Oct. 4, 1949. F. E. GRAY 2,483,826

GYROSCOPE

Filed Dec. 28, 1944 5 Sheets-Sheet 1

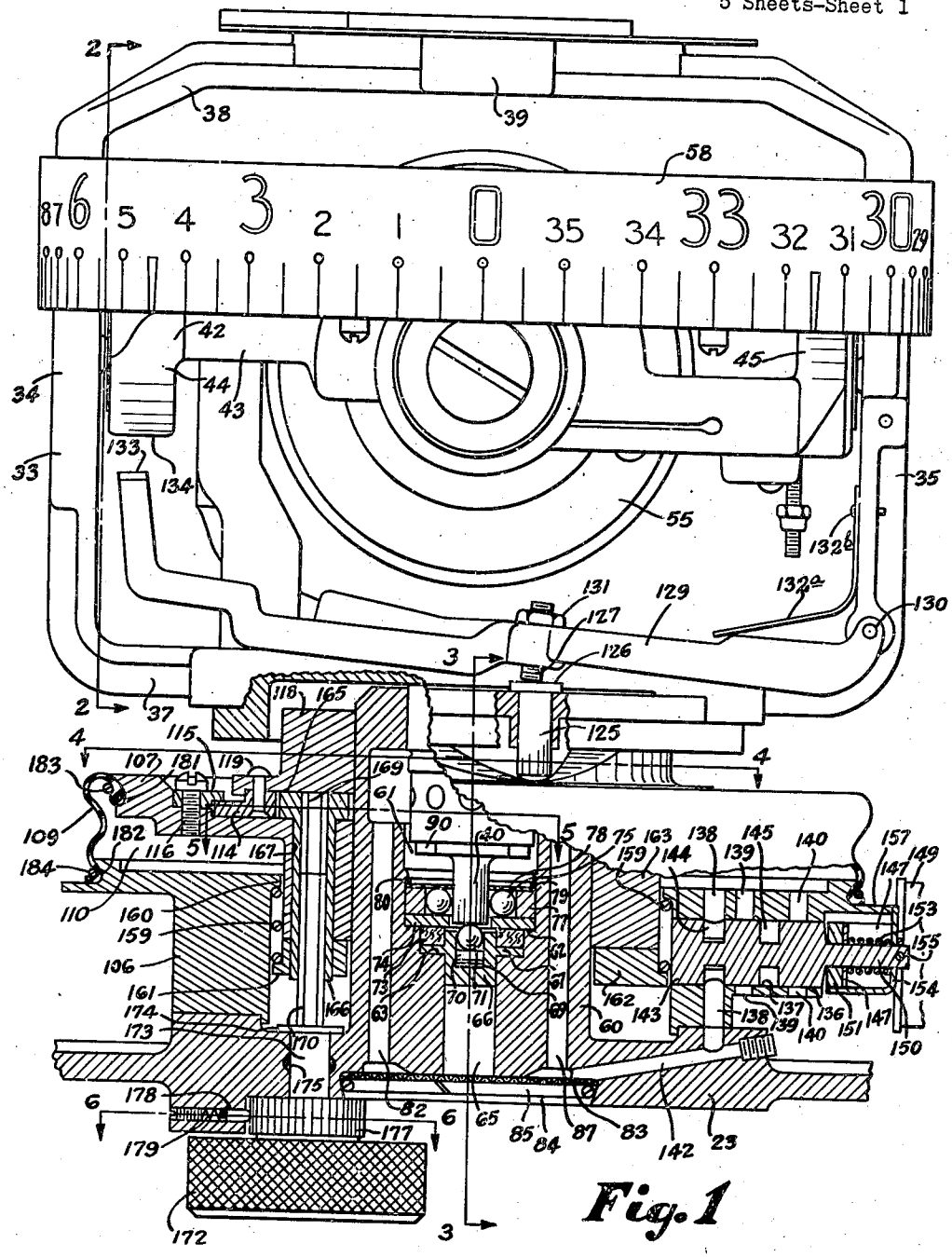

Fig. 1

