

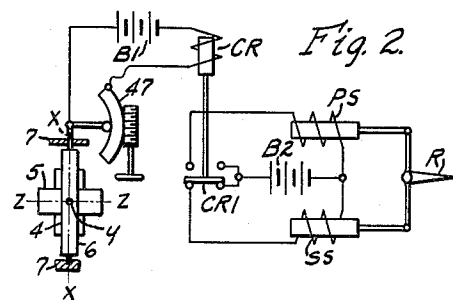
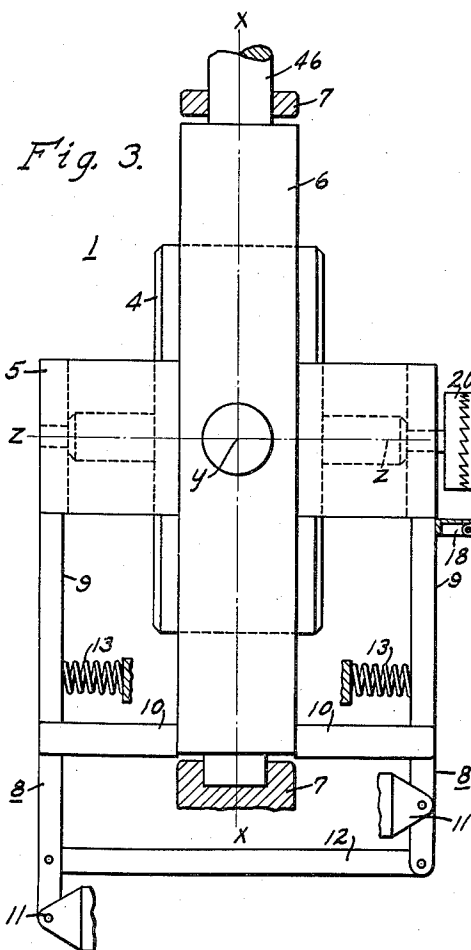
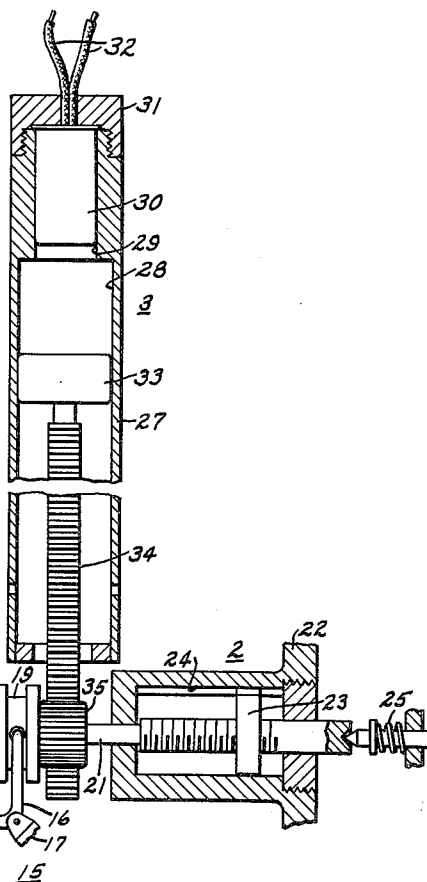
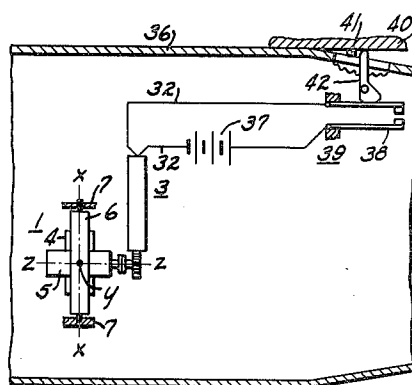
Jan. 23, 1962

