

PATENT SPECIFICATION

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DRAWINGS ATTACHED



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(54) IMPROVEMENTS IN OR RELATING TO STABILIZED BASE MOUNTS

(71) We, N.V. HOLLANDSE SIGNAAL-
 PARATEN, of 40, Zuidelijke Havenweg, Hen-
 gelo (0), The Netherlands, a company
 organized and existing under the laws of The
 Netherlands, do hereby declare the inven-
 tion, for which we pray that a patent may
 be granted to us, and the method by which
 it is to be performed, to be particularly des-
 cribed in and by the following statement:—

The invention relates to stabilized base
 mounts of the type comprising a base mem-
 ber supported by a gimbal system for move-
 ment about two orthogonal axes and a gyro-
 scopically controlled servo-drive system for
 stabilizing said base member about said two
 orthogonal axes.

Such stabilized base mounts find particu-
 lar application aboard ships, where the two
 orthogonal axes form roll and pitch axes;
 the roll axis lying in a fixed position parallel
 to the fore and aft line of the ship and sup-
 porting the pitch axis, which is in parallel
 to the earth's surface.

The base member may constitute or carry
 a training axis, which may in turn support
 an elevating axis, thus providing a developed
 base mount stable about three or four axes.
 With such developed base mounts no
 accelerations in training movements occur,
 resulting from roll and pitch and no com-
 puters are required, such base mounts are
 particularly suitable for mounting a radar
 antenna or other sighting means, such as
 for instance a television camera and/or in-
 frared camera, especially when these sighting
 means have to rotate at high speeds as in
 searching and/or tracking operations. Their
 applicability to stabilization problems is,
 however, severely limited by the mechanical
 difficulties encountered. These difficulties
 arise from the fact that separate servo drives
 are needed for controlling the rotation about
 each one of the different axes. As a result
 the known stabilized base mounts are rela-
 tively massive and tend to be top-heavy.

It is an object of the present invention to
 provide a base mount in which the above
 mentioned difficulties have been substantially
 overcome.

According to the invention we provide a
 stabilized base mount of the type compris-
 ing:

— a base member supported by a
 gimbal system for movement about two
 orthogonal axes,

— longitudinally extending transmis-
 sion means having one end connected to
 the gimbal systems, and

— a gyroscopically controlled servo-
 drive system connected to the other end
 of the transmission means, so that when
 mounted on a structure subject to roll and
 pitch with the transmission means in ver-
 tical disposition, the drive system acts
 through the transmission means and gim-
 bal system to stabilize the base member
 about said two orthogonal axes during
 rolling and pitching movements of the
 structure.

Other features of the invention will be-
 come apparent from the following detailed
 description, when considered in conjunction
 with the accompanying drawings, wherein

Fig. 1 is a cut away perspective view of a
 stabilized base mount according to the inven-
 tion showing in detail the base member to be
 stabilized and the manner in which it is sus-
 pended;

Fig. 2 is an over-all perspective view of
 the stabilized base mount according to the
 invention, and

Fig. 3 is a perspective view of a preferred
 embodiment of a servo drive system.

In these figures, like reference numerals
 denote like parts.

In the following description, reference is
 made to "sets of identical parts", even if
 only one part of such a set is actually visible
 in the relevant figure. However, since the
 arrangement shown is symmetrical with re-
 spect to two orthogonal axes, it will be
 understood, that the other part of such a
 set is present in a position symmetrically
 opposite the part shown.

Referring to Fig. 1, reference numeral 1
 designates a base member to be stabilized
 about two orthogonal axes; a roll axis 2 and
 a pitch axis 3. To this end, there is provided

a gimbal system comprising a set of identical supports, such as 4, and a gimbal ring 5 having a first set of identical hollow shafts, such as 6 and a second set of identical hollow shafts, such as 7. Both sets of shafts are rigidly connected to said gimbal ring 5 to constitute the said roll and pitch axes respectively. The first set of shafts constituting the roll axis is rotatably mounted in the supports 4 which are rigid with respect to, for instance, the deck plane of a ship. The second set of shafts constituting the pitch axis is mounted in bearings of base member 1, so as to permit the base member to rotate about these shafts. Base member 1 is hollow and has a cylindrical portion which extends vertically when the base member is stabilized. This cylindrical portion, therefore, may be used directly as a training axis or may carry a platform onto which any type of sighting means may be mounted for training about a vertical axis and an elevating axis.

