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(54) **AN ELECTRIC SAILDRIVE**

(57) An electric saildrive (2) for a sailing boat. The electric saildrive (2) comprises an elongate hollow shaft and an elongate transmission axle extending longitudinally within said elongate hollow shaft, and a hollow housing (8) surrounding the elongate hollow shaft. A pod housing (9) is rigidly connected to the end of said elongate hollow shaft and the transmission axle to extends into an inner compartment of the pod housing (9). The inner compartment accommodates an angle drive connecting the transmission axle to a propeller shaft (10) which extends from said inner compartment to the exterior of the pod housing (9) through a second aperture in a sealed manner. The hollow housing (8) has an elongate cross-section so as to provide a fin-shape.

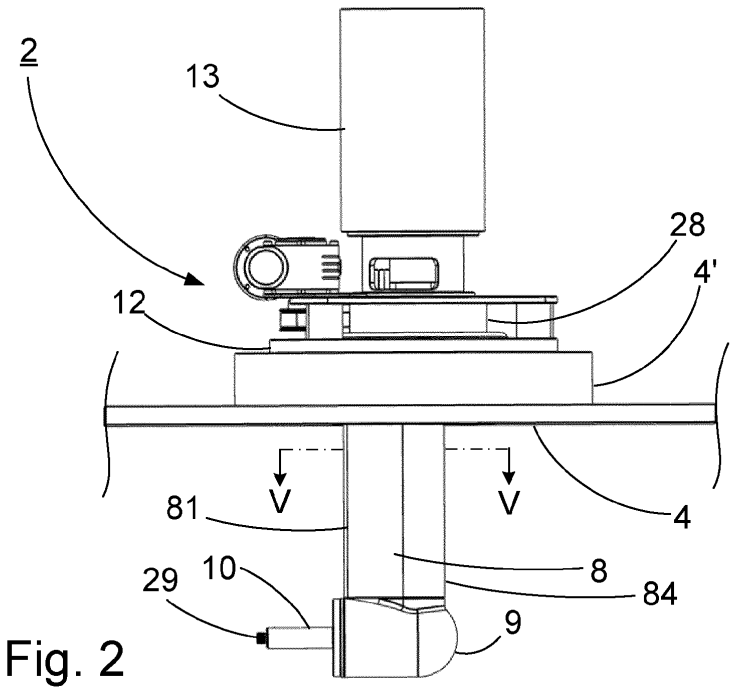

Fig. 2

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Description

[0001] The present invention relates to saildrives, in particular retrofittable electric sails drives for sailing boats.

[0002] It is well known to fit sailing boats with an auxiliary engine driving a propeller in order to provide propulsion for the sailing boat, e.g. when the wind is not blowing, or for manoeuvring. Typically, the engine is an onboard engine located within the hull of the sailing boat, preferably amidships in order to give a good weight distribution. The propeller is arranged at the distal end of an elongate drive housing extending from the bottom of the sailing boat, and via appropriate angle gears driven by a transmission axle running along the inside of the elongate drive housing. On a sailing boat the elongate drive housing will normally extend vertically downward from the hull just aft of the keel, i.e. between the keel and the rudder at the transom and in the same common vertical plane shared by keel and rudder.

[0003] Several examples of such an arrangement are known from GB2063196. In GB2063196 the vertically arranged elongate drive housing, referred to as drive leg, comprises tubular part accommodated within a tubular part sealed to the hull of the boat. The drive leg in turn may be sealed to in a solid fashion to the tubular member or by means of a further vibration damping flexible tubular member. Inside the drive leg a hollow shaft, referred to as torque tube, for azimuthally turning the pod with the propeller. The propeller itself is turned abouts a horizontal axis for propulsion by means of and angle gear located in the pod and connected to a vertical drive axle. The vertical drive axle runs coaxially within the torque tube to the engine above the tubular part sealed to the hull. The tubular part sealed to the hull preferably extends above the water line so as to prevent ingress of water into the boat.

[0004] Although, not intended for sailing boats and with focus on low height EP2280862 discloses details of a similar arrangement of a propeller pod with an angle drive arranged at the end of a drive leg in which a coaxial torque tube and the likewise coaxial drive axle is accommodated. Focus is on the low height and the use of electric ring motors to achieve this, in turn resulting in a drive leg with a substantial diameter, which would cause excessive drag for a sailing boat where the saildrive is only an auxiliary propulsion - the main propulsion of course being wind and sails.

[0005] Because of the latter, it is of high importance that the drag of the saildrive is kept as low as possible in order not negatively influence the sailing performance of the boat under sail, *inter alia in* terms of speed.

[0006] Furthermore, with the increased focus on CO_2 emissions there is growing interest in electrical saildrives to substitute conventional saildrives driven by fossil fuel combustion engines. This applies not only to new sailing boats but also to retrofitting existing sailing boats with electric saildrives and batteries that may then be recharged during operation under sail by the propeller driving the electric motor as a generator. In this respect EP2154063 suggest a hybrid drive not replacing the combustion engine but supplementing it with two electric machines one working as a generator coupled to the combustion engine and one arranged at the distal end of a vertically extending leg for driving the propeller. This obviates the need of the drive shaft and the torque tube, because the entire leg may be azimuthally turned. The propeller is preferably a folding propeller. This allows the propeller to have three modes. That is to say propulsion mode with the propeller facing rearwardly, idle sailing mode where the propeller folds to reduce drag, and regeneration mode where the leg entire with the propeller is azimuthally turned 180° to a forward facing direction in order to increase generation efficiency in the water flow.

[0007] One problem with this arrangement is that is that if the leg is not circular in cross-section but streamlined in order to reduce drag when under sail, the water flow will be sub-optimal with increased drag when turned 180° for generation, and even worse for intermediate angles.

[0008] Based on this it is the object of the invention to provide an electric saildrive for sailing boats having improved efficiency and reduced influence on the sailing performance of the sailing boat.

