June 11, 1946. W. M. NYE 2,401,771

AUTOMATIC STEERING OF MARINE VESSELS

Filed Nov. 10, 1944 3 Sheets-Sheet 1

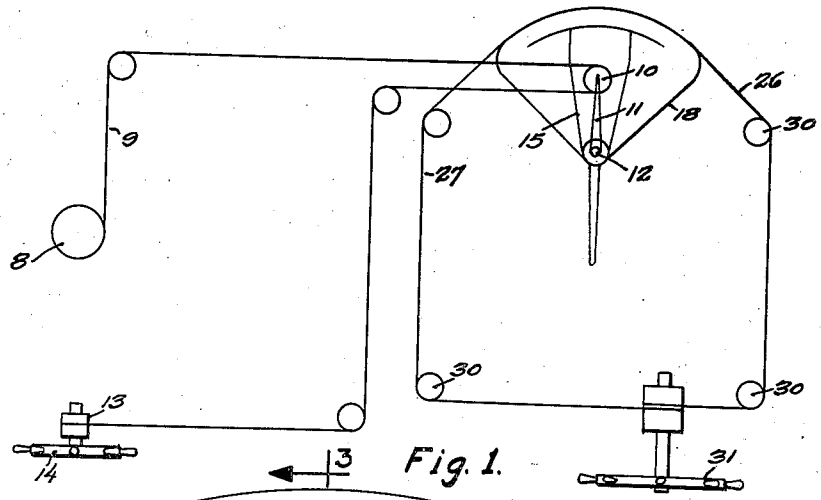


Fig. 1.

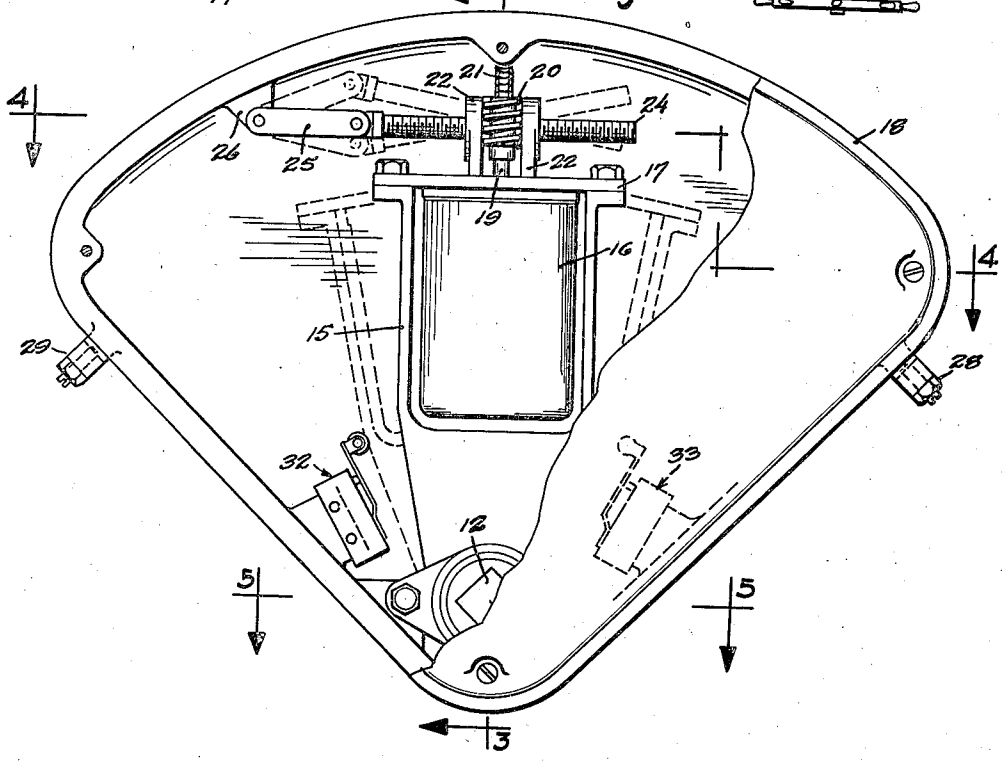


Fig. 2.

