Feb. 14, 1956 P. CHRISTOPH 2,734,280

GYRO-COMPASSES

Filed July 1, 1952 2 Sheets-Sheet 1

Fig. 1

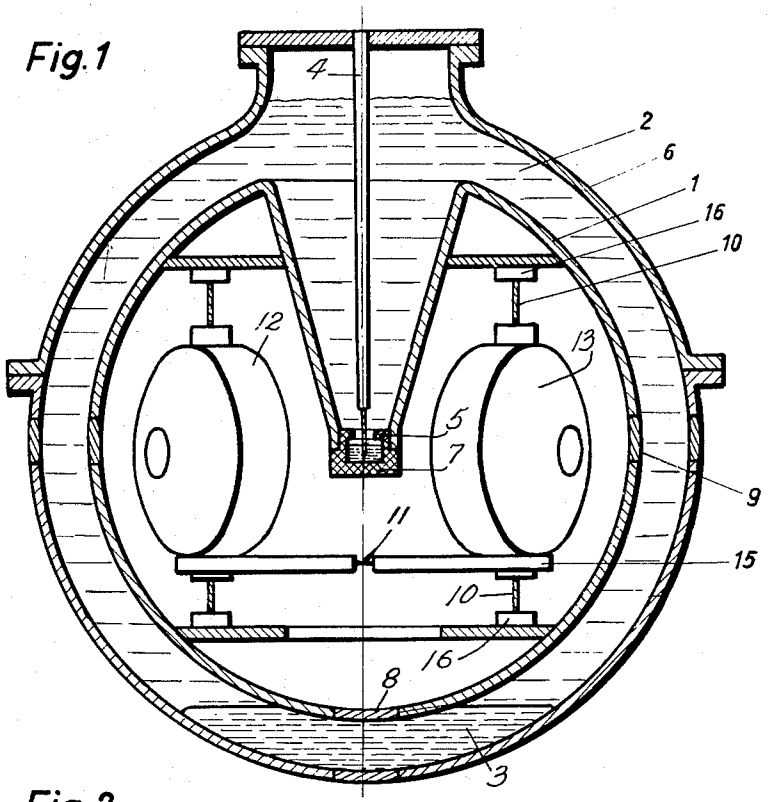
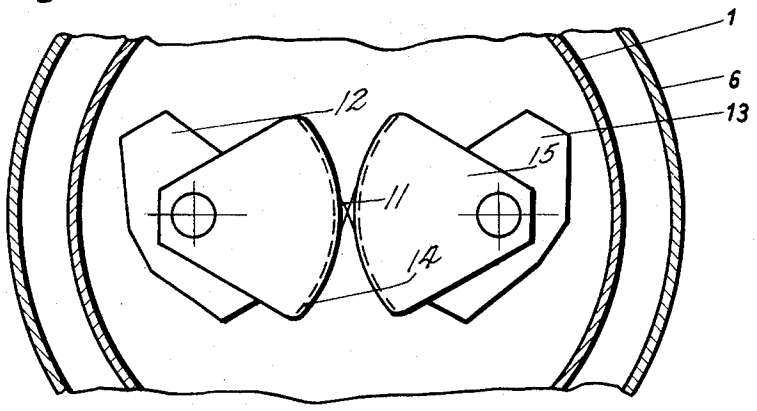


