Feb. 13, 1945. J. H. HAMMOND, JR 2,369,456

STEERING MECHANISM FOR VESSELS

Filed March 18, 1942 4 Sheets-Sheet 1

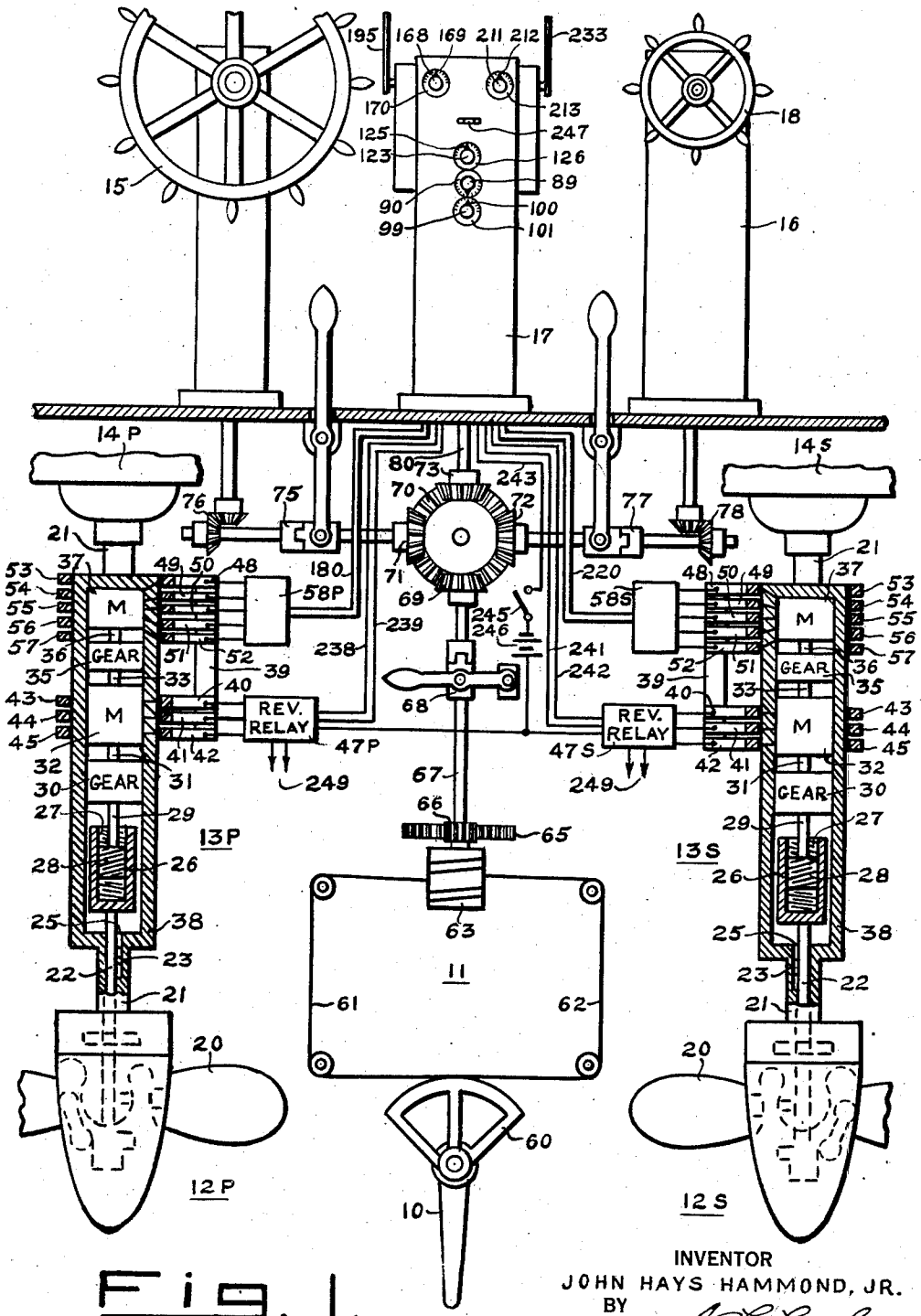


Fig. 1.

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STEERING MECHANISM FOR VESSELS

