Oct. 4, 1938. F. S. HODGMAN 2,131,951

AUTOMATIC STEERING DEVICE FOR SHIPS

Original Filed Sept. 19, 1934 4 Sheets-Sheet 1

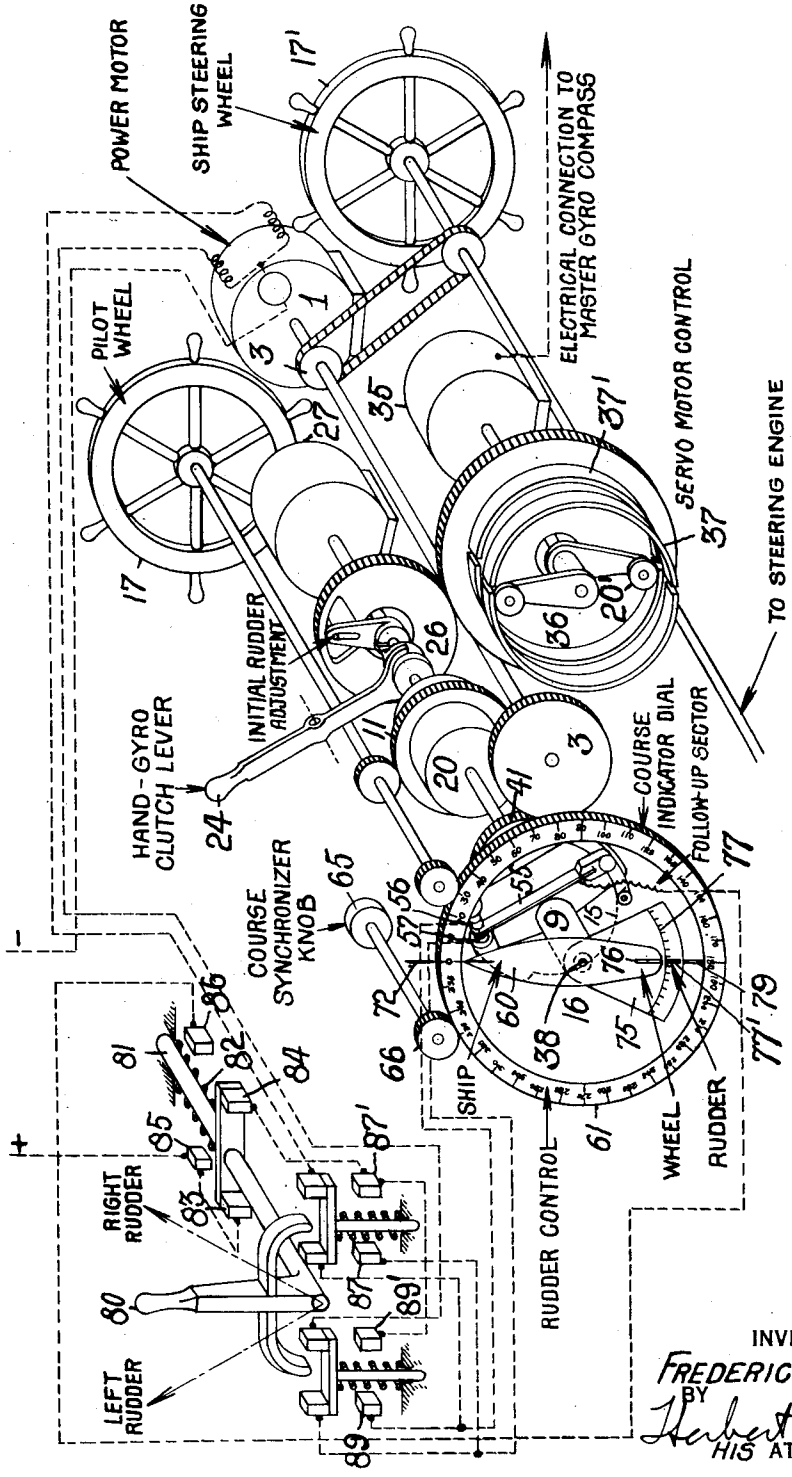


Fig. 1.