Fig. 2



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Fig. 3

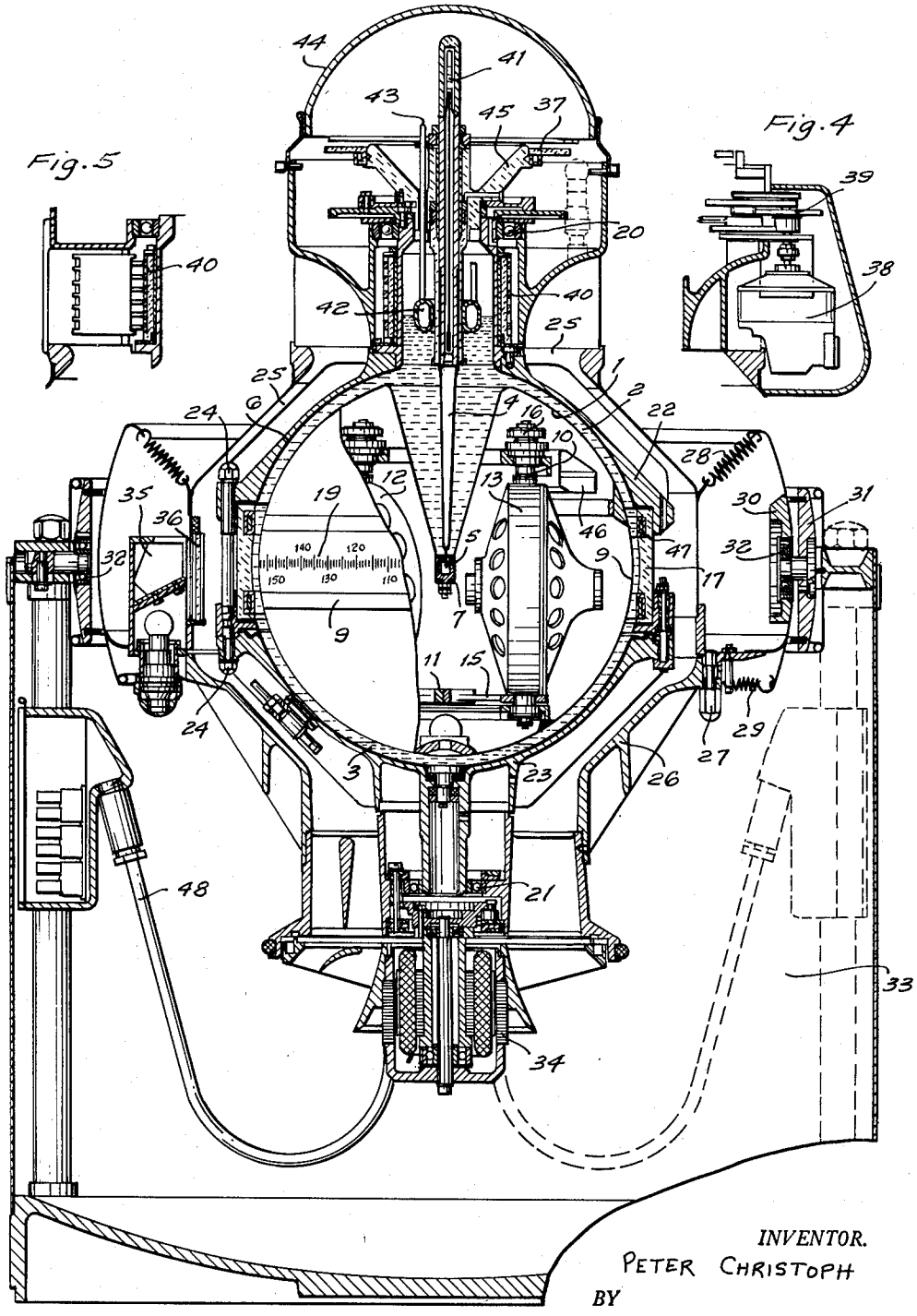


Fig. 4

Fig. 5

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GYRO-COMPASSES

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10 Claims. (Cl. 33—226)

The present invention relates to gyro-compasses.

In known gyro-compasses of the Anschuetz type, it is necessary to maintain the temperature about the gyro-compass system within a range of ±2° C. for an efficient operation of the compass. The temperature regulation is carried out by means of a water cooling system associated with a temperature-controlled throttling device. When the cooling system fails or operates imperfectly, great errors arise in the direction indication obtained from such compasses.

In addition to the above mentioned disadvantages of the water cooling system, further disadvantages of the above type of compass arise from the bearing supports of the two gyroscopes of the Anschuetz type gyro-compass and the linkage interconnecting these gyroscopes. Undue friction or play in the gyroscope bearings and in the bearings of the linkage results in great errors in the direction indication of the gyro-compass. The precision of these compasses resides in the quality of the ball-bearings used in the same.

In the above described Anschuetz type gyro-compass, the north seeking system comprises a pair of gyroscopes located within a hollow spherical housing which floats in a liquid bath. The support of this spherical housing in the liquid is obtained for most part by the buoyancy produced by the liquid weight displaced by the spherical housing, and the rest of the lifting force which maintains the spherical housing surrounded by the liquid is obtained from electromagnetic forces derived from a coil located beneath the spherical housing and automatically working to maintain the spherical housing in a central position within the liquid bath. If the temperature of the liquid surrounding the spherical housing varies beyond a range of ±2° C., the specific gravity of the carrying liquid changes sufficiently to change its buoyant force by an amount sufficient to cause the centering coil to operate improperly, and that is why it is so important to regulate the temperature of the carrying liquid.

