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(54) DEVICE FOR ROTATIONALLY DRIVING AND STEERING A STEERABLE PROPELLER OF A WATERCRAFT

(71) We, SOCIETE ANONYME FRANCAISE DU FERODO, a French Body Corporate, of 64 Avenue de la Grande Armee, Paris 17 eme, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device for rotationally driving and for steering a steerable propeller for a watercraft of the kind (herein after referred to as the "kind defined") comprising a support for mounting on a watercraft, a tubular casing mounted on the support, a steering shaft rotatably mounted in the tubular casing by means of thrust bearing means a nacelle suspended rigidly on the steering shaft, on which nacelle may be mounted a steerable propeller first drive means for rotationally driving the propeller for propelling the watercraft, and second drive means for rotating the steering shaft for altering the course steered by the watercraft.

An object of the invention is to provide a device of this kind, in which the means for driving the propeller comprises at least one hydraulic motor housed in the nacelle and connected to an hydraulic pump by a pair of oil circulation conduits which are adapted to enable the rotation of the steering shaft in the tubular casing and by means of the second drive means, which arrangement is a simple, robust, and compact construction which permits the transmission of high power.

According to one aspect of the invention there is provided a device of the kind defined hereinbefore, wherein said first drive means comprises at least one hydraulic motor housed in the nacelle, an hydraulic pump and a pair of oil circulation conduits connecting the hydraulic motor to the hydraulic pump, the conduits comprising a pair of axial ducts within the steering shaft and a pair of rotary couplings interposed between the steering shaft and the tubular casing, said second drive means being grouped with said pair of rotary couplings and said thrust bearing means and being disposed at the upper end of the steering shaft for rotating the steering shaft in the tubular casing in order to steer the propeller, the rotary couplings being disposed immediately below said second drive means and immediately above said thrust bearing means.

As the result of this arrangement the oil circulation conduits can have a large cross-section which permits the transmission of high power.

The device may further comprise centering bearing means supporting the steering shaft in the tubular casing at the bottom end of the tubular casing.

The second drive means, for rotating the steering shaft, preferably comprises a rack meshing with a toothed end portion of the steering shaft which constitutes a pinion and which is disposed immediately above the pair of rotary couplings, which themselves are disposed immediately above the thrust bearing means.

The construction is simple, robust and compact, permitting excellent operation. The diameters of the tubular casing and of the steering shaft may be relatively small. In particular a very small diameter may be selected with advantage for the pinion driven by the rack at the top of the steering shaft.

In one embodiment the hydraulic motor housed in the nacelle is coaxial to and directly connected to the propeller, while in another embodiment the hydraulic motor and the propeller have their axes parallel and spaced apart and the hydraulic motor drives the propeller through gearing.

In yet another embodiment at least two hydraulic motors are provided and, here, these motors and the propeller have their axes parallel and spaced apart, and the motors drive the propeller through planet gears and a ring gear.

The nacelle is preferably provided with a domed water guide cowling disposed upstream of the propeller. The hydraulic motor (s) is/are advantageously housed in this cowling.

When a plurality of hydraulic motors are provided, it is preferable to use a nacelle

comprising a prefabricated cowling which incorporates connection means for the hydraulic motors and with parts of the oil circulation conduits which connect these motors to the axial ducts in the steering shaft, this nacelle being provided with a fairing for the cowling which also houses transmission and bearing means.

According to a further aspect of the invention there is provided a watercraft comprising a device according to said one aspect of the invention.

Embodiments of the invention will now be described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a general view of the rear of a watercraft and shows diagrammatically a device according to the invention for rotationally driving and steering a steerable propeller;

Figure 2 is a diagrammatic view on a larger scale of the nacelle shown in Fig. 1 incorporating a hydrostatic motor;

Figure 3 is an elevation, partly in section on the line III—III in Figure 4 of the mounting of the nacelle on the steering shaft, of housing of the steering shaft in a tubular casing, and of the mounting of the tubular casing on a support;

Figure 4 is a corresponding view of the device in elevation in the direction of the arrow IV in Figure 3;

Figure 5 is a view on a larger scale of the top end of the steering shaft, in a horizontal section on the line V—V in Figure 3;

Figures 6 and 7 are views of the top end of the steering shaft in vertical sections on the line VI—VI and VII—VII respectively in Figure 5; and

Figures 8, 9 and 10 are views similar to Figure 2 of three more embodiments of a nacelle.

