Dec. 12, 1961 R. S. RANSOM ET AL 3,012,439

GYROSCOPES

Filed Jan. 19. 1959 4 Sheets-Sheet 1

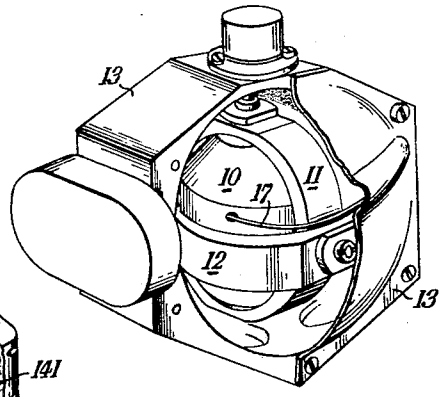



Fig. 1.

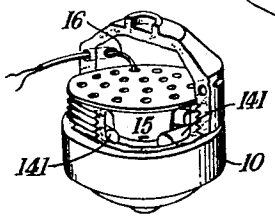



Fig. 2.

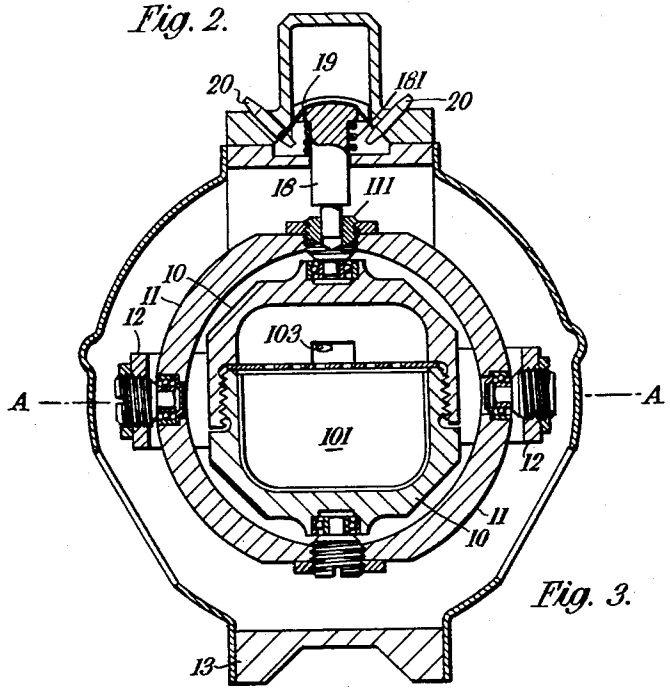



Fig. 3.

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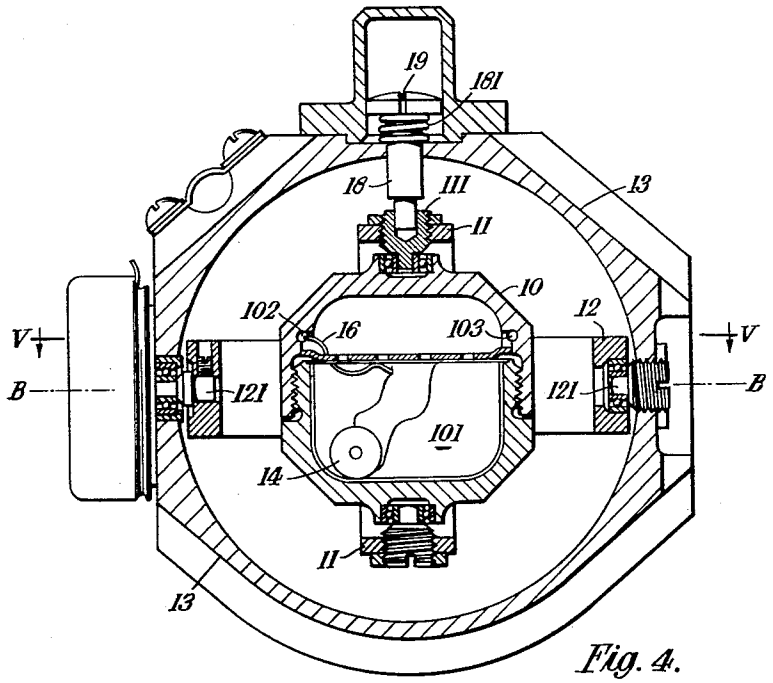



Fig. 4.

