



(11)

EP 2 471 708 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
31.07.2013 Bulletin 2013/31

(51) Int Cl.:
B63H 21/20 (2006.01)

(21) Application number: **11195719.7**

(22) Date of filing: **23.12.2011**

(54) **Method and electronic system for controlling the propulsion modes of a boat**

Verfahren und elektronisches System zur Kontrolle der Antriebs-Modi eines Boots

Procédé et système électronique pour contrôler la mode de propulsion d'un bateau

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **28.12.2010 IT MI20102430**

(43) Date of publication of application:
04.07.2012 Bulletin 2012/27

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(56) References cited:
**EP-A2- 2 090 507 WO-A1-97/40999
CA-A1- 2 643 878**

EP 2 471 708 B1

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Description

[0001] The present invention relates to a method and an electronic system for controlling the propulsion modes of a boat.

[0002] Over the last few years, in commercial and pleasure marine, the need of reducing the emissions for environmental reasons, as well as the need of reducing consumptions due to economic reasons, have given a considerable impulse to the analysis and design of hybrid propulsion means.

[0003] To this end, boats are known that are provided with an electric motor and with a thermal motor configured according to a so-called hybrid thermal-electric layout, which may be of the type in series or of the type in parallel or of the mixed type, according to the connection mode between the two motors.

[0004] In such boats, the switch from one propulsion mode to the other is automatically regulated on the basis of the cruising speed in order to maximize the energy efficiency.

[0005] However, it is clear that despite the energy optimization that can be obtained by the use of hybrid propulsion means, motor-driven navigation is not capable of fully meeting the requirements regarding economic and environmental sustainability.

[0006] The reduction of energy consumptions, in fact, is not always so significant as to generate a considerable saving in economic terms.

[0007] A partial solution to said drawbacks is given by the use of groups of sails for propulsive purposes together with the hybrid thermal-electric propulsion means.

[0008] The integration of such groups of sails with the traditional electric and/or thermal motors, in fact, allows accommodating the requirements in terms of environmental sustainability and limiting consumptions, with other typical features of motor boats, such as for example the possibility of estimating certain travelling times for a stretch.

[0009] However, it is clear that the contribution to the propulsion provided by sail systems depends on the wind conditions.

[0010] In order to estimate such contribution, sensors for detecting the wind speed and direction are advantageously provided on the boats currently known. In this way, on the basis on such detection, the sailor estimates the favourable time for hoisting and/or lowering said group of sails.

[0011] However, it is worth stressing that such estimate is not deterministic since it is dictated above all by the sailor's experience and intuition, which is particularly unfavourable for commercial marine navigation.

[0012] In fact, at high cruising speeds of a merchant ship it is always very difficult to understand if the wind force is sufficiently strong to allow hybrid sail-motor propulsion.

[0013] Document WO-A-97/40999 discloses an auxiliary propulsion system for a boat or other marine vessel which incorporates an electric motor/transmission device for generating locomotive force to propel the boat or vessel, an electrical power supply for providing electrical energy to drive the electric motor/transmission device, at least one electrical energy generating device for generating electrical energy through conversion from one of at least sunlight, wind motion and water motion, a charging circuit having means for controlling charging of the power supply with electrical energy from the energy generating device, and means for controlling speed and direction operation of the electric motor/transmission device. In operation, electrical energy is inputted into the electric motor/transmission device from the electrical power supply and locomotive force is thereby generated by the electric motor/transmission device when the primary propulsion system of the boat or other marine vessel is inactive. Electrical energy to be stored in the electrical power supply is generated by converting at least one of sunlight, wind motion and water motion into electrical energy.

[0014] Inexact forecasts and/or estimates can cause considerable delays or in any case a non optimized propulsion from the energy point of view.

[0015] The object of the present invention is to obviate the drawbacks mentioned above and in particular that of devising a method for controlling the propulsion modes of a boat capable of managing the use of sail propulsion on a boat provided with a motor.

[0016] Another object of the present invention is to devise a method for controlling the propulsion modes of a boat that allows integrating the contribution to the propulsion provided by a group of sails and that provided by a motor.

[0017] A further object of the present invention is to provide an electronic system for controlling the propulsion modes of a boat that allows optimizing the energy consumption of the motor.

[0018] These and other objects according to the present invention are achieved by providing a method and an electronic system for controlling the propulsion modes of a boat as illustrated in the independent claims 1 and 13.

[0019] Further features of the method and of the electronic system for controlling the propulsion modes of a boat are object of the dependent claims.

[0020] The features and the advantages of a method and an electronic system for controlling the propulsion modes of a boat according to the present invention will appear more clearly from the following description, exemplifying and not limiting with reference to the annexed schematic drawings, wherein:

- figure 1 shows a block diagram of a first embodiment of an electronic system for controlling the propulsion modes

of a boat according to the present invention;

- figure 2 shows a block diagram of a second embodiment of the electronic system of figure 1;
- figure 3 shows a block diagram of a third embodiment of the electronic system of figure 1;
- figure 4 shows a flow chart relating to a first embodiment of a method for controlling the propulsion modes of a boat according to the present invention;
- figure 5 shows a flow chart relating to a second embodiment of the method of figure 4.

[0021] With reference to the figures, an electronic system for controlling the propulsion modes of a boat according to the present invention is shown, globally indicated with reference numeral 10.

[0022] Such electronic system 10 is advantageously coupled with a boat 20 of the type comprising a power controlled motor 21, a group of sails 22, a mobile centreboard 24 and a first plurality of sensors 23 of the wind and motion conditions of the same boat 20.

[0023] In detail, the power controlled motor 21 can be an electric motor or a thermal motor, as well as a hybrid thermal-electric motor, comprising both an electric motor and a thermal motor.

[0024] The first plurality of sensors 23 of the wind conditions and of the motion conditions of the boat preferably comprises anemometric sensors capable of detecting the direction or the incidence angle AWA and the apparent speed of the wind AWS, as well as speed sensors capable of detecting the navigation speed BS of boat 20.

[0025] The electronic system 10 for controlling the propulsion modes of a boat comprises a central processing and controlling unit 11 connected to the first plurality of sensors 23 of the wind conditions and of the motion conditions of the boat.

[0026] Such central processing and control unit 11 therefore is capable of receiving and processing the data detected by the first plurality of sensors 23 in order to calculate the actual speed TWS and the actual direction TWA of the wind.

[0027] Preferably, the connection between the central processing and control unit 11 and the first plurality of sensors 23 is wired but it may also be obtained by air through two two-way radio means by air (not shown), coupled the one with the central processing and control unit 11 and the other with the first plurality of sensors 23.

[0028] The electronic system 10 for controlling the propulsion modes of a boat further comprises means for generating a signal 13 connected to the central processing and control unit 11.

[0029] In detail, the means for generating a signal 13 are capable of producing an output signal for warning a user in order to indicate the instant when it is advantageous to hoist or lower the group of sails 22 on the basis of the data regarding speed TWS and real direction TWA of the wind.

[0030] If boat 20 also comprises means (not shown) for controlling the group of sails 22 capable of hoisting or lowering the same sails 22, the means for generating a signal 13 are capable of producing in output an actuating signal for the above control means for hoisting or lowering the group of sails 22.

[0031] The electronic system 10 for controlling the propulsion modes of a boat also comprises interface means for a user 14 advantageously coupled with the central processing and control unit 11.

[0032] The interface means for a user 14 allow the user to select, on the basis on his/her navigation needs, at least one driving mode of boat 20 from a plurality of driving modes of boat 20 memorized in memorization means 30 comprised within the electronic system 10 and connected to the processing and control unit 11.

[0033] In detail, the plurality of driving modes of boat 20 comprises at least one driving mode at a guaranteed minimum navigation speed VMNG, one driving mode at a guaranteed minimum navigation time TMN and one driving mode at a guaranteed minimum travel distance DMN.

[0034] If the driving mode at a guaranteed minimum navigation speed VMNG is selected, the user sets the value of the guaranteed minimum speed VMNG through the interface means for a user 14. Such driving mode allows keeping the navigation speed of boat 20 at a value greater than or equal to the guaranteed minimum speed VMNG set.

[0035] If the driving mode at a guaranteed minimum navigation time TMN is selected, the user sets the value of a minimum speed VMN' and of a guaranteed minimum time TMN through the interface means for a user 14. Such driving mode ensures that the navigation of boat 20 continues by the guaranteed minimum time TMN set.

[0036] If the driving mode at a guaranteed minimum travel distance DMN is selected, the user sets the value of a minimum speed VMN' and of a guaranteed minimum distance DMN through the interface means for a user 14. Such driving mode ensures that boat 20 travels the guaranteed minimum distance DMN set.

[0037] If the power controlled motor 21 comprises an electric motor with generator functionalities, the plurality of driving modes of boat 20 also comprises a driving mode with a minimum speed of electric power generation (VMG), which indicates the speed of boat 20 above which the generator functionality of the electric motor is actuated. It is stressed that the driving mode at minimum speed of electric power generation VMG may only be selected if the driving mode at guaranteed minimum speed VMNG has been selected in advance. In that case, in fact, the user sets the value of the minimum speed of generation VMG that is greater than the value of the guaranteed minimum speed VMNG; in this way, the generator functionality of the electric motor is only actuated when the propulsion due to the wind is sufficient for exceeding both the guaranteed minimum speed VMNG and the minimum speed of electric power generation VMG. The

driving mode at minimum speed of electric power generation VMG, therefore, allows recovering electric energy if the propulsive force of the wind is sufficient for moving boat 20 according to the driving mode at guaranteed minimum speed VMNG.