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Filed Nov. 10, 1944 3 Sheets-Sheet 2

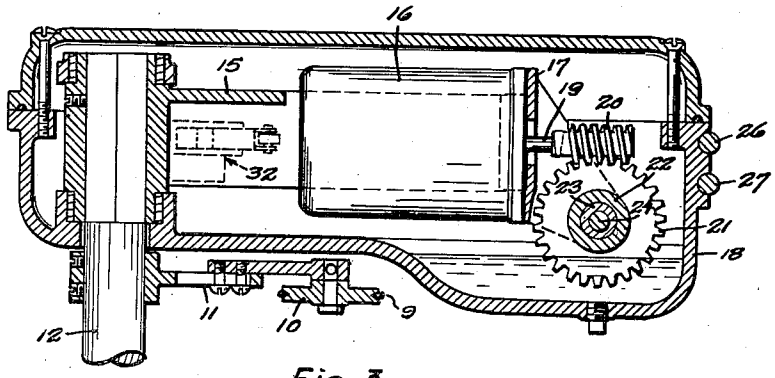


Fig. 3.

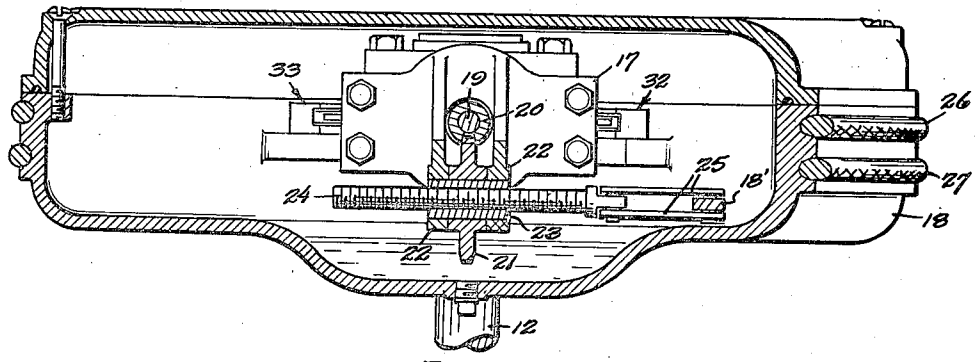


Fig. 4.

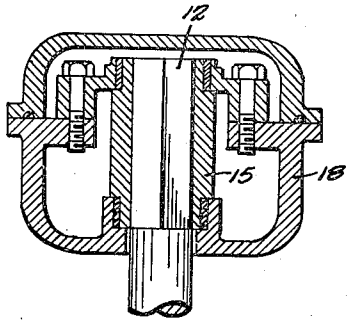


Fig. 5.

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June 11, 1946. W. M. NYE 2,401,771

