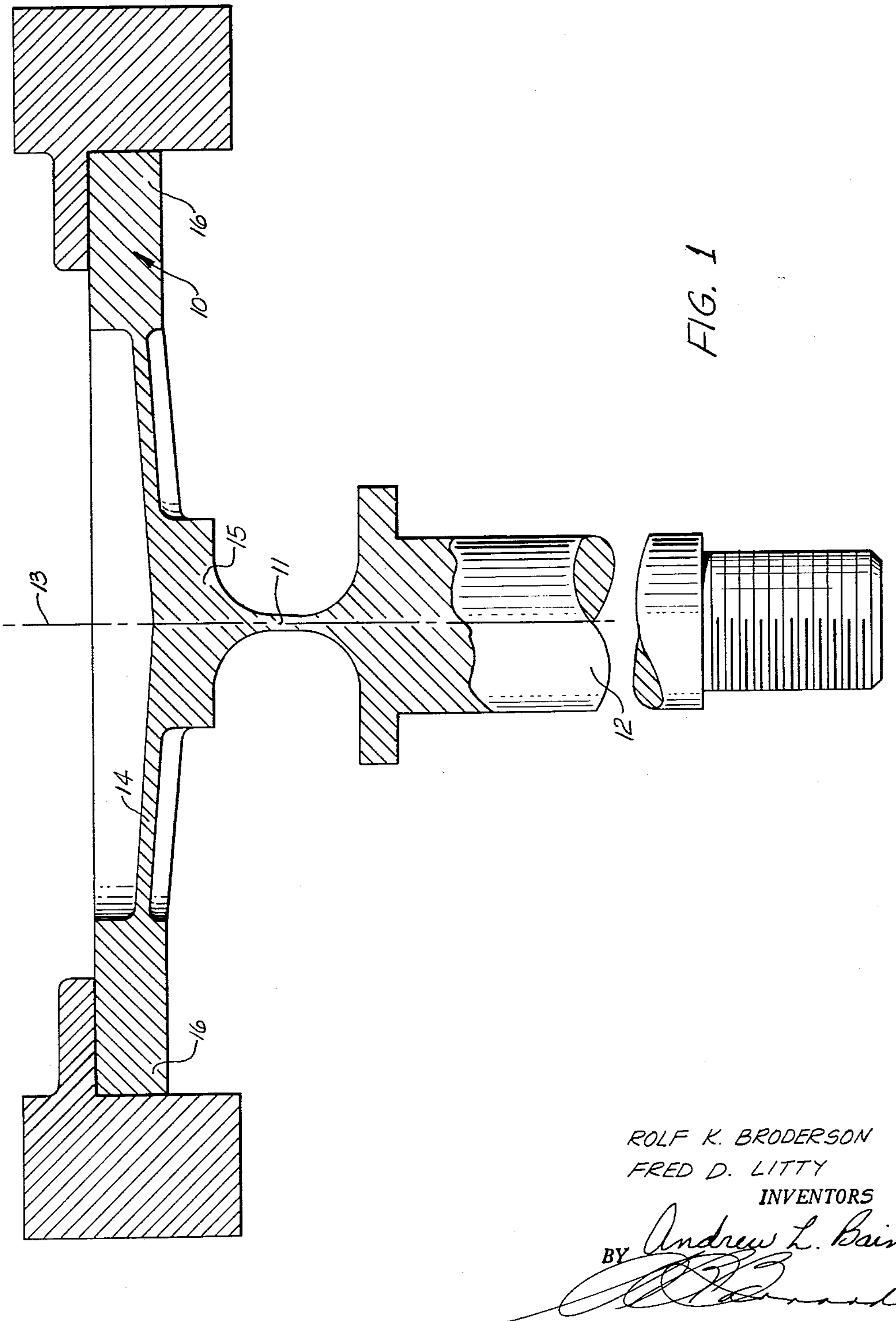

FIG. 1

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FIG. 2

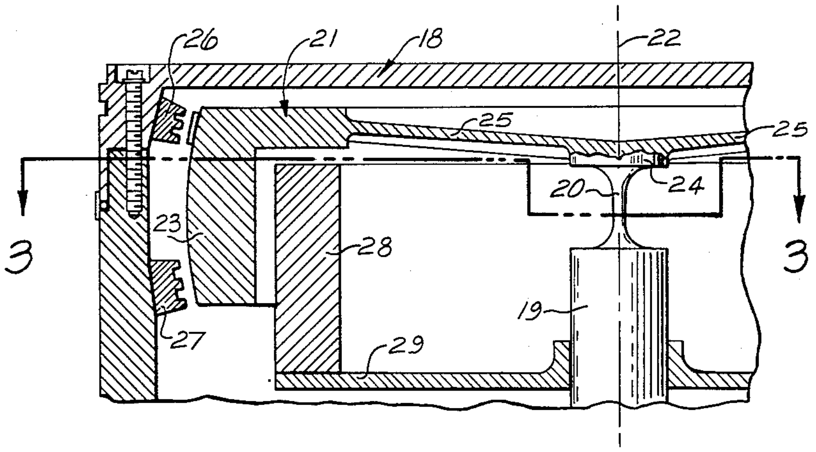
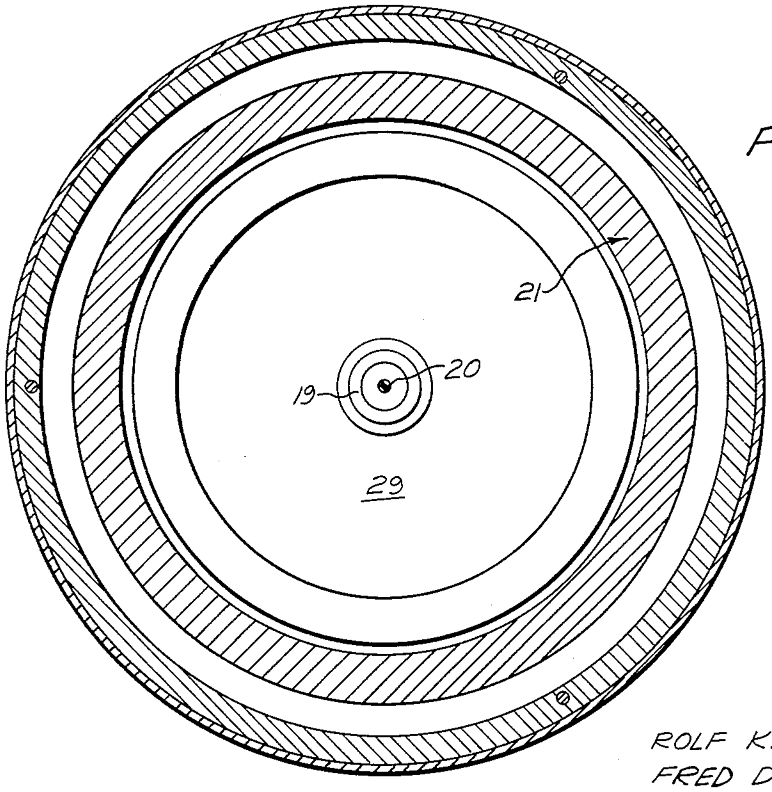


