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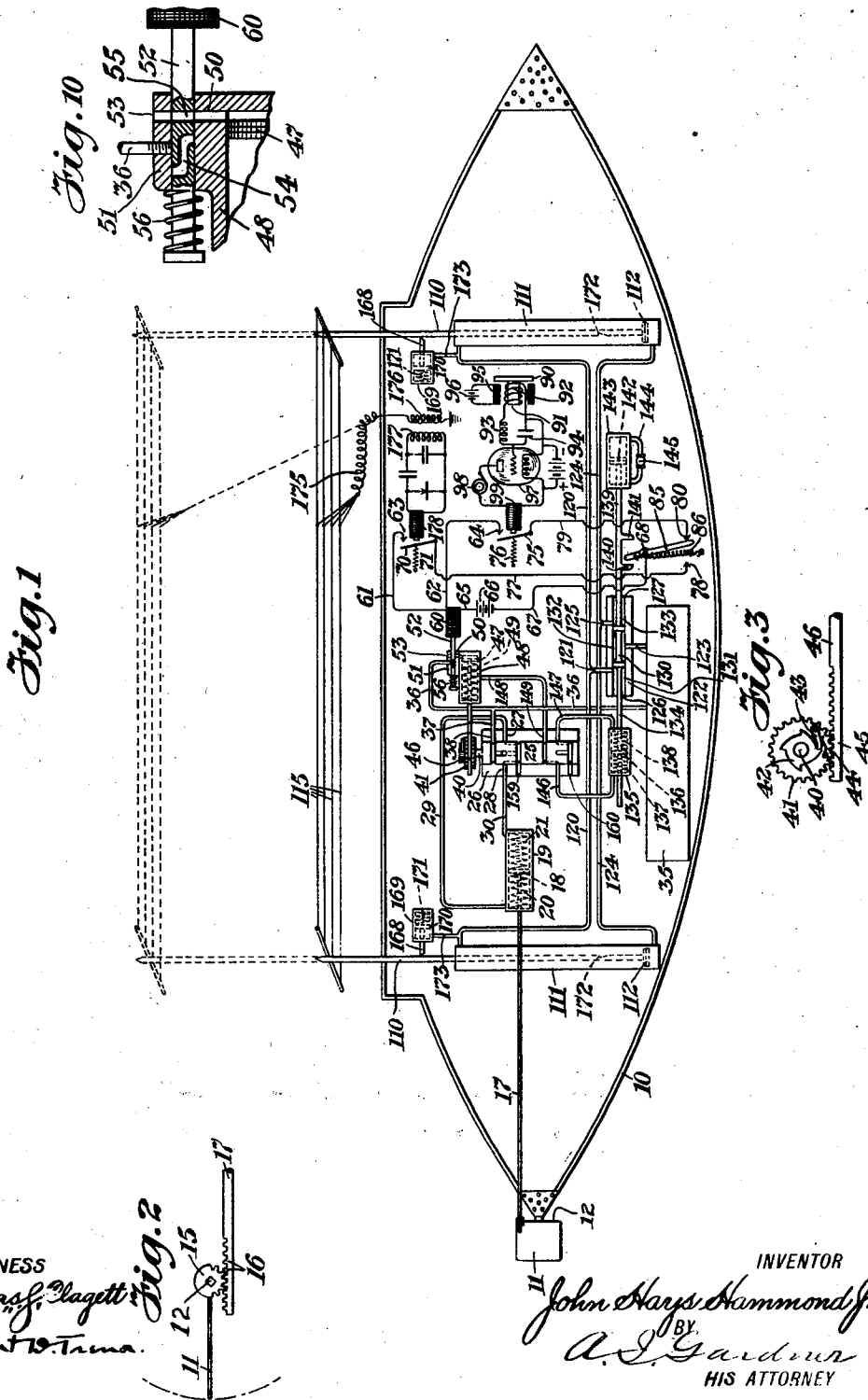
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DUAL SYSTEM OF CONTROL FOR DIRIGIBLE DEVICES

