

June 10, 1924.

L. T. BATES

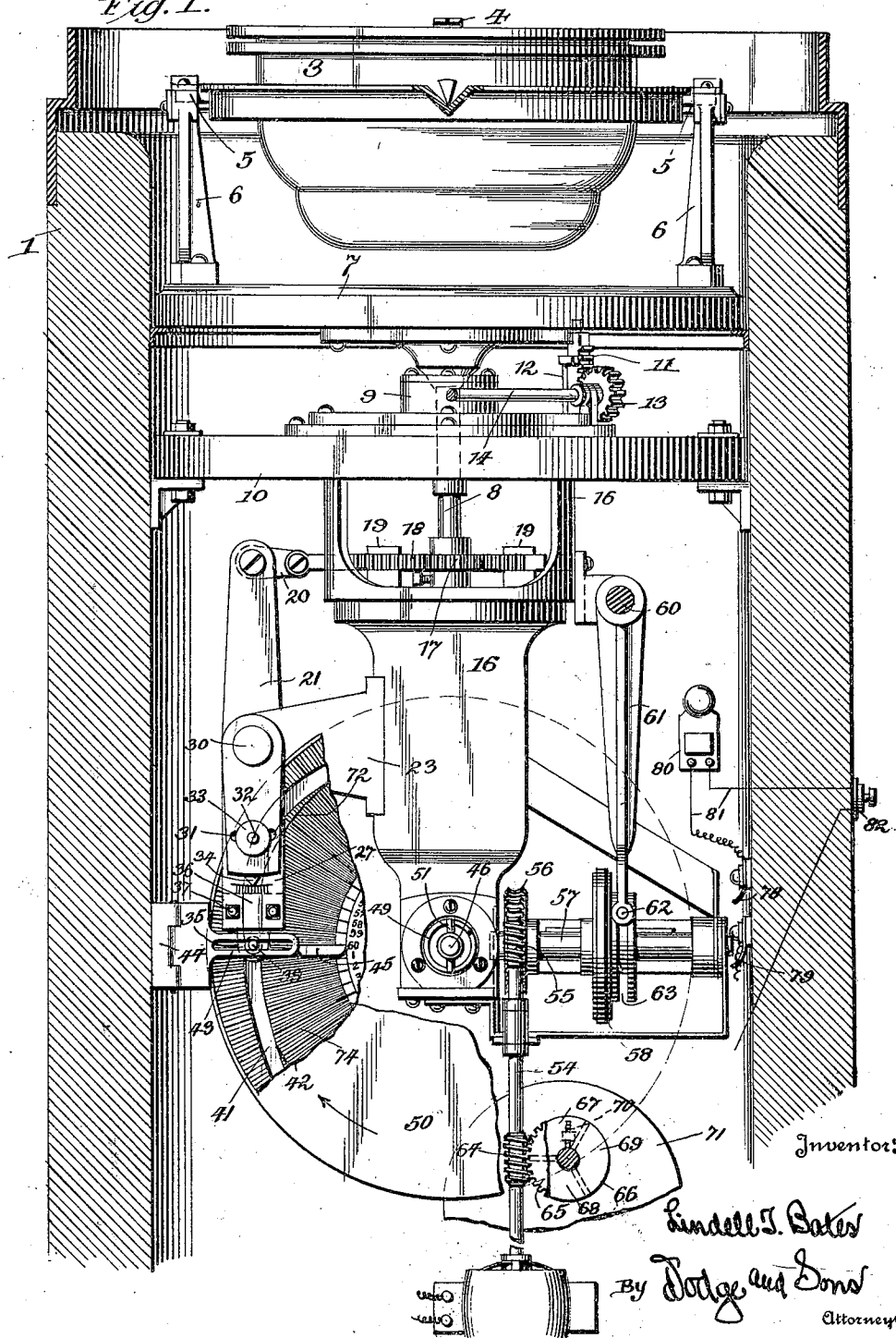
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METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT

Filed Jan. 25, 1919

5 Sheets-Sheet 1

Fig. 1.



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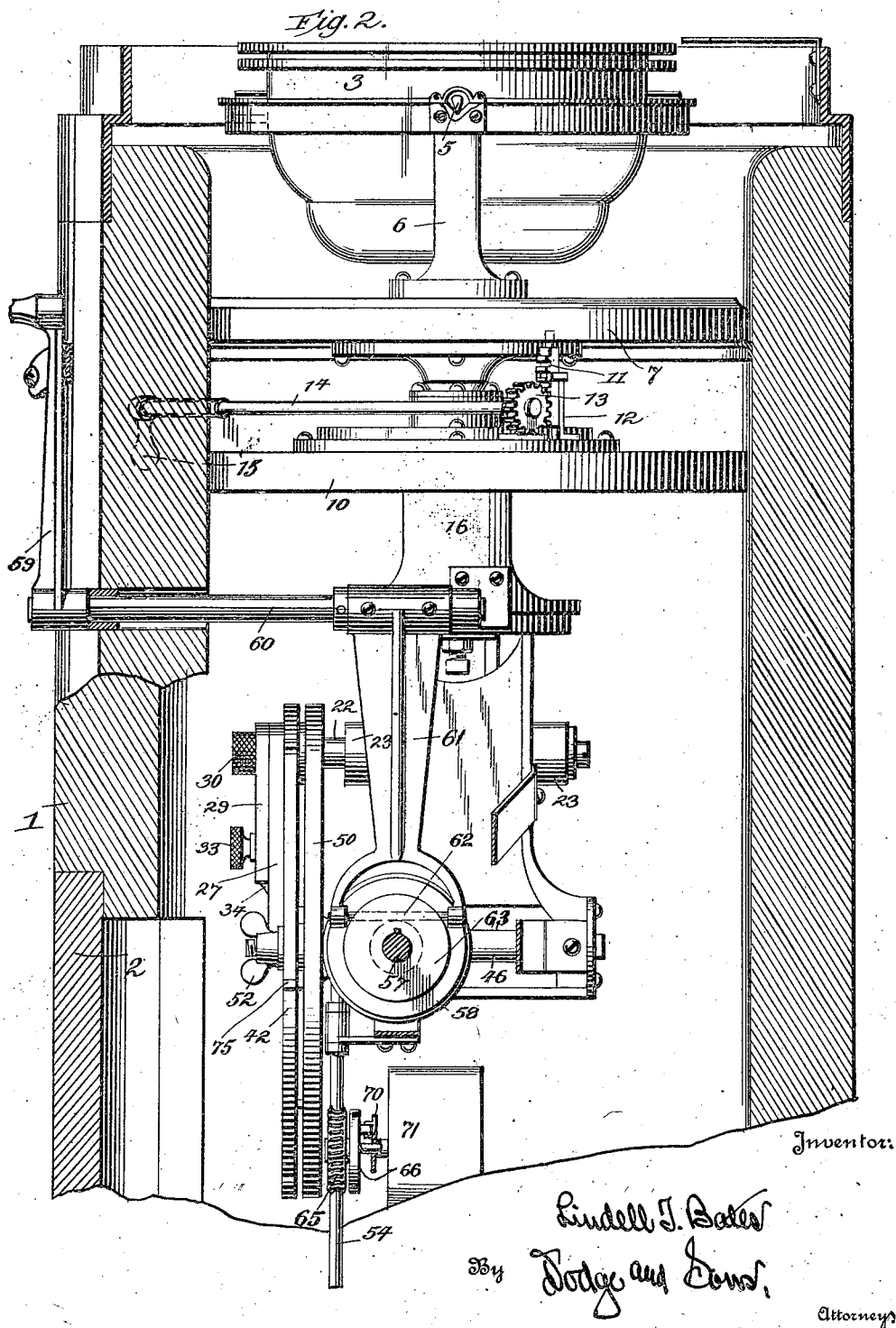
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METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT

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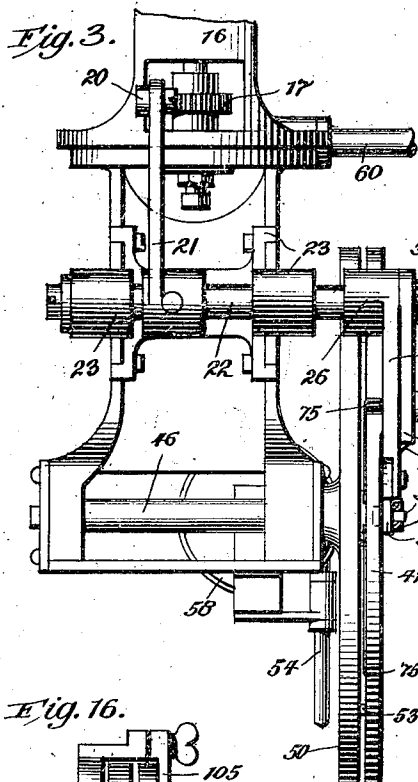
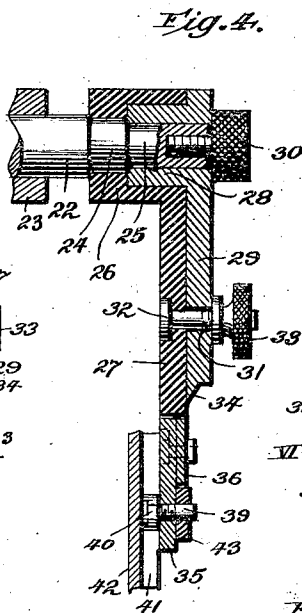
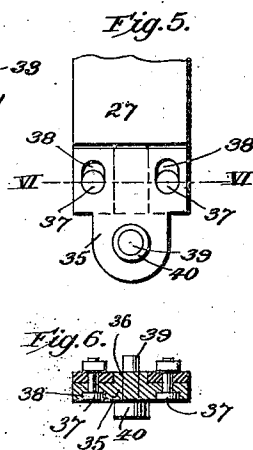
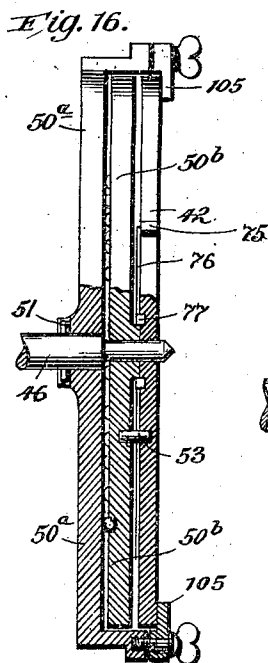
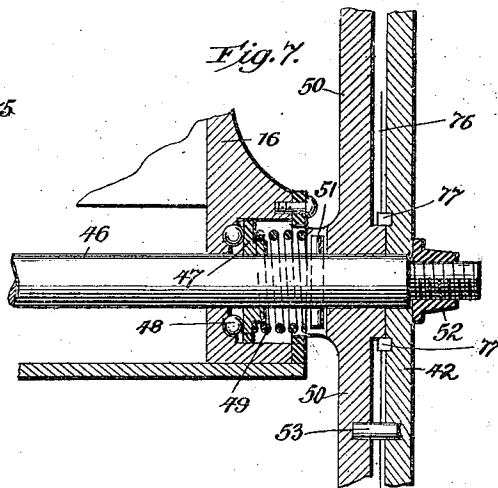
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METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT

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Attorney

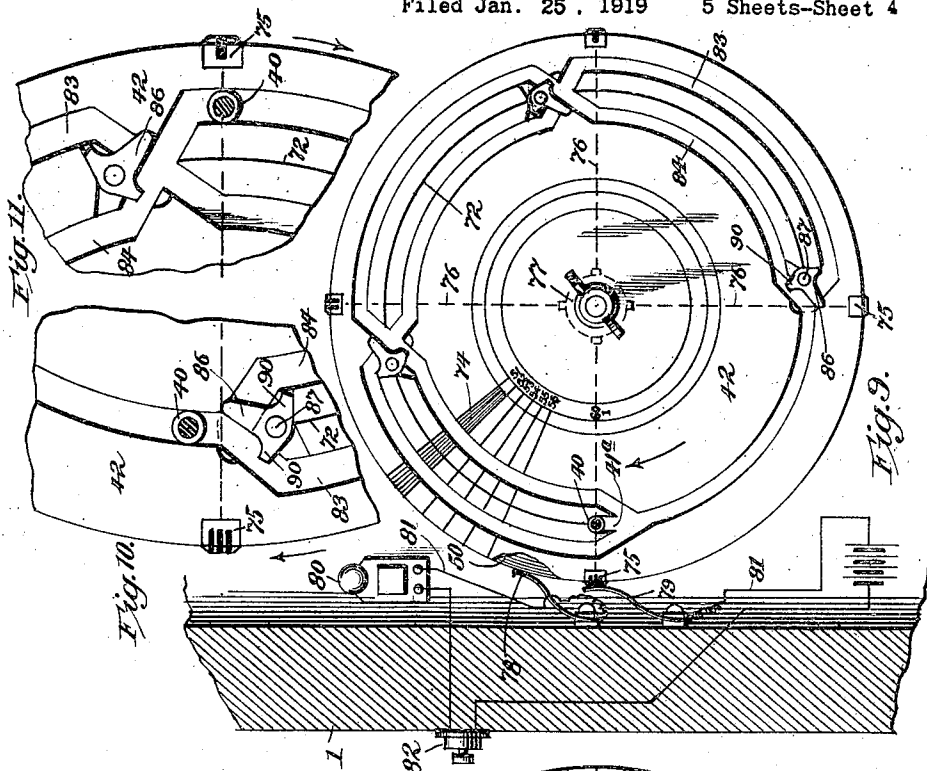
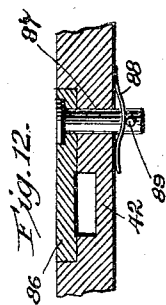
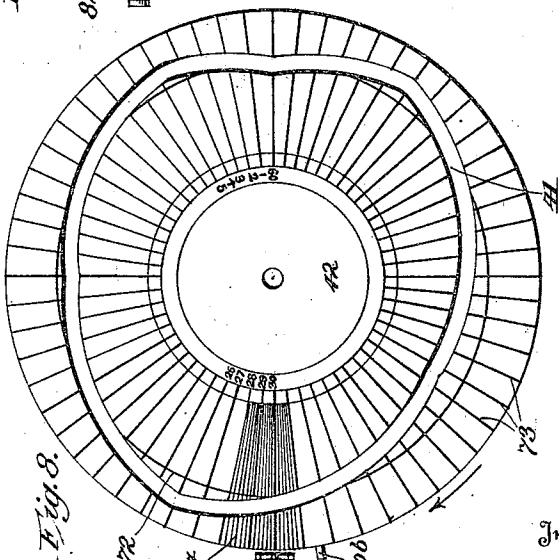
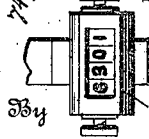
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METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT

Filed Jan. 25, 1919 5 Sheets-Sheet 4



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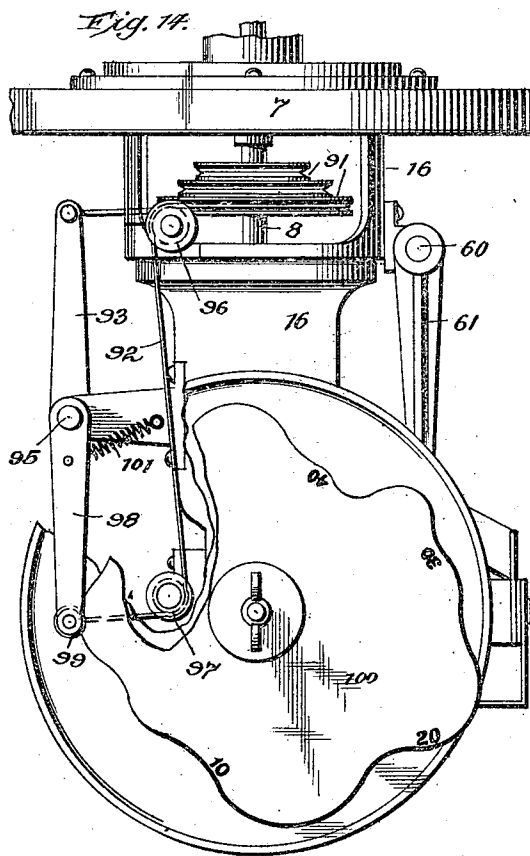
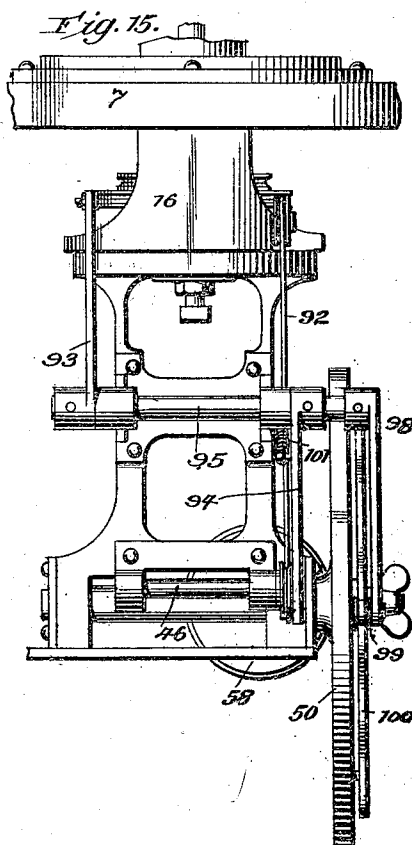
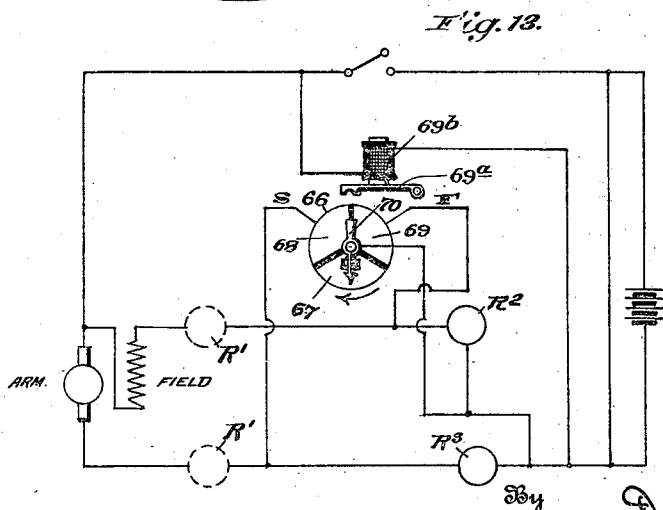
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METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT

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UNITED STATES PATENT OFFICE.