L. B. LYNN  
CONTROL DEVICES

3,017,778

Filed March 8, 1946

3 Sheets-Sheet 1



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Fig. 1.  
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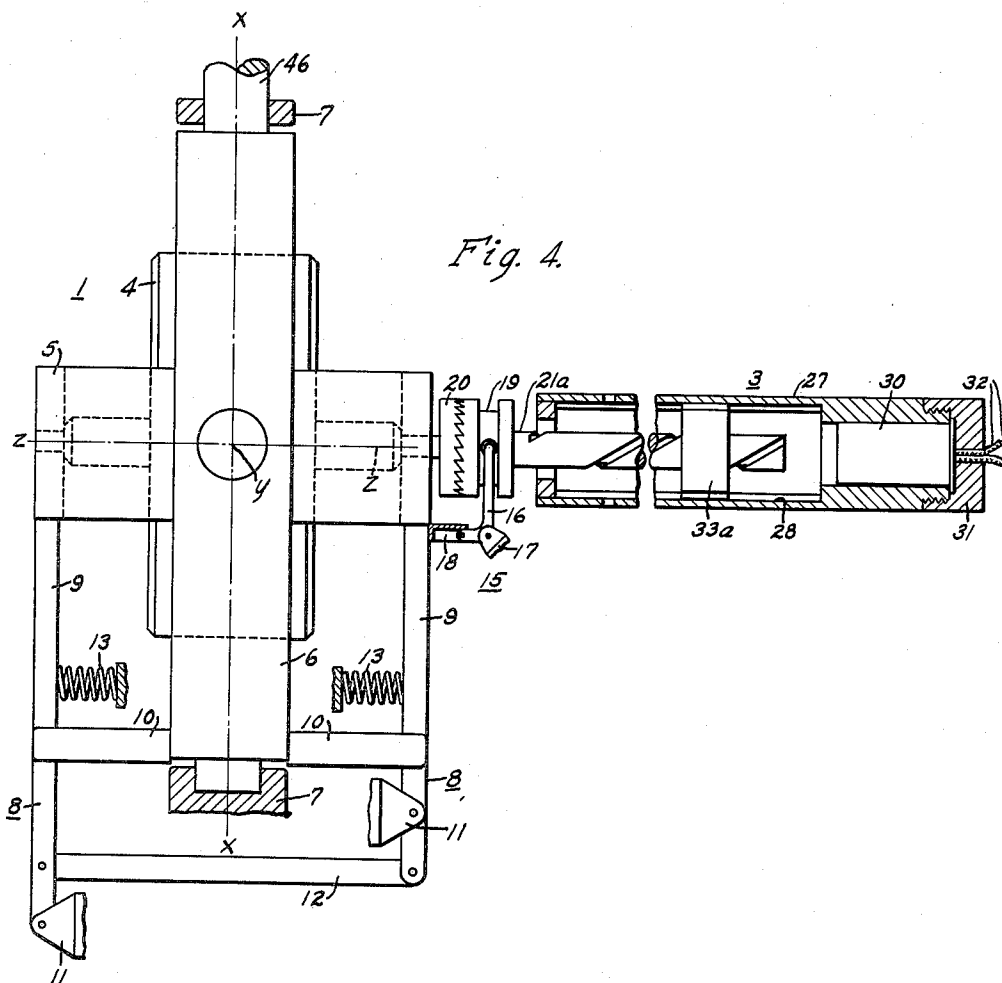
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3 Sheets-Sheet 2



