Summary of Invention~~Object, solution, advantage~~

Embodiments~~It is therefore the object~~ of the present invention seek to provide an upper rudder carrier bearing which overall simplifies the mounting structure of the rudder post and reduces the maintenance expenditure. ~~This object is achieved with an upper carrier bearing according to claim 1.~~

According to a first aspect of the present invention, there is provided a rudder carrier bearing for the mounting of a rudder post of a rudder of a watercraft, in particular a ship, wherein the rudder carrier bearing comprises a bearing housing and an axial and a radial bearing wherein the axial and/or the radial bearing is configured as a self-lubricating bearing, wherein the rudder carrier bearing is an upper rudder carrier bearing, and wherein the bearing housing comprises two housing parts, namely a housing base body and a housing cover, and wherein the axial and the radial bearing are disposed in the bearing housing in such a manner that the two bearings are each disposed inside the bearing housing and are also integrated therein, and wherein the axial bearing comprises a first bearing element and a second bearing element, which are movable with respect to one another, wherein the first bearing element is fastened to the housing base body and that the second bearing element is fastened to the housing cover, and wherein the axial and/or the radial bearing are both configured as plain bearings.

According to a second aspect of the present invention, there is provided a rudder arrangement for watercraft, in particular ships, wherein the rudder arrangement comprises a rudder carrier bearing as defined in the first aspect.

According to a third aspect of the present invention, there is provided a watercraft, in particular a ship, wherein the watercraft has a rudder carrier bearing defined in the first aspect or a rudder arrangement defined in the second aspect.

According to a fourth aspect of the present invention, there is provided a rudder carrier bearing kit for manufacturing an upper rudder carrier bearing for mounting a rudder post of a rudder of a watercraft, in particular a ship, wherein the kit comprises a bearing housing, comprising a housing base body and a housing cover, an axial bearing comprising a first annular disk made of a non-metallic material comprising a solid lubricant and a second annular disk made of a metallic material, in particular stainless steel, a radial bearing made of a material comprising a bearing bush made of a non-metallic material comprising a solid lubricant and optionally a rudder post sleeve made of a metallic material, in particular stainless steel, and optionally a sealing means, wherein the kit is configured in particular to manufacture a rudder carrier bearing defined in the first aspect.

According to a fifth aspect of the present invention, there is provided a method for manufacturing an upper rudder carrier bearing, comprising the steps of: providing a bearing housing that comprises a first sleeve-like housing part, namely a housing base body, and a second housing part, namely a housing cover, inserting and fastening a bearing bush comprising a material having a solid lubricant, into the first housing part, in particular by joining by means of thermal expansion and/or gluing, wherein the bearing bush is made of a non-metallic material and fastening a first bearing annular disk on the first housing part, in particular by means of screwing, and fastening a second bearing annular disk associated with the first bearing annular disk on the second housing part, wherein the first and/or the second bearing annular disk comprises a non-metallic material having a solid lubricant.

Accordingly, the rudder carrier bearing ~~according to the invention~~ has a bearing housing which is preferably formed in two parts and particularly preferably comprises a housing base body and a housing cover. Both an axial bearing and a radial bearing are disposed in the bearing housing. Since both axial and radial bearing are configured to be disposed in a single housing or are configured to be integrated in the housing, an extremely compact arrangement and easy

installation and dismantling of the rudder carrier bearing is possible. Furthermore, both the axial and the radial bearing are configured as plain bearings, i.e. the elements to be mounted (bearing elements) move directly past one another or only separated by a lubricating film. By this means, the structure is further simplified since no additional rolling bodies or the like need to be provided.

Furthermore, the axial bearing and/or the radial bearing are configured as self-lubricating bearings. Self-lubricating bearings are also called "solid friction bearings" since friction between solids generally occurs in these bearings. This is due to a self-lubricating property of one of the partners or one of the bearing elements. These bearings do not need additional lubrication or lubricant since solid lubricants embedded in the material of which they are made are provided, which reach the surface during operation due to microwear and thereby lower friction and wear of the bearings. In particular plastics or plastic composites and/or ceramic structural materials are used to form such bearings or one of the normally two bearing elements which are movable relative to one another. Examples of such materials are PTFE (polytetrafluoroethylene) and ACM (acrylate rubber). Graphite-containing materials can also be used. In one