AUTOMATIC STEERING OF MARINE VESSELS

Filed Nov. 10, 1944 3 Sheets-Sheet 3

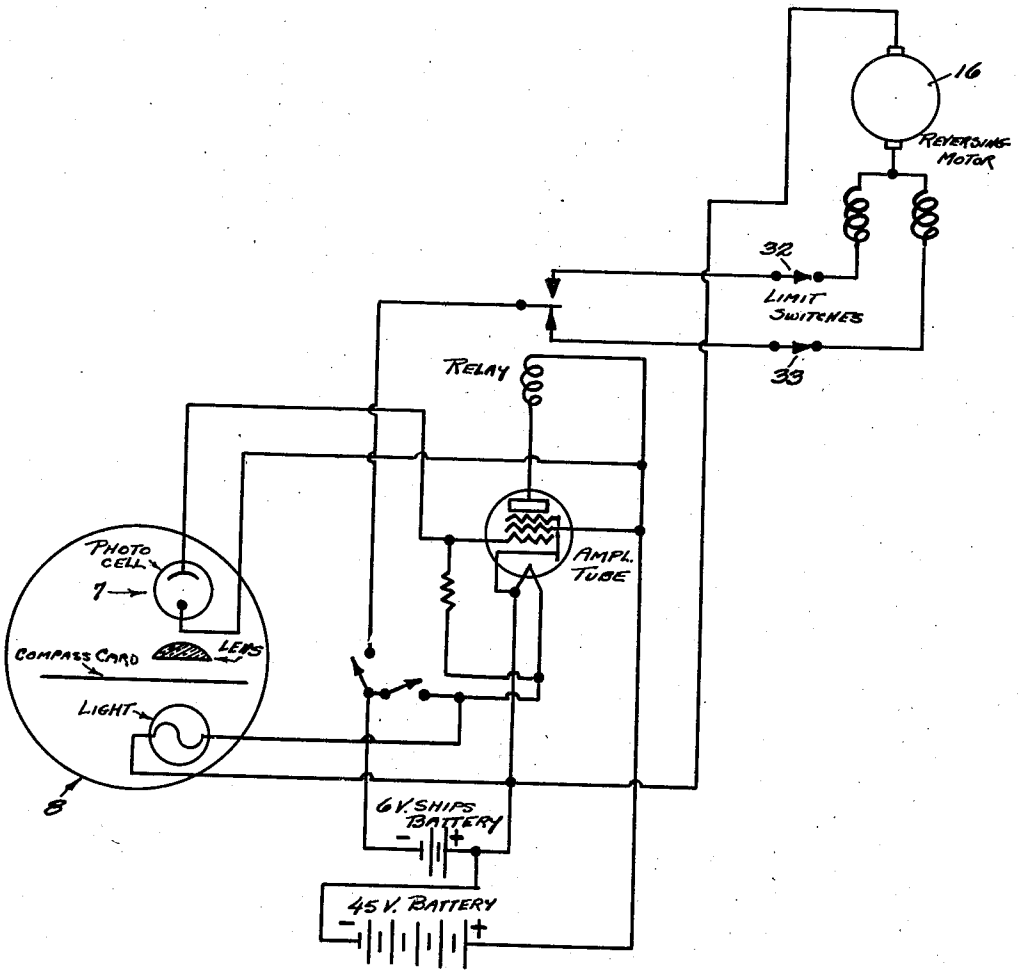


Fig. 6.

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atty.

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UNITED STATES PATENT OFFICE

2,401,771

AUTOMATIC STEERING OF MARINE VESSELS

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Application November 10, 1944, Serial No. 562,894

10 Claims. (Cl. 114—144)

1

This invention relates to the automatic steering of marine vessels, and has for its general object the provision of an especially compact yet highly efficient mechanism for this purpose which can be produced at small cost by comparison with previously developed automatic piloting systems.

The invention is designed with the especial object of producing an automatic pilot peculiarly applicable to the smaller class of vessel—pleasure craft, fishing boats and the like—and to the end of permitting the vessel to clear a log or other obstacle, lying in the direct path of a set course, has the further and important aim of providing a system enabling a helmsman to instantaneously change course by recourse to the hand wheel, either swinging the latter hard over or in such lesser degree as circumstances may require, and in response to such hand movement overcoming the automatic pilot and causing the rudder to swing in concert with the hand wheel, the operation being entirely automatic without, as has been characteristic of previous devices, first calling for the manipulation of pilot-deenergizing controls. The invention has this further important feature, namely, that the vessel reverts automatically from hand to pilot steering by the simple instrumentality of returning the hand wheel to neutral or amidships position.

Further and more particular objects still, with the foregoing, will appear and be understood in the course of the following description and claims, the invention consisting in the novel construction and in the adaptation and combination of parts hereinafter described and claimed.

In the accompanying drawings wherein I have illustrated a system embodying the teachings of the present invention:

Figure 1 is a somewhat schematic lay-out plan view of the complete assembly.

Fig. 2 is a top plan view of that part of the mechanism which is applied to the vessel's rudder post and acts as a responding unit to the action of either the hand wheel or the piloting binnacle, the scale being considerably enlarged from the showing of the corresponding parts in Fig. 1. A hollow quadrant which is made a part of this post-carried mechanism is partially broken away to permit a full-line illustration of elements received therein.

Fig. 3 is a longitudinal vertical section taken on line 3—3 of Fig. 2.

Fig. 4 and Fig. 5 are each a fragmentary detail transverse vertical section, the former on line 4—4 and the latter on line 5—5 of Fig. 2; and

Fig. 6 is a wiring diagram portraying the electrical hook-up of a light sensitive device engineered into the piloting binnacle, the reversing electric motor which is housed within the hollow quadrant, an amplifying circuit incorporating a vacuum tube and motor relay, and an on-off switch.

2

Referring to said drawings, and first giving substance to the binnacle which is not detailed by reason of the same being widely used in automatic steering, it will suffice to say that the same contains a photo-electric cell, a light train, and a compass with a slotted card, the binnacle being free to turn against the resistance of a coil spring. The light-sensitive cell connects with the input side of the amplifier tube, and the relationship of the parts contained within the binnacle is such that the motor is inactive when the cell is subject to light rays of medium intensity, energized for operation in one direction when the beamed light reaches maximum, and energized for operation in the opposite direction when a condition of zero light obtains, all of which conditions reflect given relationships as between the position of the binnacle and the position of the compass card. The particular binnacle which I elect to employ follows the teachings of U. S. Letters Patents numbered 1,885,098, 2,112,490, 2,112,504 and 2,116,629 and is peculiarized in its employment of a single photo-electric cell. Other binnacles resorting to the use of paired cells could, perforce, be utilized in carrying the present invention into practice, and which is to say that the particular principle relied upon in the engineering of the binnacle is of no import to the present system of automatic piloting other than that the same be made to close two oppositely acting power circuits by movements of the vessel in opposite directions from a set course.