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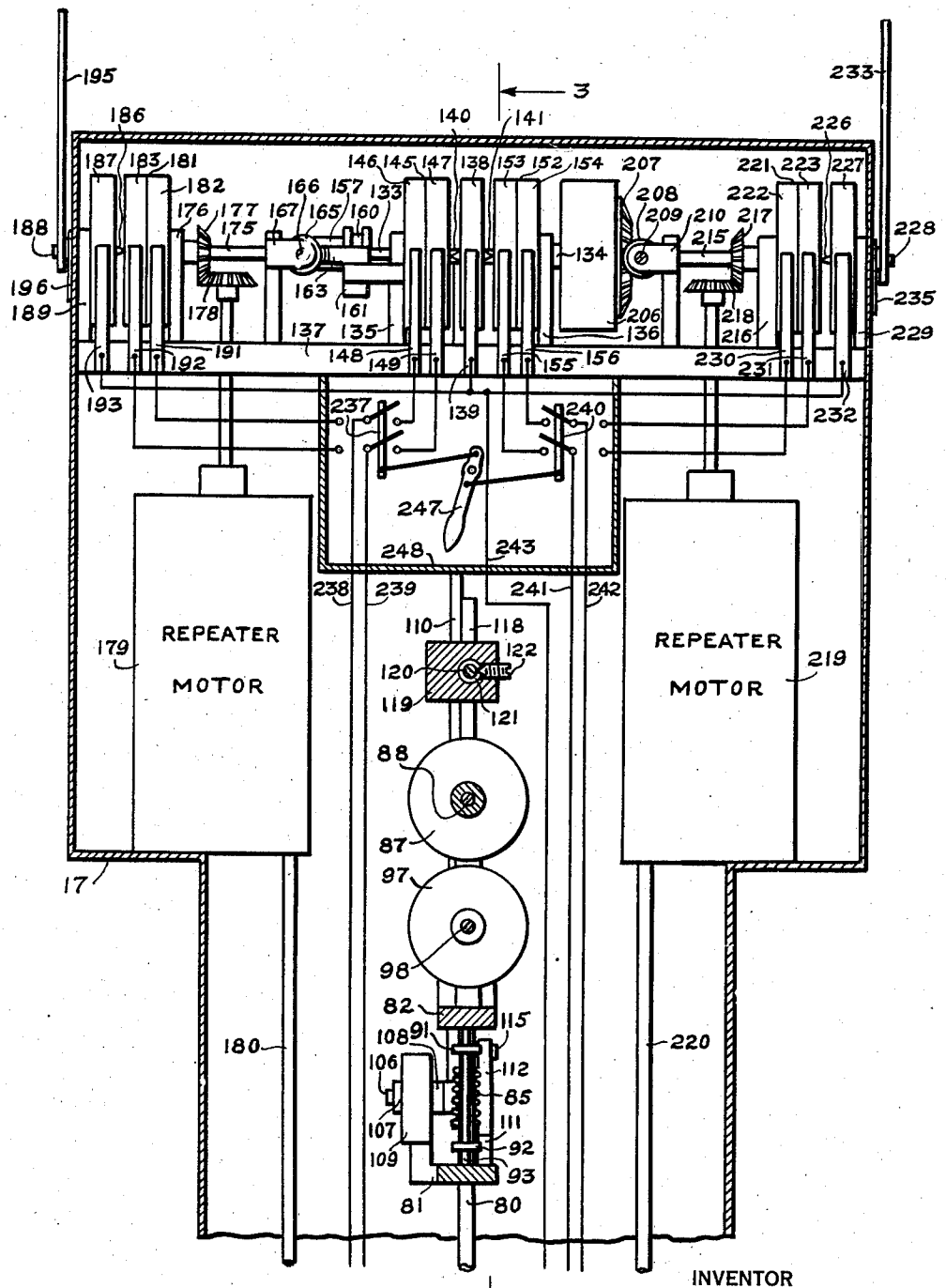


Fig. 2.

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STEERING MECHANISM FOR VESSELS

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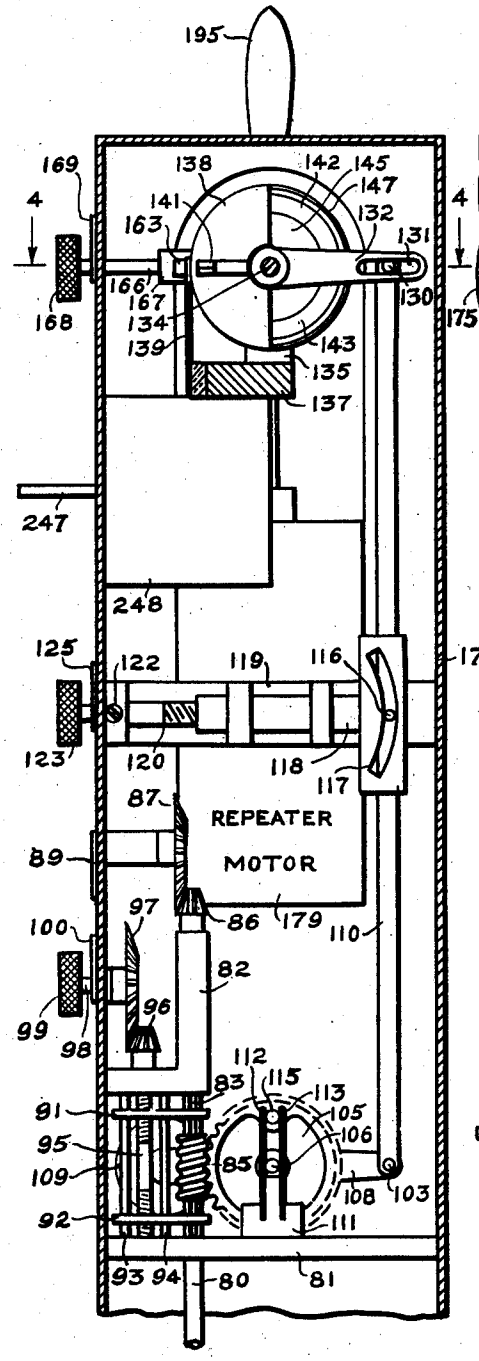


Fig. 3.

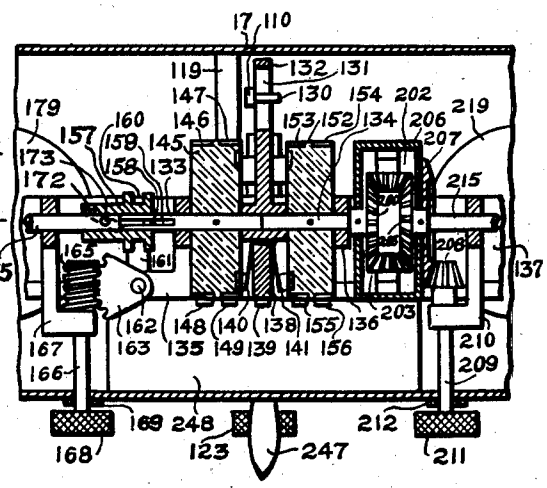


Fig. 4.