FIG. 3



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ISOELASTIC FLEXURE SUSPENDED AND DRIVEN GYROS

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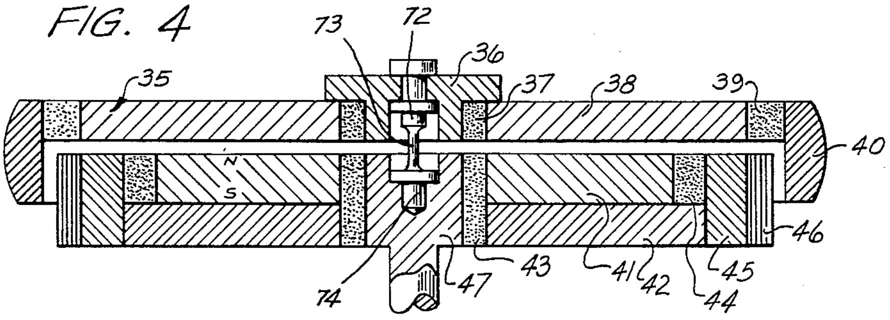
FIG. 4



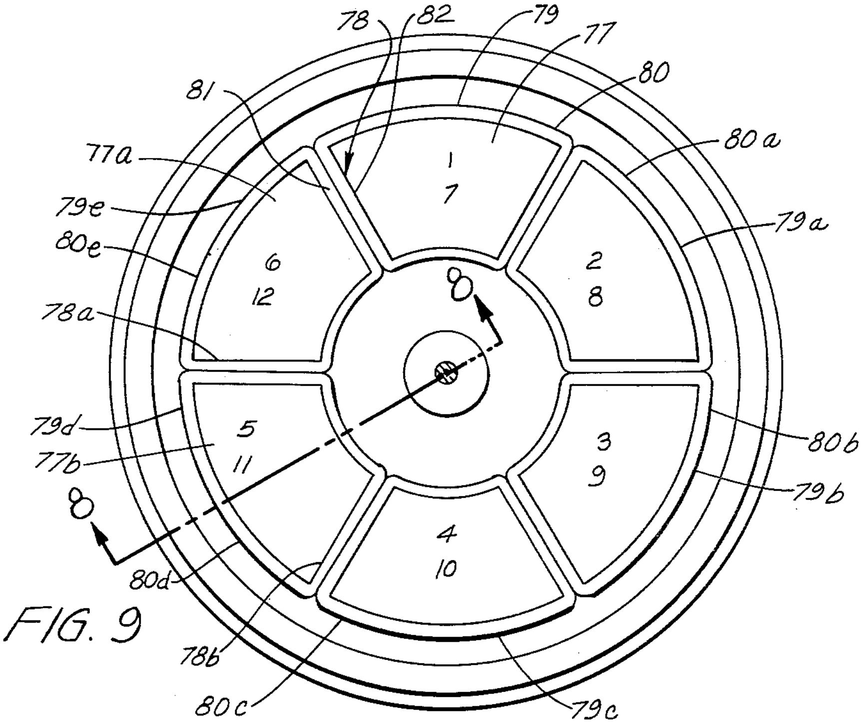


FIG. 9

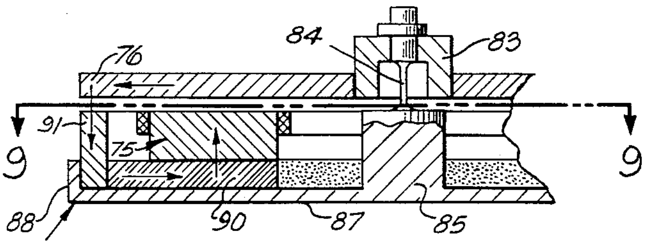


FIG. 8

