

Watercraft having a kite-like element

The invention relates to a watercraft having a
5 kite-like element, which is connected to the watercraft
by a hawser.

In one already known watercraft (WO 01/192102 A1), it
is possible for the kite-like element to be connected
10 to the watercraft by a plurality of hawsers. In this
case, the kite-like element is used to propel the
vessel by wind, in which case this propulsion system
can be operated exclusively by wind, or else the
propulsion system uses the wind only to assist the
15 mechanical propulsion system in order in this way to
save fuel or to increase the speed. The kite-like
element can be controlled by the plurality of hawsers.
A plurality of hawsers have the disadvantage, however,
that they must be hauled in and paid out individually
20 in order to retrieve or to deploy the kite-like
element. In addition, the plurality of hawsers could
also become entangled. The cited document therefore
also discloses a watercraft having a kite-like element
of the type mentioned initially, in which only one
25 hawser is provided, by means of which the stated
problems are avoided.

However, this has the disadvantage that the kite-like
element can no longer be controlled directly.

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The object of the invention is to create a watercraft
having a kite-like element of the type mentioned
initially, in which the kite-like element can be
controlled deliberately.

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The solution according to the invention comprises the
kite-like element being provided with adjusting devices
which are supplied from the watercraft with power which
is transmitted in or on the hawser.

Adjusting devices are therefore provided, by means of which the shape of the sail of the kite-like element, the incidence angle, opening valves, the reefing processes and the like can be changed or provided. In this case, the control process can be carried out automatically by means of sensors provided on the kite-like element or, and this is particularly advantageous, by radio from the vessel. In this case, there are no problems in sending the signals to the kite-like element. However, a power supply is required for the adjusting devices. According to the invention, this power supply is now provided from the watercraft, to be precise in or on the hawser.

In one advantageous embodiment, a power transmission element which connects the watercraft and the kite-like element is attached to the hawser. In another embodiment, the hawser is in the form of a tension-resistant power transmission element which connects the watercraft and the kite-like element.

The power transmission element may be an electrical cable. The electrical cable may in this case, in particular, be a carbon-fiber cable. The entire hawser could thus also be composed of carbon fibers. In a hawser such as this, the hawser braids lie parallel to one another and are held together only by a casing. In this case, by way of example, the braids can be electrically split in two so that one half of the braids is insulated from the other half, so that the carbon-fiber cable can be used for the forward path and return path of the electric current, and there is no need to provide any extra conductors. In this case, the braids which are used to carry electrical power can also at least partially absorb the tensile force. On the outside, the cable is insulated by a casing.

If the electrical cable is in the form of a hawser, then it can be provided with appropriate reinforcing

cables or wires in order to provide it with sufficient tensile strength.

Electrical power can then be transmitted through this power transmission element from the watercraft to the kite-like element in order to supply it with electrical power. However, the electrical cable can also be used to transmit control signals from the watercraft to the kite-like element. However, these control signals could also be transmitted, for example, by radio.

In another advantageous embodiment, the power transmission element is a flexible tube. A fluid can then be transmitted through this power transmission element to the kite-like element, acting on appropriate operating elements there.

The power transmission element in another advantageous embodiment is an optical waveguide, in particular a glass fiber. Light can then be transmitted through this power transmission element, and can be converted to electrical power by suitable transducers in the kite-like element.

If the power transmission element and the hawser are combined to form a single element, then this results in less aerodynamic drag. Handling on the winch is easier than if a plurality of separate elongated elements had to be wound up or unwound. This also results in the hawser/power transmission element being lighter in weight.

The disadvantage is that the power transmission element and the cable must be capable of expanding to approximately the same extent and this must be true over the operating temperature range. If a flexible tube is used, this must not be trapped on the winch by the cable when on load, or while being wound up.

If it is not possible to select the power transmission element such that it can expand to precisely the same extent as the hawser, the power transmission element must be arranged such that it can slide with respect to the hawser. This can be achieved by a sliding layer, if the power transmission element is arranged within the hawser. If they can expand to approximately the same extent, the hawser and the power transmission element can be adhesively bonded to one another.