[0009] According to a first aspect of the invention this object is achieved by an electric saildrive for a sailing boat, said electric saildrive comprising, an electric machine, an elongate hollow shaft having a proximal shaft end and distal shaft end, an elongate transmission axle extending longitudinally within said elongate hollow shaft and having a proximal axle end and a distal axle end, said electric machine being mechanically coupled to said elongate transmission axle at said proximal axle end, a hollow housing surrounding the elongate hollow shaft, a pod housing rigidly connected to the distal shaft end of said elongate hollow shaft and having a first aperture adapted to allow the transmission axle to extend into an inner compartment of the pod housing, where said inner compartment accommodates an angle drive connecting the transmission axle to a propeller shaft, said propeller shaft extending from said inner compartment to the exterior of the pod housing through a second aperture in a sealed manner, characterized in that the hollow housing has an elongate cross-section so as to provide a fin-shape. This in turn has the further advantage that the rotation direction of the propeller does not need to be reversed for stopping or regeneration, in turn, minimizing the risk that the propeller gets unscrewed from the propeller shaft and lost.

[0010] This allows only the pod with the propeller to be azimuthally turned the 180° between the propulsion direction and the generation direction while the hollow housing with its fin-shape remains in the orientation with respect to the water flow direction for which the streamlined shape is optimized, as well as aligned with flow

around the keel and hull in general. The fin does thus not function as a rudder influencing the water flow, but rather functions as an auxiliary keel in stabilizing the sailing boat.

[0011] According to an embodiment of the first aspect of the invention the elongate cross-section is generally rounded at the leading end, comprises a wider middle part and has a taper from said wider middle part towards the trailing end. This provides the fin-shaped housing with a generally teardrop shaped cross-section so as to be streamlined with respect to water flow so as to reduce turbulence and other drag inducing effects.

[0012] According to another embodiment of the first aspect of the invention, the inner compartment of the pod housing is oil-filled. This efficiently lubricates the gear, propeller shaft and other parts of the transmission accommodated in the inner compartment of the pod. Furthermore, the oil counteracts the external pressure from the surrounding water on seals, e.g. surrounding the propeller shaft where it exits the pod, thus reducing the risk of ingress of water.

[0013] This is particularly efficient when, according to a further embodiment of the first aspect of the invention, the sail drive comprises an oil reservoir adapted to be arranged above the water line of the sailing boat, and in fluid communication with said inner compartment of the pod housing via a gap between said elongate hollow shaft and said transmission axle. This will allow the oil pressure in the pod to be equal to or preferably exceed the external water pressure, thus further reducing the risk of ingress of water.

[0014] According to yet a further embodiment of the first aspect of the invention, the elongate hollow shaft comprises a number of oil passages allowing the gap between said elongate hollow shaft and said transmission axle to remain oil-filled from said reservoir. This increases the freedom in positioning the reservoir as it need not be accommodated above the level of the gap between the elongate hollow shaft and the transmission axle, i.e. above the proximal end of the hollow shaft, but may instead be provided sideways thereof as long as it is ensured that it is positioned above the water line of the sailing boat.

[0015] According to yet another embodiment of the first aspect of the invention, the saildrive further comprises a, preferably, electric azimuth control motor adapted to turn said elongate hollow shaft with respect to the hollow housing. An electric motor is cost-efficient in provision, easy to maintain and easy to control so that the azimuthal position of the hollow shaft and, in turn, the pod is well defined.

[0016] According to a further embodiment of to the first aspect of the invention, the electric azimuth control motor is coupled to said elongate hollow shaft via a belt drive for transmission of rotary motion. A belt drive is cost-efficient in provision, easy to maintain, and needs no lubrication of protection from corrosive substances, such as saline seawater.

[0017] According to another embodiment of the first aspect of the invention, the saildrive further comprises a base plate adapted to allow the sail drive to be mounted on said sailing boat from the inside of a hull of said sailing boat and with the longitudinal direction of the hollow housing aligned with the longitudinal direction of the hull. This facilitates the placement and attachment to the sailing boat. It furthermore allows substitution of an existing sail drive using the mounting facilities already present in the sailing boat. Preferably, the saildrive further comprises a flexible seal between said base plate and said hollow housing.

[0018] According to another embodiment of the first aspect of the invention, the electric machine comprises an output shaft axially aligned with said transmission axle. This allows vertical, space saving arrangement of the electric machine and obviates the need of angle gears or the like, thus reducing the number of parts that need to be serviced and maintained.

[0019] According to a further embodiment of the first aspect of the invention, the sail drive comprises further electric machines with output shafts aligned with said transmission axle. This allows the use of several, in particular flat disc shaped machines, that may be stacked according the specific need, i.e. in a number suitable to fit a desired output power of the saildrive.

[0020] The invention will now be described in greater detail based on non-limiting exemplary embodiments, and with reference to the drawings on which:

Fig. 1 schematically shows a sailing boat equipped with a saildrive according to the invention.
Fig. 2 schematically shows a first embodiment of the saildrive according to the invention,
Fig. 3 shows an exploded view of the saildrive of Fig. 2,
Fig. 4a shows a cross-section taken along a vertical centre plane of Fig. 2,
Fig. 4b shows a cross-section taken along a vertical centre plane of a second embodiment of the saildrive according to the invention, and
Fig. 5 shows a cross-section taken along a horizontal plane of the hollow housing of the saildrive.

[0021] Turning first to Fig. 1 a sailing boat 1 with a sail drive 2 is schematically shown. For illustration reasons it is only shown in part, the top of the mast 3 being omitted as it is irrelevant for the present invention. The sailing ship comprises a hull 4. The hull 4 will normally have mirror symmetric about vertical symmetry plane extending bow to stern in the longitudinal direction of the hull 4. Asymmetric hulls 4 are of course also known, e.g. for catamarans, but for this description it will be assumed that the sailing boat 1 is a single hull boat with one mirror symmetric hull 4. In the illustrated embodiment the hull 4 has an integral keel 5, but, as will be understood by the person skilled in the art, the saildrive 2 would also be applicable to sailing boats with lowering keels or dagger-

boards etc. as this, like the number of hulls 4 is of little relevance to the saildrive 2 *per se*. The saildrive 2 is mounted in the hull 4 and extends downwardly from the hull 4, preferably in the vertical symmetry plane. The sailing boat 1 in the illustrated embodiment is shown with a single rudder 6, the rotations axis of which also extends downward from the hull 4 in the vertical symmetry plane, s that in a neutral rudder position the central symmetry plane of the rudder 6 is aligned with the vertical symmetry plane of the hull 4. The sail drive 2 preferably also extends from the hull 4 in the vertical symmetry plane, preferably at a location of the between the keel 5 and the rudder 6.

