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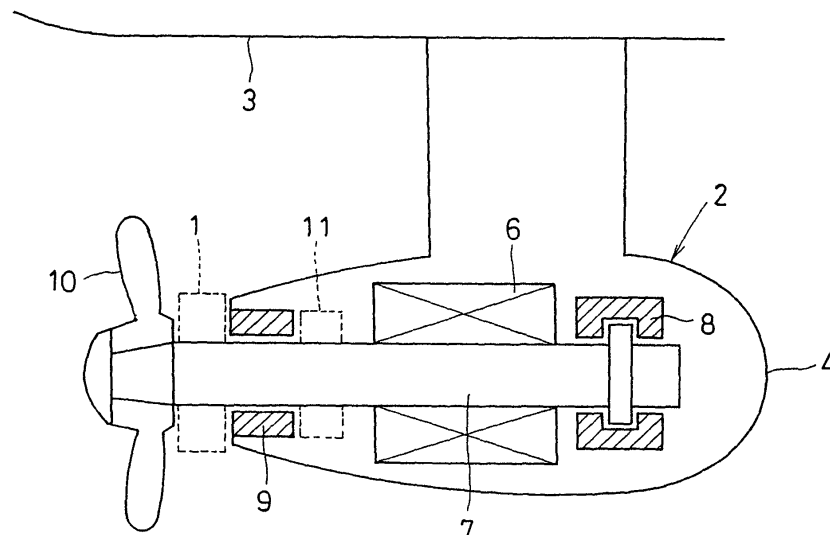
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(54) **Sealing device for pod propeller propulsion systems**

(57) A sealing device for pod propeller propulsion systems according to the present invention comprises: a pod (4) provided on a structure (3) floating on the water so as to rotate freely about a vertical axis; a cylindrical casing (5) connected to the rear-side of the pod (4); a propeller shaft (7) inserted coaxially into the casing (5) and connected to an electric motor (6) disposed in the pod (4); a plurality of seal rings (12, 13, 14, 15) in sliding

contact with the outer periphery of the shaft (7) for sealing outside water (W); first air supplying means (26) for supplying compressed air into an air chamber (20) defined between a pair of adjacent seal rings (13, 14) out of the plurality of seal rings (12, 13, 14, 15); and second air supplying means (27) for supplying compressed air having air pressure higher than air pressure (P1) in the air chamber (20) and varying corresponding to variations in draft pressure (P) into the pod (4).

FIG.1



Description

[0001] The present invention relates to a sealing device for pod propeller propulsion systems.

[0002] In recent years, a pod propeller propulsion system in which an electrical power generated by a diesel engine in the hull is transformed into an electric signal by an electric system, and the signal is transmitted to an electric motor in the pod rotatably mounted on the stern of the hull by means of a wire, so that the propeller is rotated by a propeller shaft connected to the motor (for example, "AZIPOD", a product of ABB Azipod) has been a focus of attention. Since the pod is freely rotatable outside the hull, this system has various advantages such that a steering apparatus is not necessary and the steerage is improved; that inboard noise and vibration can be reduced because it is electrically propelled; that the variation of design such as to dispose the engine on the bow-side of the hull expands; and the like.

[0003] Even in such a pod propeller propulsion system, a sealing device is required as a matter of course. The sealing device employed in this case comprises a pod provided at the stern of the hull in such a manner that it is able to rotate freely about the vertical axis, a cylindrical casing connected to the pod on the stern-side of the hull, a propeller shaft coaxially inserted into the casing and connected to the electric motor disposed in the pod, and a plurality of seal ring to be brought into sliding contact with the outer periphery of the shaft to seal off outside water.

[0004] Recently, there is a problem in that increase in draft pressure in association with upsizing of marine vessels promotes early damage of the seal ring, which may cause outboard leakage of lubricant and accordingly results in environmental pollution.

[0005] Therefore, as a stern tube sealing device employed in a normal marine vessel propulsion system other than the above-described pod propeller propulsion system, an air-seal stern tube sealing device in which sliding load on the lip of the seal ring is lowered to improve durability of the seal ring by supplying compressed air to an air chamber defined between an adjacent pair of seal rings out of a plurality of seal rings to constantly blow off air from the chamber toward outboard water (See Japanese Examined Utility Model Publication No. 35249/1993, and Japanese Unexamined Patent Application Publication No. 304005/1999), or by supplying compressed air having air pressure which varies corresponding to variation in draft pressure and is lower than the draft pressure by a predetermined pressure difference into the air chamber (See Japanese Patent Publication No.2778899) is known.

[0006] In the pod propeller propulsion system of the related art, it is necessary to solve the problem that when the draft pressure increases with upsizing of the marine vessel, the seal ring may be damaged at an early stage and accordingly lubricant leaks outboard, which may result in environmental pollution. Therefore, it is be-

lieved that the durability of the seal ring is improved by adopting the above-described air-seal stern tube sealing device employed in the normal marine vessel propulsion system to the rear portion of the pod that constitutes the pod propeller propulsion system.

