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GYROSCOPIC COMPASS.
APPLICATION FILED JAN. 2, 1915.

1,253,574. Patented Jan. 15, 1918.

3 SHEETS—SHEET 1.

Fig. 2.

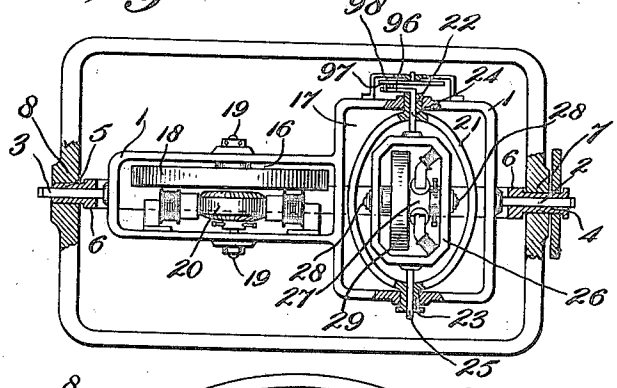


Fig. 1.

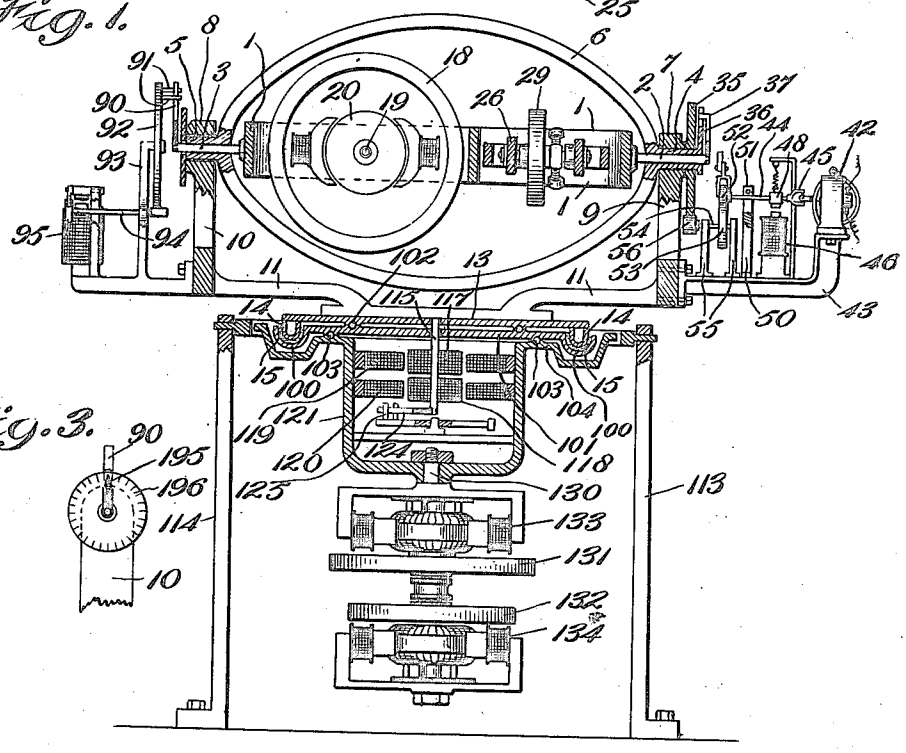


Fig. 3.

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3 SHEETS—SHEET 2.

Fig. 4.

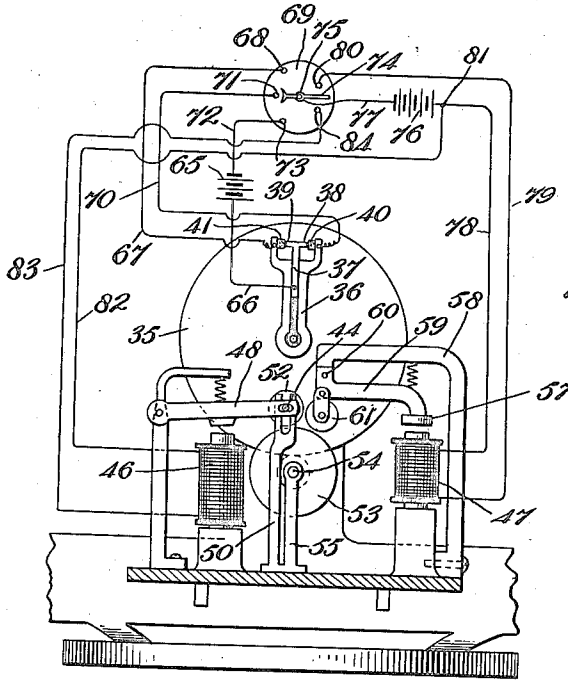


Fig. 10.

