Oct. 25, 1966 H. V. FRIELINK 3,280,643

PYROTECHNIC GYRO

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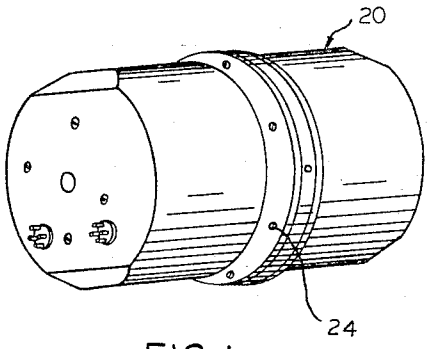


FIG. 1

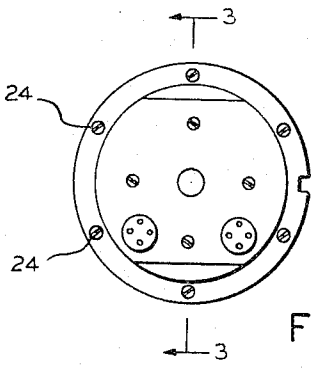


FIG. 2

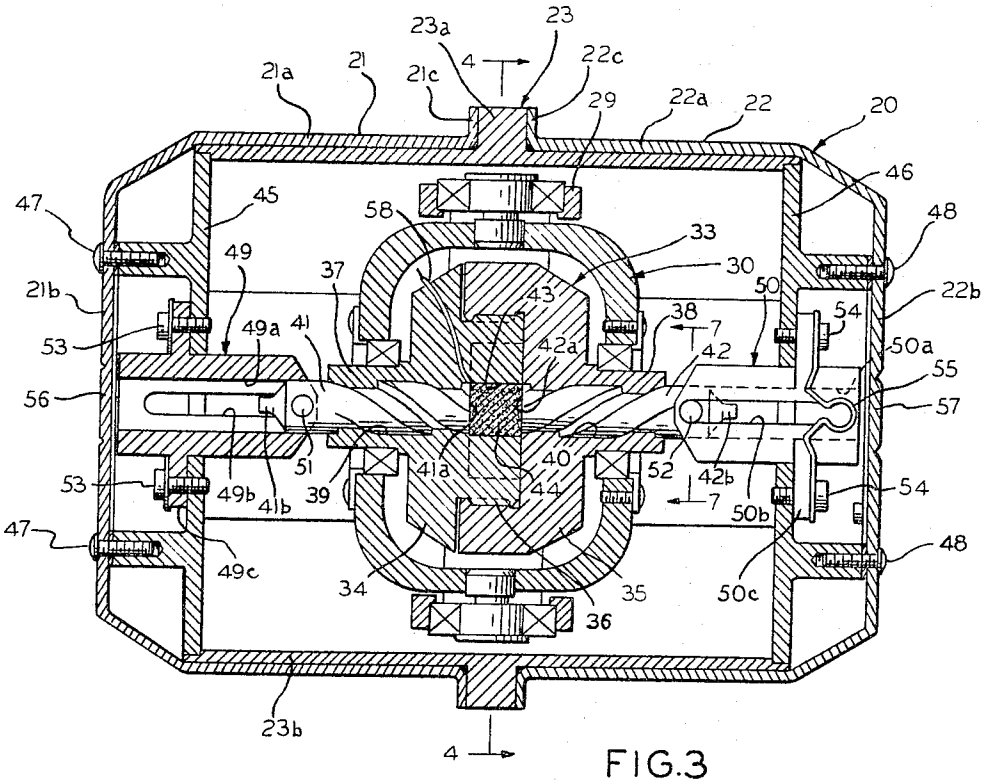


FIG. 3

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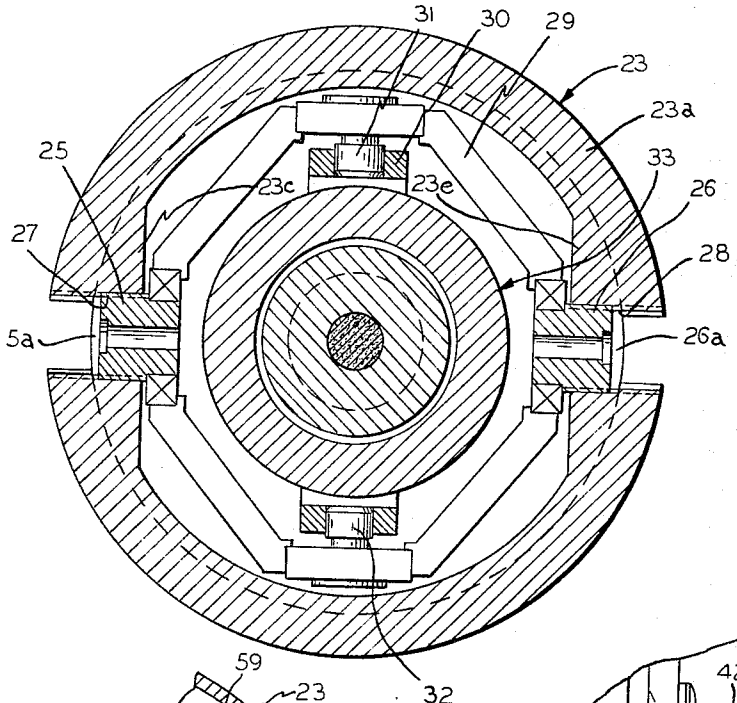


