No. 794,654. PATENTED JULY 11, 1905.

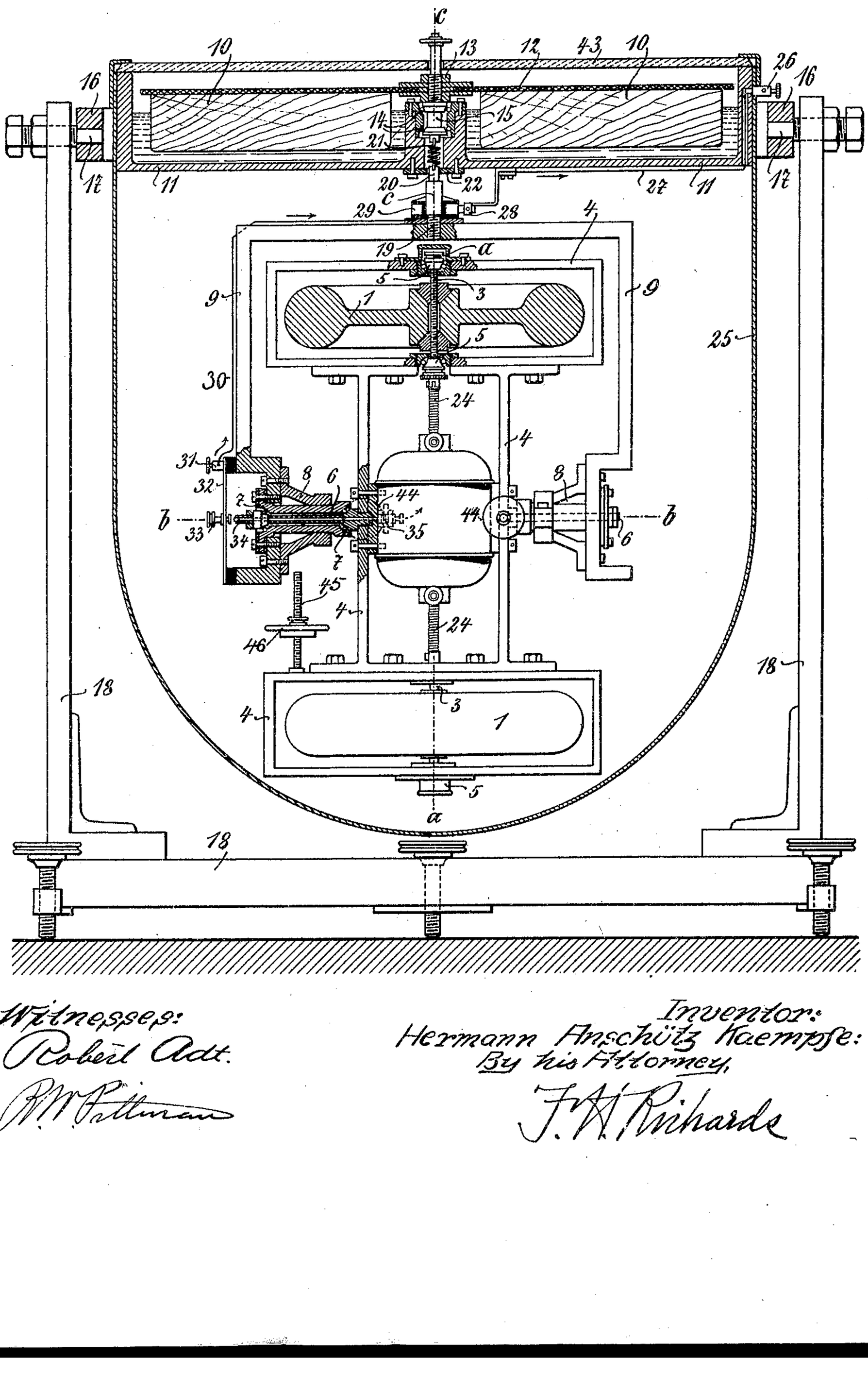
H. ANSCHÜTZ-KAEMPFE.

GYROSCOPE.

APPLICATION FILED MAR. 27, 1905.

2 SHEETS—SHEET 1.

Fig. 1.