[0038] If the power controlled motor 21 is of the hybrid thermal-electric type, the plurality of driving modes of boat 20 further comprises a driving mode at an optimized energy efficiency η_{HYB} of the power controlled motor 21. Such driving mode at an optimized energy efficiency η_{HYB} can be selected individually or in addition to at least one driving mode of boat 20 selected before. In particular, the driving mode at an optimized energy efficiency η_{HYB} allows optimizing the energy consumption of the power controlled motor 21.

[0039] In order to ensure the respect of the driving modes of boat 20, the electronic system 10 comprises means 12 for controlling the power controlled motor 21 on the basis of the selected driving mode of the boat and on the typical parameters of the wind conditions and of the motion conditions of the boat detected by the first plurality of sensors 23; such means 12 for controlling the power controlled motor 21 are connected to the central processing and control unit 11.

[0040] In particular, the means 12 for controlling motor 21 are capable of generating a power request signal PP for the power controlled motor 21 on the basis of the typical parameters of the wind conditions and of the motion conditions of boat 20 detected by the first plurality of sensors 23 and of the value of the minimum navigation speed VMN', VMNG set by the user. Preferably, such means 12 for controlling the power controlled motor 21 comprise regulators PID or linear optimal regulators or non linear regulators.

[0041] The electronic system 10 also comprises means for energy optimization 16 connected to the central processing and control unit 11 and coupled with the power controlled motor 21.

[0042] The means 12 for controlling motor 21 and the means for energy optimization 16 are capable of communicating with each other by interposition of the central processing and control unit 11 or through a dedicated connection.

[0043] The means for energy optimization 16, moreover, are capable of operating on the power controlled motor 21 along with the means 12 for controlling the same motor 21, in order to ensure the respect of the driving modes at guaranteed minimum navigation time TMN, at guaranteed minimum travel distance DMN and at optimized energy efficiency of the power controlled motor 21.

[0044] In detail, such means for energy optimization 16 generate a regulated power request signal PPR on the basis of the typical parameters of the wind conditions and of the motion conditions of the boat detected by the first plurality of sensors 23, of the selected driving mode of boat 20 and of the energy capacity CBAT, CFUEL of the power controlled motor 21. Such energy capacity CBAT, CFUEL refers to the charge state CBAT of a battery of an electric motor and/or to the energy capacity of a fuel tank CFUEL of a thermal motor, according to the nature of the power controlled motor 21.

[0045] The detection of the energy capacity CBAT, CFUEL of the power controlled motor 21 is carried out by the electronic system 10 for controlling the propulsion modes of a boat through a second plurality of sensors 19 connected to the central processing and control unit 11.

[0046] In the embodiment of the present invention shown in figure 2, the electronic system 10 advantageously comprises a selector block 15 connected to the central processing and control unit 11 and to the power controlled motor 21.

[0047] In that case, the electronic system 10 for controlling the propulsion modes of a boat is advantageously applied to a boat 20 provided with a motor 21 that comprises an electric motor provided with the electric power generator functionality. Such power controlled motor 21 therefore is an electric motor or a hybrid thermal-electric motor wherein an electric motor is present, provided with a charge generator, preferably hydro-dynamic. The selector block 15 is capable of selectively actuating the propulsion or the generation function of the electric motor comprised within the power controlled motor 21, if the selected driving mode is the driving mode at minimum speed of generation VMG. In the embodiment of the present invention shown in figure 3, the electronic system 10 for controlling the propulsion modes of a boat also comprises means for regulating the sails 17 and/or control means of the centreboard 18 respectively coupled with the group of sails 22 and with the mobile centreboard 24 of boat 20, as well as both with the central processing and control unit 11. In that case, the electronic system 10 is capable of optimising the propulsive effect of the group of sails 22, modifying the configuration of the same, and the position of centreboard 24, on the basis of the detected wind conditions.

[0048] Method 100 for controlling the propulsion modes of a boat comprises a first measurement step that consists in detecting 101 a plurality of typical wind parameters through the first plurality of sensors 23.

[0049] In such measurement step 101, the processing and control unit 11 receives the data relating to the detection of speed AWS and the incidence angle AWA of the apparent wind and of speed BS of boat 20 and it calculates the actual speed TWS and the actual direction TWA of the wind.

[0050] Thereafter, an observation step is provided wherein the processing and control unit 11 verifies 102 whether the plurality of parameters typical of the wind conditions so detected satisfies a predetermined set of extreme conditions for hoisting or lowering the group of sails 22.

[0051] In particular, in such observation step it is verified that the actual speed TWS of the wind is greater than a preset minimum value TWSMN and that the direction, expressed in terms of an incidence angle of the wind TWA, is comprised within a present range of angles [TWAMN1, TWAMN2].

[0052] After the observation step 102, a step is provided consisting in generating 103 a signal for warning the user

and/or for actuating the control means of the group of sails 22, if provided, for hoisting or lowering the group of sails 22.

[0053] When the group of sails 22 is hoisted, method 100 for controlling the propulsion modes of a boat comprises a step that consists in selecting 104 at least one driving mode of boat 20 from a plurality of driving modes of boat 20.

[0054] According to the present invention, after such selection step 104, the method for controlling the propulsion modes of a boat comprises a step consisting in controlling 110 the power controlled motor 21 on the basis of the selected driving mode of the boat and of the typical parameters of the wind conditions and of the motion conditions of the boat detected by the first plurality of sensors 23.

[0055] If the driving mode at guaranteed minimum navigation speed VMNG is selected, method 100 for controlling the propulsion modes of a boat comprises the steps (not shown) that consist in setting the value of the guaranteed minimum speed VMNG, detecting the navigation speed BS of boat 20 through the first plurality of sensors.

[0056] In that case, moreover, method 100 comprises a step wherein the central processing and control unit 11 compares 111 the navigation speed BS of boat 20 and the guaranteed minimum speed VMNG. If the navigation speed BS of boat 20 is lower than the guaranteed minimum speed VMNG, the control step 110 of the power controlled motor 21 comprises generating 112 a power request signal PP for the power controlled motor 21 on the basis of the current value of the parameters typical of the wind conditions.

[0057] In detail, the power request signal PP may be better defined as the combination of a request signal of torque TP and rotation speed of shaft WP of the power controlled motor 21, so that $PP = TP \cdot WP$. Such power request signal PP stimulates motor 21 to supply the power required for reaching the guaranteed minimum navigation speed VMNG.

[0058] If the navigation speed BS of boat 20 is greater than the guaranteed minimum navigation speed VMNG, the control step 110 of the power controlled motor 21 comprises minimizing 113 the energy consumption of the power controlled motor 21 through the energy optimization means 16.

[0059] In particular, if the power controlled motor 21 comprises an electric motor, the minimization step 113 of the energy consumption consists in turning off said electric motor.

[0060] Differently, if the power controlled motor 21 comprises a thermal motor, the minimization step 113 of the energy consumption consists in ensuring a minimum rotation speed of shaft WPMN of the thermal motor.

[0061] It is worth stressed that keeping the minimum rotation speed WPMN of the thermal motor also implies that in the conditions wherein the sail propulsion generates enough power, the navigation speed BS of boat 20 shall be greater than the guaranteed minimum speed VMNG due to the concurrent sail and thermal propulsion.

[0062] If the power controlled motor 21 comprises an electric motor with generator functionalities and the driving modes at guaranteed minimum navigation speed VMNG and at minimum speed of electric power generation VMG are selected, method 100 for controlling the propulsion modes of a boat further comprises the steps (not shown) consisting in setting the value of the minimum speed of generation VMG and in comparing such speed VMG with the navigation speed BS of boat 20.

[0063] In that case, if the navigation speed BS of boat 20 is greater than the minimum speed of electric power generation VMG, the control step 110 of the power controlled motor 21 comprises actuating (not shown) the generator functionality of the electric motor through the selector block 15.

[0064] On the contrary, if the navigation speed BS of boat 20 is lower than the minimum speed of electric power generation VMG and greater than the guaranteed minimum speed VMNG, the selector block 15 turns off the electric machine.

[0065] If the driving mode at guaranteed minimum navigation time TMN is selected, method 100 for controlling the propulsion modes of a boat comprises the steps (not shown) consisting in setting the value of the guaranteed minimum navigation time VMNG and the value of a minimum navigation speed VMN'.

[0066] Below, the energy capacity CBAT, CFUEL (not shown) of the power controlled motor 21 through the second plurality of sensors 19 is determined, and the coherence of the values of minimum speed VMN' and of guaranteed minimum time TMN set is checked 131 with respect to such energy capacity CBAT, CFUEL detected.

[0067] In detail, the coherence checking step 131 provides for verifying the following disequation:

$$\int_0^{TMN} TP * WP dt \leq (CBAT, CFUEL)$$

wherein TP and WP are generated by the control means 12 of the power controlled motor 21 on the basis of the detected typical parameters of the wind and of the motion conditions of boat 20 and of the value of the minimum navigation speed VMN' set.

[0068] In case of a positive result of such coherence checking step 131, the control step 110 of the power controlled motor 21 comprises generating 133 a power request signal regulated PPR on the basis of the plurality of parameters typical of the wind conditions, of the value of the guaranteed minimum navigation time TMN and of the energy capacity

CBAT, CFUEL of motor 21.