FIG. 4

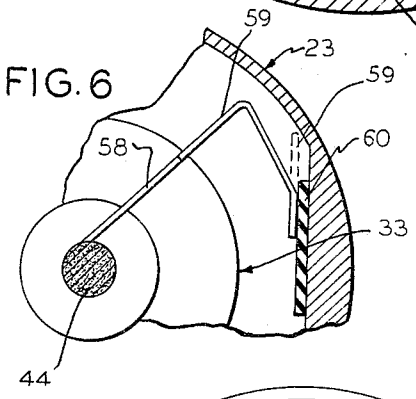


FIG. 6

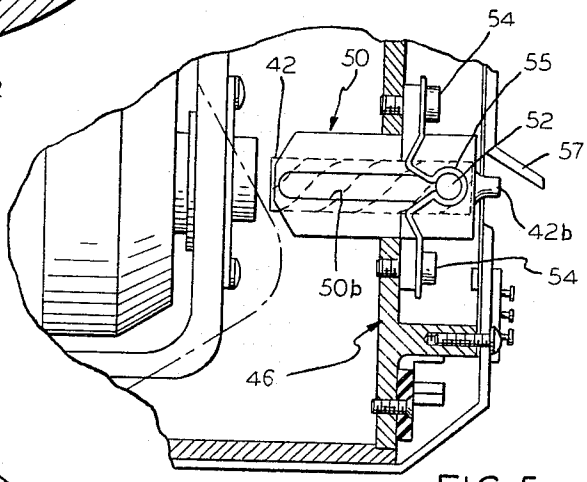


FIG. 5

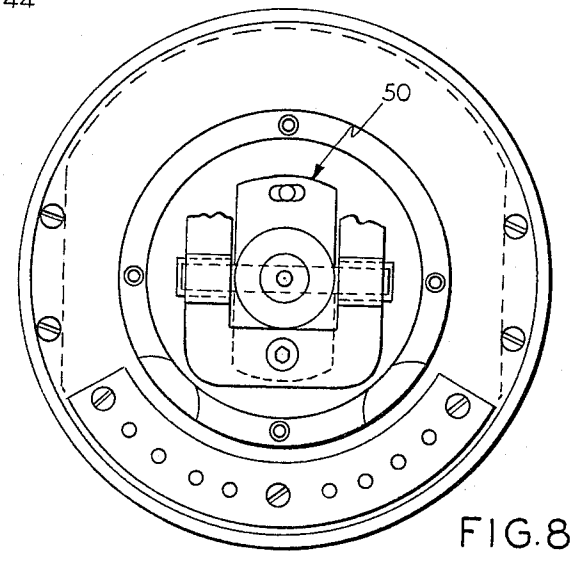


FIG. 8

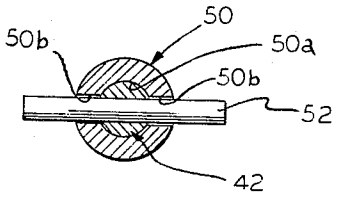


FIG. 7

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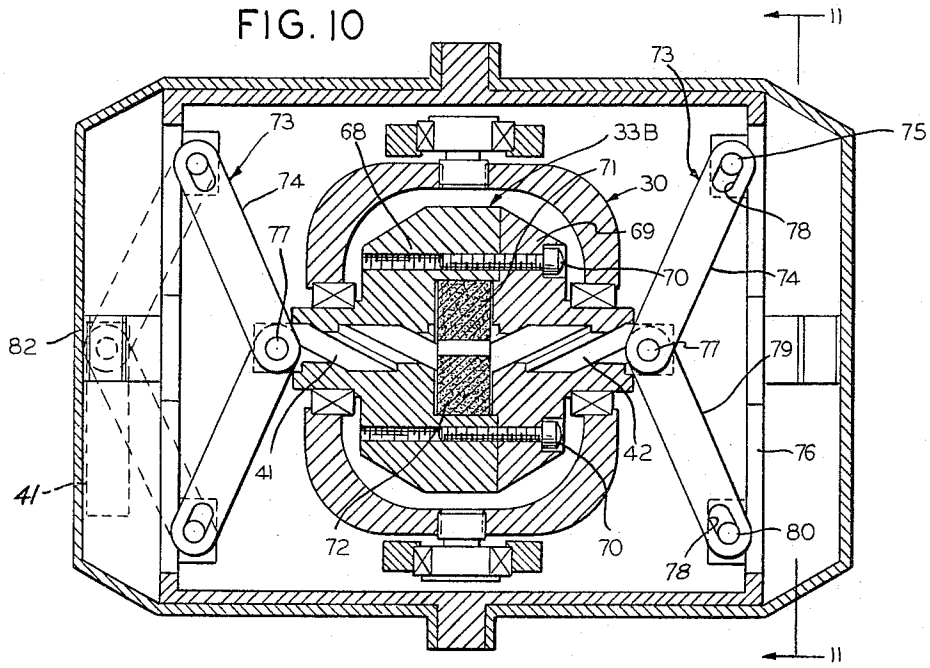
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FIG. 10



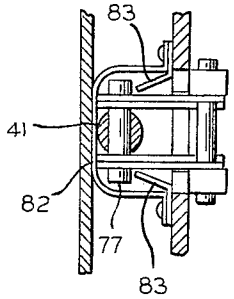


FIG. 12

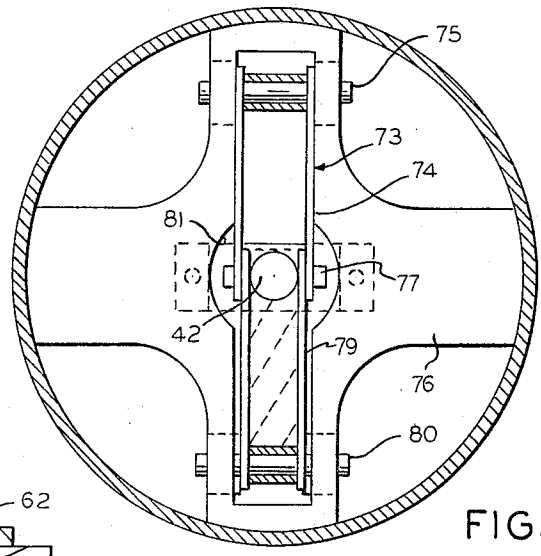


FIG. 11

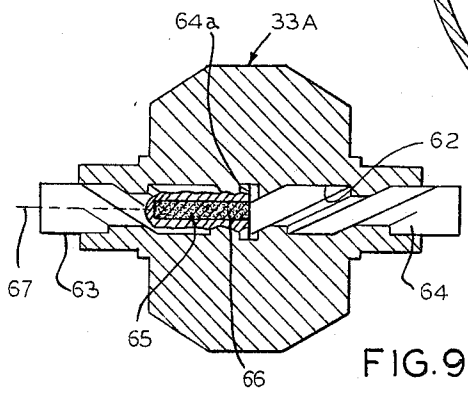


FIG. 9

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3,280,643

PYROTECHNIC GYRO

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Filed Oct. 21, 1963, Ser. No. 317,659
18 Claims. (Cl. 74—5.7)

This invention relates in general to a gyro, and more particularly to a gas-powered gyro, and still more particularly to a gas-powered gyro utilizing a propulsive or explosive charge for power. A gyro of the type of the present invention may be referred to as a pyrotechnic gyro.

The gyro of the present invention is particularly useful in airborne vehicles wherein the vehicles' time in the air is relatively short-lived. Specifically, the gyro of the present invention is useful in missile guidance systems or the like, although other uses and purposes may be apparent to one skilled in the art.