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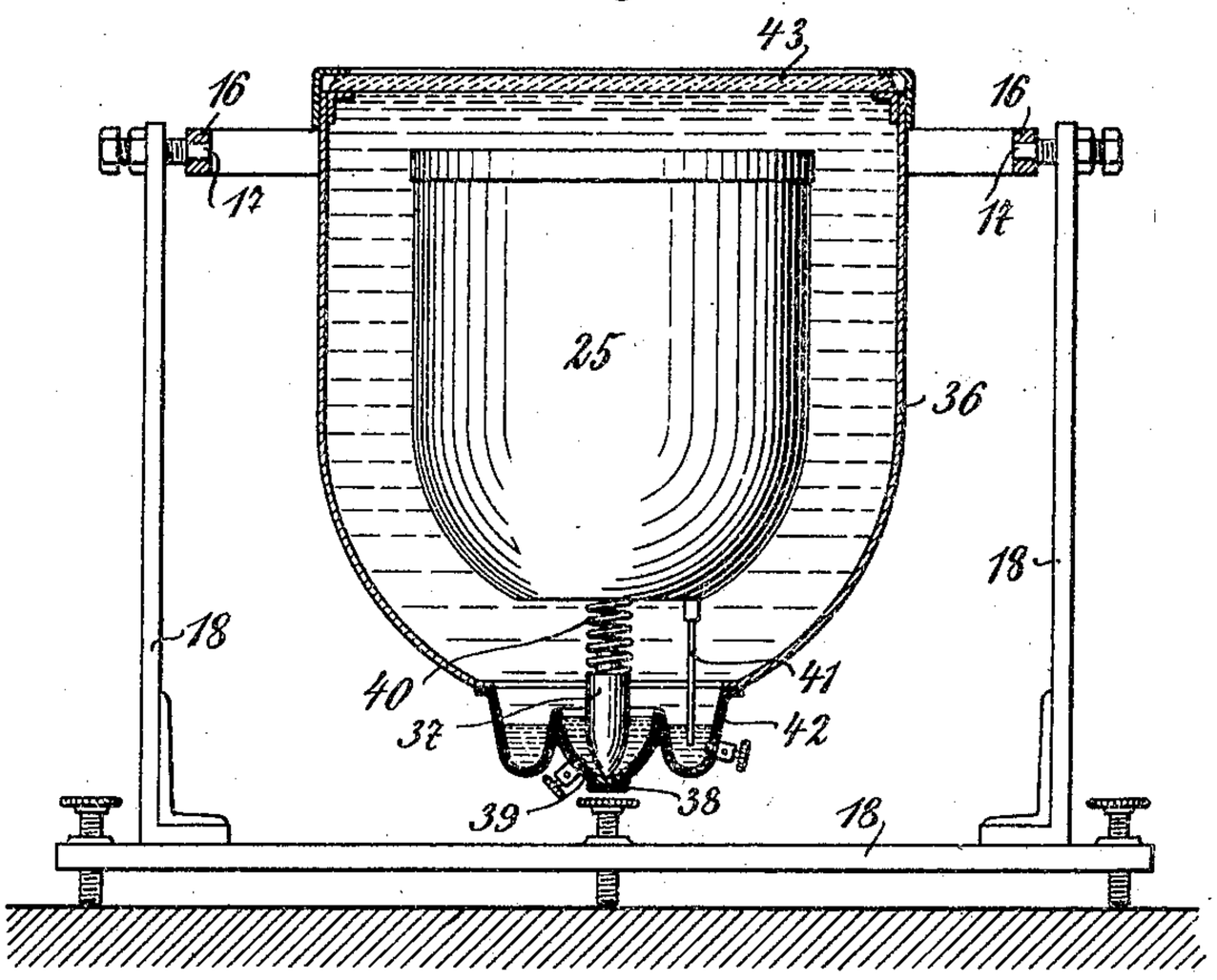
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

HERMANN ANSCHÜTZ-KAEMPFE, OF KIEL, GERMANY.

GYROSCOPE.

SPECIFICATION forming part of Letters Patent No. 794,654, dated July 11, 1905.

Application filed March 27, 1905. Serial No. 252,182.

To all whom it may concern:

Be it known that I, HERMANN ANSCHÜTZ-KAEMPFE, Dr. Phil., a subject of the German Emperor, residing in Kiel, in the Kingdom of Prussia, Germany, have invented certain new and useful Improvements in Gyroscopes, of which the following is a specification.

The present invention relates to a gyroscope which is constructed particularly for use on ships as a substitute for or as a means for corroborating or correcting the magnetic compass. It can, however, be employed for other purposes. In contrast with the devices of this kind which have hitherto been known the new instrument is distinguished by the gyroscope being carried by a float and by it not being rigidly connected with the latter, but by means of an elastic intermediate member, and also by the connection of the driving-motor with the spinning body being likewise an elastic connection, and, finally, by the center of gravity of the system lying somewhat deeper than Cardan's point—*i. e.*, the point where the three axes of rotation intersect—so that the system behaves like a balance, and consequently participates in the rotation of the earth instead of, like Foucault's pendulum, being independent of the motion of the earth and being fixed in space—*i. e.*, lagging behind the rotation of the earth by an amount depending upon the geographical latitude.