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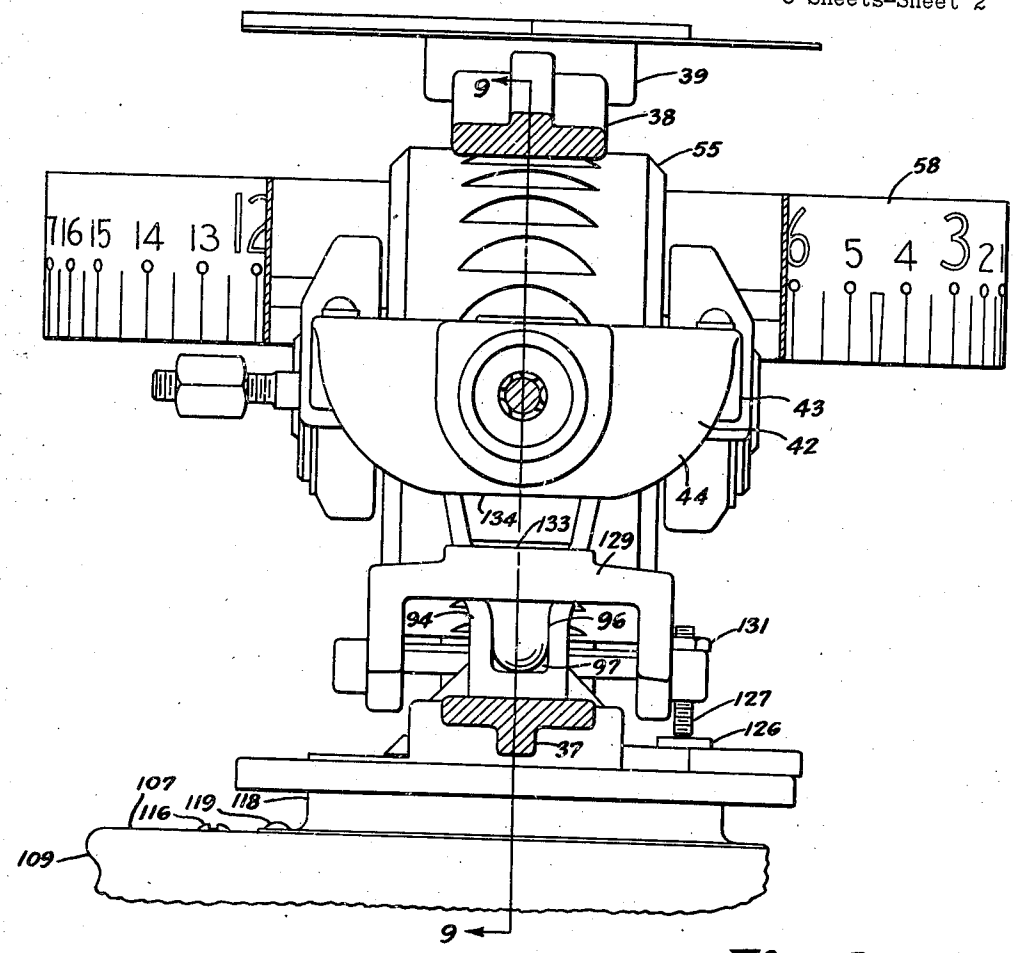

Fig. 2.

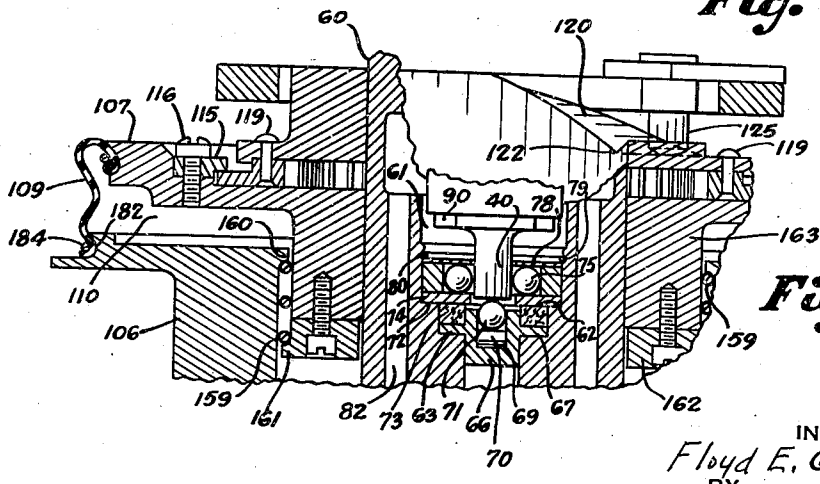

Fig. 3.