Heretofore, spring-powered gyros have been employed where only short periods of life were required, but most spring-powered gyros have inadequate speed and consequently decay quickly, thereby limiting their life and usefulness. Moreover, such spring-powered gyros have been relatively complex and have included a large number of precision parts thereby making such gyros expensive to construct.

It is therefore an object of this invention to provide a pyrotechnic gyro which obviates the difficulties heretofore encountered in spring-powered gyros and heretofore developed pyrotechnic gyros.

Another object of this invention resides in the provision of a pyrotechnic gyro having a relatively small number of precision parts and being capable of extremely high rates of speed to effectively prolong useful life.

A further object of this invention is in the provision of an improved pyrotechnic gyro that is less expensive to construct than spring-wound gyros and more efficient than other pyrotechnic gyros.

A still further object of this invention is to provide an improved pyrotechnic gyro that may be reloaded for reuse.

Another object of this invention is in the provision of a pyrotechnic gyro that requires less weight and space to obtain equal or superior results as from heretofore developed pyrotechnic gyros.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheets of drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a perspective view of the gyro according to the present invention;

FIG. 2 is an end view of the gyro of FIG. 1;

FIG. 3 is a longitudinal sectional view taken through the gyro of FIG. 1 and substantially along line 3—3 of FIG. 2;

FIG. 4 is a transverse sectional view taken through the gyro of the present invention and substantially along line 4—4 of FIG. 3;

FIG. 5 is a detail fragmentary view illustrating the position of a splined bolt actuator after the gyro has been uncaged and fired;

FIG. 6 is a detail fragmentary view illustrating the manner of obtaining access to the propulsive or explosive charge for firing same;

FIG. 7 is a detail and enlarged sectional view taken substantially along line 7—7 of FIG. 3;

FIG. 8 is a detail and elevational view of the gyro with an end cover removed;

FIG. 9 is a sectional view taken through a modified rotor and splined bolt actuator arrangement;

FIG. 10 is an axial sectional view taken through a gyro of the present invention and showing a modified mechanism for guiding the splined bolt actuators when they are fired from the rotor;

FIG. 11 is an end view of the mechanism for guiding the splined bolt actuators, and taken substantially along line 11—11 of FIG. 10; and

FIG. 12 is a top plan view of the splined bolt actuator guide mechanism and showing the securing of the mechanism after the gyro has been fired.

Referring now to the drawings and particularly to FIGS. 1–4, an illustration of the gyro of the present invention is shown which includes in general a casing **20** comprised of a pair of substantially identical cup-shaped halves or covers **21** and **22** fitted over a frame **23**. The cup-shaped halves **21** and **22**, respectively, include cylindrical side walls **21***a* and **22***a*, and end walls **21***b* and **22***b*. At the open ends of the halves, radially extending flanges **21***c* and **22***c* coact with an annular ridge **23***a* of the frame **23**. Suitable fastening means **24**, FIGS. 1 and 2, secure the flanges **21***c* and **22***c* to the ridge **23***a*. The frame **23** includes a cylindrical portion **23***b* integral with the ridge **23***a* and which guidably supports the cylindrical walls **21***a* and **22***a* of the cup-shaped halves **21** and **22**.

Axially aligned trunnions **25** and **26** having external threads are adjustably received in coaxially aligned threaded bores **27** and **28**, respectively. The bores are arranged in thickened portions **23***c* along the ridge **23***a* of the frame **23** and at the center thereof. Trunnion caps **25***a* and **26***a* are threadedly received in the bores **27** and **28** to lock the trunnions in place and to seal against the entrance within the casing of unwanted matter. The trunnions **25** and **26** bearingly support an outer gimbal **29**. An inner gimbal **30** is provided with trunnions **31** and **32** in coaxial alignment, which trunnions are bearingly supported in the outer gimbal **29** along an axis perpendicular to the axis of support of the outer gimbal. A rotor **33** is bearingly supported in the inner gimbal **30** along an axis normal to the axis of support of the inner gimbal. Thus, rotation of the rotor **33** will be about an axis perpendicular to the pivotal axis of the inner gimbal **30** and the pivotal axis of the outer gimbal **29**, while the pivotal axis of the outer gimbal **29** is perpendicular to the outer axis of the inner gimbal **30**.