[0022] Aligning keel 5, saildrive 2 and rudder 6 is beneficial for the flow around the saildrive 2, be it in a propulsion configuration, as shown, with the propeller 7 facing backwards from the saildrive 2 as seen with respect to the sailing boat 1 or in a generation configuration with the propeller 7 facing forwards from the saildrive 2.

[0023] Turning now to Fig. 2 the saildrive 2 is schematically shown mounted in a section of the hull 4 of the sailing boat 1. The saildrive 2 comprises external parts below the section of the hull 4 schematically shown, adapted to be immersed in the water, and parts accommodated within the hull 4, i.e. above the section of the hull 4 schematically shown. The parts adapted to be immersed in and hence in contact with the water comprise a hollow housing 8, a pod housing 9 and a propeller shaft 10. The hollow housing 8 may preferably be a solid block of marine grade aluminium or other suitable material for marine purposes made hollow by having a through bore adapted in diameter for accommodating a hollow shaft 15 and other parts of the transmission to be explained below. The propeller 11 is not shown in Fig. 2. The skilled person will know that the propeller 11, as such, is a separate and interchangeable part that may be supplied and sold separately from the remainder of the saildrive 2 without deviating from the inventive idea and construction thereof and has therefore been omitted. The propeller 11 is normally secured to the propeller shaft 10 by a threaded part 29 of the propeller shaft 10 with an external thread matching an internal thread in a bore in the propeller 11 (not shown).

[0024] The saildrive 2 furthermore comprises parts adapted to be mounted within the hull 4. These parts comprise a base plate 12 adapted to allow the saildrive 2 to be mounted on said sailing boat 1 from the inside of the hull 4 of the sailing boat 1, typically on a mounting part 4' or other reinforced part of the hull 4 as schematically shown in Fig. 2. The base plate 12 directly or indirectly carries all the parts of the saildrive 2, so that the saildrive 2 may be provided and mounted as one single preassembled unit by securing the base plate 12 to the hull 4 by suitable means such as bolts (not shown) in bolt holes 31 in the hull 4, cf. Fig. 4a. Above the base plate 12 an electric machine 13 is provided. the electric machine 13 coupled to the proximal end of a vertical transmission axle 14 visible in the exploded view of Fig. 3 and the cross-sectional view of Fig. 4a. The arrangement is similar in the embodiment of Fig 4b. The coupling between the electric machine 13 and the vertical transmission axle 14 is preferably directly, i.e. so that the output shaft of the electric machine 13 is aligned with the transmission axle 14 and in direct connection therewith without any intermediate gear or the like, although an axial gear such as a planetary gear. The electric machine 13 may act as both a generator for recharging energy storage of the saildrive 2 such as batteries and as a propulsion motor powered by the energy storage when needed. Control of the electric machine 13, charging and discharging of the energy storages, and the energy storage itself are not considered part of the invention and will not be dealt with.

[0025] Though only a single electric machine 13 is should be understood that several may be operating in tandem. That the sail drive could comprise several, preferably flat disc-shaped electric machines 13 acting directly on or having their output shafts aligned with the vertical transmission axle 14. This allows the total output power to adapted to the specific power needs or available space, allowing the user to order to some extent a saildrive 2 custom built to his or her sailing boat 1 .

[0026] The vertical transmission axle 14 extends longitudinally within an elongate hollow shaft 15. The distal end of the elongate hollow shaft 15 is coupled to the pod housing 9 by a suitable coupling means e.g. and external thread 16 adapted to match an internal thread (not visible) in a tubular connection part 17. The tubular connection part provides a first aperture in the pod housing 9 adapted to allow the transmission axle 14 to extend into the inner compartment 18 of the pod housing 9. The propeller shaft extends 10 from a second aperture in the pod housing 9. Both the first aperture and the second aperture of the pod housing 9 are suitably sealed against ingress of water from the exterior. Being preferably a solid block of metal, the hollow housing 8 yields good support for the hollow shaft 15 and the vertical transmission axle 14 against bending forces from the surrounding water.

[0027] As can best be seen in Fig. 4a and 4b the inner compartment 18 accommodates an angle drive connecting the transmission axle 14 to the propeller shaft 10. The angle drive in the illustrated example comprises a bevel gear with one conical gear wheel 19 on the transmission axle 14 meshing with a likewise conical gear wheel 20 on the propeller shaft 10. Bearings 21 for the propeller shaft 10 are also provided in the inner compartment of the pod housing 9. Bearings 22 for the distal end of the transmission axle 14 are also provided, preferably within the tubular connection part 17. As will be understood the gap 23 between the hollow shaft 15 and the transmission axle 14 be in fluid connection with the inner compartment 18 of the pod housing 9. This allows simple lubrication of the propeller shaft, the transmission axle 14, bearings 21, 22, the conical gear wheels and possibly other parts of by simply filling the gap 23 and the inner compartment 18 with oil from a reservoir 33 above the proximal end of the hollow shaft 15 as can be seen in

Fig. 4b. The reservoir 33 is preferably located above the water line of the sailing boat 1. Filling the gap 23 and the inner compartment entirely with oil this way, provides counter pressure against the external water pressure, in turn preventing ingress of water. Moreover, if the oil is properly circulated, e.g. by suitably arranges impellers, any ingress of water will easily be detectable at the reservoir which is accessible within the hull even when the sailing boat is in the water. Visual inspection would suffice as the resulting oil/water mixture clearly differs from the oil in colour and transparency. As can be seen in fig. 4b the gap 34 between the hollow shaft 15 and the hollow housing 8 is preferably also oil-filled. Preferably, passages 35 are then provided in the hollow shaft 8 to allow oil to flow between the gaps 23 and 34. This furthermore allows the oil from the reservoir 33 to be fed or flow under gravitation into the inner compartment 18 via at least one suitable oil duct 36 provided in the otherwise solid body forming the hollow housing 8. The connection from the reservoir 33 to the oil duct 36 may be any suitable conduit 37 such as a flexible hose and is only shown schematically as a dashed line.