Base member 1 is held in a given fixed position with respect to a stable reference. The stable reference is provided by gyroscopes 8 and 9, the respective housings of which are secured in the interior of hollow shafts 6 and 7 respectively. The two gyroscopes have two degrees of freedom. Gyroscope 8 has a spin axis in the horizontal plane and is oriented in a given direction (for example North); it is therefore termed the azimuth or directional gyroscope, which supplies synchro-data used, inter alia, for calculating corrections required in view of deviations in azimuth owing to yawing of the ship. Since the gyroscope 8 does not play a direct part in the stabilization of base member 1, it will be left out of consideration here. Gyroscope 9 has a spin axis which by means of the conventional gyroscopic control means is held in an accurately vertical position. This gyroscope, which is termed the vertical gyroscope, supplies at its two outputs 10 and 11, formed by synchros (not shown), two error voltages, the magnitude and sign of which are a measure of the deviation of base member 1 from zero position as determined by the vertical spin axis of the gyroscope. These error voltages are supplied through respective servo amplifiers (not shown), to a servo drive system 12 (Fig. 3) to be described hereinafter. This servo drive system, when properly energized, is capable of tilting the base member to be stabilized about the hollow shafts 6 and 7, so that these error voltages are reduced to their zero value.

A particularly advantageous stabilized base mount is shown in the Figures. Fig. 2 shows a hollow column 13 secured in a position perpendicular to the deck plane with means 14 for mounting the gimbal system of Fig. 1 at the upper end and casing 16 enclosing the servo drive system of Fig. 3. (described

below) at the lower end. Transmission means 15 (Fig. 3) controlled by said servo drive system 12 extends through the length of the interior of said hollow column 13 to act on said base member to be stabilized.

In the preferred embodiment, hollow column 13 is of cylindrical shape except for its lower end portion, which is secured to the delta-shaped casing 16 enclosing the servo drive system 12. This box is secured to the deck, preferably by means of shock absorbers (not shown) supporting said box at its three corners.

By mounting the servo drive system in casing 16 at the lower end portion of hollow column 13, instead of directly on the gimbal system, the weight and size of the gimbal system can be materially reduced and the centre of gravity of the whole assembly lowered. As a result, hollow column 13 as well as the shock absorbers may be less heavy. At the same time the shock absorbers can be closer together as their relative spacing will be determined mainly by the size of casing 16. Hence, a saving of valuable deck space is obtained. Moreover, owing to the reduced massiveness of the gimbal system, the latter may be realized in a manner permitting its total enclosure. To this end, as shown in Fig. 1, the set of supports 4 are mounted on a top-plate 14 of column 13 and in a position such that the point of intersection of roll axis 2 and pitch axis 3 is on the longitudinal axis 17 of hollow column 13. The set of shafts constituting the roll axis 2 and the set of shafts constituting the pitch axis 3 are both rigidly connected to the gimbal ring 5, so that they project inwardly therefrom; the outer diameter of said gimbal ring being slightly smaller than the outer diameter of hollow column 13. Base member 1 is provided with a circular cover plate 18 fixedly connected thereto and having a circular hole at its centre, through which the cylindrical portion of base member 1 protrudes. The outer diameter of cover plate 18 is chosen to be equal to the outer diameter of hollow column 13. The gimbal system is enclosed by said circular cover plate 18 and a rubber bellows 19, the end portions of which are tightly fitted around the outer circumference of cover plate 18 and hollow column 13, by means of clamp rings 20 and 21 respectively.

In the preferred embodiment of the stabilized base mount thus far described, use is made of a servo drive system as illustrated in Fig. 3.