INVENTOR
FREDERICK S. HODGMAN
BY
Herbert F. Thompson
HIS ATTORNEY

Oct. 4, 1938. F. S. HODGMAN 2,131,951

AUTOMATIC STEERING DEVICE FOR SHIPS

Original Filed Sept. 19, 1934 4 Sheets-Sheet 2

Fig. 2.

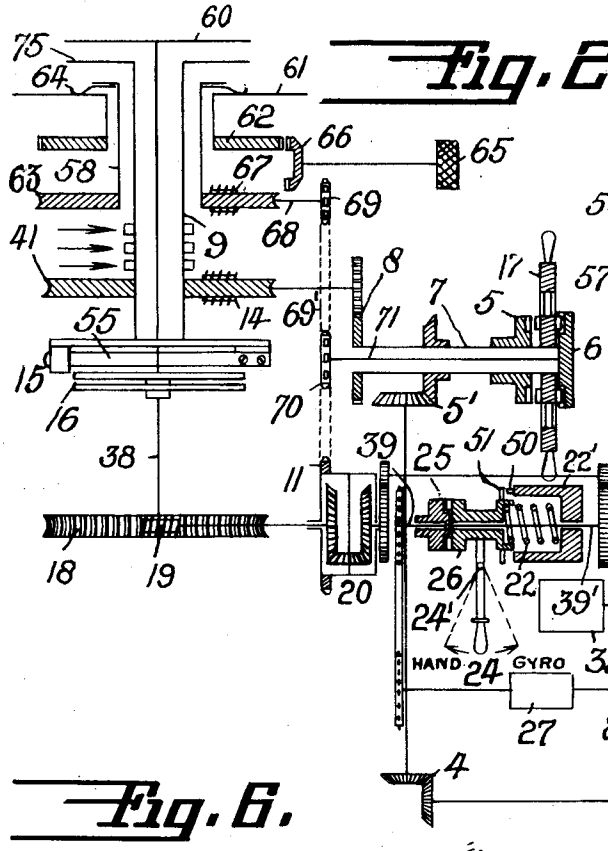


Fig. 5.

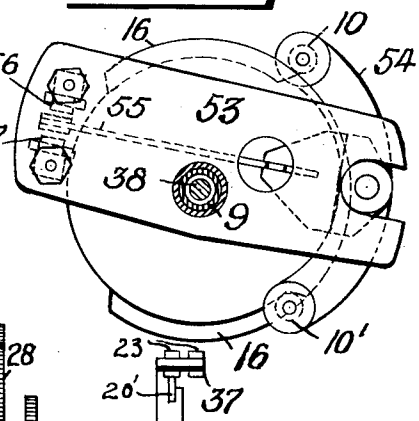
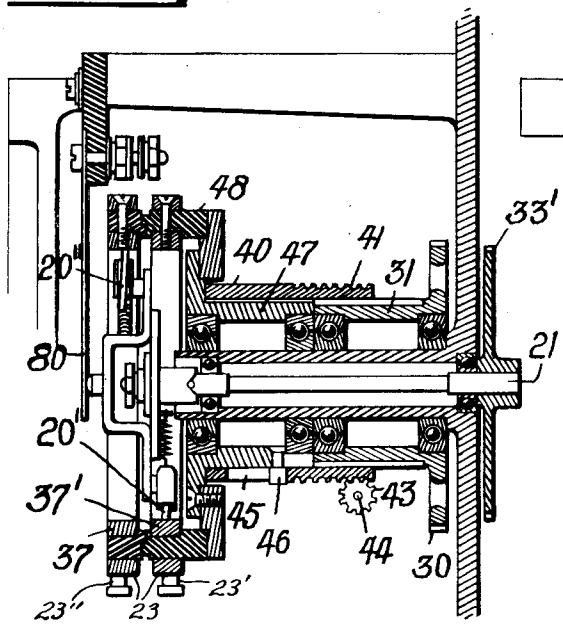


Fig. 6.



INVENTOR
FREDERICK S. HODGMAN
BY
Herbert H. Thompson
HIS ATTORNEY.