The light-sensitive cell, designated by the numeral 7, is shown in the wiring diagram of Fig. 6, and the binnacle, indicated generally by 8, is illustrated in Fig. 1.

Fixedly associated with the binnacle and disposed concentric to the latter's turning axis is a drum on which a cable 9 is wound, and from the binnacle this cable runs about suitable pulleys—including a pulley 10 made fast to an arm 11 extending radially from and swingable with the rudder stock 12—to and about a drum 13 located in the pilot house and to which is fixedly attached a course-changing wheel 14 calibrated upon its face in the degrees of the compass. It will be seen, therefore, that a setting of the course-changing wheel will act through the cable to give a corresponding movement to the binnacle, and

that, through movements of the arm 11, the cable will thereafter serve a follow-up office actuating the binnacle in accordance with the rudder's swing.

Now considering the mechanism detailed in Figs. 2 through 5, inclusive, and which may be termed the responding end of the system, there is provided a lever 15 fixedly secured to the rudder stock 12 and produced with a bifurcate extremity accommodating the reversing electric motor 16 of the system, the motor being fixedly secured to the lever by means of a flange-forming plate 17 attached to the outer face of the motor casing. Said lever and the motor constitute, in effect, the functional counterpart of a tiller arm and are housed within a hollow quadrant 18 which is given a floating journal upon the hub of the lever for pivotal movements independently thereof about the center of the stock as an axis.

The armature shaft 19 of the motor projects through and is exposed beyond the plate 17 and upon its exposed end carries a worm, as 20, in mesh with a worm wheel 21, the worm wheel being received between spaced hanger arms 22 projected outwardly and downwardly as integral prolongations of the tiller arm assembly, and made fast to the worm wheel and receiving a journal in said hanger arms is an internally threaded bushing 23. The arrangement is one which places the axis of the worm wheel at substantial right angles to the longitudinal median line of said tiller arm assembly.

Working in the threads of the bushing is a threaded shaft 24. Links 25 connect by one end with an ear 26 integral with the quadrant and form a shackle from the quadrant to an end of said shaft 24. It will be thus seen that the tiller arm is normally tied for unitary movement to the quadrant, and which is to say that the two will operate as one during periods of motor inactivity, and permitting, however, relative movements as between the two by the act of energizing the motor. If the quadrant be held stationary, the rudder stock will turn by an energizing of the motor, and will also turn by swinging the quadrant.

In giving manual control to the quadrant, I employ the usual tiller lines 26—27 which seat in cable-grooves produced in the exposed face of the quadrant's arcuate wall, have their ends attached to the quadrant by clamps 28—29, and carry about pulleys 30 to the vessel's hand steering wheel 31. These tiller lines are free of slack, and in the absence of hand pressure upon the wheel produce sufficient frictional resistance to maintain a set position. Under automatic piloting, and as will be hereinafter made clear, the wheel 31 is placed in neutral position and, in lieu of or as a supplement to the friction of the tiller lines, either a friction brake or a bullet catch (subject to manual overpowering) could, if desired, be applied to the hand wheel as a means of yieldingly securing the wheel, and hence the quadrant, in centered position.

The operation is readily understood. When the automatic pilot is made inactive by throwing the switch on the pilot house control panel to "off" position, the worm, worm wheel, and the threaded rod are locked and produce an anchoring tie from the quadrant to the tiller arm assembly. The boat may then be steered by hand in the normal manner. To place the pilot in operation, the course is set by positioning the course-changing wheel 14 in selected position. Then locating the hand wheel 31 in a neutral or amidships position, the binnacle and motor circuits are cut in by placing the switch in "on" position. The quadrant now remains stationary, and the tiller arm shifts back and forth by oppositely directed rotation of the motor following a more or less continual hunting of the binnacle's compass card. Assuming, now, that a floating log or other obstacle appears ahead, the helmsman need only swing the hand wheel and the rudder instantly acts. The binnacle will, of course, be affected by the vessel's swerve out of the set course, and responsively will energize the motor toward correcting the change of course. The resulting relative shift of the tiller arm assembly within the quadrant causes the tiller arm to bring up against a limit switch, as 32—33, and the motor cuts out. The binnacle and associated parts are again caused to automatically take up the piloting function by simply returning the vessel on course and re-positioning the hand wheel in neutral or amidships position.

