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(54) **Title**: CONSTANT VELOCITY JOINT FOR HELICOPTER ROTORS

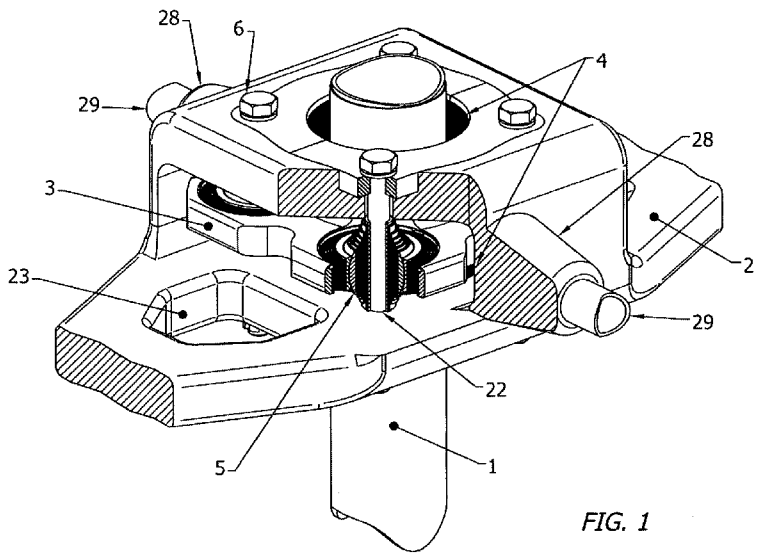


FIG. 1

(57) **Abstract**: The invention concerns a constant velocity joint for gimballed helicopter rotors in which the rotor hub (2) is connected to a drive shaft (mast) (1) by means of two opposing elastomeric laminated spherical bearings (4), which allow the said rotor hub to tilt on two axes, and whose upper and lower supports are located at the opposite ends of a horizontal cavity of the hub, inside which a series of improved elastomeric dragging devices have been installed (5) that are identical to each other and which are composed of spherical bearings to which are secured - externally and internally - two elastomeric cylindrical radially laminated bearings which slide elastically on their axis, such bearings being of different sizes but, at the same time, being also characterized by the fact that they have the same longitudinal rigidity. The external bearings of these devices are lodged in appropriate annular apertures which are arranged on a flange (3) secured to the mast, whereas the bearings that are inside the couplings are secured, by means of feathering bolts (6), to the hollow rotor hub (2). The rotor hub tilts relative to the mast also on account of the spherical couplings of the aforementioned dragging devices, whose centers - thanks to the identical rigidity of both elastomeric cylindrical bearings connected thereto - are arranged on a plane which bisects the angle between the mast flange and the rotor hub, thus creating a constant- velocity joint. This type of constant-velocity joint is used in a two- blade helicopter rotor and is also used in three-blade and multi-blade helicopter rotors in general. It is, moreover, used - in the event that constant-velocity joints are required - in generic appliances for the transmission of motion between two masts tilting towards each other.

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Constant Velocity Joint for helicopter rotors

This patent application is for a "gimballed" constant velocity rotor and the related dragging devices, to be used as the main rotor in two-blade helicopters, as well as in three-blade helicopters, and more generally in multi-blade helicopters.

As is well-known, the direction of the translational motion in helicopters is controlled by tilting the rotation plane of the disc, which is defined by circular movement of the blades relative to the drive shaft (mast) secured to the helicopter's structure.

In helicopters with 3 or more blades, use is normally made of so-called articulated rotors possessing hinges which are eccentric to the axis of rotation and which are horizontal, so as to allow a teetering motion, as well as use being made of vertical hinges for drag - the latter being appropriately equipped with friction devices or with viscous devices which act on the disk's plane in order to contrast the Coriolis accelerations, such accelerations acting upon the blades when the rotor disk tilts and there is a teetering motion - so as to minimize the oscillations.

In this type of rotor, thanks to the eccentricity of the teetering hinges and the centrifugal force of the blades, the tilting of the disk plane exerts a favorable control movement upon the mast, regardless of the lift exerted by the rotor itself.

A variation on articulated rotors are so-called

"hingeless" rotors in which the hinges are replaced by deformable elastic devices which act as virtual hinges. In this type of rotor, as well as in articulated rotors, the tilting of the disk plane is controlled by the cyclical oscillatory motion - carried out by the swashplate - of the blades around the feathering hinges.

There exist, moreover, two-blade rotors whose rotor hub is hinged to the top of the mast by a cylindrical hinge which is at a right angle to the axis of the blades as well as to the axis of the mast, giving rise to a teetering motion and allowing the rotor disk to tilt.

In this last type of rotor - which is also called a suspended rotor - the cylindrical hinge connecting the rotor hub to the mast needs to be higher than the position in which the blades are attached to the said mast - and, in particular, on the plane defined by the barycenter of the blades, which are tilted upwards for lift - so as to eliminate the two per rev vibrations which would be caused by the cyclical shifting of the rotor's barycentre relative to the axis of rotations as a result of the tilting of the disk. The blades - which are, in fact, subjected to centrifugal forces as a result of the rotation and the lift keeping the helicopter in the air - adopt an upwards balancing point, thus making the disk appear conical, with the ensuing raising of the rotor's center of mass. The variation in the angle of conicity of the blades - which is due to numerous dynamic conditions and the variability of the weight of the helicopter - is,

nevertheless, such as to prevent this source of vibration being eliminated in all types of helicopter flight and weight conditions.

Moreover, in this type of rotor, there is another source of vibration originating from the semi-cardanic geometry of the central teetering hinge which, since it is not a constant velocity joint, generates two per rev torque on the mast and on the helicopter's structure, the intensity thereof increasing as the rotor disk tilts towards the mast. This type of rotor, moreover, does not - in the light of the presence of the central teetering hinge - exert any sort of direct control motion on the said mast. As a result thereof, it is possible - in low-g or zero-g flight conditions - to lose control of the rotor with catastrophic results.

Even in this type of rotors, in fact, the tilting of the disk is controlled by means of the oscillatory motion of the blades around the teetering hinges carried out by the swashplate.

All of the aforementioned types of rotors are characterized by the considerable stress placed upon the feathering hinges - which secure the blades to the rotor hub, contrasting the centrifugal force thereof - that is caused by the alternating motion around the hinge axis as a result of the cyclical action of the swashplate on the feathering blades, whose purpose is that of keeping the rotor disk titled.

In order to provide a remedy for such inconveniences, various systems have been devised and disclosed.

In the development of elastomeric laminated bearings

(US patent 2,481,750 and US patent 2,900,182), right from the start the type of elastomeric bearings applied subsequently to helicopter rotors were disclosed (USAAMRDL-TR-75-39B): and namely axial cylindrical bearings, radial cylindrical bearings, spherical bearings and conical bearings.

Many of these types of bearings are the basis for important improvements in feathering hinges (US patents 3,111,172 and 3,652,185) which have reduced friction, as well as the ensuing stress on helicopter controls - which were characteristic of the traditional rolling-element bearings used in feathering hinges subjected to the oscillatory movement of the blades on the feathering axis - with considerable advantages also in terms of the duration and maintenance thereof.

In the field of two-blade rotors hung with a central teetering hinge, US patent 4,115,031 disclosed a method allowing for the installation of a restoring spring attached to the rotor hub suspended around the teetering hinge, with a view to directly controlling the momentum of the rotor relative to the mast and the helicopter, as well as to finding a remedy for the inconvenience of losing control in low-g or zero-g flights and absorbing the ensuing two per rev vibrations generated by the restoring spring through the flexibility of the blades in the rotation plane. Such solution does not eliminate, however, the torsional oscillation caused by the semi-cardanic geometry of the teetering rotor.

With a view to reducing the intensity of the

alternating oscillations on the feathering hinges caused by the cyclical command in conventional rotors as described above, as well as for the purpose of eliminating drag hinges in rotors with 3 or more blades, so-called "gimballed" rotors have been developed whose central rotor hub is supported by a spherical hinge at the top of its mast, or with other devices which are kinetically equivalent and which allow the rotor hub to tilt on two axes.

