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[Continued on next page]

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(54) Title: SYSTEM AND PROCESS FOR MANAGING AND CONTROLLING THE FLIGHT OF WING PROFILES, IN PARTICULAR FOR WIND GENERATOR

(57) Abstract: A system is described for managing and controlling the flight of at least one wing profile (1), in particular for wind generator, comprising at least one orientable lever (2) adapted to deviate at least one tether (3) connecting the wing profile (1) to at least one ground station (4), such orientable lever (2) comprising means (5) adapted to orient at least one tether (3) along a movement direction of the wing profile (1). A process is further described for managing and controlling the flight of wing profiles through such system.

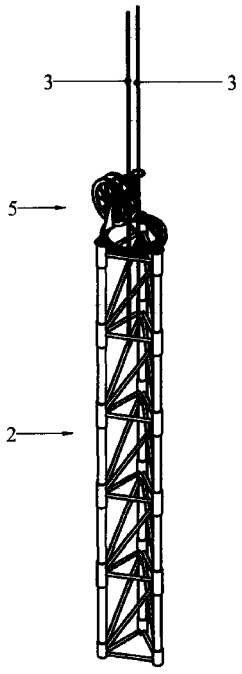


FIG. 2

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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SYSTEM AND PROCESS FOR MANAGING AND CONTROLLING THE FLIGHT OF WING PROFILES, IN PARTICULAR FOR WIND GENERATOR

The present invention refers to a system and to its related process for managing and controlling the flight of at least one wing profile, in particular for wind generator.

The prior art is represented by patent US6523781, which discloses an apparatus to exploit wind energy comprising a wing profile of an inflatable sail, a ground station with at least one pulley adapted to transmit operating power of a shaft for producing energy, a flexible tether adapted to connect such inflatable sail to the pulley to transfer the wing profile lift to such pulley generating operating power, means for controlling the flight trajectory of such wing profile, means for actuating such wing profile and means for rewinding such flexible tether onto the pulley. The inflatable sail is connected to the ground station through control tethers and support

tethers. The control tethers can change length for controlling incidence angle, flight direction, and flight speed of such wing profile. The length variation of such control tethers is managed by the ground station through a system of mobile pulleys. Both control tethers and support tethers are wound on a power shaft through a system of pulleys connected to an electric energy generator. The inflatable sail is pushed at a very high speed by the wind speed, causing a rotation of the pulleys. Once having ended the tether unwinding, the inclination angle of the wing profile is modified to be able to start the rewinding of the tethers using a minimum force. Once the tethers have been rewound at the right distance, the wing profile is again inclined for its high-speed operation adapted to generate axial power. Since the tether winding force is much lower with respect to the winding force, a net power is generated. The control group comprises a plurality of mobile supports adapted to separately interact with such control and support tethers for supporting the inflatable sail and regulated the inclination angle of the two ends, through a controller electrically actuated by the ground station.

US6523781 however does not solve the problem of controlling the attitude of a power wing profile avoiding the use of control tethers.

According to ITTO20080423 filed by the same Applicant, a wind generator is composed of a rotatable basement, an orientable arm, a jet-type ventilation plant, a support system of a variable geometry wing, a system for guiding the tethers. Such flexible and resistant orientable arm assumes an inflexed position given by the tension acting on the tethers depending on the aerodynamic actions acting on the wing in order to reduce the amount of an overturning moment. Such orientable arm can be made of trunks connected by cardan joints while the inflexion is controlled in a programmed way through servomechanisms. Such basement can rotate around a vertical axis while the supporting system is composed of a part of small arms.

ITTO20080423 however does not solve the problem of having to modify the shape of the orientable arm when there are high axial loads along the tethers, using high twisting torques of the servomechanisms to move apart said small arms.

Object of the present invention is solving the above prior art problems by providing a system and

its related process for managing and controlling the flight of a wing profile, in particular for wind generator, comprising means for controlling the axial tension of the supporting tethers placed in the ground station and means for controlling the attitude of the wing profile placed on board the inflatable sail.

A further object is using orientable means through servomechanisms for controlling the axial tension of the tethers placed on board an orientable arm connected to a ground station.

A further object is providing a process for managing and controlling the flight of such power wing profile lacking tethers for controlling the attitude.

The above and other objects and advantages of the invention, as will appear from the following description, are obtained with a system and a process as claimed in the respective independent claims. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

It is intended that the enclosed claims are an integral part of the present description.