The embodiment illustrated in Figures 1 to 7 is a device for rotationally driving and steering a steerable propeller which can be used on watercraft of all kinds, such as boats, ships, barges, dinghies, pontoons, submersible craft or amphibious vehicles.

A watercraft V, Figure 1, comprises at the rear a chassis, Figures 1, 3 and 4, of any suitable shape, for mounting a steerable screw propeller assembly.

On the chassis is fixed a device for mounting a steerable screw propeller. Such a device is described in our co-pending British Patent Application No. 216/78 (Serial No. 1,593,441). The device comprises a support S fixed to the chassis and having vertical slide guides 11 which receive slide shoes 12 and 13. A tubular casing 14 is mounted for sliding on the slide guide 11 by means of the shoes 12 and 13. A power cylinder 15 acting between the support S and the tubular casing 14 slides the casing 14 for adjusting the depth of the nacelle and screw propeller unit 10.

In addition, the tubular casing 14 can be raised in order to bring the screw propeller and nacelle 10 out of the water for inspection and repair. For this purpose the tubular casing 14 is pivotable about the upper shoes 12 by the power cylinder 15, the lower shoes 13 being adapted to move out of the slide guides 11.

In the tubular casing 14 there is mounted a downwardly extending steering shaft 16 to the lower end 17 of which the nacelle for the screw propeller is rigidly connected.

The steering shaft 16 is centered and supported on the tubular casing 14 by means of a thrust bearing 18, Figures 3 and 6 at the top of the casing 14, and a centering bearing 19 at the bottom of the casing 14, (Figure 3).

The nacelle comprises a frame 20 which is fastened to the bottom end 17 of the shaft 16 and is provided with bearings 21. A rotatable shaft 22 is mounted in the bearings 21 and carries a screw propeller 23 disposed at the rear of the nacelle. The nacelle also includes a domed water guide cowling 24 mounted upstream of the screw 23.

A first drive means is provided for rotationally driving the screw 23 to propel the craft V.

The first drive means comprises as shown in Figure 2, an hydraulic motor 25 housed in the water guide cowling 24 of the nacelle 10. The hydraulic motor 25 is coaxial with the screw 23 and is directly coupled with the screw by means of a splined connection 26.

The hydraulic motor 25 is connected by a pair of oil circulation conduits 27 and 28 to an hydraulic pump 29 housed on board the craft V and driven by an engine M, for example a diesel engine.

The pair of conduits 27 and 28 comprises portions 27A and 28A, Figure 2, disposed in the nacelle portions 27B and 28B, Figure 7, consisting of axial ducts provided inside the steering shaft 16; rotary couplings 27C and 28C, Figure 7, interposed between the steering shaft 16 and the tubular casing 14; and portions 27D and 28D in the form of pipes, Figures 1 and 7, which extend between the tubular casing 14 and the hydraulic pump 29 and which pipes are at least partly deformable, for example flexible or articulated, in order to be adjustable to both sliding and pivoting displacement of the tubular casing 14 relative to the support S.

The axes X and Y of the ducts 27B and 28B inside the steering shaft 16, Figure 5, extend parallel to and on each side of the axis Z of the steering shaft 16. The plane P, Figures 1 and 5, defined by the axes X, Y, Z is perpendicular to the axis W of the screw 23, Figure 1. The plane P constitutees a neutral dimetrical plane of the shaft 16 when the shaft 16 flexes during operation.

In the embodiment illustrated the ducts 27B and 28B, Figure 7 comprise tubes 30 and 31 housed inside the shaft 16, which is hollow

over the major portion 32 of its length, and bores 33 and 34 in the upper end portion 35 of the shaft 16, which is solid. The ducts 27B and 28B have a large diameter, thus enabling high power transmission.

The rotary couplings 27C and 28C, Figures 6 and 7, consist of annular grooves provided one above the other in the tubular casing 14 and surrounding the solid upper end portion of the shaft 16, in such a manner as to be in permanent communication with the bores 33 and 34. The grooves 27C and 28C are connected respectively to the portions 27D and 28D of the conduits 27 and 28.

A second drive means is provided for rotating the steering shaft 16 in the tubular casing 14 for altering the coourse steered by the vehicle V.

