Aug. 28, 1956 A. ROESCH ET AL 2,760,376

GYROSCOPES

Filed Feb. 3, 1955 2 Sheets-Sheet 1

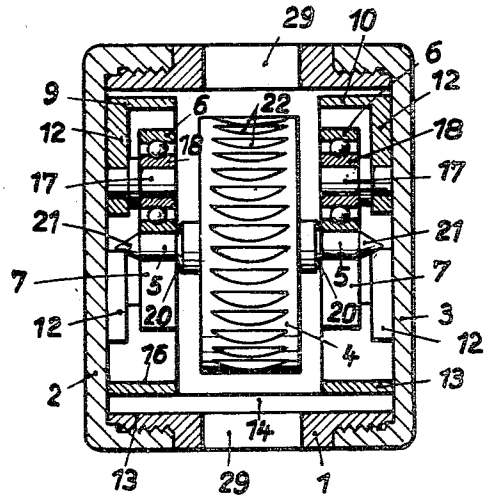


Fig. 1

Fig. 3

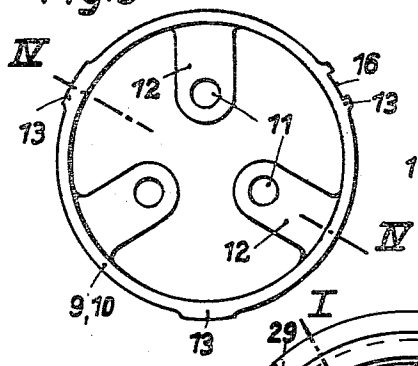
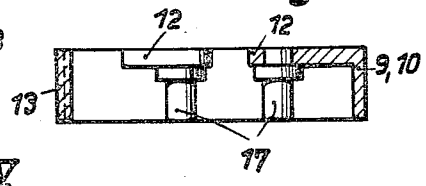


Fig. 4



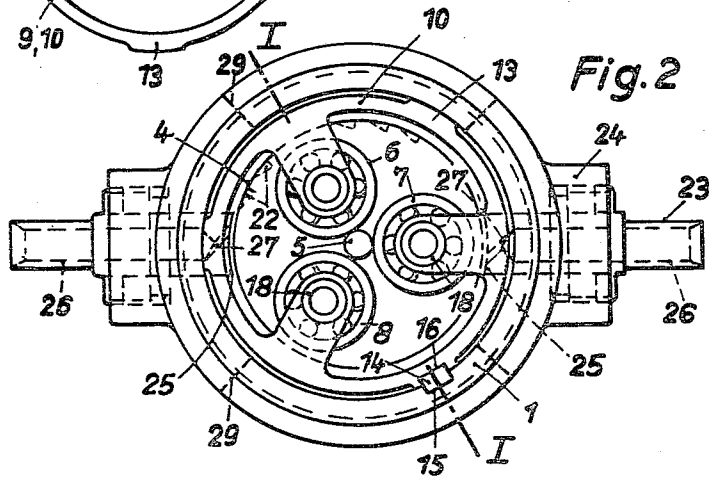


Fig. 2

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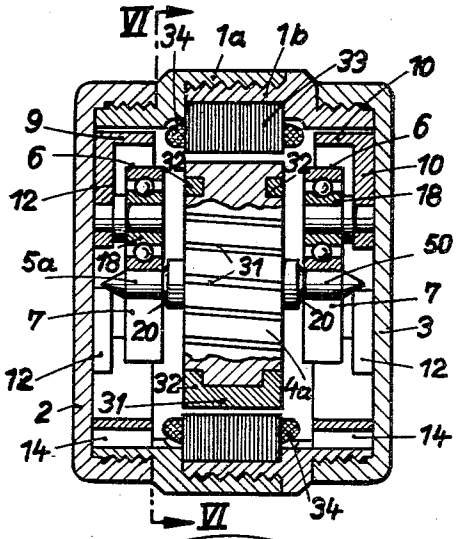