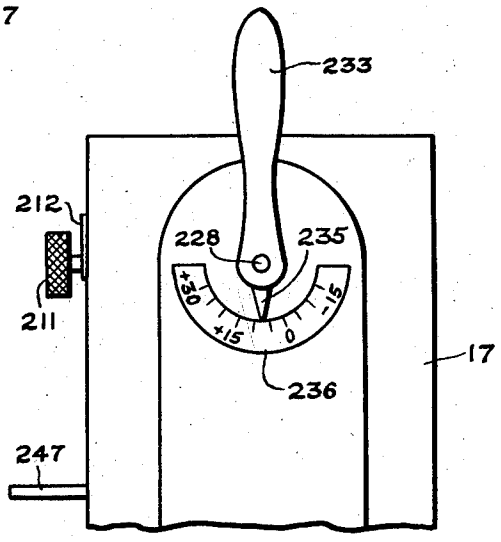


Fig. 5.

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STEERING MECHANISM FOR VESSELS

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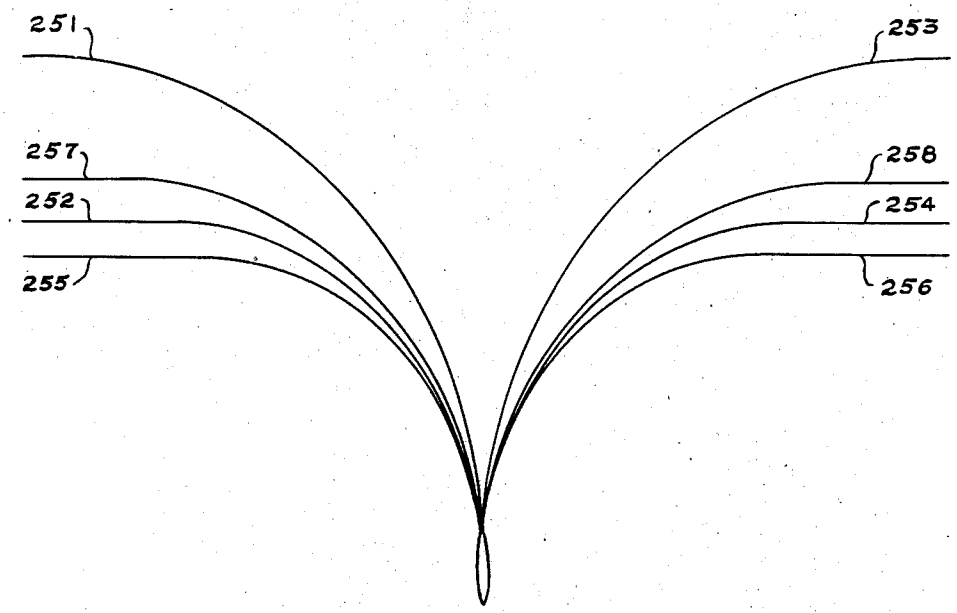


Fig. 6.

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Patented Feb. 13, 1945 2,369,456

UNITED STATES PATENT OFFICE

2,369,456

STEERING MECHANISM FOR VESSELS

John Hays Hammond, Jr., Gloucester, Mass.

Application March 18, 1942, Serial No. 435,197

9 Claims. (Cl. 115—35)

This invention relates to variable pitch propellers and has for an object to provide mechanism for automatically varying the pitches of a plurality of propellers in accordance with the operation of the steering means.

The invention provides means in connection with the steering mechanism of the vessel to cause the pitches of a plurality of propellers to vary in such a manner as to assist in the steering of the vessel.

More specifically the invention provides means to control the pitches of the propellers of a twin screw vessel so that when the vessel is steered to port the pitch of the port propeller will be decreased and the pitch of the starboard propeller increased and when the vessel is steered to starboard the reverse action will take place.

In this manner the manoeuvering of the vessel is greatly facilitated and the steering accelerated. If desired, the steering may be accomplished entirely by varying the pitch of the propellers without the use of the rudder. Means are also provided for varying the relationship between the steering mechanism and the pitch changing devices.

The invention also provides means for allowing the rudder to be moved thru a predetermined adjustable angle either to port or starboard before the propeller pitch changing mechanism comes into action. Means are also provided for rapidly changing the propeller pitch control mechanism from automatic to manual or vice versa.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

Figure 1 illustrates diagrammatically the system for controlling the propeller pitches, by means of the steering mechanism of the vessel,

Figure 2 is a front elevation partly in section of the control apparatus,

Figure 3 is a transverse section of the control apparatus taken on line 3—3 of Figure 2,

Figure 4 is a fragmentary section taken on line 4—4 of Figure 3,

Figure 5 is an end elevation of the upper part of the control apparatus, and

Figure 6 illustrates diagrammatically the course of a vessel with and without the auxiliary propeller control.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

In accordance with the present invention, the port and starboard propellers are provided with pitch changing mechanisms having a follow up indicator and are connected for individual manual setting by control handles mounted on a standard near the steering wheel. Provision is made for disconnecting the control by the manual control handles and connecting the pitch changing mechanisms for automatic operation by an element actuated with the rudder so that in making a turn, the pitch of the outer propeller is increased and the pitch of the inner propeller is decreased. Suitable linkage are provided for varying the ratio of the rudder movement to that of the pitch changing mechanism. An adjustable lost motion device permits a limited movement of the rudder as desired without bringing the pitch changing mechanism into operation. Suitable clutches permit the steering control mechanism to be operatively disconnected from the rudder and connected only to the pitch changing mechanism so that steering can be effected by the propellers alone.