One of the objects of the present invention is to overcome the above-mentioned defects by providing a gyro-compass system which functions at high efficiency without any temperature control.

A further object of the present invention is to provide a gyro-compass system which does not require any centering coil as described above.

Yet another object of the present invention is to provide a gyro-compass which does not require any ball bearings as described above.

Still another object of the present invention is to provide a gyro-compass system of the above type in which the housing for the gyroscopes will be free to turn with a minimum of frictional dragging.

With the above objects in view, the present invention mainly consists of a direction indicating apparatus having a container in which a relatively small quantity of a first liquid, such as mercury, is located, this first liquid only partly filling the container and having a top surface. A second liquid which is immiscible with this first liquid

and of a lower specific gravity than the same, such as water for example, is located within the container on the top surface of the first liquid. Within the container and beneath the top surface of this second liquid there is located a gyro-compass system which floats on the separating surface between the two immiscible liquids and extends only a slight distance into the heavier of the liquids to minimize friction and surface tension effects. This gyro-compass system comprises a hollow spherical housing in which a pair of spaced gyroscopes are located, each of these gyroscopes being supported by at least one pair of wires extending from opposite parts of each gyroscope along a predetermined axis and being mounted within the housing to be maintained at a predetermined tension so that the gyroscopes may turn about these axes along which the pairs of wires respectively extend by twisting of the wires. The axes along which the pairs of wires respectively extend are parallel to each other, and in a plane substantially perpendicular to these axes there are located a pair of crossed wires each of which is connected at opposite ends to said gyroscopes, respectively, so as to interconnect said gyroscopes for simultaneous turning movement about said axes by the same amount and in opposite directions.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic, elevational sectional view of a gyro-compass constructed in accordance with the present invention;

Fig. 2 is a sectional plan view of the structure of Figure 1, taken just below a pair of gyroscopes of Fig. 1 and diagrammatically showing how these gyroscopes are interconnected;

Fig. 3 is a partly sectional elevational view illustrating a practical embodiment of a gyro-compass to which the structure diagrammatically illustrated in Figures 1 and 2 is applied;

Fig. 4 is a fragmentary sectional view of a detail of the structure of Fig. 3; and

Fig. 5 is a fragmentary sectional view of still another detail of the structure of Fig. 3.

Referring now to the drawings, and in particular to Figure 1 thereof, it will be seen that a spherical gyroscope housing 1 is freely suspended in two immiscible liquids 2 and 3 of different specific gravities, for example water and mercury. The spherical housing 1 floats on the separating surface between these immiscible liquids. By using mercury as the lower liquid, the parts can be arranged, by proper design of the spherical housing 1 and the parts located therein and by proper choice of the specific gravity of the liquid 2, in such way that the spherical housing 1 extends only a slight distance into the mercury 3 so that friction and surface tension effects only have a very small influence on the operation of the gyro-compass.

Lateral movement of the housing 1 is limited as shown by a centering shaft 4 which extends down substantially to the center of the spherical housing 1 through a funnel-shaped indentation formed in the upper part of the spherical housing 1, this funnel-shaped indentation being provided with a plate 5 having a central aperture through which the bottom end of shaft 4 extends with clearance to a point spaced as shown from the bottom of the indentation to cooperate with said plate for centering the spherical housing 1. Thus, plate 5 forms a means surrounding the rigid member 4 with clearance for limiting

the lateral movement of housing 1 with respect to the rigid member 4. The centering shaft 4 is fastened to the top of an outer spherical container 6 in which the liquids 2 and 3 are located together with the spherical housing 1. Thus, the north seeking gyro-compass system can turn freely in all directions about the center of the spherical housing 1 and can move upwardly with respect to the same.