In these rotors rotation and torque are transmitted from the mast to the hub with various systems designed to eliminate torsional oscillation, numerous solutions having been proposed in order to make constant velocity joints.

The central spherical hinge, which is normally made with elastomeric laminated spherical bearings of a known type (for example patent US 3,941,433), possesses an appropriate rigidity, on account of which the rotor disk - when it is tilted - exerts upon the rotor mast a favorable control momentum which is similar to that of rotors possessing eccentric teetering hinges.

This type of rotor model was disclosed with patent US 4,729,753, in which the rotor hub - which is suspended with two elastomeric spherical laminated bearings that are opposite to each other on the mast - is kept rotating thanks to elastomeric devices which are supposed to form a constant velocity joint.

Many solutions of this type have been proposed in the light of applications on hybrid rotors which have been applied to tiltrotors. The complexity of these systems

has restricted the possible uses which could be made thereof and has also prevented a widespread use thereof in small commercial helicopters. In the same framework of rotors with complex mechanisms, other authors have disclosed different types of rotating devices (link-type rotary couplings, US 4,804,352) for three-blade rotors for the purpose of obtaining spherical rotor suspension and almost constant velocity motion transmission.

Even in other spheres of application, types of constant-velocity joints - composed of several assembled elastomeric devices, which allow the transmission of rotational momentum with torque between two tilted rotating masts - have been proposed. An example of these devices was disclosed by patent US 4,208,889.

In general, the making of gimballed constant-velocity rotors is very complex and the assembly thereof involves the assembling of an extremely large number of components.

The fundamental aim of this invention is to provide a remedy for the aforementioned inconveniences which are encountered in helicopter two-blade and multi-blade rotors. This will be achieved through the creation of an improved "gimballed" constant-velocity rotor head and of the related means of installation on the mast - including a hollow hub fixed to the mast with two opposite spherical annular hinges and a series of improved elastomeric dragging devices located inside the said hub and in a hinge shaped to the mast - that

is highly flexible and adaptable, as well as being easy to assemble since it is composed of a limited number of components which can be safely used and which work effectively.

A second purpose of this invention is to make a constant-velocity rotor head for two-blade helicopters which can be equipped with an improved inertial and aerodynamic stabilizing device of the fly-bar "Bell-Hiller" type. The rotor hub will, in fact, not only be capable of tilting relative to the mast, but will also tilt on the teetering axis and on the feathering axis since it will be kept rotating at a constant velocity, regardless of the angle at which it tilts, thanks to four improved elastomeric devices fitted inside a specific mast flange and connected to the rotor hub.

A further purpose of the invention is that of reducing, in two-blade rotors, the intensity of the oscillations of the blades rotating around the feathering hinges caused by the cyclical control thereof.

Another objective of the invention is that of eliminating the problems - and more specifically the problem of torsional oscillation on the mast which is connected to the rotor - that are encountered in two-blade rotors on account of the mast's central feathering hinge.

Another purpose of the invention is that of eliminating 2 per rev vibrations which are usually encountered in the masts of two-blade rotors - when they tilt in order to carry out normal maneuvers, as well as in cruising flight - that are caused by the conical shape thereof.

Another purpose of this invention is to achieve a "gimballed" rotor head with three or more blades fitted to the mast with an improved constant-velocity joint - in which the rotor head is the joint's conducted element, composed in turn of a limited number of components that are without "hinges" and drag shock absorbers - that reduces oscillations on the feathering hinges and requires limited maintenance.

A further objective of this invention is that of making an improved elastomeric device to be used in the making of constant-velocity joints for general use.

This invention consists, therefore, in a constant-velocity joint for helicopter rotors, for the coupling of a drive shaft (mast) with a rotor hub so as to keep it rotating at a constant velocity around an axis which is titled relative to the axis of rotation of the said mast, such joint being composed of:

- several elastomeric dragging devices, which are identical to each other and each one of which is assembled with a spherical coupling, a series of alternating concentric cylindrical metal shims that are bonded to uniform layers of resilient elastomer, in such a manner as to form a first elastomeric laminated radial cylindrical-shaped bearing - which is secured to the external cylindrical surface of the spherical coupling - as well as a series of alternating concentric cylindrical metal shims which are bonded to uniform layers of resilient elastomer, in such a manner as to form a second elastomeric laminated radial cylindrical-shaped bearing characterized by the fact of

having the same value of the spring constant to the axial movement of the first bearing secured to the internal cylindrical surface of the spherical coupling. Preferably, according to the invention, such constant-velocity joint shall, moreover, include:

- a flange possessing an annular aperture - whose axis is parallel to the axis of the mast and in which the dragging devices are permanently lodged - such annular apertures being arranged symmetrically and at equal distances from the axis of the central splined hole into which the mast's flange is fitted;
- two spherical annular and opposite hinges, each of such hinges being divided into two or more elements so that they may be assembled;
- a mast having a shoulder ring to which the rotor's axial stresses - which are in turn transmitted by the said spherical hinges - are transferred, that is also capable - as a result of the fitting of the flange on which the dragging devices are mounted - to transmit the rotor's power;
- a rotor hub to which blades may be fitted and which has a central cavity in which the mast flange and related elastomeric dragging devices may be lodged, and which possesses - on the uppermost and lowermost opposing exterior sides - apertures in which the spherical bearings supporting the mast may be positioned; the aforementioned spherical bearings of the dragging devices allowing the rotor hub to incline - around said spherical support bearings - at an angle relative to the mast, as well as the cylindrical

elastomeric bearings supporting the spherical couplings and always making - on account of the fact that they have the same spring constant - opposite and identical linear movements, the centre thereof arranging all the spherical bearings on a plane bisecting the rotor hub's angle of tilting relative to the mast flange, thus ensuring that there is a constant velocity joint therebetween.

In particular, according to the invention, each spherical bearing is of a known type equipped with antifriction linings positioned between spherical sliding surfaces.

Another form in which the constant-velocity joint may be made according to the invention comprises, moreover:

- a mast with a flange having annular apertures, in which the elastomeric dragging devices may be lodged permanently, such apertures being arranged symmetrically at an equal distance from, and parallel to, the axis of the mast;
- a second mast having a rotor hub containing a central cavity in which the mast flange may be lodged with the related elastomeric dragging devices, and the centre of which has a support for a spherical bearing connected to the first mast; the spherical bearings of the dragging devices allow the second mast to tilt around the central coupling in respect of the first mast and the cylindrical elastomeric bearings - which are secured to the spherical bearings - make, on account of the fact that they have the same stiffness, opposing and identical linear movements, the centre thereof

arranging all of the spherical couplings on a plane bisecting the angle at which the second mast rotor hub tilts relative to the first mast flange, thus ensuring that there is a constant velocity joint therebetween.

Furthermore, according to the invention, the torque transmitted between the mast and the rotor hub may be inverted, as may be inverted the direction of the rotating movement.

The invention regards, moreover, a two-blade helicopter rotor hub comprising a constant velocity joint as described above, which is characterized by the fact that the rotor hub contains two yokes to which may be fitted the same number of blades and related transmission devices, as well as a couple of supports that are perpendicular to the longitudinal axis of the blades, to which are fitted a couple of opposing bars at whose extremities are hinged two small-sized blades that have been given a symmetric cordal shape and an appropriate mass with a view to functioning as an auxiliary aerodynamic device.

In particular, the said two-blade helicopter rotor head Envisages that the auxiliary blades are hinged to the bars on an axis which is placed before the axis in which the aerodynamic pressure centre of the blades is located and by the fact that the related hinges possess viscous friction devices, thus allowing the auxiliary blades to align themselves with the air flow and exert their cyclical action on the basis of the frequency with which the rotor head rotates.

The invention also regards a three-blade helicopter

rotor head - including the previously described constant velocity joint - which consists in a rotor hub with three yokes for as many blades and related transmission devices and which possesses a central cylindrical cavity in which three elastomeric dragging devices - as described above - may be positioned.