Referring to the accompanying drawings, and more particularly to Figure 1, a diagrammatic layout of the propeller control mechanism is shown which includes a rudder 10, a rudder control 11, port and starboard variable pitch propellers 12P and 12S respectively, variable pitch mechanisms 13P and 13S for varying the pitch of the propellers 12P and 12S respectively, two governor controlled prime movers 14P and 14S for driving the propellers 12P and 12S, a hand steering wheel 15 for manually operating the rudder 10, gyro pilot 16 for steering the vessel automatically and a control mechanism 17 for varying the pitch of the propellers 12P and 12S in accordance with the throw of the rudder 10. The gyro pilot 16 is provided with a hand wheel 18.

The propellers 12P and 12S are provided with

adjustable blades 20 and are attached to hollow shafts 21 which are connected to the variable pitch mechanisms 13P and 13S, which may be of any well known and standard construction such as that manufactured by the S. Morgan Smith Company, of York, Pennsylvania, the details of which form no part of the present invention and are accordingly not specifically set forth herein. The mechanism in general comprises a rod 22 slidable longitudinally within the shaft 21 and connected to control the pitch of the blades 20. The rod 22 is prevented from rotating with respect to the shaft 21 by means of a key 23 which slides in a keyway 25 cut in the shaft 21. The inner end of the shaft 22 is attached to a nut 26 which is provided with internal threads 27. Threaded into the nut 26 is a member 28 which is attached to the slow speed shaft 29 of a reduction gearing 30. The high speed shaft 31 of this gearing is driven by a motor 32.

The motor 32 is also connected to the high speed shaft 33 of a reduction gearing 35, the low speed shaft 36 of which is connected to Selsyn repeating motor 37. All of this mechanism is mounted in the casing 38 which forms part of the drive shaft 21.

Secured to a bracket 39 of insulating material are three brushes 40, 41 and 42 which engage three slip rings 43, 44 and 45, which are mounted on but insulated from the casing 38. The slip rings 43 and 45 are connected to the reversing windings of the motor 32 and the slip ring 44 is connected to the return lead from these windings. The brushes 40, 41 and 42 are connected to reversing relays 47P and 47S.

Secured to the bracket 39 are five brushes 48—52 which engage five slip rings 53—57 which are mounted on but insulated from the casing 38. The slip rings 53—57 are connected to the Selsyn motor 37. The brushes 48—52 are connected to control boxes 58P and 58S.

The rudder 10 is provided with the usual rudder quadrant 60 which is connected by means of cables 61 and 62 to a cable drum 63. The drum 63 is attached to a gear 65 which meshes with a pinion 66 which is mounted on a shaft 67. The shaft 67 is connected thru a clutch 68 to a bevel pinion 69 which meshes with a bevel gear 70. Meshing with the bevel gear 70 are three other bevel pinions 71, 72 and 73. The pinion 71 is connected thru a clutch 75 and bevel gears 76 to the hand steering wheel 15 and the pinion 72 is connected thru a clutch 77 and bevel gears 78 to the gyro pilot 16.

The pinion 73 is connected to a shaft 80 which is rotatably mounted in brackets 81 and 82 (Figures 2 and 3) in the control mechanism 17 and is provided with a keyway 83. Slidably mounted on the shaft 80 is a worm 85 which is provided with a key (not shown) which slides in the keyway 83 which causes the worm 85 to rotate with the shaft 80. Attached to the upper end of the shaft 80 is a bevel pinion 86 which meshes with a bevel gear 87. The gear 87 is attached to a shaft 88 to the outer end of which is secured a pointer 89 which registers with a scale 90 (Figure 1) mounted on the front of the case of the control mechanism 17 and which is graduated in degrees of rudder angle.

Slidably mounted on the shaft 80 are two members 91 and 92 which are also slidably mounted on two rods 93 and 94 and which are threaded on a shaft 95, the member 91 having a right hand thread and the member 92 having a left hand thread. Secured to the upper end of the shaft 95 is a bevel pinion 96 which meshes with a bevel gear 97 secured to a shaft 98. Mounted on the shaft 98 is a knurled knob 99 and a pointer 100 which registers with a scale 101 (Figure 1) mounted on the front of the case of the control mechanism 17.

Meshing with the worm 85 is a worm wheel 105 which is secured to a shaft 106 which has a bearing in an arm 107 of the bracket 81. Secured to the shaft 106 is an arm 108 to one end of which is attached a counter-weight 109 and to the other end a pin 103 to which is pivotally connected the lower end of a link 110. Mounted on the bracket 81 is a T-shaped block 111 to which is secured two flat springs 112 and 113. Secured to the worm wheel 105 is a pin 115 which is normally positioned between the two springs 112 and 113.

Secured to the link 110 is a pin 116 which slides in a slot 117 provided in the head of a T-shaped member 118. The member 118 is slidably mounted in a bracket 119 and is provided with a threaded bore which is engaged by the threaded end of a rod 120. The rod 120 is provided with a V-shaped groove 121 (Figure 2) which is engaged by a set screw 122. This prevents longitudinal motion of the rod 120 but allows it to be freely rotated. Secured to the rod 120 is a knurled knob 123 and a pointer 125 which registers with a scale 126 (Figure 1) mounted on the front of the case of the control mechanism 17.