The gyro being herein described, because of having inner and outer gimbals, is a free gyro, although it should be appreciated that the present invention may also be employed with rate gyros where only a single gimbal is provided.

As may be seen particularly in FIG. 3, the rotor **33** includes first and second sections **34** and **35** held together by means of a screw-threaded arrangement **36**. Stub shafts **37** and **38** coaxially extend from the sections **34** and **35**, respectively, and are bearingly received by the inner gimbal **30**. It should be appreciated that when the sections **34** and **35** are screwed together as shown in FIG. 3, a unitary rotor is provided.

The sections **34** and **35** are provided with helically splined bores **39** and **40**, respectively, which are adapted to receive therein in mating engagement helically splined bolt actuators or shafts **41** and **42**. The helically splined or threaded bolts and bores are arranged so that upon forcing the bolts outwardly, they will coact to spin the rotor **33** in one direction. Thus, the bolt actuators **41** and **42** are of opposite hand, as are their respective bores **39** and **40**. In the embodiment of FIGS. 1–4, the helically splined bolt actuators **41** and **42** are provided with flat opposed end faces **41***a* and **42***a* that are adapted to be in spaced relation when the bolt actuators are positioned in the rotor prior to the firing of the gyro to thereby define a cavity **43** within the rotor which receives a propulsive or explosive charge **44**. This charge may be of any

suitable material such as cordite and may be molded or otherwise formed to fit intimately within the cavity **43**. The helically splined bores **39** and **40** terminate inwardly of the rotor at the boundaries of the cavity **43** so that the charge **44** may take a cylindrical shape. The charge **44** would be inserted into the cavity **43** prior to assembling of the sections **34** and **35** of the rotor **33**, while the bolt actuators may thereafter be inserted after assembling the rotor and mounting same in the inner gimbal **30**. Thus, it can be readily appreciated that once the gyro is fired, it may be reloaded with another charge **44** for future firing.

End plates **45** and **46** are provided at the opposite ends of the frame **23** and are suitably fitted to the frame and held in place after the cup-shaped halves or covers **21** and **22** are secured in place to the frame. Fasteners **47** and **48** are provided for additionally securing the end plates to the cover when the covers are in place over the frame. Splined bolt actuator guides **49** and **50** are respectively mounted on the end plates **45** and **46** and respectively adapted to coact with the splined bolt actuators **41** and **42** during the firing of the gyro. The guides **49** and **50** include cylindrical bores **49** and **50**, respectively, sized to freely receive the splined bolt actuators, and diametrically opposed slots **49***b* and **50***b* which slidably receive guide pins **51** and **52** secured to the splined bolt actuators **41** and **42**, respectively. Thus, the splined bolt actuator guides **49** and **50** prevent rotation of the splined bolt actuators **41** and **42**, respectively, and serve to hold the bolt actuators when the gyro has been fired. And since only linear motion of the splined bolt actuators **41** and **42** is permitted, the rotor **33** will be caused to spin when the bolt actuators are forced outwardly after ignition of the charge **44**.

The splined bolt actuator guides **49** and **50** are suitably flanged at **49***c* and **50***c* so that they may be connected to the end plates **45** and **46**, respectively, by suitable fasteners **53** and **54**. The guides further extend through the end plates and project on each side thereof as may be most clearly seen in FIG. 3.

In order to prevent return of the splined bolt actuators **41** and **42** toward the rotor **33** after the gyro has been fired, since such a return would interfere with the rotation of the rotor, spring clips **55** (only illustrated in connection with the guide **50**) are mounted at the outer ends of the guide pin slots to receive and hold the guide pins such as the guide pin **52** as shown in FIG. 5, when the gyro has been fired and the bolt actuators have been forced to their outer positions.

Knockouts **56** and **57** are provided in the casing end walls **21***b* and **22***b* which are dislodged by reduced end portions **41***b* and **42***b* of the splined bolt actuators **41** and **42** when the gyro has been fired. Note particularly FIG. 5 wherein the bolt actuator **42** is shown in fired position as being held by the clips **55** and wherein the reduced end portion **42***b* has dislodged the knockout **57** to thereby permit the escape of gases from within the gyro casing.