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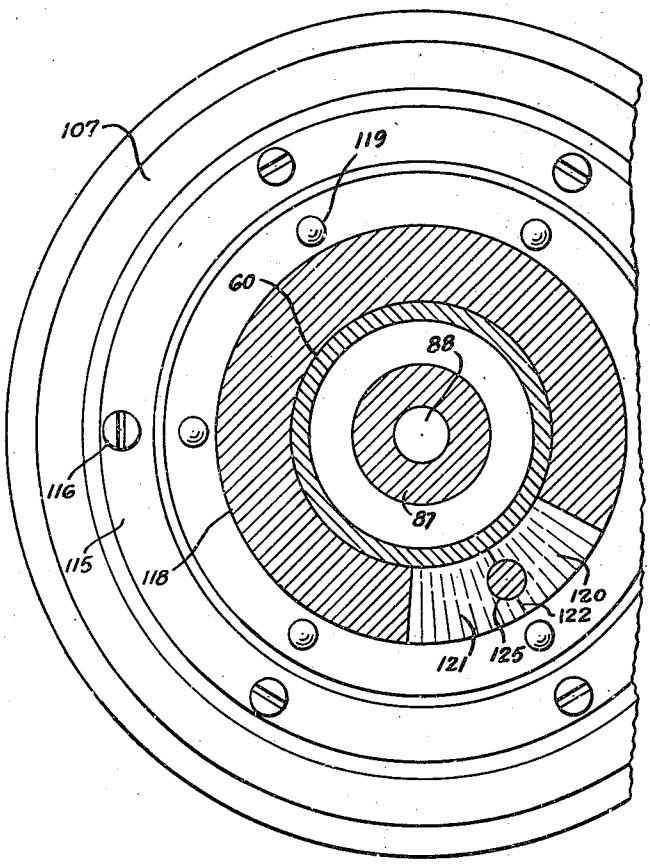

Fig. 4.

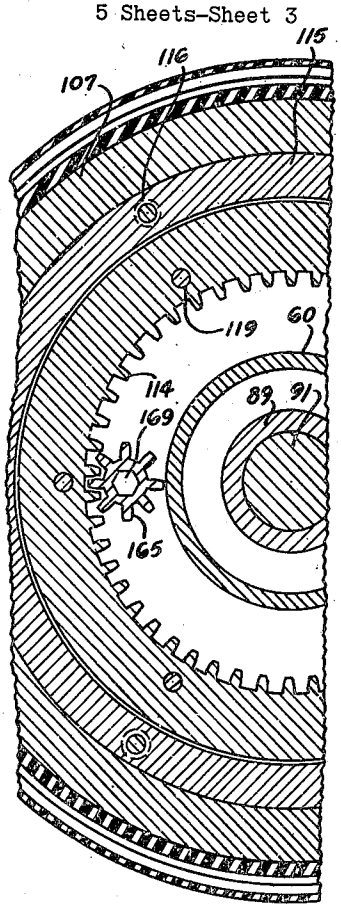

Fig. 5.

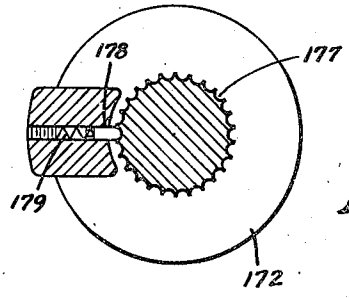

Fig. 6.

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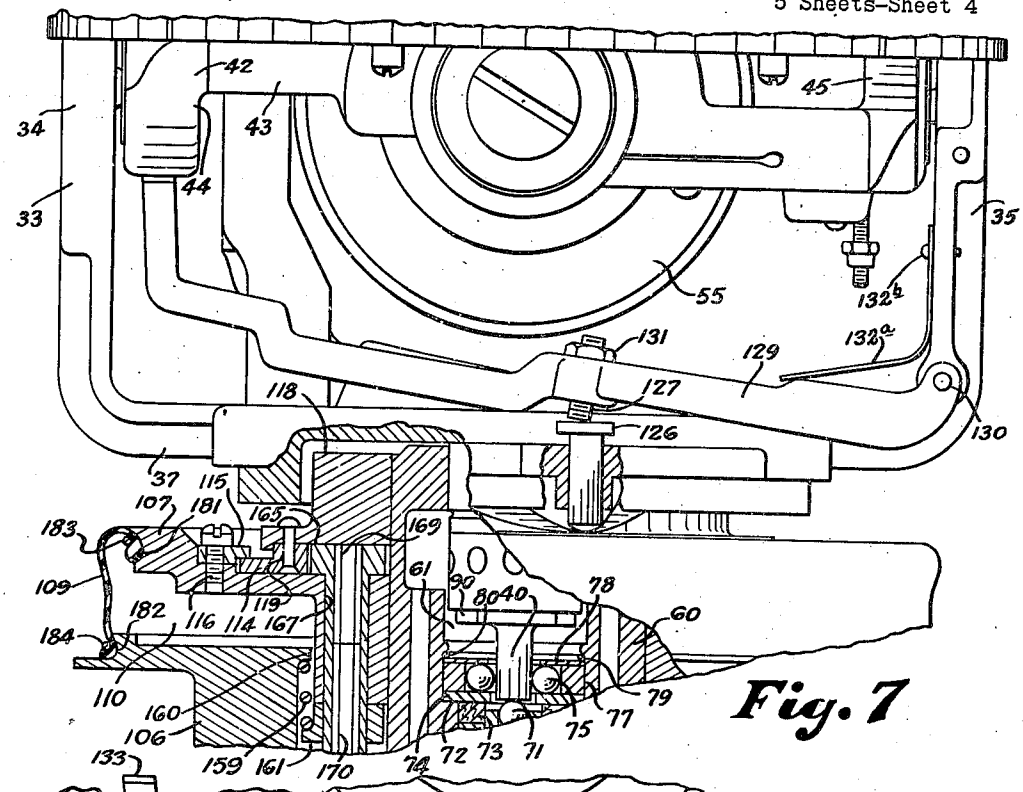

