

April 26, 1966

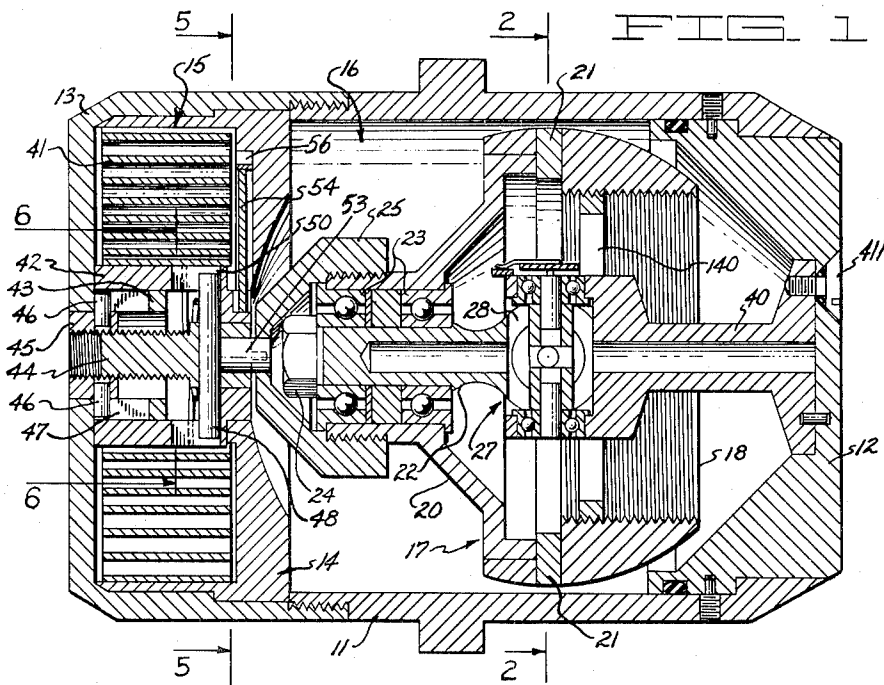
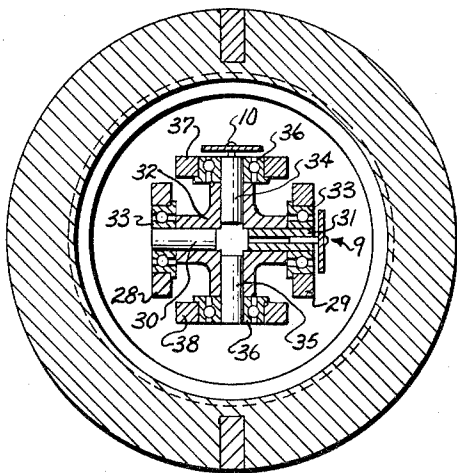
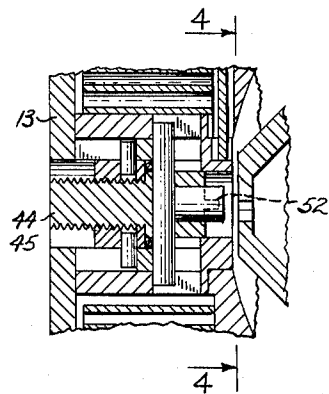
G. F. EAST ETAL