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If a flexible tube is used, this is expediently held by a raised pressure, since in this case the internal pressure in the flexible tube prevents kinking or pinching.

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In another embodiment, the power transmission element and the hawser are separated, but are connected to one another, expediently by brackets. The advantage is that the power transmission element and the hawser may have different expansion capabilities, if the power transmission element can move relative to the hawser. If there is no need to take account of them having the same expansion capability, better material optimization is possible. In addition, maintenance can be better carried out. The disadvantages are that the aerodynamics are poorer, handling on the winch is more difficult, and the weight may be higher.

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As an alternative to the use of brackets for attachment as mentioned, in which case the brackets are expediently secured against sliding on the hawser, attachment is possible, for example, by means of splicing, a Velcro strip between the cable and the power transmission element, bindings, fixed clips or sheathing (wear-resistant envelope). The larger the gap between the power transmission element in the hawser, the greater is the aerodynamic drag.

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If the hawser and the power transmission element are separate elements, then it is important for the two elements to be able to move with respect to one another within certain limits. In this solution, it is highly
5 advantageous for the power transmission element to move with respect to the hawser, and not vice versa.

When a hawser and a power transmission element that is separate from it are used, the warping drum must be
10 adapted such that it has two different radii, so that the hawser and the power transmission element can be rolled up in parallel on the same warping drum. In this solution, it is important for the power transmission
15 element to be able to expand to a greater extent than the hawser, since the tensile load must not be exerted through the power transmission element.

The overall system must be optimized to the maximum ultimate load/working load, minimum expansion, minimum
20 drag, minimum mass and maximum power transportation capability.

It is self-evident that the power transmission element must be connected by appropriate contact elements for
25 power transmission to the watercraft and to the kite-like element.

If a flexible tube is used, compressed air, in particular dried and/or heat-compressed air, is
30 particularly advantageous as the power transmission fluid, since, otherwise, moisture could freeze in the flexible tube which would not only increase the weight of the hawser but would also result in the risk of the flexible tube being obstructed, so that no more
35 compressed air can be transmitted.

In another advantageous embodiment, a combustible gas, in particular hydrogen or methane, is used rather than compressed air as the power transmission fluid. A fuel

is then available in the kite-like element, and can likewise be used to provide a drive. Methane could drive a fuel cell or internal combustion engine in the kite-like element or in a pod attached to it. A high-
5 density fluid, that is to say in particular liquids, is less suitable for use as the power transmission medium since the corresponding fluid or liquid column in the flexible tube would be very heavy.

10 A winch is expediently provided for the hawser and/or for the power transmission element on the watercraft, and is provided with a guide surface or a guide plate in front of the warping drum, for alignment of the hawser and/or of the power transmission element.

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Two, three or even more warping drums with one cable store are expediently provided, thus making it possible to ensure that the hawser, and the assembly formed by the hawser/power transmission element do not rub on the
20 wall of the warping drum. When using two or three warping drums, between which the hawser/power transmission element runs backwards and forwards, a looping angle of at least 450° can nevertheless be achieved, which is adequate for the tensile loads to be
25 absorbed.

For safety reasons (for example in the event of transmission breakage, etc.), each warping drum expediently has its own emergency brake, which may
30 expediently be in the form of a strap brake. An adjustable disk brake can be provided for normal braking. A cable store can be arranged behind the warping drums, and may be in the form of a drum, which is likewise driven and braked.

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If the hawser and the power transmission element are arranged alongside one another, a double-start warping drum profile is expediently used, in order that the hawser and the power transmission element can be held

in separate grooves matched to their cross section.

The abovementioned expedient embodiments with the winch having a guide surface and a guide plate, with 2, 3 or
5 more warping drums with a cable store, with the emergency brake for each warping drum and with a double-start warping drum profile, are particularly advantageous for the situation mentioned above, in which the hawser also has a power transmission element,
10 and/or is connected to a power transmission element. These particular advantages of the winch also exist, however, in situations in which only a hawser is provided, without any power transmission. The protection of this application is therefore expressly
15 intended to cover those situations in which the winch is designed as stated, but only a hawser without any power transmission element is provided.