Original Filed Oct. 14, 1915

2 Sheets-Sheet 1



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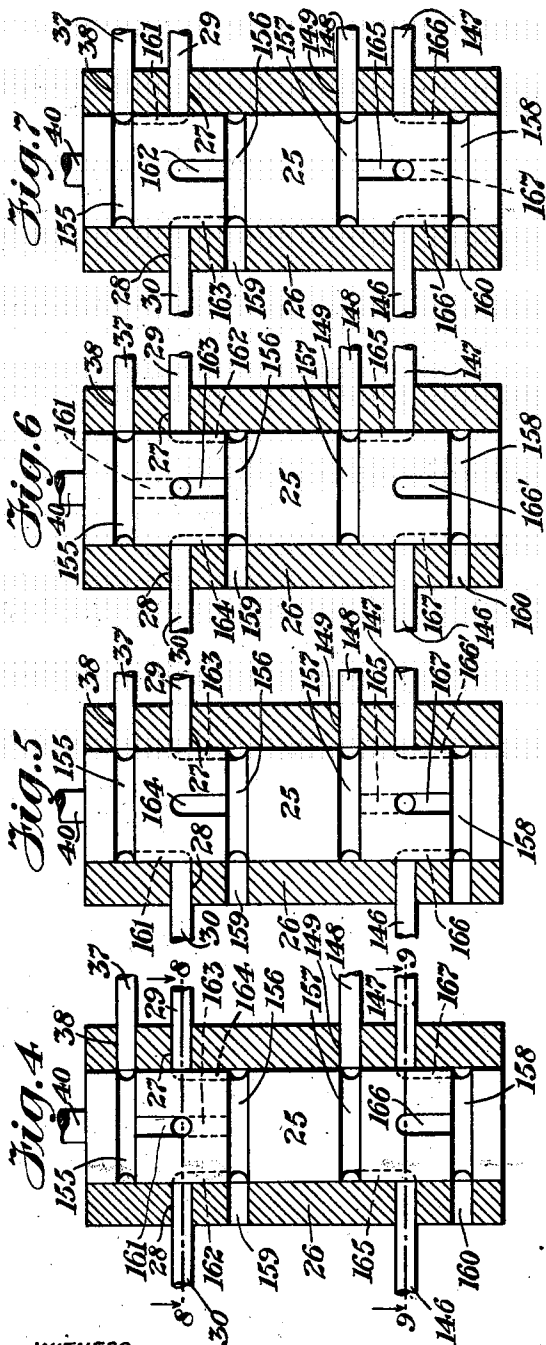
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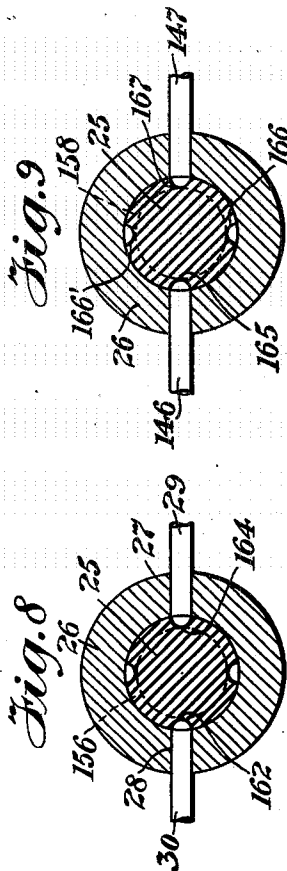
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DUAL SYSTEM OF CONTROL FOR DIRIGIBLE DEVICES

Original Filed Oct. 14, 1915 2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

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DUAL SYSTEM OF CONTROL FOR DIRIGIBLE DEVICES.

Application filed October 14, 1915, Serial No. 55,895. Renewed August 25, 1923.

To all whom it may concern:

Be it known that I, JOHN HAYS HAMMOND, Jr., a citizen of the United States, residing in Gloucester, county of Essex, State of Massachusetts, have invented a certain new and useful Dual System of Control for Dirigible Devices, of which the following is a specification.

One of the objects of this invention is to provide means whereby a prime mover or actuating device may be controlled from a distance either by one form of energy, or by another,—for instance, either by electromagnetic radiant energy or by sound waves.

A further object of this invention is to provide means whereby a dirigible device such, for instance, as a marine vessel, a torpedo, an aeroplane, or any other dirigible device, may be steered or stabilized with respect to a given axis, either through the agency of one form of energy or through the agency of another form of energy.

Other objects of this invention are to provide improved means for raising a mast and holding the same in an elevated position and for releasing and lowering the same; and to provide other improvements as will appear hereinafter.