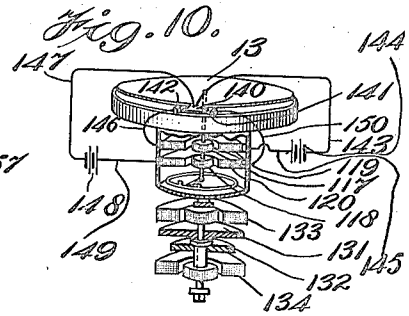


Fig. 6.

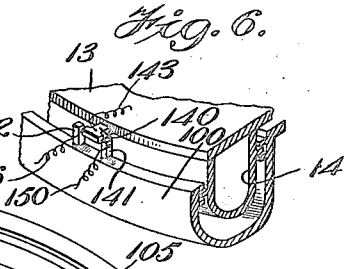
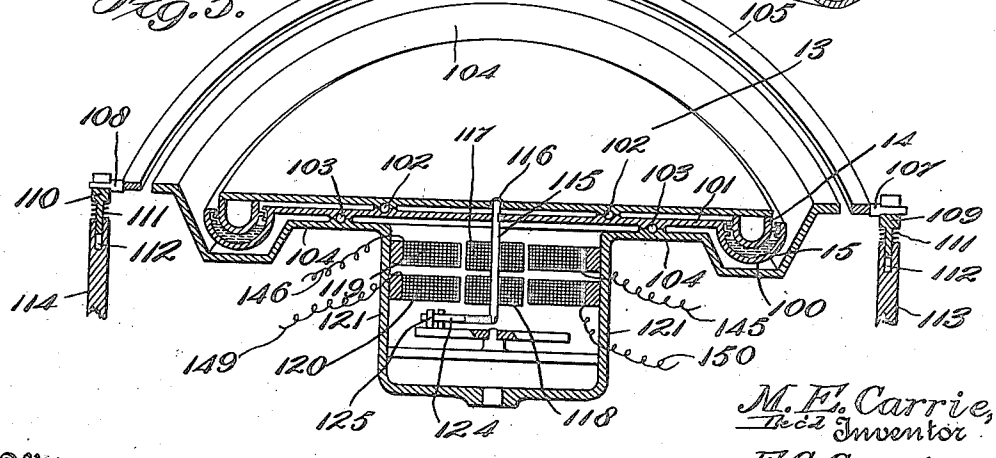


Fig. 5.



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1,253,574.

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3 SHEETS—SHEET 3.

Fig. 8.

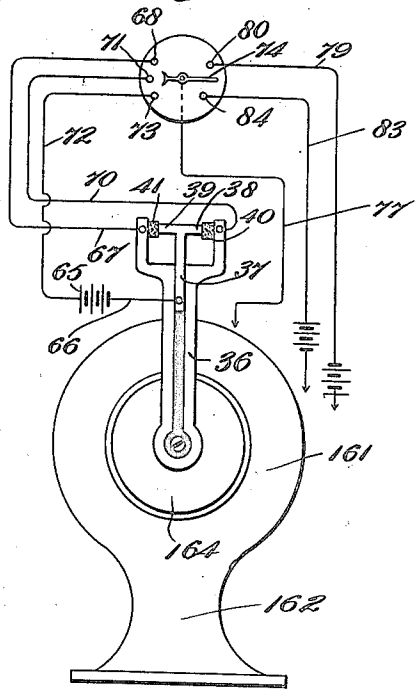


Fig. 7.

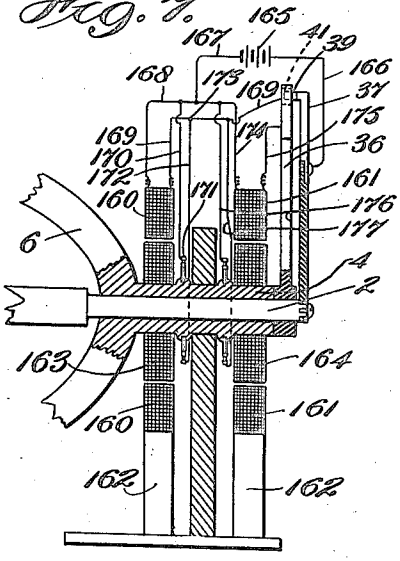
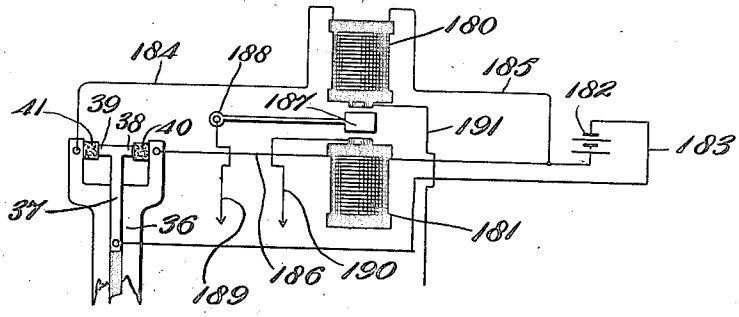


Fig. 9.



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MERVYN EDWARD CARRIE, DECEASED, LATE OF PHILADELPHIA, PENNSYLVANIA, BY FRANKLIN G. CARRIE, ADMINISTRATOR, OF NEW YORK, N. Y.