[0069] In detail, such regulated power request signal PPR is generated by the energy optimization means 16.

[0070] In case of a negative result of the coherence checking step 131 or if the values of the guaranteed minimum navigation times TMN and of the minimum navigation speed VMN' generate a request of torque TP and of rotation speed of shaft WP that motor 21 cannot meet in light of the energy capacity CBAT, CFUEL detected, the control step 110 of the power controlled motor 21 comprises reducing 132 the value of the minimum navigation speed VMN' until the coherence checking step has a positive result.

[0071] If the driving mode at guaranteed minimum travelled distance DMN is selected, method 100 for controlling the propulsion modes of a boat comprises the steps (not shown) consisting in setting the value of the guaranteed minimum travelled distance DMN and the value of a minimum navigation speed VMN'.

[0072] Below, the energy capacity CBAT, CFUEL (not shown) of the power controlled motor 21 through the second plurality of sensors 19 is determined, and the consistency of the values of minimum speed VMN' and of guaranteed minimum distance DMN set is checked with respect to such energy capacity CBAT, CFUEL detected. In case of a positive result of such coherence checking step 131, the control step 110 of the power controlled motor 21 comprises generating 133 (not shown) a regulated power request signal PPR on the basis of the plurality of parameters typical of the wind conditions, of the value of the guaranteed minimum distance DMN and of the energy capacity CBAT, CFUEL of motor 21. In detail, such power request signal regulated PPR is generated by the energy optimization means 16.

[0073] In case of a negative result of the coherence checking step or if the values of the guaranteed minimum travelled distance DMN and of the minimum navigation speed VMN' generate a request of torque TP and of rotation speed of shaft WP that motor 21 cannot meet in light of the detected energy capacity CBAT, CFUEL, the control step 110 of the power controlled motor 21 comprises reducing 132 (not shown) the value of the minimum navigation speed VMN' until the coherence checking step has a positive result.

[0074] If the driving mode at optimized energy efficiency of the power controlled motor 21 η_{HYB} is selected, method 100 for controlling the propulsion of a boat additionally comprises an optimization step (**not shown**) wherein the energy optimization means 16 maximize efficiency η_{HYB} of the hybrid thermal-electric motor in light of the typical parameters of the wind conditions and of the motion conditions of the boat detected by the first plurality of sensors 23 and by the energy capacity CBAT, CFUEL of the motor.

[0075] By way of an example, the equation system is shown whereon the above procedure of efficiency maximization η_{HYB} is based if the driving time at guaranteed minimum navigation time TMN and the driving mode at optimized energy efficiency η_{HYB} are selected.

$$\eta_{HYB} = \frac{1}{\sigma C / \eta E(TP, WP) + [1 - \sigma C] / \eta T(TP, WP)}$$

$$\arg \min_{\sigma C} J(\sigma C, TP, WP) = \int_0^{TMN} (1 - \eta_{HYB})^2 dt$$

$$BS(\sigma C, TP, WP) \geq VMN$$

$$TMN = \frac{DMN}{VMN}$$

$$\int_0^{TMN} [1 - \sigma C] * TP * WP dt \leq CFUEL$$

$$\int_0^{TMN} \sigma C * TP * WP dt \leq CBAT$$

wherein σC is a control signal that defines the actuation of the electric propulsion ($\sigma C=1$) or of the thermal propulsion ($\sigma C=0$), $\eta E(TP, WP)$ is the efficiency of the electric machine function of parameters TP and WP required by the means 12 for controlling the power controlled motor 21, $\eta T(TP, WP)$ is the efficiency of the thermal machine function of parameters TP and WP and J ($\sigma C, TP, WP$) is a target function to be minimized.

[0076] The features of the method and of the electronic system object of the invention as well as the relevant advantages are clear from the above description.

[0077] In fact, the method for controlling the propulsion modes of a boat according to the present invention allows knowing, in a deterministic manner, the moment when the propulsive force of the wind can be used in an advantageous manner in order to reduce the motor energy consumptions.

[0078] Moreover, the propulsion control and the energy optimization made on the basis of the selected driving modes of the boat, of the typical parameters of the wind detected, as well as the energy capacity of the boat motor, allows integrating the propulsive force deriving from the wind with that of the motor, leading to significant savings in consumptions, as well as a very quiet navigation.

[0079] Finally, it is clear that several changes and variations may be made to the method and the electronic system thus conceived, all falling within the invention; moreover, all details can be replaced with technically equivalent elements. In the practice, the materials used as well as the sizes, can be whatever, according to the technical needs.

Claims

1. Method (100) for controlling the propulsion modes of a boat of the type comprising a power controlled motor (21), a group of sails (22) and a first plurality of sensors (23) of the wind conditions and of the motion conditions of said boat, said method being **characterized in that** it comprises the phases consisting of:

- detecting (101) a plurality of parameters typical of the wind conditions by means of said first plurality of sensors (23);
- verifying (102) whether the plurality of parameters typical of the wind conditions so detected satisfies a pre-determined set of extreme conditions for hoisting and lowering said group of sails (22);
- selecting (104) at least a driving mode of said boat, chosen from a plurality of driving modes of said boat (20), when said group of sails (22) is hoisted;
- controlling (110) said power controlled motor (21) on the basis of the selected driving mode of said boat.

2. Method (100) for controlling the propulsion modes of a boat according to claim 1, **characterized in that** said plurality of parameters typical of the wind conditions comprises the actual speed (TWS) of the wind and the angle of incidence of the wind (TWA), and **in that** said predetermined set of extreme conditions comprises a minimum value of the actual speed of the wind (TWSMN) and a range of variability of the angle of incidence of the wind comprised between a minimum value (TWAMN1) and a maximum value (TWAMN2).

3. Method (100) for controlling the propulsion modes of a boat according to claim 1 or 2, **characterized in that**, after said verification phase (102) and before said selection phase (104), also comprises a phase consisting in generating (103) a signal for warning a user and/or for actuating control means of said group of sails (22) for hoisting or lowering said group of sails (22).

4. Method (100) for controlling the propulsion modes of a boat according to one or more preceding claims, **characterized in that** said plurality of driving modes of said boat (20) comprises at least:

- a driving mode at a guaranteed minimum navigation speed (VMNG);
- a driving mode at a guaranteed minimum navigation time (TMN);
- a driving mode at a guaranteed minimum travel distance (DMN).

5. Method (100) for controlling the propulsion modes of a boat according to claim 4, **characterized in that**, in case said power controlled motor (21) comprises an electric motor with generator functionality, said driving plurality of modes of said boat (20) also comprises a driving mode with a minimum speed of electric power generation (VMG) wherein said minimum speed of electric power generation (VMG) is greater than said guaranteed minimum navigation speed (VMNG).

6. Method (100) for controlling the propulsion modes of a boat according to claim 4, **characterized in that**, in case said power controlled motor (21) be of the hybrid thermal-electric type, said plurality of driving modes of said boat

(20) also comprises a driving mode at an optimized energy efficiency (η_{HYB}) of said power controlled motor (21).

7. Method (100) for controlling the propulsion modes of a boat according to one or more claims from 4 to 6, **characterized in that**, in case said selected driving mode be said driving mode at a guaranteed minimum navigation speed (VMNG), it comprises the steps consisting on:

- setting the value of said guaranteed minimum navigation speed (VMNG);
- detecting the navigation speed (BS) of said boat by means of said first plurality of sensors (23);
- comparing (111) the detected navigation speed (BS) of said boat with said set guaranteed minimum navigation speed (VMNG);

wherein

- if the detected navigation speed (BS) of said boat is lower than said set guaranteed minimum navigation speed (VMNG), said control step (110) of said power controlled motor (21) comprises generating (112) a power request signal (PP) for said power controlled motor (21) on the basis of the current value of the parameters typical of the wind conditions.

8. Method (100) for controlling the propulsion modes of a boat according to claim 7, **characterized in that**, if the detected navigation speed (BS) of said boat is greater than said set guaranteed minimum navigation speed (VMNG), said control step (110) of said power controlled motor (21) comprises minimizing (113) the energy consumption of said power controlled motor (21).

9. Method (100) for controlling the propulsion modes of a boat according to claim 8, **characterized in that** when said power controlled motor (21) comprises an electric motor, said minimizing (113) consists in turning off said electric motor, and **in that**, when said power controlled motor (21) comprises a thermal motor, said minimizing (113) consists in guaranteeing a minimum rotation speed (WPMN) of the shaft (WP) of said thermal motor.

10. Method (100) for controlling the propulsion modes of a boat according to claim 5 and one or more claims from 7 to 9, **characterized in that** it also comprises the steps consisting in:

- setting the value of said minimum speed of electric power generation (VMG);
- comparing the detected navigation speed (BS) of said boat with said minimum speed of electric power generation (VMG);

wherein

- if the navigation speed (BS) of said boat (20) is greater than the minimum speed of electric power generation (VMG), said control step (110) of said power controlled motor (21) comprises actuating the generator functionality of said electric motor.

11. Method (100) for controlling the propulsion modes of a boat according to claim 4, **characterized in that**, in case said selected driving mode be said driving mode at a guaranteed minimum navigation time (TMN), it comprises the steps consisting in:

- setting the value of said guaranteed minimum navigation time (TMN);
- setting a value of a minimum navigation speed (VMN');
- detecting the energy capacity (CBAT; CFUEL) of said power controlled motor (21) by means of a second plurality of sensors (19);
- controlling (131) the coherence of the values of said guaranteed minimum navigation time (TMN) and of the minimum navigation speed (VMN') set with respect to the detected energy capacity (CBAT; CFUEL);

wherein, in case of a positive result of the coherence control, said control step of said power controlled motor (21), comprises generating (133) a power request signal regulated (PPR) on the basis of said plurality of parameters typical of the wind conditions, of the value of said guaranteed minimum navigation time (TMN) and of said energy capacity (CBAT, CFUEL).