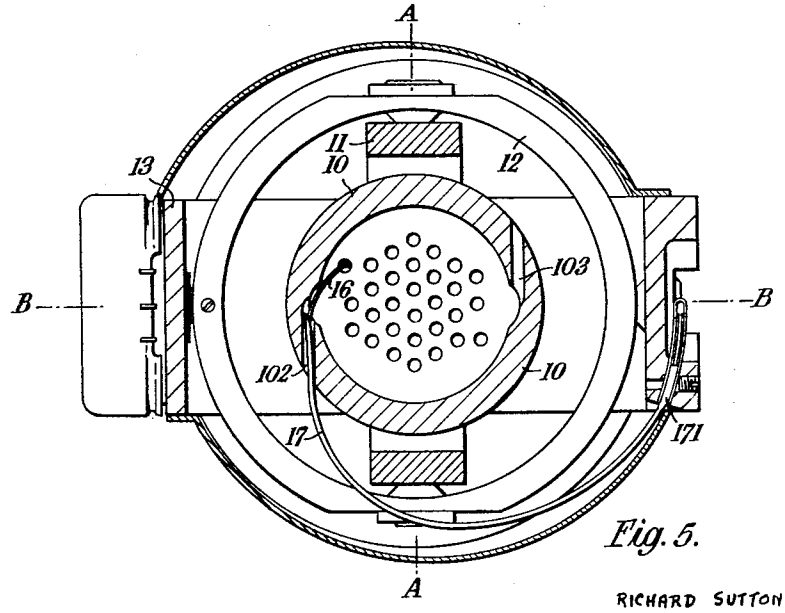



Fig. 5.

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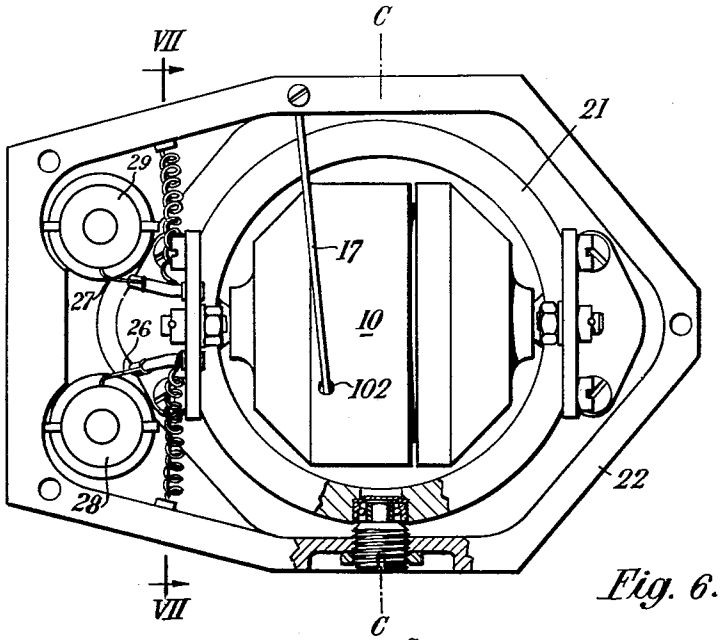



Fig. 6.