GYROSCOPIC COMPASS.

1,253,574. Specification of Letters Patent. Patented Jan. 15, 1918.

Original application filed March 24, 1903, Serial No. 149,400. Divided and this application filed January 2, 1915. Serial No. 266.

To all whom it may concern:

Be it known that MERVYN EDWARD CARRIE, late a citizen of the United States, and a resident of Philadelphia, Pennsylvania, deceased, did invent certain new and useful Improvements in Gyroscopic Compasses, of which the following is a specification.

This invention relates to gyroscopic compasses and has for one of its objects to provide a mechanism which will be more efficient in action, while comparatively less expensive to construct, than those heretofore proposed.

With these and other objects in view, the invention consists in the novel details of construction and combinations of parts more fully hereinafter disclosed and particularly pointed out in the claims.

This application is a division of the prior application, Serial Number 149400, filed March 24, 1903 and entitled Method and mechanism for indicating and registering latitude and longitude.

Referring to the accompanying drawings forming a part of this specification in which like numerals designate like parts in all the views:

Figure 1 is a part longitudinal sectional and part side elevational view of an apparatus made in accordance with the invention;

Fig. 2 is a part transverse sectional part plan view of the mechanism shown in Fig. 1 with certain parts omitted;

Fig. 3 is a detail view of a dial and pointer for adjusting the gyroscope frame;

Fig. 4 is a part diagrammatic and part end view of a portion of the controlling apparatus illustrated on the right in Fig. 1;

Fig. 5 is a part perspective part sectional view of the supporting table and attachments;

Fig. 6 is a detail perspective view, partly in section, of a portion of the parts shown in Fig. 5, and illustrating a pair of contacts;

Fig. 7 is a vertical sectional view of a modified form of controlling device;

Fig. 8 is a diagrammatic view of a still further modified form of controlling apparatus; and

Fig. 9 is yet another modified form of controlling devices, Fig. 10 is a diagrammatic partly sectional view of the lower portion of the gyroscopic apparatus illustrated in Fig. 1 and showing the circuits.

1 represents a balanced frame, provided with the short shafts, or arbors, 2 and 3, which pass through or are received in the hollow stub shafts 4 and 5 respectively of a second frame 6. The said hollow shafts 4 and 5 are in turn journaled in the bearings 7 and 8 respectively carried by the supports or standards 9 and 10, mounted on the brackets 11, carried by the supporting table 13, provided with the hollow float 14 supported on the mercury 15, all as will be more fully disclosed below.

The supporting frame 1 is or may be substantially rectangular in form and provided with the oblong comparatively narrow portion 16 and the comparatively larger portion 17.

In the portion 16 of the frame 1, is pivotally mounted as on the axis 19, a gyroscopic disk 18, and 20 represents a suitable motor for rotating said disk 18. In the portion 17 of said frame 1 is mounted a third frame 21, having the hollow short stub shafts 22 and 23 journaled to turn in said portion 17 of said frame 1, as will be clear from Fig. 2. Pivotally mounted to turn relatively to said hollow shafts 22 and 23 are respectively the pivots 24 and 25 of a fourth frame 26. Carried by said fourth frame 26 and moving therewith is a motor 27, and adapted to turn as on the shaft 28 is a second gyroscopic disk 29.

It is well known from the properties of a rapidly rotating gyroscopic disk that if its supports are free to turn under, or with reference to it, that when once set in rapid rotation in a given plane, it will tend to maintain its position in said plane, and will resist with considerable force any sudden efforts to displace it from that plane. In other words, it will now be clear that if the disks 18 and 29 be set in rapid rotation through their motors 20 and 27, and the shaft or axis 19 be pointed true north while the shaft or axis 28 is pointed true east and west, then, since the supports of the parts are free to turn relatively to said disks, these said shafts or axes will experience a strong tendency to maintain their original orientation. even though the supports are moved or turned in various ways, or are carried over the face of the earth.

But, more or less friction between the various bearing surfaces is inevitable and unless this friction is compensated for, errors will arise as will now be pointed out.

For example, in order to fix the idea, suppose the rotating disk 18 is in the plane of the equator, with its axis 19 pointing true north and south, while the rotating disk 29 is in the plane of the meridian with its axis 28 pointing true east and west, and the disks be carried true north along the meridian, while the standards 9 and 10 are free to assume a perpendicular or vertical position at each new place arrived at. It is evident that the disk 18 and shaft 19 will tend strongly to remain in planes respectively parallel to their original planes, while the bearings 7 and 8 rotate or move around the hollow shafts 4 and 5. It is further evident if the disk 29 be carried true east or west the bearings in the frame 1 of the hollow shafts 22 and 23 will rotate around said hollow shafts, and in both cases a certain amount of friction must be engendered. It likewise follows if the instrument be carried over the earth's surface to any point which will cause a change in both its latitude and longitude, friction will accordingly be generated between the hollow shafts 4 and 5 and their bearings as well as between the hollow shafts 22 and 23 and their bearings.