Fig. 7

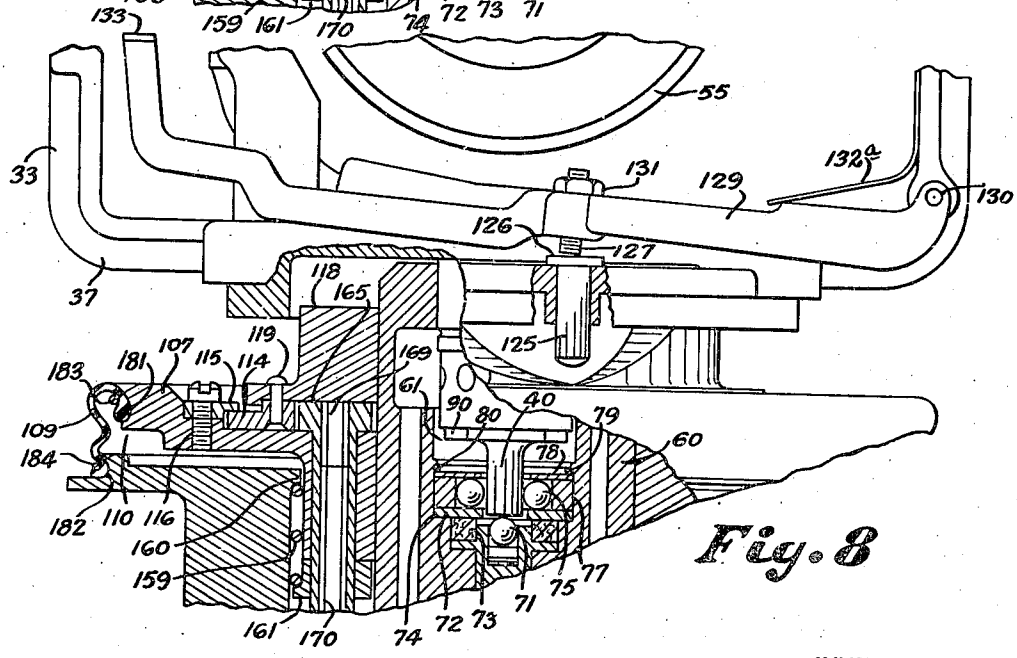

Fig. 8

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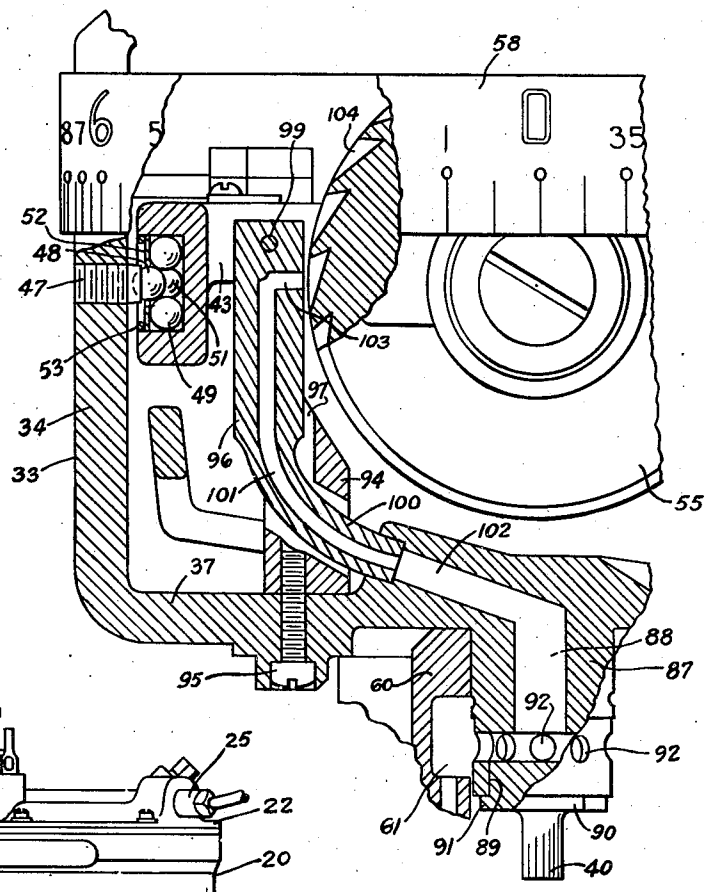

