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1,446,348.

H. HORT.
GYROSCOPE.
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Fig. 1.

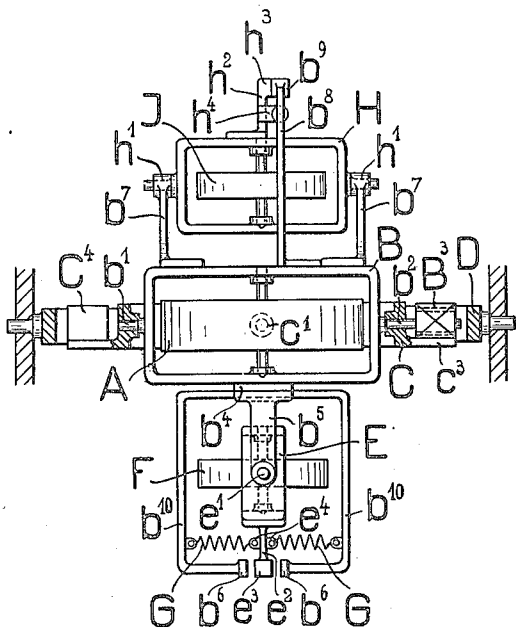


Fig. 2.

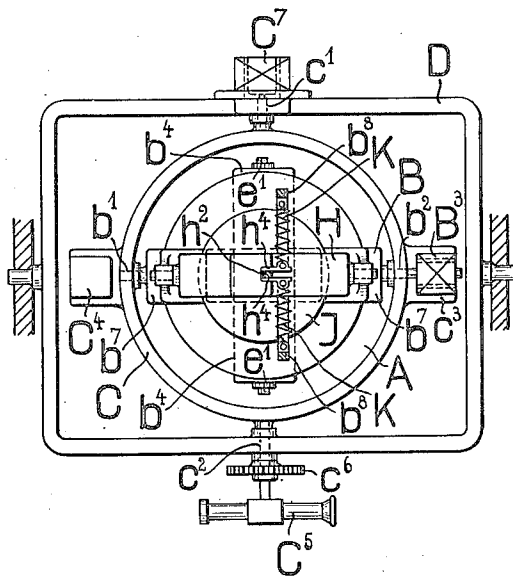
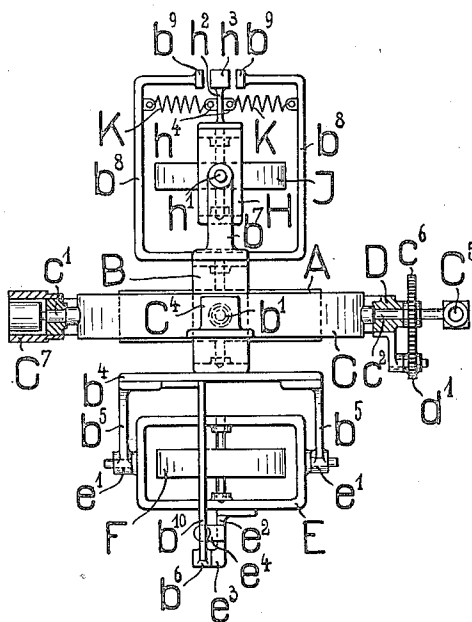


Fig. 3.

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UNITED STATES PATENT OFFICE.

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GYROSCOPE.

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To all whom it may concern:

Be it known that I, HERMANN HORT, residing at Essen, Germany, a citizen of the German Republic, have invented a certain new and useful Improvement in Gyroscopes, of which the following is a specification.

This invention relates to a universally suspended gyroscope comprising a main rotor and an auxiliary rotor mounted for oscillation at the carrier of the main rotor.

The invention has for its object to provide a gyroscope of the kind stated in which the axis of oscillation of the auxiliary rotor is vertical with respect to the plane determined by the axis of rotation and oscillation of the main rotor, and in which the auxiliary rotor is provided with an electric contact device, the several parts of which are fastened to the carriers of the main and auxiliary rotors and which is adapted, upon a movement of oscillation of the carrier of the auxiliary rotor with relation to the carrier of the main rotor, to exert, by means of a motor arrangement, a turning moment around the Cardan axis which is parallel to the axis of oscillation of the auxiliary rotor.

The accompanying drawing illustrates, by way of example, as an embodiment of the invention, a gyroscope designed to be used on ships and comprising two auxiliary rotors and an aiming device.