**WITNESSES:**

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3 Sheets-Sheet 3

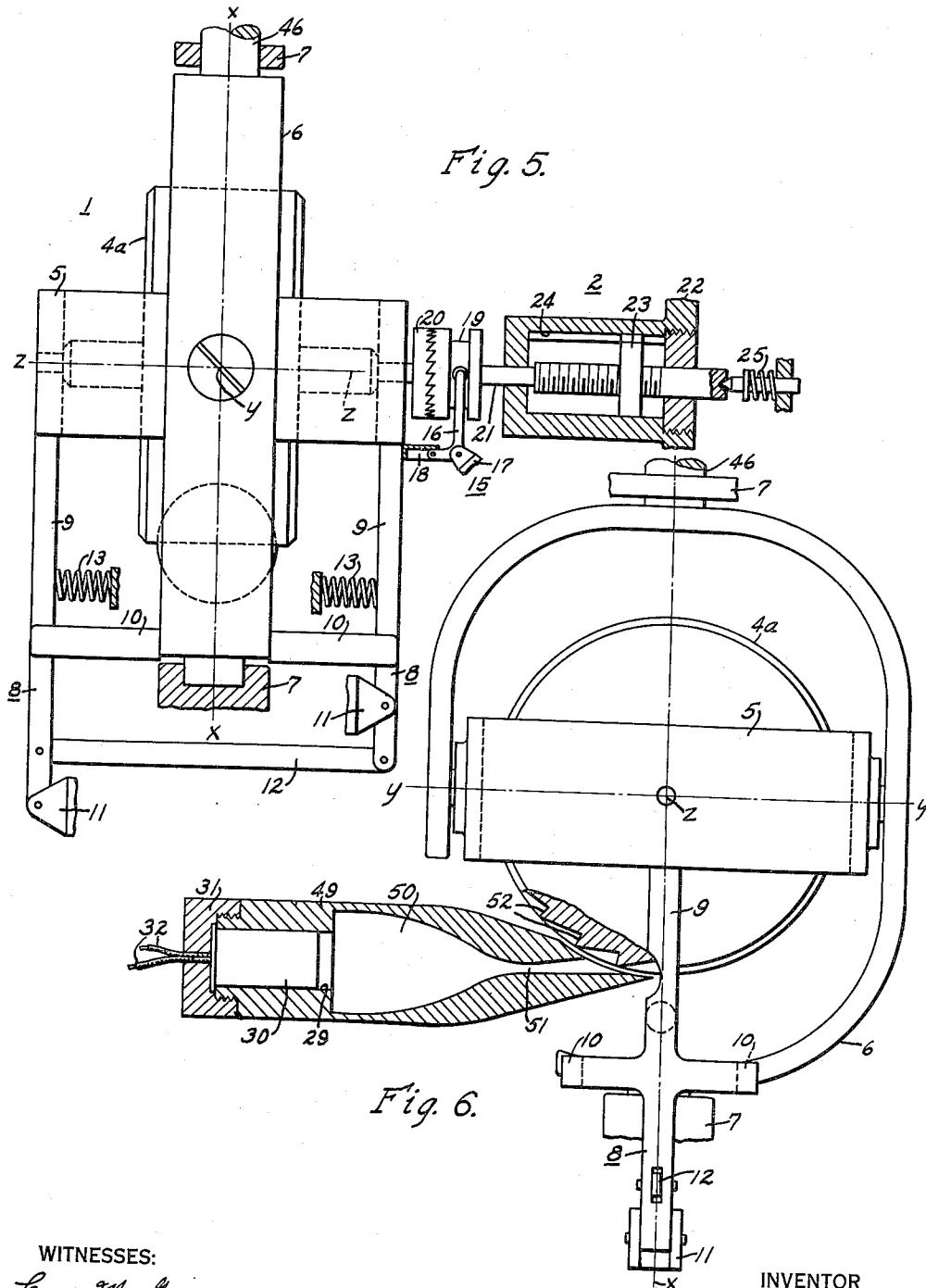


Fig. 6.

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3,017,778

## CONTROL DEVICES

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7 Claims. (Cl. 74-5.12)

This invention relates generally to starting devices and and more particularly to such devices which are utilized to start directional control devices used in controlling conveyances operable in a fluid medium, for example, torpedoes.

In the operation of torpedoes it has been found satisfactory to employ gyroscopes of the free spinning type, that is, gyroscopes which are brought up to a relatively high speed prior to the time of launching of the torpedo and then permitted to spin free for the duration of the torpedo's run. Such a run is of sufficiently short duration both for test or exercise and war shot purposes that the gyroscope does not decelerate to a point where it no longer functions effectively as a directional control device.

