

PATENT SPECIFICATION

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(54) REVERSING OF WATER CRAFT HAVING STEERABLE DRIVE POWER GENERATORS

(71) We, SCHOTTEL-WERFT JOSEF BECKER KG, of 5401 Spay/Rhein, Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a water craft comprising a drive power generator, such as a propeller screw or a jet rudder, which is pivotable about a substantially vertical axis, and particularly to the reversing of the main direction of travel of such a craft (ahead or astern) by pivoting the drive power generator.

Reversing apparatus is known in which thus the main travelling direction is reversed by means of the rudder installation, e.g. by rotating a steering propeller screw. In general they operate satisfactorily. Nevertheless improvements are useful to personnel accustomed only to normal steering installations in which reversal of the main travelling direction in this way is impossible. For the purpose of reversing from forward to backward and vice versa, e.g. with the known steering propeller screw, the propeller screw must be swung through 180° by the steering setting device. If the steering setting device is a handwheel, this must be rotated from 3 to 20 times in one direction, depending on the gear ratio between the handwheel and the propeller screw, in order to attain the desired drive reversal. In particular when manoeuvring in narrow waters in which the craft must not be displaced by more than a few metres or centimetres, although the steering propeller screw is superior to other drive-and-steer installations, it requires strength and skill of the helmsman. Moreover difficulties may occur in the matching of the steering setting device and the rudder indication. If the steering reversal of the main travelling direction is not performed with the necessary speed and the operating personnel are not

experienced, an undesirable transverse offset may result.

The present invention provides a water craft, comprising a drive power generator which is pivotable about a substantially vertical axis and control means for controlling the pivoting of the drive power generator in order to control the course of the craft, in which the control means comprises a setting device for setting the steering of the craft relative to the main direction of travel, i.e. ahead or astern, and switching means for selecting the main direction of travel and matching the operation of the setting device to the main direction of travel selected.

Thus the operation of steering the craft is separated from that of choosing the main travelling direction. When the selection switch is operated to reverse the main travelling direction, the control means will pivot the drive power generator through 180° independently of the steering set by the setting device.

It is preferable for the control means to provide a set value-actual value comparator for controlling steering during forward travel and a set value-actual value comparator for controlling steering during reverse travel, the switching means being arranged to select the appropriate comparator. In this way the operation of the setting device and the indication of the steering indicator, if one is provided, can be made to correspond to the actual steering imposed, whatever the main direction of travel.

In order to minimize the extent to which the drive power generator may produce a deleterious lateral drive during reversal of the main travelling direction, means are preferably provided for accelerating the pivotal displacement of the drive power generator during such reversal. In order that the necessary power reserve is always present for the rapid reversal of the travelling direction, without a need for making the drive for the pivotal

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displacement correspondingly large, the accelerating means may advantageously comprise a switchable energy store such as a hydraulic store.

5 In order to ensure reliable operation during reversing, without the attention of the operating personnel being distracted by supplementary operations, it is preferable for the drive power generator to be
10 connected to the prime mover via a clutch controlled by the switching means, and for the switching means to operate in conjunction with means for controlling the power of the drive power generator. For
15 instance, as the main travel direction is reversed, the power is reduced to a minimum, the clutch is disengaged, the drive power generator is turned through 180°, the clutch is engaged, and finally the
20 power is increased.

The invention is of particular importance for craft having two drive power generators (or pairs of drive power generators), both being synchronously steered by the setting
25 device. A control circuit arrangement can be used which upon change of the main travelling direction, orders opposite directions of pivotal movement of the two drive power generators. It is ensured
30 thereby that the ship does not "drop out" of the desired course, even when the power of the drive generators has not been reduced completely.

In a craft according to the invention, the
35 drive power generator can be reversed rapidly and without effort through 180° and the main travelling direction thereby changed. The switching means for this purpose will usually operate from the
40 driving stand. When the main travelling direction is changed by means of this switching means, the drive power generator pivots through 180° independently of the steering set by the setting device. During
45 reversal, the switching means may switch in a high steering power for a short period of time, in addition to the normal power, so that a high speed of pivoting is attained and the desired change of the travelling
50 direction is performed most rapidly. A power control and a clutch for the drive power generator may be coupled to the switching means so that, upon change of the main travelling direction, the power is
55 then reduced automatically and, if desired, the clutch disengaged. The craft remains then in its desired course without a considerable damaging lateral drive occurring. Moreover a reversal of the main
60 direction of travel can be communicated by the switching means to the setting device, the drive power generator direction detector, and the steering indicator; thus it is possible to obtain an unambiguous
65 relationship between these three

components whatever the main travelling direction. Since such a reversal is equivalent to an inversion of the set value—actual value comparison, simple
70 potentiometers and bridge balancing circuits may be used for steering. Different potentiometers are used for forward travel and backward travel, only a sector of 180°
75 being required in each potentiometer. The switching means for forward-reverse thus does not only invert the direction of rotation, but simultaneously switches in the potentiometers necessary for the main travelling direction selected.