It will be immediately obvious that numerous

variations and modifications can be made to the described apparatus and method (for example related to shape, sizes, arrangements, various colors and parts with equivalent functionality) without departing from the scope of the invention as appears from the enclosed claims.

The present invention will be better described by some preferred embodiments, provided as a non-limiting example, with reference to the enclosed drawings, in which:

- Figure 1 shows a perspective view of a wind generator comprising a system for managing and controlling the flight of a wing profile according to the present invention;
- Figure 2 shows a perspective view of a preferred embodiment of an orientable lever of the system according to the present invention comprising means adapted to orient at least one tether in the movement direction of such wing profile;
- Figure 3 shows an enlarged view of Figure 2;
- Figure 4 shows a perspective view of a servomechanism of the system according to the present invention adapted to orient at least one tether in the movement direction of such wing

profile;

- Figure 5 shows an enlarged view of the particular contained in circle V in Figure 4;

- Figure 6 shows a perspective view of a device of the system according to the present invention adapted to detect the angular inclination of at least one tether in the movement direction of such wing profile; and

- Figure 7 shows an enlarged part of Figure 6.

With reference to Figure 1, it is possible to note that a system according to the present invention for managing and controlling the flight of at least one wing profile 1, in particular for wind generator, comprises at least one orientable lever 2 adapted to deviate at least one tether 3 connecting such wing profile 1 to at least one ground station 4.

With reference to Figures 2 and 3, it is possible to note that such orientable lever 2 comprises means 5 adapted to orient at least one tether 3 along the movement direction of the wing profile 1. Such means 5 comprise at least one idle pulley 51 adapted to deviate the tether 3 by orienting itself along the movement direction of such wing profile 1.

With reference to Figures 4 and 5, it is possible to note that such means 5 comprise at least one servomechanism 6 adapted to orient at least one idle pulley 51 along the movement direction of the wing profile 1.

Such servomechanism 6 comprises a carrier structure 7 adapted to rotate with respect to the orientable lever 2 by means of at least one motored fifth wheel 8.

The carrier structure 7 is composed of a space structure comprising a ring 71 surmounted by a pair of beams 72 opposed by beams 73 with respect to such ring 71. A cylindrical pin supported by such carrier structure 7 allows rotating at least one idle pulley 51 with respect to an axis 74.

The ring 71 is equipped with a toothed wheel 75 integral with a first part of the motored fifth wheel 8.

A second part of the motored fifth wheel 8 is fastened to a frame 21 in turn fastened to the projecting end of the orientable lever 2.

At least one pinion 81 actuated by a motor-reducer 82 belonging to the frame 21 transmits the rotary motion to the ring 71 through the toothed wheel 75 allowing the carrier structure 7 to rotate

with respect to the orientable lever 2.

With reference to Figures 6 and 7, it is possible to note that such means 5 further comprise at least one device 9 adapted to detect at least one angular inclination of at least one tether 3 with respect to the orientable lever 2.

The device 9 comprises at least one arm 91 with fulcrum on the axis 74 on which at least one idle pulley 51 rotates. The arm 91 is equipped with at least one cable raceway 92 crossed by such tether 3 allowing such arm 91 to rotate by the same winding angle of at least one tether 3 on at least one idle pulley 51.

Such device 9 further comprises at least one slotted support 93 equipped with means for measuring the transverse displacement of at least one tether 3 with respect to the arm 91.

A system controller (not shown) manages the operation of the motor-reducer 82, processes the values of angular measure detected by the device 9, controls means (not shown) adapted to lift the orientable lever 2.

According to a preferred version, at least one slotted support 93 is integral with the arm 91 through a tangential extension 94.

The optimum winding angle of the tether 3 with respect to the pulley 51 is equal to 20°.

The present invention further deals with a process for managing and controlling the flight of a wing profile 1, implemented through a system for managing and controlling the flight of a wing profile as previously described. In particular, the process according to the present invention comprises the following steps:

a) at least one tether 3 is deviated by the orientable lever 2 by winding on at least one pulley 51;

b) the arm 91 rotates with respect to the axis 74 by the same winding angle of the pulley 51;

c) the angular measure is transmitted to the system controller adapted to drive one or more actuators of the orientable lever 2 in order to take the winding angle to a value preferably equal to 20°;

d) the measure value of the inclination angle of the tether 3 with respect to the arm 91 is processed by the system controller to move the servomechanism 6 adapted to orient the idle pulley 51 along the movement direction of the wing profile 1.