embodiment, however, exclusively plastics and optionally additional metal materials and no ceramic materials can be used. In particular, composite materials can also be used to manufacture at least one of the bearing elements of the axial and/or radial bearing configured as a self-lubricating bearing, wherein at least one of the components of the composite material then has a solid lubricant. Advantageously no vulcanised rubber, "rubber" or similar elastic materials are used. By this means, the structure of the rudder carrier bearing according to embodiments of the invention is further simplified since no additional means for providing a lubricating film or the like and no external lubricants need to be provided. From ecological aspects, embodiments of the present invention areis also advantageous since no lubricants, for example, grease can enter into the environment from the bearing. It is further advantageous that in contrast to conventional bearings frequently consisting of metal, in which for example one of the bearing elements is made of bronze, the risk of seizing in self-lubricating bearings may is almost be eliminated. Furthermore, such bearings may beare also extremely low-maintenance. It is advantageous that the upper rudder carrier bearing according to embodiments of the invention maydoes not require any oil/grease lubrication or other external lubrication. This may beis permanently the case, i.e. throughout the entire operating time and not merely during emergency operation or in the short term.

Furthermore, in a rudder carrier bearing comprising at least one self-lubricating bearing, the requirements for the seal of the rudder carrier bearing are not so high as in the bearings lubricated with external lubricants, known from the prior art since there is no risk of a lubricant escaping from the bearing into the environment. By this means the structure of the rudder carrier bearing may beis further simplified. It is particularly appropriate to configure both the axial and the radial bearing as self-lubricating bearings since the advantages according to embodiments of the invention can be increased as a result.

The bearing housing can fundamentally be manufactured in any suitable form and in any suitable material, a metallic material, in particular steel, being preferably used. Moreover, the formulation that the axial and the radial bearing "are disposed in the bearing housing" should be understood in the present

context in such a manner that the two bearings can each be disposed inside the bearing housing and also can be integrated therein, i.e., for example, in the case of a multi-part configuration of the bearing housing, parts of the axial and/or of the radial bearing can also be disposed between individual parts of the bearing housing or in edge zones of the housing or the housing parts. The crucial thing is that the bearing housing together with the axial and the radial bearing forms a unit and is therefore configured compactly. The bearing housing is advantageously configured to be closed and/or sealed towards the outside.

In principle, the upper rudder carrier bearing according to embodiments of the invention can be provided in all known types of rudder, i.e. fully floating rudders, semi-spade type rudders or rudders mounted in the stern. The bearing could also be used in other control or manoeuvring systems of watercraft, for example, on rotary Kort nozzles or the like. Preferably the upper rudder carrier bearing is used for rudders, especially fin rudders for ships in the commercial or military field. These include both ocean-going ships and inland navigation vessels. The carrier bearing is not usually suitable for motor boat or the like.

In principle, the upper carrier bearing is designed in such a manner that it can withstand tilting movements or reciprocating rotary movements up to a maximum deflection of $\pm 70^{\circ}$. No further swivelling usually takes place with rudders. Thus, the upper rudder carrier bearing according to embodiments of the invention is not configured for revolving rotating shafts or similar, as is the case with other types of bearings. In this respect, the carrier bearing according to embodiments of the invention is not a bearing for continuous rotational or rotary movements but for tilting movements up to a maximum of $\pm 70^{\circ}$.

In the rudders for which the upper rudder carrier bearing according to embodiments of the invention is particularly suited, that is for ships from the commercial or military field, the rudder posts frequently have long lengths so that the rudder carrier bearing only covers a fraction of the total length of the rudder post. In other words, the length of the rudder carrier bearing in the axial direction is only a fraction of the length of the rudder post. In particular, the length of the rudder

It is further expedient to configure the rudder carrier bearing according to embodiments of the invention in such a manner that the ratio of the width of the axial bearing or the width of the bearing face of the axial bearing to the diameter of the rudder post is 1:3, preferably 1:4.5, particularly preferably 1:5.5. In other words, the diameter of the rudder post in this embodiment is 3 times, preferably 4.5 times, particularly preferably 5.5 times larger than the width of the axial bearing. A particularly compact structure of the carrier bearing is thereby achieved. In another embodiment it is preferred that the ratio between the diameter of the post and the diameter of the housing of the rudder carrier bearing is 1:1.25 to 1:1.75, preferably 1:1.35 to 1:1.65. Any flanges or similar which project from the housing for fastening purposes are not included in the diameter of the housing. An optimal, compact rudder carrier bearing arrangement can also be achieved by this means.