This invention will - by way of illustration, but without limitation thereto - now be described with specific reference to the preferred form of realization thereof, as well as to the figures shown in the attached drawings, in which:

figure 1 shows the form of execution of the invention referring to a two-blade helicopter rotor head viewed cross-sectionally, with the rotor hub cross-sectioned in order to show one of the dragging devices;

figure 2 shows the exploded view of all the significant components of the two-blade rotor head and the end part of the mast;

figure 3 shows the place in which the dragging devices are lodged in the mast flange;

figures 4a-4d show, respectively, a complete and cross-sectioned dragging device; an external elastomeric dragging device; a spherical coupling; an internal elastomeric bearing;

figure 5 shows a cross-section of the rotor hub tilted at 8° relative to the mast and the movements of the dragging devices;

figure 6 shows the auxiliary aerodynamic bar;

figure 7 shows a form of execution of the invention consisting in a three-blade rotor viewed cross-

sectionally, with the rotor hub being cross-sectioned in order to show one of the dragging devices;
figure 8 shows an exploded view of the components of the three-blade rotor head; and
figure 9 shows cross-sectionally a form of execution of the constant-velocity joint for general use.
Referring initially to figures 1, 2, 3, 4 and 6, which show a first form of preferred execution of the invention to be used in two-blades helicopter rotors, it can be seen how flange 3 is equipped centrally with a splined hole 33 which allows it to be fitted to the mast 1, which has a splined profile 11 that allows the latter to be coupled with the splined flange so as to transmit torque to the flange 3, whereas shoulder ring 12 is designed to sustain the rotor's axial force transmitted by the rotor hub 2 through two couples of elastomeric spherical bearings 4 acting upon the lower part of the shoulder ring that - in opposition to the flange - leans upon the related splined sleeve.
The bearings 4 are of a known type which come within the category of elastomeric laminated spherical bearings(Type III - Ref. USAAMRDL-TR-75-39B).
Each of the dragging devices 5, figure 4 - which are identical to each other - are part of the same compact unit composed of a spherical coupling of a known type and two elastomeric radial bearings which are respectively secured to the internal and external cylindrical surfaces of the spherical coupling. The said coupling is composed of two concentric elements, the internal part of which 54 - since it is hollowed

out - has an external toroidal spherical convex surface. The external cylindrical device 56 has a toroidal spherical concave surface covered in antifriction material 55 which allows the internal joint to move without friction; the two parts normally supplied on the market are concentric, mobile, already coupled together and without any yoke. The angle of non-alignment admitted by the aforementioned joint shall be at least equal to the rotor's maximum angle of tilting relative to the mast.

Inside coupling device 54 one can find - stuck together with known processes of vulcanization - a concentric succession of thin metallic cylindrical shims 53 alternated with thin layers 52 of resilient elastomer of a constant thickness. Outside of element 56 there is a similar elastomeric structure composed of metallic shims 59 which are alternated with layers 58 of elastomer. This type of composite structure is commonly known as an elastomeric laminated cylindrical radial bearing(Type II - Ref. USAAMRDL-TR-75-39B).

In order that the constant-velocity joint may work properly, it is necessary that the centres of all the spherical bearings are on a plane bisecting the angle at which the rotor hub tilts relative to the flange 3. This means that - in the event that the outermost ring 59 of the external hinge performs axial movements which are equal and opposite to those of the innermost cylinder 51 of the internal hinge - the centre of the intermediate spherical coupling must stay still. In order to achieve this, the internal and external radial

bearings must have the same spring constant along the cylindrical axis. The method claimed here in order to obtain this characteristic consists in realizing two radial hinges with the same number of layers of elastomer and with the same thickness, as well as with the same cylindrical surface; the complete device possessing the dimensions which have just been described assumes, therefore, the appearance depicted in fig. 4a, in which the smaller diameter layers are longer than the larger diameter layers, having, therefore, the same surface.

Another way of obtaining the same spring constant in the two external and internal radial hinges is that of using elastomers with differing degrees of hardness and/or layers of elastomer with different degrees of thickness.

The elastomeric laminated bearings possess - in the normal sense of the term - a high load capacity towards the superficial development of elastomer layers, making them suitable, in the present case, for the transmission of drag between the mast flange 3 and the hub 2 and, therefore, for the transmission of torque. They can, instead, slide relatively easily and can perform linear movements, fig. 5, which allow the intermediate spherical bearings of the dragging devices to be aligned on a plane which bisects the angle at which the rotor hub tilts relative to the mast.

The elastomeric devices, complete with internal spherical bearings, are housed permanently inside the annular rings 32 etched onto the flange 3 and are, in

turn, secured thereto with snap rings 31. The flange 3 - which is substantially square-shaped since it is envisaged that there should be four dragging devices in this form of execution of the invention - is positioned inside the cavity of the hub 21 aligned with the longitudinal axis of the blades anchored to the yokes 23, with the holes 22 corresponding to the inner cylindrical apertures 51 of the dragging devices 5.

The elastomeric bearings 4 are hitched to the shoulder ring 12 of the mast 1 and are mounted together in the lodging 25 located in the lower part of the rotor hub 2, whereas another two bearings 4 are positioned in the lodging located in 24 the uppermost part of the hub and are 2 opposite to the previous bearings. The feathering bolts 6 with nuts 8 are the only fastening devices which keep the rotor hub fastened to the mast together with the related dragging devices.

Figures 1 and 2 show, moreover, two opposite supports 28 on the hub 2, on which two bars 29 belonging to an auxiliary stabilization bar are fixed.

In figure 6 there is an illustration of a device composed of two opposite radial bars 29 - at the two ends of which are two blades 201 with a low aspect wing ratio and with a symmetrical aerodynamic shape, the said blades being hinged to the bars by means of plain bearings with brake linings 202, in correspondence with axis **O'**, which is positioned foreward the centre of pressure thereof **O**. The value of eccentricity of the hinges and the value of the viscous friction devices' action is established in such a manner to allow the

blades 201 to align themselves with the incident air flow but also to exercise their aerodinamic cyclical action at the frequency of rotation of the rotor. The blades 201, moreover, possess sufficient mass to confer them with inertial momentum around the axis of the friction hinges and the rotor hub 2, as well as with appropriate inertial momentum around the feathering axis.

Figures 7 and 8 are a second form of realization of the invention, which refers to a three-blade rotor head in which the rotor hub 2′ is equipped with three yokes 23′ for the anchoring of the blades and possesses, in alignment with such yokes, three vertical bulges 27′, at the top of which is a circular support 26′, that is fastened by means of screws 9′ and contains a fitting 24′ in which an elastomeric laminated spherical bearing - divided into three equal parts 4′ - and a flange 41′ are installed.

The said bulges 27′ and supports 26′ define the cavity 21′ inside which the flange 3′ - which is of a substantially triangular shape since three dragging devices are envisaged therefor 5′ - is to be found.

The rotor hub, in the lower part thereof, contains a fitting for a lower semi-spherical bearing consisting in three elements 4′ and a flange 41′. The bolts 6′, together with the related nuts 8′, fasten the related spherical bearings with the related flanges 41′, as well as fastening the dragging devices 5′ to the rotor hub 2′, thus assembling the three-blade constant velocity joint on the drive shaft (mast).

Figure 9 views in cross-section a further form of execution of a constant velocity joint for general use, to be used to connect to each other two masts rotating with tilted axes. The conducted mast has a hollow rotor hub 2'' which is equipped with an internal axial support 22'' and which is fastened - by means of a spherical bearing 4'' - with a bolt 9'' and washers 91'' and 92'' to the second mast 1'', the latter being hollow and possessing a flange 3'' which has a series of annular apertures 32''- as well as annular openings 32'' - in which are permanently lodged elastomeric dragging devices 5'' that are not depicted but are rather described in figure 4. The internal cylindrical elements thereof are fixed in the hollow rotor hub 2'' with bolts 6'' and washers 7''.