LINDELL T. BATES, OF NEW YORK, N. Y.

METHOD AND APPARATUS FOR NAVIGATING VESSELS AND AIRCRAFT.

Application filed January 25, 1919. Serial No. 273,094.

To all whom it may concern:

Be it known that I, LINDELL T. BATES, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improved Methods and Apparatus for Navigating Vessels and Aircraft, of which the following is a specification.

This invention pertains to a method and apparatus for navigating vessels and aircraft on a predetermined irregular course.

Prior to the great war there had been little occasion for ships to travel on other than straight courses. In fact, the art of navigation had been directed to enabling a vessel to steer as nearly straight a course as possible. Submarines had played practically no role in earlier maritime conflicts and fleets usually fought on straight-line parallel courses. The zigzag was resorted to one rare occasions when vessels in a fleet would "follow-the-leader" in action, steering alternately one point to starboard, then one point to port of the mean or normal course. Even these tactics to disturb the opponents' gun fire were rarely used as they unduly complicated the fleet maneuvers. When, however, the German U-boats demonstrated that a new era in naval warfare had begun, surface ships were obliged to resort to these special maneuvers to prevent and avoid torpedo and gunfire attack. The zigzag course became, with armament and marine camouflage, the anti-submarine defense; and the zigzag, at first hesitatingly resorted to by single vessels, has been extended even to convoys of over thirty ships.

The zigzag course is of considerable advantage against torpedo and shell fire attack from a submarine, other vessel or aircraft. In order to approach to the torpedo firing position it is necessary for the submarine commander to determine and predict from intermittent periscopic observations the ship's course, distance and speed. Upon the accuracy of the data so obtained depends the success of submarine's maneuvers for position and subsequent attack. It is clear that there is a difficulty in predicting the future position of a target which is going first in one direction, then in another, first at a fast speed, then slowing down on a corner, first at one range, then at a further or closer distance.

But the zigzag, while it increases safety

to a notable extent, has certain inherent disadvantages. A vessel is still vulnerable on a zigzag because for several minutes she is headed in a fixed direction, at a uniform speed. If a submarine can approach into a torpedo firing position during this interval the vessel will be in extreme peril. While the zigzag disturbs spot firing or shelling based upon range finding, it is not as serious an obstacle as possible owing to the straight legs. The zigzag corners, whether short or gradually turned, retard the vessel materially, and the gain or loss of every knot in speed between 5 knots and 14 knots means about ten percent increase or decrease, respectively, in safety. The zigzags, furthermore, increase the distance towards port sometimes as much as 30%; which means a longer journey in the danger-zone. The zigzag course, moreover, is hard to steer. Prior to my invention only bell or light signals have been available to remind the helmsman to change course. Inaccuracies are frequent. The requirement to change compass mark sometimes twelve times an hour is a burden which the most skilled navigator may well regard with apprehension.

The zigzag course, in allied practice, has evolved during the war from a course having a few wide angle turns, sharply made, and with five to twenty minute legs, to a course having several turns, slowly made, and with three to fifteen minute legs. These changes have been made since the inventor's published analyses regarding the zigzag and S courses and have brought the zigzag as near to the S course as is possible, in view of the necessity heretofore existing of repeatedly changing compass-mark to steer an irregular course. Fleet zigzag in action have not changed from the elementary maneuver mentioned earlier.

Close study of the present naval tactics shows that a course composed of a combination of spiral arcs, forming an S course, the combination having no formula, would be the final perfecting of the zigzag as a maneuver. Such a course would afford the most safety possible both against torpedo and shell fire. The submarine commander's course-estimate would be disturbed, because every time the vessel is seen she will be heading in a different direction. Further, distance prediction would be upset, as there is no way to tell to what place the curve

will carry the vessel. Speed estimate would also be adversely affected. Speed is calculated in view of the time which the vessel takes to traverse the known space between two observed points. If the vessel goes directly from the one to the other, the known time interval and distance disclose her speed exactly. If she follows a curved course of unknown arc the distance traversed is unknown so that her speed cannot precisely be determined. In regard to shell fire the effect of an S course is to introduce a serious error into the range finding for big guns and mortars, where the future position of the vessel has to be predicted a considerable time in advance. Spot firing is also disturbed because it will take longer than is now the case when opponent is on a straight course to find the mean center of impact and once found this cannot be retained. On the other hand, the gun crew of the vessel steering an S course will know from a table of distances and angles the heading of their vessel at a future time and her position on the curve, and may fire accordingly. A fleet proceeding on an S course will be able to outthit a fleet proceeding on a straight course or on the "follow-the-leader" zigzag.

The use of the indicator by air craft may take place when a bombing expedition is planned. An aeroplane desiring to proceed on a bombing or other expedition at a high altitude may steer the desired course, making due allowances for wind drift, keeping always the same compass-mark in view for the entire voyage.