The invention is illustrated, by way of example, in the accompanying drawings, in which—

Figure 1 is a part-sectional front elevation of one constructional form, showing all details, while Fig. 2 is a part-sectional front elevation showing a modified general arrangement.

The gyroscope comprises two spinning bodies 1, which rotate about the same axis *a a* and which are set in rotation by a motor 2, which in the embodiment illustrated is an electric motor, though of course any means for driving other than means adapted to be driven electrically may be employed. In the drawings one of the spinning bodies is shown in cross-section and the other is represented in front elevation. The spinning bodies, which are accurately centered, are fastened on axles 3, which rotate extremely easily in the frame 4. In the case of the embodiment shown in the drawings ball-bearings 5 are employed for the axles 3. The pivots 6 are fastened in the two side cheeks of the frame 4 and are guided with the aid of ball-bearings 7 in the bearer-brackets 8, which in their turn are secured to the frame 9. The frame 4, with the motor and the spinning bodies, is consequently revoluble about the axis *b b* and is connected with the frame 9. If now this frame 9 is so suspended that it can rotate about an axis *c c* at right angles to the axis of the pivots 6, a system suspended after the manner of Cardan arises.

The special suspension of the frame 9 about its axis of rotation forms an important feature of the invention, as is mentioned above. The said frame is suspended on a float 10, which in the form shown is a ring which floats on a suitable liquid in a vessel 11. The frame 9, and with it the whole gyroscope with the other parts fastened on it, is supported on said float by means of the disk 12. The disk 12 for its part is secured to a nave 13, which rests on a pivot 15, running on ball-bearings 14. The pivot 15 has a certain amount of upward and downward play in its bearing, so that it can move in its axial direction to only a slight extent. As can be seen from the drawings, the vessel 11 consequently carries the whole apparatus and is to be set up upon the support whose angular deviations from a given line of direction are to be observed—*i. e.*, on the ship. According to the constructional form here represented the vessel 11 for the float is attached to the frame 18 by the aid of a ring 16, which is revoluble about pivots 17. The suspension of the frame 9 on the pivot 15 is likewise effected in a special manner, which forms one of the main features of the invention. The connection between 9 and 15 is, namely, elastic, and by this arrangement the continuous slight shaking of the ship, which is due, for example, to the machinery on board, is not transmitted to the gyroscope—an essential condition for the reliable working of the same. In the case of the present embodiment the connection comprises a pin 19, which is inserted in the frame 9 and which

at the place where it enters the hole in the vessel 11 possesses a projecting piece or pivot 20. The latter is connected with the pivot 15 by means of a spiral spring 21, a so-called "flexible" shaft, or the like. An annular edge 22, which surrounds the pivot 20 with a certain amount of play, is fastened at the end of the hole in the vessel 11. The pivot can consequently set itself obliquely to the axis *c c*.

Another important feature of the present invention, as mentioned above, relates to the means for connecting the motor 2 with the axles 3 of the spinning bodies. The connection is likewise not rigid, but flexibly elastic, and in the present case consists of a spiral spring 24. For this purpose any coupling which permits of a limited relative motion of the coupled parts can be employed. Only by this arrangement is it possible for the spinning bodies, the exact balancing of which can be carried out without excessive difficulty, to remain uninfluenced by the vibrations which the motor must receive by necessity in consequence of its mass being never absolutely symmetrically distributed and the balancing of which is extraordinarily difficult, if not impossible.

The manner in which the device acts will now be entered into in detail. The frame 18 is set up at a suitable place, so that the apparatus inclosed by a casing 25 is suspended from the horizontal ring 16, and then the electric motor is connected in the electric circuit. The current is supplied to the motor 2 through a terminal 26 on the vessel 11, from which terminal an insulated conductor 27 leads to the brush 28. The latter slides on a slide-ring 29, mounted on and insulated from the pin 19, and said slide-ring is connected through a conductor 30 with the screw-terminal 31. An insulated leaf-spring 32 is connected with the latter, and said leaf-spring carries a contact-screw 33. One of the pivots 6 on the frame 4 is hollow, and an insulated silver wire 34 passes through the same. The set-screw 33 abuts against the end of said wire, whereas the other end lies against a resilient contact 35, which is connected with the one brush of the motor. The other brush is connected with the framework of the device, so that the second terminal of the apparatus only requires to be connected with the frame of the instrument. If now the motor is started, its armature begins to rotate, and the rotation is communicated through the elastic couplings 24 to the spinning bodies 1. It may be assumed that the axis *a a* of the motor and of the spinning bodies is in a horizontal position, (at right angles to the plane of the paper,) whereas in the drawings it is drawn in a perpendicular position merely for the sake of clearer representation.