Preferably, the direction of pivotal
80 motion for the reversal of the main travelling direction is selected by the control means so that it coincides with the direction of rotation of a vertical shaft in the drive power generator. This minimizes
85 the energy required and prevents damage.

The invention will be described further, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates diagrammatically the
90 drive and control of a steering propeller screw of a water craft;

Figure 2 illustrates a drive and control with a single control lever;

Figure 3 illustrates another drive and
95 control with a single control lever; and

Figure 4 illustrates the drive of a pair of steering propeller screws in a water craft.

Referring now to Figure 1, a drive power generator 1 is illustrated, comprising a
100 propeller screw mounted on an under-water member 2 which can be pivoted about a vertical axis endlessly through 360°. Rotation about this axis is driven by a hydraulic motor 4 by way of a universal
105 joint control shaft 3. The hydraulic motor 4 is supplied by a hydraulic aggregate 5 which comprises the means usual for this purpose, such as a pump, a storage container, a filter, and control valves (not shown) which will
110 not be expressly described here, since they are already well known. The propeller screw for generating the drive power is driven by an internal combustion engine 7 or another prime mover by way of a clutch
115 6.

The angle of rotation of the propeller screw about the vertical is detected at the under-water member 2 or at the hydraulic motor 4 or (as shown) in the linkage
120 between them, by means of a belt drive 8, 9 (or a gear wheel drive or a chain drive or any other drive) actuating four potentiometers 10 to 13. The output signals of the potentiometers 10, 11, 12, 13 are to a
125 control device 18 by way of respective leads 14, 15, 16, 17. The two potentiometers 10, 11, are actual value receivers for follow-up control. The potentiometers 12, 13 provide a steering indication. A control desk
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comprises a steering indicator 20, a handwheel 21 for setting the steering, and a selector-switch lever 22 for selecting the main travelling direction (ahead or astern).
5 The steering can be set at the handwheel 21 preferably by merely $\pm 90^\circ$ relative to the main travel direction, or if necessary by slightly more. The available steering is limited by a cam 23 and abutments 24. The
10 steering set is transmitted by a potentiometer 25 (set value transmitter) to a control device 18 by way of a lead 26.

The main travelling direction of the craft can be selected by means of the lever 22, in that this lever is pressed forwards or
15 backwards. The direction of movement and the position of the selector switch lever therefore corresponds then to the main travelling direction. The selection is effected by a cam 27 actuating one of two
20 contactors 28, 29. The contactor actuated transmits the desired travelling direction to the control device 18. The lever 22 carries a cam 30 which cooperates with a contactor 31 which, when actuated renders the clutch
25 6 inoperative by way of the control device 18.

Moreover the lever 22 actuates a slide potentiometer 32 which sets the desired
30 rotary speed of the engine 7 by controlling the carburettor or fuel pump of the engine via the control device 18. The rotary speed is selected by means of a follow-up control which is incorporated in the control device
35 18.

The arrangement is such that in the vertical position of the lever 22 the rotary speed of the engine 7 is switched to idling, the cam 30 having disengaged the clutch 6
40 by way of the contactor 31. When the lever 22 is pushed forwards or backwards, the desired main travelling direction thus selected is transmitted to the control device 18 by the contactor 29 or 28 actuated by the
45 cam 27. Simultaneously various switching processes are performed in the control device 18. In particular the two potentiometers 10 and 12 or 11 and 13 pertaining to the desired main travelling direction are connected to the steering
50 indicator 20 and to the setting potentiometer 25, by way of a relay 34; a lead 35 from the indicator 20 and the lead 26 from the potentiometer 25 are connected by the relay 34 to the respective
55 leads 16 and 14 or 17 and 15. If the desired main travelling direction does not agree with the position of the steering propeller screw, the hydraulic aggregate 5 is switched
60 on by the control device 18.