The second drive means, Figures 5 and 6, comprises a rack 36 meshing with a toothed end 37 of the solid upper end portion 35 of the shaft 16, which forms a pinion. The rack 36 is driven hydraulically and is formed by a plunger piston engaged slidingly in a cylinder 38. Hydraulic chambers 39 and 40 are provided in the cylinder 38 on each side of the piston 36 for operating the piston.

As can be seen in Figure 6, the rotary couplings 27C and 28C, the second drive means 36, 37, and the thrust bearing 18 are grouped together in a compact arrangement at the upper end portion 35 of the steering shaft 16.

The pinion 37 is disposed immediately above the grooves 27C and 28C, which are disposed immediately above the thrust bearing 18.

The diameter of the pinion 37 may be selected so as to be as small as desired having regard to the position which it occupies.

An oil leakage collector duct 45 is shown in Figure 6.

During operation the motor M drives the hydraulic pump 29, which by circulation of oil through the conduits 27 and 28 drives the hydraulic motor 25, which drives the screw 23 and thus propels the craft V. In order to change the course steered, the hydraulic chambers 39 and 40 are acted on so as to cause the rack 36 to slide and the shaft 16 carrying the unit 10 to turn.

In the embodiment which has just been described with reference to Figures 1 to 7 the hydraulic motor 25 is coaxial with and directly coupled to the screw 23.

An alternative is illustrated in Figure 8. The hydraulic motor 25 and the screw 23 have their axes U and W parallel, but spaced apart. The motor 25 is housed in the cowling 24 and drives the screw 23 through a gear train 41.

In another embodiment, illustrated in Figure 9, at least two hydraulic motors 25′ and 25″ are provided, and are housed in the cowling 24. The axes U′ and U″ of the motors 25′ and 25″ and the axis W of the screw 23 are parallel and spaced apart. The motors 25′ and 25″ drive the screw 23 through planet gears 43 and a ring gear 42.

It is sometimes advantageous to provide a prefabricated form of cowling 24 as shown in Figure 10, in which the portions 27A and 28A of the conduits 27 and 28 are provided in the form of passages, a rear fairing 45 is provided which has a partition 44 adapted to receive bearings 46 for the hydraulic motors 25′ and 25″, and another partition 47 is adapted to receive bearings 48 for the motors 25′ and 25″, as well as the ring gear 42.

All that is then required is to install the rotating parts, that is to say the motors 25′ and 25″ and pinions 43.

WHAT WE CLAIM IS:—

1. A device of the kind defined hereinbefore, wherein said first drive means comprises at least one hydraulic motor housed in the nacelle, an hydraulic pump and a pair of oil circulation conduits connecting the hydraulic motor to the hydraulic pump, the conduits comprising a pair of axial ducts within the steering shaft and a pair of rotary couplings interposed between the steering shaft and the tubular casing, said second drive means being grouped with said pair of rotary couplings and said thrust bearing means and being disposed at the upper end of the steering shaft for rotating the steering shaft in the tubular casing in order to steer the propeller, the rotary couplings being, disposed immediately below said second drive means and immediately above said thrust bearing means.

2. A device according to Claim 1, further comprising centering bearing means supporting the steering shaft in the tubular casing at the bottom end of the tubular casing.

3. A device according to Claim 1 or 2, wherein the second drive means comprises a rack meshing with a toothed end portion of the steering shaft, which forms a pinion.

4. A device according to any preceding claim, wherein said hydraulic motor has a drive shaft which is parallel to the rotational axis of the steerable propeller and spaced therefrom and gear means connect the hydraulic motor to the steerable propeller.

5. A device according to any preceding claim comprising at least two said hydraulic motors housed in the nacelle, which motors have parallel drive shafts which are parallel to the rotational axis of the steerable propeller in and are spaced therefrom, and planet gears and a ring gear connecting the hydraulic motors to the propeller.

6. A device according to Claim 5, wherein the nacelle comprises a dome-shaped water guide cowling disposed upstream of the propeller and the hydraulic motors are housed in the cowling.

7. A device according to Claim 6, wherein

over the major portion 32 of its length, and bores 33 and 34 in the upper end portion 35 of the shaft 16, which is solid. The ducts 27B and 28B have a large diameter, thus enabling high power transmission.