The power supply for the kite-like element can be used
20 not just for adjustment. In fact, electrical power can be transmitted, or can be generated in the kite-like element on the basis of the other power supply, in order to provide an operating voltage for control purposes, and for the sensors, etc. A rechargeable
25 battery is expediently provided in the kite-like element or in the pod, for storage of electrical energy.

In particular (but not exclusively) in situations where
30 an electrical cable is used as the power transmission element, there is a risk of lightning strike or of overvoltages resulting from electrostatic effects. Lightning protection and/or protection against electrostatic charging and discharging are thus
35 expediently provided. The lightning protection and/or the protection against electrostatic charging and discharging are/is however, not restricted to the situation in which a power transmission element is provided. The protection of the utility model is also

expressly intended to cover the situation in which lightning protection devices and/or protection devices against electrostatic charging and discharging such as these are provided in the situation where a hawser is
5 used without a power transmission element.

The invention will be described in the following text using, by way of example, advantageous embodiments and with reference to the attached drawings, in which,
10 illustrated schematically:

- Figures 1-3 show cross sections through three different hawsers with an integrated power transmission element;
15 Figure 4 shows a winch with two warping drums;
Figure 5-6 show profiles of different warping drums;
20 Figure 7 shows a cable guide with three warping drums and a cable store;
Figures 8-10 show flanges with sheaves by means of which a hawser/power transmission element are attached to the kite-like element;
25 Figure 11 shows a schematic illustration of the watercraft and of the kite-like element;
30 Figure 12 shows a detailed illustration of the overvoltage protection A in the pod; and
35 Figure 13 shows a detailed illustration of the overvoltage protection B on the watercraft.

Figure 1 shows a hawser 1 (or its tension-resistant fiber structure) in which a power transmission element 2 is arranged centrally and is separated by a layer 3 from the main part 1 of the hawser. The power transmission element 2 may be a flexible tube, in which case the element 3 is then the flexible tube wall. The element 2 may, however, also be a cable, in which two semicircular conductors are separated from one another by insulation and are surrounded by insulation 3.

In the embodiment shown in Figures 2 and 3, the main part 1 of the hawser and the power transmission element 2 are surrounded by common envelopes 4.

Figure 4 shows a winch with two warping drums 5, 6 which are connected to one another by means of a transmission 7. The warping drum 5 is in this case connected to a motor 8, and the warping drum 6 is connected to a brake 9. The two warping drums 5, 6 also have emergency brakes 10, in particular in the form of a strap brake. The electrical power supply is shown at 11.

The warping drum 12 in Figure 5 has a single-start profile for holding the hawser/power transmission element, which is in an integrated form. The warping drum 13 in Figure 6 has a double-start profile, in which the hawser is held in one of the profile grooves, and the power transmission element is held in the other.

Figure 7 shows an arrangement with three warping drums 14, 15, 16 and a cable store 17, by means of which the hawser 1 and the power transmission element 2 can be wound up and unwound.

Figures 8 to 10 show sheaves 18 in order to indicate various possible ways indicating how the hawser 1 and the power transmission element 2 can be connected to

the kite-like element which is not shown in the figures.

Figure 11 shows a watercraft 21, illustrated
5 schematically, which has a winch 5 which holds a hawser
1. This hawser is connected to the control pod 22 of a
kite-like element 23. This control pod 22 can be used
to match the hawsers 24 for the kite-like element 23 to
the wind conditions and maneuver conditions. An
10 enlarged illustration of the hawser 1 with the two
conductors for an electrical cable (2) is shown in the
circle 25. The control pod 22 is connected by means of
cable insulators 26 to the hawsers 24, in order in this
way to provide lightning protection and protection
15 against electrostatic discharges. Corresponding cable
insulators may alternatively or additionally be
provided between the control pod 22 and the hawser 1.