[0028] As can be seen from the cross-sections in Fig. 4a and 4b, the hollow shaft 15 to which the pod housing 9 is rigidly secured extends through a hollow housing 8, the hollow housing 8 at least being hollow in the sense that it comprises a through passage adapted to accommodate the hollow shaft 15. The hollow housing 8 supports the hollow shaft 15 in the radial direction and prevents forces of the flow of surrounding water when sailing from deflecting the hollow shaft 15 in the radial direction. The hollow housing 8 is rigidly connected to the base plate 12, preferably directly thereto. The base plate in turn is adapted to be rigidly secured to the inside of the hull 4 e.g. by means of bolts fitting in existing bolt holes 31 for a prior saildrive that is to be replaced by the electric saildrive 2 according to the invention. Accordingly, the base plate has matching bolt holes 32, so arranged respect to with the remainder of the saildrive 2, that the alignment of the fin-shape of the hollow housing 8 matches the sailing direction of the sailing boat 1 is ensured. A flexible seal 30 is preferably interposed to prevent ingress of water and to accommodate for vibrations and flexing of the parts of the saildrive 2 extending from the hull 4.

[0029] These rigid connections allow the hollow housing 8 of the saildrive to be fitted in a fixed position with respect to the hull 4 of the boat, preferably longitudinally aligned with the keel 5 and the rudder 6 of the sailing boat 1 in order to optimize flow, be it under sail or during propulsion by the saildrive 2. To further optimize the flow the hollow housing 8 has an elongate cross-section, as can be seen in Fig. 5. Being fixed, the flow around the hollow housing 8 is not to any significance influenced by the azimuthal turning of the pod 9 from propulsion configuration to regeneration configuration.

[0030] The hollow shaft 15 to which the pod housing 9 is rigidly secured on the other hand may turn azimuthally with respect to the hollow housing 8 through which it extends, allowing *inter alia* the propeller shaft to point in any 360° azimuthal direction as indicated by the dashed arrows Az in Fig. 5. As will be understood the hollow shaft 15 and hence the pod housing 9 may freely rotate through in principle an infinite angle, and because there need not be any electrical leads, lubrication or the like to take into account the angle is not limited to a restricted angle of a finite number of 360° turns. This can be achieved by an electric azimuth control motor 24 adapted to turn said elongate hollow shaft 15 with respect to the hollow housing 8 via a suitable transmission. Currently, it is preferred that the electric azimuth control motor 24 is coupled to said elongate hollow shaft 15 via a belt drive with a drive belt 25. The electric azimuth control motor 24 preferably acts on or at the distal end of the hollow shaft 15. The hollow shaft 15 may in this respect comprises a disk 28 with larger diameter than the hollow shaft 15 as well as a larger diameter than the output shaft 26 of the azimuth control motor 24 or a pulley 27 arranged thereon in order to provide a suitable reduction gearing, allowing only a small electric azimuth control motor 24 to turn the pod housing 9 in the water. Needless to say that the azimuth control motor 24 need not actually be electric, but in an electric sail drive it would make little sense to use other means such as a hand crank, a hydraulic motor or the like.

[0031] The disc 28 may comprise a tacho disk or milled-in markings or similar for optical or other capture of the azimuthal position of the pod housing 9 and hence the direction in which the propeller shaft 10 points. Alternatively, as shown in Fig. 4b an second circular disc or cylinder 38 may be excentrically arranged on the disc 28. The azimuthal position of the pod housing 9 can then be determined by means of range sensors (not shown) arranged in the horizontal plane of the disc or cylinder 38 and angularly spaced apart by e.g. 90°.

[0032] It will be understood that the change in azimuth of the pod housing 9 and hence the direction of the propeller shaft 10 and the propeller. Will not only be useful for propulsion when pointing in in one direction and regeneration from sailing when pointing in the opposite direction under sail or during stopping, but may also be useful for maneuvering the boat as such. Azimuthally turning to pod housing so that the propeller faces forward for regeneration and stopping has further the advantage that the rotation direction of the propeller does not need to be reversed, in turn minimizing the risk that the propeller 11 gets unscrewed from the propeller shaft 10 and lost.

[0033] As can be seen in the cross-sections of Fig. 4a and 4b the hollow housing 8 surrounds the hollow shaft 15 in an asymmetric manner in the lengthwise direction, i.e. that the trailing part (on the left-hand side of the hollow shaft 15 in Fig. 4a and 4b) extends much farther away from the hollow shaft 15 than the leading part (on the right-hand side of the hollow shaft 15 in Fig. 4a and 4b). As can be seen in the cross-section in Fig. 5 taken along the line V-V in Fig. 2 the lengthwise dimension is also

larger than the cross-wise dimension, so that the cross-section has an elongate shape, i.e. is fin-shaped. It can further be seen that the cross-section is generally tear-drop shaped, having a rounded leading end 81, a wider middle part 82 and from the wider middle part 82 a trailing part 83 with a taper from said wider middle part 82 towards the trailing end 84. In the illustrated example the trailing end 84 is also slightly rounded, but with a far smaller radius that the leading end 81. It could in principle be as sharp as technical constrictions and safety allow. The taper in the illustrated example is generally wedge shaped, i.e. flat straight surfaces, but it is to be understood that the taper could also involve convexly or concavely curved surfaces. This is merely a matter of optimizing the shape of the streamline of the elongate cross-section. In this respect it should be noticed that any other streamlined elongate shape is of course also possible, e.g. ellipsoid, lentil-shaped, oval etc. as long as a fin is provided. Still without deviation from the invention, some of these cross-sections may have the hollow shaft 15 centrally and/or symmetrically arranged with respect to the hollow housing 8. The essential part being that the elongate fin-shape is fixed with respect to the hull and provides good flow with low drag around the sail drive 1.