In the drawing:

Fig. 1 is a vertical section through the device,

Fig. 2 is an elevation, partially in section, of Fig. 1, seen from the left, and

Fig. 3 is a plan view corresponding to Fig. 1.

A designates the main rotor of the gyroscope which rotor is universally suspended in a frame D by means of a frame B, two co-axial pivots b^1 , b^2 , another frame C and two co-axial pivots c^1 , c^2 . The frame D, on its part, is suspended for oscillation in a stationary part of the ship in the manner to be seen from the drawing. The main rotor A possesses a vertical spinning axis and is being driven by an electric motor (not shown). Splined to the end of the pivot b^2 which extends through the frame C, is the rotary member of a small electric motor B^3 (Figs. 1 and 3), the stationary member of which is mounted on a bearing plate c^3 formed by the frame C. A counter-weight

C^4 arranged at the side of the frame C opposite to the motor B^3 , causes the centre of gravity of the frame C to be displaced into the point of intersection of the Cardan axes. The free end of the pivot c^2 projecting out of the frame D carries an aiming telescope C^5 (Figs. 2 and 3) in such a manner that its aiming line is parallel to the axis of the pivots b^1 , b^2 . Besides, there is fastened to the portion of the pivot c^2 projecting from the frame D, a toothed pinion c^6 (Figs. 2 and 3) which meshes with a pinion d^1 mounted on the frame D (Fig. 2) and which is designed to operate the transmitter (not shown) of an electric long-distance controlling device transmitting the aiming line of the telescope C^5 . Splined to the end of the pivot c^1 which projects through the frame D, is the rotary member of a small electric motor C^7 the stationary member of which is arranged at the frame D.

A plate b^4 fastened to the lower side of the frame B is provided with two downwardly extending hanger bearings b^5 , in which a frame E (Figs. 1 and 2) is swingingly mounted by means of co-axial pivots e^1 . The common axis of the pivots e^1 is vertical with relation to the plane determined by the axes of rotation of the main rotor A and of the pivots b^1 , b^2 (middle plane of the frame B) and crosses the axis of the pivots b^1 , b^2 . Mounted for rotation in the frame E is an auxiliary rotor F (Figs. 1 and 2) which is likewise driven by an electric motor (not shown). The spinning axis of the auxiliary rotor F which is in indifferent equilibrium with relation to the axis of the pivots e^1 , vertically intersects the axis of the pivots e^1 .

Fastened to the lower cross bar of the frame E is a downwardly extending finger e^2 , the free end e^3 of which is bent-off rectangularly and constructed as electric contact member (Figs. 1 and 2). The plate b^4 which is fastened to the frame B, carries two downwardly extending brackets b^6 of the shape illustrated in the drawing (Figs. 1 and 2). The free ends b^6 of these brackets are likewise constructed as electric contact members and are positioned at a slight distance from the contact member e^3 at both sides of the same. The contact members e^3 and b^6 together with a source of current (not shown) and the motor C^7 form parts

of a circuit which is closed upon the member e^3 entering into contact with one of the contact members b^6 , and the current of which is adapted to cause rotation of the armature of the motor C^7 in one direction or the other. In the position in which the contact member e^3 lies intermediate the two contact members b^6 , the frame E is yieldably fixed with relation to the frame B by means of two helical springs G arranged at both sides of the frame E and each being fastened by one end to an ear e^4 of the finger e^2 and by the other end to the brackets b^{10} .

There are further fastened to the frame B two upwardly extending bearing brackets b^7 in which a frame H is swingingly mounted by means of two co-axial pivots h^1 . The common axis of the pivots h^1 is situated in the plane (middle-plane of the frame B) determined by the spinning axis of the main rotor A and the axis of the pivots b^1 , b^2 , and it is parallel with respect to the axis of the pivots b^1 , b^2 . Mounted in the frame H is an auxiliary rotor J which is likewise driven by an electric motor (not shown). The spinning axis of the auxiliary rotor J which is in indifferent equilibrium with respect to the axis of the pivots b^1 , b^2 , intersects the axis of the pivots h^1 by a right angle.