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ISOELASTIC FLEXURE SUSPENDED AND DRIVEN GYROS

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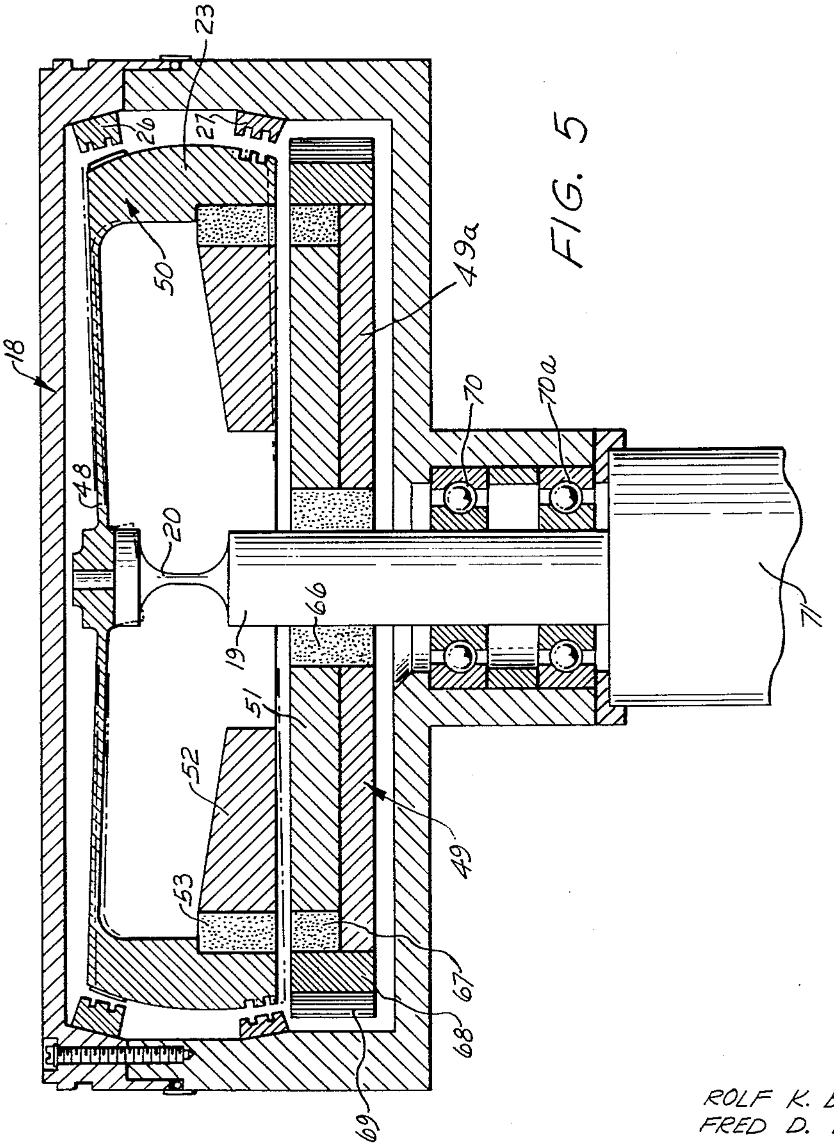

FIG. 5

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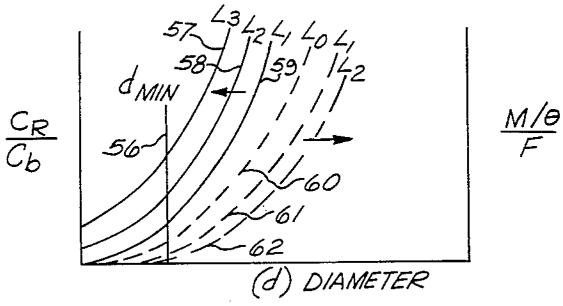
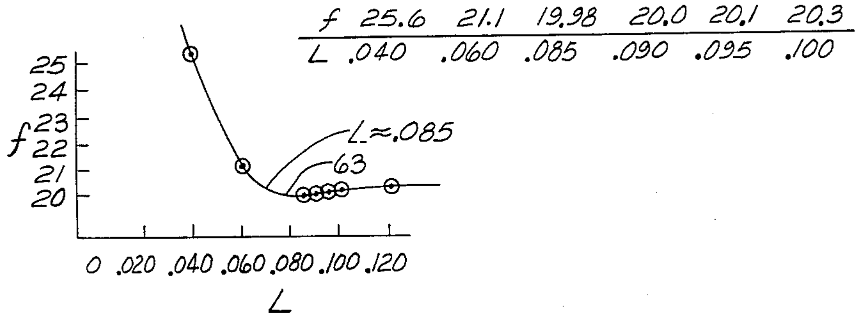
FIG. 6