Oct. 4, 1938. F. S. HODGMAN 2,131,951

AUTOMATIC STEERING DEVICE FOR SHIPS

Original Filed Sept. 19, 1934 4 Sheets-Sheet 3

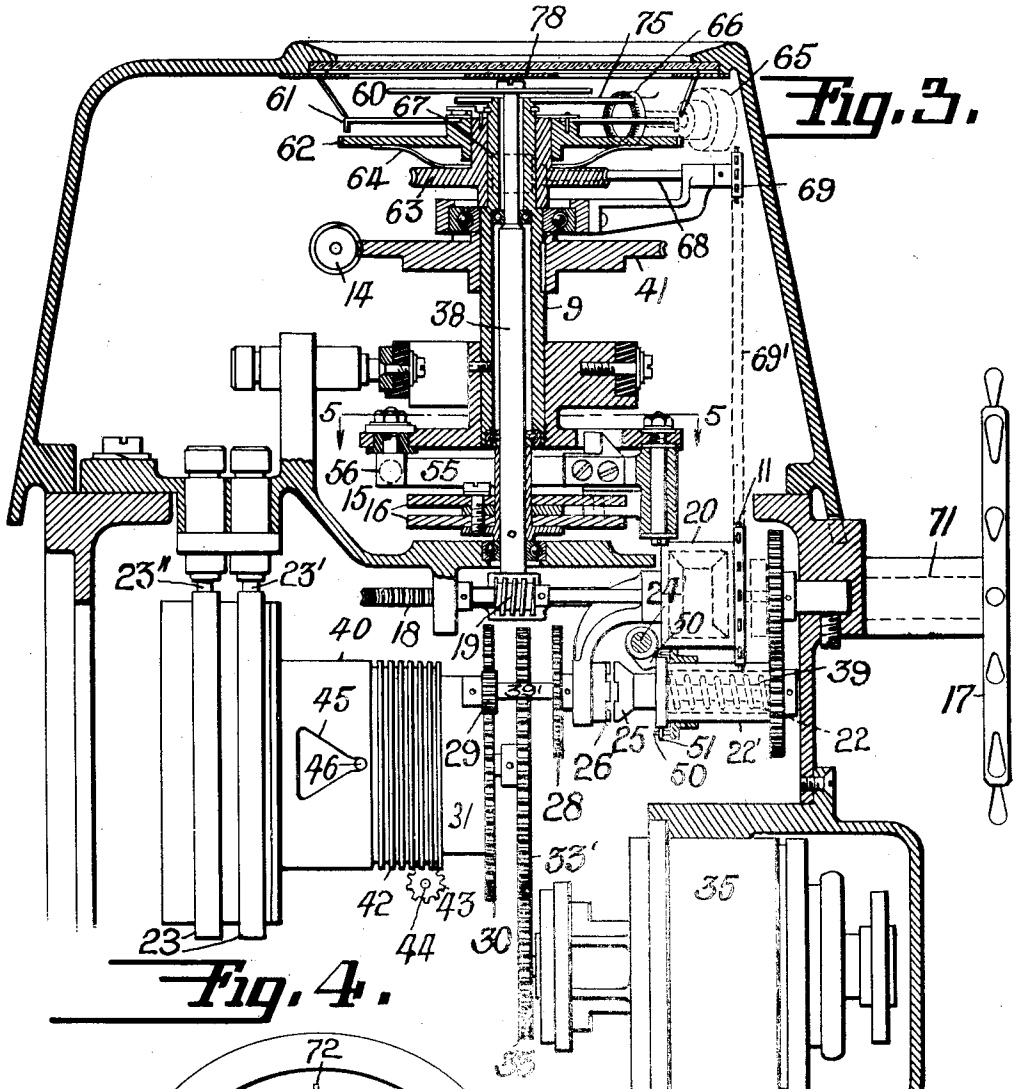
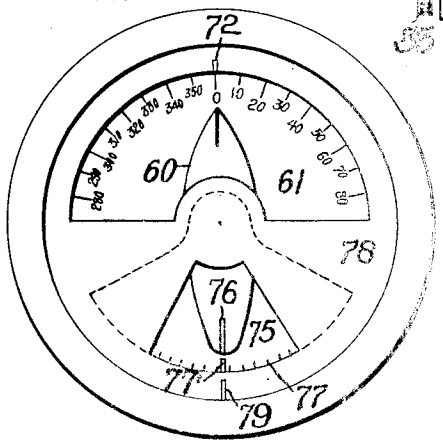


Fig. 3.