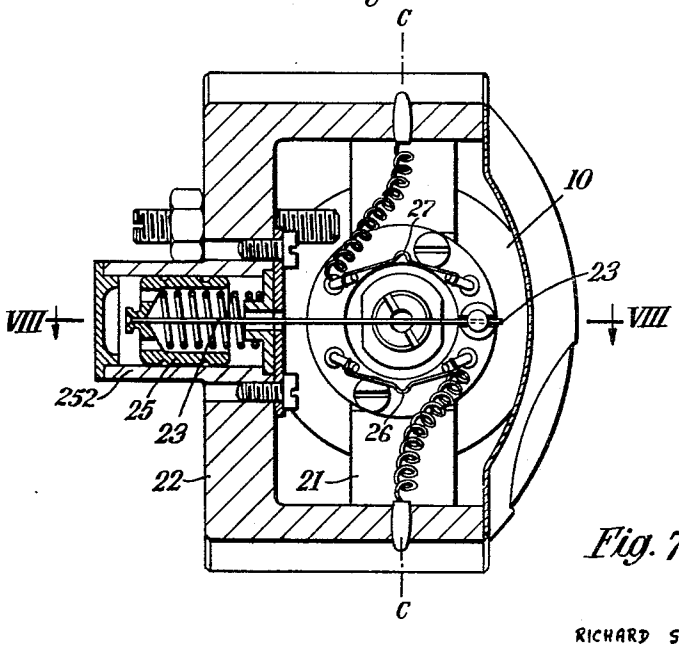



Fig. 7.

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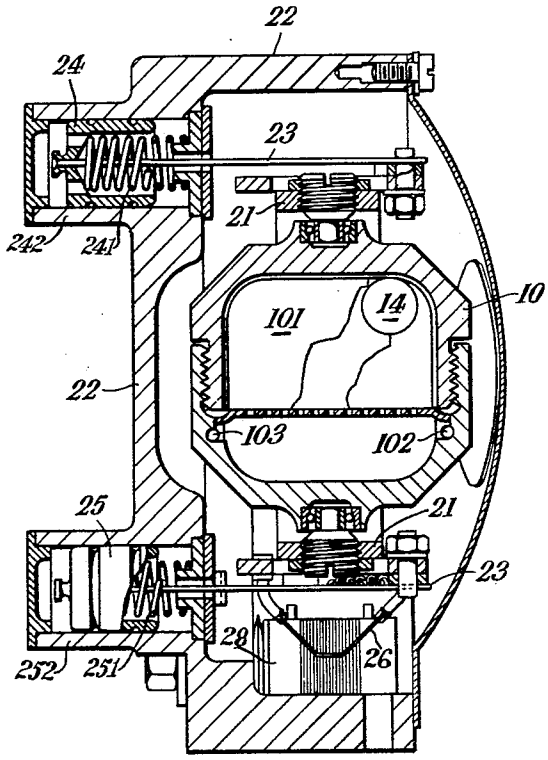



*Fig. 8.*

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3,012,439

# GYROSCOPES

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Claims priority, application Great Britain Jan. 20, 1958
10 Claims. (Cl. 74—5.12)

The object of the invention is to provide an improved form of gyroscope which, being of a simple and relatively inexpensive mode of construction, and also because of its small size and rapid start characteristic, will be particularly suitable for installation in guided missiles.

According to the invention the rotor of a gyroscope is set in motion by jet reaction through tangential nozzles in the sides of the rotor of gases generated by the combustion of a charge contained within the rotor, means being provided for igniting said charge and (where necessary) for restraining the parts of the gyroscope in a datum position until the rotor has attained operational speed. The invention also provides for the automatic liberation of said restrained parts in timed relationship with the ignition of said combustible charge.

The manner in which the invention may be carried into effect is hereinafter more fully described with reference to the accompanying drawings. In said drawings FIGS. 1 to 5 illustrate the application of the invention to a free gyroscope,

FIG. 1 being a perspective view of the gyroscope, and

FIG. 2 a similar view of the rotor shown separately, the wall of the rotor being cut away to reveal the internal components.

FIGS. 3 and 4 are sections in two planes at right angles to each other, on the axes of rotation of the rotor; and

FIG. 5 is a section on the line V—V of FIG. 4.

FIGS. 6 to 8 illustrate a modification, in which the invention is applied to a rate gyroscope.