f	25.6	21.1	19.98	20.0	20.1	20.3
L	.040	.060	.085	.090	.095	.100

FIG. 7

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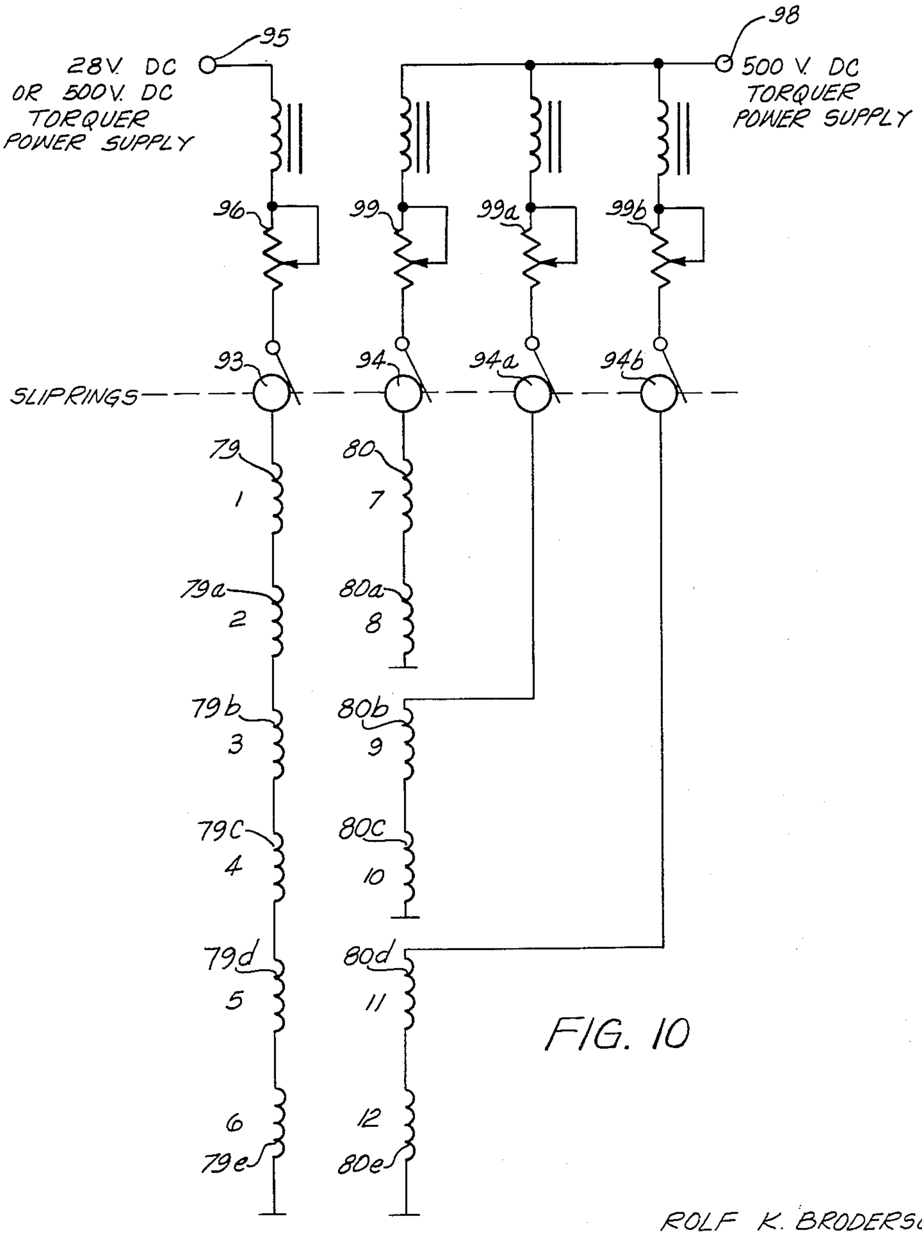

FIG. 10

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2,995,938
Patented Aug. 15, 1961

2,995,938

ISOELASTIC FLEXURE SUSPENDED AND DRIVEN GYROS

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Filed July 13, 1960, Ser. No. 42,717
12 Claims. (Cl. 74—5.7)

This invention generally relates to improvements in flexure suspended and driven gyroscopes and more particularly to gyroscopes having two-degrees-of-freedom which are provided by means of a magnetically compensated flexure suspension.

In a prior application Serial No. 838,979, filed September 9, 1959, directed to a "Pivot Spring Suspended Gyro" and assigned to the same assignee, there is disclosed an improved gyro construction that eliminates the use of conventional gimbals and bearings or pivot-type movable joints and substitutes instead a deflectable solid spring flexure member that is compensated to minimize unbalances and undesired spring return forces and torques. This construction considerably simplifies the manufacture of the gyro and, quite importantly, markedly reduces or eliminates many types of gyro errors that are inherently associated with bearings and other known prior art pivots.

According to the present invention there is provided improvements in the construction of both the flexure pivot and deflection means and in the magnetic compensating means for the flexure suspension, which improvements are directed toward rendering the gyro more sensitive and reliable and otherwise improving its performance.

It is, accordingly, a principal object of the invention to provide an improved flexure suspended gyro having an isoelastic flexure joint coupled with a supplementary angular deflection member, whereby the gyro responds uniformly to displacement about all sensitive axes.

A further object is to provide such a gyro having increased sensitivity about all sensitive axes.

A primary feature is the isoelasticity of the flexure mechanism, in that the degree of flexibility is substantially equal in three directions.

A still further object is to provide such a gyro having an improved magnetic compensating means for the spring flexure.

Other objects and many additional advantages will be more readily understood by those skilled in the art after a detailed consideration of the following specification, taken with the accompanying drawings wherein:

FIGURE 1 is a vertical sectional view illustrating a preferred dual spring flexure and flywheel construction for use in a gyro;

FIGURE 2 is a partial vertical section illustrating a similar flywheel and multiple spring flexure embodied in a gyroscope construction;

FIGURE 3 is a cross-sectional view taken through lines 3—3 of FIGURE 2;

FIGURE 4 is a vertical sectional view illustrating another embodiment of the invention;

FIGURE 5 is a cross-sectional view similar to FIGURES 2 and 4, and illustrating further features of the invention;

FIGURES 6 and 7 are plotted graphs illustrating the preferred relationships between the flexure and flywheel dimensions and the operational characteristics of these elements; and

FIGURE 8 is a vertical section, similar to FIGURE 4, through a modification of the construction shown in FIGURE 4, the section being taken on the line 8—8 of FIGURE 9;

FIGURE 9 is a plan view of the construction shown in FIGURE 8, with the flywheel removed, the view being taken on the line 9—9, FIGURE 8.

FIGURE 10 is a schematic wiring diagram of the coils and related portions of the apparatus shown in FIGURES 8 and 9.

Referring now to the drawings for a detailed consideration of the invention, there is shown, in FIGURE 1, one preferred construction of the flywheel **10** and flexure **11** for the gyro. As shown, the flywheel **10**, solid flexure portion **11**, and drive shaft portion **12** are all preferably formed as an integral and symmetrical unit about the central or spin axis **13** passing lengthwise through the members.