Fig. 4.



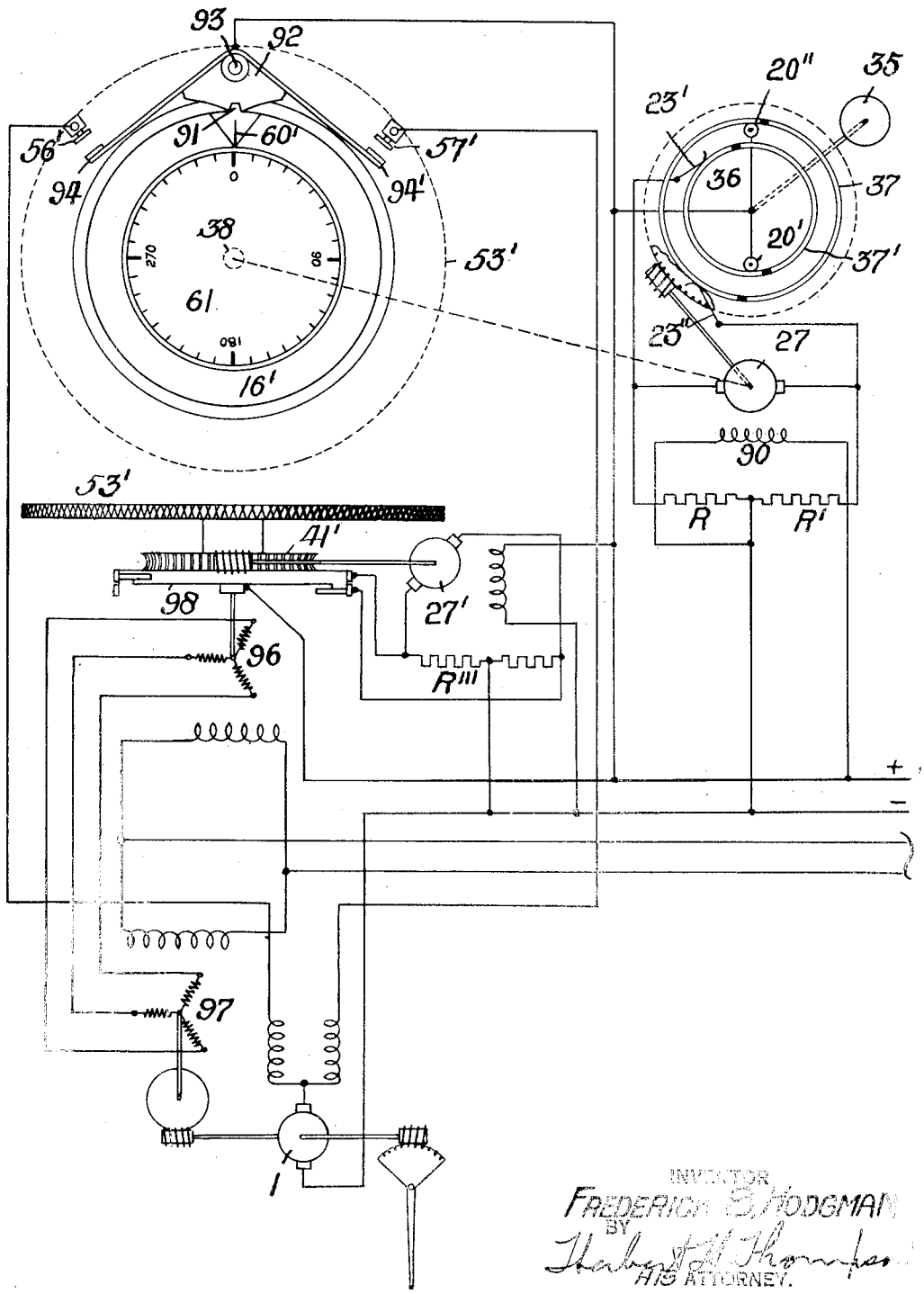
INVENTOR
FREDERICK S. HODGMAN
BY
Herbert H. Thompson
HIS ATTORNEY.