This invention has been described by way of mere example but without any limitation thereto, according to its preferred forms of realization. It is to be understood, however, that variations and/or amendments may be made thereto by persons skilled in the art without having to go outside the scope of protection, as defined by the attached claims.

CLAIMS

1. A constant velocity joint for helicopter rotors for the coupling of a mast with a hub, in order to keep it rotating at a constant velocity around an axis which is tilted relative to the axis of rotation of the mast, such joint being characterized by the fact that it is composed of:

- a number of identical elastomeric dragging devices, each of which is composed of a spherical coupling consisting in a series of alternating concentric cylindrical metal shims bonded to uniform layers of resilient elastomer in such a manner as to constitute a first radial elastomeric laminated cylindrical bearing secured to the external cylindrical surface of the spherical bearing, as well as a series of alternating concentric cylindrical metal shims which are bonded to uniform layers of resilient elastomer so as to constitute a second radial elastomeric laminated cylindrical bearing having the same spring rate shown in the axial movement of the first bearing and secured to the internal cylindrical surface of the spherical bearing.

2. A constant velocity joint according to claim 1, characterized by the fact that it is composed, moreover, by:

- a flange possessing annular apertures in which the said dragging devices are fitted, whose axis is parallel to the mast axis, such annular apertures being arranged symmetrically and at an equal distance from

the axis of the central splined hole into which the mast is fitted;

- two opposing concentric spherical annular elastomeric laminated bearings, each of which is, in turn, composed of two or more elements permitting the assembly thereof;

- a main shaft (mast), having a shoulder ring to which the rotor's axial stresses - which in turn are transmitted by the aforementioned spherical bearings - is transferred, that is also capable - as a result of the fitting of the flange (on which the dragging devices are mounted) - to transmit the rotor power;

- a rotor hub to which blades may be fitted and which has a central cavity in which the mast flange and related elastomeric dragging devices may be located, and which possesses - on the uppermost and lowermost opposing exterior sides - apertures in which the spherical bearings supporting the mast may be positioned;

the aforementioned spherical bearings of the dragging devices allow the rotor hub to incline - around said spherical support bearings - at an angle relative to the mast, whereas the cylindrical elastomeric bearings supporting the spherical couplings always make - on account of the fact that they have the same spring constant - opposite and identical linear movements, the centre thereof having all the spherical bearings on a plane bisecting the rotor hub's angle of tilting relative to the mast flange, thus ensuring that there is a constant velocity joint therebetween.

3. A constant velocity joint according to claim 1, characterized by the fact that it is composed by:
- a driving shaft with a flange having annular apertures in which the elastomeric dragging devices may be fitted, such apertures being arranged symmetrically at an equal distance from, and parallel to, the driving shaft axis;
- a second shaft having an hub provided with a central cavity in which the flange of the first shaft may be positioned, with the related elastomeric dragging devices, and the centre of which has a support for a spherical bearing connected to the first shaft;
the spherical bearings of the dragging devices allow the second shaft to tilt - around the central coupling - in respect of the first shaft and the cylindrical elastomeric bearings, which support the spherical bearings, make - since they have the same stiffness - opposing and identical linear movements, the centre thereof having all the spherical couplings on a plane bisecting the tilting angle of the second shaft hub relative to the first shaft flange, thus ensuring that there is a constant velocity joint therebetween.
4. A constant velocity joint according to one of the previous claims, characterized by the fact that the aforementioned spherical hinges keeping the rotor hub secured to the mast are composed of elastomeric laminated spherical bearings radially distributed in two or more parts which are stiff when sliding and which transmit to the mast a constant control momentum tending to restore it to a perpendicular position

relative to the rotor head that increases with the tilting of the rotor hub relative to the mast.

5. A constant velocity joint according to one of the previous claims, characterized by the fact that the aforementioned elastomeric dragging devices have radial cylindrical elastomeric bearings both outside and inside the spherical coupling which possess the same number of layers, the same thickness and the same average cylindrical surface, thus ensuring that the two bearings have the same spring rate.

6. A constant velocity joint according to one of the previous claims, characterized by the fact that it possesses at least three elastomeric dragging devices which tend to restore the perpendicular position of the rotor hub with respect to the mast, which is generally constant with the rotation of the rotor and which increases in correspondence with the angle of inclination of the rotor head relative to the mast.

7. A constant velocity joint according to one of the previous claims, characterized by the fact that the motor torque transmitted between the mast and the rotor hub may be inverted, as may inverted therein the direction of the rotating movement.

8. Two-blade helicopter rotor head comprising a constant velocity joint according to the claims 1-2, characterized by the fact that the rotor hub contains two yokes to which may be fitted the same number of blades and related supporting devices, as well as a couple of supports that are perpendicular to the longitudinal axis of the blades and in which are fitted

a couple of opposing bars at whose extremities are hinged two small-sized blades that have been given a symmetric cordal shape and an appropriate mass with a view to functioning as an auxiliary aerodynamic device.

9. Two-blade helicopter rotor head according to claim 8, characterised by the fact that the auxiliary blades are hinged to the bars on an axis positioned foreward the axis in which the aerodynamic pressure centre of the blades is located and by the fact that the related hinges possess viscous friction devices, thus allowing the auxiliary blades to align themselves with the air flow and exert their cyclical action on the basis of the frequency with which the rotor head rotates.

10. Three-blade helicopter rotor head including a constant velocity joint according to the claims 1 - 2 - 6, characterized by the fact that the rotor hub is comprised of three yokes for as many blades and related transmission devices and that the rotor hub possesses a central cylindrical cavity in which three elastomeric dragging devices may be positioned.