A hydraulic store 50 serving as an energy store is also provided in or associated with the hydraulic aggregate. Such hydraulic
65 stores are known *per se*, and therefore need be described in detail here. The energy

stored in the hydraulic store 50 is additionally connected to the pump power only when a change of the main travelling direction is selected. Because of the extra
70 power, needed only for a brief period of time, the under-water member 2 carrying the propeller screw can thus be rotated very quickly. A limitation of the rotation to 180° is effected by the circuit bridge constituted
75 by the two potentiometers 25 and 10 or 11. A branch line 36, which branches off the previously mentioned lead 26 and leads to the control device 18, ensures that continuous comparison between the set value and actual value provided by the
80 potentiometers is performed by the control device 18.

Furthermore, when the selector switch lever 22 is swung forwards or backwards, the contactor 31 is released by the cam 30
85 and as a result the clutch 6 is engaged. Upon further displacement of the lever 22 in the same direction, the slider of the slide potentiometer 32 is drawn out, which has as a consequence an increase of the rotary
90 speed of the engine 7.

If the craft is travelling forwards and the main traveling direction is to be reversed the selector switch lever 22 is pulled back
95 initially to the upright position. Thereby the rotary speed of the engine 7 is first lowered, then the clutch 6 is disengaged, so that the driving force of the propeller screw is removed. Upon further pulling back of the
100 lever 22 the cam 27 actuates the contactor 28 and thereby sets the main travelling direction "astern" in the control device 18. Correspondingly the control device 18 reacts by changing over the potentiometers
105 by means of the relay 34 and connecting the hydraulic store 50. The underwater member 2 is rotated through 180° .

When the main travelling direction is changed from ahead to astern, the potentiometers connected to the steering
110 indicator 20 and to the setting potentiometer 25 are changed so that the steering always corresponds to the setting of the handwheel 21. This means that if the handwheel 21 is turned to the right, the
115 steering of the craft changes always to the right, independently of whether the view is over the bow or the stern. Correspondingly the steering indication coincides also always appropriately with the travelling
120 direction of the craft. The indicator 20 illustrated in Figure 1 does not rotate its pointer to point backwards when the main travelling direction is changed to astern, and the pointer indicates only the steering
125 not the direction of travel. It is obviously possible, upon reversal, to switch to a second indicator whose pointer stands at reverse, or to use an indicator which permits an indication all round.
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The control device 18 uses electronic control circuits and electronic constructional components which are known *per se* and can easily be designed to achieve the control functions described above.

Figure 2 illustrates an embodiment in which the functions of the handwheel and of the selector switch lever are combined in a single control lever 22a which has two degrees of freedom and is provided with a transverse handle 37 at its upper end. A cam 51 and selectively cooperating contactors 52, 53 for signalling the main travelling direction to the control device 18, a cam 54 and a cooperating contactor 55 for controlling the clutch 6, and a slide potentiometer 56 for setting the rotary speed of the engine 7 are mounted on a support 38 which is rotatable about a vertical axis through 180°. The rotary movement is limited by an abutment 40 on the support 38 and fixed counter-abutments 39, 41. The rotary movement is caused by turning the handle 37 and is transmitted by a potentiometer 25a to the control device 8 as a steering setting. The lever 22a and the cams 51, 54 referred to above are mounted in the support 38 by means of a horizontal shaft 57 and are therefore forwardly and backwardly rotatable, thereby to select the main travelling direction. The functioning of the switching arrangement corresponds to the description given in connection with Figure 1.

Figure 3 illustrates an embodiment in which a control lever 42 having two degrees of freedom is rotatable through an angle of 90° about a horizontal axis. By this rotational movement a rod 49, which is mounted rotatable in a vertical bearing and longitudinally displaceable, is moved up or down and thereby the clutch-control switch 31 and the slide potentiometer 32 for the control of the engine speed are actuated. During rotation of the rod 49 about the vertical axis a rotation transmitter 43 (nominal value) is rotated and thereby the desired steering is set. The rotational position of the underwater member 2 is scanned by means of rotation transmitters 44, 45 (actual value), compared with the position of the rotation transmitter 43 (set value), and transmitted to a steering indicator 46. The main travelling switch cam 47 and a selector switch 48.

The rotation of the control lever about the vertical axis of the rod 49 automatically causes, by way of the selector switch cam 47 and the selector switch 48, the rotary speed of the engine 7 to be reduced, the clutch 6 to be disengaged and the steering propeller screw 1 to be rotated through 180° at a high speed, these operations being controlled by the control device 18.