The centering shaft 4 is insulated over all of its length except the lowermost part thereof so that this centering shaft 4 may serve as an electrode for one phase of the current fed to the gyroscopes, this bottom end of the centering shaft 4 being located within a mercury bath 7 located in the bottom of the funnel-shaped indentation of spherical housing 1 beneath the centering plate 5. The two other phases of the three-phase current for the gyroscopes are transferred directly through the immiscible liquids 2 and 3, the latter being chosen from electrically conductive materials such as mercury to carry current from a contact at the bottom of outer container 6 to a contact 8 at the bottom of the spherical housing 1. An acidulated water is chosen for the liquid 2 so that it acts as a conductor to carry current from an outer ring on the container 6 to an inner ring 9 located in the center of the spherical housing 1 and serving as an electrical conductor for the third phase of the current. By eliminating the above-discussed centering coil and by conducting the top and bottom phases of the gyroscope current through metallic conductors without electrolytic loss, the electrical power required to operate the gyroscopes is greatly reduced.

The above-described novel arrangement for suspending the gyro-compass housing 1 produces great advantages over the old constructions because all devices for cooling the carrying liquid are eliminated, maintenance costs are diminished, the operation is simplified, and the master compass itself may be considerably smaller than has thus far been the case. Because of the lower energy requirement of the gyro-compass, the converter for producing the current to operate the gyro-compass may be made appreciably smaller.

In order to eliminate rolling errors, it is known to interconnect two gyroscopes whose housings are free to turn within the spherical housing 1 about predetermined vertical axes, respectively, these gyroscopes being maintained within the gyro-compass housing 1 with their horizontal turning axes at 90° with respect to each other and the gyroscopes being interconnected in such a way that they can only turn about the vertical axes simultaneously in opposite directions and through the same angle.

As was mentioned above, various difficulties arise from the bearing structures which are used to mount such gyroscopes for turning movement about the vertical axes and which are used in the linkage which interconnects such gyroscopes. In order to eliminate such bearings and the disadvantages produced thereby, the gyroscopes 12 and 13 are each suspended between vertical wires 10 which may be tensioned by turnable members 16 so that the gyroscopes 12 and 13 are accurately mounted for turning movement about the vertical axes along which the wires 10 extend, the latter becoming twisted upon turning of these gyroscopes. Instead of a single wire 10 located above and below each gyroscope, a bundle of wires may be located above and below each gyroscope which function in the same way as the single wire but distribute the load among the several wires of the bundle.

In order to eliminate the above-discussed disadvantages of a linkage which interconnects the two gyroscopes for simultaneous turning movement in opposite directions by the same amounts, a linkage is eliminated entirely, and in its place there are provided a pair of crossed cables 11 each of which is connected at opposite ends thereof, respectively, to a pair of arcuate, circular sections 15 rigid with the gyroscopes 12 and 13, respectively, as is illustrated most clearly in Figure 2. The cables 11 may each be formed by a single wire or a bundle of wires. It is apparent that the crossed cables 11 will constrain the gyroscopes 12 and 13 for simultaneous movement about the vertical axes of wires 10 in opposite directions and by the same amounts.

The construction illustrated in Figures 1 and 2 is only diagrammatic. The tension in cables 11 will tend to pull the gyroscopes 12 and 13 toward each other, which is of a certain disadvantage since this conflicts with the mounting of the gyroscopes for turning about the vertical axes defined by the wires 10. Therefore, the sectors 15 are actually much larger than illustrated in Figures 1 and 2 and almost contact each other so that the top and bottom angles, as viewed in Figure 2, at the intersection of the cables 11 are exceedingly small, and in this way any tendency of the cables 11 to draw the gyroscopes toward each other out of their vertical turning axes is for all practical purposes completely eliminated.

Although, as was mentioned above, it is highly advantageous to transmit the top and bottom current phases, passing through the gyroscopes 12 and 13, through a metallic conductor such as the mercury baths 3 and 7, a certain amount of the current of these two phases will stray to the electrically conductive acidulated water 2. However, the conductivity of the liquid 2 is very carefully chosen so as to be low enough to maintain the stray current loss in this liquid 2 to a minimum value while at the same time enabling this liquid 2 to transfer the third phase of the current to the electrically conductive ring 9.

A practical embodiment of the features described above and diagrammatically illustrated in Figures 1 and 2 is illustrated in Figure 3. This figure shows the above-described spherical housing 1 formed with the funnel-shaped indentation into which the centering shaft 4 extends. The spherical gyro-compass housing 1 is suspended within the larger hollow member 6, at the separating surface between the acidulated water 2 and the mercury 3. The centering shaft 4 is fixed to an upper part of the hollow casing 6 and engages the central aperture of plate 5 to prevent lateral movement of spherical housing 1. In the center of the hollow casing 6 there is located a transparent Plexiglas ring 17.