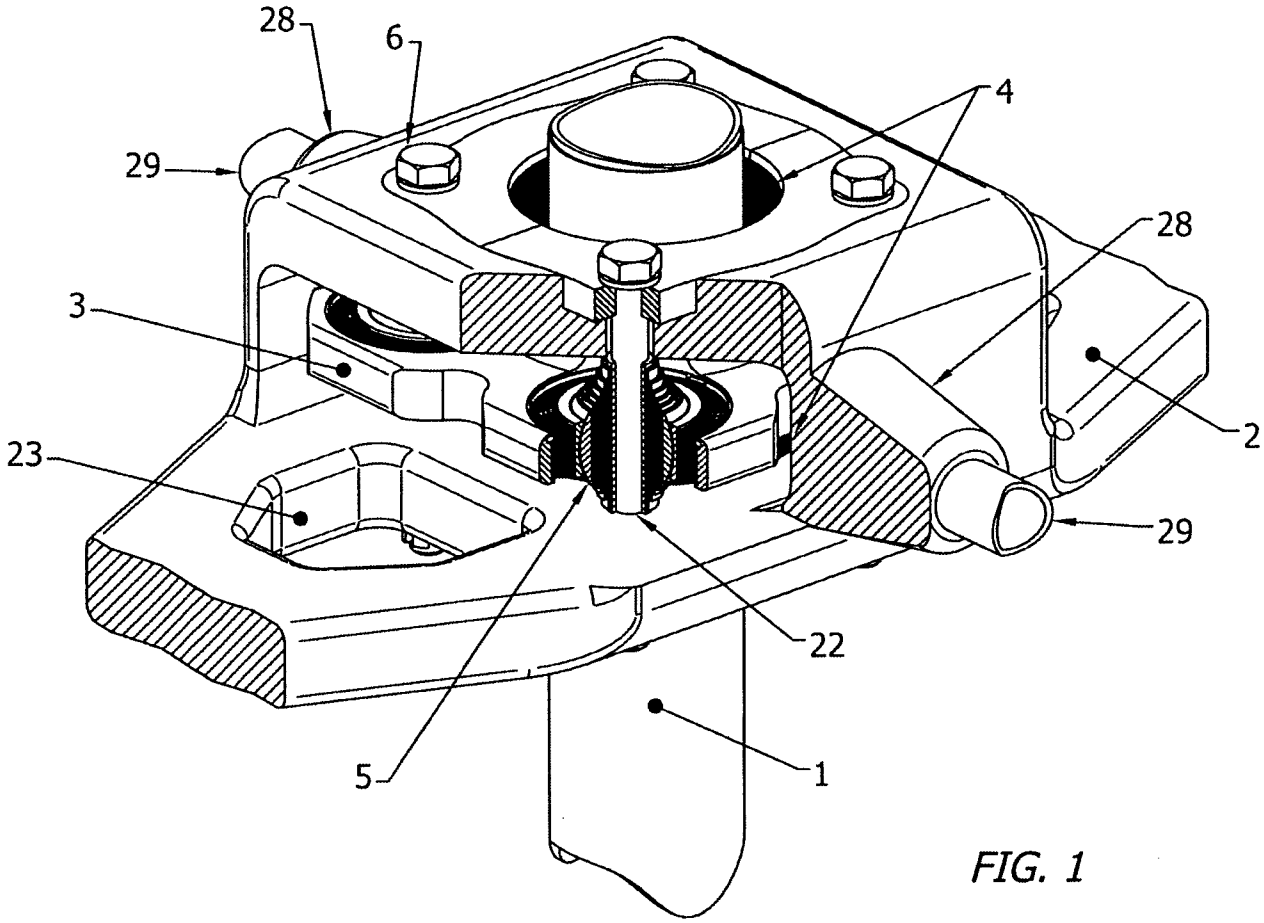


FIG. 1

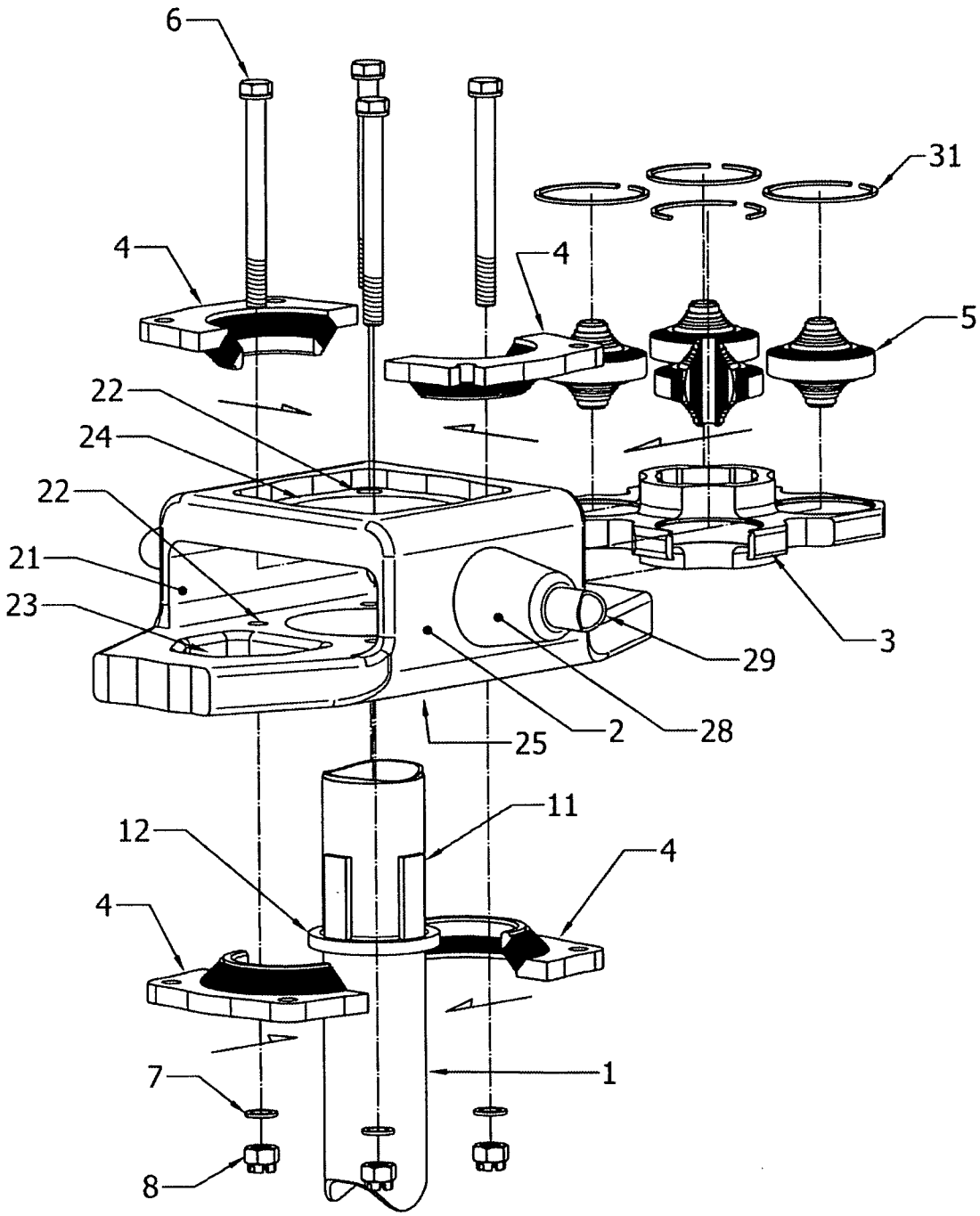


FIG. 2

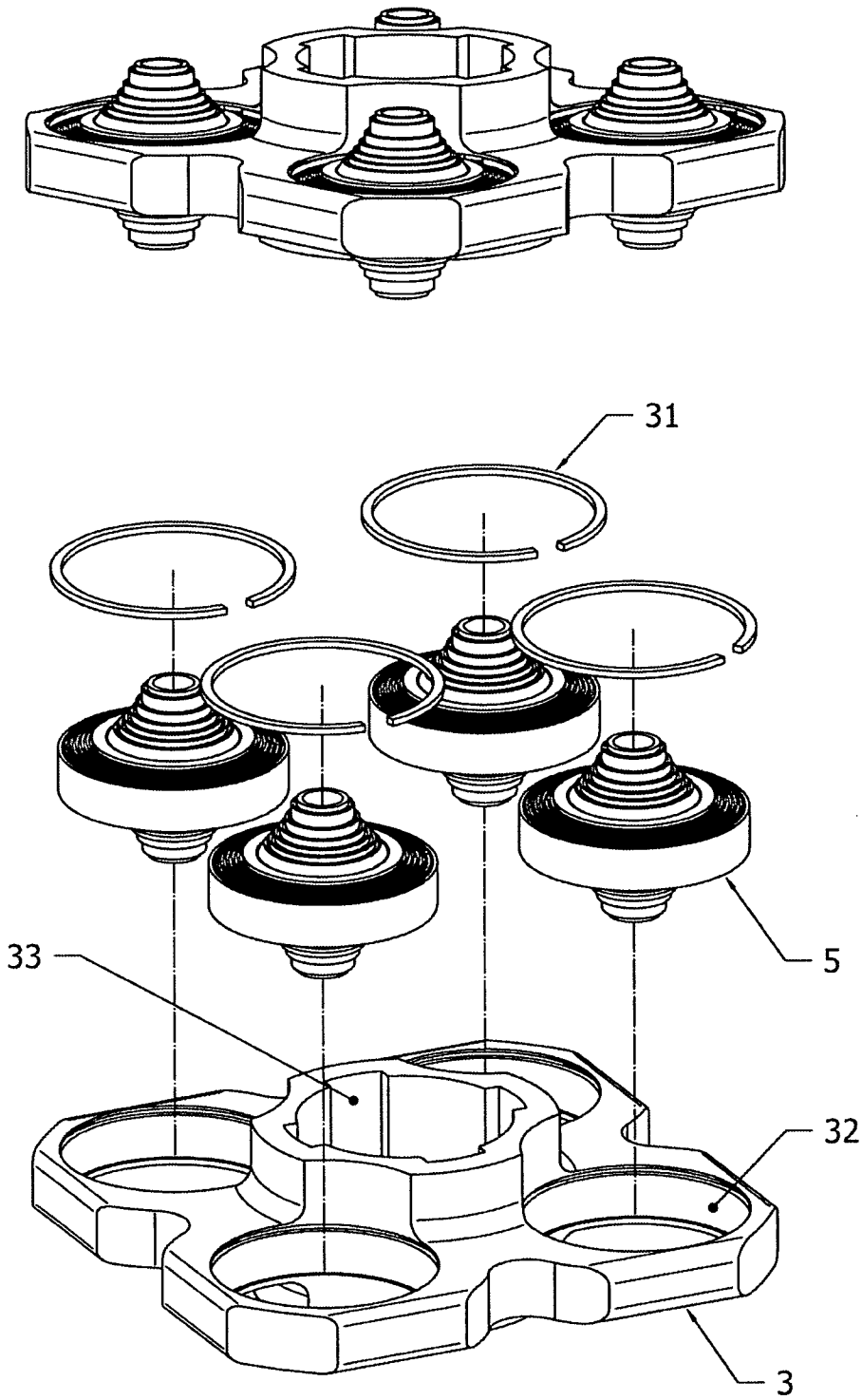


FIG. 3