In the accompanying drawings, Fig. 1 is a diagrammatic side elevation of a marine vessel provided with a dual system of control constructed in accordance with this invention; Figs. 2 and 3 are top plan views of details of the same; Figs. 4, 5, 6 and 7 are enlarged longitudinal sections showing in its different positions a valve forming a part of this invention;

Figs. 8 and 9 are transverse sections on lines 8—8 and 9—9 respectively of Fig. 4; and Fig. 10 is an enlarged section of a portion of Fig. 1.

Referring to the drawings, one embodiment of this invention comprises a marine vessel or torpedo including a hull or body portion 10 provided at one end with a normally vertical rudder 11 pivotally connected thereto and arranged to swing with respect thereto about a normally vertical axis. For swinging the rudder in either direction about its axis, a segmental gear 15 is rigidly secured to the rudder coaxially therewith and is engaged by a rack 16 which forms one end of a piston rod 17, the other end of which is provided with a piston 18 which is arranged to reciprocate in a steering cylin-

der 19 which is fixedly secured within the hull 10. The piston 18 is normally held in a central position in the cylinder 19 by means of opposed spiral springs 20 and 21 arranged within the cylinder upon opposite sides of the piston, and when the piston 18 is in a central position the rudder 11 is held in alinement with the longitudinal axis of the hull 10.

For distributing compressed air or other fluid under pressure to the steering cylinder 19, and for other purposes as will appear hereinafter, a rotary cylindrical valve 25 is arranged to rotate about its longitudinal axis and is held against longitudinal movement in a valve casing 26 which is fixedly secured in the hull 10. This valve casing 26 is provided with two oppositely disposed ports 27 and 28 which communicate with the opposite ends of the cylinder 19 respectively through pipes 29 and 30. A suitable tank 35, or other source of compressed air or other fluid under pressure, is fixedly secured in the hull 10 and communicates through a pipe 36 and branch pipe 37 with an inlet port 38 provided therefor in the valve casing 26.

For giving the valve 25 a step-by-step rotary movement, one end of the valve is provided with a valve stem 40 upon which is loosely mounted a gear 41, outside of which is fixedly secured upon the stem a ratchet 42 which is arranged to be engaged by a pawl 43 which is pivotally secured to the gear 41 and which is pressed into engagement with the ratchet 42 by means of a spring 44. Engaging the gear 41 is a rack or actuator 45 which forms one end of a piston rod 46, the other end of which is provided with a piston 47 which is arranged to reciprocate in a cylinder 48 which is fixedly secured within the hull 10, the piston being normally held in its innermost position in the cylinder by means of a spiral spring 49 surrounding the piston rod 46. The cylinder 48, which for convenient future reference may be called the ratchet cylinder, is provided with a port 50 (see Fig. 10) and with a valve casing 51 containing a reciprocatory slide valve 52 which is arranged to connect the port 50 either with an exhaust port 53 provided therefor in the valve casing 51, or with the pipe 36 leading from the source of compressed air 35, the valve 52 being provided with two ports 54 and 55

for this purpose. The valve 52 is normally held in such a position as to prevent communication between the cylinder 48 and the air pipe 36 and to permit communication
 5 between the space in the cylinder 48 back of the piston 47 and the exhaust port 53, by means of a spiral spring 56 surrounding one end of the valve. For reciprocating the valve 52, the other end of the valve forms
 10 the core of a solenoid 60 which is fixedly secured in the hull 10.

For energizing the solenoid 60 to control the vessel, either in response to radiant energy in the form of electromagnetic waves
 15 or in the form of sound waves, one end of the winding of the solenoid 60 is connected by two wires 61 and 62 with two stationary terminals or contacts 63 and 64 respectively, and the other end of the winding of the
 20 solenoid 60 is connected by a wire 65 with one pole of a battery 66, the other pole of which is connected by a wire 67 with a terminal 68. The terminal 63 is arranged to be engaged by the free end of a switch 70
 25 which is pivoted to swing about a fixed axis and which is normally held open by a spring 71. The terminal 64 is arranged to be engaged by a switch 75 which is normally held open by a spring 76. The former switch 70
 30 is connected by a wire 77 with a terminal 78, and the latter switch 75 is connected by a wire 79 with a terminal 80, which is spaced slightly from the terminal 78. A switch 85 is arranged to oscillate about the terminal
 35 68 to connect the battery 66 with either the terminal 78 or the terminal 80, the switch 85 being held yieldingly in either position by means of a spiral spring 86, one end of which is connected to one end of the
 40 switch 85 and the other end of which is fixedly secured in such a position that the spring 86 will tend to hold the switch 85 at either end of its path.