Secured to the upper end of the link 110 is a pin 130 which slides in a slot 131 provided in an arm 132 which is rotatably mounted on two shafts 133 and 134 (Figures 2 and 4) which are journaled in two brackets 135 and 136 (Figure 2) mounted on a cross frame 137. Mounted on but insulated from the arm 132 is a segment 138 of conducting material (Figure 4) which is engaged by a brush 139 which is mounted on but insulated from the frame 137. Secured to the segment 138 are two brushes 140 and 141. The brush 140 cooperates with two semi-circular conducting segments 142 and 143 which are mounted on one side of a circular drum 145 of insulating material which is secured to the shaft 133. The segments 142 and 143 are electrically connected to two slip rings 146 and 147 respectively mounted on the periphery of the drum 145. Engaging the slip rings 146 and 147 are two brushes 148 and 149 which are mounted on but insulated from the frame 137.

The brush 141 cooperates with two semi-circular conducting segments which are mounted on one side of a circular drum 152, which is secured to the shaft 134, and are electrically connected to two slip rings 153 and 154 mounted on the periphery of the drum 152. The slip rings 153 and 154 are engaged by two brushes 155 and 156 which are mounted on but insulated from the frame 137.

Slidably mounted on the shaft 133 is a collar 157 which is provided with a key 158 which slides in a keyway 159 provided in the shaft 133, so that the collar 157 may slide longitudinally on the shaft 133 but cannot rotate with respect thereto. The collar 157 is provided with a groove 160 which is engaged by a pin (not shown) carried on the end of an arm 161. The arm 161 is secured to the lower end of the shaft 162 which has a bearing in an extension of the bracket 135. Secured to the upper end of the shaft 162 is a segment of a worm gear 163 which engages a worm 165 secured to a

shaft 166 which has a bearing in a bracket 167. Attached to the end of the shaft 166 is a knurled knob 168 and a pointer 169 which indicates on a dial 170 (Figure 1) attached to the front of the case of the control mechanism 17.

The collar 157 is provided with a helical slot 172, which engages a pin 173 which is secured to a shaft 175 which is slidably and rotatably mounted in the collar 157 and which has bearings in the bracket 167 and in a bracket 176 (Figure 2). Secured to the shaft 175 is a bevel gear 177 which meshes with a bevel gear 178 secured to the shaft of a Selsyn repeater motor 179. This motor is connected by a five wire cable 180 to the control box 58P (Figure 1).

Secured to the end of the shaft 175 is a drum 181 (Figure 2) of insulating material on the periphery of which are mounted two slip rings 182 and 183 which are electrically connected to two conducting segments mounted on the end of the drum 181 which are engaged by a brush 186. The brush 186 is mounted on a circular drum 187 of conducting material which is secured to but insulated from a shaft 188 which has a bearing in a bracket 189 mounted on the frame 137.

The two slip rings 182 and 183 and the drum 187 are engaged by three brushes 191, 192 and 193, respectively, which are mounted on but insulated from the frame 137. Attached to the end of the shaft 188 is a handle 195 and a pointer 196 which registers with a dial (not shown) on the side of the case of the control mechanism 17.

The end of the shaft 134 is secured to a bevel gear 200 (Figure 4) which forms part of a differential, which comprises two bevel pinions 202 and 203 and a second bevel gear 205 mounted in a rotatable casing 206. Attached to the side of the casing 206 is a bevel gear 207 which meshes with a bevel pinion 208 attached to a shaft 209 which has a bearing in a bracket 210. Secured to the end of the shaft 209 is a knurled knob 211 and a pointer 212 which indicates on a dial 213 (Figure 1) attached to the front of the casing of the control mechanism 17.

Attached to the gear 205 is a shaft 215 which has bearings in the bracket 210 and a bracket 216, which is mounted on the frame 137. Secured to the shaft 215 is a bevel gear 217 (Figure 2) which meshes with a second bevel gear 218 attached to the shaft of a Selsyn repeater motor 219. The Selsyn motor 219 is connected by a five conductor cable 220 to the control box 58S.

Attached to the end of the shaft 215 is a drum 221 of insulating material on the periphery of which are mounted two slip rings 222 and 223 which are electrically connected to two conducting segments mounted on the end of the drum 221 which are engaged by a brush 226. The brush 226 is mounted on a circular drum 227 of conducting material which is secured to but insulated from a shaft 228 which has a bearing in a bracket 229 mounted on the frame 137.

The two slip rings 222 and 223 and the drum 227 are engaged by three brushes 230, 231 and 232, respectively, which are mounted on but insulated from the frame 137. Attached to the end of the shaft 228 is a handle 233 and a pointer 235 which registers with a dial 236 (Figure 5) on the side of the case of the control mechanism 17.

The brushes 148 and 149 are connected to two contacts of a double pole double throw switch 237 (Figure 2) the other two contacts of which are connected to the brushes 191 and 192. The blades of the switch 237 are connected by two conductors 238 and 239 to the reversing relay 47P. The brushes 155 and 156 are connected to two contacts of a double pole double throw switch 240 the other contacts of which are connected to the brushes 230 and 231. The blades of the switch 240 are connected by two conductors 241 and 242 to the reversing relay 47S. The brushes 139, 193 and 232 are connected by a conductor 243 to one side of a switch 245, the other side of which is connected thru a battery 246 to the reversing relays 47P and 47S. A source of energy for operating the relays 47P and 47S and driving the motors 32 is indicated at 249. The switches 237 and 240 are operated by a handle 247. The switches 237, 240 and operating handle 247 are located in a casing 248.

Operation

In the operation of the form of the invention shown in the accompanying figures, the pitch of the blades 20 is set at the normal operating angle taking into consideration such conditions as the loading of the vessel, the average weather conditions expected to be encountered on the trip, etc. The setting of the blades 20 is accomplished by first moving the handle 247 to the right, which throws the switch 237 to the left and the switch 240 to the right and places the reversing relays 47P and 47S under the control of the manual handles 195 and 233. The handles 195 and 233 are then manipulated until the pointers 196 and 235 indicate the desired pitch angle on the corresponding scales.