FIG. 6 being a partially sectional elevation of the gyroscope from which the cover has been removed,

FIG. 7 a section on the line VII—VII of FIG. 6, and

FIG. 8 is a section on the line VIII—VIII of FIG. 7.

Referring to FIGS. 1 to 5 of the drawings, it will be seen that the gyroscope comprises an approximately spherical rotor **10** which is supported in two conventionally disposed inner and outer gimbals **11** and **12** which are respectively arranged to pivot about axes A—A and B—B which intersect at right angles to each other. The outer gimbal **12** is pivotally mounted at **121**, **121** in a casing **13** enclosing the whole instrument. Potentiometer or other means (not shown) may be provided for indicating the angular position of the gimbal **12**.

The rotor **10** houses a combustion chamber **101** in which is provided a combustible charge **14** and an electric igniter or primer **15**. The walls of the rotor are pierced by two diametrically opposed passages **102**, **103** arranged tangentially with respect to the rotor axis, said passages **102**, **103** constituting jet discharge nozzles such that the reaction of gases generated by combustion of the charge **14** will be effective to impart rotatory driving motion to the rotor **10**.

The charge **14** consists of a plurality of solid fuel cartridges **141**, which are capable of being ignited by the primer **15** in which is embedded a low-tension electric fuse. Said fuse is connected to an external power source through conductor wires **16** which are led to the interior of the rotor **10** through one of the aforesaid jet nozzles e.g. the nozzle **102**, the arrangement being such that said wires **16** are severed upon ignition to permit free rotation of the rotor **10**. To avoid interference by



said wires **16** with the operation of the gyroscope, whilst protecting them from breakage by rotor inertia loads which may be imposed during handling or transportation, they are passed into the rotor through a hollow curved spring **17** which is attached at **171** to the casing **13** and is arranged to extend into the rotor nozzle **102** in such fashion that it will exert a light force passing through the rotor axis, and thereby apply a light restraining torque contrary to possible small disturbances to the rotor.

Upon ignition of the charge, the heat and thrust of the gases passing through the nozzle **102** operate to sever the wires **16** and eject the free end of the spring **17** before any appreciable movement of the rotor **10** occurs. The spring **17** together with any unburnt portions of the wires **16** are ejected from the nozzle **102** and are caused by the tension of the spring to take up a position within the casing **13** clear of the gimbals and rotor.

It is necessary to restrain both gimbals in a datum position relative to the casing until the rotor **10** has been brought to the desired operational speed, i.e. when the rotor charge has been fully expended. The inner gimbal **11** is locked to the outer casing **13** by a spring-loaded bolt **18** mounted in the latter and arranged to engage a socket **111** in the former, the bolt **18** being held against its spring **181** by a length of electrical fuse wire **19** (FIG. 3) which is anchored at its ends to terminal pins **20**, **20**. The geometry of the apparatus is such that the outer gimbal **12** is also restrained when the inner gimbal **11** is locked. So long as the fuse wire **19** remains intact, its presence across the head of the bolt **18** prevents the retraction of the bolt by its spring, and means may be provided for passing a fusing current through the wire **19** at the required instant. The fusing circuit may be closed simultaneously with the energisation of the firing circuit for the rotor charge, the required delay in fusing the restraining wire **19** being achieved by making the latter of an appropriate gauge or material.

In the application of the invention to a rate gyroscope which is illustrated in FIGS. 6 to 8, the rotor **10** is mounted in a single gimbal **21** which is pivotably supported in the casing **22** for rotary movement about the axis C—C. The means provided for propelling the rotor, and for restraining it against rotation during handling or transport, are as hereinbefore described with reference to the illustrations of the free gyroscope in FIGS. 1 to 5. In this case, however, the gimbal **21** is attached by wires **23** to plungers **24**, **25**, loaded by springs **241** and **251**, the movement of the plungers in their respective cylinders **242** and **252** being a measure of the precessional torque exerted about the axis C—C. The precessional movement of the gimbal **21** about the axis C—C is transmitted to wipers **26** and **27** of two potentiometers **28** and **29**, which are connected in a circuit (not shown) to produce an output signal representative of the precessional torque.