According to the well-known laws of the motion of the gyroscope, the spinning bodies of such an apparatus when they are once in a state of rotation have the tendency to retain the once assumed direction of their axis in space. The axial direction can consequently be regarded as a fixed line of direction, by which, for example, a ship can be steered accurately, as when a compass is employed. If, however, the apparatus, as would at first sight follow by applying the ordinary laws of mechanics, is in neutral equilibrium—*i. e.*, if the center of gravity coincides with Cardan's point, or, in other words, the point of intersection of the three axes *a a*, *b b*, *c c*—the axis retains its direction in space. The device behaves like Foucault's pendulum, and consequently does not participate in the rotation of the earth about its axis, but, on the contrary, exhibits a motion relatively to the earth. This property, however, would render the instrument almost unserviceable for nautical purposes, as the apparent rotation of the instrument with regard to the earth occurring in consequence of the earth's rotation would have to be taken into account or compensated for by clockwork or the like, an expedient which in case the ship did not follow a constant course, but described curves of any kind, might be entirely impossible to carry into execution. The important point, consequently, is to arrange the instrument so that it participates in the slow rotation of the earth, but indicates the comparatively sudden changes in the course of the ship or other movable support on which it is set up by not participating in the rotary motion of the same. According to the present invention the arrangement is such that a certain amount of stability with regard to the horizontal axis perpendicular to the axis of rotation is given to the system of spinning bodies. This can, for example, be effected by placing the center of gravity of the whole system somewhat lower than Cardan's point—*i. e.*, the point of intersection of the three axes. The result obtained by this arrangement is that the spinning bodies when in the condition of rotation experience an elevation when a couple is applied to them, which elevation leads to a precession of the instrument. This precession, which is a constant and accurately-determinable quantity, has for its object to allow the apparatus to participate in the motion of the earth, whereas, on the other hand, it does not share the ship's motion, which is executed in a short time. Thereby, of course, an instrumental error arises which, however, can be either neglected on account of its insignificance or be taken into account as a constant quantity. The distance between the center of gravity and the point of support determines the magnitude of this error. In practice the center of gravity must lie so near to the point of support that the instrument when brought out of its position of equilibrium can set itself again into the position of equilibrium when it is not in a condition of rotation, like a highly-sensitive balance. The regulation of the position of the center of

gravity can be effected in any desired manner. In the embodiment represented adjustable weights 44 are provided for this purpose on suitable parts of the instrument. It is obvious that the arranging of such weights and similar devices may be abandoned if the instrument is from the start so successfully constructed that the center of gravity has the desired position.

In practice it will be extremely difficult to get the two ends of the frame 4 and the spinning weights 1 evenly balanced upon the axle 6, and to afford means for balancing the parts one end of the frame may carry a screw 45, projecting toward the center, upon which a balance 46 will be screw-threaded, so that the balance-weight may be moved back and forth until the equilibrium of the two ends is established.

It is evident that the construction represented could be varied in many ways without the scope of the invention being exceeded.

The suspension on a float could finally be modified in such a manner that the whole casing 25, containing the apparatus, is itself formed as the float. Such an arrangement is diagrammatically shown in Fig. 2 in part-sectional front elevation. The completely-closed casing 25, which contains the apparatus, is here shown in external elevation. It floats in a suitable liquid, such as alcohol, in a second vessel 36. The buoyancy is such that the casing 25 is supported on a point or pivot 37 with any desired slight amount of pressure, dependent upon the amount of friction admissible. The pivot 37 runs in a stone 38. The stone is arranged on the bottom of a receptacle 39, containing mercury, so that the pivot 37 simultaneously serves as means for conducting the electric current to the instrument. The connection of the pivot 37 with the casing 25 is again effected by means of an elastic intermediate member, such as a spiral spring 40, so that the small vibrations of the vessel 36, which is mounted on the ship, are not transmitted to the apparatus.

The current can leave the apparatus simply through a rod or wire 41, which dips into mercury in the channel 42.