Oct. 4, 1938. F. S. HODGMAN 2,131,951

AUTOMATIC STEERING DEVICE FOR SHIPS

Original Filed Sept. 19, 1934 4 Sheets-Sheet 4

Fig. 7.



INVENTOR
FREDERICK S. HODGMAN
BY
Harbert & Thompson
HIS ATTORNEY.

Patented Oct. 4, 1938 2,131,951

UNITED STATES PATENT OFFICE

2,131,951

AUTOMATIC STEERING DEVICE FOR SHIPS

Frederick S. Hodgman, Glen Rock, N. J., assignor to Sperry Gyroscope Company, Inc., Brooklyn, N. Y., a corporation of New York

Application September 19, 1934, Serial No. 744,628
Renewed February 25, 1938

9 Claims. (Cl. 114—144)

This invention relates to improvements in automatic steering devices for ships, wherein the main course controller is automatically maintained synchronous with the gyro compass and wherein a predetermined course change may be ordered and set on the course indicator dial and the ship will automatically come around to the new course without further manipulation by the pilot. It is understood, of course, that I use the word "ships" throughout the specification in the generic sense and intend to include thereby both water borne and air borne vehicles, that is, both vessels and dirigible aircraft. A further object of the invention is to improve the controller arrangement so that more sensitive control is obtained. A further object of the invention is to provide a means for limiting at will the amount of rudder throw regardless of the total amount of course change desired. In other words, if a group of vessels is steaming in formation, it may be desired to change course through any desired angle, such as 90°, but for the individual ships to swing around an arc of predetermined radius in doing so. With the ordinary automatic steering device the rudder would be run hard over in order to make such a large course change and the ship would turn to the new course about a short radius arc. I have provided, according to my invention, means so that the rudder may be limited to any desired angle in making a turn through the automatic steering device.

Referring to the drawings,

Fig. 1 is a diagrammatic view, in perspective, of the elements of my improved automatic steering device.

Fig. 2 is a diagrammatic view, in skeleton form, of the same.

Fig. 3 is a vertical section through the top portion of the steering stand.

Fig. 4 is a plan view of the indicator dial on the stand.

Fig. 5 is a detail sectional plan view of the contact on the master controller, the section being taken on line 5—5 of Fig. 3.

Fig. 6 is a sectional view through the auxiliary controller, and Fig. 7 is a wiring diagram of a slightly modified form.

This invention is an improvement, in many respects, on the type of automatic steering system shown in my prior Patent No. 2,015,183, dated September 24, 1935, for Self-synchronous automatic pilots, and in my prior Patent No. 1,965,378 of July 3, 1934, for Sensitive remote control system and automatic pilot, and to that extent is a continuation of the same.

Referring first to the Figs. 1, 2 and 3, my automatic steering device is shown as controlled from a gyro or other compass (not shown) through a repeater motor 35, the transmitter for which is geared to rotate many times for one turn of the ship. Said motor operates an auxiliary controller 36, shown in the form of trolleys which contact with reversing contact rings 37 and 37'. Said contacts control a small reversible motor 27 which operates the main controller contacts 15. As shown in Fig. 2, the motor 27 drives a gear 28 on shaft 39'. One end of said shaft is shown as having a pinion 29 which turns a large gear 30, furnishing a follow-back connection to the controller 36. This gear is shown as having a large hub 31 (Fig. 6) on which is keyed a sleeve 40 having annular teeth 41, by means of which said sleeve may be axially moved along said hub, by means of a pinion 43 on shaft 44 which meshes with said teeth 41. By turning said shaft, the sleeve may be moved along said hub for the "telemotor" lost motion adjustment. To this end the sleeve is provided with a triangular slot 45, into which projects a pin 46 on an interior sleeve 47. Said sleeve has secured thereto a contact carriage 48 which supports the reversing contacts 37, 37'. It will readily be seen that by adjusting the sleeve 40 axially, the amount of lost motion between the pin 46 and the walls of the slot 45 may be adjusted to vary the telemotor adjustment. The trolleys 20' and 20'' are carried by a central shaft 21 actuated by repeater motor 35, either directly as in Fig. 2 or indirectly as in Figs. 3 and 6, through gears 33 and 33'. Slip rings 23, spring arm 80, and brushes 23' and 23'' are shown on the outer surface of carriage 48 for leading current out of the split rings 37 and 37'.