The starting requirements for a gyroscope of the type generally described are rather severe. With modern electrically operated torpedoes, the practice is to insert the torpedo into the torpedo or launching tube and then apply the air pressure source to the tube to eject the torpedo therefrom. Usually about one-half of a second is required for the torpedo to move from the launching tube. During this interval such preliminary operations as bringing the directional control gyroscope up to speed must be accomplished. Otherwise the torpedo will be inadequately controlled after launching.

Numerous devices for starting torpedo gyroscopes have been considered and experimented with. One form, which proved successful and could be cheaply manufactured, involved a small electric motor energized by the torpedo's trigger switch the instant torpedo movement from the tube began. These motors were designed for short life, since their useful purpose was fulfilled in a matter of less than one-half of a second after operation began. In this brief interval the motor accelerated a two-pound, 3½-inch diameter gyro wheel to a speed of about 12,000 r.p.m.

There are applications, for example, those involving a primary battery as the main source of energy of a torpedo wherein it is not always convenient to provide sufficient secondary battery energy to drive the gyroscope motor prior to launching. The use of compressed air and suitable mechanical coupling offers a solution to the problem but has the attendant disadvantage of the space required for an air reservoir together with other equipment for controlling the air supply. Rather than this, the use of a cartridge as the energy source for starting the gyroscope appears to offer the more sensible solution.

One object of this invention is to provide a control arrangement for a conveyance operable in a fluid medium involving a load unit for performing a useful function in the control of said conveyance and which load unit must be accelerated from zero speed to full speed in the relatively short period of time required to launch said conveyance, in which means are provided for accelerating said load unit to full speed within the relatively short period of time required for launching of said conveyance.

Another object of this invention is to provide a system for starting a gyroscope utilized as a control element in a conveyance operable in a fluid medium in which a source of energy is utilized requiring only a small amount of electric power for initiating release of the energy.

More specifically, it is an object of this invention to provide a system for starting a gyroscope on a torpedo

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which utilizes a cartridge as the source of energy supply for the system.

Still more specifically stated, it is an object of this invention to provide a system for starting a gyroscope on a torpedo which utilizes an electrically detonated cartridge as the source of energy supply for the system.

Yet another object of this invention is to provide a gyroscope mechanism or starting system of the character referred to in which the gyroscope is caged during acceleration thereof to full speed and thereafter uncaged to provide proper control of the torpedo by the gyroscope.

The foregoing statements are merely illustrative of the various aims of this invention. Other objects and advantages will become apparent from a study of the following disclosure when considered in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic diagram of the gyroscope mechanism installed in a torpedo.

FIG. 2 is a schematic diagram of the gyroscope directional control for a torpedo.

FIG. 3 is an enlarged schematic showing of the gyroscope mechanism of FIG. 1 illustrating additional details of the arrangement.

FIG. 4 is a modification of the invention illustrated in FIG. 3.

FIG. 5 is a further modification of the invention, and FIG. 6 is an end view partly in section of the embodiment of the invention illustrated in FIG. 5.

Referring now to FIG. 3 the assembly therein illustrated includes generally a gyroscope 1, a declutching mechanism 2 and a starting mechanism 3. Gyroscope 1 is conventional in arrangement. Numeral 4 designates the gyro wheel which is suitably mounted in bearings in gimbal ring 5, in turn mounted in bearings in gimbal ring 6 which in its turn is pivotally mounted in stationary brackets 7 conventionally secured to the torpedo frame structure. The torque axis of the gyroscope is designated  $x-x$ , the precession axis appears as a point and is designated  $y$  while the spin axis is designated  $z-z$ . As illustrated in FIG. 1 the gyroscope is mounted so that the axis of spin  $z-z$  is parallel with the longitudinal axis of the torpedo. Prior to use of the torpedo in either test or exercise run, or in war shot, the gyroscope is caged in the position described by latches 8, each having extensions 9 and 10, respectively, engaging gimbal rings 5 and 6 to lock the gyroscope in the described predetermined relationship with the torpedo axis. Latches 8 are mounted on pivot members 11 and are pivotally joined by a link 12 at points on opposite sides of the respective pivot members 11, the arrangement effecting opposite angular movement of the latches to positions disengaging the gimbal rings 5 and 6 under the influence of compression springs 13. Latches 8 are retained in the gyroscope caging position illustrated by means of the trigger mechanism 15 consisting of a bell crank 16 mounted on pivot member 17 and link 18 pivotally attached to the extremity of bell crank 16 directed towards the latch mechanism. Link 18 together with the bell crank forms a toggle mechanism which as shown is in locked position with the free extremity of link 18 abutting the cooperating latch 8 and holding the latch mechanism in caging position.