Fastened to the upper cross bar of the frame H is an upwardly extending finger h^2 , the free end of which (Figs. 1 and 2) is bent-off rectangularly and constructed as electric contact member. The frame B carries two brackets b^8 the free ends b^9 of which are likewise constructed as electric contact members and arranged at both sides of the contact member h^3 at a slight distance from the same. The contact members h^3 and b^9 together with a source of current (not shown) and the motor B^3 form parts of an electric circuit, which is closed by the entering into contact of the contact member h^3 with one of the contact members b^9 and the current of which is adapted to cause rotation of the motor in one direction or the other. In the position in which the contact member h^3 lies intermediate the contact members b^9 , the frame H is yieldably fixed with respect to the frame B by means of two helical springs K each fastened by one end to an ear h^4 of the finger h^2 and by the other end to the brackets b^8 . The arrangement as a whole is so that the centre of gravity of the entire gyroscope approximately coincides with the point of intersection of the Cardan shafts, i. e., of the axes of the pivots b^1 , b^2 and c^1 , c^2 , so that the device is approximately in indifferent equilibrium.

With a view of setting forth the operation of the described gyroscope, it is assumed that all parts take the position according to the drawing in which, more particularly, the aiming line of the aiming telescope C^5 is

horizontal and the spinning axes of the three rotors A, F and J, rotating at a high angular velocity, are vertical.

If now, for instance, the frame D which is mounted in a stationary part of the ship, 70 makes rolling motions around the axis of the pivots c^1 , c^2 , the pinion d^1 which is designed to operate the transmitter (not shown) of the long-distance controlling device, will travel round the pinion c^6 which retains its angular position in the space under the influence of the main rotor A. The cooperation of the pinions d^1 , c^6 will cause a turning moment to be exerted on the Cardan axis determined by the pivots c^1 , c^2 , which turning moment will tend to rotate the frame C around the axis of the pivots c^1 , c^2 . According to the gyroscopic laws, however, the frame C cannot perform any markable rotation, but the turning moment will cause a slight rotation of the frame E of the auxiliary rotor F around the axis of the pivots e^1 . The springs G will not be able to prevent this rotation, so that the finger e^2 will be deflected. Owing to this deflection of the finger e^2 , the electric contact member e^3 will be brought into leading contact with one of the two contact members b^6 . The circuit containing a source of current (not shown) and the motor C^7 will thus be closed, and the armature of the motor C^7 will commence to exert a turning moment on the pivot c^1 , which turning moment will tend to rotate the frame C around the axis of the pivots c^1 , c^2 . The turning moment acting on the frame C will, of course, also produce a rotation of the frame E around the axis of the pivots e^1 . The electrical connections of the current circuit containing the motor C^7 are made in such a manner that the sense of the turning moment produced upon the entering into contact of the contact members e^3 , b^6 , will cause a rotation of the frame E which is opposite to the rotation of this frame caused by the cooperation of the pinions d^1 , c^6 . Therefore, as soon as the turning moment produced by the cooperation of the pinions d^1 , c^6 becomes equal to zero, such as for instance in a dead centre of the rolling motion of the frame D, the contact member e^3 will again remove from the contact member b^6 with which it was in contact until that moment, and therefore the turning moment previously produced by the motor C^7 will likewise disappear. The effect of the turning moment produced by the cooperation of the pinions d^1 , c^6 and acting around the Cardan axis c^1 , c^2 will therefore always be balanced by the arising of an oppositely acting turning moment produced by the motor C^7 , so that the cooperation of the pinions d^1 , c^6 cannot cause any oscillation of the frame B and of the axis of the main rotor. As the frame B does not change its angular position with relation to the frame C dur- 130

ing the cooperation of the pinions d^1 , c^6 , the frame H of the auxiliary rotor J will also not be caused to make any swinging movement with relation to the frame B. The turning moment necessary for operating the transmitter (not shown) of the long-distance controlling device is thus produced by the motor C' without allowing an evasion of the rotor axis to take place.