It is practically impossible, in view of the nature of the task, to steer an S course or other curved course changing compass-marks to do so. It would require a perpetual change, sometimes of one degree, sometimes more, at irregular time intervals. No practical chart or signal board can enable a change of compass mark every few seconds. It is hard enough to obey accurately a signal coming as frequently as a dozen times an hour. Since vessels are steered by keeping the lubber line opposite a particular compass-mark, it is a scientific fact noted by the inventor that if the lubber line is placed say five degrees to starboard of its usual position in line with the ship's axis, and if the same compass-mark is kept opposite the lubber line in its new position, the vessel will go five degrees to port of the direction the vessel would have gone if the lubber line had been in the usual position; that is to say, she will go ten degrees to the left of the compass-mark. If, therefore, the lubber line is rotated to the right and left of its usual position, and the same compass-mark is kept opposite it, the vessel instead of steering a straight line will steer a curve. Given a desired curved course it is possible to make any vessel follow that curve. To

do so divide the course into sections corresponding to time or distance traversed and then cause the lubber line to take such a position at that time or distance that the axis of the vessel will be at the same angle to its mean course as the tangent of the curve at that same interval. One may therefore plot the tangents of the curve at various intervals and then cause the lubber line automatically to take such positions as will place the axis of the vessel at the required angle at the given interval. Following this novel navigation principle, one may steer any course desired, retaining the same compass-mark all the while. This new method of navigation revolutionizes steering with the compass. Heretofore, to change course, the compass-mark was changed; now, in accordance with the present invention, to steer any given course the lubber line is changed in position automatically. The new method of steering consists in selecting a normal or mean course compass-mark and then causing it to follow the lubber line which is rotated in such fashion as to cause the vessel to steer a predetermined course.

The mechanism to rotate the lubber line may be combined with any form of compass used on vessels or aircraft, either the magnetic or gyroscopic compass. In the latter case it would preferably be used with the repeater compasses than with the master compass. It may also be used with the Pelorus, known as the "dead compass," and with other instruments. The lubber line to be rotated may be the usual one on the compass or a special line represented by an indicator rotated around the compass rim. It is found more convenient to rotate the compass-rim, on which the lubber line is marked or attached, in the case of the magnetic compass and to rotate an indicator lubber line in the case of the gyroscopic. When the rotation passes 90° it is found well with the magnetic compass to use a reduced size of compass card and to have the lubber line a bent wire in the bowl. For emergency purposes and to give the actual compass heading of the ship, it is well to have not only the movable lubber line, but a fixed one as well, which is always in line with the axis of the vessel. The mechanism to rotate the compass, itself carrying the lubber line, or to rotate an indicator lubber line may be actuated by clockwork or electricity, or a combination of these. Other means, such as steam, magnetism, or compressed air, may be utilized. Clockwork may be utilized to regulate the actuating mechanism utilizing the principle of cutting in or out resistance to accelerate or decelerate the motor. The rotary motion may be transmitted through lever systems, rack and pinion or pulleys. The cam may

be in the horizontal or vertical position. A gear or friction drive to the cam may be used. The course to be steered may be plotted, in the fashion indicated, either on a reel or on a cam. The latter system is preferable. A roller on an arm actuating a rack and pinion or pulleys is a suitable means whereby the course plotted on the rim or groove bearing-surface of a cam may be utilized to rotate the lubber line. The cam may be set to rotate at any given speed.

To plot a course on a cam, in which the maximum deflection from a straight course is not over about 180° , only one normal line on the cam need be used. This line represents the lubber line coincident with the axis of the ship. The tangents are plotted to the right or left of this line. For a rotation through 360° to port or starboard three normal lines are needed, one representing the lubber line in line with the axis before rotation, one representing the lubber line after a 360° rotation to port, the other after 360° rotation to starboard. The latter type of cam will best be used for war vessels, where search curves have to be occasionally resorted to and complicated evolutions made.

An automatic course indicator, whereby the method above outlined may be practiced, is illustrated in the annexed drawings, wherein:

Figure 1 is a vertical sectional elevation of the apparatus shown as mounted in the usual magnetic compass binnacle case, with the top or cover removed;

Fig. 2 is a similar view taken at right angles to Fig. 1;

Fig. 3 is a detail side elevation of the lubber line actuating mechanism;

Fig. 4 is a sectional view showing the details of the construction of the lever arm which cooperates with the cam having the course plotted on it as a groove;

Fig. 5 is a rear elevation of the lower portion of said arm;

Fig. 6 is a transverse sectional view taken on the line VI—VI of Fig. 5;

Fig. 7 is a vertical sectional view showing the manner in which the cam carrying shaft is mounted;

Fig. 8 is a face view of a cam and an associated revolution counter;

Fig. 9 is a sectional elevation illustrative of a bell, light or other signaling mechanism which may be employed in conjunction with the cam, especially zigzag or search curve cams, when it is desired to indicate a special point, a change in direction, or a change in compass-mark, the cam shown being of a special form set to rotate once in one hour, and bearing a zigzag course completed in two hours;

Figs. 10 and 11 are enlarged face views

illustrative of the operation of the switches employed in connection with this or other type of cam;

Fig. 12 is a detailed sectional view showing the manner of securing the switch in place;

Fig. 13 is a diagrammatic view illustrative of the wiring and mechanism employed to regulate the speed of rotation of the motor;

Figs. 14 and 15 are elevations taken at right angles to each other showing a pulley drive for moving the lubber line, instead of the rack and pinion drive shown in Fig. 1; and

Fig. 16 a sectional elevation of a modified form of mounting for the cam supporting plate.

Referring to the construction shown in Figs. 1 to 8 inclusive, 1 denotes the usual binnacle case provided with a door or opening 2 to afford access to the mechanism so that one or another of the cams may be placed in position as desired. The compass having the usual lubber line is denoted generally by 3 and stands adjacent to an additional and fixed lubber line or pointer 4. The compass card, of course, maintains its normal position while in the present case the lubber line which is marked upon the compass ring is movable therewith in a manner hereinafter set forth. The lower bearings 5 of the compass are seated in standards 6 which in turn are rigidly secured to a table 7, which table in turn has secured to its under side a shaft 8, a suitable bearing 9 being employed for the shaft and table. Said bearing is mounted upon a fixed plate 10 secured to the binnacle case, as indicated in Fig. 1.

The compass while adapted to use in steering a predetermined course may and is intended to be used also for normal navigation, and to that end I provide a bolt 11, mounted in suitable guides 12, the upper end of the bolt being adapted to enter an opening formed in the lower face of the table 7. The opening is of course so located that the table and consequently the compass must be brought to proper position in which the usual lubber line is in line with the ship's axis before the bolt can be raised and this may be readily accomplished by manual actuation of the compass operating mechanism hereinafter set forth. Bolt 11 takes the form of a rack with which meshes a pinion 13 carried at the inner end of a shaft 14 which at its outer end is provided with a handle 15, Fig. 2, by which the shaft may be actuated to raise or lower the bolt and to thus lock or release the compass.