Claims

1. An electric saildrive for a sailing boat, said electric saildrive comprising,

an electric machine,
an elongate hollow shaft having a proximal shaft end and distal shaft end,
an elongate transmission axle extending longitudinally within said elongate hollow shaft and having a proximal axle end and a distal axle end, said electric machine being mechanically coupled to said elongate transmission axle at said proximal axle end,
a hollow housing surrounding the elongate hollow shaft,
a pod housing rigidly connected to the distal shaft end of said elongate hollow shaft and having a first aperture adapted to allow the transmission axle to extend into an inner compartment of the pod housing, where
said inner compartment accommodates an angle drive connecting the transmission axle to a propeller shaft, said propeller shaft extending from said inner compartment to the exterior of the pod housing through a second aperture in a sealed manner, **characterized in that**
the hollow housing has an elongate cross-section so as to provide a fin-shape.

2. An electric saildrive according to claim 1, wherein the elongate cross-section is generally rounded at the leading end, comprises a wider middle part and has a taper from said wider middle part towards the trailing end.

3. An electric saildrive according to any one of the preceding claims, wherein the inner compartment of the pod housing is oil-filled.

4. An electric sail drive according to claim 3, further comprising an oil reservoir adapted to be arranged above the water line of the sailing boat, and in fluid communication with said inner compartment of the pod housing via a gap between said elongate hollow shaft and said transmission axle.

5. An electric saildrive according to claim 4, wherein the elongate hollow shaft comprises a number of oil passages allowing the gap between said elongate hollow shaft and said transmission axle to remain oil-filled from said reservoir.

6. An electric saildrive according to any one of the preceding claims, further comprising an azimuth control motor adapted to turn said elongate hollow shaft with respect to the hollow housing.

7. An electric sail drive according to claim 6, wherein the azimuth control motor is coupled to said elongate hollow shaft via a belt drive for transmission of rotary motion.

8. An electric saildrive according to any one of claims 6 or 7, wherein the azimuth control motor is an electric motor.

9. An electric saildrive according to any one of the preceding claims, further comprising a base plate adapted to allow the sail drive to be mounted on said sailing boat from the inside of a hull of said sailing boat and with the longitudinal direction of the hollow housing aligned with the longitudinal direction of the hull.

10. An electric saildrive according to claim 9, further comprising a flexible seal between said base plate and said hollow housing.

11. An electric saildrive according to any one of the preceding claims, wherein said electric machine comprises an output shaft axially aligned with said transmission axle.

12. An electric saildrive according to claim 10, comprising further electric machines with output shafts aligned with said transmission axle.