Thus, for example, if it is desired to set the blades 20 of the starboard propeller 12S at a normal operating angle of 18° the handle 233 is turned until the pointer 235 indicates 18° on the scale 236. As the handle 233 is moved in a clockwise direction, as seen in Figure 5, the drum 227 and brush 226 will be moved thru an equal angle. This will cause the brush 226 to engage the upper semi-circular segment on the end of the drum 221 which will complete a circuit from the slip ring 222, brush 230, switch 240, conductor 241, reversing relay 47S, battery 246, switch 245, conductor 243, brush 232, drum 227 back to brush 226.

This will operate the reversing relay 47S, which will supply current from the source 249 to the motor 32 to cause it to rotate in such a direction as to cause the member 28 to move into the nut 26. As the member 28 is held fixed longitudinally this will cause the nut 26 and shaft 22 to be moved upward to increase the pitch of the blades 20.

As the motor 32 rotates it will turn the Selsyn motor 37 by means of the reduction gearing 35. The motion of the Selsyn motor 37 will be transmitted thru the control box 58S and cable 220 to the Selsyn repeater motor 219 the shaft of which will be turned thru the same angle as the shaft 36 of the Selsyn motor 37. The rotation of the Selsyn motor 219 will be transmitted thru the bevel gears 218 and 217 to the drum 221, which will be rotated in the same direction as the drum 227 until it has been rotated thru the same angle as the drum 227, at which time the brush 226 will be on the insulation between the two semi-circular segments, thus breaking the circuit thru the reversing relay 47S which will stop the rotation of the motor 32. At the end of this operation the pitch of the blades 20 will be that indicated by the pointer 235 on the dial 236. In a similar manner the pitch of the port propeller 12P is set to the desired angle by manipulating the handle 195.

The clutch 77 is then opened and the rudder 10 is brought to a central position by turning the hand steering wheel 15 in the usual manner. The mechanism will now be in the neutral position as shown in Figure 3. The knobs 168 and 211 are turned so that the pointers 169 and 212 indicate the normal pitch angles which have been set on the port and starboard propellers. By turning the knob 168 the worm 165 will be rotated, which in turn will rotate the worm wheel 163. This motion will be transmitted by means of the shaft 162 and arm 161 to the collar 157 which will be moved to the right and at the same time rotated thru a small angle, as the pin 173 slides in the diagonal slot 172. The rotation of the collar 157 will be transmitted to the shaft 133 by means of the key 158. As the shaft 133 rotates it will rotate the drum 145. When the pointer 169 indicates the pitch angle to which pointer 196 has been set as above described, the insulation between the segments 142 and 143 will be under the brush 140.

By turning the knob 211 the bevel pinion 208 will be rotated, which, by means of the bevel gear 207 will cause a slight rotation of the differential housing 206 which will, in a well known manner cause a small rotation of the shaft 134. As the shaft 134 rotates it will rotate the drum 152. When the setting of the pointer 212 corresponds to that of pointer 235 the insulation between the semi-circular segments will be under the brush 141.

For varying the ratio of the change of propeller pitch to the rudder throw, the knob 123 is turned until the pointer 125 registers the desired ratio on the dial 126. Thus for example, if it is desired to have a high ratio of propeller pitch to rudder angle the knob 123 is turned to the right, which will cause the threaded shaft 120 to be rotated in a clockwise direction thus entering the member 118 which will be moved to the left, as the shaft 120 is restrained from longitudinal movement by the set screw 122. As the member 118 moves to the left the link 110 will be rotated by means of the pin 116 thru a small angle in a counterclockwise direction about the pin 103. The pin 130 will slide to the left in the slot 131 so that the lever arm from the shaft 134 to the pin 130 will be less than the lever arm from the shaft 106 to the pin 103, thus increasing the ratio of rotary movement between the shafts 106 and 134.

If it is desired to decrease the ratio of change of propeller pitch to rudder throw the knob 123 is turned to the left, causing the member 118 and the pin 130 to be moved to the right to decrease the ratio of the rotary movement between the shafts 106 and 134. As shown in Figure 3 the mechanism is set for a mean ratio.

In order to vary the angle thru which the rudder may be turned before affecting the pitch of the propellers the knob 99 may be manipulated until the pointer 100 registers the desired rudder throw on the dial 101. Thus if it is desired to increase this angle the knob 99 is turned clockwise which by means of the bevel gear 97 and bevel pinion 96, will cause the shaft 95 to be rotated in a clockwise direction, as seen from above. This rotation will cause the two members 91 and 92 to move apart, due to the right and left threads cut on the shaft 95, which will permit the worm 85 to slide a greater distance along the shaft 80 before it engages these members. If it is desired to decrease the angle the knob 99 is turned counterclockwise which causes the members 91 and 92 to move closer together.

When it is desired to have the pitch changing mechanism function in conjunction with the rudder the handle 247 is moved to the left into the position shown in Figure 2, thus throwing the switches 237 and 240 to the right and left respectively, which connects the brushes 148 and 149 to the reversing relay 47P and the brushes 155 and 156 to the reversing relay 47S.

The vessel is now steered in the usual manner by means of the steering wheel 15, which acting thru the bevel gears 76, 71, 70 and 69, rotates the pinion 66, which by means of the gear 65 rotates the drum 63. The rotation of the drum 63, acting thru the cables 61 and 62, turns the rudder 10 in a well known manner.

