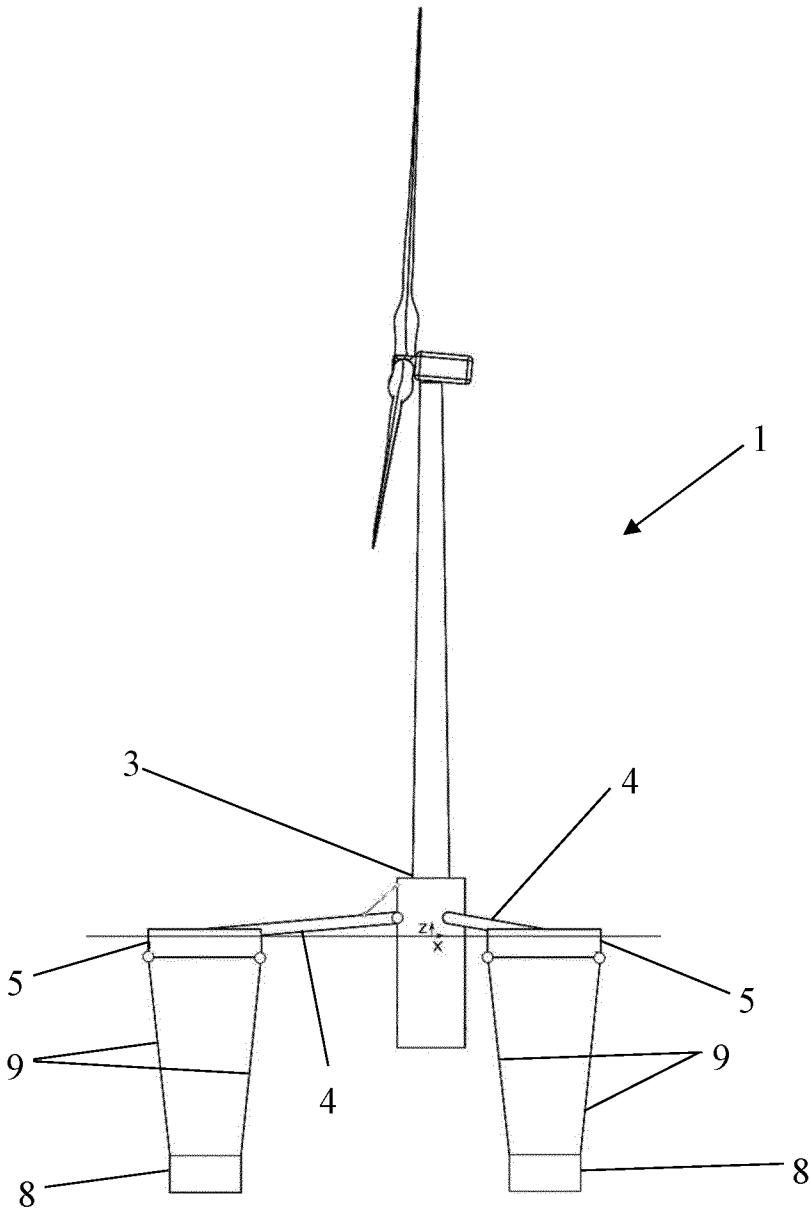


Fig. 5

Fig. 6



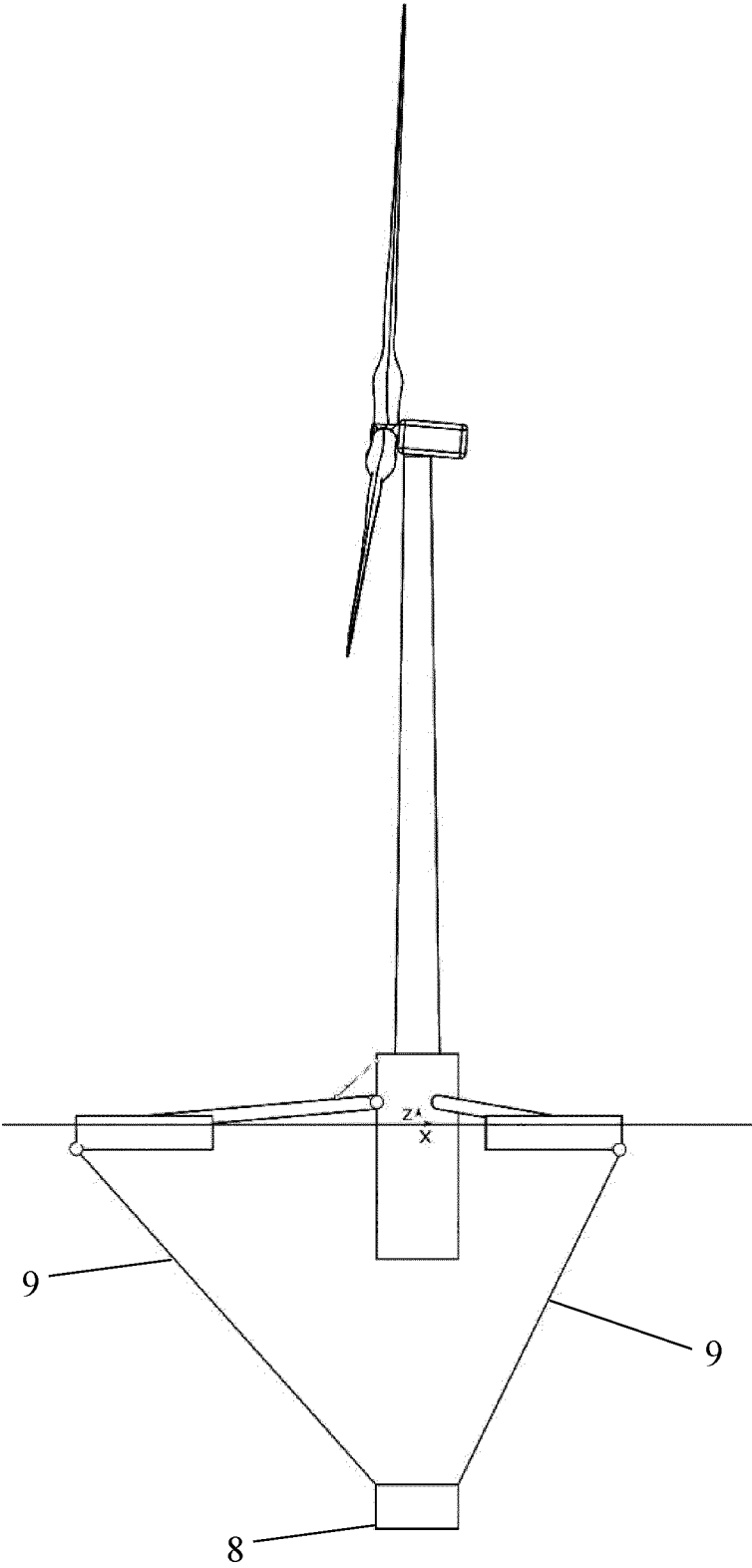


Fig. 7

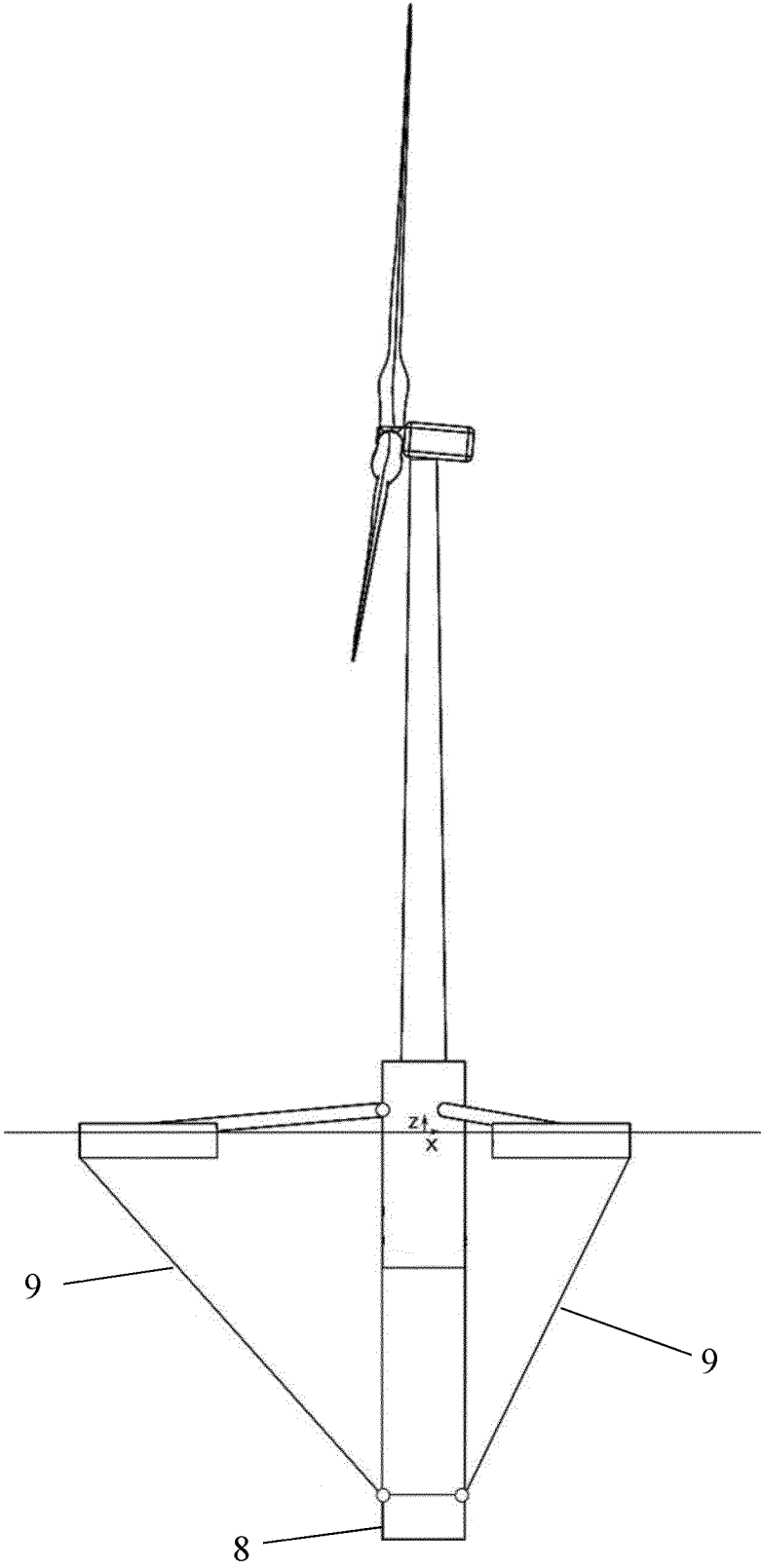


Fig. 8

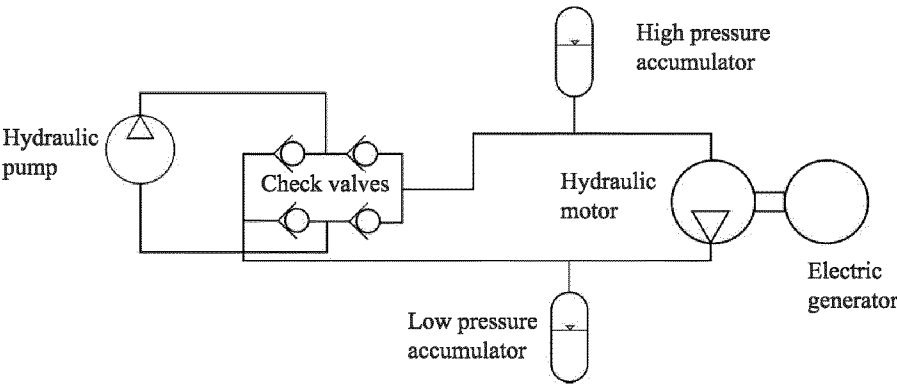


Fig. 9

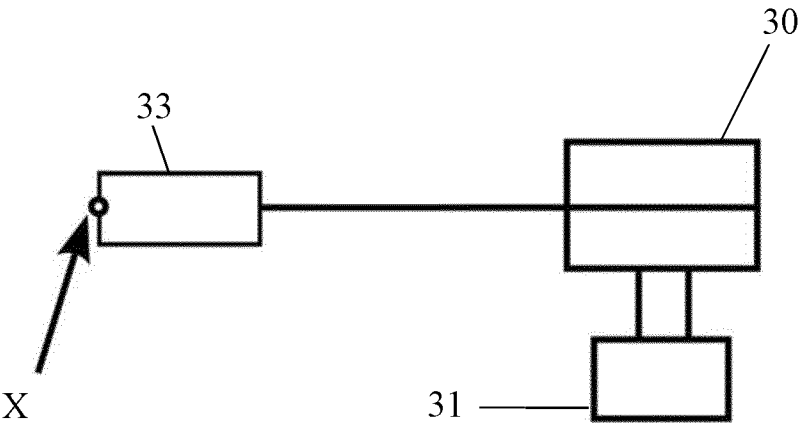


Fig. 10a

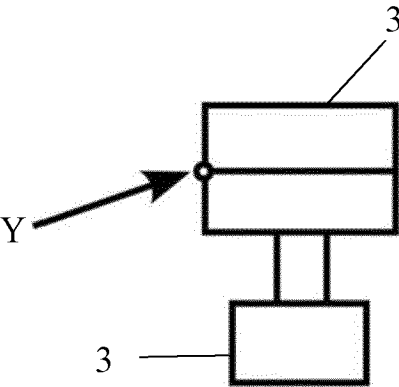


Fig. 10b

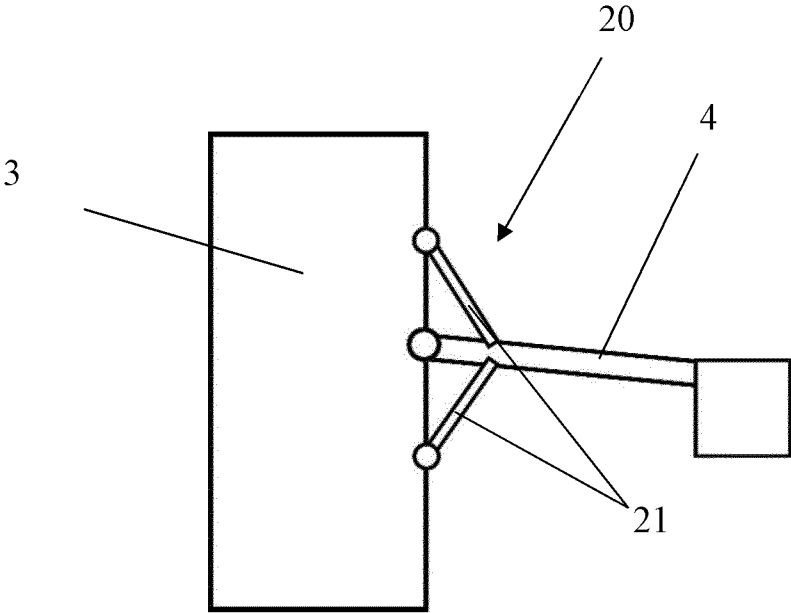


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/083305