Fig. 9

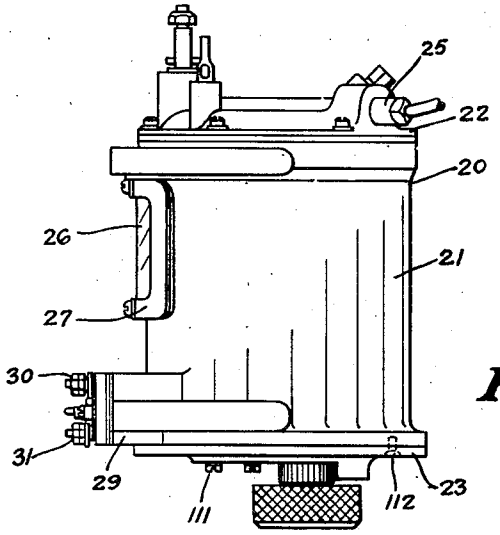

Fig. 10

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GYROSCOPE

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4 Claims. (Cl. 74—5.14)

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The present invention relates to caging devices for instruments employing gimbal rings and is more particularly directed to caging devices for gyroscopes.

One of the objects of the present invention is to provide a caging device which is operated by a movable wall of a housing or casing forming a variable capacity chamber and in which the movable wall is connected with the stationary wall of a housing by an expansive and flexible sealing sleeve.

Another object of the present invention is to provide a cam on the movable wall and a cam follower associated with a gimbal caging element, and to provide for adjusting the position of the cam with respect to the wall.

In carrying out the last mentioned object, it is another object of the present invention to provide a driving gear on the movable wall and a cooperating gear on the cam through which the relative position of the cam with respect to the movable wall can be adjusted at will.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a side view of a gyroscope with the casing therefor removed and showing substantially all of the lower casing in cross section;

Fig. 2 is a sectional view of the upper part of the gyroscope, the section being taken on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view of the lower part of the gyroscope, the section being taken on line 3—3 of Fig. 1;

Figs. 4 and 5 are fragmentary sectional views taken respectively on the lines 4—4 and 5—5 of Fig. 1;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 1;

Figs. 7 and 8 are fragmentary views partly in section showing the movable wall of the casing in different positions from that shown in Fig. 1;

Fig. 9 is a fragmentary view partly in elevation and partly in section, the section being taken on line 9—9 of Fig. 2; and

Fig. 10 is a side view of the gyroscope on a smaller scale turned 180° from that shown in Fig. 1.

Although the present invention is applicable to many instruments of the type employing a gimbal ring or gimbal rings, it has been shown and

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described in connection with a gyroscope employing two gimbal rings.

Referring first to Fig. 10, the gyroscope 20 comprises a main casing 21 having a top end cover 22 and a bottom end cover 23. The top end cover 22 includes a fitting 25 which is arranged to be connected with a source of low pressure for the purpose of creating a partial vacuum within the casing 21. The front of the casing 21 is provided with a transparent window 26 held in place by a frame 27. An electro-magnet is carried in the hollow boss portion 29 of the casing 21 and this electro-magnet is connected by terminals 30 and 31 to an electric circuit.

Referring more in detail to the drawings, the gyroscope includes an outer gimbal ring 33 including spaced uprights 34 and 35 which are connected with one another at the bottom by portion 37 and at the top by portion 38. An upper bearing is formed in the central part 39 of the portion 38 and the lower portion 37 carries a pintle 40. The central portions of the uprights 34 and 35 carry bearings for a second gimbal ring 42 including similar front and rear portions 43 and end portions 44 and 45. One form of bearing for the gimbal ring 42 is shown in Fig. 9 wherein the upright 34 carries a screw 47 having a socket for a hardened ball 48 which cooperates with a series of like balls 49 arranged in ring formation within the socket 51 in the end 44 of the gimbal ring 42. The balls 49 are held in position by a retaining ring 52 which in turn is held in position by a circularly shaped split ring formed of resilient material. The same type of bearing is provided at the opposite side of the gimbal rings. Thus it will be seen that the gimbal ring 42 is mounted for rotation on a horizontal axis. A rotor 55 is suitably journalled in the opposite portions 43.

An indicator in the form of a band 58 is carried by the outer gimbal ring 33 and is viewable through the window 26. This indicator is marked in degrees and the window 26 perferably carries a vertical disposed hair line with which the markings on the indicator 58 are arranged to register.

The bearing for the upper part of the outer gimbal ring 33 may be similar to that shown in Fig. 9 in which the screw 47 is carried in the upper cover 22 and the cone or the ball carried by the screw will cooperate with balls similar to balls 49 disposed within the part 39.