The lower phase of current which passes through the mercury 3 is fed to a contact 18 at the bottom of the casing 6 and is received at the spherical housing 1 by the electrode 8 located at the bottom of the spherical housing 1 opposite the contact 18. The top current phase passes through the centering shaft 4 to the mercury bath 7, and the third current phase passes from a pair of rings 47 through the liquid 2 to the electrically conductive rings 9 located opposite the rings 47 on the spherical housing 1. Between the rings 9 there is located, on the outer surface of gyro-compass housing 1, a compass dial 19 which is visible through the Plexiglas ring 17 and the liquid 2.

Except for the above mentioned electrically conductive parts, the housings 1 and 6 are made from non-conductive material, or conductive materials coated with an insulating material.

The outer casing 6 is formed from an upper part 22 and a lower part 23 which by means of the screws 24 are pulled toward each other and clamp between themselves the Plexiglas ring 17, the assembly of parts 22, 23 and 17 being water tight as a result of the clamping action of screws 24.

The entire hollow casing 6 is turnably supported in a frame 25 by means of an upper ball bearing 20 and a lower ball bearing 21, this frame 25 including a lower part 26 which is rendered removable by means of the screws 27. The frame 25 is suspended against vibrations by means of springs 28 and 29 which are fixed to the frame 25 and to the inner gimbal ring 30 which is mounted for turning movement about a horizontal axis in ball bearings 32 of the outer gimbal ring 31, and the latter is mounted on the support 33, which is rigid with the ship on which the

apparatus is located, for turning about a horizontal axis perpendicular to the turning axis defined by bearings **32**. To the lower part of frame **25** there is connected a motor driven fan device **34** which produces an air stream between the outer casing **6** and the frame **25**. The compass dial **19** may be read through the five-sided prism **35** which is located in front of a window **36** aligned with the Plexiglas ring **17**.

However, it may be more convenient to read the ship's course from a dial **37** which is fixed to the casing **6**, the latter being electrically maintained in a predetermined relationship with the spherical gyro-compass housing **1** by means of a Wheatstone bridge arrangement. The parts **1** and **6** are respectively provided with a pair of contacts across which a voltage is maintained to indicate when the parts **1** and **6** move out of their predetermined orientation with respect to each other, and these contacts are connected in a circuit of a motor **38** (Fig. 4) which is set into operation by respective movement of these contacts and operates a gearing **39** to automatically return the parts **1** and **6** to their predetemined relationship, the gearing **39** being connected to the outer casing **6** to turn the same with respect to the housing **1**.

The current is carried between the stationary part **33** and the frame **25** by a flexible cable **48**, and the current passes from the frame **25** to the hollow casing **6** through the medium of slip rings **40**, showin in detail in Fig. 5 where a plurality of carbon brushes are shown mounted in holders and maintained in contact with the slip rings **40**. From these slip rings current passes to the centering shaft **4**, to the rings **47**, and to the contact **18**.

A thermometer **41** is built into the top part of centering shaft **4**. Also, within the top part of hollow casing **6** there is a float **42** carrying upwardly extending members **43** which indicate the level of the liquid **2** in the hollow casing **6**, these members **43** being visible through a Plexiglas cover **44** which seals a funnel **45**, leading to the interior of casing **6** through apertures through which the members **43** extend, against the entrance of dust and other foreign matters to the interior of casing **6**. The latter is filled through funnel **45**.

As is clearly illustrated in Figure 3, the gyroscopes **12** and **13** within the spherical gyro-compass housing **1** are carried by wire bundles **10** which may be tensioned by knobs **16**. The crossed cables **11** maintain the compasses **12** and **13** with their turning axes at approximately 90° to each other, as was described above, and it is clearly shown in Figure 3 that the sectors **15** extend almost up to each other and provide a small space through which the cables **11** extend over each other so that pulling of the gyroscopes **12** and **13** toward each other by the cables **11** is prevented. Within the housing **1** there are built-in chambers **46** which are distributed about the interior of housing **1** and half filled with oil to dampen undesired movement of the housing **1** when the compass is set into operation. The three-phase current is led to the gyroscopes **12** and **13** along the suspension cables **10** by special, flexible copper wiring.