The reading of the indications of the apparatus is provided for by arranging a compass-card 43 over the vessel 11, Fig. 1, for the float, and a pointer on the pivot 15. The rotary movements of the same with regard to the compass-card indicate the angle by which the ship carrying the apparatus deviates at the time from the direction of the axis *a a*.

It has been explained above that one of the main features of the present invention consists in so arranging the apparatus that the system of spinning bodies can set itself again in the position of equilibrium, like a highly-sensitive balance, when the spinning bodies are stationary. Now it is obvious that this property of a pendulum or balance can be obtained by other arrangements and means than by providing for the center of gravity to be in a certain position. For example, the position of the center of gravity could be so selected as to coincide with Cardan's point or the point of intersection of the three axes. In each case the motion of the horizontal axle perpendicular to the axle of the spinning bodies is not free, but is executed in opposition to the action of special forces, which when the central plane of the spinning bodies which is perpendicular to the axis of spinning is turned out of the perpendicular produce a couple tending to move the system back into the vertical position like a pendulum, the object being to bring about an elevation of the spinning bodies, and consequently a precession of the instrument, which effect a participation of the axle of spinning in the rotation of the earth.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A gyroscope comprising in combination a spinning body, power-actuated means for driving the same, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a support revolubly carrying said second frame, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest.

2. A gyroscope comprising in combination a spinning body, power-driven means for driving the same, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a support revolubly carrying the second frame, the center of gravity of the spinning body, its axle and the frame carrying the same being lower than the point of intersection of the axes of rotation of the spinning body and the axes of rotation of the two frames, so that the frame carrying the axle of the spinning body is adapted when said body is not spinning to oscillate about its position of rest.

3. A gyroscope comprising in combination a spinning body, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a support revolubly carrying said second frame and a motor carried by one of said frames for driving said spinning body, a frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest.

4. A gyroscope comprising in combination a spinning body, a motor for driving the same, an axle supporting said body, a frame carrying an axle, a second frame revolubly supporting the former frame, a support revolubly carrying the second frame, the center of gravity of the spinning body, its axle and the frame carrying the same being lower than the point of intersection of the axes of rotation

of the spinning body and of the two frames so that the frame carrying the axle of the spinning body is adapted when said body is not spinning to oscillate about its position of rest and means adjustably mounted on the frame carrying the spinning body for adjusting the position of said center of gravity.

5. A gyroscope comprising in combination, a spinning body, means for driving the same, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a vessel containing a liquid, a float floating on such liquid, and carrying said second frame, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest, substantially as and for the purpose set forth.

6. A gyroscope comprising in combination, a spinning body, means for driving the same, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a vessel containing a liquid, a float floating on said liquid, elastic means suspending the said second frame from the said float, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest, substantially as and for the purpose set forth.

7. A gyroscope comprising in combination, a spinning body, means for driving the same, an axle supporting said body, a frame carrying said axle, a second frame revolubly supporting the former frame, a vessel containing a liquid, a float floating on said liquid, a spiral spring suspending the said second frame from the said float, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest, substantially as and for the purpose set forth.

8. A gyroscope comprising in combination, a spinning body, an axle supporting the same, a frame carrying said axle, an electric motor mounted on said frame and having a driving-shaft, elastic means connecting said driving-shaft with the axle of said spinning body, a second frame revolubly supporting the former frame, a support revolubly carrying said second frame, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest, substantially as and for the purpose set forth.

9. A gyroscope comprising in combination, a spinning body, an axle supporting the same, a frame carrying said axle, an electric motor mounted on said frame and having a driving-shaft, elastic means connecting said driving-shaft with the axle of said spinning body, a second frame revolubly supporting the former frame, a vessel containing a liquid, a float floating on said liquid, elastic means suspending said second frame from the said float, the frame carrying the axle of the spinning body being adapted when said body is not spinning to oscillate about its position of rest, substantially as and for the purpose set forth.

10. A gyroscope comprising in combination a spinning body, a motor for driving the same, an axle supporting said body, a frame carrying an axle, a second frame revolubly supporting the former frame, a support revolubly carrying the second frame, the center of gravity of the spinning body, its axle and the frame carrying the same being lower than the point of intersection of the axes of rotation of the spinning body and of the two frames so that the frame carrying the axle of the spinning body is adapted when said body is not spinning to oscillate about its position of rest and weights adjustably mounted on the frame carrying the spinning body for adjusting the position of said center of gravity.

In witness whereof I have hereunto signed my name, this 10th day of March, 1905, in the presence of two subscribing witnesses.

HERMANN ANSCHÜTZ-KAEMPFE.

Witnesses:

WOLDEMAR HAUPT,

HENRY HASPER.