Subsequently the clutch 6 is automatically engaged again and the rotary speed is run up again to the value set by the lever 42. Moreover the operation of the rotation transmitters 43, 44, 45 and the steering indicator 46 is inverted. Unlike the preceding embodiment, this embodiment does not utilise potentiometers for the actual value—nominal value comparison, but rotation transmitters. Rotation transmitters operating with direct current and alternating current are well known and are therefore not described in detail here. (Suppliers are, for example: the Firm Hagenuk, Kiel, Germany; VDO Tachometer Werks, Frankfurt, Germany; Simmonds Precision, Rockingham Road, Bellows Falls, Vermont 05101, USA.)

Figure 4 illustrates a double steering-propeller-screw installation. The two steering propeller screws 60, 61 are driven by a primer mover 62 by way of a branching gear 63 in a known manner. A hydraulic motor 64, 65 is provided for each steering propeller screw 60, 61 for driving its rotary displacement. The steering and reversing control means (not shown) corresponds to the embodiments described above. For steering the ship, the under-water members of the steering propeller screws 60, 61 are rotated in synchronism, whereas for reversal of the main travelling direction, the underwater members are rotated in opposition through 180°, so that the craft is not deflected from the travelling direction set by the steering device.

Electro-hydraulic control systems have been described in the above embodiments. Naturally it is possible to construct equivalent mechanico-hydraulic or mechanico-electrical control systems in which the selector switch for selecting the main travelling direction actuates corresponding gears or couplings and thereby effects rapid pivoting of the steering propeller screw through 180° and reversal of the relationship between the steering propeller screw and the steering indication.

WHAT WE CLAIM IS:—

1. A water craft comprising a drive power generator which is pivotable about a substantially vertical axis and control means for controlling the pivoting of the drive power generator in order to control the course of the craft, in which the control means comprises a setting device for setting the steering of the craft relative to the main direction of travel, i.e. ahead or astern, and switching means for selecting the main direction of travel and matching the operation of the setting device to the main direction of travel selected.
2. A craft as claimed in claim 1, in which



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WHAT WE CLAIM IS:—

1. A water craft comprising a drive power generator which is pivotable about a substantially vertical axis and control means for controlling the pivoting of the drive power generator in order to control the course of the craft, in which the control means comprises a setting device for setting the steering of the craft relative to the main direction of travel, i.e. ahead or astern, and switching means for selecting the main direction of travel and matching the operation of the setting device to the main direction of travel selected.

2. A craft as claimed in claim 1, in which



the pivotal displacement of the drive power generator for steering and the pivotal displacement of the drive power generator for reversal of the main travelling direction are performed by one and the same motor.

5 3. A craft as claimed in claim 1 or 2, in which the control means comprises a set value—actual value comparator for controlling steering during forward travel and a set value—actual value comparator for controlling steering during backward travel, and in which the switching means is arranged to select the appropriate comparator.

10 4. A craft as claimed in any of claims 1 to 3, in which the control means comprises means for accelerating the pivotal displacement of the drive power generator when the main travelling direction is being reversed.

20 5. A craft as claimed in claim 4, in which the accelerating means comprises a switchable energy store.

25 6. A craft as claimed in claim 5, in which the energy store is a hydraulic store.

7. A craft as claimed in any of claims 1 to 6, in which the drive power generator is connector to a prime move *via* a clutch controlled by the switching means.

30 8. A craft according to any of claims 1 to 7, in which the control means includes means for controlling the power of the drive power generator, the said power controlling means being associated with the

switching means so as to operate in conjunction therewith. 35

9. A craft as claimed in any of claims 1 to 8, including a steering indicator controlled by the switching means and indicating the steering relative to the main travelling direction selected. 40

10. A craft as claimed in any of claims 1 to 9, in which the setting device and the switching means are operated by a single control member having two degrees of freedom. 45

11. A craft as claimed in claim 3, in which the set value—actual value comparators comprise potentiometers or rotation transmitters. 50

12. A craft as claimed in any of claims 1 to 11, having two said drive power generators, in which the control means is arranged to cause the drive power generators to pivot in opposite directions when reversal of the main travelling direction is selected by the switching means. 55

13. A water craft as claimed in claim 1 and substantially as described herein with reference to Figure 1, Figure 2, Figure 3, or Figure 4 of the accompanying drawings. 60

MARKS & CLERK,
Chartered Patent Agents,
57—60 Lincolns Inn Fields,
London, WC2A 3LS.
Agents for the applicant(s).