3,247,726

GYROSCOPIC DEVICE

Filed Feb. 21, 1962

2 Sheets-Sheet 1



INVENTORS
GEORGE F. EAST
JOSEPH R. WALTERS

BY

Paul J. Schwend
ATTORNEY

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2 Sheets-Sheet 2

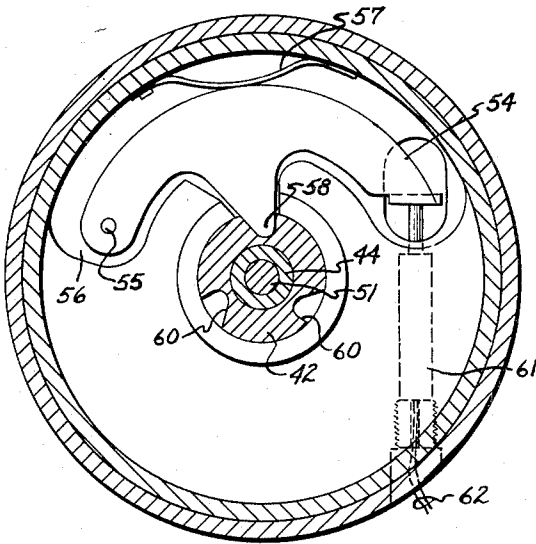


FIG. 5

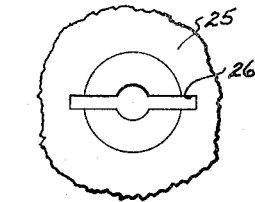


FIG. 4

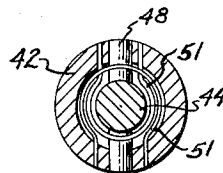


FIG. 6

FIG. 7

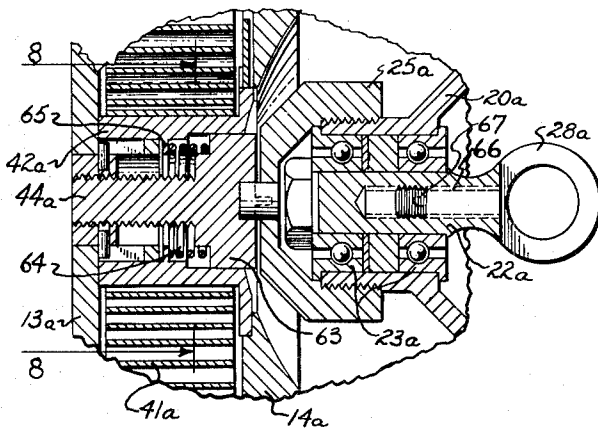
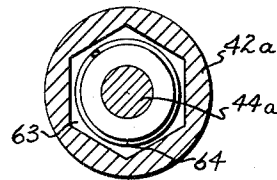


FIG. 8



INVENTORS
GEORGE F. EAST
JOSEPH F. WALTERS

BY

Paul E. Schumacher
ATTORNEY

1

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GYROSCOPIC DEVICE

George F. East, Whittier, and Joseph P. Walters, Temple City, Calif., assignors to Clary Corporation, San Gabriel, Calif., a corporation of California
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6 Claims. (Cl. 74-5.12)

This invention relates to gyroscopes and has particular reference to spring driven gyroscopes especially applicable, but not necessarily limited, to use in guided missiles and like having an operational life ranging from several seconds to several minutes.

Gyroscopes of the above type are generally supported for two degrees of movement wherein the gyroscope maintains a fixed position in space during operation. Attitude pick-off devices are provided to indicate the displacement of the missile relative to the spin axis of the gyroscope, which indications are either transmitted back to a control station or are applied to a control system within the missile which, in turn, directly effects or corrects changes in the attitude of the missile.

Gyroscopes of the above type are generally held in caged condition and are uncaged at the time of firing the missile. Normally, the rotor is brought up to full operational speed prior to uncaging. Also, upon reaching such speed the spring must be disconnected from the rotor to permit free rotation of the latter thereafter and during the travel of the missile.

Since missiles of the above type must often be fired at precise times and quite often no advance notice is given to enable the rotor to be brought up to its operational speed, it is imperative that such rotor be brought to speed with a minimum time delay and the uncaging take place precisely thereafter so that such operation will not unduly delay firing of the missile. At the same time, since such missiles are generally expendable, it is highly desirable that the gyroscope be inexpensive and that the various operations of the gyroscope be carried out without expensive and complicated timing controls.

It therefore becomes a principal object of the present invention to provide a spring driven gyroscope having the above noted desirable attributes.

Another object is to provide a spring driven gyroscope of the above type in which a minimum length of time is required to place the same in full operating condition.

Another object is to provide a spring driven gyroscope in which only a single signal is required to release the drive spring, to uncage the gyroscope and to disconnect the drive means from the rotor.

Another object is to insure proper timing of the different stages of operation of a spring driven gyroscope in placing the same in full operating condition.