Referring thereto, reference numeral 22 designates a frame to be stabilized about two orthogonal axes, i.e. an associated roll axis 23 and pitch axis 24. To this end, the stabilized base mount is provided with a second gimbal system comprising a set of supports 25, 26 and a gimbal frame 27. 130

Frame 22 and gimbal frame 27 are each provided with a set of hollow shafts, such as 29 and 28 respectively. Each set of hollow shafts is rigidly connected to the relevant frame and projects outwardly therefrom to constitute the pitch and roll axes 24 and 23 respectively. The set of shafts constituting the roll axis 23 is rotatably mounted in the set of supports 25, 26 so as to permit gimbal frame 27 to rotate with respect to said supports. These supports are rigidly secured to the inside top wall of casing 16 (Fig. 2) and in a position such that the central axis 17 of hollow column 13 passes not only through the point of intersection of roll axis 2 and pitch axis 3, but also through the point of intersection of roll axis 23 and pitch axis 24; roll axis 2 and roll axis 23 being in parallel to one another. Gimbal frame 27 is further provided with a gear segment 30 which is fixedly connected to said gimbal frame. This gear segment is partially enclosed by a gear box 31 constituting the lower portion of support 25. Gear box 31 comprises a schematically presented gear train 32 and a reversible electric motor 33, which may apply a rotational movement to gimbal frame 27 by driving gear segment 30 via said gear train 32 in the one or in the other sense. The maximum angle through which gimbal frame 27 may rotate with respect to said supports is limited by stops 34 and 35. These stops are on the outside back wall of the supports 25, 26 and in a position symmetrical with respect to the roll axis 23. They cooperate with a member 36 which is fixedly connected to one end of a torsion bar 37 extending centrally through the length of said hollow shaft 28. The other end of said torsion bar is rigidly connected to gimbal frame 27, so that member 36 rotates with gimbal frame 27. When the member 36 meets a stop, torsion bar 37 operates as a shock-reducing resilient means.

The set of shafts constituting the pitch axis 24 is rotatably mounted in bearings of gimbal frame 27, so as to permit frame 22 to rotate with respect to said gimbal frame. Frame 22 is provided with a gear segment 38 which is fixedly connected to said frame 22. Gear segment 38 is partially enclosed by a gear box 39 forming part of gimbal frame 27. Gear box 39 comprises a schematically presented gear train 40 and a reversible electric motor 41 which may apply a rotational movement to frame 22 by driving gear segment 38 via gear train 40 in the one or in the other sense. The maximum angle through which frame 22 may rotate with respect to gimbal frame 27 is limited by stops such as 42 and 43. These stops are on the outside of gimbal frame 27 and in a position symmetrical with respect to pitch axis 24. They co-operate with portions, such as 44,

46, projecting from a cover 46. The latter is fixedly connected to one end of a torsion bar 47 extending centrally through the length of hollow shaft 29. The other end of this torsion bar is rigidly connected to frame 22; so that cover 46 and the projecting portions 44, 45 rotate with frame 22. When the projecting portions meet the stops, torsion bar 47 operates as a shock-reducing resilient means.

Frame 22 and base member 1 are linked to one another in a manner such that the cylindrical portion of base member 1 will be in the vertical position when frame 22 is horizontal. To this end, use is made of mechanical transmission means 15 which extend through the length of the interior of hollow column 13. In the embodiment shown these transmission means are constituted by four identical connecting rods. Frame 22 is provided with four shafts such as 48 and 49 which are disposed in parallel to the roll axis 23 and in positions symmetrical with respect to the roll and pitch axes 23 and 24 respectively. Likewise base member 1 in Fig. 1 is provided with four shafts, such as 50, which are disposed in parallel to the roll axis 2 and in positions symmetrical with respect to the roll and pitch axes 2 and 3 respectively. The relative spacing of the four shafts in frame 22 is equal to the relative spacing of the four shafts of base member 1, so that each one of the four shafts in frame 22 may be said to form a pair with one of the four shafts of base member 1. The shafts of each pair are interconnected by one of the four connecting rods 15. In connecting these rods to the shafts, use is made of spherical bearings such as 51 in Fig. 1 and 52 in Fig. 3, providing two degrees of freedom of motion. Since these connecting rods extend through the length of the interior of hollow column 13, the great advantage is obtained that, with the exception of the protruding cylindrical portion of base member 1, all moving parts of the stabilized base mount are totally enclosed.