For controlling the rudder 11 in response
 45 to sound waves, a diaphragm 90 is arranged within the hull 10 and preferably below the water-line in such a manner that one side of the diaphragm will be in contact with the water surrounding the hull, and the dia-
 50 phragm will be free to vibrate in response to sound waves transmitted through the water. Rigidly secured to the diaphragm 90 is a core 91 around which is fixedly secured a conducting coil 92 which is in series
 55 with a closed oscillatory circuit including an inductance 93 and a condenser or capacity 94. Spaced from and surrounding the vibratory coil 92 is a fixed solenoid 95 which is continuously energized by a battery 96
 60 connected to the opposite ends of the solenoid. Connected in any suitable manner with the closed oscillatory circuit 92, 93, 94, is a gaseous or other suitable detector 97, having in series therewith a source 98 of current
 65 and an electromagnet 99 arranged to control

the switch 75. When the diaphragm 90 is vibrated in response to sound waves, electrical oscillations are set up in the closed circuit 92, 93, 94, and the inductance 93 and the capacity 94 are preferably so adjusted that
 70 they respond only to a certain frequency of oscillations, thus forming a selective system. When the closed circuit is thus tuned and the diaphragm 90 is vibrated in response to sound waves at a corresponding frequency,
 75 the electromagnet 99 will be energized in a well known manner and act to close the switch 75 upon the contact 64, thus closing the circuit through the solenoid 60 and operating the reciprocatory valve 52 to permit
 80 compressed air to enter from the pipe 36 into the cylinder 48 to force the piston 47 outwardly and to rotate the rotary valve 25 therewith one step or a predetermined number of degrees, which in the present instance
 85 is 90 degrees. By repeated signals of sound waves of the proper frequency the rotary valve 25 may be rotated any desired number of steps of 90 degrees each to control the rudder 11 accordingly, as will appear here-
 90 inafter.

For controlling the rudder 11 in response to radiant energy in the form of electromagnetic waves any suitable receiving means may be provided, but in the present
 95 instance improved means are provided including two vertical parallel masts 110 which are arranged to reciprocate vertically in two cylinders 111 fixed within the hull 10. The lower ends of the masts 110 are provided
 100 respectively with pistons 112, and the upper ends of the masts 110 project above the hull 10 and are connected by antennae 115.

For elevating and holding the masts 110
 105 in operative positions and later releasing and depressing the masts, the upper ends of the cylinders 111 are connected by a pipe 120 and branch pipe 121 with a valve casing 122 which is connected by a pipe 123 with
 110 the source 35 of compressed air or other motive fluid, and the lower ends of the cylinders 111 are connected by a pipe 124 and branch pipe 125 with the valve casing 122. The valve casing 122 is provided with two
 115 exhaust ports 126 and 127, and a reciprocatory piston valve 130 is arranged in the valve casing 122 to control the distribution of air from the source 35 to and from the cylinders 111. This piston valve 130 is provided
 120 within the valve casing 122 with three annular recesses 131, 132 and 133, forming passages for the compressed air.

For rendering the antennae 115 operative and the sound receiving means inoperative simultaneously with the raising of the
 125 masts 110, and for later rendering the antennae inoperative and the sound receiving means operative simultaneously with the lowering of the masts, one end of the
 130

piston valve 130 is provided with a cylindrical stem 134 which forms a piston rod extending through a cylinder 135, which for convenient future reference may be called the switch cylinder, and the rod is provided within this cylinder with a piston 136 rigidly secured thereto and normally held in a central position in the cylinder 135 by means of opposed springs 137 and 138 surrounding the stem 134 on opposite sides of the piston 136. The other end of the valve 130 is extended in the form of a stem 139 provided with two spaced lugs or trips 140 and 141 which are arranged upon opposite sides of and normally in spaced relationship to the free end of the switch 85, the arrangement being such that when the valve 130 is in its central position as shown in Fig. 1 the distance between the trip 140 and the free end of the switch 85, when the switch is in the position shown, will be the same as the distance between the trip 141 and the free end of the switch 85 when the valve 30 is in a central position and the switch 85 has been shifted to bring its outer end into engagement with the contact 78.