In order to compensate for this friction the following mechanism is provided:— Rigid with the hollow shaft 4 is the arm or fork 36 Fig. 4, as well as the disk or wheel 35; and rigid with the arbor or shaft 2, but insulated therefrom is the contact arm 37 having the contacts 38 and 39 adapted to close circuit with the carbon buttons 40 and 41 respectively carried by the fork 36, so that a current will flow across the contacts 38 and 40, or 39 and 41 within limits according to the pressure exerted. all as is well known.

A suitable motor 42 Fig. 1 is supported on the bracket 43 rigid with the standard 9 and is provided with a shaft 44 having a universal joint 45, to give a flexible action to said shaft. Two magnets 46 and 47 are located between the motor 42 and the wheel 35, and an armature 48 is elastically supported on a suitable frame over the magnet 46, and the shaft 44 is passed through or attached to said armature, and extended toward said wheel 35. 50 represents a slotted support through which said shaft passes, and 51 is a stop pin to limit its upward movement. The end of said shaft 44 nearest the wheel 35, is provided with a friction wheel 52, which under certain conditions engages with a friction wheel 53 mounted on a shaft 54 which is supported in suitable standards 55. On the end of said shaft 54 is another friction wheel 56, which is always engaged with the wheel 35 rigid with the hollow shaft 4.

57 represents another armature Fig. 4, associated with the magnet 47, 58 represents a frame or bracket and 59 an angular member pivoted at 60 to said bracket and carrying said armature 57. A friction wheel 61 is carried by the member 59, which under certain conditions disclosed below, is also brought into contact with the wheel 53, as well as with the wheel 52.

65 represents a battery or other source of current, 66 a wire leading from one pole of said battery to said arm 37, 67 a wire leading from the carbon button 41 to the post 68 of the differential galvanometer 69, 70 a wire leading from the other carbon button 40 to the post 71 of said galvanometer, and 72 is a wire leading from the other pole of said battery to the post 73 of said galvanometer 69.

74 represents the needle of the galvanometer pivoted at 75, and leading from said pivot to one pole of another battery 76 is the wire 77: Leading from the other pole of said battery 76 is the wire 78 joined to the coils of the magnet 47, from which leads the wire 79 back to the contact 80 on the galvanometer 69. Joined to the wire 78 as at the point 81 is the wire 82 connected with the coils of the magnet 46 from which leads the wire 83 joined to the contact 84 on the galvanometer 69. The post 68 is connected with one coil of the galvanometer, the post 71 to the other coil thereof, while the post 73 is connected to a common return for the two coils.

In order to render the operation clear so far as has now been disclosed we may assume the instrument is on the equator with the latitude frame 6 and disk 18 in a vertical plane and the shaft or axis 19 pointing true north and south. We may also assume that the longitude frame 21 and disk 29 are in a vertical plane with the axis or shaft 28 pointing true east and west. We will also assume that there are pendulous weights as motors, etc., to be disclosed below, which will keep the supporting table 13 always in a horizontal plane, and the standards 9 and 10 always in a vertical plane as the instrument is carried from place to place.

The parts being positioned as stated, and the disk 18 given a rapid rotation, let us suppose the instrument is carried true north or south while the disk 29 is not rotating. The disk 18 and shaft 19 as well as the frame 1 will remain parallel to their original planes, while the curvature of the earth and pendulous weights serving to keep the standards 9 and 10 always in a vertical plane, will cause the bearings 7 and 8 on said standards to rotate or move around or relatively to the stationary shafts 2 and 3 of the frame 1. This relative movement due to the

earth's curvature will cause a certain amount of friction between the inner surfaces of the bearings 7 and 8 and the outer surfaces of the hollow shafts 4 and 5, and this friction will tend to turn said shafts and latitude frame 6 in the same direction as said standards 9 and 10, are being turned as the earth's surface is traversed. Let us suppose the turning of said shaft 4 by said friction is in a clockwise direction as viewed in Fig. 4. Then the disk or wheel 35 and frame 36 will be very slightly turned in a clockwise direction as seen in said figure, and an increased pressure will be exerted between the contacts 39 and 41 because the member 37 tends to remain stationary. It follows that an increased current will flow from battery 65 along wire 66, across contacts 39 and 41, along wire 67 to post 68, through one of the coils of galvanometer 69, to post 73 and over wire 72 back to battery 65. This increased current through one of the coils of the galvanometer will deflect the needle 74 and cause it to close the circuit at say, contact 84 on said galvanometer. Current will now flow from battery 76 over wire 77 to pivot 75, over needle 74 to contact 84, wire 83, through the coils of magnet 46, and over wire 82 back to battery 76, thus energizing magnet 46 and causing the armature 48 to be attracted. The attraction of the armature 48, will cause the wheel 52 on the shaft 44 to contact with the wheel 53, and as the motor 42 is constantly running and therefore turning said wheel 52, the wheel 53 will be rotated along with its shaft 54 as well as the wheel 56. The rotation of the wheel 56 will turn the wheel 35. The direction of rotation of the motor is such that the wheel 35 will be, in this instance, rotated in a counter clockwise direction, so that the pressure between the contacts 39 and 41 will be relieved and the circuit broken at the contact 84. The movement of the parts 39 and 41 is exceedingly minute in the first instance, and the circuit is automatically decreased when the same movement is had in the opposite direction, so that any tendency to turn the arbor 2, and disk 18 by friction engendered in the manner disclosed is automatically counteracted, when the motion is in the direction assumed.