An example of how the charge **44** may be ignited is shown in FIGS. 3 and 6, wherein an ignition wire **58** extends through a hole in the rotor **33** and into the charge **44**, and is connected to a spring wire **59** that is secured to an insulating panel **60**. The spring wire **59** is suitably connected to a source of electrical potential for firing the charge **44**. In initially readying the gyro for firing, it is necessary to cage the rotor **33** to thereby hold the splined bolt actuators **41** and **42** in tight against the charge **44** until the charge is fired. The spring wire **59** engages in the hole in the rotor **33** to connect to the ignition wire **58**, thereby to hold the rotor **33** in caged position. When the charge **44** is fired, the spring wire **59** breaks loose and snaps out of the path of movement of the rotor **33** as shown in dotted lines in FIG. 6. The ignition wire may also be brought into the rotor in another manner as will be hereinafter explained with another embodiment.

In operation, the gyro is held in caged position, as illustrated in FIG. 3, by means of the spring wire **59**, and wherein the splined bolt actuators **41** and **42** are tight in against the charge **44**. Upon electrically igniting the charge **44** through the ignition wire **58** and the spring wire **59**, the gases generated force the splined bolt actuators **41** and **42** outwardly at a high rate of speed to spin the rotor **33** and thereby power the gyro. The splined bolt actuators **41** and **42** are held in their outer positions by the spring clips **55** and the knockouts **56** and **57** are displaced by the splined bolt actuators to permit the escape of gases generated from the charge **44**.

Referring now to FIG. 9, a modified rotor **33A** is shown which differs from the rotor **33** in that it is constructed of one piece, and in that the helically splined bores **61** and **62** extend inwardly to the center of the rotor. Further, the splined bolt actuators **63** and **64** of this embodiment differ from the splined bolt actuators **41** and **42** in that the splined bolt actuator **63** is provided with a hollow interior or blind bore **65** for receiving a charge **66**. The charge **66** completely fills the blind bore or cavity **65** and therefore is tight against the face **64***a* of the opposing splined bolt actuator **64**. In this embodiment, an ignition wire **67** is provided which extends through a hole formed in the splined bolt actuator **63** for the purposes of igniting the charge **66**, and this manner of wire placement is preferred to avoid any possible rotor unbalance. It should be appreciated that a blind bore may also be provided in the bolt actuator **64** so that the charge is supported by both bolt actuators. This embodiment will operate identical to the embodiment of FIGS. 1–4, however, it is not necessary to disassemble the rotor for reloading or to even take the rotor out of the inner gimbal. It is only necessary to place the charge in the splined bolt actuator **63** and position the splined bolt actuators **63** and **64** properly within the rotor **33A**.

Referring now to the embodiment of FIGS. 10–12, a modified rotor and bolt actuator guide and retaining mechanism is shown, these differing from the previous embodiments. The rotor **33B** is split or sectional and includes sections **68** and **69** which are secured together by a plurality of fasteners **70**. The sections coact to define a civity **71** for receiving the charge **72**. Like numerals are employed in all embodiments where like parts are described.

The mechanism in this embodiment employed for guiding the splined bolt actuators **41** and **42** during the ejection from the rotor **33B**, and preventing rotation of the bolt actuators comprises a linkage assembly **73**. This linkage assembly is identical at both sides of the gyro and for each splined bolt actuator **41** and **42**, and accordingly only the arrangement at one side will be described in detail. The linkage arrangement includes an upper double link **74** pivotally carried on a pin **75** mounted in the end plate **76** at one end and pivotally mounted at the other end to a pin **77** fixed to the outer end of the bolt actuator **42**. Slots **78** are provided in the upper ends of the double link **74** to additionally define a slidable relation with the pin **75**. A lower double link **79** identical to the upper double link **74** is pivotally mounted at one end to the bolt pin **77**, and pivotally and slidably mounted at the other end to a pin **80** secured in the end plate **76**. A suitable slotted opening **81** is provided in the end plate **76** for accommodating the movement of the double links **74** and **79** and the bolt actuator **42** and its pin **77** during the firing of the gyro. Thus, the linkage assembly **73** prevents rotation of the bolt actuator **42** when the gyro is fired to thereby cause the rotor **33B** to spin, while at the same time guiding the movement of the bolt actuator **42** as it leaves the rotor **33B**. After the gyro has been fired, and the bolt actuators **41** and **42** have left the rotor **33B**, the bolt actuators will swing down-

wardly to a position as shown by the bolt actuator **41** in dotted lines in FIG. 10.