Another object is to provide an inexpensive spring driven gyroscope capable of effecting proper control of missiles and the like.

Another object is provide a simple and compact spring driven gyroscope of the above type.

The manner in which the above and other objects of the invention are accomplished can be readily understood on reference to the following specification when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a longitudinal sectional view through a gyroscope embodying a preferred form of the present invention.

FIG. 2 is a transverse sectional view through the rotor and gimbal means and is taken along the line 2-2 of FIG. 1.

FIG. 3 is a fragmentary view similar to a part of FIG. 1 but illustrating the drive mechanism in retracted position after bringing the rotor up to speed.

FIG. 4 is a front view of the rotor and is taken along the line 4-4 of FIG. 3.

2

FIG. 5 is a transverse section view illustrating the spring trip mechanism and is taken along the line 5-5 of FIG. 1.

FIG. 6 is a transverse section view taken along the line 6-6 of FIG. 1.

FIG. 7 is a longitudinal sectional view, with parts broken away, of a modified form of the invention.

FIG. 8 is a transverse sectional view taken along the line 8-8 of FIG. 7.

Referring to the drawings, the gyroscope comprises a cylindrical case 11, preferably of aluminum or other non-magnetic material, to the right hand end of which is secured an end cap 12. A removable cover 13 is threadably attached to the opposite end of the case.

The cover 13 clamps a cup-shaped bulkhead member 14 in place against the forward edge of case 13 to thereby form a drive compartment 15 on one side thereof and a rotor compartment 16 on the opposite side thereof.

A hollow rotor generally indicated at 17 is mounted in the rotor compartment. The rotor comprises a rim 18 of relatively heavy non-magnetic material such as brass and a hub 20 of relatively light material, such as aluminum, which is suitably secured to the rim. A pair of diametrically opposed permanent magnets 21 are suitably embedded in the rim for the purpose of actuating a suitable magnetically responsive counting mechanism or the like (not shown) which is effective to sense the movement of the magnets through the case whereby the speed and possibly the attitude of the rotor may be determined.

The rotor is rotatably mounted on a shaft 22 by ball bearings 23. The bearings are retained on the shaft by a nut 24 which is screw threaded on one end of the shaft. A cap member 25 is threadably attached to the rotor and has a groove 26 cut thereacross as seen in FIG. 4 to form a coupling part. The screw threads are in an appropriate direction to prevent unthreading during driving of the rotor.

The shaft 22 forms part of the gimbal means generally indicated at 27 located within the hollow rotor. For this purpose, the shaft is formed at its right hand end into a bifurcated yoke, comprising a first gimbal, and formed with two spaced arms 28 and 29 which are pivotally supported by coaxially extending shaft sections 30 and 31 (FIG. 2) of a center block 32 through ball bearing 33. The center block, comprising a second gimbal, is in turn pivotally supported by coaxial shaft sections 34 and 35 of the block 32, which shaft sections are pivotally supported by ball bearings 36 mounted on spaced arms 37 and 38 forming the yoked end of a pedestal 40. The pedestal is attached by screws, i.e., 41 to the end cap 12. The axes of the shaft sections 30, 31 and 34, 35 are mutually perpendicular to each other and to the spin axis of the rotor to permit universal positioning of the case 11 relative to such spin axis.

The rotor 17 is balanced about the intersection of the axes of the various shaft sections of the center block 32 and to effect minor adjustment of such balance a counter weight in the form of an angular ring 140 is adjustably threaded on the interior of the rim 18.

Suitable attitude pick-off devices generally indicated as 9 and 10 are carried by the shaft sections 31 and 34, respectively. These may be of any well known construction.

Describing now the spring drive motor, the latter is contained in the drive compartment 15 and comprises a spiral torsion spring 41 which is suitably attached at its outer end to the cylindrical flange of bulkhead 14 and is attached at its inner end to a hollow spindle 42. The latter is rotatably mounted on a hollow hub 43 extending inwardly from the center of the cover 13.