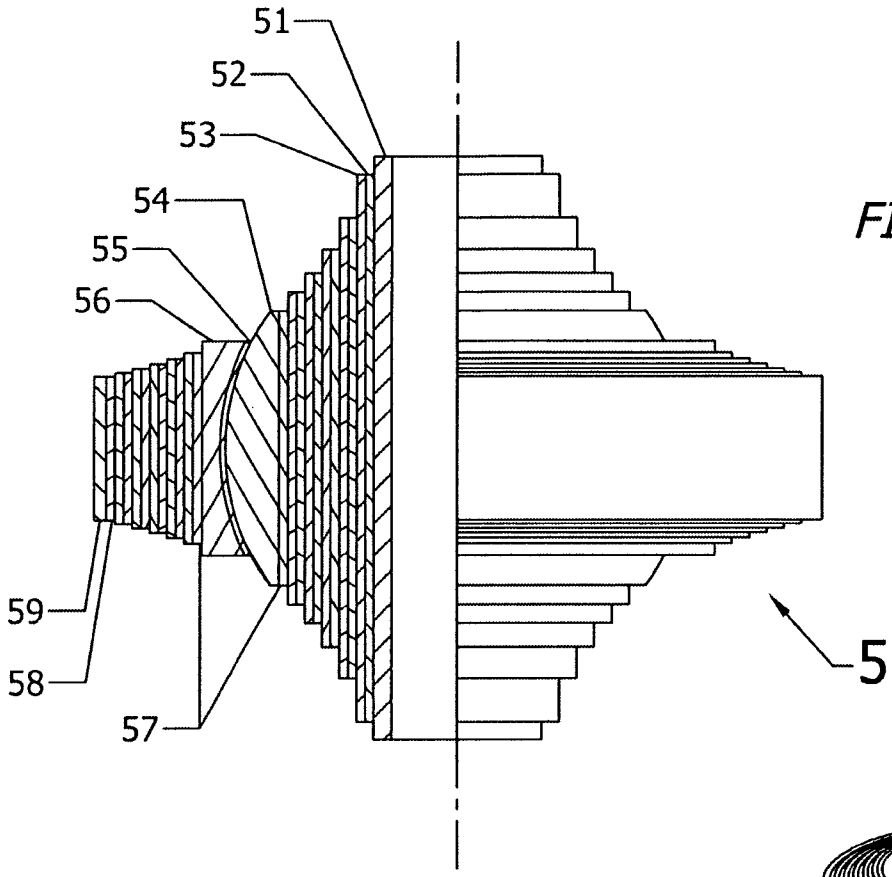


FIG. 4a

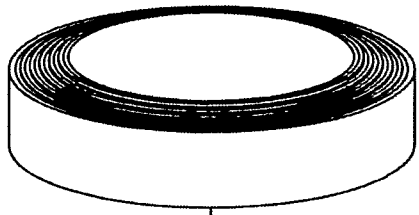


FIG. 4b

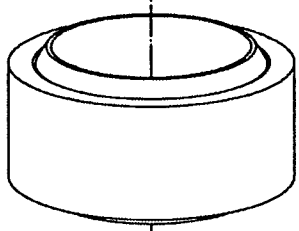


FIG. 4c