12. Method (100) for controlling the propulsion modes of a boat according to claim 4, **characterized in that**, in case said set driving mode be said driving mode at a guaranteed minimum travelled distance (DMN), it comprises the steps consisting in:

- setting the value of said guaranteed minimum travel distance (DMN);

- setting a value of a minimum navigation speed (VMN');
- detecting the energy capacity (CBAT; CFUEL) of said power controlled motor (21) by means of a second plurality of sensors (19);
- controlling the coherence of the values of said guaranteed minimum travel distance (DMN) and of minimum navigation speed (VMN') set with respect to the detected energy capacity (CBAT; CFUEL);

wherein, in case of a positive result of the coherence control, said control step of said power controlled motor (21) comprises generating a power request signal regulated (PPR) on the basis of said plurality of parameters typical of the wind conditions, of the value of said guaranteed minimum travel distance (DMN) and of said energy capacity (CBAT, CFUEL).

- 13.** An electronic system (10) for controlling the propulsion modes of a boat of the type provided with a power controlled motor (21), a group of sails (22) and a first plurality of sensors (23) of the wind conditions and of the motion conditions of said boat, said electronic system (10) being **characterized in that** it comprises:

- a central processing and control unit (11) connected to said first plurality of sensors (23),
- means for memorizing (30) a plurality of driving modes of said boat (20) connected to said central processing and control unit (11),
- interface means for a user (14) connected to said central processing and control unit (11) for selecting at least one driving mode of said boat (20) from said plurality of driving modes of said boat (20),
- means for generating a signal for warning a user and/or for actuating control means of said group of sails (22) for hoisting or lowering said group of sails (22), connected to said central processing and control unit (11);
- means for controlling (12) said power controlled motor (21) on the basis of the selected driving mode of the boat and of the parameters typical of the wind conditions and of the motion conditions of said boat detected by said first plurality of sensors (23), said means for controlling (12) being connected to said central processing and control unit (11).

- 14.** The electronic system (10) for controlling the propulsion modes of a boat of the type provided with a power controlled motor (21) according to claim 13, wherein said power controlled motor (21) comprises an electric motor with generator functionality, **characterized in that** it also comprises a selector block (15), coupled with said power controlled motor (21) and with said processing and control unit (11), said selector block (15) being capable of selectively actuating the propulsion or generation function of said electric motor.

- 15.** The electronic system (10) for controlling the propulsion modes of a boat of the type provided with a power controlled motor (21) according to one or more claims from 13 to 14, **characterized in that** it also comprises means for the energy optimization (16) connected to said central processing and control unit (11) and coupled with said power controlled motor (21).

- 16.** The electronic system (10) for controlling the propulsion modes of a boat of the type provided with a power controlled motor (21) according to claim 15, **characterized in that** it also comprises a second plurality of sensors (19) of the energy capacity (CBAT; CFUEL) of said power controlled motor (21), connected to said central processing and control unit (11).

- 17.** The electronic system (10) for controlling the propulsion modes of a boat according to any of claims from 13 to 16, wherein said boat (20) comprises a mobile centreboard (24), **characterized in that** it also comprises means for regulating the sails (17) and/or control means of the centreboard (18) coupled with said group of sails (22) and with said mobile centreboard (24) of said boat (20) respectively, said means for regulating the sails (17) and said control means of the centreboard (18) being coupled with said central processing and control unit (11).

Patentansprüche

- 1.** Verfahren (100) zum Steuern der Antriebsmodi eines Boots, das einen leistungsgesteuerten Motor (21), eine Gruppe von Segeln (22) und eine erste Vielzahl von Sensoren (23) für die Windbedingungen und die Bewegungsbedingungen dieses Boots umfasst, wobei dieses Verfahren **dadurch gekennzeichnet ist, dass** es die Phasen umfasst, die in Folgendem bestehen:

- Erfassen (101) einer Vielzahl von für die Windbedingungen charakteristischen Parametern mit Hilfe dieser

ersten Vielzahl von Sensoren (23);

- Prüfen (102), ob die Vielzahl der derart erfassten für die Windbedingungen charakteristischen Parameter einen vorbestimmten Satz von Extrembedingungen für das Setzen und Bergen der Gruppe von Segeln (22) erfüllt;

- Auswählen (104) von mindestens einem Antriebsmodus für das Boot, der aus einer Vielzahl von Antriebsmodi des Boots (20) ausgewählt wird, wenn die Gruppe von Segeln (22) gesetzt ist;

- Steuern (110) des leistungsgesteuerten Motors (21) auf Grundlage des gewählten Antriebsmodus des Boots.

2. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vielzahl von für die Windbedingungen charakteristischen Parametern die wahre Windgeschwindigkeit (TWS) und den Windeinfallswinkel (TWA) umfassen, und dadurch, dass der vorbestimmte Satz von Extrembedingungen einen Mindestwert der wahren Windgeschwindigkeit (TWSMN) und einen Variabilitätsbereich des Windeinfallswinkels zwischen einem Mindestwert (TWAMN1) und einem Höchstwert (TWAMN2) umfasst.

3. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** es außerdem nach der Prüfphase (102) und vor der Wählphase (104) eine Phase umfasst, die im Erzeugen (103) eines Signals zum Warnen eines Benutzers und/oder zum Betätigen von Steuermitteln der Gruppe von Segeln (22) zum Setzen oder Bergen der Gruppe von Segeln (22) besteht.

4. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Vielzahl von Antriebsmodi des Boots (20) mindestens Folgendes umfasst:

- einen Antriebsmodus bei einer garantierten Mindestfahrgeschwindigkeit (VMNG);

- einen Antriebsmodus bei einer garantierten Mindestfahrzeit (TMN);

- einen Antriebsmodus bei einer garantierten Mindestweglänge (DMN).

5. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 4, **dadurch gekennzeichnet, dass** die Vielzahl von Antriebsmodi des Boots (20), wenn der leistungsgesteuerte Motor (21) einen Elektromotor mit Generatorfunktion umfasst, außerdem einen Antriebsmodus mit einer Mindestgeschwindigkeit für die elektrische Energieerzeugung (VMG) umfasst, wobei diese Mindestgeschwindigkeit für die elektrische Energieerzeugung (VMG) größer als die garantierte Mindestfahrgeschwindigkeit (VMNG) ist.

6. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 4, **dadurch gekennzeichnet, dass** die Vielzahl von Antriebsmodi des Boots (20), wenn der leistungsgesteuerte Motor (21) ein Verbrennungs-/Elektro-Hybridmotor ist, außerdem einen Antriebsmodus bei einer optimierten Energieeffizienz (η_{HYB}) des leistungsgesteuerten Motors (21) umfasst.

7. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach einem oder mehreren der Ansprüche von 4 bis 6, **dadurch gekennzeichnet, dass** es, wenn der gewählte Antriebsmodus der Antriebsmodus bei einer garantierten Mindestfahrgeschwindigkeit (VMNG) ist, die Schritte umfasst, die in Folgendem bestehen:

- Einstellen des Werts der garantierten Mindestfahrgeschwindigkeit (VMNG);

- Erfassen der Fahrgeschwindigkeit (BS) des Boots mit Hilfe der ersten Vielzahl von Sensoren (23);

- Vergleichen (111) der erfassten Fahrgeschwindigkeit (BS) des Boots mit dieser eingestellten garantierten Mindestfahrgeschwindigkeit (VMNG);

wobei

- wenn die erfasste Fahrgeschwindigkeit (BS) des Boots niedriger als die eingestellte garantierte Mindestfahrgeschwindigkeit (VMNG) ist, der Schritt zum Steuern (110) des leistungsgesteuerten Motors (21) das Erzeugen (112) eines Leistungsanforderungssignals (PP) für diesen leistungsgesteuerten Motor (21) auf Grundlage des aktuellen Werts der für die Windbedingungen typischen Parameter umfasst.

8. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 7, **dadurch gekennzeichnet, dass**, wenn die erfasste Fahrgeschwindigkeit (BS) des Boots größer als die eingestellte garantierte Mindestfahrgeschwindigkeit (VMNG) ist, der Schritt zum Steuern (110) des leistungsgesteuerten Motors (21) das Minimieren (113) des Energieverbrauchs des leistungsgesteuerten Motors (21) umfasst.

9. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 8, **dadurch gekennzeichnet, dass**,

wenn der leistungsgesteuerte Motor (21) einen Elektromotor umfasst, das Minimieren (113) im Ausschalten des Elektromotors besteht, und dadurch, dass, wenn der leistungsgesteuerte Motor (21) einen Verbrennungsmotor umfasst, dieses Minimieren (113) im Garantieren einer Mindestdrehzahl (WPMN) der Welle (WP) dieses Verbrennungsmotors besteht.