Another advantage of the stabilized base mount here described is that even if hollow column 13 is bent, which may happen under adverse conditions, this will not affect the angular position of base member 1, owing to the fact that the identical connecting rods will remain in parallel at all times.

As stated above, when frame 22 is in the horizontal position, the cylindrical portion of base member 1 will be vertical. Any roll and pitch angles applied to the deck plane will be measured by the vertical gyroscope 9 and corresponding error voltages occur at its outputs 10 and 11. These error voltages are applied to control reversible motors 33 and 41 respectively, which tilt

frame 22 and hence base member 1 to reduce these error voltages to their zero value.

In the embodiment described use is made of four connecting rods 15, it will be clear, however, that a smaller number of connecting rods may suffice.

In the embodiment described, the gyroscopes are incorporated in the base mount assembly. This construction, although advantageous, is not essential, as it is also possible to arrange the gyroscopes at a distance remote from the base member to be stabilized, for example in the metacentre of the ship.

Finally, it may be observed that the stabilized base mount disclosed herein is not limited to the use of the servo drive system as shown and described with reference to Fig. 3. Other types of servo drive systems, such as, for example, a hydraulic servo drive system can be used as well.

WHAT WE CLAIM IS:—

1. A stabilized base mount, comprising:
— a base member supported by a gimbal system for movement about two orthogonal axes.

— longitudinally extending transmission means having one end connected to the gimbal system, and

— a gyroscopically controlled servo-drive system connected to the other end of the transmission means, so that when mounted on a structure subject to roll and pitch with the transmission means in vertical disposition, the drive system acts through the transmission means and gimbal system to stabilize the base member about said two orthogonal axes during rolling and pitching movements of the structure.

2. A stabilized base mount as claimed in claim 1, wherein the servo-drive system is secured to the lower end of a hollow column enclosing the transmission means, the gimbal system being mounted on the transmission means at the upper end of said column.

3. A stabilized base mount as claimed in claim 2, wherein said gimbal system is mounted at the top of said hollow column in a position such that the point of intersection of the orthogonal axes of said gimbal system lies on the longitudinal axis of said hollow column.

4. A stabilized base mount as claimed in claim 1, 2 or 3, wherein said gimbal system comprises a gimbal ring having two sets of hollow shafts projecting inwardly therefrom to constitute a roll and pitch axis respectively.

5. A stabilized base mount as claimed in claim 4, wherein one of the hollow shafts constituting the pitch axis accommodates a vertical gyroscope producing error voltages which in magnitude and sense correspond to

the deviation of said base member from the zero position as determined by said vertical gyroscope.

6. A stabilized base mount as claimed in claim 4, wherein said hollow column is of circular cross section and wherein the outer diameter of said gimbal ring is smaller than the outer diameter of said hollow column.

7. A stabilized base mount as claimed in claim 1, wherein said base member comprises a cylindrical portion which extends in the vertical when said base member is stabilized.

8. A stabilized base mount as claimed in claim 7, wherein said base member is provided with a circular cover plate fixedly connected thereto and having a central hole through which the cylindrical portion of said base member protrudes.

9. A stabilized base mount as claimed in claims 6 and 8, wherein the outer diameter of said cover plate and the outer diameter of said hollow column are equal and wherein the gimbal system is totally enclosed by means of said cover plate and a bellows the end portions of which are tightly fitted around the outer circumference of said cover plate and the upper portion of said hollow column.

10. A stabilized base mount as claimed in claim 2, wherein the lower end portion of said hollow column is secured to a casing enclosing said servo drive system.

11. A stabilized base mount as claimed in claims 3 and 10, wherein said servo drive system comprises a frame suspended by a second gimbal system having orthogonal axes, said second gimbal system being mounted in said casing in a manner such that the point of intersection of said orthogonal axes lies on the longitudinal axis of said hollow column.

12. A stabilized base mount as claimed in claims 5 and 11, wherein said frame is stabilized about said orthogonal axes by means of direct gearing from electric motors to which the error voltages are applied.