For retarding or damping the movement of the valve 130, the outer end of its stem 139 is provided with a piston 142 arranged to reciprocate in a fixed cylinder 143, the piston being normally in a central position in the cylinder. The opposite ends of the cylinder communicate through a by-pass 144, the effective area of which is adjustably controlled by a plug valve or other suitable valve 145, and the cylinder 143 and its by-pass are filled with air, water, oil, or any other suitable fluid or liquid but preferably with oil.

The opposite ends of the cylinder 135 are connected by corresponding pipes 146 and 147 with corresponding diametrically opposed ports in the valve casing 26 of the rotary valve 25. The ratchet cylinder 48 is connected intermediate of its ends by a pipe 148 with a corresponding port 149 in the valve casing 26 in such a manner that when the piston 47 is in its normal position there will be no communication between the pipe 148 and the pipe 36 leading from the source of compressed air 35, but when the piston 47 has been moved forward a part of its stroke, the pipe 148 will be placed in communication with the source of air supply 35 through the cylinder 48 and pipe 36.

The rotary valve 25 is provided with four spaced annular recesses 155, 156, 157 and 158, which register respectively with the hereinbefore mentioned port 38, an exhaust port 159, the hereinbefore mentioned port 149, and an exhaust port 160, provided therefor in the valve casing 26. Leading from the first or outermost annular recess 155 inwardly is a short longitudinal recess

161, and leading outwardly from the second annular recess 156 are three short longitudinal recesses 162, 163 and 164 of equal lengths, these four longitudinal recesses being arranged to communicate at proper times respectively with the pipes 29 and 30. Leading from the third annular recess 157 inwardly is a short longitudinal recess 165, and leading from the innermost or fourth annular recess 158 outwardly are three short longitudinal recesses 166, 166' and 167, of equal lengths, two, 166 and 166' of these last three being diametrically opposite, and all of these last four recesses being arranged to communicate at proper times with the pipes 146 and 147.

The construction of the rotary valve 25 and its casing 26 are such that when the rotary valve 25 is in one position, as shown in Figs. 1 and 4, both ends of the steering cylinder 19 are open to the exhaust passage 159, or, in other words, the valve will be in a neutral position and the rudder will not be under the influence of the pneumatic pressure and will be held in a central position by the springs 19 and 20. When the rotary valve is in this neutral position, as shown in Fig. 1, and when the piston 47 is at the left of the cylinder 48, communication is established from the ratchet cylinder 48, pipe 148, annular passage 157, longitudinal passage 165 and pipe 146 with the left hand end of the switch cylinder 135. When the rotary valve 25 has been rotated two steps or 180 degrees from the position shown in Fig. 1 to the position shown in Fig. 6, it will again be in a neutral position, and both ends of the steering cylinder 18 will be open to the exhaust 159, but in this case communication will be established from the ratchet cylinder 48 through the pipe 148 and longitudinal passage 165 and pipe 147 with the right hand end of the switch cylinder 135.

When the valve has been rotated one step or through 90 degrees from the position shown in Figs. 1 and 4 to the position shown in Fig. 5, communication will be established from the source of air 35 through the pipe 36, branch pipe 37, annular passage 155, longitudinal passage 161 and pipe 30 with the right hand end of the steering cylinder 19, which will force the piston rod 17 outwardly and turn the rudder 11 accordingly to steer the vessel to the left. When the rotary valve 25 has been rotated through three steps or through 270 degrees from the position shown in Figs. 1 and 4 to the position shown in Fig. 7, communication will be established from the source of air supply 35 through the valve casing 26 and into the left hand end of the steering cylinder 19 to turn the vessel to the right. When either end of the steering cylinder 19 is in communication with the source of air sup-

ply 35, the other end of the cylinder will be in communication with the exhaust passage 159, and both ends of the switch cylinder 135 will open to the exhaust port 160.