Fig. 5

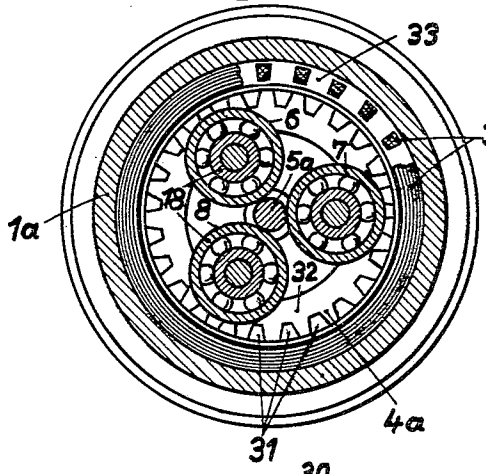


Fig. 6

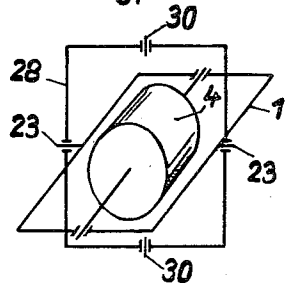


Fig. 7

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GYROSCOPES

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7 Claims. (Cl. 74—5)

The present invention relates to gyroscopes.

Although gyroscopes having rotors capable of turning at extremely high speeds are known, these known gyroscopes have an extremely complex construction and are very expensive.

One of the objects of the present invention is to provide a gyroscope of the above type which has a construction which is far simpler than the known constructions of such gyroscopes.

Another object of the present invention is to provide a gyroscope of this type which produces the same results as gyroscopes of far more complicated structures.

A further object of the present invention is to provide a gyroscope which is without any springs or adjusting devices for providing proper engagement between the rotor shaft and bearings therefor.

An additional object of the present invention is to provide a gyroscope of the above type with an exceedingly simple means for preventing axial shifting of the gyroscope rotor within the housing of the gyroscope.

With the above objects in view the present invention mainly consists of a gyroscope which includes a rotor and a pair of shafts fixed coaxially to the rotor and respectively extending in opposite directions from opposed side faces of the rotor. A plurality of bearings of a diameter several times greater than that of the shafts are distributed about and engage each of the shafts. A plurality of pins are respectively coaxial with and carry the bearings, and these pins extend beyond the bearings. A pair of rings are respectively located on opposite sides of and are coaxial with the rotor, these rings having ears integral therewith and extending radially inward toward the axis of the rotor. These ears respectively carry the pins, and the rings each have at their outer periphery a plurality of projections extending radially outward from the rotor axis. A cylindrical housing is coaxial with the rotor, surrounds the same, and has its inner surface in engagement with these projections.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a sectional, elevational view of a gyroscope constructed in accordance with the present invention and having a rotor which also serves as a turbine wheel, Fig. 1 being taken along the line I—I of Fig. 2;

Fig. 2 is an end view of the gyroscope of Fig. 1 with an end wall removed to show the structure in the interior of the gyroscope;

Fig. 3 is a side elevational view of one of the ring structures for supporting bearings of the gyroscope of the invention;

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 3;

Fig. 5 is a sectional view corresponding to Fig. 1 of a gyroscope constructed in accordance with the present invention but having a rotor which is constructed to rotate in an electromagnetic field;

Fig. 6 is a sectional, elevational view taken along the line VI—VI of Fig. 5 in the direction of the arrows; and

Fig. 7 is a schematic illustration in the manner in which the gyroscope of the invention is mounted.

Referring now to the drawings, and to Figs. 1–4 in particular, it will be seen that the gyroscope of the invention includes a cylindrical housing 1 closed at its opposite open ends by covers 2 and 3, respectively. These covers 2 and 3 have inwardly extending annular flanges which are threaded onto the cylindrical housing 1, in the manner shown most clearly in Fig. 1. Within the cylindrical housing 1 is located the rotor 4 of the gyroscope, this rotor 4 being coaxial with the cylindrical housing 1. A pair of shafts 5 are respectively fixed coaxially to the rotor 4 and extend in opposite directions from opposite side faces of the rotor 4, respectively. Each of the shafts 5 is turnably supported by three bearings 6, 7 and 8. The diameter of each of these bearings is several times greater than the diameter of the shaft 5, so that in this way the bearings turn only at a fraction of the speed with which the rotor turns.