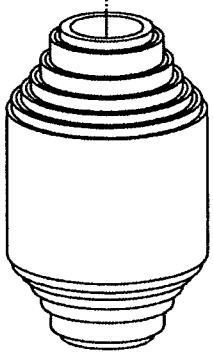


FIG. 4d

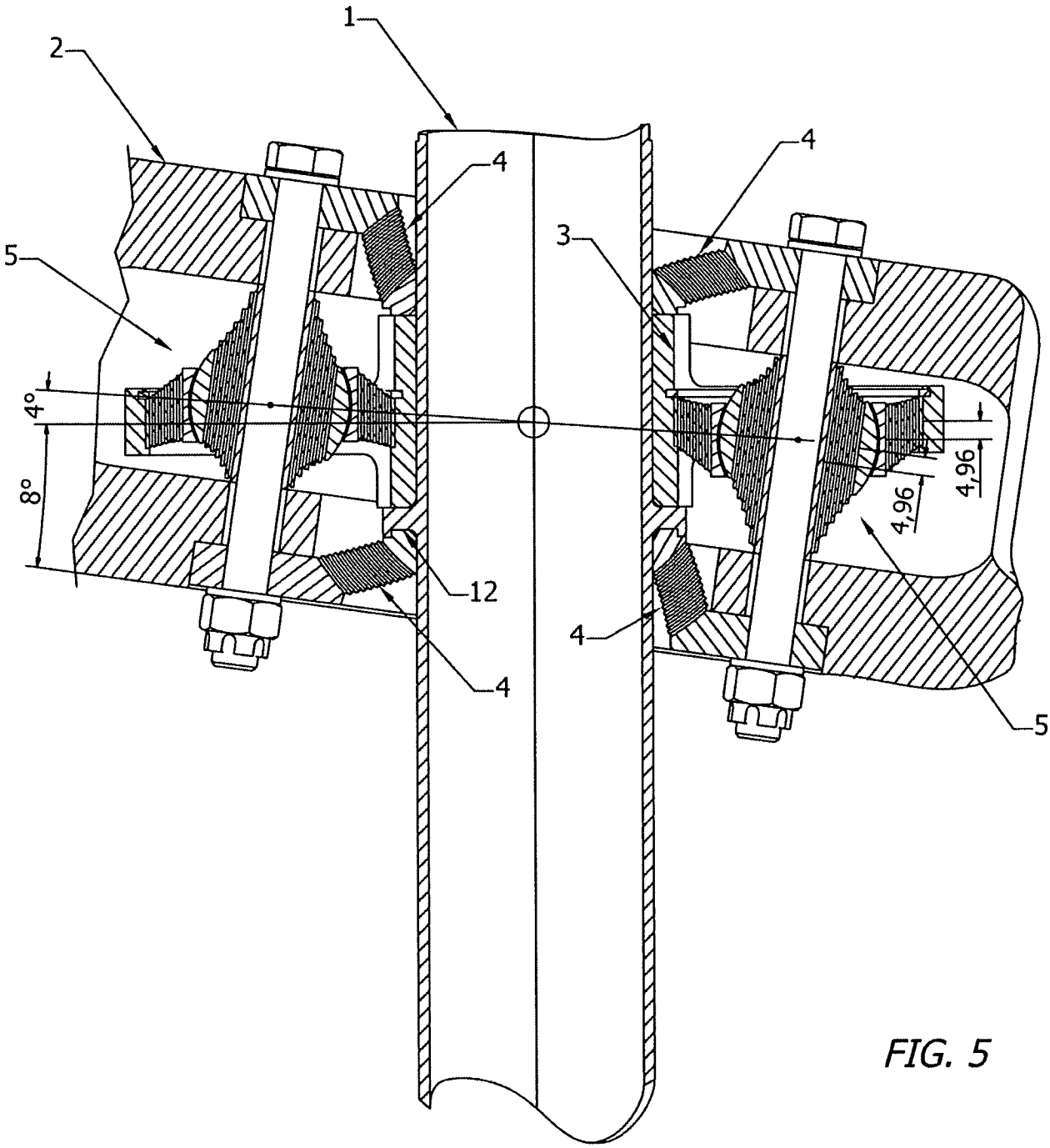


FIG. 5

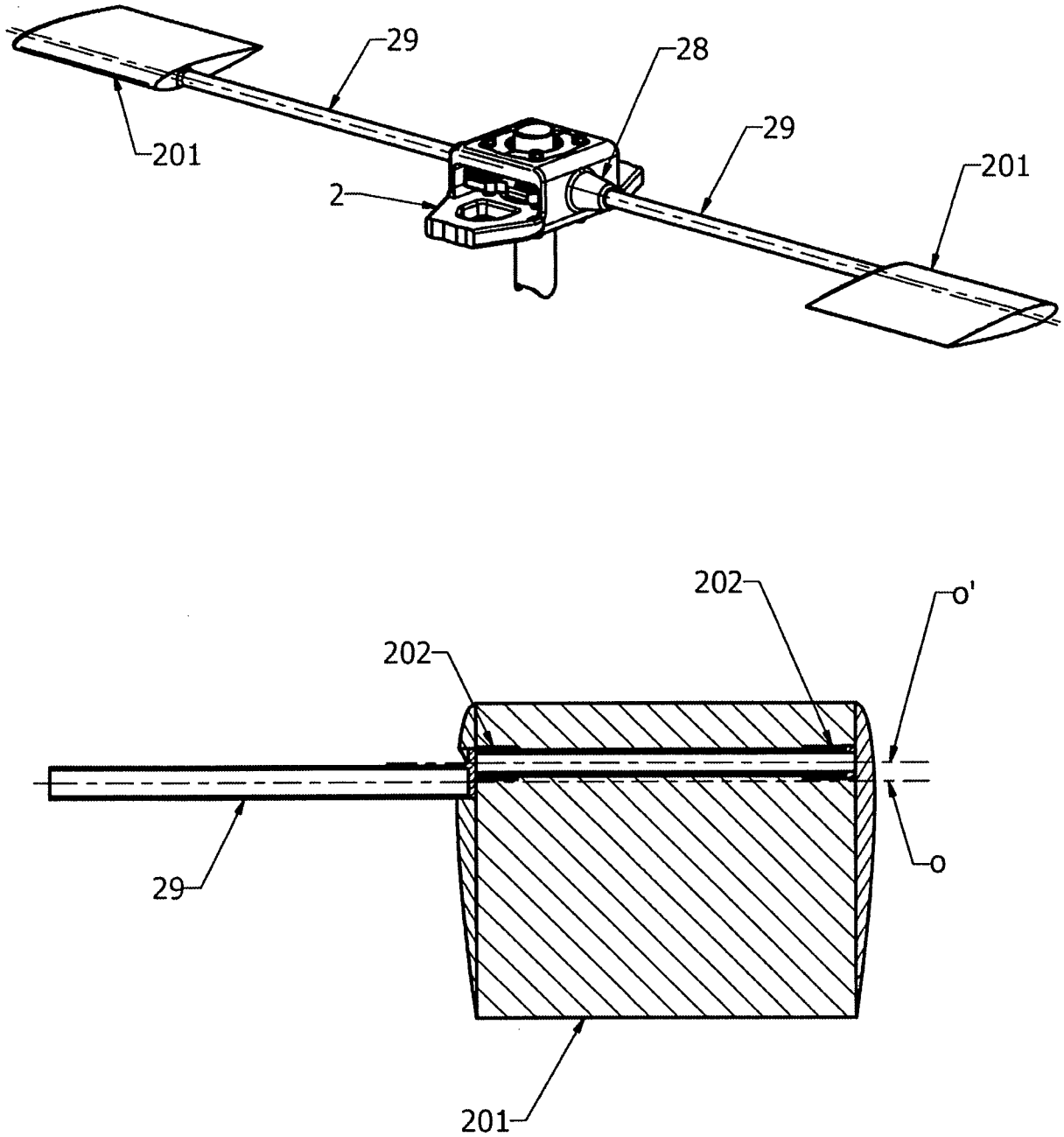


FIG. 6