A bracket **82** functions as a stopper for the bolt actuators when they are in the fired position, and spring clips **83** are mounted on the end plates and positioned to prevent return of the linkage arrangement after the gyro has been fired as shown particularly in FIG. 12. The spring clips **83** interfere with the pins **77** to prevent return of the linkage. Actually the pins **77** push the spring clips **83** apart as the bolt actuator moves to its completed fired position and against the stopper **82**, after which the clips **83** spring inwardly to block return movement of the pins **77**. It should be appreciated that any other type of mechanism may be employed which prevents rotation of the splined bolt actuators **41** and **42** when they are fired and which guides their movement and prevents their return to interfere with the operation of the rotor. While not shown, an ignition wire may be brought in through the rotor or through a splined bolt actuator to electrically ignite the charge **72**. Further, knockouts may be provided to permit the escape of gas after the gyro has been fired.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

The invention is hereby claimed as follows:

1. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

2. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and means for preventing said actuators from interfering with the rotation of said rotor after ejection of said actuators from said rotor.

3. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and means for holding said actuators out of contact with said rotor after ejection of the actuators therefrom.

4. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and means for holding said actuators out of contact with said rotor after ejection of the actuators therefrom, said holding means including a pin on each of said actuators coacting with spring means mounted on said frame.

5. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, said means including guiding means mounted on said frame for guiding the movement of the actuators during ejection from the rotor, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

6. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, said means including hollow guide brackets slidably receiving said actuators during ejection from the rotor, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

7. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, said means including toggle linkage arrangements connected to the outer ends of said actuators, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

8. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, said rotor being sectional so that it may be disassembled to insert the charge.

9. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, and a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, said rotor being one-piece and one of said actuators being hollow at the inner end to receive the charge.

10. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and an ignition wire extending from said charge and being connectable to a source of electrical energy.

11. A pyrotechnic gyro comprising a frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned helically splined bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of helically splined bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators, a propulsive charge within said rotor for ejecting the actuators from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, said rotor being one-piece and one of said actuators being hollow at the inner end to receive the charge, and an ignition wire extending through said hollow actuator and being connectable to a source of electrical energy.

12. A pyrotechnic gyro comprising a frame, a casing surrounding said frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, and a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

13. A pyrotechnic gyro comprising a frame, a casing surrounding said frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, and a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and a knockout in said casing operable by the ejection of an actuator for permitting the escape of gases generated by the charge.

14. A pyrotechnic gyro comprising a frame, a casing surrounding said frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, and means for igniting the charge.

15. A pyrotechnic gyro comprising a frame, a casing surrounding said frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, means for caging the rotor prior to firing, and means for igniting the charge.

16. A pyrotechnic gyro comprising a frame, a casing surrounding said frame and secured thereto, an outer gimbal pivotally mounted in said frame, an inner gimbal pivotally mounted in said outer gimbal on an axis perpendicular to the pivot axis of the outer gimbal, a rotor rotatably mounted in said inner gimbal about an axis normal to the axes of said inner and outer gimbals, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, and a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof.

17. A pyrotechnic gyro comprising a frame, a casing surrounding said frame, a gimbal pivotally mounted within said frame, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of aligned threaded bores of opposite hand in said rotor coaxial with the axis of rotation thereof, a pair of threaded bolt actuators of opposite hand mating with said bores, means connected to said frame for preventing rotation of said actuators but allowing same to be ejected from the bores, a propulsive charge within said rotor for ejecting the actuators at a high rate of speed from the bores to thereby impart a rotational spin to said rotor upon ignition thereof, means for igniting the charge, and means on said frame for preventing said actuators from engaging said rotor after the charge is fired.

18. A pyrotechnic gyro comprising a casing, a gimbal pivotally mounted within said casing, a rotor rotatably mounted in said gimbal along an axis normal to the pivot axis of said gimbal, a pair of coaxial opposite hand helically splined bores in said rotor coaxial with the axis of rotation thereof, a pair of opposite hand helically splined bolt actuators mating with said bores, a propulsive charge between the adjacent ends of the actuators within said rotor, means for energizing said charge, and means for preventing rotation of said actuators and for guidingly receiving same when they are forced from the rotor.

References Cited by the Examiner

UNITED STATES PATENTS

2,960,876	11/1960	Saphra	74—5.7
2,986,945	6/1961	Riola	74—5.12
3,012,439	12/1961	Ransom et al.	74—5.12
3,017,778	1/1962	Lynn	74—5.12

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