Should the motion be in the opposite direction, or should there be a tendency to turn the wheel 35 in a counter clockwise direction as seen in Fig. 4, then the pressure between the contacts 38 and 40 will be increased, current will flow along wire 66 across said contacts over wire 70 to post 71, through the other coil of the galvanometer and by way of post 73 and wire 72 back to battery 65. The needle 74 will now make circuit with contact 80 and current will flow from battery 76 over wire 77, needle 74, wire 79 to and through coils of magnet 47 and over wire 78 back to battery 76. The magnet 47 being energized, armature 57 will be drawn down, carrying wheel 61 into contact with the motor driven wheel 52, and also into contact with wheel 53, thus causing the latter to turn in a direction opposite to its previously described rotation and also causing the wheels 56 and 35 to be turned in directions opposite to those previously described. In other words the pressure between the contacts 38 and 40 will be immediately released and the curent broken at the contact 80, while the shaft 4 and latitude frame 6 will receive a slight turn in a direction opposite to and equal to the turn it had received through the friction due to the turning of the standards 9 and 10.

When using this instrument as a gyroscopic compass, it is not necessary to rotate the disk 29, and therefore the circuits to the motor 27 are usually broken. The said disk 29, however, as fully disclosed in the parent application above is necessary when the instrument is to be used as a latitude and longitude indicator. Accordingly the friction compensating mechanism disclosed above is duplicated in connection with the shaft 25 and the hollow shaft 23, all as will be clear from the said parent application above. Further when using the instrument as a latitude and longitude indicator, the shaft 3 is provided with a hand or pointer 90 contacting with the pins 91 on the wheel 92 mounted on the standard 93 supporting the driving shaft 94 operated by the motor 95, all as will likewise be clear from the said application above. Further the mechanism consisting of the parts lettered from 90 to 95 just mentioned are duplicated in connection with the shaft 24, and hollow shaft 22 associated with the disk 29, as is disclosed in said parent application. That is to say an arm 96 contacting with pins 97 carried by a wheel 98 are associated with said shafts 22 and 24 and they serve to aid in the indications of longitude as will be clear from said parent application. Such indicating mechanisms however associated with the disks 18 and 29 form no part of the present invention and therefore will not be further disclosed in this case.

Coming now to the table for supporting the gyroscopic wheels 18 and 29 and their associated frames, Fig. 5 best illustrates the said table 13 and its associated parts consisting of the float 14, the mercury 15, the trough 100 carried by the second table or base 101 provided with the ball sets 102 on which said table 13 rests, and itself resting on the ball sets 103 carried by the frame 104, pivoted at diametrically opposite points to the ring 105. One of said pivoted points is indicated at 106 in Fig. 5, and the ring 105 is in turn pivoted on diametrically located knife edges 107 and 108 to the verti-

cal supports 109 and 110 respectively, while each of said supports 109 and 110 is provided with spring cushioned means 111 mounted to move up and down in the recesses 112 with which the deck supports 113 and 114 are provided.

115 represents a short shaft fast to the base 101 and on the upper end of which the table 13 rests as by means of the pivot 116 so as to allow said table 13 to revolve freely with reference to the table or base 101, and substantially without friction.

The shaft 115 has wound on its portion extending beneath the base 101, two armatures 117 and 118 respectively located within the magnetic fields of the coils 119 and 120, carried by the lower or bell shaped portion 121 of the frame. The rotary motors formed by the coils 117, 119 and 118, 120 are for the purpose of rotating the shaft 115 in opposite directions from time to time for a purpose that will presently appear.

The lower end of the shaft 115 carries a contact arm 124 insulated from said shaft as shown, and adapted to close circuits not shown at the contacts 125 for indicating changes in azimuth, all as will be clear from the said parent application Number 149400, but which circuits form no part of the present invention.

From the bottom or underside of the bell shaped extension 121, extends another shaft 130, and carried by this shaft are two heavy gyroscopic disks 131 and 132 arranged in horizontal positions, and adapted to be rotated in opposite directions by the motors 133, and 134 operatively connected with circuits not shown.