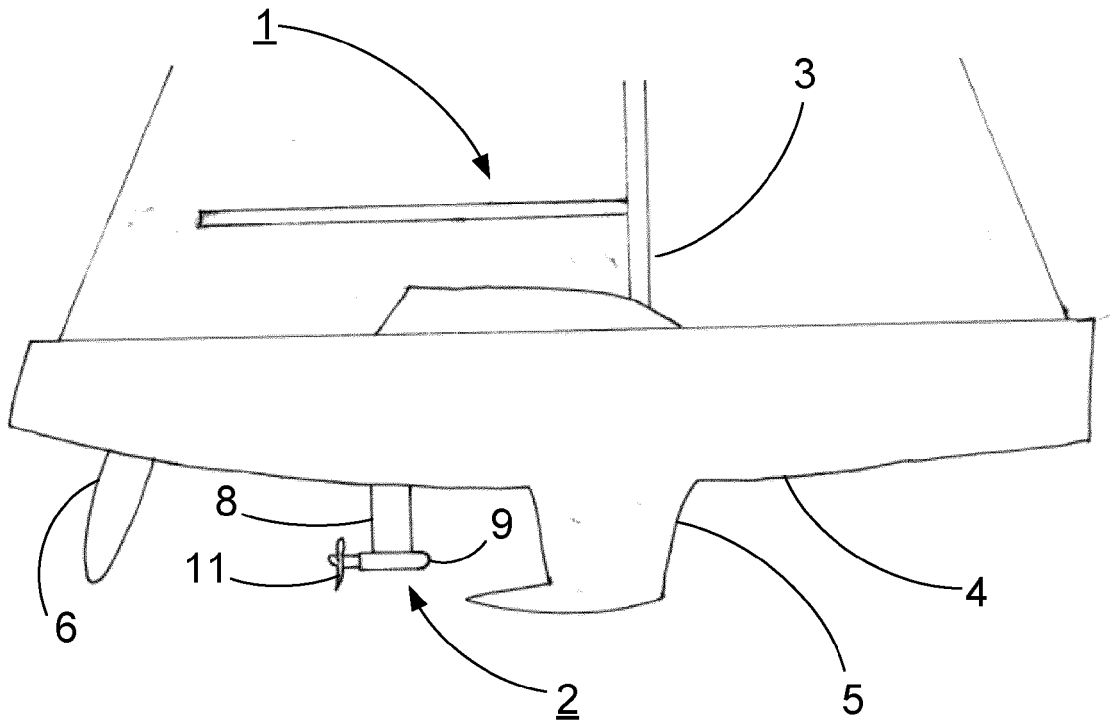

Fig. 1

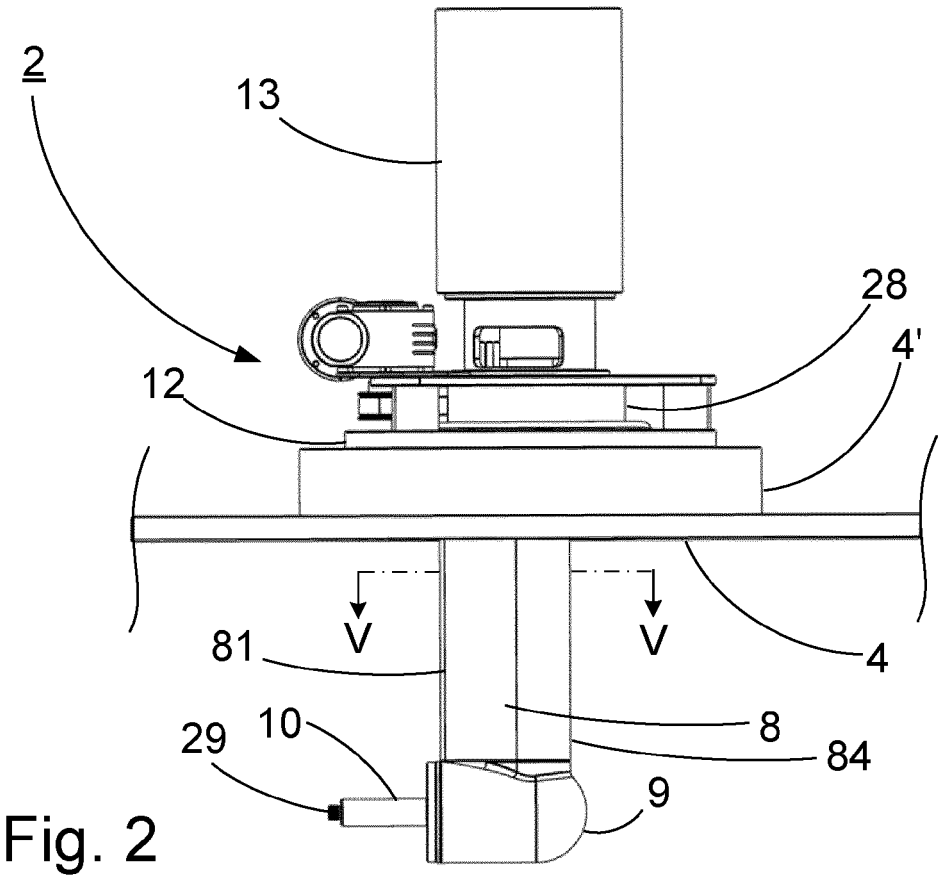

Fig. 2

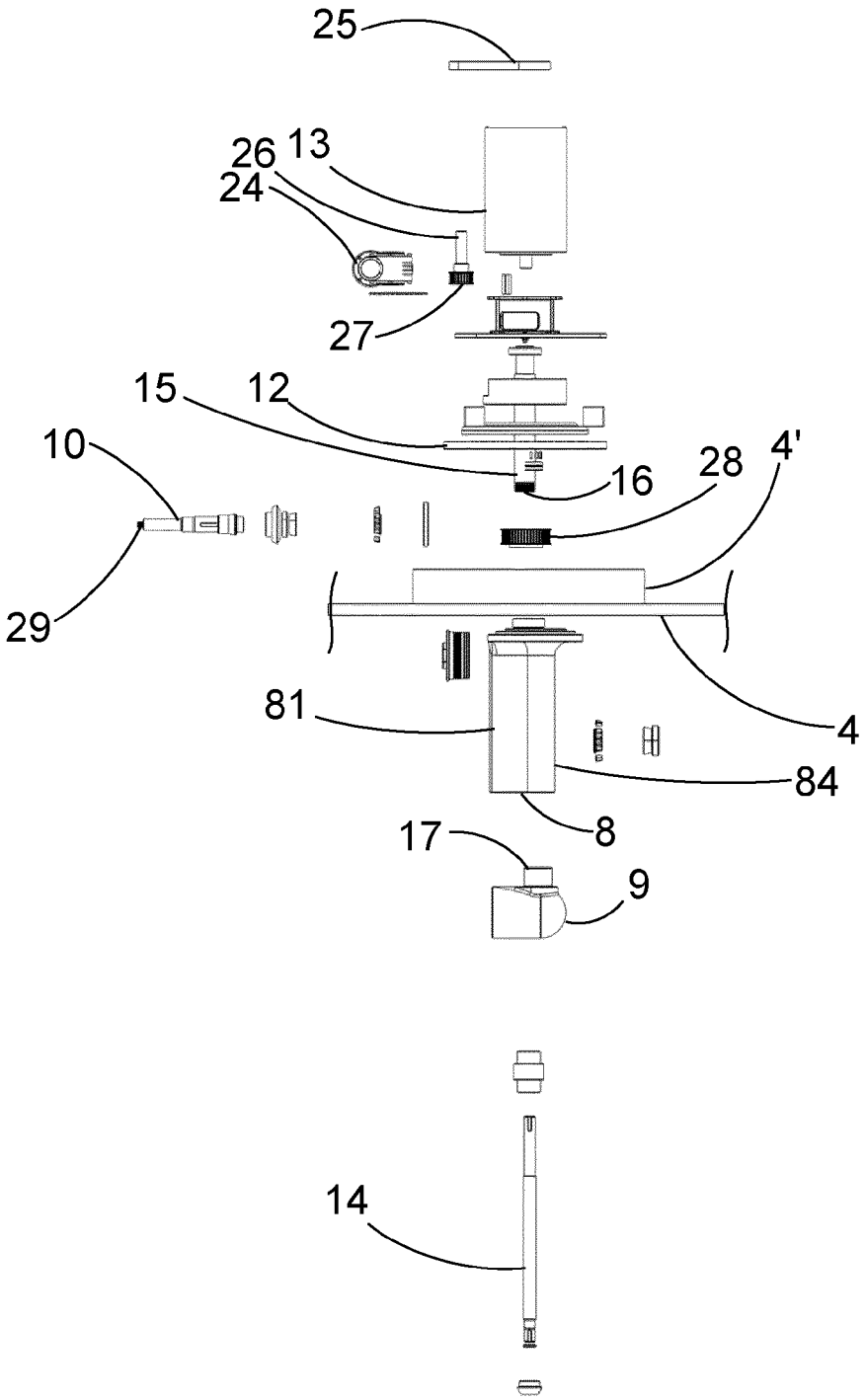

Fig. 3