Extending downwardly from plate 10 is a bracket or member 16, said member forming the support for the operating parts in general. Shaft 8 adjacent its lower end has se-

cured thereto a pinion 17 with which meshes a rack 18 held up thereto by guides 19, Fig. 1. To the outer end of the rack is secured a short link 20 pivotally connected to the upper end of a lever 21, the lower end of the lever being secured to a rock shaft 22 journaled in brackets 23 extending outwardly from member 16. To the outer end of the shaft is secured the actuating arm or lever which is preferably constructed as shown in Figs. 1 and 3 to 6 inclusive.

As will be seen upon reference to Fig. 4, the end of the shaft 22 is provided with two reduced and shoulder sections 24 and 25. Fitting over the former is a hub 26 of the actuating arm or lever 27 and fitting over the latter and extending into the hub 26 is a hub 28 of a secondary lever 29, the two hubs and levers being forced into engagement with each other and secured to the shaft 22 through a thumb-screw 30. Lever 29 adjacent its lower end is provided with an elongated slot 31, Fig. 1, and a bolt 32 mounted in lever 27 extends therethrough, a thumb-nut 33 being mounted on the bolt and bearing against the face of lever 29. The extreme lower end of lever 29 is fashioned into a pointer or finger 34 which lies adjacent to a series of graduations formed or produced on the face of lever 27. The utilization of these parts will presently appear.

The lower end of lever 27 is reduced in thickness and provided with a transverse opening and a sliding extension plate 35 is imposed on such reduced portion, the plate having a lug 36 which extends through the opening just mentioned. The lug is of a length slightly less than the length of the slot or opening into which it extends, and the heads of bolts 37, employed to hold the plate to the lever, lie in slots 38 formed in the sliding plate. The slide may thus have an up and down motion with reference to the lever, though both swing or move laterally as one. Threaded into and through the slide 35 is a pin 39, upon the inner end of which is mounted a roller 40 which lies within the cam groove 41 of the actuating cam 42.

A slotted guide arm 43, Figs. 1 and 4, hinged to a bracket 44 secured to case 1, straddles the outer end of pin 39 and causes the pin to travel in a right line and consequently causes the slide 35 to move up and down as the lever 27 is swung to one or the other side of its vertical position by the action of the roller 40 as it traverses the cam groove. An index finger or marker 45, Fig. 1, is formed as an extension of the guide arm, overlies the cam and enables the navigating officer to properly and readily place the cam 42 in its proper initial position.

The cam supporting and driving shaft is denoted by 46 and is mounted in suitable bearings carried by the lower portion of

the supporting member 16. The shaft adjacent its outer end passes through a plate 47, see Fig. 7, which bears at one side against balls 48 while on the other takes one end of a coiled spring 49. Said spring at its outer end bears against the hub of a driving or brush plate 50, the plate being connected to the shaft by a pin 51. The outer end of the shaft is threaded and a thumb-nut 52 serves to force the cam 42 in contact with the hub of plate 50, and to place the spring 49 under compression, the cam and plate at such time being interlocked by a pin 53 which extends outwardly from plate 50 and passes into a hole in the rear face of the cam.

Motion is imparted to the driving plate from an electric motor (Figs. 1 and 13), located preferably below deck, and driving a shaft 54 (Figs. 1 and 2). Said shaft at its upper end carries a worm 55 which meshes with a worm gear 56 mounted on a counter shaft 57. A brush wheel 58 is splined to rotate with the shaft and is in normal driving contact with the rear face of the driving plate 50. It may be adjusted along the shaft and consequently brought nearer to or further away from the periphery of the plate with a consequent change in speed of rotation of said plate, through the manipulation of a handle 59, Fig. 2, secured to the outer end of a rock shaft 60, the shaft at its inner end having secured thereto an arm 61, the lower end of which is bifurcated and carries a cross-pin 62 which engages a groove 63 formed in the hub of the wheel 58. The cam is designed to make one complete revolution each hour and the brush wheels and gearing will be adjusted with relation to the motor speed to effect such movement.

To maintain the speed of the motor constant suitable means working in conjunction with a clock mechanism will be provided for cutting in or out suitable resistances to the motor armature or field. To this end shaft 54 is provided with a second worm 64, Fig. 1, with which meshes a worm gear 65 that drives a disk-like member 66 (Figs. 1 and 13) having three sections 67, 68 and 69, the first being formed of suitable dielectric material and the others of conducting material insulated from each other. A second hand 70 (Figs. 2 and 13) driven by clock mechanism 71, contacts the face of said sections and rotates in the same direction as the disk.

In Fig. 13 a diagrammatic layout is shown. When the motor runs too fast the second hand contacts with section 69 and the resistance R_2 is short circuited from the field, thereby slowing the motor. When the motor runs too slow the second hand makes contact with 68 and the resistance R_3 is short-circuited from the armature, thereby accelerating the motor. When, however, the motor is running at the proper speed, R_1 is

either in the armature or field, or in both, as the adjustment may require; R_2 is in the field and R_3 in the armature. In this case the second hand makes connection with 67 which is insulated. Any arrangement which will regulate the motor may be employed and the circuits and resistances will be modified to suit the particular type of motor employed. A pivoted bar 69^a controlled by an electro-magnet 69^b will be placed in the circuit so as to stop the clock simultaneously with the motor. When the current is switched on the magnet draws up the bar which releases the clock. The cam groove 41 formed in the face of the cam plate will be given a contour such as will impart to the compass for each complete revolution of the cam that movement which will carry the vessel to one or the other side of its normal course as desired and then back to its proper course and position, provided only that the helmsman keeps the movable lubber line in coincidence with the compass-mark.