The right-hand end, as viewed, of the gyro wheel shaft extends through gimbal ring 5 and has secured thereto an element of a jaw clutch assembly 20. The other element of jaw clutch 20 is carried by a shaft 21 journaled for rotational and axial movement in the housing 22 forming a part of the declutching mechanism 2. The remaining extremity of bell crank 16 is loosely keyed in a groove 19 formed in the jaw clutch element connected to shaft 21. That portion of shaft 21 within housing 22 is threaded and has threaded thereover a nut

23 keyed at 24 to the housing 22 to prevent rotation thereof. Shaft 21 is biased to clutch engaging position by spring 25.

In this embodiment of the present invention, the starting mechanism 3 includes a block 27 having a cylinder 28 of suitable length formed therein and terminating at its upper end as viewed in a cartridge chamber 29 containing a cartridge 30 and sealed by the breech 31. Leads 32 are connected with the caps (not shown) within the cartridge 31 for detonating the cartridge. A piston 33 which strokes in cylinder 28 has secured thereto a rack 34 meshing with a pinion 35 secured to shaft 21 adjacent the coupling 20, completing the driving connection for the gyro wheel 4.

As schematically illustrated in FIG. 1, the gyroscope assembly is housed entirely within the torpedo body 36. Leads or conductors 32 are connected in a series circuit with a battery 37 and switch contacts 38 of trigger switch 39. When prepared for firing the torpedo is placed within the launching tube fragmentarily shown at 40 and dog 41 is projected into the tube 40 just ahead of trigger 42 of trigger switch 39. When the air pressure is applied to the launching tube the torpedo is accelerated to the left as viewed, dog 41 rotating trigger 42 clockwise and the camming action thereof closing contacts 38. As a consequence battery energy is applied to the caps of the cartridge 30 and detonation thereof follows. The products of combustion of cartridge 30 exhausting into cylinder 28 drive piston 33 and rack 34 downwardly, as viewed, rotating pinion 35 and through the jaw clutch 20, the gyro wheel 4. In view of the high driving forces which may be obtained the gyro wheel 4 is rapidly brought up to speed. Meanwhile, due to rotational movements of shaft 21, nut 23 is travelling along the housing 22 towards the left-hand end thereof. Prior to the time movement of rack 34 ceases, nut 23 will have reached the limit of its movement at the left of housing 22. As a consequence of continued rotation of shaft 21 with nut 23 restrained from further axial movement, shaft 21 is driven to the right against the bias of spring 25, disengaging the clutch 20 and permitting gyro wheel 4 to spin free. Simultaneously therewith bell crank 16 is rotated clockwise causing the toggle connection including link 18 to be broken and permitting latches 8 under the influence of compression springs 13 to be biased clear of the gimbal rings 5 and 6. The gyro is now an effective control element properly oriented or indexed with respect to the torpedo axis and operating at proper speed. Shortly thereafter the torpedo is ejected from the launching tube into the water.

As illustrated in FIG. 2 an arm projects at right angles from the shaft 46 containing the  $x$ - $x$  or torque axis of the gyroscope. The extremity of the arm carries a roller which sweeps the adjustable arcuate segment 47 supported in the torpedo body. The upper half of this segment is of electrical conducting material while the lower half is non-conducting. Coil of relay CR is connected in a series loop with the contact arm, conducting segment and a battery B1. Arcuate segment 47 is adjusted prior to launching of the torpedo to cause the torpedo to circle from the launching path to the true heading. Rudder R is controlled by the port and starboard solenoids PS and SS, respectively. The coils of solenoids PS and SS are respectively connected with the battery B2 through the front and back contacts of the contact assembly CR1.