The deviation by winding the tether 3 on the pulley 51 by an angle of 20° allows the current system to dampen the effect of a sudden increase of the axial tension of the tether 3.

Moreover, the system controller can intervene on the inclination of the orientable lever 2 to increase the winding angle up to a value greater than 90°.

CLAIMS

1. System for managing and controlling the flight of at least one wing profile (1), in particular for wind generator, comprising at least one orientable lever (2) adapted to deviate at least one tether (3) connecting said wing profile (1) to at least one ground station (4), said orientable lever (2) comprising means (5) adapted to orient said tether (3) along a movement direction of said wing profile (1), said means (5) comprising at least one idle pulley (51) adapted to deviate said tether (3) by orienting itself along said movement direction of said wing profile (1), said means (5) comprising at least one servomechanism (6) adapted to orient said idle pulley (51) along said movement direction of said wing profile (1), characterized in that said servomechanism (6) comprises a carrier structure (7) adapted to rotate with respect to said orientable lever (2) by means of at least one motored fifth wheel (8).

2. System according to claim 1, characterized in that said means (5) comprise at least one device (9) adapted to detect at least one angular

inclination of said tether (3) with respect to said orientable lever (2).

3. System according to the previous claim, characterized in that said device (9) comprises at least one arm (91) with its fulcrum on a rotation axis (74) of said idle pulley (51) adapted to rotate by the same winding angle of said tether (3) with respect to said idle pulley (51).

4. System according to the previous claim, characterized in that said device (9) comprises at least one slotted support (93) equipped with means for measuring a transverse displacement of said tether (3) with respect to said arm (91).

5. System according to any one of claims 3 or 4, characterized in that said slotted support (93) is integral with said arm (91).

6. Process for managing and controlling the flight of a wing profile (1) for wind generator, through a system according to any one of claims 3 to 5, characterized in that it comprises the following steps:

a) said tether (3) is deviated by said orientable lever (2) by winding onto said pulley (51);

b) said arm (91) rotates with respect to said axis

(74) by the same winding angle of said pulley (51);

c) the angular measure is transmitted to at least one system controller adapted to control one or more actuators of said orientable lever (2) in order to take said winding angle to a value preferably equal to 20°;

d) the measure value of the inclination angle of said tether (3) with respect to said arm (91) is processed by said system controller to move said servomechanism (6) adapted to orient said idle pulley (51) along said movement direction of said wing profile (1).

7. Process according to the previous claim, characterized in that it comprises a step of damping the effect of a sudden increase of the axial tension of said tether (3) by increasing said winding angle up to a value greater than 90°.

