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J. FIEUX

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STABILIZING DEVICE

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Fig. 1.

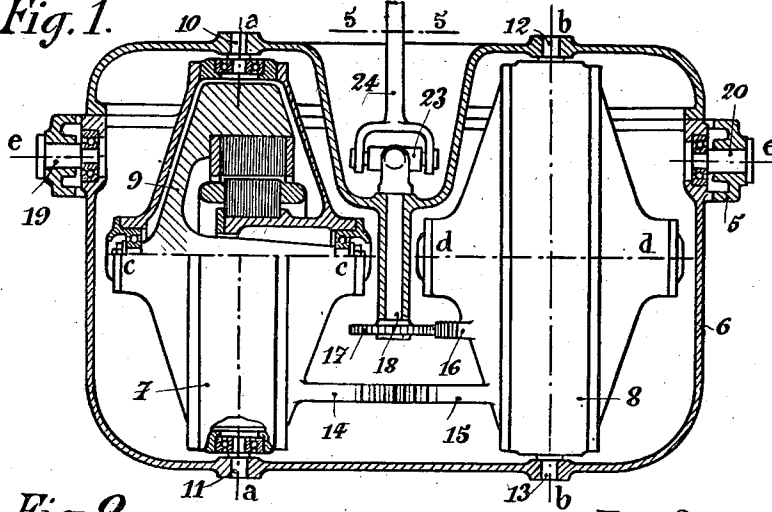


Fig. 2.

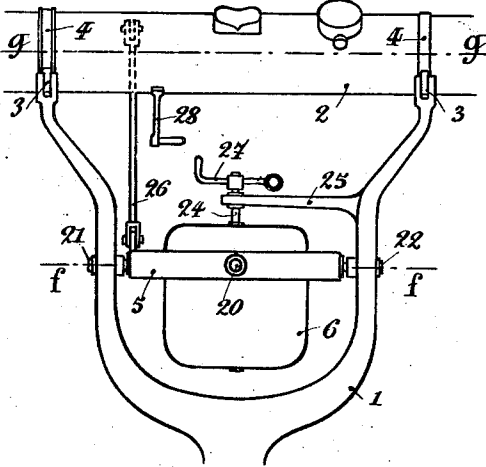


Fig. 3.

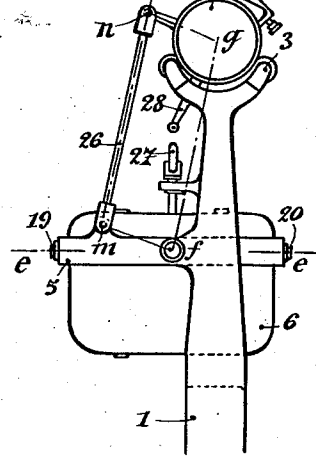


Fig. 4.

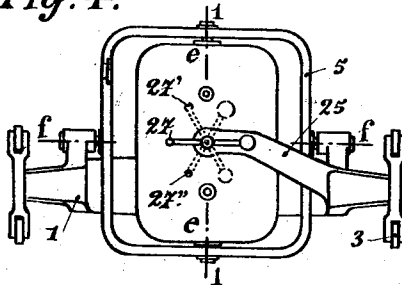
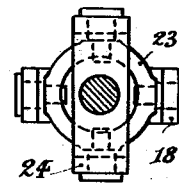


Fig. 5.



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UNITED STATES PATENT OFFICE

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STABILIZING DEVICE

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7 Claims. (Cl. 33—46)

The present invention relates to a stabilizing device for ensuring the continuous aiming in elevation of certain ships' apparatus, such as telescopes, range-finders, firing apparatus, etc., by utilizing two conjugate gyroscopic rotors.

The gyroscopic effect has already been utilized for establishing on board ships a horizon reference point in a variable direction, for example, in the direction of a moving target. For this purpose the common support of twin gyrostats having contrary precessions has been adopted as base member, that is to say, as a supporting member stabilized in elevation, the said support being suspended with only one degree of freedom along a horizontal axis perpendicular to the axes of the rotors in their mean position. The reference point obtained with such a device, however, lacks fixedness or at least requires vigilant compensation by the operator when the axis of suspension is subjected to an inclination due to the rolling, pitching or a permanent heel of the ship, and when at the same time it is subjected to a swivelling movement due to lateral aiming. In the case, which is moreover very frequent, in which such a concomitance is produced, the couples acting on the gyrostats about their individual axes of precession do not cancel each other completely. The resultant couple gives rise to a common precession driving the whole of the suspended system in a movement of elevation and consequently causing a systematic disturbance of the reference point.