The bottom cover 23 includes a centrally disposed and upwardly extending boss 69 and this boss is drilled and counterbored to provide an upper chamber 61, a circular shoulder 62, a

smaller diameter shoulder 63 therebelow and a hole 65. A plug 66 fits within the hole 65 and is provided with a circularly shaped flange 67 which rests upon the shoulder 63. Plug 66 is bored to receive shims 69 and a hardened steel block 70. A hardened steel ball 71 is disposed within the bore of the plug 66 and the bottom of the pintle 40 rests upon this ball. A washer shaped oil bearing pad 73 surrounds the upper part of plug 66 and rests upon flange 67. This pad 73 is retained in position by a hardened steel washer shaped disc 74 which rests upon the shoulder 62. A series of circularly arranged hardened steel balls 75 surround the pintel 40 and ride upon the disc 74. These balls are held in position by a retaining ring 77. The retaining ring and the balls are held in position by a metallic disc 78 which in turn is held in position by a circularly shaped split ring 79. This ring 79 is formed of resilient material and is resiliently held in a circular groove 80 formed in the boss 60.

From the foregoing, it will be seen that the gimbal 33 is retained in position between the upper bearing, contained in the portion 39 and the top cover 22, and the lower bearing 71, yet it is free to rotate about a vertical axis.

A plurality of vertically extending holes 82 are connected with the upper chamber 61 through the screen 83 to the exterior of casing 21. Screen 83 rests within a recess 84 in the bottom of the cover 23 and is held in place by a split ring 85.

Referring particularly to Fig. 9, it will be seen that the lower portion 37 of gimbal ring 33 is provided with a hub like portion 87. This hub like portion is provided with a central bore 88 and a counter-bored portion 89 into which is pressed a plug 90 having a flange shoulder 91 which bears against the bottom of portion 87. The pintle 40 is formed integrally with the plug 90. The lower part of hub 87 is provided with a series of lateral holes 92 to establish intercommunication between passage 61 in the boss 60 and passage 88.

An upwardly extending bracket 94 is secured to the top side of the bottom portion 37 of the gimbal ring 33 by a screw 95. The upper part of this bracket is bifurcated to receive a tube 96 which is clamped between the tines 97 of the bracket 94 by a screw 99. The tube is formed into a curved section 100 and the passage 101 thereof is connected with a passage 102 which extends laterally from and is connected with the passage 88. Passage 101 merges into a passage 103 extending toward the rotor 55. The end of passage 103 terminates adjacent the periphery of the rotor and the rotor is provided with a series of notches 104 which completely surround the rotor. When a partial vacuum is present within the casing 21, air will be directed through passages 82, chamber 61, holes 92, passages 88, 102, 101 and 103. Air impinging upon the walls of the notches will cause rotation of the rotor 55.

Due to drifting of the gimbal rings, it is necessary from time to time to cage the same, that is, to realign the axis of the rotor 55. In order to accomplish this, it is necessary to shift the position of the gimbal rings. In the present illustration, this is accomplished pneumatically. For this purpose there is provided two spaced walls 106 and 107, the periphery of which are connected with one another by a flexible and expansible element in a form of a sleeve 109. This sleeve may be formed of any suitable material but in the preferred embodiment is shown as formed of rubber. Walls 106 and 107 and sleeve 109 cooperate to provide a sealed chamber 110.

Wall 106 is secured to the top surface of the bottom cover 23 by screws 111 and the bottom cover is secured to the casing 21 by screws 112.

The top side of wall 107 carries an internal tooth ring gear 114. This ring gear is mounted for rotation and is prevented from displacement by a ring 115 which extends over the periphery of the ring gear. Retaining ring 115 is held in place by screws 116. A block 118 is secured to the ring gear by rivots 119. The top of this block 118 provides camming surfaces which when viewed from above are of generally circular contour. These surfaces indicated at 120 and 121 extend from the top of the block downwardly and merge at the point indicated at 122. The block 118 has a central opening and is journalled on the upper end of boss 60.

A cam follower in a form of a pin 125 is slidably mounted and projects below the lower horizontal portion 37 of gimbal ring 33. Pin 125 is provided with a head 126 which limits the extent of downward movement thereof. Normally, the end of the pin clears the lower portions of the camming surfaces whereby the gimbal ring is free to rotate partially in either direction. The upper end of pin 125 is arranged to engage a screw 127. This screw is carried by an arm 129 which is pivotally connected by a pin 130 to the upright 35 of gimbal ring 33. The screw 127 is adjustably secured to the arm 129 by a nut 131. Arm 129 extends below the rotor 55 and projects upwardly adjacent the end portion 44 of gimbal ring 42. The top side of the end of the arm 129 is provided with a flat 133 which is arranged to engage the flat 134 formed on the bottom side of end portion 44.