For automatically holding the masts 110 in their elevated positions, and for later releasing the same and forcing the same downwardly, each mast is engaged by one end of a catch 168, the other end of which extends in a cylinder 169 and is provided with a piston 170 which is normally pressed outwardly by means of a spiral spring 171 within the back portion of each cylinder. The lower end of each mast is provided with a notch 172 adapted to receive the outer end of the corresponding catch 168 when the mast has been raised to its uppermost position. The front portion of each cylinder 169 communicates through a pipe 173 with the pipe 120, whereby when the masts are in their elevated positions and compressed air is admitted to the latter pipe each piston 170 will be forced inwardly and retract its catch 168 from the corresponding notch 172, and at the same time compressed air from the pipe 120 will enter the upper ends of the cylinders 111 and will force the masts downwardly assisted by gravity.

For steering the vessel in response to radiant energy in the form of electromagnetic waves, the antennae 115 are connected to a conductor 175 which leads downwardly and is grounded at its lower end upon the hull 10 through an inductance 176 which forms the primary of a transformer, the secondary 177 of which forms part of the closed oscillatory circuit of any suitable construction and arranged to control an electromagnet 178 which is arranged to control the switch 70. The construction is such that when a signal is received by the antennae 115 the magnet 178 is energized to close the switch 70 against the contact 63 whereby when the lower end of the switch 85 is in engagement with the contact 78, the electromagnet 60 will be energized and cause the rotation of the rotary valve 25 through one step.

When the switch 85 is in position to render the sound receiving apparatus operative to control the vessel, as shown in Fig. 1, and it is desired to render the sound receiving apparatus inoperative and to control the boat through the action of the antennae, the rotary valve 25 is first rotated in response to sound waves of the proper pitch or frequency until it comes into the neutral position shown in Figs. 1 and 4, in which the left hand end of the cylinder 135 is in communication through the pipe 146, recesses 165 and 157, and pipe 148 with the cylinder 48, and by continuing the sound impulse which has moved the valve 25 into this position the piston 47 is held over to the left,

thus uncovering the pipe 148 and allowing the compressed air to pass from the source 35 through the pipe 36 and ratchet cylinder 48 into the left hand end of the switch cylinder 135 and move the piston 136 towards the right, which, after a predetermined amount of movement of the piston, the speed of which is governed by the damping cylinder 143, first causes the valve 130 to cut off communication between the lower ends of the mast cylinders 111 and the exhaust port 127 and opens communication between the lower ends of the cylinders 111 and the source of compressed air 35, whereupon the masts will be raised and the catches 168 will hold them in their elevated positions. A further predetermined movement of the piston 136 towards the right causes the trip 140 to engage the switch 85 and to move it across its center, whereupon the spring 86 acts to throw the lower end of the switch 85 into engagement with the contact 78, thus rendering operative the circuit including the electromagnetic switch 70 controlled by the antennae and rendering inoperative the circuit including the electromagnetic switch 75 controlled by the sound waves.

The shifting of the switch 85, as just described, de-energizes the solenoid 60 and permits the slide valve 52 to cut off communication between the source 35 of compressed air and the cylinder 48 and to open the cylinder 48 to the exhaust port 53 whereupon the pressure is relieved from the left hand end of the piston 136 and the piston 136 is allowed to return towards the left and to resume a central position under the action of the springs 137 and 138 and to cause the piston valve 130 to resume its normal central position shown in Fig. 1, which, owing to the lost motion between the trip 141 and the switch 85, is accomplished without again disturbing the switch 85, which is left in such a position (the reverse of that shown in Fig. 1) that the system is now ready to be controlled through the antennae 115 acting in response to radiant energy in the form of electromagnetic waves having a given characteristic.

After the system has been thus set to respond to radiant energy received by the antennae 115, successive impulses of radiant energy received by the antennae will rotate the valve step by step through 90 degrees at each step as hereinbefore described, and by quickly passing over the so-called neutral positions and by permitting the valve to remain for an appreciable period only in the steering position it is desired to utilize at the time, the vessel may be steered selectively either to the right or to the left, and may be rotated in either direction to any desired extent.