This disadvantage is obviated according to the present invention by the fact that the pendulous unit employed for stabilizing and comprising the two gyrostats and their common support is suspended from the swivelling stand, the said suspension being effected by means of a gimbal frame constituting the base or reference member, to which the object or apparatus to be aimed is connected in a suitable manner. The common support of the gyrostats is adapted to oscillate relatively to the suspension frame about pivots in a line parallel to the axes of the rotors in their mean position, while the said frame itself is adapted to oscillate about pivots in a line perpendicular to the first-mentioned line, relatively to the swivelling stand which is subjected to all the movements of inclination of the ship.

Due to the two degrees of freedom which are thus provided, the pendulous unit is now only subjected, in the changes in orientation, to an angular movement about an axis substantially vertical and parallel to the axes of precession of the gyrostats. The result of this is that the dis-

turbing effect mentioned hereinbefore is not produced or remains negligible, irrespective of the inclination of the stand and the speed of lateral aiming.

As it is a question of effecting aiming by means of stabilization, it is necessary to be able to effect corrections in the reference point. The invention provides a rational means permitting the operator conveniently to apply couples to the gyrostats for effecting these corrections. The impulse mechanism comprises two shafts connected together by a universal joint, the centre of oscillation of which coincides in principle with the centre of suspension of the pendulous unit. One of the shafts is integral with the latter and actuates one of the gyrostats. The other is guided by a part integral with the stand and constitutes the actual aiming shaft, the operation of which merely requires simple and natural movements on the part of the operator.

The accompanying drawing represents by way of example a constructional form of the device and its application to a range finder.

Figure 1 is a section of the pendulous unit and the suspension frame taken along the line I—I in Figure 4, that is to say, along a vertical axial plane.

Figures 2 and 3 are, respectively, a front elevation and a side elevation of an aggregate showing the application of the device to a rangefinder.

Figure 4 is a plan view of this aggregate, the rangefinder and its connecting link having been removed.

Figure 5 is a horizontal section, taken along the line 5—5 in Figure 1, of the elevating shaft.

The swivelling stand 1 supports the rangefinder 2 by means of rollers 3 belonging to the stand and rolling tracks 4 integral with the rangefinder tube. It likewise supports, by means of a frame 5, the pendulous unit comprising chiefly a common casing 6 for two gyrostats constituted by the separate casings 7 and 8 forming stators and by the rotor masses 9 one only of which is visible, one (8) of the separate casings not being shown in section. The rotors 9 rotate in opposite directions about axes *c—c* and *d—d*.

The casings 7 and 8 are adapted to oscillate relatively to the casing 6 about vertical axes *a—a* and *b—b* called individual axes of precession, determined by the lines of the pivots 10, 11 and 12, 13. They carry respectively toothed segments 14 and 15 meshing with each other. One of them, the casing 8, also carries a smaller toothed segment 16 meshing with a pinion 17

keyed to a shaft 18, the latter being guided in the common casing 6 along an axis parallel to the axes of precession and situated in their plane. The axes of the rotors $c-c$ and $d-d$ are perpendicular to the axes of precession and in their mean position are likewise situated in the plane of the said axes of precession.

The casing 6 is pivoted to the frame 5 by pivots 19 and 20 along a horizontal axis $e-e$ which again is situated in the plane of the axes $a-a$ and $b-b$. The frame 5, in its turn, is pivoted to the stand 1 by pivots 21 and 22 along an axis $f-f$ parallel to the axis $g-g$ of the rangefinder and perpendicular to the axis $e-e$. The axes $e-e$ and $f-f$ intersect. The point in which they meet is situated above the centre of gravity of the pendulous unit and substantially coincides with the centre of articulation of the gimbal joint connecting by means of its frame 23 the shaft 18 to the aiming shaft 24, the latter being guided in its upper part by a bracket 25 integral with the stand 1. With the center of articulation of the gimbal or universal joint thus located substantially in the same plane as that defined by the pivotal axes of the casing 6 and frame 5, the distance between bracket 25 and the gimbal or universal joint remains constant regardless of the tilting movements of said casing and frame.