What we claim as our invention and desire to secure by Letters Patent is:

1. A gyroscope comprising a casing, a rotor having tangential nozzles in the sides thereof and containing a combustible charge which upon ignition generates gases which pass through said tangential nozzles in the sides of the rotor to set the rotor in motion by jet reaction, electrical charge igniting means within the rotor, at least one electrical current carrying lead extending from the inside of the gyroscope casing through one of said nozzles to said igniting means, and spring biasing means biasing the lead to cause the latter to be brought to the inside of the casing and clear of the rotor when the charge has been fired.

2. A gyroscope according to claim 1, wherein the lead

is adapted to be severed from the charge igniting means by the burning within the rotor and the thrust thereof, and to be ejected from the nozzle when the rotor commences to rotate.

3. A gyroscope according to claim 1, wherein the spring biasing means comprises a hollow spring through which the lead is led to the rotor.

4. A gyroscope according to claim 3, wherein the hollow spring is a curved resilient tube which extends into the said one of the nozzles and which is so biased and disposed that upon firing of the charge and rotation of the rotor the tube disengages from the nozzle and springs to a position in which it extends along the inside of the gyroscope casing.

5. A gyroscope according to claim 3, wherein the spring extends into the said one of the nozzles and is so inclined to the direction of the rotor axis as to oppose rotation of the rotor resulting from slight disturbances.

6. A gyroscope according to claim 1, comprising inner and outer gimbals, locking means mounted on the casing for temporarily and releasably locking the inner gimbal against movement relative to the casing, biasing means for spring biasing the locking means out of the locking position, and an electrically fusible element holding the locking means in the locking position.

7. A gyroscope according to claim 6, wherein the locking means comprises a spring-loaded bolt mounted in the casing and arranged to engage in a socket in the inner gimbal, and wherein the fusible element comprises a fusible wire stretched across the head of the bolt to hold the latter in the locking position.

8. A rate gyroscope comprising a casing, a rotor having tangential nozzles in the sides thereof and containing a combustible charge which upon ignition generates gases which pass through said tangential nozzles in the sides of the rotor to set the rotor in motion by jet reaction, electrical charge igniting means within the rotor, at least one electrical current carrying lead extending from the inside of the gyroscope casing through one of said nozzles



to said igniting means, and spring biasing means biasing the lead to cause the latter to be brought to the inside of the casing and clear of the rotor when the charge has been fired, a gimbal mounted for pivotal movement within the casing and carrying said rotor, a first cylinder forming part of said casing, a first plunger slidable within the cylinder, first spring means coupled to said plunger, first connecting means for connecting the plunger and gimbal to cause the precessional movements of the gimbal to be restrained by said spring, a second cylinder forming part of said casing, a second plunger slidable within the second cylinder, a second spring means coupled to said second plunger and second connecting means for connecting the second plunger and gimbal to cause the precessional movements of the gimbal to be restrained by the said second spring means, the first cylinder and associated plunger and spring means being disposed in spaced relation to said second cylinder and associated plunger and spring means on opposite sides of the gimbal axis to form a symmetrical arrangement.

9. A rate gyroscope according to claim 8, comprising a potentiometer winding in the form of a straight helix extending at right angles to the gimbal axis, and a wiper mounted on the gimbal so as to traverse the winding in the direction of the longitudinal axis of the winding.

10. A rate gyroscope according to claim 9, comprising a further potentiometer winding and wiper arranged to form with the first-mentioned winding and wiper a symmetrical arrangement.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,077,344 | Hennig | Nov. 4, 1913 |
| 2,386,686 | Hunsdorff | Oct. 9, 1945 |
| 2,732,721 | Summers | Jan. 31, 1956 |
| 2,743,576 | Crockett | May 1, 1956 |
| 2,754,789 | Minisini | July 17, 1956 |