In Fig. 8 the normal course line is indicated by 72 and the cam groove passes from one to the other side thereof, so that the ship will travel a course upon a series of connected curves crossing back and forth the mean or normal line. Such zig-zag or S-shaped course may be repeated as many times as desired by allowing the cam to continue to rotate. Or, if desired, upon the completion of a revolution another cam having a differently plotted course may be substituted.

A revolution counter 70^a, Fig. 8, may be positioned near the driving plate 50 and operated by a pin or finger 70^b extending outwardly from the plate.

The cam plate will preferably be produced from aluminum, brass or bakelite and will have its face provided with graduations in intervals of minutes from 1 to 60 depicted by the heavy lines 73 with second graduations demarked by the lighter radial lines 74. It will also be provided with a series of numerals from 1 to 60, indicating minutes. With a cam plate so marked the navigating officer may readily ascertain his exact position with reference to the normal course. Thus, by noting the position of the cam with reference to the index finger 45, and looking at a chart and table of distances for various speeds of ship, which chart and table are prepared to conform to the various positions of the actuating groove on the cam with reference to the normal course line, he may determine just how far the vessel has traveled on the curve, away from normal and along normal and upon what particular portion of the plotted route or course the vessel then stands. There will, of course, be such a chart for each particular course and inasmuch as the charts and cams are numbered or bear like designating marks

no difficulty or confusion will arise. The same cams may be used over and over as above noted, or a new cam substituted on the completion of the rotation of a cam through a sixty minute or longer period.

When the vessel is being navigated in fleet or convoy formation on a zigzag or special maneuver it may be desirable to have an audible signal to indicate change in course. To that end I employ an arrangement such as best shown in Figs. 1 and 9. The cam will be provided with a series of contact blocks 75 adjacent the periphery thereof with leads 76 extending therefrom to a contact ring 77, see Fig. 7, adapted to make electric contact with the supporting plate 50. A spring brush 78 contacts the periphery of the plate 50 and a second brush 79 is designed to contact the blocks 75. A signal such as a bell or light 80 is connected in the circuit denoted generally by 81 and a switch 82 is located upon the outer face of the binnacle case 1. The blocks 75, by dividing them up into sections, may cause the bell to ring one or more times in rapid succession to denote the degree of movement or the position of the cam at such time. By dividing the blocks into a successively greater number of parts a different signal will be given at each successive position of the cam in its rotation as the blocks complete the signal circuit. In the arrangement shown the bell will be rung every fifteen minutes, but this, of course, may be changed, if desired, by employing a greater or less number of contact closing blocks 75. When this audible signal mechanism is in operation the compass may be locked and the lever arm normally operated by the cam disconnected therefrom, though the two may, of course, be used simultaneously, if for any reason it be found desirable so to do.

In Figs. 9 to 12 inclusive, I have shown a modified form of cam plate designed to be rotated once an hour through a period of two hours to produce a completion of the course plotted thereon. The plate has formed in its face a groove or channel, portions of which, as indicated by 83 and 84, are placed at different radial distances from the center of the plate and merge into each other at each end, as at 85. A switch 86 is located at the point of mergence of the channel sections, the switch being held in place by a pivot pin 87 which in turn is preferably held in position by a spring washer 88 and a through-pin 89. Each switch will be provided with two oppositely disposed wings 90 which stand in the path of the roller 40, which roller as the cam plate is rotated contacts the wing and in passing thereby throws the switch from one position to its opposite position. Thus as the cam plate rotates in the direction of the arrow, Fig. 10, the roller will contact the switch

and be carried laterally to the left in contact with the then upwardly extending wing 90, and as it passes down into the groove 83 would throw the point of the switch to the left, or to the opposite position to that shown in said figure. The roller would then travel in the groove 84 until it came to the next switch, which, if it kept the position shown in Fig. 11 would throw the roller into the outermost groove 83. The grooves or channels will, of course, be given a desired contour, as in the case of the single cam groove and it would take two complete revolutions of the cam plate to cause the roller to traverse the entire length of the cam groove.

To enable one to properly position the cam at the start, it is essential that an extension of the cam groove be formed in line with the indication 60 thereon for the initial reception of roller 40 and such extension is denoted by 41^a in Fig. 9.

In Figs. 14 and 15 a slight modification of the invention is illustrated wherein instead of employing the rack and pinion mechanism above described to actuate the shaft 8 and consequently to move the table 7, the shaft 8 is provided with a series of pulleys of different diameters indicated by 91. A cord 92 is placed about one or another of the pulleys according to the speed of movement of the compass desired, said cord being connected at one end to a lever 93 and at its opposite end to a second lever 94. Said levers are secured to and movable with a rock shaft 95, the cord in passing from the pulley to the lower arm 94 being carried over guide rollers 96 and 97. Shaft 95 has secured to it a third arm or lever 98 upon the lower end of which is mounted a roller 99 which contacts with the periphery of a cam 100. This cam is plotted and formed to the desired course through which the ship is to pass and the roller is held in operative contact with the cam by a spring 101.

In order to adjust the mechanism for compass variation and to compensate for the effects of wind, tide, current and compass deviation, the navigating officer will loosen thumb-nuts 30 and 33 and swing the member 29 in one or the other direction according to the adjustment required and then lock the parts by setting up the nuts. This starts the movable lubber line to starboard or port of the axis line and so compensates for the factors mentioned. The fixed lubber line 4 is not, of course, essential and is usually ignored in the navigation of the vessel; it serves two purposes, however; first, it shows the actual compass heading of the ship, and, secondly, when the movable lubber line is to one or the other side of the ship's axis, the fixed lubber line may be used to steer the ship when it is desired to abandon the S or zigzag course without arresting the

movement of the movable lubber line or bringing it back to its normal position in line with the ship's axis and locking it.

In Fig. 16 a further modification of the invention is shown wherein instead of employing a single plate as 50, a two-part construction is used, a recessed plate 50^a, having seated therein a secondary plate 50^b upon which latter is imposed the cam 42 and locked thereto by the pin 53 as in the other construction. Clamps 105 are adapted to bind the various elements 50^a, 50^b and the cam 42 together so that they will rotate as one with the shaft 46. The purpose of constructing the parts in this manner is to permit the cam to be shifted to secure initial adjustment without the necessity of shifting the plate 50^a and shaft 46 which is locked against movement through the worm drive.