From the foregoing, it will be seen that when the wall 107 is raised sufficiently, one or the other of the cam surfaces 120 or 121, if the gimbal ring 33 is out of line, will engage the bottom of the pin 125 and upon further upward movement of the wall 107, the pin 125 will cam toward the point 122, because the weight of the arm 129 is impressed upon the top of pin 125 through screw 127 and this weight is augmented by a leaf spring 132*a*. This leaf spring is attached to the upright 35 of gimbal ring 33 by a rivet 132*b*. The upward movement of the pin 125 will cause a rotation of the arm 129 in a clockwise direction, as viewed in Fig. 1, and the flat 133 on arm 129 will engage the flat 134 of end portion 44 and if at that time the gimbal ring 42 has shifted, the flat 133, in engaging the flat 134, will cause alignment of these flats and a shifting of the gimbal ring 42.

Thus, it will be seen that the gimbal rings 33 and 42 are caged by the upward movement of the wall 107. The upward movement of wall 107 is accomplished by increasing the pressure differential between the chamber 110 and the exterior thereof and this is accomplished by admitting air to chamber 110. The control of the inflation and deflation of chamber 110 is effected by a valve structure 136. It will be seen from Fig. 1 that the wall 106 is provided with a horizontal bore 137 which is intersected by three vertically drilled passages 138, 139 and 140. The bottom of passage 136 is connected with a transversely extending passage 142 which is connected to the exterior of the casing 21 through the filtering screen 83. The upper ends of passage 138, 139 and 140 are in open communication with the chamber 110 and the lower ends of passages 139 and 140 are connected to the interior of casing 21. The flow of air through passages 138, 139 and 140 is controlled by a cylinder valve 143 having circular

grooves 144 and 145. Valve 143 is adapted to reciprocate within the bore 137 and when in one position, chamber 110 is open to atmosphere through passage 138, groove 144 and passage 142. Air entering chamber 110 at atmospheric pressure will cause the wall 107 to be lifted to perform the caging operation.

Valve 143 is normally urged to the position shown in Fig. 1 by a leaf spring 147, the ends of which bear respectively against the core of two electro-magnets, one of which is shown at 149. An opening is provided in the leaf spring 147 which encircles a stem 150 formed integrally with the valve 143. A bar shaped armature 151 is also provided with a central opening which receives the stem 150 and said armature is interposed between the end of the valve 143 and the leaf spring 147. A coil spring 153 surrounds the stem 150 and is interposed between a spring 147 and an L-shaped clip 154. Clip 154 is provided with an opening which receives the stem 150. A pin 155 extends through the stem and limits the outward movement of the clip 154. A lip 157 on the wall 106 prevents misalignment of the armature 141 and leaf spring 147.

When the armature 151 is attracted by the electro-magnet 149, valve 143 is moved to the right, as viewed in Fig. 1, to move groove 144 out of registering position with the passage 138 and into position in which it registers with the passage 139; likewise, groove 145 is simultaneously moved into registering position with passage 140 so that the chamber 110 is no longer connected to atmosphere but is in intercommunication with the interior of the gyroscope casing 21 which latter is under reduced pressure. The wall 107 is immediately moved toward collapsing position through the action of a coil spring 159. Coil spring 159 is interposed between an inwardly extending flange 160 of the wall 106 and the flange 161 on the bottom ring 162 which latter is suitably secured to the downwardly extending hub 163 on the wall 107. The hub 163 slides upon the boss 60.

During normal operation the circuit to the electro-magnet 149 is closed and chamber 110 is deflated, as shown in Fig. 8. When it is desirable to cage the gimbal rings, the circuit to the electro-magnet 149 is interrupted whereby the leaf spring 147 forces the valve 143 to the position shown in Fig. 1 which will cause the wall 107 to move to the caging position for both gimbal rings, as shown in Fig. 7. When the caging operation is complete, the circuit to the electro-magnet 149 is again completed so as to retract the valve 143 and as previously explained, spring 159 will return the wall 107 to the position shown in Fig. 8.