A ring 9 is provided to support the bearings 6—8 on the left side of rotor 4, as viewed in Fig. 1, and a ring 10, identical with ring 9, is provided to support the bearings 6—8 on the right side of the rotor 4, as viewed in Fig. 1. These rings 9 and 10 are made of a relatively thin springy steel. Each of the rings 9 and 10 is provided with three integral ears 12 extending radially inward toward the axis of the gyroscopes, and each of these ears 12 is formed with a bore 11. At its outer periphery each of the rings 9 and 10 is provided between the ears 12 with relatively small projections 13 extending radially outward from the axis of the gyroscope, these projections 13 having outer surfaces located along a cylinder whose diameter is the same as the inner diameter of the housing 1. The projections 13 serve to center the rings 9 and 10 within the housing 1 and transfer forces from the bearings to the housing. The springiness of the rings 9 and 10 contribute to the capability of these rings to withstand the forces of the gyroscope and this springiness contributes also to maintain proper contact between shafts 5 and the bearings 6, 7 and 8. In order to prevent turning of the rings 9 and 10 within the housing 1, a projection 13 of each ring is formed with a keyway 16, and the housing 1 is formed with a keyway 15, and a key 14 extends into the keyway 16 and into the keyway 15, as indicated in Figs. 1 and 2, so that in this way the rings 9 and 10 are prevented from turning with respect to the housing 1. A plurality of pins 17 are fixed to the ears 12, respectively, as by being pressed into the openings 11, respectively, and these pins 17 extend from the ears 12 toward the rotor 4. Each of the bearings 6—8 is provided with an inner race 18, and the free ends of the pins 17 respectively extend into the races 18 and are rigidly fixed thereto as by being pressed into the races 18. The bearings 6—8 also include a plurality of balls engaging each race 18 and an outer race means which in the illustrated example is in the form of a single ring although this outer race means also could include an outer race and a sleeve located thereon, if desired. In the illustrated example the outer races are in direct engagement with the shafts 5.

In the unstressed condition of the rings 9 and 10 the bearings 6—8 carried by one of the rings 9 or 10 are located along a circle of a smaller diameter than the free end portion of each shaft 5 shown in Fig. 1. The shafts 5 are each provided with a pointed end 21 to facilitate the insertion of the shafts 5 into the space between the bearings, and when thus inserted the shafts 5 spread the bearings 6—8 apart from each other and deflect thereby

the ring portions located between the projections 13 slightly outwardly, and these elastically deformed ring portions urge the bearings 6 into engagement with the shaft 5, so that in this way advantage is taken of the springiness of the rings 9, 10 to maintain the bearings in engagement with the shafts, and no special springs or adjusting devices are required for this purpose.

A further feature of the invention is the manner in which the disclosed construction prevents axial shifting of the rotor 4 within the housing 1. This is brought about first by the fact that the cover plates 2 and 3 are in direct engagement with the rings 9 and 10, as illustrated in Fig. 1. Furthermore, each of the shafts 5 is formed with a shoulder 20 which is cambered so that it presents a convex face directed toward the bearings. The bearings 6—8 are located against these shoulders, and due to the curvature of the latter there is only a line contact between the bearings and the shoulders. The abutment between the bearings and the shoulders prevents axial shifting of the rotor 4 with respect to the bearings, and the abutment between covers 2 and 3 and rings 9 and 10, respectively, prevent axial shifting of the bearings, so that in this way the rotor is restrained against axial movement within the housing 1. If desired, however, it is possible to locate resilient inserts between the rings 9 and 10 and the covers 2 and 3, respectively.