The frame 5 and the rangefinder 2 are connected by a coupling link 26 having its axes of articulation parallel to the axes $f-f$ and $g-g$, the projections of these various axes on the side elevation (Figure 3) being situated at the corners of a parallelogram g, f, m, n .

The aiming shaft 24 carries a crank arm 27, having its handle near a hand lever 28 (Figure 2) integral with the rangefinder.

Under the conditions of such an arrangement, theory and practice show that the resultant couple about the individual axes of precession is zero or is negligible, irrespective of the inclination of the stand, the speed of swivelling of the device and the angle between the axes of the rotors at the moment in question. The result is that any undesired precession about the axis $f-f$, that is to say, any disturbance of the aim in elevation is rendered practically impossible, irrespective moreover of the couples exerted about the said axis or, what amounts to the same thing, about the axis $g-g$.

When the operator wishes to correct or alter the aim in elevation, he imparts to the gyrostats a couple in the appropriate direction by acting upon the crank arm 27 for the necessary length of time. Because of the fact that the rotors spin in opposite directions, this movement of the stators about axes $a-a$ and $b-b$ causes a common precession of the gyroscopes about the axis $f-f$ driving in a movement in elevation the common casing 6, the suspension frame 5 and the rangefinder 2.

By continuing to move further away from their mean position, there would sometimes be a risk of the gyrostats coming into contact with their stops. The operator is warned of this by the movement of the crank arm 27 which approaches one or the other of the extreme positions 27' and 27'', said positions being indicated in any suitable manner as by marks upon either casing 6 or bracket 25, or by cooperating electrical contacts carried by shaft 24 and bracket 25, the closing of which may complete a suitable alarm circuit. The operator then releases the said crank handle for a moment in order to seize

the lever 28 and exert a compensatory impulse which returns the gyrostats into a more favourable position. In practice, this operation is always of short duration and does not require any precision.

What is claimed is:

1. In a stabilizing device, the combination of a reference member comprising a frame supported for pivotal movement about a substantially horizontal axis, a casing supported in said frame for pivotal movement about an axis substantially at right angles to and in the same horizontal plane with said first named axis, a pair of gyrostats supported in said casing, said gyrostats having opposite directions of rotation, and means coupling said gyrostats for equal and opposite movement in said casing about parallel axes normal to said first two axes, said gyrostats when in normal position having their axes of rotation substantially coaxial with one another and parallel to said second named pivotal axis.

2. In a stabilizing device, the combination of a reference member comprising a frame supported for pivotal movement about a substantially horizontal axis, a casing supported in said frame for pivotal movement about an axis substantially at right angles to said first named axis, a pair of gyrostats supported in said casing for rotation in opposite directions about substantially horizontal axes, said axes of rotation being substantially parallel to said second named pivotal axis when the gyrostats are in normal position, means coupling said gyrostator stators for equal and opposite movement in said casing about parallel axes normal to said first two axes, and means for moving the stators of said gyrostats about said last named parallel axes to apply a couple thereto for changing the position of said reference member with respect to the horizontal.

3. In a stabilizing device, the combination of a reference member comprising a frame supported for pivotal movement about a substantially horizontal axis, a casing supported in said frame for pivotal movement about an axis substantially at right angles to said first named axis, a pair of gyrostats supported in said casing for rotation in opposite directions about substantially horizontal axes and having their stators coupled together, said axes of rotation being substantially parallel to said second named pivotal axis when the gyrostats are in normal position, means mounting said gyrostator stators for pivotal movement in said casing about parallel axes normal to said first two axes, and manually operable means for moving the stators of said gyrostats simultaneously and in opposite directions about said last named parallel axes to apply a couple thereto for changing the position of said reference member with respect to the horizontal, including a shaft journaled in said casing, means for transmitting rotation of said shaft to said stators, and a manually operable shaft connected to said first named shaft by a universal joint lying substantially in the plane defined by said first and second named pivotal axes.