These said gyroscopic disks serve to yieldingly maintain the table 13 always in a horizontal plane. It is pertinent to remark that a gyroscope retains its plane of rotation only when freely suspended and free from outwardly impressed mechanical disturbances which, of course implies that the line passing through its points of suspension shall also pass through its center of gravity. These conditions are true of the latitude and longitude gyroscopic disks above but are not true of the gyroscopes suspended beneath the table, and well below the center of gravity of the table and the apparatus upon it. Inasmuch as these lower gyroscopes have weight they act as any other dead weight would act in preserving the horizontality of the table. In addition to this they resist swaying disturbances to the table caused by sudden shocks from the rolling or pitching of the vessel, the vibrations of the engine, etc., as dead weight would not do; for a gyroscope will violently resist any sudden effort to change its place of rotation while it yields perfectly to any gradually impressed force. It is this last mentioned property of yielding to gradually impressed force (in this case gravity) that allows the disks 131 and 132 to hang vertically and in no way interfere with the change of plane of the table 13 owing to the curvature of the earth, and to changes in latitude and longitude.

As stated above there will be errors of the instrument due to the friction generated between the bearings 7 and 8 and the short shafts 4 and 5, as it is carried over the earth's surface, unless said friction is compensated for by turning said shafts 4 and 5 in a direction opposite to the turning of the said bearings. In the same way, there will be errors of the instrument due to the friction generated between the supporting members of the table 13, as the ship turns in azimuth, unless said last named friction is also compensated for.

This last named friction due to the turning of the instrument in azimuth is compensated for as follows: The table 13 is provided with a suitable insulated contact 140 which is located between the two companion insulated contacts 141 and 142 carried by the mercury trough 100 as is best shown in Fig. 6. Leading from the contact 140 is the wire 143 joined to the battery 144, Fig. 10, from which leads the wire 145 to the coils 119 of the rotor 117 and from said coil 119 leads the wire 146 to the contact 142. From the contact 140 also leads the wire 147 to the battery 148 from which leads the wire 149 to the coil 120 of the rotor 118 and from the coil 120 leads the wire 150 back to the contact 141, all as will be clear from Fig. 10.

It follows from the construction just disclosed that should the supports 113 and 114 be turned in azimuth, a like motion of course would be imparted through the knife edges 107 to the ring 105, which through the pivots 106 would turn the frame 104 in azimuth, as well as the ball sets 103. A certain amount of friction would be generated between the said ball sets 103 and the base of second table 101, which would have a tendency to turn the ball sets 102 in azimuth. A certain amount of friction would further be generated between the ball sets 102 and the table 13, which would have a further tendency to turn the said table 13 and contact 140 in azimuth, but of course the tendency to turn the table 13 would be less than the tendency to turn the second table 101 and trough 100, so that there would be a greater or less pressure exerted between the contact 140 and one or the other of the contacts 141 and 142, whenever a sufficient turning movement of the instrument in azimuth is had. When said contact 140 makes circuit with one of the contacts carried by the trough 100 as for example when it makes circuit with the contact 141, then current flows from the battery 148 along the wire 149 through the coils of the

field 120 out of said coils and along the wire 150 to said contact 141 from said contact 141 to the contact 140 and along the wire 147 back to the battery 148, thus causing the rotor 118 to turn the shaft 115 in such a direction as will turn the table 13 in a direction opposite to the original direction in which the above mentioned friction turned it, and cause the circuit to be made between the contacts 140 and 141. The turning of the table 13 in azimuth to correct the error due to friction, will also cause the current to be broken at the contacts 140 and 141, and will thereupon leave the said table oriented in its original position. Now should friction between the parts due to a turning of the instrument in azimuth cause the contacts 140 and 142 to close circuit through the battery 144, current from said battery will flow along the wire 145 through the coils 119 along the wire 146 across said contacts 142 and 140 and along the wire 143 back to the battery 144. The rotor 117 will now turn the shaft 115 and the table 13 in an opposite direction and sufficiently to break the circuit between the contacts 140 and 142, thus again leaving the table oriented in its original position. The above action or correction due to friction will take place so long as the instrument is turned in azimuth and the effect will be to leave the table 13 oriented in its original position, thus insuring that the shaft 19 will be left pointing in its original direction.

In other words, it will now be clear that errors due to friction caused by turning the instrument in azimuth will be corrected in a manner entirely similar and practically the same as are the errors due to friction that is caused by the curvature of the earth when the instrument is carried from place to place.