Additional features of the indicator are many. An azimuth circle may be attached to the compass rim whereby the navigator will be enabled to secure a reading of azimuth without going on to a fixed course. In other words, by the use of this invention azimuth may be obtained while maintaining the vessel upon the S or zigzag course which the vessel may be at that time following.

It is obvious that in so far as the generic invention is concerned the structure may be varied in many of its details and yet fall within the scope of my invention. The two structures above outlined have been tested out in actual practice on a naval vessel and have been found to give excellent results.

The term vessel or ship as used in the claims is to be understood as including aeroplanes and air ships as well as those which navigate the seas.

As above noted, the compass card (or its equivalent) will as usual remain stationary and where the claims refer to movement or oscillation of the compass they refer more particularly to the compass bowl or a movable lubber line and are to be read with this in view; the card remains unaffected.

What is claimed is:

1. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted thereon; a vertically disposed shaft to which said table is secured; means for effecting the oscillation of the shaft and consequently of the table according to a predetermined course through which the vessel is to be steered; and means for locking said table against movement.

2. In an apparatus of the character specified, the combination of a binnacle case; a fixed member supported therein; a rotatable table; a shaft extending through the fixed member and attached at its upper end to the table; a ship's compass mounted on the table and movable therewith; a cam having a cam surface plotted to the course through which the ship is to be steered; and connec-

tions between said cam and the shaft for oscillating the same in accordance with the movement of the cam.

3. In an apparatus of the character specified, the combination of a binnacle case; a fixed member supported therein; a rotatable table; a ship's compass mounted on the table and movable therewith; a shaft connected to the table and extending downwardly through the fixed member; a cam plotted to the course through which the vessel is to be steered; means for driving the cam; a lever; a roller carried by the lever and co-acting with the cam; and connections between the lever and the shaft aforesaid whereby the shaft and consequently the compass will be oscillated in accordance with the movement of the cam.

4. In an apparatus of the character specified, the combination of a binnacle case; a fixed support mounted therein; a rotatable table; a ship's compass mounted thereon; a shaft extending downwardly from the table through said fixed support; a cam surface plotted to the course through which the ship is to be steered; means for driving the cam; a rock shaft; a lever extending from said rock shaft; a rack and pinion connection between said lever and the shaft first mentioned; a second lever secured to the rock shaft; and a roller carried by said second lever and co-operating with the cam.

5. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted on and movable with the table; a cam plotted to the course through which the ship is to be steered; means interposed between the cam and the table for imparting an oscillating movement to the table about its axis in accordance with the movement of the cam; and adjustable means for driving the cam.

6. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted on and movable with the table; a cam plotted to the course through which the ship is to be steered; means interposed between the cam and the table for imparting an oscillating movement to the table about its axis in accordance with the movement of the cam; a motor and adjustable driving connections between said motor and the cam whereby the speed of the cam may be regulated as desired.

7. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted on and movable with the table; a cam plotted to the course through which the ship is to be steered; means interposed between the cam and the table for imparting an oscillating movement to the table about its axis in accordance with the movement of the cam; a motor; adjustable driving means interposed between the motor and cam whereby the speed of the cam

may be regulated; and a synchronizing mechanism for controlling the speed of the motor.

8. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted thereon and movable therewith; a cam plotted in accordance with the course through which the ship is to be steered; and driving connections intermediate said cam and the table for oscillating the latter, said connections embodying an adjustable device whereby compensation may be made for magnetic, tidal, current, wind and other navigation effects.

9. In an apparatus of the character specified, the combination of a rotatable table; a ship's compass mounted thereon and movable therewith; a cam plotted to the course through which the ship is to be steered; a rock shaft; actuating means interposed between the shaft and the table; a lever secured to the rock shaft; a sliding member mounted upon the lower end of the rock shaft; a roller carried by said member and cooperating with the cam; and a guide co-operating with said member.

10. In an apparatus of the character specified, the combination of a compass; a cam having plotted thereon the course through which the vessel is to be steered; driving connections between said cam and compass for moving the latter about its axis in consonance with the movement of the cam; an electric motor for driving the cam; and a clock controlled mechanism for maintaining the motor at proper speed.

11. In an apparatus of the character specified, the combination of a compass; a cam having plotted thereon the course through which the vessel is to be steered; driving connections between said cam and compass for moving the latter about its axis in consonance with the movement of the cam; an electric motor for driving the cam; a clock controlled mechanism for maintaining the motor at proper speed; and means for locking the clock when the motor circuit is interrupted.

12. In an apparatus of the character specified, the combination of a compass; a cam having plotted thereon the course through which the vessel is to be steered; driving connections between said cam and compass for moving the latter about its axis in consonance with the movement of the cam; an electric motor for driving the cam; a clock controlled mechanism for maintaining the motor at proper speed; and a magnetically actuated lock included in the motor circuit and adapted to arrest the clock upon interruption of the motor circuit.

13. In an apparatus of the character specified, the combination of a compass; means for moving the same about its axis toward and from the normal line of travel of the

ship; and a signal device, controlled by said means, and actuated at predetermined intervals by the said means.

14. In an apparatus of the character specified, the combination of a ship's compass including a movable member bearing the lubber line; and means including a cam for moving said member relatively to the compass card, said cam having a plurality of interconnected grooves or channels; and a switch located at the mouth or entrance end of one or more of said channels.

15. In an apparatus of the character specified, the combination of a ship's compass including a movable member bearing the lubber line; and a cam for moving said member relatively to the compass card, said cam having a plurality of interconnected grooves or channels formed on its face, said grooves

being arranged in pairs, in part at least; and a switch located at the mouth of each pair.

16. In an apparatus of the character specified, the combination of a ship's compass including a movable member bearing the lubber line; and a cam for moving said member relatively to the compass card, said cam having a plurality of interconnected grooves or channels formed in its face, said grooves being arranged in pairs, in part at least, with a starting recess located in line with the initial starting point of the cam; and a switch located at the mouth or entrance of each pair.

In testimony whereof I have signed my name to this specification.

LINDELL T. BATES.