The function of the solid flexure portion **11** is to provide a positive rotative drive connection between the drive shaft **12** and flywheel **10**, but to permit flexing or pivoting action therebetween about all coordinate axes perpendicular to spin axis **13**. Consequently, when the rather large and heavy flywheel **10** is being rotated at high speed by the drive shaft **12**, it serves as an effective gyroscope rotor tending to maintain its same orientation in space despite pivoting or tilting of the drive shaft **12**. Any such tilting or pivoting of shaft **12**, about any axis transverse to spin axis **13**, merely serves to flex or bend the cylindrical flexure portion **11** about that axis, thereby providing a universally pivotable joint between the flywheel **10** and drive shaft **12**.

According to the present invention the construction of the solid flexure portion **11** and flywheel **10** is such as to provide an isoelastic joint between the members providing a high bending compliance therebetween that is equal about all axes transverse to the spin axis **13**. To provide such a joint, it is also necessary that the axial compliance in a direction parallel to or in substantial alignment with axis **13** and the radial compliance in a direction transverse to axis **13** also be made equal to one another. In other words, the construction is such as to provide, not only uniform pivoting deflection about axis **13** by means of bending of the solid cylindrical flexure portion **11**, but also to provide equal radial and axial deflections (transverse to axis **13** and parallel to axis **13**, respectively) for equal radial and axial forces being exerted upon the flywheel and the solid cylindrical flexure portion **11**. The deflection relative to a plane perpendicular to the axis **13**, is provided by the thin dished flexure portion.

To provide this desired function the flywheel **10** is preferably formed in a flexible dished washer-type configuration having a relatively thin central flexure portion **14** extending radially outward and being inclined slightly upwardly from the central hub portion **15** of the flywheel. The outer rim portion **16** of the flywheel **10** is, in turn, formed of a considerably thicker wall section than the central dished flexure portion **14** to not only concentrate the weight of the flywheel about the periphery thereof, as is desired, but also to provide a substantially rigid outer ring. With this construction, the central dished flexure portion **14** of the flywheel is relatively flexible and will yield or comply in response to axially directed forces operating parallel to the spin axis **13**. Thus, by suitably dimensioning the thickness of the central dished flexure portion **14** to provide the desired flexibility to axial forces with the diameter and length of the solid cylindrical flexure portion **11**, an isoelastic joint may be provided which has low and equal radial and axial compliance while providing a high compliance in bending uniformly about the solid cylindrical flexure portion **11**.

FIGURE 2 illustrates one preferred gyro structure employing the isoelastic joint construction of FIGURE 1. As shown, the gyro is composed of an outer housing, generally indicated at **18**, within which is contained the integrally formed drive shaft portion **19**, solid flexure portion **20** and which is integral with the shaft portion **19**, and flywheel portion **21** which is integral with, or supported by, the shaft portion **19**, all being normally rotatable about spin axis **22**.

The flywheel portion **21** is in an inverted cup-shaped form having a relatively massive outer rim **23** depending downward about its periphery and being connected to the hub portion **24** by means of a relatively thin-walled central flexure portion **25**, which flexure wall is sufficiently thin in relation to the diameter and length of the solid flexure **20** to permit axial compliance or limited deflection in response to axial forces directed lengthwise along spin axis **22**. The walls of the central portion are also inclined in a direction slightly upwardly from the cylindrical hub **24**, as shown, thereby to resemble in function, a flexible dished washer construction as discussed above in connection with FIGURE 1.

For spinning the flywheel at the high speed desired, an electrical, or other type of drive motor (not shown), may be located either within or outside the housing **18**, which drive motor is connected to drive shaft **19**, thereby rotating the shaft **19** and the flywheel in synchronism through the solid cylindrical flexure portion **20**.

When the flywheel **21** is being rotated at high speed, it serves as an effective gyroscope tending to maintain its same orientation in space despite tilting or pivoting of the housing **18** about any axis perpendicular to or aligned with the normally vertical axis **22**. Any such tilting or deflection of the housing **18** merely serves to flex the solid cylindrical flexure portion, thereby providing a universally pivotable joint between the flywheel and the housing, the limits of such flexure being, of course, determined by the clearances existing between the outer surface of the flywheel and the adjoining portions of the housing or the members attached to the interior thereof. Pickoff means are provided for producing an electrical signal proportional to the deflection between the flywheel and housing and torque producing means are provided for precessing the flywheel spin axis as desired. Such means are generally indicated as elements **26** and **27** in FIGURE 2, having portions supported inside the housing and being adapted to cooperate with the outer portion of the flywheel rim **23**.

The solid cylindrical flexure portion **20** operates as a spring and provides a restoring torque in such direction as to oppose any displacement between the flywheel **21** and housing **18**. To compensate for this spring force, there is provided one or more permanent magnet members **28** which is supported on a series of arms or a circular disc **29**, which disc is positioned underneath the flywheel **21** and connected to the drive shaft **19** to rotate with the flywheel.

The magnet **28** which is in the form of a heavy walled tubular permanent magnet is located under the flywheel and consequently exerts no unbalanced force upon the flywheel when the flywheel and housing are in alignment, a shown in FIGURE 2. However, upon relative deflection between the flywheel and housing, the magnet exerts a net attracting force tending to increase the deflection and this force is designed to be equal and opposite the spring return force being exerted by the solid cylindrical flexure **20** and the dished central flexure portion **25**. Consequently, the magnet provides compensation for the solid cylindrical flexure **20** and the dished central flexure portion **25**, to insure a substantially neutral universal suspension of the flywheel as desired.

The combination of the small cylindrical flexure **20**, and the central dished flexure portion **25** integral with the flywheel, provides isoelasticity of the unit, in that it provides, a substantially equal degree of flexibility in three directions, relative to the normally vertical axis of the drive shaft **19**.