A hand lever 24 mounted on shaft 24' controls a clutch which couples and uncouples shafts 39 and 39', and hence the servo motor 27, from the main contacts 15. When said handle is in the position marked "gyro", clutch faces 25, 26 are closed and the motor 27 turns said contacts through shafts 39 and 39', differential 20, worm 19, worm wheel 18 and shaft 38, the clutch being held closed by the spring 22. When, however, the handle is thrown to the "hand" position, the clutch is open and all mechanical control from the gyro compass is disconnected. At this time the compass side of the differential 20 may be prevented from rotating by a plurality of pins 50 on spring housing 22' which engage pin 51 on clutch 26 (see Figs. 2 and 3).

The master controller in this instance is shown

as contact arm 55 and opposite contacts 56, 57, which arm is operated from a cam device on shaft 38 (Figs. 3 and 5) having camming surfaces 16. Secured to sleeve 9 adjacent said cam device is a member 53 on which is pivotally mounted a rocker arm 54 having rollers 10, 10' thereon adapted to be engaged by one or the other of the cam surfaces on said cams 16. In the position shown in Fig. 5, the spring arm 55 secured to said rocker arm lies midway between contacts 56 and 57 on member 53, but a very slight movement of the cam in one direction or the other will close one or the other of said contacts, not only because of the shape of the cam but because the contact arm 55 is much longer than the radius of cam 16 or the radius of rocker arm 54. By this means, coupled with the auxiliary motor control, very quick action of the main steering engine is secured with very slight lost motion.

The follow-up from the steering control motor 1 to the controller may be of any suitable type, mechanical or electrical. As shown in Fig. 2, suitable gearing 3, 4 and 5' is provided for this purpose, which may also serve to actually turn the rudder or rudder control from the main steering wheel 17' (Fig. 1) or from the wheel 17 (Fig. 2), which in this figure performs either the function of the gyro-pilot trick wheel or the main pilot wheel by pushing it back or forward to engage either clutch face 5 on sleeve 7 on which bevel gear 5' is mounted, or clutch face 6 on shaft 71 connected by sprocket 70 to large sprocket 11 on differential 20. Sleeve 7 is shown as turning a worm wheel 41 through worm 14 and gears 8. Worm wheel 41 is secured to a sleeve 9 which carries the member 53 of contactor 15. Shaft 38 extends through said sleeve and may carry at the top thereof an indicator 60 showing the course which has been set with respect to the compass points, which may be marked on the card 61. Said card is shown as secured to a large gear 62 which is frictionally mounted on the hub of the worm wheel 63, friction contact being provided by spring 64. Said card will therefore normally rotate with said worm wheel, but may be set with respect thereto by pushing in on the handle 65, thus bringing the crown gear 66 into mesh with said gear 62. The worm wheel 63 is shown as actuated from a worm 67 on the shaft 68 of a sprocket 69. The chain 69' coupled with said sprocket is shown as leading both to the sprocket 70 on the shaft 71 of the course changing wheel 17 and also to a sprocket 11 connected to the planetary arm of a differential 20. The card 61 therefore, when read in connection with the index 60 which is shown in the shape of a ship's hull, will show continuously the ship's compass heading as long as automatic steering is used, even including the short time that the course is being changed, at which time it may be used for setting in the desired course change, since the scale on card 61 may be read not only on the index 60 but also on the fixed lubber's line 72.

When steering by hand (i.e., through trick wheel 17), index member 60 will show wheel position. To this end, the index member 60 also has an index 76 at the rear representing wheel position, and sleeve 9 may also have an indicator secured thereto in the form of a graduated segmental card 75, having a zero index 77'. By comparing 76 and 77' the rudder follow-up may be observed and by reading 76 on scale 77 the amount of turn of the wheel is indicated. A mask 78 is cut out adjacent said scale indices to show the index 76 at the rear end of the index 60. Scale 77 and index 77' may also be read with reference to the lubber's mark 79 on mask 78 to show rudder position.