Assuming that the arcuate segment 47 is set with the joint between the conducting and non-conducting portions substantially at the roller on the contact arm, any movement of the torpedo about a vertical axis will angularly displace the arcuate segment with respect to the contact arm, first engaging the roller with the conducting portion and then the non-conducting portion alternately picking up and dropping out the control relay CR. This alternately energizes the circuits for the port and starboard solenoids first applying right rudder and then left

rudder. The resulting control is hardover-to-hardover and the path of the torpedo is approximately sinusoidal in a horizontal plane about a projection of the torpedo axis at launching.

In the embodiment of the invention illustrated in FIG. 4 a slightly different principle is utilized to start the gyro wheel 4. The gyroscope assembly including the clutch 20, the latching mechanism and trigger mechanism 15 is essentially a duplicate of that illustrated in FIG. 3. Hence, detailed discussion thereof is deemed unnecessary. Shaft 21a is now provided with a helix having sufficient pitch that its action with piston 33a is not self-locking. In this application, piston 33a is slidably keyed to the cylinder 28 to prevent rotation. Otherwise the assembly of block 27 forming the communicating cylinder and cartridge chamber is the same as that of FIG. 1.

Upon detonation of cartridge 30, piston 33a is driven axially in the cylinder and drives shaft 21a in rotation, which rotative movement is transmitted through jaw clutch 20 to the gyro wheel 4 causing acceleration thereof to its normal high full speed. When the piston reaches the end of the cylinder axial movement thereof ceases. Immediately the gyro wheel 4 overdrives the clutch 20 tending to force the clutch elements apart, which coupled with the inertia of the shaft 21a in rotation completely clears the clutch elements permitting the gyroscope to spin free. Simultaneously therewith the toggle linkage, including link 18 of the trigger assembly, is broken and the latches 8 are biased clear of the gimbal rings 5 and 6 as previously described in connection with FIG. 3.

In FIGS. 5 and 6 the turbine principle is employed to start the gyro wheel 4a. In this embodiment of the invention, the gyroscope, latching mechanism, trigger mechanism and declutching mechanism 2 are essentially the same as that illustrated in FIG. 3. Like parts bear like reference numerals. The gyro wheel, however, has been modified and is now provided with a plurality of turbine buckets or blades 52 about the periphery thereof. A nozzle 49 having a cartridge chamber 29 containing the cartridge 30 and sealed by the breech 31 is directed into the turbine blades. The products of combustion of the cartridge expand into the chamber 50 and are exhausted through the restricted section 51 through opening 51 to impinge upon the turbine blades 52, the arrangement converting the pressure head in chamber 50 to a velocity head which is applied to the turbine, in the manner well known in the art. Extremely high rates of acceleration may be realized by the direct application of the gas jet to the turbine wheel, since in such application there is no possibility of shearing gear teeth, splined connections or shafts as in FIGS. 3 and 4. The trigger and latch mechanisms again perform their useful function in response to axial movement of shaft 21 of the declutching mechanism 2 as in FIG. 3 and will be understood in connection therewith.

While the cartridges of the starting mechanism have been illustrated as ignited by a battery, it is, of course, apparent that other sources, such as permanent magnet generators actuated by the trigger switch may be employed as disclosed in the copending application of L. D. Jennings and J. Naymik, Serial No. 653,193, filed on the same date as this application, entitled Induction Generator Starting Gear and assigned to the same assignee as this invention, and which has now matured as U.S. Patent 2,445,435, dated July 20, 1948. It will also be apparent that the device of this invention is not necessarily limited specifically to torpedoes but may be employed equally well in other applications without departing from the spirit and scope hereof. It is, therefore, intended that the foregoing disclosure and illustrations in the drawings shall be considered only as illustrative and not interpreted in a limiting sense. The only limitations are to be determined from the scope of the appended claims.