Due to the relative movement between the gyro flywheel **21** and the permanent magnet **28** upon deflection of the flywheel **21**, eddy currents may be produced in the flywheel **21** and in the magnet supporting disc **29** as well as in other portions of the gyro structure in the vicinity of the magnetic lines of force. Under certain conditions such eddy currents may produce undesired torques operating upon the flywheel **21** and tending to displace or unbalance the flywheel from its proper axis.

In FIGURES 4 and 5 there are shown in diagrammatic form, preferred means for minimizing the eddy current effects. In principle, the means employed for reducing the effect and magnitude of the eddy currents being produced is to construct all portions of the gyro that are subjected to the magnetic field, of a high electrical resistance material such as a ferrite composition or a laminated metal layer construction. Thus the flywheel **35**, in FIGURE 4, is constructed of a composite number of materials, with the hub portion **36** being of steel or other material as in FIGURES 1 to 3, and next a central ring insulator **37** of ceramic material or the like, concentrically about which is placed the extended wall top portion **38** of the flywheel which is made of a ferrite composition or other high resistivity material. This central top portion is acted upon by the magnetic field and hence the high resistivity material markedly reduces the amplitude of the eddy currents being generated. Completing the flywheel **35**, the central wall portion **38** is, in turn, banded by an insulating ring **39** of ceramic or other non-conductor which is finally encircled by the outer massive rim **40** which is made of a ceramic material, or other suitable material. In a similar manner the cylindrical disc type magnet **41** is also carried by a composite support comprised of high electrical resistivity material and insulators whereby all portions of the gyro being subjected to the magnetic field are so constructed as to minimize eddy current flow. Specifically, in the preferred embodiment shown, the shallow cylindrical magnet **41** is carried on a flat cylindrical disc **42** of high resistivity material such as a ferrite which is connected to the drive shaft **47** by a tubular non-conducting band **43** made of a ceramic material, or other suitable material, the tubular band **43** also separating the permanent magnet **41** from the shaft **47**. A second non-conducting ring **44** encircles the opposite upright side of the magnets, followed by a concentric ring **45** of a high resistivity ferrite or the like and finally by a laminated or tape wound retaining ring **46** that maintains the magnet assembly together.

The flexure member shown in FIGURE 4, comprises a substantially cylindrical upper body section **72**, which is pressed into, or otherwise attached to the hub portion **36**, a reduced diameter cylindrical flexure portion **73**, integral with the upper body, and a cylindrical lower body section **74**, which is pressed into, or otherwise attached to the upper hub of the drive shaft **47**, as shown in FIGURE 4.

A shoulder or collar may be formed integral with each of the cylindrical body sections **72**, **74** of the flexure member, to locate the body sections relative to the respective hub portions **36**, **47**.

FIGURE 5 illustrates an alternative embodiment of the invention that is similar to that of FIGURE 2 but also including an eddy current control device, similar to that shown in FIGURE 4. In this construction a composite flywheel **50** is introduced, the flexure section **48** of the head of the flywheel being supported from the base thereof, which is located close to the permanent magnet disc. This phase of the construction is similar to the inclined wall or dished portion **25** of FIGURE 2 or **14** of FIGURE 1, which latter constructions are of the dished flexible washer type, as discussed above. In the construction of FIGURE 5, the axial compliance of deflection in response to unit force of this flat wall has been found by calculation to be about one-third of the compliance obtainable with the flexible dished washer type construction and consequently may be desired in the larger gyros employing a larger diameter solid cylindrical flexure **20** and providing a low radial compliance in response to transversely directed forces. In operation, the joint functions in essentially the same manner as does that of FIGURES 1 and 2, in providing an isoelastic joint wherein the bending torques and transverse forces are taken by deflection of the solid cylindrical flexure **20** and the axial forces are taken by deflection of the thin central wall portion **48** of the flywheel **50**.

FIGURE 5 also illustrates an alternative construction and arrangement of the compensating magnet **51** and further details of the motor drive and bearings for the drive shaft **71**. As shown, the compensating magnet **51** may be supported on a composite disc **49** underneath the depending rim, which is attached to and aligned with the bottom of the rim portion **23** of the flywheel **50** rather than under the central thin wall section **25** of FIGURE 2. This arrangement enables the relatively flexible portion of the wall section to be extended beyond that obtainable in the construction of FIGURE 2.

In order to compensate for the eddy currents in a manner similar to FIGURE 4, and still maintain a central dished flexure **48** similar to that shown in FIGURE 1, the flywheel **50** is formed of a composite construction, the head construction and the rim **23** thereof being similar to those shown in FIGURE 1.

The annular base **52** of the flywheel, is substantially parallel to the disc type permanent magnet **51**, the base disc being fixedly attached to and isolated from the rim **23** of the flywheel by a ring **53**, which is formed of a non-conducting or ceramic material, the ring being inserted in a counter-bore in the rim **23** of the flywheel, The permanent magnet **51** is supported by a composite disc **49**, which is in turn attached to the cylindrical portion of the shaft **19**. The circular disc type permanent magnet **51** is carried by a composite support disc **49** which is basically formed of a composite consisting of electrical high resistivity materials, and insulators, in a manner similar to that shown in FIGURE 4, so that all portions of the gyro subjected to the magnetic field, are so constructed as to minimize eddy current flow. The permanent magnet **51** is carried on a flat circular disc **49*a***, of a high resistivity material, such as a ferrite, which is supported on the drive shaft **19** by a tubular non-conducting bushing or ring **66**, which is made of a ceramic material, the ring **66** extending upward into the inner diameter of the permanent magnet **51**. A second non-conducting ring **67**, which is also made of a ceramic material, surrounds the outer diameter of the permanent magnet **51**, the second ring **67** being supported by the circular disc **49*a***. An outer ring **68**, of a ferrite or other electrical high resistivity material, surrounds the outer circumference of the disc **49*a***, and the ring **67**, a laminated or tape wound retaining ring **69**, being wrapped around the outer ring **68**, to grip and retain the magnet and disc assembly in the relation shown in FIGURE 5.