In Fig. 7 of the drawings, is illustrated a modified form of mechanism for taking the place of the friction compensating mechanism disclosed in Figs. 1 and 4, and whereby the movement of the hollow shaft 4 in opposite directions may be effected. In this figure two electrical motors are shown comprising stationary field coils 160 and 161 secured to the frame 162 and surrounding the rotors 163 and 164, sustained by the shaft or bearing 4 and rigid therewith. To the outer end of said shaft 4 and insulated therefrom, is connected the fork or frame 36 as in Fig. 4, and to the outer end of the shaft or arbor 2 is an arm 37 also insulated from said shaft 2 as is the case in Fig. 4. The said frame 36 is further provided with carbon buttons 40 and 41 and the said arm 37 is provided with the contacts 38 and 39 not shown in Fig. 7, but plainly shown in Fig. 4, as well as in Fig. 8. A battery 165 is provided from which leads the wire 166 to the arm 37, and from which also leads the wire 167 connected to the wire 168 leading to the field coil 160, from which leads the wire 169 back to a carbon button such as 41 carried by the fork 36. It therefore follows that should the arm 37 through one of its contacts such for example as 39 make contact with the carbon button 41, current will flow from the battery 165 through the wire 166 to the arm 37 to the contact 39 to the carbon button 41, along the wire 169, through the coil 160, along the wire 168, to the wire 167 and back to the battery 165. Current thus exciting the coil 160, will cause the rotor 163 to turn the shaft 4, provided current is also furnished to said rotor 163. Current is furnished by the same contacts 39 and 41 to the rotor 163 as follows: Leading from the wire 168 is the wire 170 to the contact rings 171 carried by the shaft 4, and from which a connection is had to the rotor 163 by wires not shown. Current is led from the rotor 163 by the wire 172 which joins the wire 169 as at the point 173. In the same way the wire 174 connected to the wire 167 carries current to the coil 161 and the wire 175 carries current from said coil 161 to the other carbon button 40 not shown in Fig. 7, but which is carried by the fork 36. It thus happens that when the other contact 38 not shown in Fig. 7, but which is carried by the arm 37 makes circuit with the said carbon button 40 not shown in Fig. 7, current will flow through the contacts 38 and 40 along the wire 175 through the coil 161 along the wire 174, and along the wire 167 back to the battery 165, while wire 177 joined to wire 169 and wire 176 joined to wire 174 will supply current to the rotor 164, and therefore when circuit is made between the contacts 38 and 40 not shown in Fig. 7, the rotor 164 will also cause the shaft 4 to be turned. The winding is such in the two motors that the shaft 4 is turned in one direction when contact is made with one carbon button 41 and is turned in an opposite direction when contact is made with the other carbon button 40. In fact the structure disclosed in Fig. 7 is very similar to and practically identical with the construction illustrated in Figs. 5, 6 and 10 for rotating the shaft 115 in opposite directions.

In the further modified form of the invention illustrated in Fig. 8, the construction is substantially the same as that shown in Fig. 7, but only one motor need be used, and the galvanometer illustrated in Fig. 4 is utilized. This mechanism not being specifically claimed in this application, it is not deemed necessary to further describe the same.

In the still further modified form of the invention illustrated in Fig. 9, no galvanometer at all need be used. In this figure a fork 36, contact arm 37, contacts 38, 39 and carbon buttons 40 and 41 are employed as in

the preceding figures. Electromagnets 180 and 181 are also employed as well as a battery 182. From the battery 182 leads the wire 183 to the arm 37 and from the carbon button 41 leads the wire 184 to the magnet 180 from the coils of which leads the wire 185 back to the battery 182. From the carbon button 40 leads the wire 186 to the coils of magnet 181 and back to the battery 182. An armature 187 pivoted as at 188 is located between the magnets 180 and 181, and from the pivot 188 leads the wire 189. From one pole of the magnet 181 leads the wire 190, and from one pole of the magnet 180 leads the wire 191. The circuits are formed in the same manner as is the case when a galvanometer is used and need not be further disclosed.

In order to conveniently adjust the gyroscope frame 1, the pointer 195 rigid with the arbor 3 is provided and a dial 196 rigid with the bearing 8 or standard 10 is associated with the pointer. By means of said dial and pointer, the plane of the wheel or disk 18 may be inclined toward the equator at an angle to the vertical equal to the latitude of the place, when changes in latitude will be indicated, or it may be set at any other desired angle.

It will now be clear that by setting the disk 18 in any predetermined plane, and pointing the axis 19 of said disk true north and south, the friction compensating mechanism disclosed in connection with Figs. 4, 7, 8, 9 and 10 will compensate for that friction generated between the bearings not only when the instrument is carried from place to place over the earth's surface, but also whenever the axis 19 is being turned in azimuth for any cause at all. It will also be clear that the oppositely rotating gyroscopes 131 and 132 will maintain the table 13 horizontal, notwithstanding the rolling and pitching motions of the ship, and therefore, it follows if a suitable compass card or other index is provided, and the wheel 18 kept rotating, a gyroscopic compass results.

It is obvious that those skilled in the art may vary the details of construction as well as the arrangement of parts without departing from the spirit of the invention and therefore the invention covered is not to be limited to the above disclosure except as may be required by the claims.

What is claimed is:—

1. In a gyroscopic device for indicating the true north, the combination of a gyroscopic disk; a support for said disk; a bearing for said support adapted to turn relative to said support when said disk is moved over the earth's surface; and means for compensating for the error due to the friction generated by the said turning of said bearing, substantially as described.

2. In a gyroscopic device for indicating the true north and south points, the combination of a gyroscopic disk; means to set said disk in a predetermined plane; a support for said disk; a bearing for said support adapted to be turned relative to said support upon changes in latitude; and automatic means for compensating for the error due to any friction that may be generated between said support and bearing by said turning movements, substantially as described.