The rear end of the spindle is reduced in diameter to form a slide support bearing for the rear end of the rotor drive shaft 44. The latter is screw threaded to receive a nut 45 slideably fitted within the bore of hub 43. Accord-

ingly, the nut supports the forward end of the rotor shaft and is provided with radially extending pins 46 which are guided by axially extending slots 47 formed in the hub.

In order to rotate the shaft 44 while permitting lengthwise movement thereof, a pin 48 extends transversely therethrough and is embraced by axially extending slots 50 in the spindle 42.

Spring means in the form of two horseshoe shaped springs 51 (FIG. 6) are provided to normally hold the shaft in its rearward position shown in FIG. 1. The springs have their ends embedded in the spindle 42 and press rearwardly against the pin 48, the springs being effective to yield when the shaft is moved forwardly.

The shaft 44 has a tongue 52 forming a second coupling part which normally engages in the groove 26 to couple the shaft to the rotor. Also, a pin 53 embedded in the rear end of the shaft 44 normally fits within a mating hole in the cap 25 to cage the shaft 22 and gimbals in a position extending coaxially of the case 11. It will be noted that the pin extends rearwardly an appreciable amount beyond the tongue 52.

Means are provided for locking the spring 41 in wound condition preparatory to driving the rotor and for this purpose, a pawl 54 (FIGS. 1 and 5) is fulcrumed at 55 in a cutout section 56 of the bulkhead 14. The pawl is normally urged clockwise by a leaf spring 57 to hold a locking nose 58 thereof in locking engagement with the one of three notches 60 formed in the spindle 42. The pawl is actuated to release the spring motor by an explosive squib 61 which is mounted in the bulkhead. The squib contains a powder charge which is electrically fired through wire 62. When so fired, the squib will expand lengthwise to rock the pawl 54 counterclockwise sufficiently to release the spindle for rotation by the spring 41.

The spring 41 is thus effective to transmit rotation to the rotor and during such rotation the nut 45 will move along the shaft until the pins 46 engage the rear ends of the respective slots 47. At this time, the rotor will be almost up to its maximum speed and further rotation will cause the nut to feed the shaft 44 forwardly against the action of springs 51 until the tongue 52 is uncoupled from groove 26. Shortly thereafter, the pin 53 will be removed from the hole in cap 25, leaving the shaft 22 uncaged. The shaft 44 will come to rest in its position shown in FIG. 3 wherein it will be entirely clear of the rotor parts.

Initially, the spring may be wound to energized condition by removing the cover 13 and bulkhead 14 from the case 11 and turning the cover relative to the bulkhead in the appropriate direction. When the spring is fully wound, the bulkhead may be suitably pinned or otherwise attached to the cover 13.

FIGS. 7 and 8 illustrate a modified form of the invention wherein parts similar to those shown in FIGS. 1 to 6 are indicated by similar reference numbers. In this case, the rear end of the rotor drive shaft 44a is formed into a hexagonal head 63 which is slideably fitted in a mating opening in the spindle 42a. A compression spring 64 is compressed between the head and an inwardly extending angular flange 65 formed on the spindle to normally urge the shaft rearwardly so as to hold the same in coupling engagement with the rotor cap 25a. Thus, the hexagonal head enables the spindle to rotate the shaft 44a while permitting axial movement of the latter to uncouple and subsequently uncage the rotor and its support shaft.

Also shown is a modified device for balancing the rotor wherein a hole 66, axially formed in the shaft 22a, is threaded to receive a threaded slug 67. The latter can be adjusted along the hole 66 until the desired balance is achieved, thereby eliminating the need for the counterweight ring 140.

Although the invention has been described in detail and certain specific terms and languages have been used, it is to be understood that the present disclosure is illustrative rather than restrictive and that changes and modifications

may be made without departing from the spirit or scope of the invention as set forth in the claims appended hereto.