As further shown in FIGURE 5, the drive shaft **19** is rotatably supported in the housing **18** by means of large and durable anti-friction bearings **70**, **70*a***. If the motor (not shown) is to be supported outside of the housing **18**, the drive shaft may project outside the housing to engage with or be formed integrally with the motor shaft **71**.

For a more vigorous explanation of the construction and design of the preferred isoelastic joint, reference is made to the formulae and explanation and to FIGURES 6 and 7 illustrating a plot of the construction criteria.

The radial compliance C_r of the flexure joint **20** consists of two parts; that due to shear compliance C_s, and that due to double bending C_c. The total radial compliance C_r in terms of the length (L) and diameter (d) of the solid cylindrical flexure is:

$$C_r = S/F = C_s + C_c = \frac{16L^3 + 31.2Ld^2}{3E\pi d^4}$$

The compliance C_b, due to a pure moment applied at the end of the flywheel is:

$$C_b = \frac{\theta}{M} = \frac{64L}{E\pi d^4}$$

The ratio of radial compliance C_r to bending compliance C_b should be as low as possible to provide the gyro with the maximum sensitivity to tilting displacement about its sensitive axis and a minimum sensitivity to disturbances by a transverse translation force. However, the limiting factors in the construction of the diameter and diameter-to-length ratio for the solid cylindrical flexure **20** are manufacturing limitations on the size of these dimensions, sufficient strength to withstand fatigue stress and compatibility of the total radial and axial compliances.

In FIGURE 6 there is shown a plot of the ratio of radial compliance to moment compliance as the ordinate and the diameter of the solid cylindrical flexure **20** as the abscissa with the upright line **56** establishing the minimum diameter to be determined in accordance with factors such as fatigue stress, manufacturing limitations, and others as mentioned above. The three solid line curves **57**, **58**, and **59** indicate the variation in this compliance ratio for flexures of different length. Since it is desired to provide the maximum bending compliance and the minimum radial compliance, the ratio should be as low as possible; and on the basis of this criteria alone one would select the length L_1 as being preferred.

However, consideration of the spring rate of the flexure joint in bending to the permissible radial load or:

$$\frac{M/\theta}{F} = \frac{E\pi d^4}{\frac{\pi S_s \max d^2}{4}} = \frac{Ed^2}{S_s \max L}$$

indicate that this latter ratio should also be as low as possible and dotted line curves **60**, **61**, and **62**, in FIGURE 6, wherein this latter ratio is plotted for given lengths indicate that length L_1 is inferior to L_2 in this characteristic.

To obtain the optimum length for a minimum diameter of the cylindrical flexure **20**, the product of these two functions is plotted as the ordinate in FIGURE 7 as against length and the minimum value of the curve **63** being obtained gives the optimum length of the flexure desired.

After this calculation has been completed it is then necessary to compute the radial compliance of a cylindrical flexure of the length and diameter selected and to equate this compliance with the axial compliance of the flywheel thin wall flexure section.

Computation has shown that the axial compliance of a free flexible dished washer of a given size and thickness of material is 1.377×10^{-4} inches per pound, whereas that for a flat plate of the same size and material thickness rigidly constrained at its edges is much lower or $.419 \times 10^{-4}$ inches per pound. Consequently the ultimate length selected for the solid cylindrical flexure **20** of minimum diameter will be that length that yields the same radial compliance as the axial compliance of the flywheel, thereby to provide the isoelastic joint desired.

FIGURES 8 and 9 show a modification of the construction, shown in FIGURE 4, in which a plurality of coils laid in radial slots through the magnet are provided to adjust the spring rate compensation of the apparatus.

In this construction, a ring type permanent magnet **75** is provided under and substantially parallel to the substantially cylindrical flywheel **76**, which is located above and substantially parallel to the permanent magnet **75**. The upper portion of the permanent magnet is divided into six segments **77**, **77*a***, **77*b***, by a plurality of equally-spaced radial slots **78**, **78*a***, of substantially rectangular cross-section, as shown in FIGURE 9.

A coil **79**, **79*a***, **80**, **80*a*** is wrapped around each of the magnet segments, the straight side sections **81**, **82** of adjoining pairs of coils being embedded in each of the slots **78**, **78*a*** as shown in FIGURE 9.

The circuitry used to energize the coils **79**, **80** is shown in FIGURE 10 and hereinafter described.

The flywheel **76** which is in the form of a relatively flat disc having a central opening therethrough, is supported by a hollow cylindrical hub **83** having a central cavity therethrough, the necked flexure pivot **84** being attached to the solid portion of the hub in a manner similar to that shown in FIGURE 4.

A cylindrical shaft section **85**, integral with or fixedly attached to the flexure pivot **84** is mounted below the flexure pivot, the shaft supporting the magnet support member.

A hollow dished support member **86**, made of steel or other suitable material, is fixedly attached to or integral with the shaft, the flat base **87** integral with the support member having a circular rim **88** integral therewith and perpendicular thereto, the rim surrounding the return path structure, on which the permanent magnet is supported.

The permanent magnet **75** is supported by a circular ferrite disc **90**, which rests on the base **87** of the support member, the disc **90** and a ferrite ring **91**, which surrounds the disc **90** and is fitted to the inner surface of the annular rim **88** of the support member serving as a return path for the magnetic flux of the permanent magnet.

The circular segmental inner and outer portions of the coils **79**, **80**, surround the circular segmental inner and outer surfaces of the magnet segments **77** to **77*e*** in the manner shown in FIGURES 8 and 9.

As shown in the wiring circuit, FIGURE 10, two coils **79–79*e***, and **80–80*e*** are fitted to each of the segments **77–77*e*** of the permanent magnet **75**.