In order to limit the rudder throw for the purpose above described, I show in Fig. 1 an on-and-off rudder control handle 80, shown as mounted on a shaft 81 which is both rotatably and slidably mounted. When said shaft is in the forward position under the influence of the spring 82, the contacts 83 and 84 are bridged and contacts 85 and 86 open. In this position the circuit to the master gyro pilot controller 15 is open and the contacts beneath the handle 80 are energized. Therefore, when the handle 80 is rotated to the right, for instance, the contacts 87, 87' are bridged and the power motor 1 actuated to drive the rudder in the proper direction. Opposite movement of the handle will have the reverse operation by closing contacts 89, 89'. When, however, the handle 80 is pushed to the rear, the contacts 85 and 86 are bridged, thus placing the master controller contacts in the control of the power motor.

In using this portion of my invention, let us suppose that the ship is being steered automatically and the pilot desires to change course 90°,—in other words, to steer due east instead of due north, as indicated in Fig. 1. The pilot first rotates the trick wheel 17 until 90° registers with the lubber's mark 72. Simultaneously the ship's index 60 will turn counterclockwise 90° and the rudder will start to move to starboard. The rudder will continue to move to starboard, unless interrupted, until it reaches its hard over position, but if the pilot desires to turn at a given rate, he pulls out the handle 80 when the rudder indicator 77 registers the desired angle, say 15°, on the index 79. This will interrupt the circuit to the power motor. When the ship has about reached the course, the pilot may again push in the handle 80 or he may turn the handle 80, before pushing in, to steady the ship on its course by hand, and only push the handle in after the ship has been brought to the new course, as indicated by the ship's pointer 60 registering with the 90° mark on the compass dial 61.

In steering by hand (with the lever 24 in the hand position), the card 61 no longer represents the compass course which has been set and the index 76 may then be used as a wheel position index, cooperating with the rudder index 77' to show whether the rudder is following the wheel.

Referring now to Fig. 7, there is here illustrated a wiring diagram showing a slightly modified form of the invention in which the cam contactor 16 is replaced by an escapement form of contactor and in which an electric follow-back means is employed from the rudder instead of mechanical shafts. The auxiliary motor 27 and contactor 36 may be the same as shown in the other figures. The preferred construction of contactor is to have the angular position of rings 37 and 37' slightly displaced. By this means, together with a special winding on the motor 27, a very quick stoppage of the motor armature is secured, as follows:

The motor 27 is shown as provided with a continuously excited field winding 90 and the armature is connected directly across the collector brushes 23', 23'' which bear on collector rings 23 (not shown in Fig. 7). With the trolleys and contacts in the position shown in Fig. 7, the current will tend to flow from the plus side of the line through trolley 20'', brush 23'', armature

27 from right to left, and one side R of mid tapped or Wheatstone bridge type resistances R, R' to the minus side of the line. However, current would also tend to flow from the plus side of the line through trolley 20', brush 23', through the armature 27 from left to right, and through equal resistance R' to the minus side of the line. Therefore no line current would flow through the armature. However, it should be observed there is a direct short circuit through the armature and resistances R, R', and also from the armature through brush 23'', trolley 20'', trolley 20', brush 23' and back to the other side of the armature. Therefore the armature will be very quickly brought to rest by dynamic braking. In fact, with the small motor employed for driving this contactor, the armature has been brought to rest from a speed of several thousand revolutions within one revolution of the armature. By this arrangement, also, the effective dead space may be adjusted by varying the relative angular position of the two rings 37, 37'. The application of this special motor circuit to broader fields than electric steering gear for ships is reserved for my continuation application Serial No. 132,713, filed March 24, 1937, for Positional control motors.

The motor 27 operates the contactor as before. In this instance the contactor is shown as comprising a disc 16' carrying a single tooth 91 which normally engages a single notch in a rocker arm 92, pivoted at 93 and thus constituting a Geneva movement. Said arm carries a pair of spring contacts 94, 94' adapted to contact with fixed contacts 56', 57' upon a slight revolution of the tooth 91 in one direction or the other. Further revolution of the disc 16' in the same direction merely holds the contacts closed until the disc 16' is brought back to its original position or until the large disc 53', on which the pivot 93 is mounted, is revolved in the same direction to restore the original relative positions of the tooth 91 and rocker arm 92.