If the bearing housing is formed in two parts, in particular comprising a housing base body and a housing cover, it is expedient if the first bearing element of the axial bearing is fastened to a housing part, in particular to the housing base body and that the second bearing element of the axial bearing is fastened to the other housing part, in particular to the housing cover. In this case, not only the two bearing elements but with them also the two housing parts are movable with respect to one another. In particular, one housing part, for example, the housing cover can be fastened on the rudder post so that the housing cover and the second bearing element fastened thereon turn together with this. Accordingly, the other housing part, in particular the housing base body must be fixed or fastened to the hull. In this embodiment, it is particularly expedient that the axial bearing disposed in the housing is disposed between the two housing parts. Particularly preferably in this embodiment the bearing elements of the axial bearing are configured as annular disks and those of the radial bearing are configured as bushes or sleeves. This further simplifies the structure since these are commonly used components in terms of the geometrical dimensions, which can frequently be purchased directly already in the form or dimension required and need not be manufactured specially. Also no loss of material ensues as the

case, for example, when a special bearing element shape must be milled or turned from a blank.

Expediently, the bearing housing has a fastening section, in particular an outwardly projecting flange, by which means the bearing housing or the rudder carrier bearing can be fastened on the watercraft body. By this means a stable connection can be achieved between bearing housing and watercraft body. In particular, the fastening section can be connected to the watercraft body by means of welding. On the other hand, the bearing housing is not normally directed to the rudder trunk.

If the bearing housing is formed in two parts, the fastening section is expediently provided on that housing part to which the radial bearing is fastened.

It is furthermore expedient if the upper rudder carrier bearing comprises sealing means for sealing the carrier bearing, in particular in the region of the radial bearing. In particular, the sealing means can be disposed in the lower region, i.e. the region of the bearing housing facing the rudder blade or underneath the bearing housing. This may avoids particles or the like, which interfere with the plain bearing, from being able to penetrate from outside into the rudder carrier bearing.

There is also disclosed~~The object forming the basis of the invention is further achieved by~~ a rudder arrangement for watercraft, in particular ships, which has an upper rudder carrier~~according to the invention~~. Such a rudder arrangement generally further comprises a rudder blade and a rudder trunk for receiving a rudder post. Preferably in such a rudder arrangement the upper rudder carrier bearing is configured to be integrated in the rudder trunk and/or is placed on the upper end of the rudder trunk facing away from the rudder blade. In other words, upper rudder carrier bearing and rudder trunk can be formed as a unit, wherein the rudder carrier bearing can be formed in the rudder trunk or integrated therein or it can be disposed adjacent to or contiguous to said trunk, wherein in

particular in the latter case, rudder carrier bearing and rudder trunk are connected positively and/or non-positively to one another. The formulation "placed on the rudder trunk" should be understood in the present context in such a manner that the rudder carrier bearing adjoins the end of the rudder trunk facing the steering engine or facing away from the rudder blade. As a result of such an integrated design of rudder carrier bearing and rudder trunk, the structure of the rudder arrangement may beis overall more compact and manufacture may beis simplified insofar as complete units of rudder carrier bearing and rudder trunk can be installed together or dismantled in the case of maintenance.

It is particularly preferred if the upper end of the rudder trunk facing away from the rudder blade, in particular on its inner side, has a recess which is configured to receive a sealing means and/or a complementary counterpart of the rudder carrier bearing, which is provided in particular on the bearing housing and is preferably configured as a flange projecting from the front face of the bearing housing facing the rudder trunk. The counterpart of the rudder carrier bearing is formed in such a manner that it fits positively into the recess so that a bond is made and rudder carrier bearing and trunk appear as a unit. Alternatively or additionally, a sealing means can be provided in the recess. By this means a stable integral design of rudder trunk and rudder carrier bearing with appurtenant sealing means can be provided. In the present context, sealing means can be all suitable sealing means known from the prior art, for example, elastic rubber seals or the like. The sealing means can in particular comprise seawater seals whose functionality consists in sealing the interior of the rudder carrier bearing with respect to the external lake water or sea water. Such seals are frequently located in the lower area of the rudder blade carrier bearing facing the rudder blade. Preferably no sealing means are disposed between housing base body and housing cover of the rudder carrier bearing. A seal is achieved by the contact points between housing base body and housing cover each having a bearing ring of the axial bearing, which form the contact points between housing base body and housing cover and which rest firmly on one another. Since the axial bearing is configured to be self-lubricating and