Coils **79–79*e*** provide fine adjustment of compensation. The induced voltages due to the deflection of the flywheel **75** cancel if the voltage through all the coils is equal.

Coils **80–80*e*** provide 3 "high point" adjustments and need less power than the coils **79–79*e***. The induced voltages, which are generally less than 0.1 volt, and which are due to the deflection of the flywheel **76** will generate eddy currents. A high excitation voltage is therefore desirable, and a high circuit impedance at the frequency of the induced voltage is required.

Four slip rings **93** and **94–94*b*** provide excitation to the two groups of coils **79**, **80**, one slip ring being connected to one group of coils **79–79*e***, the other slip rings each being selectively connected to two of the coils **80–80*e***. Thus, one slip ring **94** is connected to coils **80**, **80*a***, the second to coils **80*b***, **80*c***, and the third to coils **80*d***, **80*e***.

The voltage for one slip ring **93** is supplied by a 500 volt D.C. torquer power supply **95** through a variable resistor **96**.

The second group of slip rings receive their voltage from a second 500 volt D.C. torquer power supply **98**, through a series of three variable resistors **99**, **99*a***, **99*b***, each of which is connected to one of the slip rings **94**, **94*a***, **94*b***.

The electrical compensation adjustment, herein described, is used to replace mechanical fine adjustment of compensation and "high points" as by the use of shims, shunt screws, and the like, which tend to contribute to instability, by substituting electrical trimming, using available power supplies. Usually coarse mechanical compensation adjustment will precede the electrical trimming.

In the wiring diagram, shown in FIGURE 10, if the circuit impedance can be kept high enough to make eddy current effects negligible, coils **79–79*e*** and the corresponding slip ring **93** can be eliminated. Coils **80–80*e*** and the corresponding slip rings **94–94*b*** can then provide all the adjustments necessary.

What is claimed is:

1. In an astatic gyro having a symmetrical mass being rotatably driven about its central axis through a central shaft having a universally flexible solid substantially cylindrical spring flexure member integral therewith, and magnetic means operating upon said mass to compensate for said spring flexure member, the improvement in said gyro comprising the provision of a unitary flexure and mass with the mass being shaped in a substantially dished flexible washer configuration leading from one end of the shaft.

2. In the gyro of claim 1, said mass being comprised of a relatively thin wall and flexible central portion radially extending from its central axis and integral therewith, and thick-walled portions about its periphery.

3. In an astatic gyro having a symmetrical flywheel being rotatably driven about its central axis by a shaft, through a universally deflectable solid cylindrical flexure member, said flexure member and shaft supporting the flywheel being formed of a unitary material, said flywheel having a thin-walled and flexible central portion and a thick-walled inflexible peripheral portion and the solid cylindrical flexure member being of related length and thickness thereto to provide an isoelastic joint having equal radial and axial compliance and high bending compliance, permanent magnetic means rotatable in synchronism with said flywheel and proximate to said flywheel, said permanent magnetic means being supported by a member of high electrical resistivity material adjacent said magnetic means to reduce eddy current flow, and the portions of the flywheel proximate said permanent magnetic means and co-acting therewith, being of high electrical resistivity material.

4. In the gyro of claim 3, said high resistivity material being a ferrite composition.

5. In the gyro of claim 3, said high resistivity material being a laminated ferrite composition material.

6. A spring flexure gyro comprising a drive motor, a flywheel, and a universal solid substantially cylindrical spring flexure member integral with a shaft, centrally connecting the flywheel for rotation by the motor, permanent magnetic means rotatable by the motor and exerting a balanced force upon the flywheel in the absence of deflection of the solid cylindrical flexure member and an unbalanced force thereon substantially equal and opposite to the flexure spring return force upon deflection of the flexure member, the shaft supporting said flywheel and the flexure member being integrally formed and said flywheel having a central thin walled flexure portion that is flexible and thicker outer peripheral wall portions that are rigidly constructed to provide with said solid cylindrical flexure member an isoelastic flexure joint providing equal radial and axial compliance and a high bending compliance that is equal in all radial directions, and means for reducing the generation of eddy currents in the gyro by reason of movement between the permanent magnetic means and the flywheel.

7. In the gyro of claim 6, said thin-walled flexure portion of said flywheel being formed in a substantially dished washer configuration and said eddy current reducing means being comprised of a supporting means for said permanent magnetic means being of a high resistivity material and portions of said flywheel exposed to the magnetic field of said permanent magnet being of high resistivity material.

8. In a two axis gyro having a flywheel centrally supported and rotatably driven by a solid substantially cylindrical spring flexure coaxial with the axis of rotation of the flywheel, magnetic means rotatably driven in synchronism with the flywheel and exerting an unbalanced force thereon during deflection of said cylindrical flexure and in opposition to said cylindrical flexure, supporting means for said magnetic means including portions adjoining said magnetic means being of high resistivity material to reduce eddy current flow, and portions of said flywheel acted upon by said magnetic means being comprised of high resistivity material, thereby to reduce spurious torques as occasioned by eddy current flow.

9. In the gyro of claim 8, said high resistivity material being formed of a ferrite composition.

10. In the gyro of claim 8, said high resistivity material being formed of a laminated ferrite material.

11. In the gyro of claim 8, said flywheel with thin flexible portions and solid cylindrical flexure member providing an isoelastic joint having substantially equal and axial compliance and high bending compliance universally about the flexure axis.

12. In the gyro of claim 11, said flywheel and cylindrical flexure being integrally formed and the thin-walled flexure portion of said flywheel being in a substantially dished washer configuration providing axial compliance along the axis of the cylindrical flexure that is substantially equal to the compliance transverse of the axis of said cylindrical flexure.

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