5 10. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 5 und einem oder mehreren der Ansprüche von 7 bis 9, **dadurch gekennzeichnet, dass** es ferner die Schritte umfasst, die in Folgendem bestehen:

- 10
- Einstellen des Werts der Mindestgeschwindigkeit für die elektrische Energieerzeugung (VMG);
 - Vergleichen der erfassten Fahrgeschwindigkeit (BS) des Boots mit dieser Mindestgeschwindigkeit für die elektrische Energieerzeugung (VMG);
- wobei
- wenn die Fahrgeschwindigkeit (BS) des Boots (20) größer als die Mindestgeschwindigkeit für die elektrische Energieerzeugung (VMG) ist, der Schritt zum Steuern (110) des leistungsgesteuerten Motors (21) das Ingangsetzen der Generatorfunktion des Elektromotors umfasst.
- 15

20 11. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 4, **dadurch gekennzeichnet, dass** es, wenn der gewählte Antriebsmodus der Antriebsmodus bei einer garantierten Mindestfahrzeit (TMN) ist, die Schritte umfasst, die in Folgendem bestehen:

- 25
- Einstellen des Werts der garantierten Mindestfahrzeit (TMN);
 - Einstellen eines Werts einer Mindestfahrgeschwindigkeit (VMN');
 - Erfassen der Energiekapazität (CBAT; CFUEL) des leistungsgesteuerten Motors (21) mit Hilfe einer zweiten Vielzahl von Sensoren (19);
 - Kontrollieren (131) der Kohärenz der Werte der garantierten Mindestfahrzeit (TMN) und der eingestellten Mindestfahrgeschwindigkeit (VMN') in Bezug auf die erfasste Energiekapazität (CBAT; CFUEL);

30 wobei im Falle eines positiven Ergebnisses der Kohärenzkontrolle der Schritt zum Steuern des leistungsgesteuerten Motors (21) das Erzeugen (133) eines Leistungsanforderungssignals (PPR) umfasst, das auf Grundlage der Vielzahl von für die Windbedingungen charakteristischen Parametern, des Werts der garantierten Mindestfahrzeit (TMN) und der Energiekapazität (CBAT, CFUEL) reguliert wird.

35 12. Verfahren (100) zum Steuern der Antriebsmodi eines Boots nach Anspruch 4, **dadurch gekennzeichnet, dass** es, wenn der eingestellte Antriebsmodus der Antriebsmodus bei einer garantierten Mindestweglänge (DMN) ist, die Schritte umfasst, die in Folgendem bestehen:

- 40
- Einstellen des Werts der garantierten Mindestweglänge (DMN);
 - Einstellen eines Werts einer Mindestfahrgeschwindigkeit (VMN');
 - Erfassen der Energiekapazität (CBAT; CFUEL) des leistungsgesteuerten Motors (21) mit Hilfe einer zweiten Vielzahl von Sensoren (19);
 - Kontrollieren der Kohärenz der Werte der garantierten Mindestweglänge (DMN) und der eingestellten Mindestfahrgeschwindigkeit (VMN') in Bezug auf die erfasste Energiekapazität (CBAT; CFUEL);

45 wobei im Falle eines positiven Ergebnisses der Kohärenzkontrolle der Schritt zum Steuern des leistungsgesteuerten Motors (21) das Erzeugen eines Leistungsanforderungssignals (PPR) umfasst, das auf Grundlage der Vielzahl von für die Windbedingungen charakteristischen Parametern, des Werts der garantierten Mindestweglänge (DMN) und der Energiekapazität (CBAT, CFUEL) reguliert wird.

50 13. Elektronisches System (10) zum Steuern der Antriebsmodi eines Boots, das mit einem leistungsgesteuerten Motor (21), einer Gruppe von Segeln (22) und einer ersten Vielzahl von Sensoren (23) für die Windbedingungen und die Bewegungsbedingungen dieses Boots versehen ist, wobei dieses elektronische System (10) **dadurch gekennzeichnet ist, dass** es Folgendes umfasst:

- 55
- eine zentrale Verarbeitungs- und Steuereinheit (11), die mit der ersten Vielzahl von Sensoren (23) verbunden ist,
 - Mittel zum Speichern (30) einer Vielzahl von Antriebsmodi des Boots (20), die mit der zentralen Verarbeitungs- und Steuereinheit (11) verbunden sind,
 - Schnittstellenmittel für einen Benutzer (14), die mit der zentralen Verarbeitungs- und Steuereinheit (11) verbunden sind, zum Auswählen von mindestens einem Antriebsmodus des Boots (20) aus der Vielzahl von

Antriebsmodi des Boots (20),

- mit der zentralen Verarbeitungs- und Steuereinheit (11) verbundene Mittel zum Erzeugen eines Signals zum Warnen eines Benutzers und/oder zum Betätigen von Steuermitteln der Gruppe von Segeln (22) zum Setzen oder Bergen dieser Gruppe von Segeln (22),

- Mittel zum Steuern (12) des leistungsgesteuerten Motors (21) auf Grundlage des gewählten Antriebsmodus des Boots und der für die Windbedingungen typischen Parameter und der Bewegungsbedingungen des Boots, die von der ersten Vielzahl von Sensoren (23) erfasst werden, wobei diese Mittel zum Steuern (12) mit der zentralen Verarbeitungs- und Steuereinheit (11) verbunden sind.

14. Elektronisches System (10) zum Steuern der Antriebsmodi eines Boots, das mit einem leistungsgesteuerten Motor (21) versehen ist, nach Anspruch 13, wobei dieser leistungsgesteuerte Motor (21) einen Elektromotor mit Generatorfunktion umfasst, **dadurch gekennzeichnet, dass** es außerdem einen Wählblock (15) umfasst, der mit dem leistungsgesteuerten Motor (21) und mit der Verarbeitungs- und Steuereinheit (11) gekoppelt ist, wobei dieser Wählblock (15) imstande ist, die Antriebs- oder Erzeugungsfunktion des Elektromotors selektiv in Gang zu setzen.

15. Elektronisches System (10) zum Steuern der Antriebsmodi eines Boots, das mit einem leistungsgesteuerten Motor (21) versehen ist, nach einem oder mehreren der Ansprüche von 13 bis 14, **dadurch gekennzeichnet, dass** es außerdem Mittel zur Energieoptimierung (16) umfasst, die mit der zentralen Verarbeitungs- und Steuereinheit (11) verbunden und mit dem leistungsgesteuerten Motor (21) gekoppelt sind.

16. Elektronisches System (10) zum Steuern der Antriebsmodi eines Boots, das mit einem leistungsgesteuerten Motor (21) versehen ist, nach Anspruch 15, **dadurch gekennzeichnet, dass** es außerdem eine zweite Vielzahl von Sensoren (19) für die Energiekapazität (CBAT; CFUEL) des leistungsgesteuerten Motors (21) umfasst, die mit der zentralen Verarbeitungs- und Steuereinheit (11) verbunden sind.

17. Elektronisches System (10) zum Steuern der Antriebsmodi eines Boots nach einem der Ansprüche von 13 bis 16, wobei dieses Boot (20) ein bewegliches Schwert (24) umfasst, **dadurch gekennzeichnet, dass** es außerdem Mittel zum Regulieren der Segel (17) und/oder Steuermittel für das Schwert (18) umfasst, die mit der Gruppe von Segeln (22) beziehungsweise mit dem beweglichen Schwert (24) des Boots (20) verbunden sind, wobei diese Mittel zum Regulieren der Segel (17) und die Steuermittel für das Schwert (18) mit der zentralen Verarbeitungs- und Steuereinheit (11) gekoppelt sind.

Revendications

1. Méthode (100) pour contrôler les modes de propulsion d'un bateau du type comprenant un moteur commandé en puissance (21), un groupe de voiles (22) et une première pluralité de capteurs (23) des conditions de vent et des conditions de mouvement dudit bateau, ladite méthode étant **caractérisée en ce qu'**elle comprend les étapes consistant à :

- détecter (101) une pluralité de paramètres typiques des conditions de vent au moyen de ladite première pluralité de capteurs (23) ;

- vérifier (102) si la pluralité de paramètres typiques des conditions de vent ainsi détectés satisfont un ensemble prédéterminé de conditions extrêmes pour hisser ou affaler ledit groupe de voiles (22) ;

- sélectionner (104) au moins un mode de conduite dudit bateau, choisi parmi une pluralité de modes de conduite dudit bateau (20), quand ledit groupe de voiles (22) est hissé ;

- commander (110) ledit moteur commandé en puissance (21) sur la base du mode de conduite sélectionné dudit bateau.

2. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 1, **caractérisée en ce que** ladite pluralité de paramètres typiques des conditions de vent comprend la vitesse réelle (TWS) du vent et l'angle d'incidence du vent (TWA), et **en ce que** ledit ensemble prédéterminé de conditions extrêmes comprend une valeur minimale de la vitesse réelle du vent (TWSMN) et une plage de variabilité de l'angle d'incidence du vent comprise entre une valeur minimale (TWAMN1) et une valeur maximale (TWAMN2).

3. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 1 ou 2, **caractérisée en ce que**, après ladite étape de vérification (102) et avant ladite étape de sélection (104), elle comprend également une étape consistant à générer (103) un signal pour avertir un utilisateur et/ou pour actionner des moyens de

commande dudit groupe de voiles (22) pour hisser ou affaler ledit groupe de voiles (22).

4. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon une ou plusieurs revendications précédentes, **caractérisée en ce que** ladite pluralité de modes de conduite dudit bateau (20) comprend au moins :

- un mode de conduite à une vitesse de navigation minimale garantie (VMNG) ;
- un mode de conduite à un temps de navigation minimal garanti (TMN) ;
- un mode de conduite à une distance de parcours minimale garantie (DMN).

5. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 4, **caractérisée en ce que**, dans le cas où ledit moteur commandé en puissance (21) comprend un moteur électrique avec une fonctionnalité de générateur, ladite pluralité de modes de conduite dudit bateau (20) comprend également un mode de conduite avec une vitesse minimale de génération d'énergie électrique (VMG), dans lequel ladite vitesse minimale de génération d'énergie électrique (VMG) est supérieure à ladite vitesse de navigation minimale garantie (VMNG).

6. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 4, **caractérisée en ce que**, dans le cas où ledit moteur commandé en puissance (21) est du type thermoélectrique hybride, ladite pluralité de modes de conduite dudit bateau (20) comprend également un mode de conduite à une efficacité énergétique optimisée (η HYB) dudit moteur commandé en puissance (21).

7. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon une ou plusieurs revendications 4 à 6, **caractérisée en ce que**, dans le cas où ledit mode de conduite sélectionné est ledit mode de conduite à une vitesse de navigation minimale garantie (VMNG), il comprend les étapes consistant à :

- fixer la valeur de ladite vitesse de navigation minimale garantie (VMNG) ;
- détecter la vitesse de navigation (BS) dudit bateau au moyen de ladite première pluralité de capteurs (23) ;
- comparer (111) la vitesse de navigation détectée (BS) dudit bateau à ladite vitesse de navigation minimale garantie fixée (VMNG) ;
- dans lequel
- si la vitesse de navigation détectée (BS) dudit bateau est inférieure à ladite vitesse de navigation minimale garantie fixée (VMNG), ladite étape de commande (110) dudit moteur commandé en puissance (21) comprend la génération (112) d'un signal de demande de puissance (PP) pour ledit moteur commandé en puissance (21) sur la base de la valeur actuelle des paramètres typiques des conditions de vent.

8. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 7, **caractérisée en ce que**, si la vitesse de navigation détectée (BS) dudit bateau est supérieure à ladite vitesse de navigation minimale garantie fixée (VMNG), ladite étape de commande (110) dudit moteur commandé en puissance (21) comprend la minimisation (113) de la consommation d'énergie dudit moteur commandé en puissance (21).

9. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 8, **caractérisée en ce que**, quand ledit moteur commandé en puissance (21) comprend un moteur électrique, ladite minimisation (113) consiste à éteindre ledit moteur électrique, et **en ce que**, quand ledit moteur commandé en puissance (21) comprend un moteur thermique, ladite minimisation (113) consiste à garantir une vitesse de rotation minimale (WPMN) de l'arbre (WP) dudit moteur thermique.

10. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 5 et une ou plusieurs revendications 7 à 9, **caractérisée en ce qu'il** comprend également les étapes consistant à :

- fixer la valeur de ladite vitesse minimale de génération d'énergie électrique (VMG) ;
- comparer la vitesse de navigation détectée (BS) dudit bateau à ladite vitesse minimale de génération d'énergie électrique (VMG) ;
- dans lequel
- si la vitesse de navigation (BS) dudit bateau (20) est supérieure à la vitesse minimale de génération d'énergie électrique (VMG), ladite étape de commande (110) dudit moteur commandé en puissance (21) comprend l'activation de la fonctionnalité de générateur dudit moteur électrique.

11. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 4, **caractérisée en ce que**, dans le cas où ledit mode de conduite sélectionné est ledit mode de conduite à un temps de navigation minimal

garanti (TMN), il comprend les étapes consistant à :

- fixer la valeur dudit temps de navigation minimal garanti (TMN) ;
- fixer une valeur d'une vitesse de navigation minimale (VMN') ;
- détecter la capacité d'énergie (CBAT ; CFUEL) dudit moteur commandé en puissance (21) au moyen d'une deuxième pluralité de capteurs (19) ;
- contrôler (131) la cohérence des valeurs dudit temps de navigation minimal garanti (TMN) et de la vitesse de navigation minimale (VMN') fixée par rapport à la capacité d'énergie détectée (CBAT ; CFUEL) ;

dans lequel, dans le cas d'un résultat positif du contrôle de cohérence, ladite étape de commande dudit moteur commandé en puissance (21) comprend la génération (133) d'un signal de demande de puissance (PPR) régulée sur la base de ladite pluralité de paramètres typiques des conditions de vent, de la valeur dudit temps de navigation minimal garanti (TMN) et de ladite capacité d'énergie (CBAT ; CFUEL).

12. Méthode (100) pour contrôler les modes de propulsion d'un bateau selon la revendication 4, **caractérisée en ce que**, dans le cas où ledit mode de conduite fixé est ledit mode de conduite à une distance parcourue minimale garantie (DMN), elle comprend les étapes consistant à :

- fixer la valeur de ladite distance de parcours minimale garantie (DMN) ;
- fixer une valeur d'une vitesse de navigation minimale (VMN') ;
- détecter la capacité d'énergie (CBAT ; CFUEL) dudit moteur commandé en puissance (21) au moyen d'une deuxième pluralité de capteurs (19) ;
- contrôler la cohérence des valeurs de ladite distance de navigation minimale garantie (DMN) et de la vitesse de navigation minimale (VMN') fixée par rapport à la capacité d'énergie détectée (CBAT ; CFUEL) ;

dans laquelle, dans le cas d'un résultat positif du contrôle de cohérence, ladite étape de commande dudit moteur commandé en puissance (21) comprend la génération d'un signal de demande de puissance (PPR) régulée sur la base de ladite pluralité de paramètres typiques des conditions de vent, de la valeur de ladite distance de parcours minimale garantie (DMN) et de ladite capacité d'énergie (CBAT ; CFUEL).

13. Système électronique (10) pour contrôler les modes de propulsion d'un bateau du type muni d'un moteur commandé en puissance (21), un groupe de voiles (22) et une première pluralité de capteurs (23) des conditions de vent et des conditions de mouvement dudit bateau, ledit système électronique (10) étant **caractérisé en ce qu'il** comprend :

- une unité centrale de traitement et de commande (11) connectée à ladite première pluralité de capteurs (23),
- des moyens pour mémoriser (30) une pluralité de modes de conduite dudit bateau (20) connectés à ladite unité centrale de traitement et de commande (11),
- des moyens d'interface pour un utilisateur (14) connectés à ladite unité centrale de traitement et de commande (11) pour sélectionner au moins un mode de conduite dudit bateau (20) parmi ladite pluralité de modes de conduite dudit bateau (20),
- des moyens pour générer un signal pour avertir un utilisateur et/ou pour actionner des moyens de commande dudit groupe de voiles (22) pour hisser ou affaler ledit groupe de voiles (22), connectés à ladite unité centrale de traitement et de commande (11) ;
- des moyens pour commander (12) ledit moteur commandé en puissance (21) sur la base du mode de conduite sélectionné du bateau et des paramètres typiques des conditions de vent et des conditions de mouvement dudit bateau détectées par ladite première pluralité de capteurs (23), lesdits moyens de commande (12) étant connectés à ladite unité centrale de traitement et de commande (11).

14. Système électronique (10) pour contrôler les modes de propulsion d'un bateau du type muni d'un moteur commandé en puissance (21) selon la revendication 13, dans lequel ledit moteur commandé en puissance (21) comprend un moteur électrique avec fonctionnalité de générateur, **caractérisé en ce qu'il** comprend également un bloc sélecteur (15), couplé audit moteur commandé en puissance (21) et à ladite unité de traitement et de commande (11), ledit bloc de sélecteur (15) étant capable d'activer sélectivement la fonction de propulsion ou de génération dudit moteur électrique.

15. Système électronique (10) pour contrôler les modes de propulsion d'un bateau du type muni d'un moteur commandé en puissance (21) selon une ou plusieurs revendications 13 à 14, **caractérisé en ce qu'il** comprend également des moyens pour l'optimisation d'énergie (16) connectés à ladite unité centrale de traitement et de commande (11) et

couplés audit moteur commandé en puissance (21).

5 16. Système électronique (10) pour contrôler les modes de propulsion d'un bateau du type muni d'un moteur commandé en puissance (21) selon la revendication 15, **caractérisé en ce qu'il** comprend également une deuxième pluralité de capteurs (19) de la capacité d'énergie (CBAT ; CFUEL) dudit moteur commandé en puissance (21), connectée à ladite unité centrale de traitement et de commande (11).

10 17. Système électronique (10) pour contrôler les modes de propulsion d'un bateau selon l'une quelconque des revendications 13 à 16, dans lequel ledit bateau (20) comprend une dérive mobile (24), **caractérisé en ce qu'il** comprend également des moyens pour régler les voiles (17) et/ou des moyens de commande de la dérive (18) couplés respectivement audit groupe de voiles (22) et à ladite dérive mobile (24) dudit bateau (20), lesdits moyens pour régler les voiles (17) et lesdits moyens de commande de la dérive (18) étant couplés à ladite unité centrale de traitement et de commande (11).