10 In a similar manner, the motor B³ which is connected to the electric contact device h^3 , b^9 of the auxiliary rotor J, will produce a turning moment acting around the axis of the other Cardan shaft (axis of the pivots b^2 , b^1), if by some disturbing force, f. i., frictional forces, a turning moment will be exerted on the frame B. In such event, the frame H will be acted upon by a turning moment tending to rotate said frame around the axis of the pivots h^1 . The springs K will not be able to resist this turning moment and, consequently, a deflection of the finger h^2 carrying the electric contact member h^3 will take place. This deflection will cause the contact member h^3 to enter into leading contact with one of the two contact members b^9 . A circuit containing a source of current and the motor B³ will thus be closed, and the armature of the motor B³ will commence to exert on the pivot b^2 a turning moment which tends to rotate the frame B around the Cardan axis b^1 , b^2 and the frame H around the axis of the pivots h^1 . The electrical connections of the circuit containing the motor B³ are made so that the sense of the turning moment produced upon the entering into contact of the electric contact members h^3 , b^9 , will produce a rotation of the frame H which is opposed to the rotation of that frame caused by the disturbing force. Therefore, the contact member h^3 will remain in touch with one of the contact members b^9 as long as the turning moments produced by the disturbing force and the motor B³ will remain in equilibrium with respect to each other, and after the turning moment produced by the disturbing force will have disappeared, the contact member h^3 will again remove from the contact member with which it was previously in contact. The action of the turning moment produced by the disturbing force and tending to cause an oscillation of the frame C and consequently of the aiming telescope C⁵ in accordance with the gyroscopic laws, will therefore be balanced by an oppositely directed turning moment before a definite deflection of the rotor axis or of the aiming telescope can take place.

60 The described gyroscope therefore makes it possible to allow the arising of turning moments forming work and acting on an axis stabilized by the main rotor, but to prevent at the same time an evasion of the spinning axis of the rotor and thus of the direc-

tion (aiming line of the telescope C⁵) that has to be maintained.

It is, of course, possible to omit the auxiliary rotor H J along with the corresponding electric contact device h^3 , b^9 and the motor B³ connected thereto. However, the device such as described has the advantage that thus the disturbing forces acting around the Cardan axis b^1 , b^2 are prevented from executing an influence which might change the direction of the spinning axis of the main rotor.

Claims:

1. A universally mounted gyroscope comprising a main rotor, a carrier for the main rotor and at least one auxiliary rotor mounted for oscillation on the said carrier of the main rotor by means of another carrier, the axis of oscillation of the auxiliary rotor being vertical with respect to the plane determined by the axes of rotation and oscillation of the main rotor, and the auxiliary rotor being provided with an electric contact device the several parts of which are fastened to the carriers of the main and auxiliary rotor and which is adapted, upon a movement of oscillation of the carrier of the auxiliary rotor with relation to the carrier of the main rotor, to exert, by the intermediary of a motor device, a turning moment around that Cardan axis of the main rotor which is parallel to the axis of oscillation of the auxiliary rotor.

2. A universally mounted gyroscope comprising a main rotor, a carrier for the same and at least one auxiliary rotor mounted for oscillation on the said carrier by means of another carrier, the axis of oscillation of the auxiliary rotor being vertical with respect to the plane determined by the axes of rotation and oscillation of the main rotor, and the auxiliary rotor being provided with an electric contact device having connection with a motor device and adapted to exert, by the intermediary of said motor device, a turning moment around that Cardan axis of the main rotor which is parallel to the axis of oscillation of the auxiliary rotor, the said Cardan axis being provided with a device for a long-distance transmission of its direction, and the disturbing influence of the latter on the direction to be maintained being liable to be obviated by means of the said motor device.

3. A universally mounted gyroscope comprising a main rotor, a carrier for the same and an auxiliary rotor mounted for oscillation on the said carrier by means of another carrier, the axis of oscillation of the auxiliary rotor being vertical with respect to the plane determined by the axes of rotation and oscillation of the main rotor, and the auxiliary rotor being provided with an electric contact device having connection with a motor device and adapted to exert, by the

intermediary of said motor device, a turning
moment around that Cardan axis of the main
rotor which is parallel to the axis of oscilla-
tion of the auxiliary rotor, the said Cardan
5 axis being provided with a device for a long-
distance transmission of its direction, and
the disturbing influence of the latter on the
direction to be maintained being liable to
be obviated by means of the said motor de-
10 vice, and another auxiliary rotor being
mounted on the carrier of the main rotor
and likewise provided with an electric con-
tact device, the axis of oscillation of the

last-mentioned auxiliary rotor being paral-
lel to the other Cardan axis of the main ro- 15
tor, and the electric contact device of the
last-mentioned auxiliary rotor being con-
nected with a second motor device which is
adapted to exert turning moments around
the Cardan axis of the main rotor which is 20
parallel to the axis of oscillation of the last-
mentioned rotor.

The foregoing specification signed at Es-
sen, Germany, this 13th day of March, 1922.

HERMANN HORT.