During the operation the bevel gear 73 will be rotated which will, by means of the shaft 80, rotate the worm 85. As the gear 105 is held in a central position by means of the springs 112 and 113 the worm 85 will merely slide along the shaft 80 until it comes up against one or the other of the members 91 or 92 depending on whether the rudder is turned to the port or starboard. The amount that the rudder 10 may be turned from a central position without turning the gear 105 is determined by the spacing of the members 91 and 92, which, as already described, is set by rotating the knob 99. In Figure 2 the members 91 and 92 are shown in a mean position, which, for example, may allow the rudder 10 to be moved thru an angle of five degrees on either side of the central position without affecting the gear 105.

If the rudder 10 is turned more than five degrees, say to port, the worm 85 will slide up along the shaft 80, when it is turned, until it engages the member 91, which will prevent any further longitudinal movement of the worm 85. When the shaft 80 is rotated further the worm 85 will cause the gear 105 to start rotating in a counterclockwise direction, as seen in Figure 3. This motion, acting thru the lever 108, will cause the link 110 to be moved upward, which will by means of the pin 130 cause the arm 132, segment 138 and brushes 140 and 141 to be rotated in a counterclockwise direction.

The brush 140 will then engage the segment 143 which will close a circuit from the battery 246, switch 245, conductor 243, brush 139, segment 138, brush 140, segment 143, slip ring 147, brush 149, switch 237, conductor 239, reversing relay 47P back to the battery 246. This will operate the reversing relay 47P which will supply current from the source 249 to the motor 32, the rotation of which will be transmitted thru the reduction gearing 30 to the member 28 which will be rotated in such a direction as to cause it to move out of the nut 26. As the member 28 is held fixed longitudinally this will cause the nut 26 and shaft 22 to be moved downward to decrease the pitch of the blades 20 of the port propeller 12P.

At the same time that the motor 32 rotates the member 28 it will, by means of the reduction gearing 35, rotate the Selsyn motor 37 thru a fraction of a revolution. This motion will be repeated to the Selsyn motor 179, which by means of the bevel gears 177—178, will transmit the rotation to the drum 145 which will be rotated until the insulation between the segments 142 and 143 is under the brush 140 at which time the relay 47P will be operated to stop the motor 32.

At the same time the brush 141 will engage the

lower semi-circular segment on the side of the drum 152, which in a manner similar to that just described will energize the reversing relay 47S. As this relay is wired up in an opposite manner to that of the relay 47P, it will operate to supply current from the source 249 to the motor 32 so as to cause the member 28 to move into the nut 26, which together with the shaft 22 will be moved upward to increase the pitch of the blades 20 of the starboard propeller 12S. This motion is repeated back to the drum 152 by the Selsyn motors 37 and 219 until the brush 141 rests on the insulation between the semi-circular segments when the motor 32 will stop.

It is thus seen that when the rudder 10 is turned to port thru an angle greater than that set on the dial 101 the pitch of the port propeller 12P will be decreased and the pitch of the starboard propeller 12S increased an amount proportional to the angle thru which the rudder 10 is turned in addition to the angle set on the dial 101. In this way, the turning moment to port of the vessel is augmented by the action of the propellers, as the thrust of the port propeller 12P is decreased due to the decrease of pitch and the thrust of the starboard propeller 12S is increased due to the increase of pitch.

Figure 6 shows in a general way the action of the pitch changing mechanism on the turning radius of the vessel. The curve 251 indicates the course of the vessel when it is steered to port with the control handle 247 thrown to the right, so that the propeller pitch changing mechanism is inoperative and curve 252 shows the course of the vessel when it is steered to port, holding the same rudder angle, but with the control handle 247 thrown to the left, so that the propeller pitch changing mechanism is operative. It is seen from these two curves that the vessel can be manoeuvered much more rapidly with the use of the propeller pitch changing mechanism in addition to the conventional action of the rudder.

When the vessel is steered to starboard the reverse action takes place and the pitch of the starboard propeller 12S is decreased and the pitch of the port propeller 12P is increased, this change of pitch being proportional to the angle thru which the rudder 10 is turned in addition to the angle indicated on the dial 101, the courses followed by the vessel when it is steered to starboard without and with the propeller pitch control are indicated by the curves 253 and 254 respectively.

As already stated the angle thru which the rudder may be turned without bringing into action the propeller pitch changing mechanism can be varied by turning the knob 99. If desired this angle may be decreased to zero by bringing the two members 91 and 92 into engagement with the worm 85. Under these conditions the propeller pitch changing mechanism will become operative as soon as the rudder 10 is turned from its central position.

The rate at which the propeller pitch changes in relation to the rudder throw may be varied by turning the knob 123. If this knob is turned in a clockwise direction so as to cause the member 118 to be moved to the left, as seen in Figure 3, the lever arm from the shaft 134 to the pin 130 will be decreased, so that the contacts 140 and 141 will be moved thru a greater angle for a given rudder throw thus increasing the change of the pitch of the propellers which in turn will increase the turning moment of the vessel causing it to turn with a shorter radius as indicated by the curves 255 and 256 of Figure 6. By turning the knob 123 in a counter-clockwise direction the opposite effect is produced and the vessel will turn with a greater radius as indicated by the curves 257 and 258.

If it is desired to use the gyro pilot 16 the rudder 10 is brought to a central position by means of the steering wheel 15 and the clutch 75 is disengaged. The hand wheel 18 of the gyro pilot is brought to a central position and the clutch 77 is engaged. The vessel is then steered by manipulating the hand wheel 18 of the gyro pilot 16 in a well known manner that need not be more fully described herein. The steering motion is transmitted to the shaft 80 which operates to vary the propeller pitches as already described.