13. A stabilized base mount as claimed in claim 7 and 12, wherein said transmission means are constituted by a number of connecting rods linking said stabilized frame to said base member in a manner such that the cylindrical portion of said base member extends in the vertical when said frame is in the horizontal position.

14. A stabilized base mount substantially as herein shown and described with reference to the accompanying drawings.

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frame 22 and hence base member 1 to reduce these error voltages to their zero value.

In the embodiment described use is made of four connecting rods 15, it will be clear, however, that a smaller number of connecting rods may suffice.

In the embodiment described, the gyroscopes are incorporated in the base mount assembly. This construction, although advantageous, is not essential, as it is also possible to arrange the gyroscopes at a distance remote from the base member to be stabilized, for example in the metacentre of the ship.

Finally, it may be observed that the stabilized base mount disclosed herein is not limited to the use of the servo drive system as shown and described with reference to Fig. 3. Other types of servo drive systems, such as, for example, a hydraulic servo drive system can be used as well.

WHAT WE CLAIM IS:—

1. A stabilized base mount, comprising:
 - a base member supported by a gimbal system for movement about two orthogonal axes,
 - longitudinally extending transmission means having one end connected to the gimbal system, and
 - a gyroscopically controlled servo-drive system connected to the other end of the transmission means, so that when mounted on a structure subject to roll and pitch with the transmission means in vertical disposition, the drive system acts through the transmission means and gimbal system to stabilize the base member about said two orthogonal axes during rolling and pitching movements of the structure.
2. A stabilized base mount as claimed in claim 1, wherein the servo-drive system is secured to the lower end of a hollow column enclosing the transmission means, the gimbal system being mounted on the transmission means at the upper end of said column.
3. A stabilized base mount as claimed in claim 2, wherein said gimbal system is mounted at the top of said hollow column in a position such that the point of intersection of the orthogonal axes of said gimbal system lies on the longitudinal axis of said hollow column.
4. A stabilized base mount as claimed in claim 1, 2 or 3, wherein said gimbal system comprises a gimbal ring having two sets of hollow shafts projecting inwardly therefrom to constitute a roll and pitch axis respectively.
5. A stabilized base mount as claimed in claim 4, wherein one of the hollow shafts constituting the pitch axis accommodates a vertical gyroscope producing error voltages which in magnitude and sense correspond to

the deviation of said base member from the zero position as determined by said vertical gyroscope.

6. A stabilized base mount as claimed in claim 4, wherein said hollow column is of circular cross section and wherein the outer diameter of said gimbal ring is smaller than the outer diameter of said hollow column.

7. A stabilized base mount as claimed in claim 1, wherein said base member comprises a cylindrical portion which extends in the vertical when said base member is stabilized.

8. A stabilized base mount as claimed in claim 7, wherein said base member is provided with a circular cover plate fixedly connected thereto and having a central hole through which the cylindrical portion of said base member protrudes.

9. A stabilized base mount as claimed in claims 6 and 8, wherein the outer diameter of said cover plate and the outer diameter of said hollow column are equal and wherein the gimbal system is totally enclosed by means of said cover plate and a bellows the end portions of which are tightly fitted around the outer circumference of said cover plate and the upper portion of said hollow column.

10. A stabilized base mount as claimed in claim 2, wherein the lower end portion of said hollow column is secured to a casing enclosing said servo drive system.

11. A stabilized base mount as claimed in claims 3 and 10, wherein said servo drive system comprises a frame suspended by a second gimbal system having orthogonal axes, said second gimbal system being mounted in said casing in a manner such that the point of intersection of said orthogonal axes lies on the longitudinal axis of said hollow column.

12. A stabilized base mount as claimed in claims 5 and 11, wherein said frame is stabilized about said orthogonal axes by means of direct gearing from electric motors to which the error voltages are applied.

13. A stabilized base mount as claimed in claim 7 and 12, wherein said transmission means are constituted by a number of connecting rods linking said stabilized frame to said base member in a manner such that the cylindrical portion of said base member extends in the vertical when said frame is in the horizontal position.

14. A stabilized base mount substantially as herein shown and described with reference to the accompanying drawings.

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