The rotary couplings 27C and 28C, Figures 6 and 7, consist of annular grooves provided one above the other in the tubular casing 14 and surrounding the solid upper end portion of the shaft 16, in such a manner as to be in permanent communication with the bores 33 and 34. The grooves 27C and 28C are connected respectively to the portions 27D and 28D of the conduits 27 and 28.

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As can be seen in Figure 6, the rotary couplings 27C and 28C, the second drive means 36, 37, and the thrust bearing 18 are grouped together in a compact arrangement at the upper end portion 35 of the steering shaft 16.

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In the embodiment which has just been described with reference to Figures 1 to 7 the hydraulic motor 25 is coaxial with and directly coupled to the screw 23.

An alternative is illustrated in Figure 8. The hydraulic motor 25 and the screw 23 have their axes U and W parallel, but spaced apart. The motor 25 is housed in the cowling 24 and drives the screw 23 through a gear train 41.

In another embodiment, illustrated in Figure 9, at least two hydraulic motors 25′ and 25″ are provided, and are housed in the cowling 24. The axes U′ and U″ of the motors 25′ and 25″ and the axis W of the screw 23 are parallel and spaced apart. The motors 25′ and 25″ drive the screw 23 through planet gears 43 and a ring gear 42.

It is sometimes advantageous to provide a prefabricated form of cowling 24 as shown in Figure 10, in which the portions 27A and 28A of the conduits 27 and 28 are provided in the form of passages, a rear fairing 45 is provided which has a partition 44 adapted to receive bearings 46 for the hydraulic motors 25′ and 25″, and another partition 47 is adapted to receive bearings 48 for the motors 25′ and 25″, as well as the ring gear 42.

All that is then required is to install the rotating parts, that is to say the motors 25′ and 25″ and pinions 43.

WHAT WE CLAIM IS:—

1. A device of the kind defined hereinbefore, wherein said first drive means comprises at least one hydraulic motor housed in the nacelle, an hydraulic pump and a pair of oil circulation conduits connecting the hydraulic motor to the hydraulic pump, the conduits comprising a pair of axial ducts within the steering shaft and a pair of rotary couplings interposed between the steering shaft and the tubular casing, said second drive means being grouped with said pair of rotary couplings and said thrust bearing means and being disposed at the upper end of the steering shaft for rotating the steering shaft in the tubular casing in order to steer the propeller, the rotary couplings being, disposed immediately below said second drive means and immediately above said thrust bearing means.

2. A device according to Claim 1, further comprising centering bearing means supporting the steering shaft in the tubular casing at the bottom end of the tubular casing.

3. A device according to Claim 1 or 2, wherein the second drive means comprises a rack meshing with a toothed end portion of the steering shaft, which forms a pinion.

4. A device according to any preceding claim, wherein said hydraulic motor has a drive shaft which is parallel to the rotational axis of the steerable propeller and spaced therefrom and gear means connect the hydraulic motor to the steerable propeller.

5. A device according to any preceding claim comprising at least two said hydraulic motors housed in the nacelle, which motors have parallel drive shafts which are parallel to the rotational axis of the steerable propeller in and are spaced therefrom, and planet gears and a ring gear connecting the hydraulic motors to the propeller.

6. A device according to Claim 5, wherein the nacelle comprises a dome-shaped water guide cowling disposed upstream of the propeller and the hydraulic motors are housed in the cowling.

7. A device according to Claim 6, wherein

the cowling is prefabricated with connection means for the hydraulic motors and with parts of said conduits for connecting said motors to said axial ducts within the steering shaft, and the cowling also houses transmission and bearing means, the nacelle further comprising a fairing for the cowling.

8. A device according to any preceding claims, wherein said pair of rotary couplings comprise two annular grooves formed one above the other in the tubular casing and surrounding the steering shaft in such manner as to be in permanent communication with said pair of axial ducts within the steering shaft, and means connecting said grooves to pipes constituting portions of said oil circulation conduits which extend between the tubular casing and the hydraulic pump.

9. A device for rotationally driving and for steering a steerable propeller for a watercraft, substantially as hereinbefore described with reference to Figures 1 to 7, or Figures 1 to 7 modified as described with reference to Figure 8, Figure 9, or Figure 10 of the accompanying drawings.

10. A watercraft comprising a device as claimed in any of Claims 1 to 9.

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