If so desired the vessel may be steered entirely by the action of the propellers without the use of the rudder 10. In this case the rudder 10 is set in a central position by means of the steering wheel 15 and the clutch 68 is opened. The knob 99 is turned in a counter-clockwise direction as far as possible, thus bringing the members 91 and 92 into engagement with the worm 85. The knob 123 is turned in a clockwise direction as far as possible, thus giving the maximum action of the propeller pitch changing mechanism.

Under these conditions when the steering wheel 15 is turned the shaft 80 will be rotated thus rotating the worm 85 the action of which will be immediately transmitted by the gear 105 and link 110 to the brushes 140 and 141, which will, as already described, operate the pitch changing mechanisms 13P and 13S at a maximum rate. This will cause a turning moment to be produced which will steer the vessel to port or starboard as desired. It is thus seen that in case the rudder is put out of action the vessel may be steered by the use of the propeller pitch changing mechanism alone.

If it is desired to put the automatic pitch changing mechanism out of operation the handle 247 is thrown to the right thus throwing the switch 237 to the left and the switch 240 to the right. This will make the brushes 140 and 141 inoperative and the brushes 186 and 226 operative. The blades 20 of the port and starboard propellers 12P and 12S will then be brought back to their normal pitch angles, as indicated by the pointers 196 and 235, this action taking place in a manner similar to that already described in connection with the manual setting of the propeller pitches. The pitches of the propellers 12P and 12S may now be changed as desired by manipulating the handles 195 and 233 as already described. Under these conditions steering will be done entirely by the action of the rudder 10.

After the propellers 12P and 12S have been set at the desired pitch the switch 245 may be opened, thus putting the pitch changing mechanism completely out of operation. The propellers will then act as propellers of fixed pitch and cannot be changed from the bridge.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not limited to any specific construction but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said

propellers, individual actuating means for independently actuating each of said pitch changing mechanisms, joint actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said joint actuating means, and means selectively connecting said individual actuating means or said joint actuating means to operate said pitch changing mechanisms.

2. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, individual actuating means for independently actuating each of said pitch changing mechanisms, manual control means for said individual actuating means for setting said pitch to a predetermined value, joint actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said joint actuating means automatically for steering said vessel by said propellers, and means selectively connecting said individual actuating means or said joint actuating means to operate said pitch changing mechanisms.

3. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, individual pitch indicating means to indicate the pitch setting of each propeller, repeater mechanisms actuated respectively by each of said pitch changing mechanisms and connected to actuate said pitch indicating means, individual actuating means for independently actuating each of said pitch changing mechanisms, manual control means for said individual actuating means for setting said pitch to a predetermined value, joint actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said joint actuating means automatically for steering said vessel by said propellers, and means selectively connecting said individual actuating means or said joint actuating means to operate said pitch changing mechanisms.

4. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, control circuits including reversing contacts connected to actuate said pitch changing mechanisms, rotatable drums carrying said contacts, a brush selectively engaging the contacts on each drum, a control arm carrying said brushes, steering control mechanism connected to shift said arm for selectively closing said contacts in accordance with steering requirements, and follow-up mechanism including repeaters actuated by said pitch changing mechanisms to cause corresponding rotation of said drums for breaking said circuits when said pitch has been changed to the desired value.

5. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, control circuits including reversing contacts connected to actuate said pitch changing mechanisms, rotatable drums carrying said contacts, a brush selectively engaging the contacts on each drum, a control arm carrying said brushes, steering control mechanism connected to shift said arm for selectively closing said contacts in accordance with steering requirements, and manual means to adjust independently the setting of each drum with respect to its brush for varying the pitch response characteristics of said propellers.

6. A steering system for vessels having port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, control circuits connected to actuate said pitch changing mechanisms, and manual and automatic control means for said circuits comprising a pair of rotatable drums for each of said circuits, reversing contacts for said circuits carried by each of said drums, brushes selectively engaging the contacts of each drum, steering control means connected to shift one of said brushes for selectively closing said contacts in accordance with steering requirements, manual means connected to shift the other of said brushes, switch means selectively connecting the contacts of one or the other of said drums to said circuits, follow-up mechanism including repeaters actuated by each of said pitch changing mechanisms to cause corresponding rotation of both of said drums for breaking said circuits when said pitch has been changed to the desired value, and adjusting mechanism to adjust the relative positions of said drums for varying the pitch response characteristics of said propellers.

7. A steering system for vessels having a steering rudder and port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, pitch actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said rudder and said pitch-actuation means for automatically varying the pitch of said propellers in a sense to aid the steering of said vessel, lost motion mechanism between said steering control mechanism and said pitch actuating means to permit a predetermined limited movement of said rudder from center position before said pitch actuating means begins to operate, and adjusting mechanism to adjust the amount of movement of said lost motion mechanism.

8. A steering system for vessels having a steering rudder and port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, pitch actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said rudder and said pitch-actuation means for automatically varying the pitch of said propellers in a sense to aid the steering of said vessel and mechanism to disconnect said rudder from said steering control mechanism to permit steering of said vessel solely by said propellers.

9. A steering system for vessels having a

steering rudder and port and starboard variable pitch propellers, comprising pitch changing mechanisms connected respectively to change the pitch of each of said propellers, pitch actuating means for simultaneously actuating both of said pitch changing mechanisms in opposite sense to increase the pitch of one of said propellers and to decrease the pitch of the other of said propellers, steering control mechanism connected to actuate said rudder and said pitch-actuation means for automatically varying the pitch of said propellers in a sense to aid the steering of said vessel, and means varying the ratio of movement of said pitch actuating means to said rudder.

JOHN HAYS HAMMOND, JR.