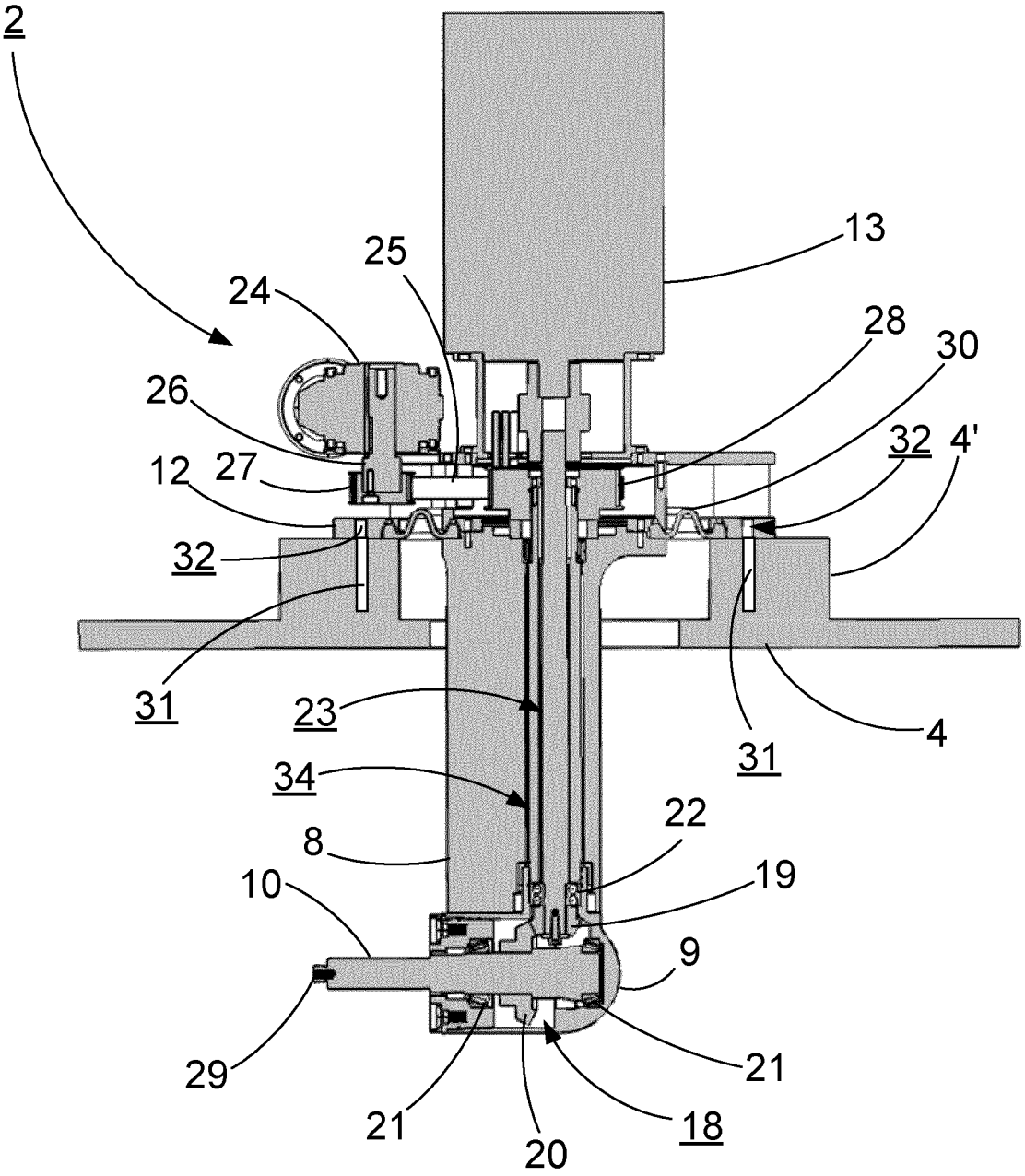

Fig. 4a

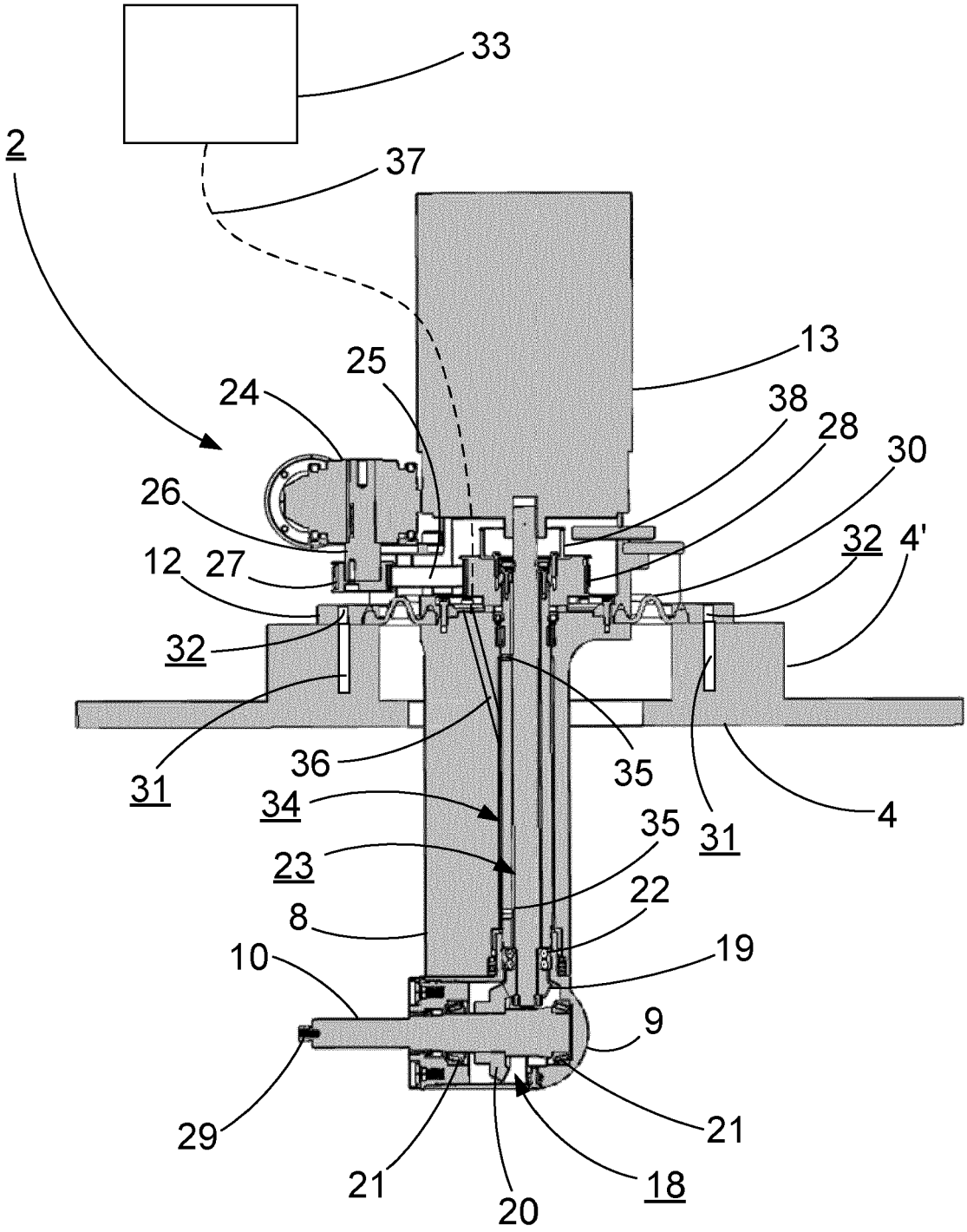
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Fig. 4b