Numerous departures from the illustrated and described embodiment will suggest themselves having knowledge of my teachings, and it is self-evident that recourse may be freely had to these departures without sacrifice of the inventive concept. It is my intention that all forms of construction and variations in detail coming within the scope of the hereto annexed claims are to be considered as comprehended by the invention.

What I claim is:

1. As a steering system, and in combination with the rudder stock of a vessel, and with a hand steering wheel which permits of being yieldingly set in a neutral or amidships position: a crank arm operatively interconnected with the rudder stock to cause the two to move relatively in concert; a second crank arm operatively interconnected with the steering wheel to cause the second said arm to move relatively in concert with the wheel; means including a reversing electric motor operating, when the motor is inactive, to produce a connecting couple tying the two arms together and hence transmitting to the rudder stock a functional counterpart of the hand movement given to the steering wheel and, when the motor is activated in opposite directions of rotation, causing the two arms to move relatively in converse directions of shifting travel; a normally incomplete electric circuit for the motor; a rotatably mounted binnacle; a drum fixedly associated with the binnacle; a wheel separate from the steering wheel for changing the vessel's course and arranged to normally occupy a fixed variable setting; a pulley offset from the axis of the rudder stock and movable rotatively about its own axis and also bodily in concert with the rudder about the center of the latter as an axis; a mechanical connection from the second said wheel to the binnacle comprising a line running from the second said wheel about the pulley and therefrom to and about the binnacle drum, and operating automatically in response to a deviation of the vessel in either direction from a given course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said hand steering wheel being set in its neutral or amidships position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

2. As a steering system, and in combination with the rudder stock of a vessel, and with a hand steering wheel which permits of being yieldingly set in a neutral or amidships position: a crank arm operatively interconnected with the

rudder stock to cause the stock to move relatively in concert with the arm; a second crank arm journaled for swinging movements about an axis coinciding with that of the first-named arm and operatively interconnected with the steering wheel to cause the second said arm to move relatively in concert with the steering wheel; a reversing electric motor; means adjustable as to length, occupying a position generally concentric to the swinging axis of the arms, and extending as a connecting couple from the free end of one to the free end of the other said arm and operating, normally, to tie the two arms together for unitary movement and hence transmit to the first-named crank arm and therefrom to the rudder stock the movements given by the hand wheel to the second-named crank arm; operative interconnection from the motor to said tie means functioning upon an activation of the motor for rotation in one direction to shorten, and by activation for rotation in the other direction to lengthen, said tie means; a normally incomplete electric circuit for the motor; a compass; and circuit-closing means associated with the compass, arranged to be variably set according to the course desired, and operating automatically in response to a deviation of the vessel in either direction from given course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said hand steering wheel being set in its neutral or amidships position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

3. As a steering system, and in combination with the rudder stock of a vessel: a crank arm operatively interconnected with the rudder stock to cause the stock to move relatively in concert with the arm; a second crank arm journaled for swinging movements about an axis coinciding with that of the first-named arm and arranged and adapted to be swung manually in opposite directions from a neutral position while admitting of being yieldingly set in said neutral position; means adjustable as to length, occupying a position generally concentric to the swing axis of the arms, and extending as a couple from the free end of one to the free end of the other said arm to operate, normally, as a tie joining the two arms for unitary movement and hence transmitting to the first-named crank arm and therefrom to the rudder stock the movements given by hand to the second-named crank arm; a reversing electric motor; operative interconnection from the motor to said coupling means arranged and adapted by an energizing of said motor for rotation in one direction to shorten the coupling means and by an energizing of the motor for rotation in the opposite direction to lengthen the coupling means; a normally incomplete electric circuit for the motor; a compass; and circuit-closing means associated with the compass, arranged to be variably set according to the course desired, and operating automatically in response to a deviation of the vessel in either direction from given course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said manually operated crank arm being set in its neutral position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

4. The system of claim 3, and limit switches functional to de-energize the motor, carried by the second-named crank arm to lie at opposite sides of and in the path of relative swinging

movement of the first-named crank arm, and so placed in relation to a normal centered position of the latter as to cut out the motor only upon a relative swing as between the two arms exceeding a given degree of minor disarrangement.