The electrically conductive liquid **2** is used, in addition to carrying out the above described functions, to carry current which is interconnected with subsidiary compasses located at various points throughout the ship to indicate at these points the direction indicated by the master compass shown in Figure 3.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of gyro-compasses differing from the types described above.

While I have illustrated and described the invention as embodied in gyro-compasses which require no cooling means and no ball bearings, I do not intend to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of my invention.

Without further analysis, the foregoing will so fully reveal the gist of my invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What I claim as new and desire to secure by Letters Patent is:

1. A direction indicating apparatus comprising, in combination, a spherical container; a first liquid located in said container, partly filling the same, and having a top surface; a second liquid immiscible with said first liquid, being of a lower specific gravity than the same, and being located on the top surface of said first liquid, said second liquid also having a top surface; a multiple phase electrical gyro-compass system having an outer spherical housing of a smaller diameter than said container located within the latter beneath the top surface of said second liquid and floating on the separating surface between the first and second liquids, said housing having an indented portion extending downwardly from the top thereof into the interior of said housing; electrically conductive means for at least one of the phases of said electrical gyro-compass system extending downwardly into said indented portion of said housing for supplying at least one of the phases of the electrical current for said gyro-compass system to the latter, said first liquid being mercury and having a specific gravity several times as great as that of said second liquid so that said spherical housing of said gyro-compass system extends only a small distance into said first liquid to minimize friction and surface tension effects at the separating surface between said immiscible liquids; second electrical conductive means for a second phase of said electrical gyro-compass system communicating with said mercury for conducting current for a second phase of the electrical gyro-compass system through said mercury to said gyro-compass system, said second liquid being electrically conductive water; and third electrical conductive means for a third phase of said electrical gyro-compass communicating with said water for conducting current for a third phase of the electrical gyro-compass system through said water to said gyro-compass system.

2. A direction indicating apparatus comprising, in combination, a spherical container; a first liquid located in said container, partly filling the same, and having a top surface; a second liquid immiscible with said first liquid, being of a lower specific gravity than the same, and being located on the top surface of said first liquid, said second liquid also having a top surface; a multiple phase electrical gyro-compass system having an outer spherical housing of a smaller diameter than said container located within the latter beneath the top surface of said second liquid and floating on the separating surface between the first and second liquids, said housing having an indented portion extending downwardly from the top thereof into the interior of said housing and said indented portion of said housing having a bottom end located substantially at the center of said spherical housing; and electrically conductive means for at least one of the phases of said electrical gyro-compass system extending downwardly into said indented portion of said housing for supplying at least one of the phases of the electrical current for said gyro-compass system to the latter.

3. A direction indicating apparatus comprising, in combination, a spherical container; a first liquid located in said container, partly filling the same, and having a top surface; a second liquid immiscible with said first liquid, being of a lower specific gravity than the same, and being located on the top surface of said first liquid, said second liquid also having a top surface; a multiple phase electrical gyro-compass system having an outer

spherical housing of a smaller diameter than said container located within the latter beneath the top surface of said second liquid and floating on the separating surface between the first and second liquids, said housing having an indented portion extending downwardly from the top thereof into the interior of said housing and said indented portion of said housing having a bottom end located substantially at the center of said spherical housing; electrically conductive means for at least one of the phases of said electrical gyro-compass system extending downwardly into said indented portion of said housing for supplying at least one of the phases of the electrical current for said gyro-compass system to the latter; a transverse wall formed with a substantially central aperture located over the bottom end of said indented portion and extending across the latter, said electrically conductive means including an elongated, substantially rigid, electrically conductive member, extending downwardly through said indented portion of said housing and through said aperture of said transverse wall, an insulating covering located on said elongated substantially rigid member over the entire outer surface portion thereof except the free bottom end portion thereof extending through said aperture, and a bath of mercury located in said indented portion of said housing beneath said transverse wall and engaging said free bottom end portion of said elongated member to receive electrical current therefrom and to transmit electrical current thereto, said substantially rigid member being fixed to a top end portion of said spherical container and cooperating with said transverse wall to center said housing in said container.

4. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container; a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion having a closed bottom; and an elongated rigid member fixed to said container and extending downwardly with substantial clearance along the interior of said indented portion to a point adjacent but spaced from said bottom thereof, the portion of said rigid member which is located within said indented portion of said housing being entirely out of contact with any rigid elements when said housing is centered with respect to said rigid member, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degre with respect to said rigid member and to move upwardly toward the same.

5. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container; a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion having a closed bottom located substantially at the center of said housing; an elongated rigid member fixed to said container and extending downwardly and with clearance along the interior of said indented portion to a point adjacent but spaced from said bottom thereof; and means located within said indented portion of said housing and surrounding said rigid member with clearance for limiting the lateral movement of said housing with respect to said rigid member, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degree with respect to said rigid member and to move upwardly with respect to the same.

6. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container; a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion and having a closed bottom; an elongated rigid member fixed to said container and extending downwardly and with clearance along the interior of said indented portion to a point adjacent but spaced from said bottom thereof, the portion of said rigid member which is located within said indented portion of said housing being entirely out of contact with any rigid elements when said housing is centered with respect to said rigid member, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degree with respect to said rigid member; and electrically conductive means for conveying current through the wall of said housing, said electrically conductive means being formed in part by said rigid member and including an electrically conductive liquid in said indented portion of said housing engaging said rigid member.

7. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container, a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion having a closed bottom located substantially at the center of said housing; an elongated rigid member fixed to said container and extending downwardly and with clearance along the interior of said indented portion to a point adjacent said bottom thereof, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degree with respect to said rigid member, said rigid member being electrically conductive; an insulating material covering said rigid member at all parts except its bottom end portion adjacent the bottom of said indented portion of said housing; and a bath of mercury located in said bottom of said indented portion of said housing and engaging the exposed bottom end portion of said rigid member for establishing an electrical connection theerwith.

8. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container; a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion having a closed bottom; an elongated rigid member fixed to said container and extending downwardly and with clearance along the interior of

said indented portion to a point adjacent said bottom thereof, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degree with respect to said rigid member; and a plate fixed to and extending across the interior of said indented portion of said housing adjacent said bottom thereof, said plate being formed with a substantially central aperture through which said rigid member extends with clearance so that said plate and rigid member cooperate to determine the location of said housing in said container within the limits of said clearance of said rigid member in said aperture.

9. In a direction indicating apparatus, in combination, an outer container; a first liquid located in a lower portion of said container; a second liquid, immiscible with said first liquid and of a lower specific gravity than the same, located on the top surface of the first liquid; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between said first and second liquids, said housing having an indented portion extending into the same from the top of said housing, and said indented portion having a closed bottom; an elongated rigid member fixed to said container and extending downwardly and with clearance along the interior of said indented portion to a point adjacent said bottom thereof, whereby said spherical housing has its location in said container determined by said rigid member while at the same time said housing is free to turn and float in said liquids and is free to tilt to some degree with respect to said rigid member; a plate fixed to and extending across the interior of said indented portion of said housing adjacent said bottom thereof, said plate being formed with a substantially central aperture through which said rigid member extends with clearance so that said plate and rigid member cooperate to determine the location of said housing in said container within the limits of said clearance of said rigid member in said aperture; a bath of mercury located in said bottom of said indented portion beneath said plate; and an insulating material covering all of said rigid member except the portion thereof extending through said plate downwardly beyond the same, said rigid member being electrically conductive so that said mercury may establish an electrical connection therewith.

10. In a direction indicating apparatus, in combination, a container having between its top and bottom ends a first electrically conductive wall portion and having adjacent its bottom end a second electrically conductive wall portion; a first mercury bath located in said container in a lower portion thereof and engaging said second wall portion of said container; a bath of electrically conductive water located on said mercury in said container and contacting said first wall portion of said container; a gyro-compass system having an outer spherical housing smaller than said container located within the latter and floating on the separating surface between the water and mercury, said housing having first and second electrically conductive wall portions respectively contacting said water and mercury so that electricity may be conveyed through said water between said first wall portions and through said mercury between said second wall portions, said housing being provided with an indented portion extending into the same from an upper part thereof and having a closed bottom; a second bath of mercury located in said bottom of said indented portion of said housing; and an elongated electrically conductive member carried by said container and extending with clearance along the interior of said indented portion of said housing into said second mercury bath to establish an electrical connection therewith.

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