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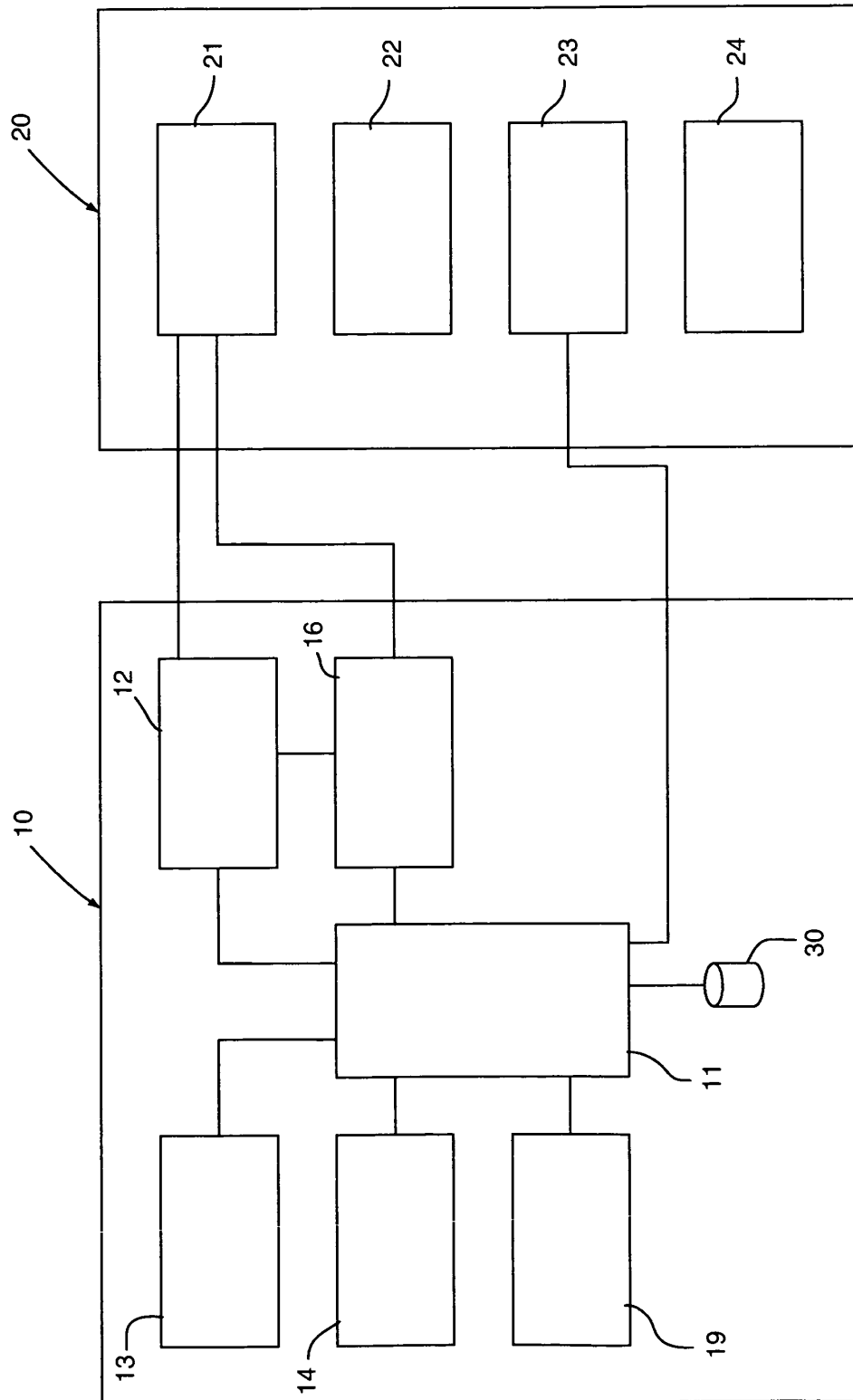