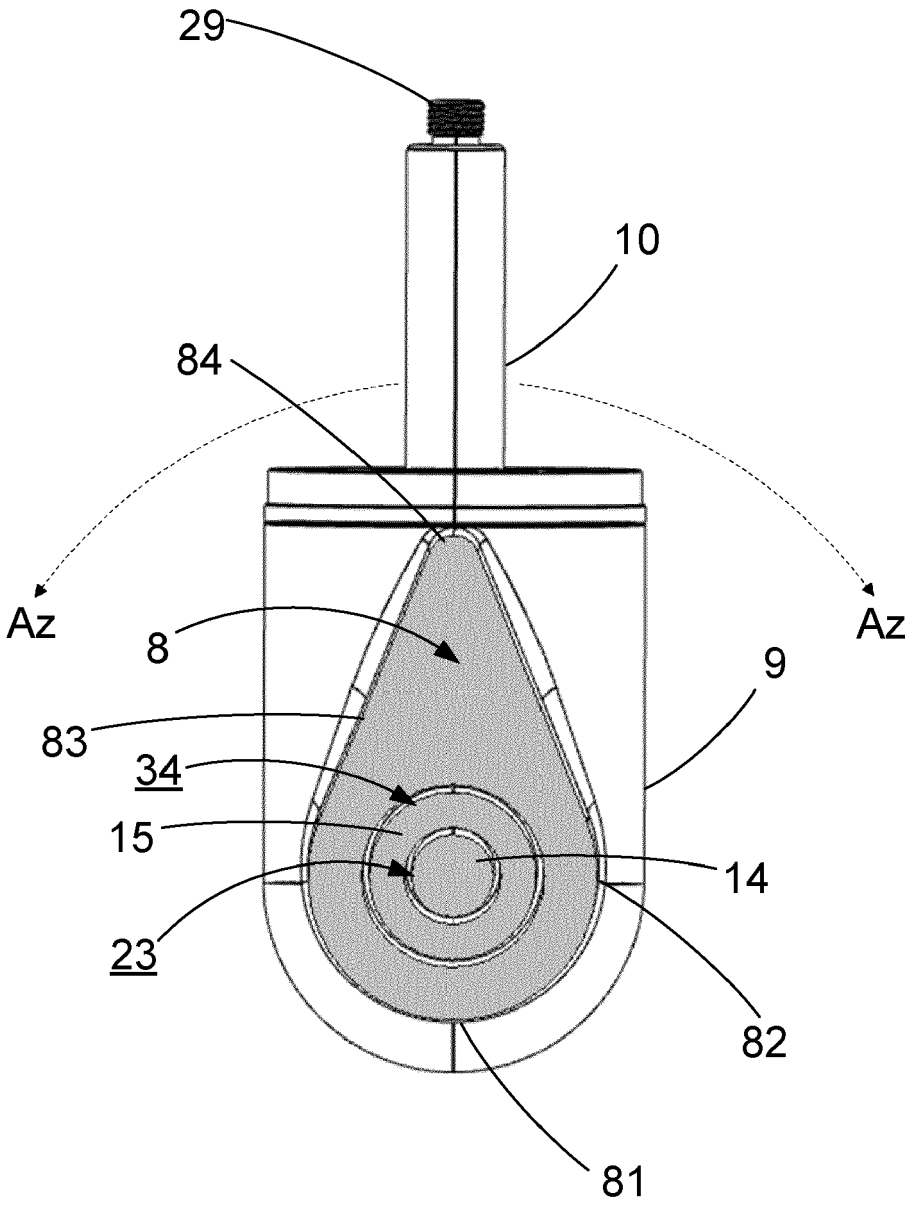

Fig. 5

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 6905

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2012/028514 A1 (GRASSI DAVIDE [IT] ET AL) 2 February 2012 (2012-02-02) * paragraphs [0003], [0051] * * figures 2, 3, 5, 6 *	1-12	INV. B63H5/125 B63H21/17 B63H21/38 B63H20/00
X	US 8 425 268 B2 (DAIKOKU KEISUKE [JP]; ACHIWA TETSUSHI [JP] ET AL.) 23 April 2013 (2013-04-23) * abstract * * figures *	1-12	
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