Having thus described the invention, what is desired to be secured by United States Letters Patent is:

1. A gyroscope device comprising a rotor having a first coupling part, means supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, a hollow spindle, means for rotating said spindle, a screw threaded member slideable axially in said spindle, means for preventing rotation of said screw threaded member relative to said spindle, a second coupling part carried by said screw threaded member, means normally maintaining said second coupling part in coupling engagement with said first coupling part, means carried by said screw threaded member and said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, a nut member threaded over said screw threaded member, and means for guiding said nut member for axial movement from one limit to another limit and for preventing rotation of said nut member, said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

2. A gyroscope device comprising a case, a rotor in said case having a first coupling part, means on said case supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, means on said case forming a hollow hub, a hollow spindle rotatably mounted on said hub, spring means for rotating said spindle, a nut member slideable axially in said hub, means for limiting axial movement of said nut member from one limit to another limit, means preventing rotation of said nut member relative to said hub, a screw threaded member threaded in said nut member, means for preventing relative rotation between said spindle and said screw threaded member, a second coupling part carried by said screw threaded member, spring means urging said screw threaded member to maintain said second coupling part in coupling engagement with said first coupling part, means carried by said screw threaded member and said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, and said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

3. A gyroscopic device comprising a rotor having a first coupling part, means supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, a hollow spindle, means for rotating said spindle, a screw threaded member slideably mounted adjacent one end thereof in said spindle for axial movement, means for preventing rotation of said screw threaded member relative to said spindle, a second coupling part carried by said screw threaded member, means normally maintaining said second coupling part in coupling engagement with said first coupling part, means carried by said screw threaded member and said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, a nut member threaded over said screw threaded member adjacent the opposite end of said screw threaded member, and means for guiding said nut member for axial movement from one limit to another limit and for preventing rotation of said nut member, said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

4. A gyroscope device comprising a case, a rotor in said case having a first coupling part, means on said case supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, means on said case forming a hollow hub, a hollow spindle rotatably mounted on said hub, a portion of said spindle ex-

5

tending beyond one end of said hub, means for rotating said spindle, a nut member slideable axially in said hub, means for limiting axial movement of said nut member from one limit to another limit, means preventing rotation of said nut member relative to said hub, a screw threaded member threaded adjacent one end thereof in said nut member, said screw threaded member being slideable adjacent the opposite end thereof in said portion of said spindle, means for preventing relative rotation between said spindle and said screw threaded member, a second coupling part carried by said screw threaded member, spring means urging said screw threaded member to normally maintain said second coupling part in coupling engagement with said first coupling part, means on said screw threaded member and on said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, and said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

5. A gyroscopic device comprising a case, a rotor in said case having a first coupling part, means on said case supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, means on said case forming a hollow hub, a hollow spindle rotatably supported on said hub, a portion of said spindle extending beyond one end of said hub, means for rotating said spindle, a nut member slideable axially in said hub, means for limiting axial movement of said nut member from one limit to another limit, means preventing rotation of said nut member relative to said hub, a screw threaded member threaded adjacent one end thereof in said nut member, said screw threaded member being slideable adjacent the opposite end thereof in said portion of said spindle, means for preventing relative rotation between said spindle and said screw threaded member, a second coupling part carried by said screw threaded member, a spring extending between said spindle and said screw threaded member to normally maintain said second coupling part in coupling engagement with said first coupling

6

part, means on said screw threaded member and on said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, and said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

6. A gyroscope device comprising a case, a rotor in said case having a first coupling part, means on said case supporting said rotor for rotation about a spin axis and for movement about mutually perpendicular axes, means on said case forming a hollow hub, a hollow spindle rotatably mounted on said hub, means for rotating said spindle, a nut member slideable axially in said hub, means comprising a pin and slot connection between said nut member and said hub for preventing rotation of said nut member and for limiting axial movement of said nut member from one limit to another limit; a screw threaded member threaded in said nut member, means for preventing relative rotation between said spindle and said screw threaded member while permitting axial movement of said screw threaded member, a second coupling part carried by said screw threaded member, spring means normally urging said screw threaded member to maintain said second coupling part in coupling engagement with said first coupling part, means on said screw threaded member and on said rotor effective when said coupling parts are coupled together to cage said rotor supporting means, and said nut member being effective upon reaching said other limit of its axial movement to move said screw threaded member axially whereby to uncouple said coupling parts and to uncage said rotor supporting means.

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BROUGHTON G. DURHAM, *Primary Examiner*.

T. W. SHEAR, *Assistant Examiner*.