4. In apparatus of the type embodying a supporting member adapted to be rotated in azimuth and a sighting member mounted on said supporting member for movement about a normally horizontal axis and adapted to be continuously aimed at any desired object, means for stabilizing in elevation the line of sight of said sighting member comprising a frame supported by said supporting member for pivotal movement about a normally horizontal axis parallel to said first

named axis, a casing supported in said frame for pivotal movement about an axis substantially at right angles to and in the same plane with the pivotal axis of said frame, a pair of gyrostats supported in said casing for stabilizing said frame in any desired plane with respect to the horizontal, said gyrostats having their axes of rotation substantially parallel to the pivotal axis of said casing when in normal position and having their stators pivotally mounted and coupled together for movement with respect to said casing about axes perpendicular to said axes of rotation, and means connecting said frame and said sighting device for maintaining the line of sight fixed relatively to the plane of said frame.

5. In apparatus of the type embodying a supporting member adapted to be rotated in azimuth and a sighting member mounted on said supporting member for movement about a normally horizontal axis and adapted to be continuously aimed at any desired object, means for stabilizing in elevation the line of sight of said sighting member comprising a frame supported by said supporting member for pivotal movement about a normally horizontal axis parallel to the axis of said sighting member, a casing supported in said frame for pivotal movement about an axis substantially at right angles to and in the same plane with the pivotal axis of said frame, a pair of gyrostats supported in said casing for stabilizing said frame in any desired plane with respect to the horizontal, said gyrostats having their axes of rotation substantially parallel to the pivotal axis of said casing when in normal position and having their stators pivotally mounted and coupled together for movement with respect to said casing about axes perpendicular to said axes of rotation, and a link connecting said frame and said sighting device, said link being at all times parallel to the plane defined by the normally horizontal axes of said sighting device and said frame, whereby the line of sight of the former is maintained fixed relatively to the plane of the latter.

6. In apparatus of the type embodying a supporting member adapted to be rotated in azimuth and a sighting member mounted on said supporting member for movement about a normally horizontal axis and adapted to be continuously aimed at any desired object, means for stabilizing in elevation the line of sight of said sighting member comprising a frame supported by said supporting member for pivotal movement about a normally horizontal axis parallel to the axis of said sighting member, a casing supported in said frame for pivotal movement about an axis substantially at right angles to and in the same plane with the pivotal axis of said frame, a pair of gyrostats supported in said casing for stabilizing said frame in any desired plane with respect to the hori-

zontal, said gyrostats having their axes of rotation substantially parallel to the pivotal axis of said casing when in normal position and having their stators pivotally mounted and coupled together for movement with respect to said casing about axes perpendicular to said axes of rotation, a link connecting said frame and said sighting device, said link being at all times parallel to the plane defined by the normally horizontal axes of said sighting device and said frame, whereby the line of sight of the former is maintained fixed relatively to the plane of the latter, and means for applying a couple to said gyrostats to vary the plane of stabilization, including a manually actuatable shaft rotatably supported by said supporting member in a fixed vertical position relative thereto, a shaft rotatably journaled in said casing, means for transmitting rotation of said last named shaft to the stators of said gyrostats, and a universal joint connection between said shafts lying substantially in the plane defined by the pivotal axes of said frame and casing.

7. In apparatus of the type embodying a supporting member adapted to be rotated in azimuth and a sighting member mounted on said supporting member for movement about a normally horizontal axis and adapted to be continuously aimed at any desired object, means for stabilizing in elevation the line of sight of said sighting member comprising a frame supported by said supporting member for pivotal movement about a normally horizontal axis, a casing supported in said frame for pivotal movement about an axis substantially at right angles to and in the same plane with the pivotal axis of said frame, a pair of oppositely rotating gyrostats supported in said casing for stabilizing said frame in any desired plane with respect to the horizontal, the axes of rotation of said gyrostats, when in normal position, being substantially coaxial and parallel to the pivotal axis of said casing, the stators of said gyrostats being pivotally mounted for movement together in opposite directions with respect to said casing about axes perpendicular to said axes of rotation, means connecting said frame and said sighting device for maintaining the line of sight fixed relatively to the plane of said frame, and means for applying a couple to said gyrostats to vary the plane of stabilization including a manually actuatable shaft rotatably supported by said supporting member in a fixed vertical position relative thereto, a shaft rotatably journaled in said casing, means for transmitting rotation of said last named shaft to the stators of said gyrostats and thereby move the rotor axes out of axial alignment, and a universal joint connection between said shafts lying substantially in the plane defined by the pivotal axes of said frame and casing.

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