I claim as my invention:

1. Caging mechanism for a gyroscope mounted in a

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pair of gimbals so as to have freedom of movement about a torque axis and a precession axis comprising, in combination, latch mechanism operable to positions engaging and disengaging both of said gimbals for releasably locking both of the gyro gimbals to prevent movement thereof, spring means biasing said latch mechanism to a position disengaging said gyro gimbals, trigger means normally engaging said latch mechanism and holding said latch mechanism in a position engaging said gyro gimbals, and means responsive to a predetermined number of revolutions of said gyroscope for actuating said trigger means to release said latch mechanism and provide freedom of movement of the gyroscope about the torque and precession axes thereof.

2. Caging mechanism for a gyroscope wheel mounted in gimbals so as to have freedom of movement about a torque axis, a precession axis and a spin axis comprising, in combination, a rotatable shaft constructed and arranged in bearings to have limited axial movement, a releasable clutch connecting said shaft and said gyroscope wheel for effecting rotation of said shaft by rotation of said gyroscope, means biasing said shaft to engage said clutch and connect said shaft and gyroscope wheel, releasable latch mechanism for locking the gimbals of said gyroscope to prevent movement thereof, means responsive to a predetermined number of revolutions of said shaft for moving said shaft axially against the biasing means therefor to effect release of said clutch, and means responsive to axial movement of said shaft for releasing said latch mechanism and permitting freedom of movement of said gyroscope about the axes of freedom thereof.

3. A gyroscope assembly including a vertical gimbal ring, bearing means pivotally mounting said vertical gimbal ring for motion about a vertical axis, a horizontal gimbal ring pivotally mounted on said vertical gimbal ring for motion about a horizontal axis, a gyroscope rotor mounted on said horizontal gimbal ring for rotation about an axis normal to said horizontal axis, a rotatable shaft, coupling means for connecting and disconnecting said shaft and the gyroscope rotor, latching means including a pair of latch members disposed on opposite sides of said vertical gimbal ring, each of said latch members having projecting portions engaging said vertical gimbal ring on opposite sides of the vertical pivot axis thereof to prevent rotation thereof and having other projecting portions engaging said horizontal gimbal ring on opposite sides of the horizontal pivot axis therefor to prevent rotation thereof, means movably mounting each of said pair of latch members for motion away from the position in which each engages said gimbal rings, biasing means for biasing said latch members away from the gimbal ring engaging positions thereof, a trigger mechanism for holding said latch members in gimbal ring engaging position and operable in response to movement of said coupling means disengaging said shaft and said rotor to release said latch members and permit movement of the gyroscope assembly about said horizontal and vertical axes, and means for moving said coupling means to disengage said shaft and said gyroscope rotor in response to a predetermined number of revolutions of said shaft.

4. Gyroscope mechanism comprising, in combination a first gimbal member, bearing means mounting said first gimbal member forming a pivot axis for the first gimbal member, a second gimbal member, bearing means mounting the second gimbal member for pivotal movement on the first gimbal member about an axis normal to the pivot axis of the first gimbal member, a gyroscope wheel, bearing means mounting the gyroscope wheel on said second gimbal member for rotation about an axis normal to the pivot axis of said second gimbal member, a pair of latch members, means pivotally mounting said latch members on opposite sides of said first gimbal member, each of said latch members having portions thereof engageable with both of said gimbal members to prevent pivotal movement of said gimbal members about the pivot

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axes thereof, means for biasing said latch members about the pivot mountings thereof away from said gimbal members to effect disengagement of said portions of said latch members and said gimbal members, a bar connecting said latch members on opposite sides of the pivot mountings therefor to effect simultaneous opposite pivotal motion of said latch members, a trigger mechanism normally engaging one of said latch members and holding said latch members in a position engaging both of said gimbal members, and means responsive to a predetermined number of revolutions of said gyroscope wheel for actuating said trigger mechanism to disengage said one latch member.