3. In a gyroscopic device for indicating the true north the combination of a gyroscopic disk; a support for said disk comprising a frame; a second frame having a bearing for said support adapted to turn relative to said support when said disk is moved over the earth's surface; and means for compensating for the error due to the friction generated by the said turning of said bearing, substantially as described.

4. In a gyroscopic device for indicating the true north and south points, the combination of a gyroscopic disk; means to set said disk in a predetermined plane; a support for said disk comprising a frame; a second frame having a bearing for said support adapted to be turned relative to said support upon changes in latitude; and automatic means for compensating for the error due to any friction that may be generated between said support and bearing by said turning movements, substantially as described.

5. In a gyroscopic device for indicating the true north, the combination of a gyroscopic disk; a motor for rotating the same; a frame having a support associated with said disk; a bearing adapted to turn relatively to said support as said device is moved over the earth's surface; and a motor associated with said bearing to move the same and to compensate for the error due to any friction that may be generated by said turning motion, substantially as described.

6. In a gyroscopic device for indicating the true north, the combination of a gyroscopic disk; an electric motor for rotating the same; a frame having a support associated with said disk; a bearing adapted to turn relatively to said support as said device is moved over the earth's surface; an electric motor and connections associated with said bearing to move the same and to compensate for any error due to any friction that may be generated by said turning motion; and a pendulous weight associated with said disk and bearing, substantially as described.

7. In a gyroscopic device for indicating the true north the combination of a gyroscopic disk; a support for the said disk; a bearing adapted to turn about said support; means for compensating for the error due

to the friction generated between said bearing and support; and a pendulous weight whose center of gravity is located below said support, substantially as described.

8. In a gyroscopic device for indicating the true north, the combination of a gyroscopic disk; means for supporting said disk; a bearing for said supporting means adapted to turn in asimuth; and means for compensating for the error due to the friction generated by the said turning of said bearing in azimuth, substantially as described.

9. In a gyroscopic device for indicating the true north the combination of a gyroscopic disk adapted to turn in azimuth; means to set said disk in a predetermined plane; a support for said disk; a bearing for said support; and automatic means for compensating for the error due to the friction generated when said disk or bearing is turned relatively to each other, substantially as described.

10. In a gyroscopic device for indicating the true north, the combination of a gyroscopic disk; means for supporting said disk; a bearing for said supporting means adapted to turn in azimuth; means for compensating for the error due to the friction generated by the said turning of said bearing in azimuth; and a pendulous weight associated with said bearing, substantially as described.

11. In a gyroscopic compass for use on a moving ship, the combination of a gyroscopic disk; means associated with said disk for indicating the true north; pendulous supporting means for said disk adapted to automatically assume a normal fixed position relative to the horizontal plane as the vessel moves over the earth's surface; and means comprising a gyroscopic device tending to prevent said supporting means from being moved out of its normal position by the rolling and pitching movements of the vessel, substantially as described.

12. In a gyroscopic compass for use on a moving ship, the combination of a gyroscopic disk; supporting means for said disk comprising a member adapted to automatically assume a fixed position relative to the horizontal plane as the ship moves over the earth's surface; and means comprising a gyroscopic apparatus associated with said member tending to prevent said member from being moved out of its said assumed position by the rolling and pitching movements of the ship, substantially as described.

13. In a gyroscopic compass for use on a moving ship, the combination of a gyroscopic disk; supporting means for said disk comprising friction generating parts and a member adapted to automatically assume a vertical position as the ship moves over the earth's surface; means associated with said parts adapted to automatically correct compass errors due to the friction generated; and a stabilizing gyroscopic device associated with said member tending to prevent said member from being moved out of its vertical position by the rolling and pitching movements of the vessel, substantially as described.

14. In a gyroscopic compass for use on a moving ship, the combination of a gyroscopic disk; supporting means for said disk comprising parts adapted to generate friction as the ship moves in azimuth and a member adapted to automatically assume a horizontal position as the ship moves over the earth's surface; means for automatically compensating for the friction generated during said movements in azimuth; and means comprising a gyroscopic apparatus associated with said member tending to prevent said member from being moved out of its said assumed position by the rolling and pitching movements of the ship, substantially as described.

15. In a gyroscopic compass for use on a moving ship, the combination of a plurality of gyroscopic disks; means for indicating the true north associated with one of said disks; a supporting means for said disks comprising friction generating parts as the ship changes its position; means for automatically compensating for compass errors due to the friction generated by said parts; and gyroscopic means for preventing compass errors due to the rolling and pitching movements of the ship, substantially as described.

In testimony whereof I herewith affix my signature in the presence of two witnesses.

FRANKLIN G. CARRIE,
Administrator of Mervyn Edward Carrie, deceased.

Witnesses:
THOMAS C. FRY,
T. A. WITHERSPOON.