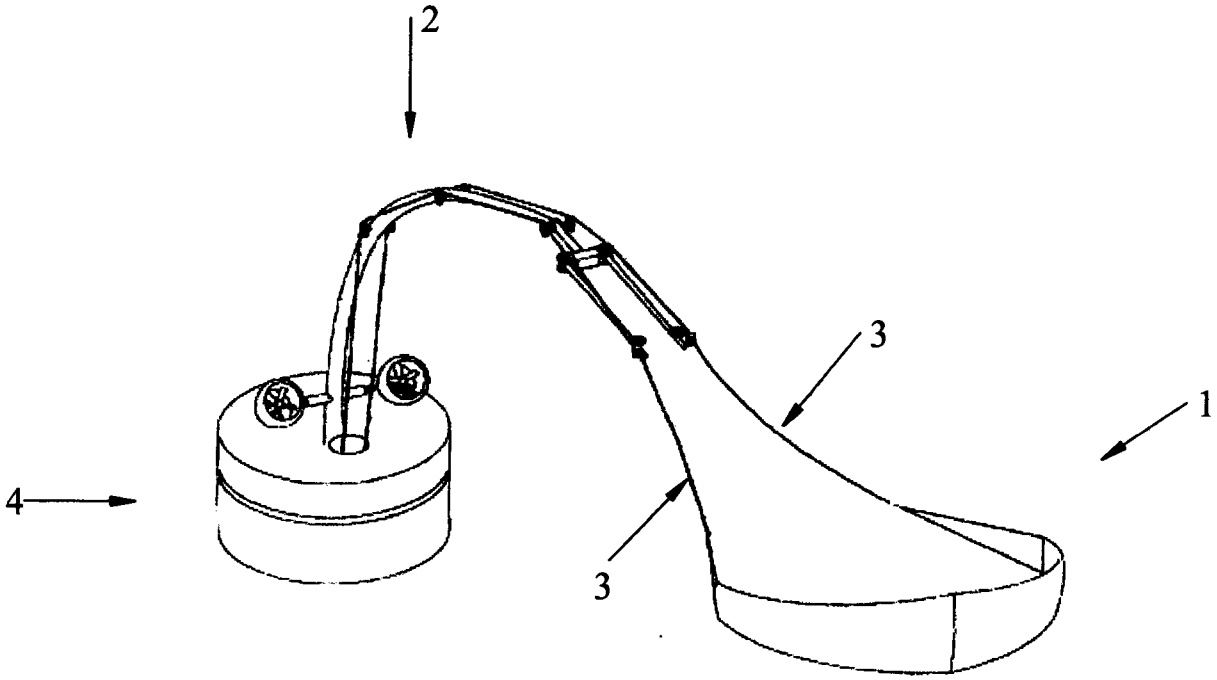


FIG. 1

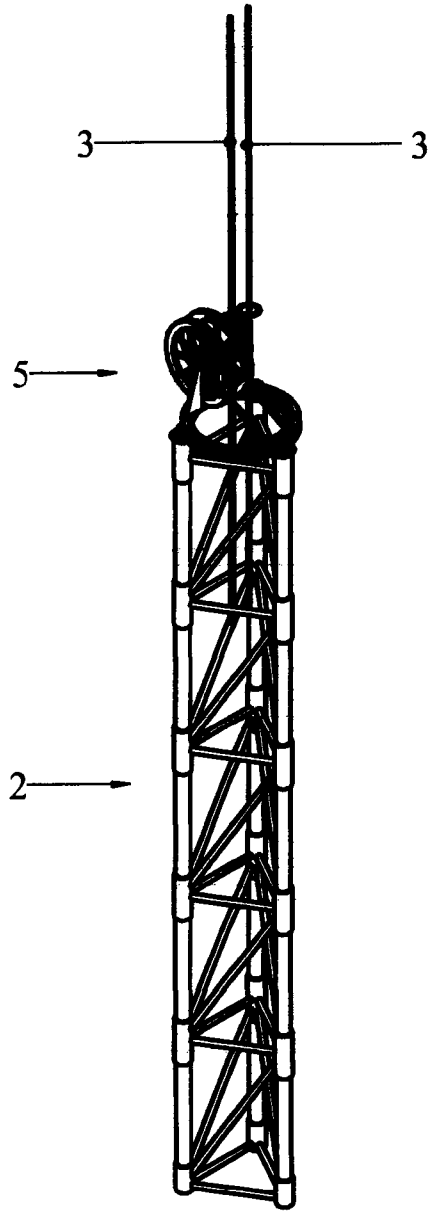


FIG. 2

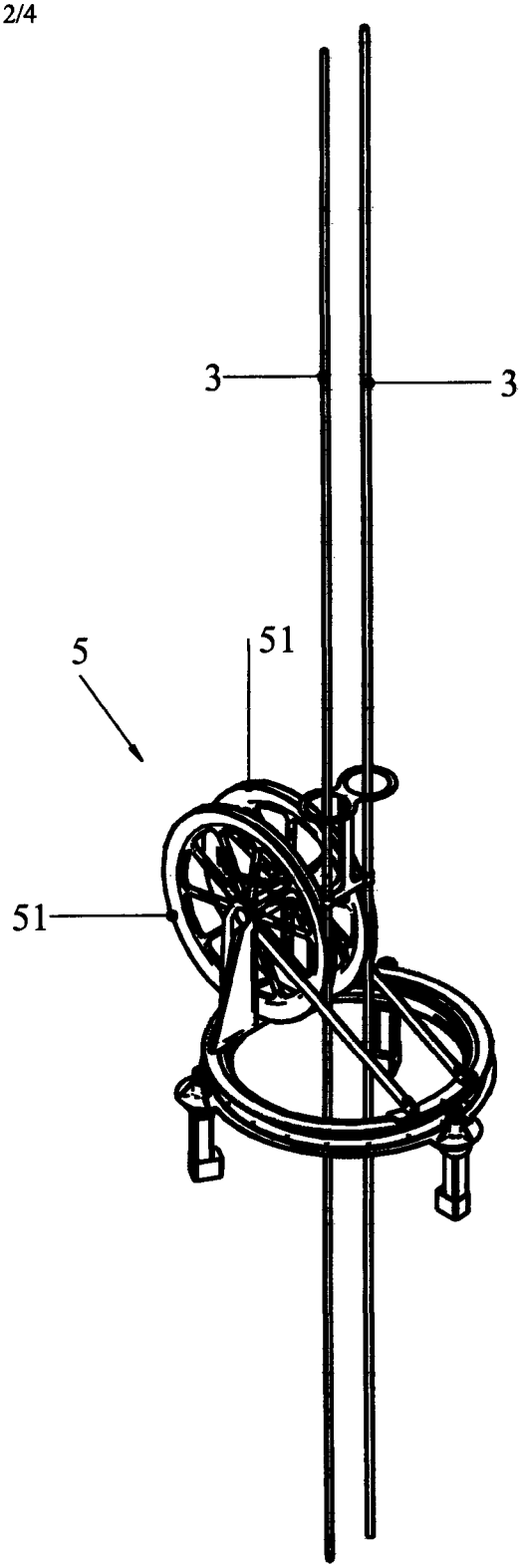


FIG. 3

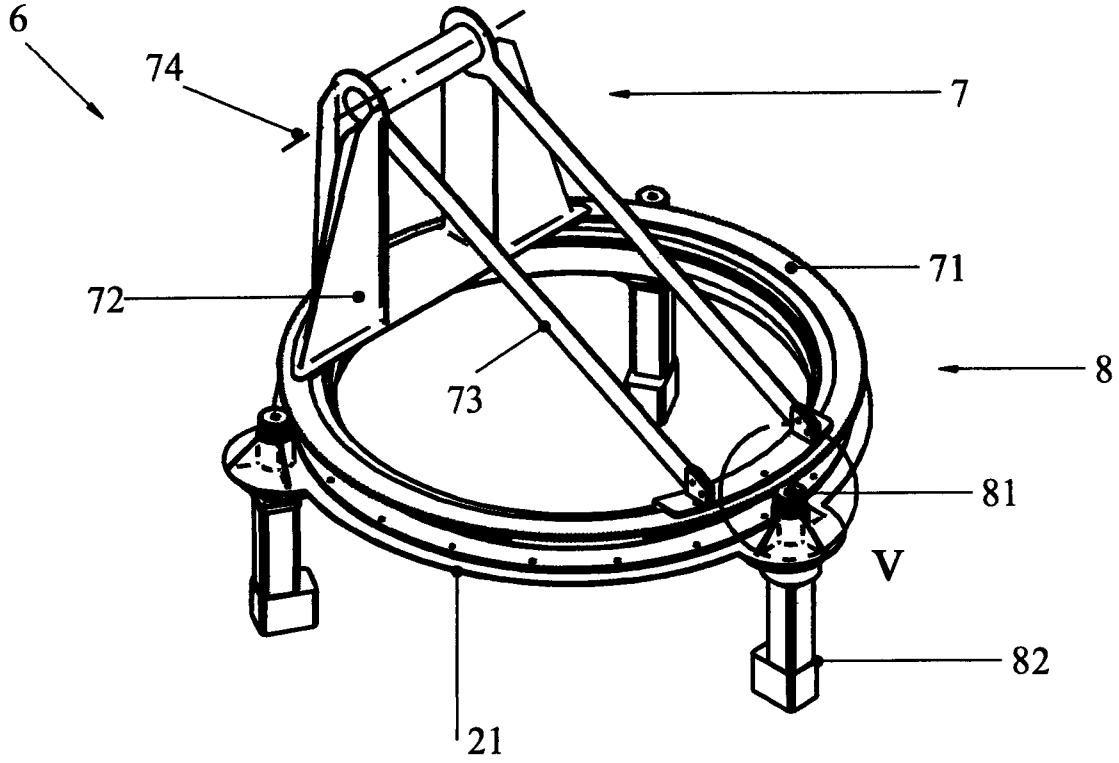


FIG. 4

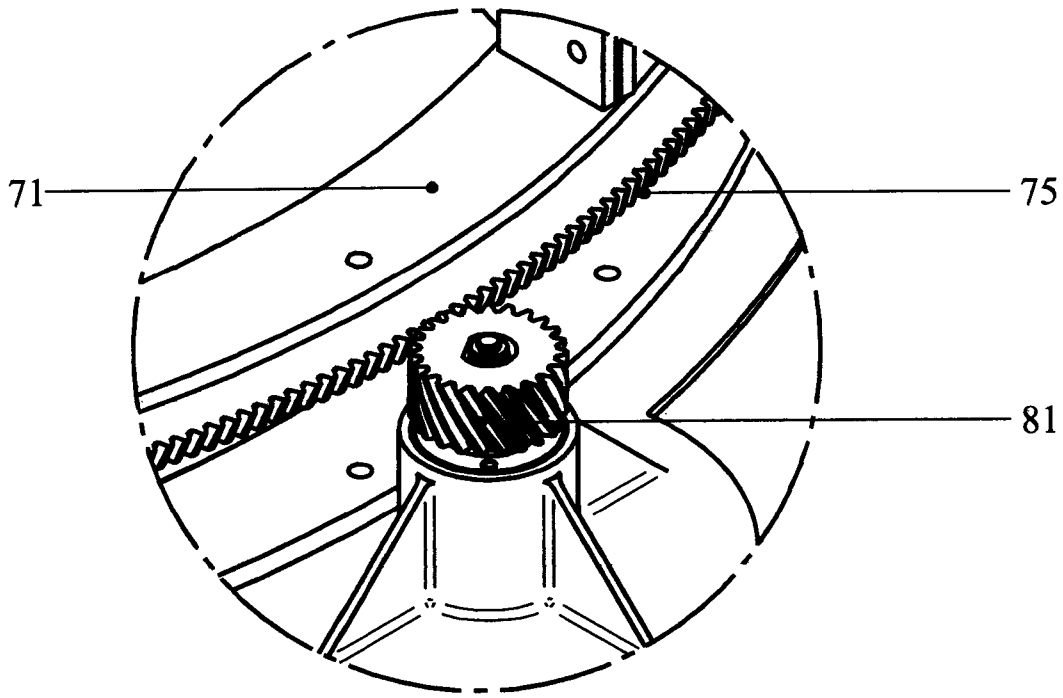


FIG. 5

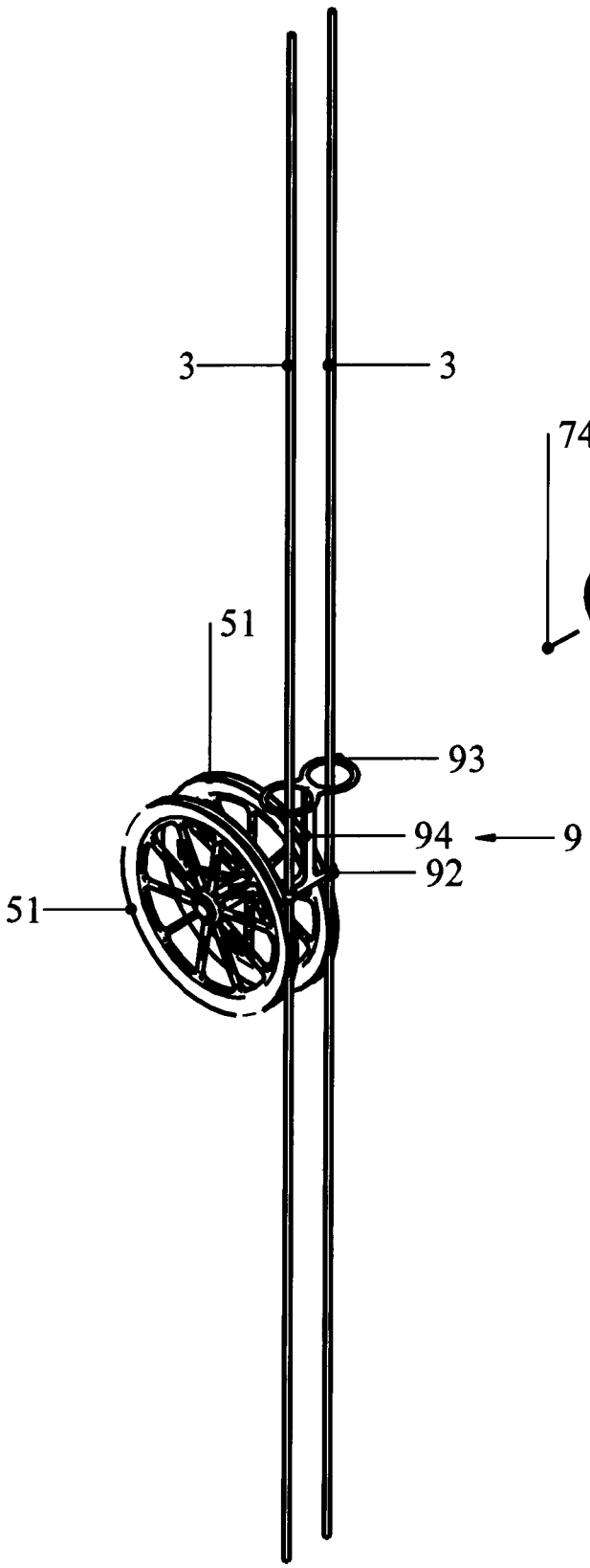


FIG. 6

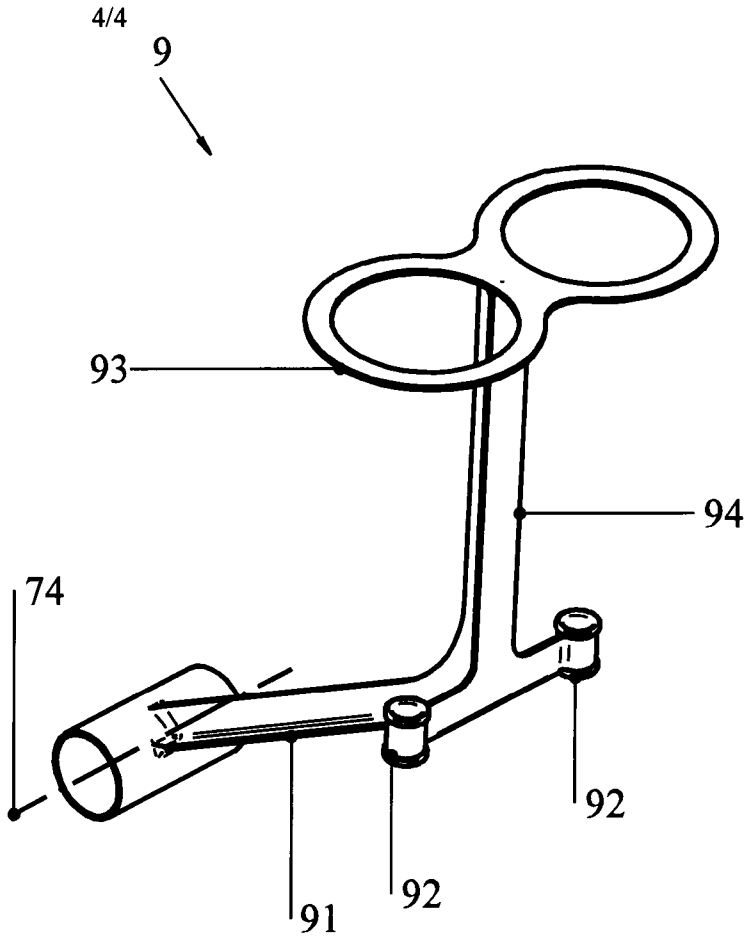


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2015/000018

A. CLASSIFICATION OF SUBJECT MATTER
INV. F03D5/00 F03D5/06
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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/147692 A2 (IPPOLITO MASSIMO [IT]) 10 December 2009 (2009-12-10) cited in the application abstract page 13, line 1 - page 16, paragraph 3 figures	1-7
A	WO 2013/094623 A1 (CAPE ECOLOGY PLAN CO LTD [JP]) 27 June 2013 (2013-06-27) abstract figures 1-10	1-5
A	WO 2013/005182 A2 (HYSTAD JAN [NO]) 10 January 2013 (2013-01-10) abstract page 4, line 5 - page 8, line 36 figures	1-7

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2015/000018

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 523 781 B2 (RAGNER GARY DEAN [US]) 25 February 2003 (2003-02-25) cited in the application abstract column 8, line 1 - column 31, line 38 figures -----	1-7

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2015/000018

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