5. Gyroscope mechanism comprising, in combination a first gimbal member, bearing means mounting said first gimbal member forming a pivot axis for the first gimbal member, a second gimbal member, bearing means mounting the second gimbal member for pivotal movement on the first gimbal member about an axis normal to the pivot axis of the first gimbal member, a gyroscope wheel, bearing means mounting the gyroscope wheel on said second gimbal member for rotation about an axis normal to the pivot axis of said second gimbal member, a pair of latch members, means pivotally mounting said latch members on opposite sides of said first gimbal member, each of said latch members having portions thereof engageable with both of said gimbal members to prevent pivotal movement of said gimbal members about the pivot axes thereof, means for biasing said latch members about the pivot mountings thereof away from said gimbal members to effect disengagement of said portions of said latch members and said gimbal members, a bar connecting said latch members on opposite sides of the pivot mountings therefor to effect simultaneous opposite pivotal motion of said latch members, a trigger mechanism normally engaging one of said latch members and holding said latch members in a position engaging both of said gimbal members, rotatable clutch actuating means, a clutch engaging said clutch actuating means and said gyroscope wheel and being operable to a disengaged position by said clutch actuating means, means responsive to a predetermined number of revolutions of said clutch actuating means for disengaging said clutch, and means responsive to disengaging movement of said clutch for actuating said trigger mechanism to disengage said one latch member.

6. Gyroscope mechanism comprising, in combination a first gimbal member, bearing means mounting said first gimbal member forming a pivot axis for the first gimbal member, a second gimbal member, bearing means mounting the second gimbal member for pivotal movement on the first gimbal member about an axis normal to the pivot axis of the first gimbal member, a gyroscope wheel, bearing means mounting the gyroscope wheel on said second gimbal member for rotation about an axis normal to the pivot axis of said second gimbal member, a pair of latch members, means pivotally mounting said latch members on opposite sides of said first gimbal member, each of said latch members having portions thereof engageable with both of said gimbal members to prevent pivotal movement of said gimbal members about the pivot axes thereof, means for biasing said latch members about the pivot mountings thereof away from said gimbal members to effect disengagement of said portions of said latch members and said gimbal members, a bar connecting said latch members on opposite sides of the pivot mountings therefor to effect simultaneous opposite pivotal motion of said latch members, a trigger mechanism normally engaging one of said latch members and holding said latch members in a position engaging both of said gimbal members, and means responsive to rotative movement of said gyroscope wheel for actuating said trigger mechanism to release said one latch member.

7. Gyroscope mechanism comprising, in combination a first gimbal member, bearing means mounting said first gimbal member forming a pivot axis for the first gimbal member, a second gimbal member, bearing means mount-

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ing the second gimbal member for pivotal movement on the first gimbal member about an axis normal to the pivot axis of the first gimbal member, a gyroscope wheel, bearing means mounting the gyroscope wheel on said second gimbal member for rotation about an axis normal to the pivot axis of said second gimbal member, a pair of latch members, means pivotally mounting said latch members on opposite sides of said first gimbal member, each of said latch members having portions thereof engageable with both of said gimbal members to prevent pivotal movement of said gimbal members about the pivot axes thereof, means for biasing said latch members about the pivot mountings thereof away from said gimbal members to effect disengagement of said portions of said latch members and said gimbal members, a bar connecting said latch members on opposite sides of the pivot mountings therefor to effect simultaneous opposite pivotal motion of said latch members, a trigger mechanism normally engaging one of said latch members and holding said latch members in a position engaging both of said gimbal members, a threaded shaft, means rotatably mounting said shaft coaxially of the axis of rotation of said gyroscope wheel when said gimbal members are engaged by said latch members, said mounting of said threaded shaft also affording axial movement of said

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threaded shaft, a clutch connecting said threaded shaft and said gyroscope wheel and being disengaged by axial motion of said threaded shaft away from said gyroscope wheel, means biasing said threaded shaft in a direction to engage said clutch, a nut arranged on said threaded shaft, means for preventing rotation of said nut, means for limiting the axial movement of said nut upon rotation of said threaded shaft by said gyroscope wheel to a distance less than the threaded length of said shaft, to affect axial movement of said shaft when said shaft rotates after axial motion of said nut ceases thereby disengaging said clutch, and means responsive to axial movement of said shaft for actuating said trigger mechanism to disengage said one latch member.

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