Fig. 1

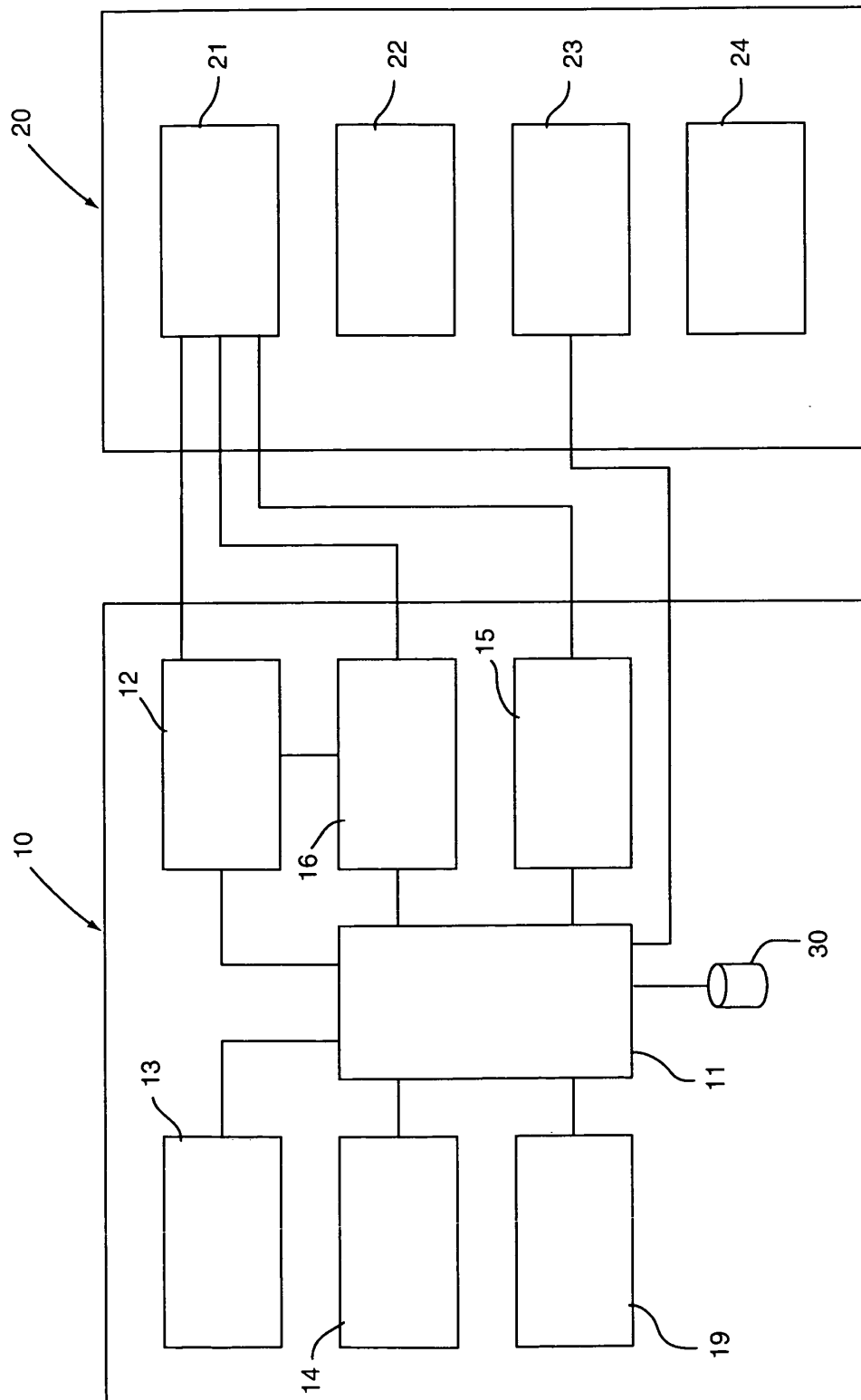


Fig. 2

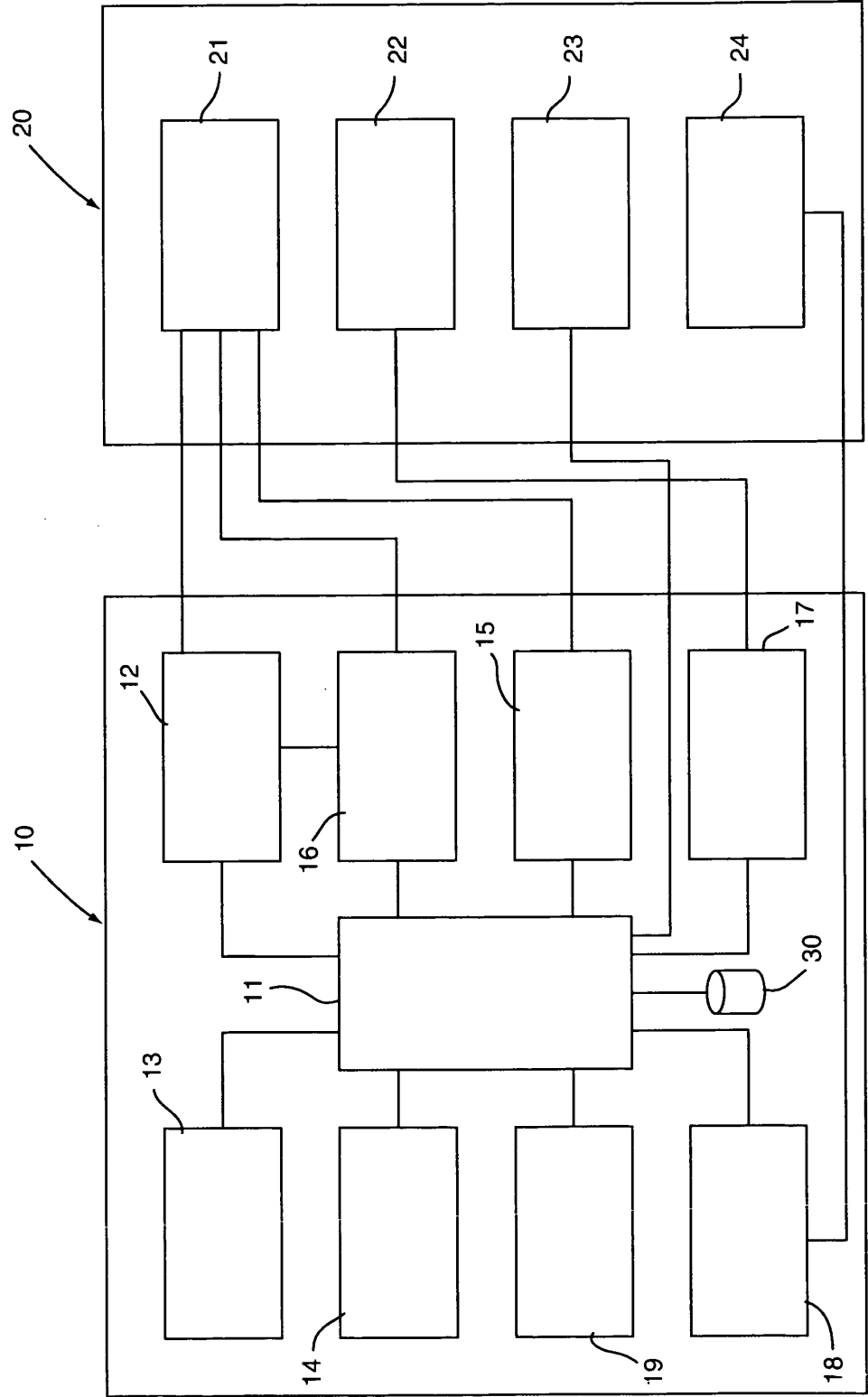


Fig. 3

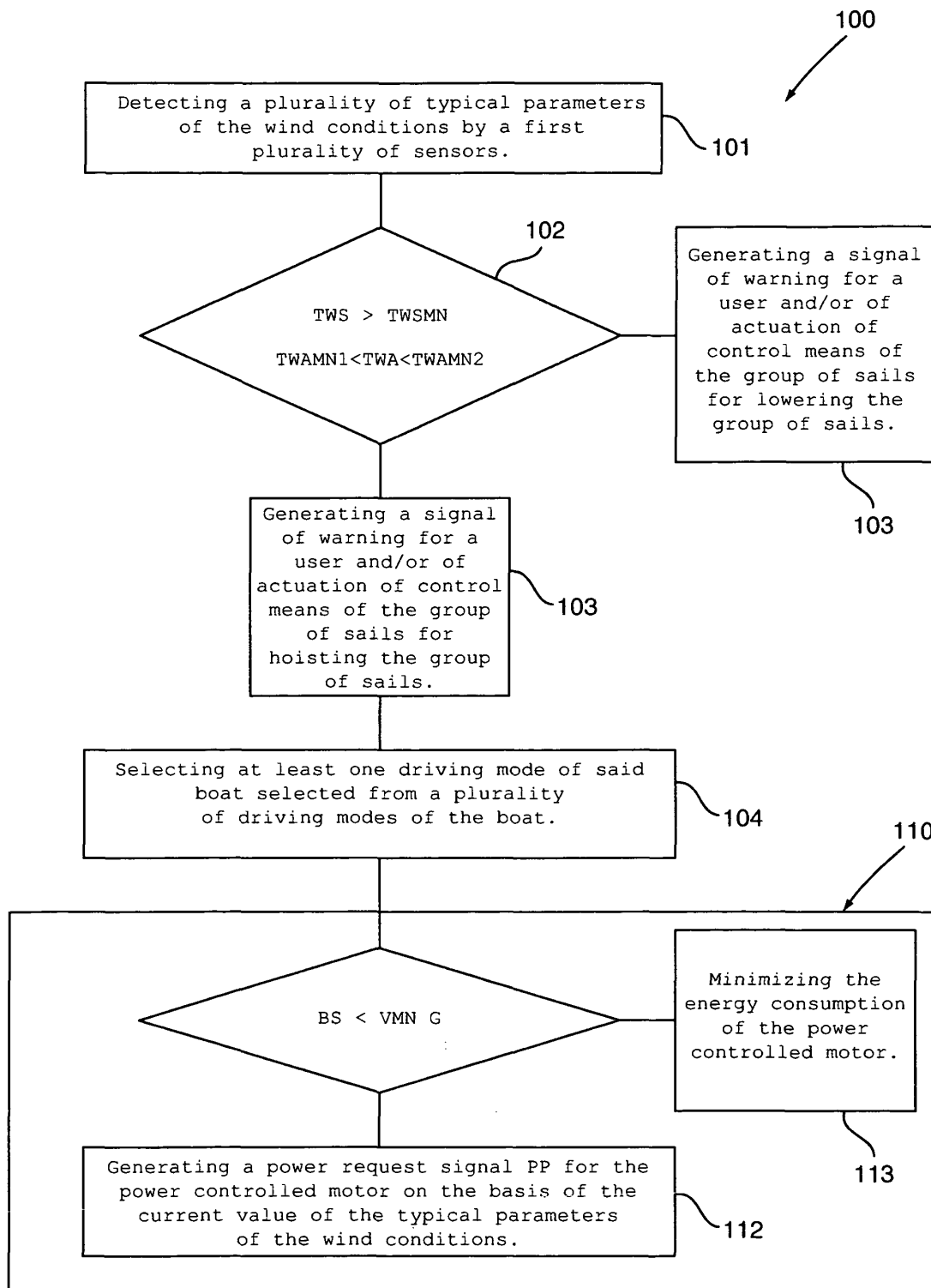


Fig. 4

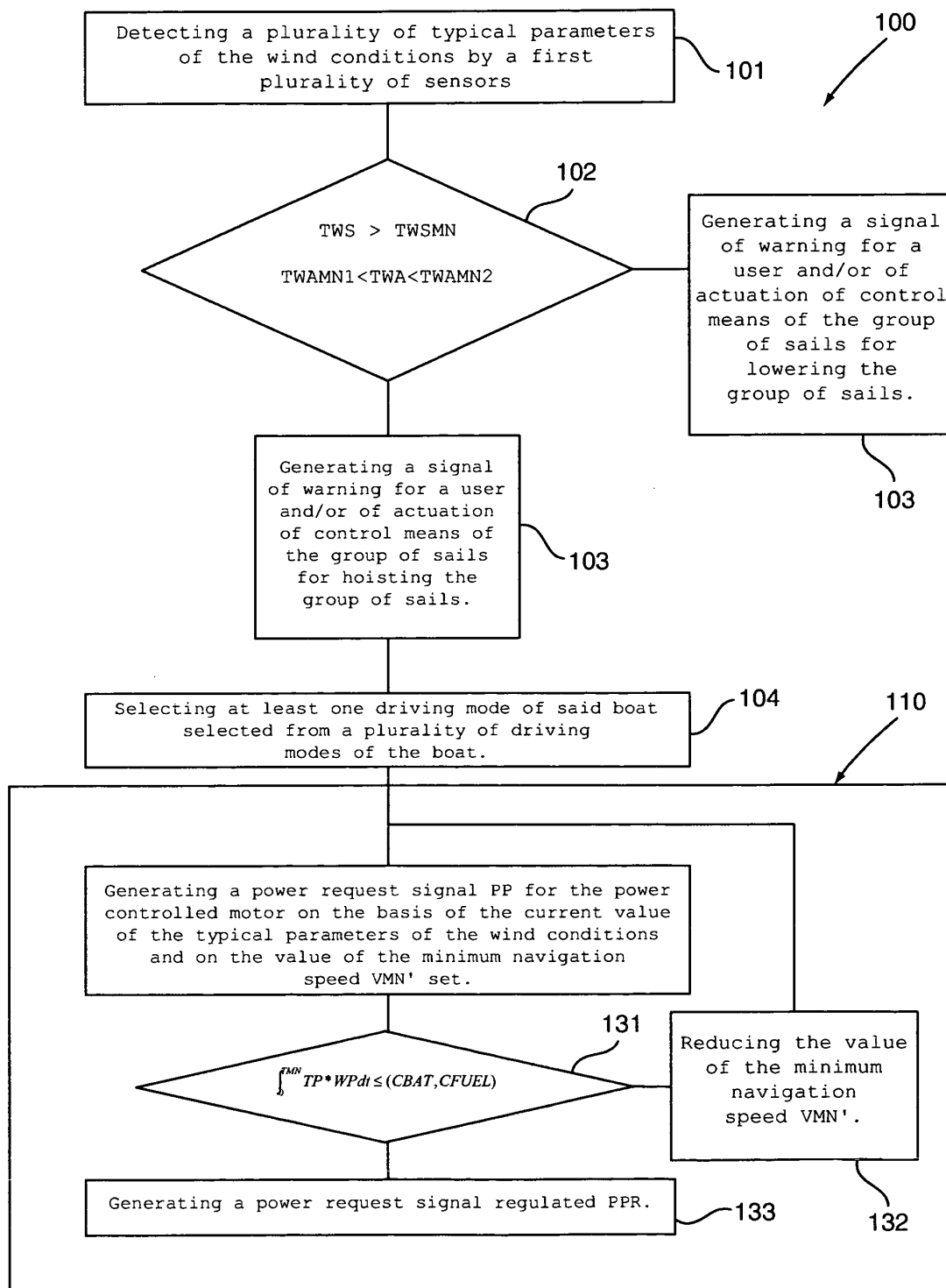


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9740999 A [0013]