Disc 16' is shown as mounted on a shaft 38, corresponding to the shaft 38 in Figs. 2 and 3, which is shown as carrying a ship's heading indicator or reference mark 60' at the top thereof, corresponding to the ship's heading indicator 60 in Fig. 4. A compass card 61 is also shown, as in Figs. 2 and 3. A follow-up worm wheel 41' is shown as operated indirectly from a self-synchronous repeater motor 96, operated from a self-synchronous sending generator 97 at the rudder. Said motor, being of small power, is shown as turning the gear 41' by means of an electrical power multiplying or follow-up system comprising a contactor 98 which may be similar to contactor 36, which controls the follow-up motor 27', similar to the motor 27. Motor 27' is shown as turning worm wheel 41', on the shaft of which is disc 53'. The Geneva contactor shown in Fig. 7 has the advantage that it is self-synchronous throughout 360°, and through it large course changes may be performed without destroying the synchronism between the compass and the controller.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In an automatic electric steering gear for ships, a compass governed follow-up controller, means for setting in any desired change in course, a non-follow-up or off and on controller, and a switch on the latter and operable thereby for transferring the rudder control motor from the former to the latter controller for limiting the rudder throw.

2. In an automatic steering gear for ships, an electric controller comprising a rotatable cam member, a pair of contacts one or the other of which is adapted to be closed by slight movement of the cam in either direction, a rotatable member supporting said contacts, a motor actuated by said contacts, compass controlled means for turning one of said members, and follow up means from said motor for turning the other of said members.

3. In an automatic steering gear for ships, a compass actuated controller, a small power motor actuated therefrom, a rotatable cam member, a pair of contacts one or the other of which is adapted to be closed by slight movement of the cam in either direction, a rotatable member supporting said contacts, and rudder follow-up means for turning one of said members, the other member being differentially turned from said motor.

4. In an automatic steering gear for ships, a compass actuated controller, a small power motor actuated therefrom, a cam member, a pivoted contact arm, one part of which is adapted to be moved by said cam, the other part being further from the pivot than said cam and adapted to carry a contact, the cam being so shaped that slight movement thereof closes said contact and further movement leaves it unchanged, said motor operating to turn said member.

5. In an automatic steering gear, a compass actuated controller, comprising two pairs of semicircular rings each spaced from the other, a relatively rotatable contact for each pair, the two pairs being slightly displaced with respect to their contacts, and a reversible motor controlled from said contacts, having a continuously excited field and the armature connected across said contacts whereby the armature is dynamically braked when said contacts lie on opposing contacts of each pair.

6. In an electrical steering gear for ships, a motor having field and armature windings the former of which is of the continuously excited type, resistances of the Wheatstone bridge type across the armature and to one side of the supply, a steering controller device adapted to send current from the other side of said supply through said armature in one or the other direction and through one or the other half of said resistance, said controller in its mid or standstill position completing a short circuit around said armature to brake the motor dynamically.

7. In an automatic electric steering gear for ships, a rudder motor, a compass governed controller for said motor, and means for effecting a change of course, including a manually operable electric controller for said motor of the push button hard-over type and switching means on said controller for transferring the rudder control from said compass governed controller to said

manual controller, the length of time said manual controller is hard-over serving to determine the degree of rudder throw, whereby the rate of turn of the ship to the new course may be limited to any desired rate.

8. In a steering gear for ships, a differential gear train, a steering wheel connected to one arm of said differential, a servo motor for turning the rudder, and a controller for said servo motor actuated from another arm of said differential and comprising a rocker arm and a cam-like device turning said rocker arm one way or the other for small relative displacement of said device, acting to drive said servo motor one way or the other until said device returns said arm to neutral, said servo motor having a follow back connection to the third arm of said differential.

9. In a steering gear for ships, a controller comprising a rotatable cam member, a three-position rocker arm which is thrown to one or the other of its outer positions by lesser movement of the cam in either direction, a rotatable member supporting said rocker arm, a servo motor actuated by said controller, steering control means for turning one of said members, and follow-up means from said servo motor for turning the other of said members.

FREDERICK S. HODGMAN.