therefore requires no extra oil lubrication or similar, additional sealing means can advantageously also be dispensed with. Additional oil or lubricant seals are also fundamentally not required.

For an optimal integral configuration, it is further advantageous that the outer side surfaces of the rudder trunk and the bearing housing of the upper rudder carrier bearing are disposed flush with respect to one another and the rudder trunk and bearing housing abut directly against one another. As a result of the flush manner of formation with respect to one another, the outer surfaces of trunk and rudder carrier bearing go over into one another.

It is furthermore preferred that the radial and/or axial bearing each abut directly against the rudder post. Particularly preferably in one embodiment only the radial bearing abuts directly against the rudder post. The term "direct abutment" is to be understood such that at least one component of the particular bearing rests against the rudder post or touches this. In the case of the radial bearing, this can advantageously, for example, be the rudder post sleeve (so-called "liner") which rests firmly on the rudder post. In other words, the radial and/or the axial bearing is not located at a distance from the rudder post. By this means, a particularly compact configuration of the rudder carrier bearing can be achieved. In the carrier bearings known from the prior art, on the other hand, additional bearing or carrier bodies are frequently provided, which have the function of functionally connecting the radial and/or the axial bearing to the rudder post. These bearing or carrier bodies thereby frequently lie on the rudder post and are firmly connected to this. In turn, the radial and/or axial bearing rests on another, frequently opposite, side of the bearing or carrier body. This frequently results in relatively large carrier bearing assemblies which are complex to manufacture. Furthermore, specific connection means such as a tongue-groove connection or similar must frequently be provided for such bearing or carrier bodies. In particular, a groove or a notch will frequently need to be provided in the bearing shaft. In the configuration according to the carrier bearing according to embodiments of the invention in which the radial bearing rests directly on the rudder post, this is not necessary, at least not for both bearings (axial and

radial bearing) since a rudder sleeve can simply be firmly attached on the rudder post.

In a further preferred embodiment, when viewed in the radial direction from the rudder post or from the carrier bearing, the axial bearing is located further outwards than the radial bearing. In other words, the distance between rudder post longitudinal axis and radial bearing in the radial direction is shorter than the distance between rudder post longitudinal axial and axial bearing. Accordingly a particularly compact and technically favourable configuration or arrangement of the carrier bearing according to embodiments of the invention can be achieved.

There is further disclosed~~In addition, the object forming the basis of the invention is achieved by~~ a rudder carrier bearing kit for manufacturing an upper rudder carrier bearing for mounting a rudder post of a rudder of a watercraft, in particular a ship, which comprises a bearing housing, comprising a housing base body and a housing cover, an axial bearing comprising a first annular disk made of a metallic material, in particular stainless steel and a second annular disk made of a material comprising a solid lubricant, in particular non-metallic, a radial bearing made of a material comprising a solid lubricant, in particular non-metallic, and optionally a rudder post sleeve made of a metallic material, in particular stainless steel, and optionally a sealing means. This kit can in particular be configured to manufacture a rudder carrier bearing according to embodiments of the invention. In particular, ACM, PTFE, Thordon or Orkot® can be considered for the material of the annular disk or the bearing bush comprising a solid lubricant. In principle, the kit can be of a complete nature so that no further additional materials or components need be added for the manufacture of the rudder carrier bearing. However, the provision of further additional components is readily possible.

~~Furthermore, the object forming the basis of the invention is achieved by a~~A method for manufacturing an upper rudder carrier bearing, in which a bearing housing that comprises a first sleeve-like housing part, in particular a housing base body, and a second housing part, in particular a housing cover, is also provided. In addition, a bearing bush comprising a material having a solid lubricant, is