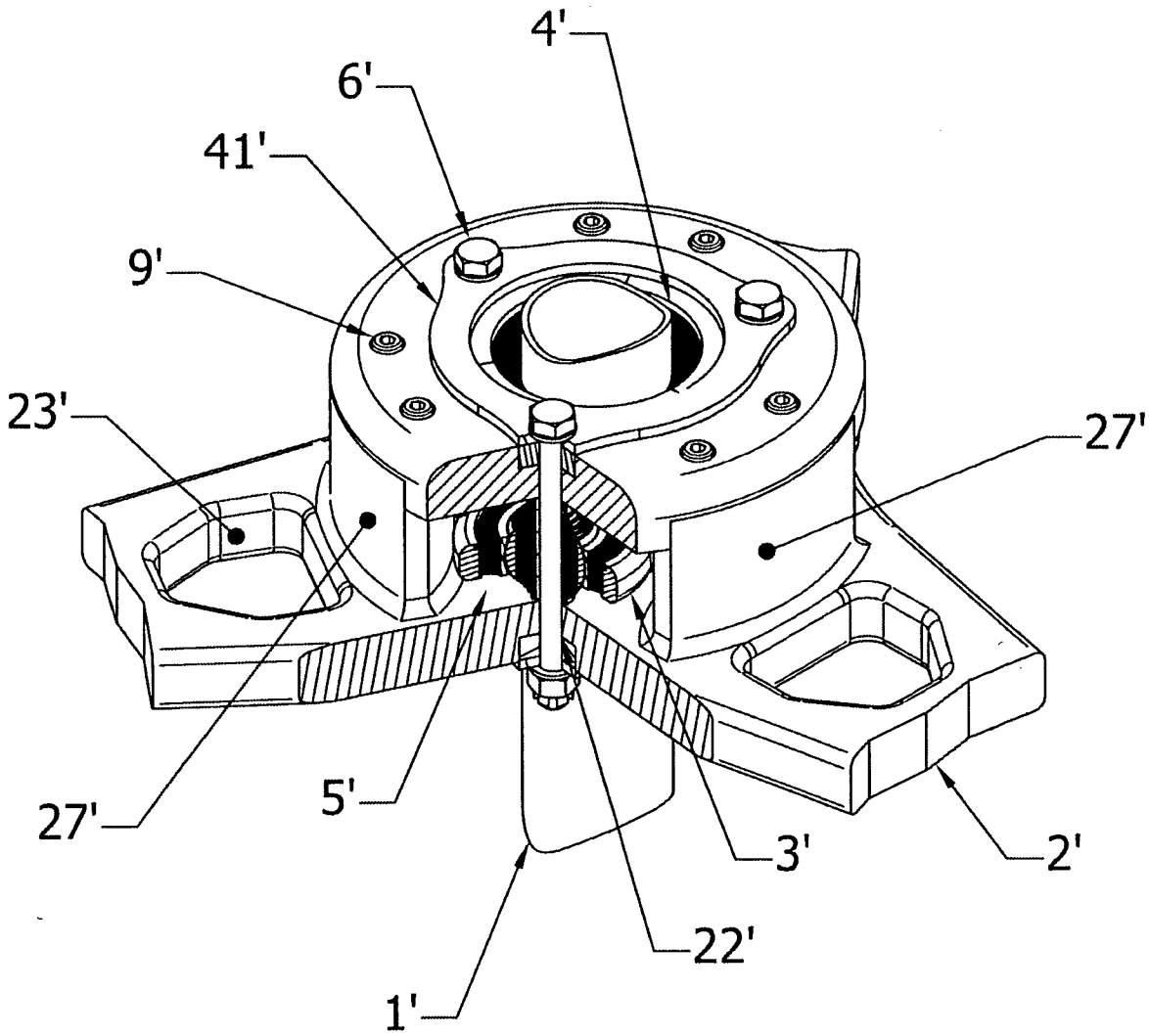


FIG. 7

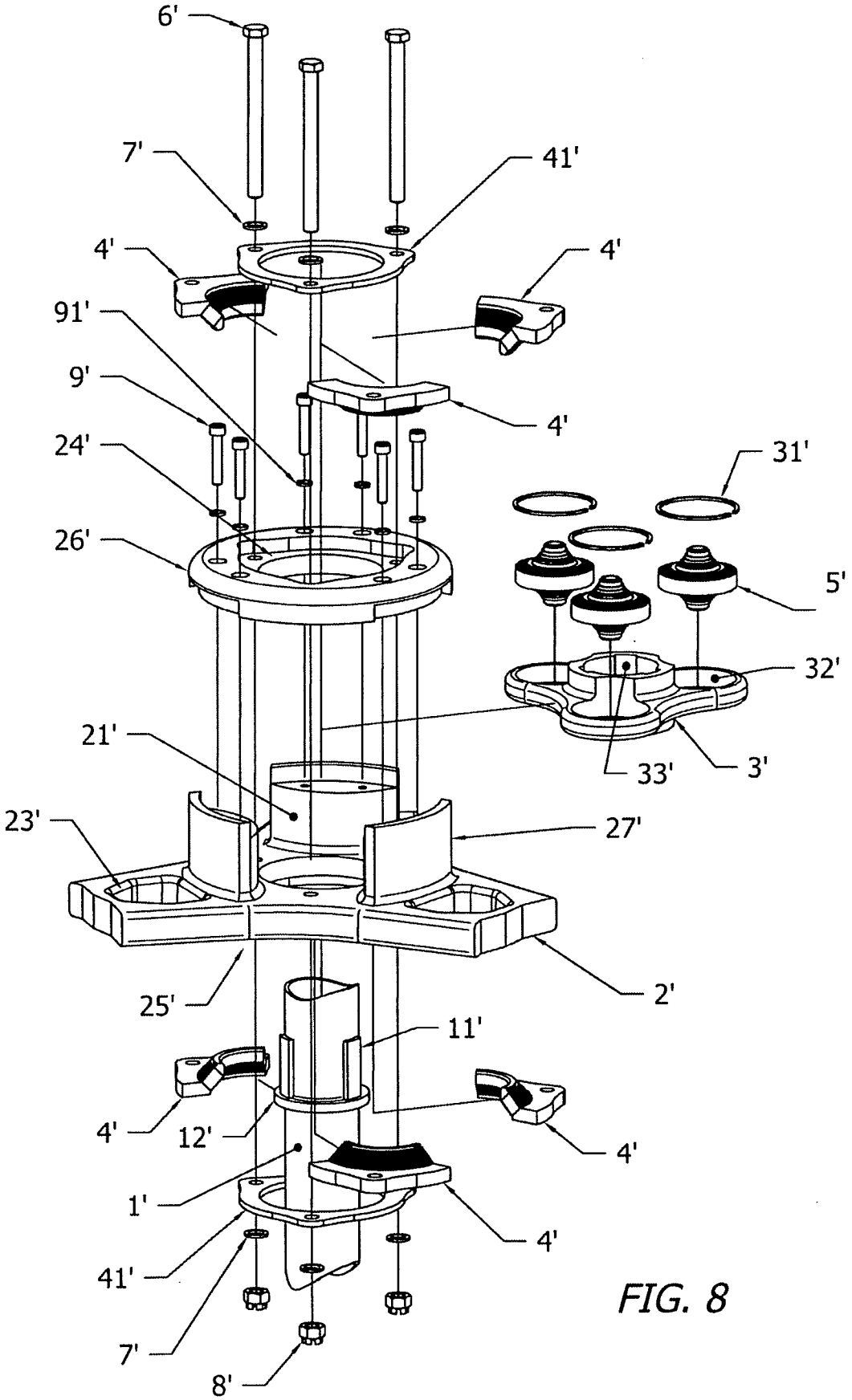


FIG. 8

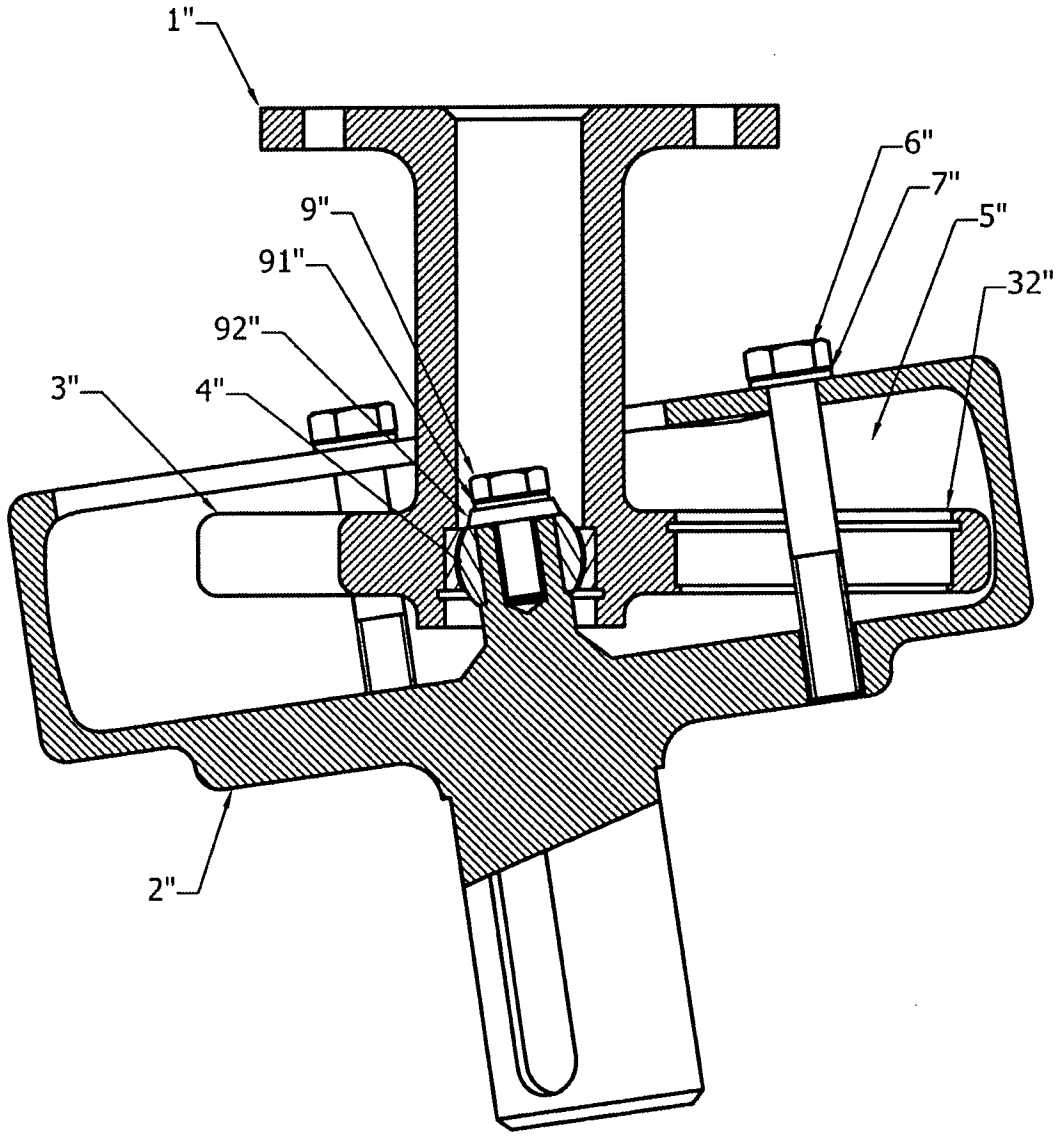


FIG. 9