A. CLASSIFICATION OF SUBJECT MATTER INV. F03B13/18 F03D9/00 F03D13/20 F03B13/20 F03D13/25 ADD.		
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) F03B F03D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013/150320 A2 (CHORIANOPOULOS DIMITRIOS [GR]) 10 October 2013 (2013-10-10) page 3 – page 6; figures 1-9,11 -----	1, 2, 4-6, 8, 10
X	CN 113 202 699 A (UNIV JIANGSU SCIENCE & TECH) 3 August 2021 (2021-08-03) page 6 – page 7; figures 1-4 -----	1, 3, 5, 7-13
X	CN 105 781 899 A (UNIV SHANGHAI JIAOTONG) 20 July 2016 (2016-07-20) paragraphs [0007], [0042], [0045], [0046]; figures 1,2,5 -----	1, 5, 7-13
A	US 2013/008164 A1 (CUNNINGHAM BRIAN T [US] ET AL) 10 January 2013 (2013-01-10) paragraphs [0035], [0101]; figure 7A ----- -/--	1-13
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
22 March 2024		09/04/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Lux, Ralph

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2023/083305

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 3 350 437 A1 (PANCENCO VITALIE [MD]; PANCENCO IULIAN [MD]) 25 July 2018 (2018-07-25) paragraphs [0002], [0013] - [0015]; figures 1-9 -----	1-13

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Information on patent family members

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