As shown in the drawings, the caging is effected for returning the gimbal ring 33 so that it can determine the position of the casing with respect to the "0" indicia. When the gyroscope is used on an airplane, the direction of flight of the airplane will be changed so that the hair line on the window 26 registers with the "0" setting if, after caging, the hair line and "0" indicia do not register. When the "0" setting is utilized by the pilot in navigation, this "0" setting is employed and maintained by periodically caging the gimbal ring and then correcting the direction of flight so as to return to the "0" indication. Under certain circumstances, it is more desirable to have the indicia on the gyroscope correspond to the angular degree of flight, with respect to north, in which event the hair

line on the window 26 should register with the indicia indicating the angle of flight. For example, if the angle of flight is supposed to be directly east, the corrections of flight should be effected on the indicia "90" on the scale 58. To carry out this feature of the invention, a pinion gear 165 is provided for turning the ring gear 114 and likewise the cam block 118. The hub 166 of the gear 165 extends through a hole 167 in the hub 163 of wall 107 and through a hole in the ring 161. A hexagonally shaped hole 169 extends through the hub 166 and a hexagonally shaped stem 170 extends into the hole 169. Rotation of the stem 170 causes rotation of the pinion gear 165 which imparts rotation to the camming block 118 through ring gear 114. The stem 170 fits loosely within the hole 169 whereby the hub 166 may slide relative to the stem when the wall 107 is raised and lowered.

Stem 170 is turned through a knurled knob 172. The stem 170 includes a cylindrical portion 173 which is journalled in the cover 23. A flange portion 174 prevents the accidental withdrawal of the stem from its operated position. Suitable packing material 175 surrounds the cylindrical portion 173 to prevent leakage of air therealong and into the main casing. A toothed wheel 177 is also secured to the stem and a detent 178 is yieldingly urged by a spring 179 to one of the spaces between a pair of teeth for holding the stem and likewise the pinion gear 165 in an adjusted position. By turning the knob 172, the gimbal ring 33 can be turned to any desirable position by rotating the same through the cam follower pin 125. In the example given, the pilot in traveling directly east will periodically cage the gimbals and then adjust the direction of the ship so that the hair line on the window 26 registers with the indicia "90" on the band 58.

One of the advantages of the present invention lies in providing for the adjustment of the position of the gimbal ring 33 from the exterior of the main casing 21.

The periphery of the walls 106 and 107 are provided with grooves 181 and 182, respectively. The upper part of the rubber sleeve 109 is pressed into the groove 181 and held in place by a tightly drawn wire ring 183 and the lower part of this sleeve 109 is pressed into the groove 182 and held therein by a tightly drawn wire ring 184. From the foregoing, it will be seen that the rubber sleeve cooperates with the walls 106 and 107 to form a sealed chamber 110.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. In combination with a device, such as a gyroscope having a gimbal ring, a caging mechanism for the gimbal ring comprising a casing having relatively movable walls and a flexible sealing sleeve connected to said walls and cooperating with said walls to form a variable capacity chamber therebetween, a cam carried by one of the walls and movable relative thereto, a driving gear on the cam carrying wall, a driven gear on the cam and cooperating with the driving gear, means for rotating the driving gear, a caging element operatively associated with the gimbal ring, a cam follower arranged in cooperative relation with said cam and ring, and means for controlling the flow of fluid between the chamber and the exterior thereof.

2. In combination with a device, such as a gyroscope having a gimbal ring, a caging mechanism for the gimbal ring comprising a casing having a first wall, a second wall movable relative thereto, and a flexible sealing sleeve connected to said walls and cooperating with said walls to form a variable capacity chamber therebetween, a cam rotatably carried by the second wall, a caging element operatively associated with the gimbal ring, a cam follower arranged in cooperative relation with said cam and ring, means for rotatably adjusting the position of the cam relative to the second wall, and means for controlling the flow of fluid between the chamber and the exterior thereof.

3. In combination with a device, such as a gyroscope having a gimbal ring, a caging mechanism for the gimbal ring comprising a casing having relatively movable walls and a flexible sealing sleeve connected to said walls and cooperating with said walls to form a variable capacity chamber therebetween, a cam rotatably carried by one of the walls, a driving gear on the cam carrying wall, a driven gear on the cam and cooperating with the driving gear, means for rotating the driving gear, a caging element operatively associated with the gimbal ring, a cam follower arranged in cooperative relation with said cam and ring, and means for controlling the flow of fluid between the chamber and the exterior thereof.

4. In combination with a device, such as a gyroscope, having an inner gimbal ring and an outer gimbal ring, one of which is pivoted to rotate about a vertical axis and the second of which is pivoted to rotate about a horizontal axis; a caging mechanism therefor comprising a single fluid pressure responsive casing having relatively movable parts responsive to differentials in fluid pressure; means operable by motion of a movable part of said casing and comprising a cam block supported by said last mentioned movable part, a pin cooperating with said cam block to cage said vertical axis gimbal, and an arm operated by said pin to cage said horizontal axis gimbal for resetting simultaneously both of said gimbal rings; and means for controlling the pressure differentials acting on said last mentioned movable part of said casing.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,451,928	Tanner	Apr. 17, 1923
1,996,896	Bennett	Apr. 9, 1935
2,207,875	Roland	July 16, 1940
2,273,309	Zand	Feb. 17, 1942