When it is desired to shift the system from the control of the antennae to the con-

5 trol of the sound receiver, the valve 25 is
 rotated under the action of the antennæ
 until it comes into the neutral position
 shown in Fig. 6, in which communication
 10 is established between the source 35 of com-
 pressed air and the right hand end of the
 switch cylinder 135 and the radiant impulse
 which has moved the valve into this posi-
 15 tion is prolonged until the piston 136 has
 been moved to the left a sufficient amount
 to cause the valve 125 to close communica-
 tion between the upper ends of the cylin-
 20 ders 111 and the exhaust port 126 and to
 open communication between the upper
 15 ends of the cylinders 111 and the source 35
 of compressed air, thus retracting the
 catches 168 and forcing the masts 110 down-
 20 wardly, and then finally to cause the trip
 141 to swing the switch 85 across its center.
 This shifting of the switch throws the lower
 end of the switch out of engagement with
 the terminal 78 and into engagement with
 the terminal 80 as shown in Fig. 1, thus
 25 simultaneously rendering the antennæ inop-
 erative and the sound receiver operative to
 control the vessel, and incidentally deener-
 gizes the solenoid 60 and permits the piston
 136 to resume its central position which,
 30 owing to the lost motion between the yoke
 140 and the switch 85, is accomplished with-
 out again disturbing the switch. The sys-
 tem as thus adjusted may be controlled by
 the sound receiver 90 in response to sound
 35 waves of a predetermined pitch as herein-
 before described.

Although only a single form has been
 shown in which this invention may be em-
 bodied, it is to be understood that the in-
 40 vention is not limited in its application to
 any particular structure or to any particular
 purpose, as it is evident that this invention
 might be applied in various forms for vari-
 ous purposes without departing from the
 spirit of the invention or the scope of the
 45 appended claims.

Having now fully described this inven-
 tion, I claim as new and desire to protect by
 Letters Patent of the United States:

50 1. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one of
 said elements being responsive to electro-
 magnetic radiant energy and the other of
 55 said elements being responsive to sound
 waves, only one of said elements being op-
 erative in any given time to control said device.

60 2. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one
 of said elements being responsive to electro-
 magnetic radiant energy and the other of
 said elements being responsive to sound
 waves, the construction and arrangement be-
 65 ing such that the prolonged operation of
 either of said elements at a predetermined

time will render said element inoperative to
 control said device and will render the other
 of said elements operative to control said
 device.

70 3. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one
 of said elements being responsive to electro-
 magnetic radiant energy and the other of
 said elements being responsive to sound 75
 waves, and means controlled by said last
 mentioned element for rendering itself inop-
 erative and for elevating the other of said
 elements and rendering the same operative.

80 4. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one
 of said elements being responsive to electro-
 magnetic radiant energy and the other of
 said elements being responsive to sound 85
 waves, and means controlled by the latter
 element for elevating the former element.

90 5. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one
 of said elements being responsive to electro-
 magnetic radiant energy and the other of
 said elements being responsive to sound 95
 waves, and means controlled by the latter
 element for rendering itself inoperative and
 for elevating and rendering the other el-
 ement operative.

100 6. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative in response to electro-
 radiant energy, and in response to sound
 waves respectively to control said device,
 one of said elements being operative to cause
 itself to be moved from an operative into an
 inoperative position and to change the other 105
 of said elements from an inoperative into
 an operative condition.

110 7. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative in response to electro-
 radiant energy and in response to sound
 waves respectively to control said device,
 one of said elements being operative in re-
 sponse to radiant energy in the form of elec-
 115 tromagnetic waves to cause itself to be
 moved from an operative into an inopera-
 tive position and to cause the other of said
 elements to be changed from an inoperative
 to an operative condition.

120 8. The combination with an actuating de-
 vice, of means including two elements sep-
 arately operative to control said device, one
 of said elements being operative in response
 to radiant energy in the form of electro-
 125 magnetic waves to cause itself to be changed
 from an operative to an inoperative condi-
 tion and to cause the other of said elements
 to be changed from an inoperative into an
 operative condition, and the other of said
 130 elements being operative in response to

sound waves to cause itself to be changed from an operative into an inoperative condition and to cause said first named element to be changed from an inoperative into an
5 operative condition.

9. In a control system, a plurality of utilities, means responsive to electromagnetic waves and additional means responsive to compressional waves for selectively actuat-
10 ing a desired one of the utilities, one of said

utilities being arranged for selectively actuating one of said wave responsive means.

Signed at New York in the county of New York and State of New York this 24th day of September A. D. 1915.

JOHN HAYS HAMMOND, JR.

Witnesses:

HENRY D. SLEEPER,

A. I. GARDNER.