However, the lightning or overvoltage protection is not
20 restricted to these cable insulators 26. In fact, the
electrical circuit A which is not shown in any more
detail in Figure 12, is also provided in the control
pod 22. The two conductors in the cable 2 are annotated
"+" and "-", and a voltage-dependent resistor 27 is
25 located between them, whose resistance decreases as the
voltage rises. 28 and 29 denote surge arrestors. A
surge arrestor is in this case an element which acts as
an insulator at normal operating voltages but, when
relatively high voltages occur, dissipates or shorts
30 them. The surge arrestor may in this case be designed
in a similar manner to a capacitor as a tube with a
center electrode and a wall electrode, or as a flat
capacitor element with two plates. The two electrodes
or plates are in this case arranged a short distance
35 apart, which is sufficient for the element to act as an
insulator at normal operating voltages. When the
operating voltages are relatively high, a current then
flows between the two electrodes or plates, thus
dissipating the overvoltage. The higher the voltage

and, as mentioned, the lower the resistance of the resistor 27, the greater the amount of current which can be dissipated via the surge arrestor 28, 29 without endangering the installed electronics. The dissipation
5 of the overvoltage (residual voltage from the surge arrestor to ground) is also shown at 30.

The circuit B is arranged in the watercraft. 31 is in this case the supply line from the vessel generator, 32
10 is a fuse on the supply circuit for the cable walls 5. 33 is a fuse for the overvoltage protection 34. 35 is the ground, that is to say the vessel body or the water, and 36 is the supply line to the winch 5.

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Patent Claims

1. A watercraft having a kite-like element which is
5 connected by a hawser (1) to the watercraft, and is
provided with adjusting devices which are supplied from
the watercraft (21) with power which is transmitted in
or on the hawser (1), with a power transmission element
(2) which connects the watercraft (21) and the kite-
10 like element (23), being attached to the hawser (1) and
the power transmission element (2) being arranged in a
cavity which extends over the length of the hawser (1).
2. The watercraft as claimed in claim 1,
15 characterized in that the hawser (1) is in the form of
a tension-resistant power transmission element (2)
which connects the watercraft (21) and the kite-like
element (23).
- 20 3. The watercraft as claimed in claim 1 or 2,
characterized in that the power transmission element
(2) is an electrical cable, in particular a carbon-
fiber cable.
- 25 4. The watercraft as claimed in claim 1 or 2,
characterized in that the power transmission element
(2) is a flexible tube.
5. The watercraft as claimed in claim 1 or 2,
30 characterized in that the power transmission element
(2) is an optical waveguide, in particular a glass
fiber.
6. The watercraft as claimed in claim 1,
35 characterized in that the power transmission element
(2) is arranged such that it can slide and can be moved
in the cavity.

AMENDED SHEET

7. The watercraft as claimed in claim 1, characterized in that the power transmission element (2) is adhesively bonded to the hawser (1).

5 8. The watercraft as claimed in claim 4, characterized in that compressed air, in particular dried and/or heated compressed air, is supplied to the kite-like element (23).

10 9. The watercraft as claimed in claim 4, characterized in that a combustible gas, in particular hydrogen or methane, is supplied to the kite-like element.

15 10. The watercraft as claimed in claim 3, characterized in that the cable is also used for signal transmission.

11. The watercraft as claimed in one of claims 1 to
20 10, characterized in that the watercraft has a winch (5, 6, 12 - 16) for the hawser (1) and/or for the power transmission element (2) which winch (5, 6, 12 - 16) is provided with a guide surface or a guide plate in front of the warping drum for alignment of the hawser (1)
25 and/or of the power transmission element (2).

12. The watercraft as claimed in claim 11, characterized in that a plurality of warping drums (14-16) having a cable store (17) are provided.

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13. The watercraft as claimed in claim 12, characterized in that each warping drum (5, 6) is provided with its own emergency brake (10).

35 14. The watercraft as claimed in one of claims 1 to 13, characterized in that the watercraft is provided with lightning protection and/or with protection against electrostatic charging and discharging.