5. The system of claim 3, said coupling means comprising a threaded rod attached to one said arm, and an internally threaded bushing working on the rod, restrained against endwise movement in relation to the other said arm, and receiving a rotary journal from the latter, the motor being carried by the arm last mentioned, and wherein the interconnection from the motor to said coupling means comprises a worm driven from the armature shaft of the motor and driving a worm wheel fast to the bushing.

6. The system of claim 3, said coupling means comprising a threaded rod shackled by an end to one of said arms, and a worm wheel having an internally threaded hub working on the rod, restrained against endwise movement in relation to the other said arm, and journaled from the latter for rotary movement about an axis approximately tangent to a circle taken about the swing-axis of the arms as a center, the motor being carried by the arm last mentioned, and wherein the interconnection from the motor to said coupling means comprises a worm driven from the armature shaft of the motor and in mesh with the worm wheel.

7. As a steering system, and in combination with the rudder stock of a vessel, and with a hand steering wheel which permits of being yieldingly set in a neutral or amidships position: a tiller arm fast to the rudder stock; a hollow quadrant housing said tiller arm and journaled for swinging movements independently of the tiller arm about the center of the rudder stock as an axis; tiller lines from the steering wheel to the quadrant for transmitting, to the latter, movements given by hand to the steering wheel; a reversing electric motor fixedly carried upon the free end of the tiller arm and fitted with a worm; a worm wheel movable bodily with the tiller arm, journaled from the latter for rotary movement about an axis approximately tangent to a circle taken concentric to the rudder stock, and driven from said worm; a threaded rod working through the threaded hub of the worm wheel and shackled by an end to the quadrant; a normally incomplete electric circuit for the motor; a compass; and circuit-closing means associated with the compass, arranged to be variably set according to the course desired, and operating automatically in response to a deviation of the vessel in either direction from its given course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said hand steering wheel being set in its neutral or amidships position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

8. The system of claim 7, and limit switches functional to de-energize the motor, carried by the quadrant to lie at opposite sides of and in the path of relative swinging movement of the tiller arm, and so placed in relation to a normal centered position of the latter as to cut out the motor only upon a relative swing as between the two swinging members, namely the tiller arm and the quadrant, exceeding a given degree of minor disarrangement.

9. As a steering system, and in combination with the rudder stock of a vessel, and with a hand steering wheel which permits of being yieldingly

set in a neutral or amidships position: a tiller arm fast to the rudder stock; crank arm journaled for swinging movements independently of the tiller arm about the center of the rudder stock as an axis; tiller lines from the steering wheel to the crank arm for swinging the latter in response to turning movements of the wheel; a reversing electric motor bodily movable with the tiller arm; means associated with the motor and operating, when the latter is inactive, to anchor the tiller arm to the crank arm and, when the motor is energized, shifting the two arms, one in relation to the other, in converse directions of swing, the relative shifting being in one direction as the motor rotates in one direction and in the opposite direction as the motor rotates in the other direction, said crank arm comprising a hollow quadrant which produces a water-tight casing completely housing therein the tiller arm, the electric motor, and the said means associated with the motor; a normally incomplete electric circuit for the motor; a compass; and circuit-closing means associated with the compass, arranged to be variably set according to the course desired, and operating automatically in response to a deviation of the vessel in either direction from its set course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said hand steering wheel being set in its neutral or amidships position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

10. As a steering system, and in combination with the rudder stock of a vessel, and with a hand

steering wheel which permits of being yieldingly set in a neutral or amidships position: a tiller arm fast to the rudder stock; a crank arm journaled for swinging movements independently of the tiller arm about the center of the rudder stock as an axis; tiller lines from the steering wheel to the crank arm for swinging the latter in response to turning movements of the wheel; a reversing electric motor bodily movable with one of said arms; means associated with the motor and operating, when the latter is inactive, to anchor the motor-carrying arm to the other said arm and, when the motor is energized, shifting the two arms, one in relation to the other, in converse directions of swing, the relative shifting being in one direction as the motor rotates in one direction and in the opposite direction as the motor rotates in the other direction, said crank arm comprising a hollow quadrant which produces a water-tight casing completely housing therein the tiller arm, the electric motor, and the said means associated with the motor; a normally incomplete electric circuit for the motor; a compass; and circuit-closing means associated with the compass, arranged to be variably set according to the course desired, and operating automatically in response to a deviation of the vessel in either direction from its set course to close the circuit and energize the motor for rotation in the direction necessary to correct the deviation, said hand steering wheel being set in its neutral or amidships position when recourse, for the piloting of the vessel, is had to said automatic circuit-closing means.

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