According to the embodiment shown in Figs. 1–2, the rotor 4 serves also as a turbine wheel which may be driven with compressed air, for example. For this purpose, the rotor is formed about its periphery with recesses 22 which form buckets for the turbine wheel. The housing 1, as is evident from Fig. 2, has a pair of tubes 23 in communication with the interior thereof, and these tubes 23 are located along an axis normal to the rotor axis. Compressed air is supplied to the interior of the housing 1 through the tubes 23. These tubes 23 are threadedly connected to the interior of the tubular projections 24 which are integral with and extend outwardly from the housing 1 in the manner shown in Fig. 2. The tubes 23 have inner free ends 25 located closely adjacent to the outer periphery of the rotor 4, and the interior 26 of the tubes 23 guide compressed air toward the ends 25 of the tubes 23. The ends 25 of the tubes 23 are in the form of walls which close the tubes except for the inclined bores 27 shown in dotted lines in Fig. 2, these bores communicating with the interior 26 of the tubes and serving as nozzles for directing the compressed air at the proper angle toward the periphery of the rotor 4 so that this compressed air engages the interior of the buckets 22 to turn the rotor at the desired high speed. The housing 1 is also formed with a pair of openings 29, as indicated in Figs. 1 and 2, to allow the compressed air to escape from the interior of the housing 1.

As is indicated schematically in Fig. 7, the tubes 23 serve simultaneously as the bearing pins for the housing 1. These tubes 23 are turnably supported in a gimbal ring 28 which is itself supported on bearing pins 30, as indicated in Fig. 7, so that in this way the universal mounting of the gyroscope is obtained.

According to the embodiment of Figs. 5 and 6, the rotor is electrically driven and is in the form of an electrical motor rotor turnable in an electric field. The embodiment of Figs. 5 and 6 is otherwise identical with that of Figs. 1–4, and the same elements are indicated with the same reference characters. In Figs. 5 and 6, the rotor 4*a* is provided in its periphery with grooves 31 (Fig. 5) which are inclined somewhat to the rotor axis. These grooves 31 communicate with annular depressions 32 formed in the side faces of the rotor, respectively. The grooves 31 and 32 are filled with copper so as to form the rotor 4*a* into a short circuit or squirrel cage rotor of an electrical motor. As is well known such a rotor is turnable within an electromagnetic field provided by a stator surrounding the same.

In the construction shown in Figs. 5 and 6 the stator 33 is formed by ferromagnetic laminations which carry the field windings 34, and this stator 33 surrounds the rotor with a fairly small clearance. In order to mount the stator 33 within the housing of the gyroscope, this housing is formed of two parts 1*a* and 1*b* with the part 1*b* threaded into part 1*a* in the manner indicated in Fig. 5. Furthermore, these parts 1*a* and 1*b* are formed with shoulders between which the stator 33 is clamped in the manner indicated in Fig. 5.

Current can be conveyed to the windings 34 in the same way that compressed air is guided into the housing in the manner shown in Figs. 1 and 2. That is, leads may extend through the tubes 23 which are fixed to the housing of Figs. 5 and 6 in the same way as to the housing of Figs. 1 and 2, and these leads which pass through the tubes 23 are electrically connected to the field windings in a known way. These tubes 23 used with the embodiment of Figs. 5 and 6 are mounted in the manner indicated in Fig. 7 to support the gyroscope.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of gyroscopes differing from the types described above.

While the invention has been illustrated and described as embodied in high speed gyroscopes, it is not intended to be limited to the details shown, since various modfications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor; a plurality of bearings of a diameter several times greater than that of said shafts distributed about and engaging each of said shafts; a plurality of pins respectively carrying and coaxial with said bearings and respectively extending beyond the same; a pair of closed rings respectively located on opposite sides of and being coaxial with said rotor, said rings having thin walls extending in the direction of said shafts and being formed from springy material so as to be deformable in radial direction so that said bearings are held in resilient engagement with said shafts, said rings having ears integral therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis; and a cylindrical housing coaxial with said rotor, surrounding the same, and having an inner surface engaging said projections.

2. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor, each of said shafts having a free end portion of a smaller diameter than the remainder thereof and joined thereto by a shoulder; a plurality of bearings of a diameter several times greater than that of said shafts distributed about and engaging said free end portions of said shafts and also engaging said shoulder; a plurality of pins respectively carrying and coaxial with said bearings and respectively extending beyond the same; a pair of rings respectively located on opposite sides of and being coaxial with said rotor, said rings having ears integral therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor

axis; a cylindrical housing coaxial with and surrounding said rotor, haivng an inner cylindrical face engaging said projections; and a pair of end walls respectively fixed to said housing at opposite ends thereof and respectively engaging said rings to maintain said bearings in engagement with said shoulders and thus prevent axial shifting of said rotor in said housing.

3. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor, each of said shafts having a free end portion of a smaller diameter than the remainder thereof and joined thereto by a convex shoulder; a plurality of bearings of a diameter several times greater than that of said shafts distributed about and engaging said free end portions of said shafts and also engaging said shoulder; a plurality of pins respectively carrying and coaxial with said bearings and respectively extending beyond the same; a pair of rings respectively located on opposite sides of and being coaxial with said rotor, said rings having ears integral therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis; a cylindrical housing coaxial with and surrounding said rotor, having an inner cylindrical face engaging said projections; and a pair of end walls respectively fixed to said housing at opposite ends thereof and respectively engaging said rings to maintain said bearings in engagement with said shoulders and thus prevent axial shifting of said rotor in said housing.

4. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor; a plurality of bearings of a diameter several times greater than that of said shafts distributed about and engaging each of said shafts; a plurality of pins respectively carrying and coaxial with said bearings and respectively extending beyond the same, said bearings being turnable on said pins; a pair of closed rings respectively located on opposite sides of and being coaxial with said rotor, said rings having thin walls extending in the direction of said shafts and being formed from springy material so as to be deformable in radial direction so that said bearings are held in resilient engagement with said shafts, said rings having ears integral therewith and extending radially inward toward the axis of said rotor, said ears being respectively fixed to and carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis; and a cylindrical housing coaxial with said rotor, surrounding the same, and having an inner surface engaging said projections.

5. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor; a plurality of bearings of a diameter several times greater than that of the shafts distributed about the same, each bearing being composed of inner and outer ball races and a plurality of ball members therebetween, said outer races of said bearings being in direct engagement with said shafts; a plurality of pins respectively coaxial with and fixed to said inner races and respectively extending beyond the same; a pair of closed rings respectively located on opposite sides of and being coaxial with said rotor, said rings having thin walls extending in the direction of said shafts and being formed from springy material so as to be deformable in radial direction so that said bearings are held in resilient engagement with said shafts, said rings having ears integral

therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis; and a cylindrical housing coaxial with said rotor, surrounding the same, and having an inner surface engaging said projections.

6. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed sides faces of said rotor; a plurality of bearings of a diameter several times greater than that of the shafts distributed about the same, each bearing being composed of an inner race and an outer race means and a plurality of ball members therebetween, said outer race means of said bearings being in direct engagement with said shafts; a plurality of pins respectively coaxial with and fixed to said inner races and respectively extending beyond the same; a pair of closed rings respectively located on opposite sides of and being coaxial with said rotor, said rings having thin walls extending in the direction of said shafts and being formed from springy material so as to be deformable in radial direction so that said bearings are held in resilient engagement with said shafts, said rings having ears integral therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis and being respectively located between and equally spaced from adjacent ears; and a cylindrical housing coaxial with said rotor, surrounding the same, and having an inner surface engaging said projections.

7. In a gyroscope, in combination, a rotor; a pair of shafts fixed coaxially to said rotor and respectively extending in opposite directions from opposed side faces of said rotor; a plurality of bearings of a diameter several times greater than that of said shafts distributed about and engaging each of said shafts; a plurality of pins respectively carrying and coaxial with said bearings and respectively extending beyond the same; a pair of closed rings respectively located on opposite sides of and being coaxial with said rotor, said rings having thin walls extending in the direction of said shafts and being formed from springy material so as to be deformable in radial direction so that said bearings are held in resilient engagement with said shafts, said rings having springy ears integral therewith and extending radially inward toward the axis of said rotor and said ears respectively carrying said pins, each of said rings having at its outer periphery a plurality of projections extending radially outward from the rotor axis, said rings in their unstressed condition locating said bearings along circles of a smaller diameter than that of said shafts so that the latter spread said bearings apart from each other and are maintained in engagement therewith by the resiliency of said rings; and a cylindrical housing coaxial with said rotor, surrounding the same, and having an inner surface engaging said projections.

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