[0007] However, since an electric motor that has a weakness for water, a radial bearing that is apt to corrode due to sea water, and the like are stored in the pod of the pod propeller propulsion system, the pod propeller propulsion system may be fatally damaged with mere adoption of the conventional air-seal stern tube sealing device to the rear portion of the pod.

[0008] In other words, when the air chamber defined at the rear portion of the pod is applied with pressure to the extent that allows a jet of air to blow off therefrom, or that is slightly lower than the draft pressure, compressed air can easily be blown off from the seal ring on the front-side (closer side to the pod) that constitutes the chamber into the pod. Therefore, there may arise another problem that outside water entered into the air chamber leaks together with compressed air into the pod, which may increase the possibility of breakdown of the electric motor or corrosion of the radial bearing.

[0009] In view of such circumstances, it is an object of the present invention to provide an air-seal type sealing device for pod propeller propulsion systems, wherein compressed air can be supplied to an air chamber provided on the rear-side of a pod while effectively preventing leakage of outside water into the pod, so that durability of the seal ring is increased without breakdown or corrosion of internal equipment in the pod.

[0010] In order to achieve the above-described object, the present invention devises following technical means.

[0011] The present invention provides a sealing device for pod propeller propulsion system comprising first air supplying means for supplying compressed air into an air chamber defined between an adjacent pair of seal rings out of a plurality of seal rings, and second air supplying means for supplying compressed air having air pressure higher than that in the air chamber and varying corresponding to variations in draft pressure into a pod.

[0012] According to the present invention, since the first air supplying means supplies compressed air into the air chamber in a casing connected to the rear-side of the pod, the sliding load on the lips of the seal rings for defining the air chamber is reduced, thereby improving durability of the seal ring.

[0013] On the other hand, since the second air supplying means supplies compressed air having air pressure higher than that in the air chamber and varying corresponding to variations in draft pressure into the pod, even when outside water enters into the air chamber because of the sliding load on the lips of the seal rings is reduced as described above, outside water is effectively prevented from being leaked into the pod.

[0014] Therefore, according to the present invention, the sliding load acting upon the lips of the seal rings can

be reduced by supplying compressed air to the air chamber provided on the rear-side of the pod by means of the first air supplying means while effectively preventing outside water from leaking into the pod by means of the second air supplying means, and thus the durability of the seal ring can be increased without breakdown or corrosion of the internal equipment of the pod.

[0015] The preferred embodiments of the present invention will now be described according to the contents of the dependent claims.

[0016] In the present invention, in order to ensure improvement of the lifetime of the seal ring, it is necessary to lubricate the lip of the seal ring by lubricating material such as grease, lubricant, or the like.

[0017] Therefore, it is recommended to construct a lubricant chamber between the seal ring on the front-side out of a pair of seal rings for defining the air chamber and a next seal ring located further on the front-side and provide liquid supplying means for supplying a liquid lubricant into the lubricant chamber.

[0018] When such a liquid supplying means is provided, since a liquid lubricant or outside water may leak into the air chamber, it is preferred to connect a drain circuit with the air chamber for collecting them within the pod or a structure to which the pod is mounted.

[0019] On the other hand, in order to keep the seal ring on the rear-side (farther side from the pod) out of a pair of seal ring for defining the air chamber lubricated, it is preferred that a lubricant chamber defined between the seal ring and a seal ring located further on the rear-side is filled with lubricant highly viscous to the extent that it cannot be blown off outside the casing even by compressed air injected from the air chamber.

[0020] In this case, since lubricant in the lubricant chamber positioned on the rear-side of the air chamber has a high viscosity to the extent that it cannot be blown off outside the casing, even when the pressure of compressed air is increased to the extent that air is blown out from the air chamber, the lubricant is prevented from being scattered out of the casing and thus environmental pollution can be prevented in advance. When lubricant filled in the lubricant chamber is highly viscous as described above, it is not necessary to add another seal ring on the rear-side for preventing oil leakage, whereby the axial dimension of the sealing device may be reduced.

[0021] In the present invention, when employing the sealing device of the type that blows off compressed air through the seal ring, the first air supplying means comprising a first compressed air source, an air control unit for setting the pressure of compressed air from the compressed air source to the extent that air is blown off outside of the casing from the seal ring on the rear-side out of a pair of seal rings that define the air chamber, and an air piping for conducting the compressed air passed through the air control unit to the air chamber may be employed.

[0022] In this case, since air is regularly blown off from

the air chamber, by employing a second air supplying means comprising a second compressed air source, an air relay for setting the air pressure of the compressed air from the second compressed air source to a predetermined output pressure with the air pressure in the air piping as a pilot pressure, and a pressurizing piping for applying the output pressure set at the air relay to the interior of the pod, and by setting the output pressure of the air relay slightly higher than the air pressure in the air chamber, compressed air having air pressure higher than that in the air chamber and varying corresponding to variations in draft pressure can be supplied into the pod.

[0023] In the present invention, when employing the sealing device of the type that the air pressure in the air chamber can be varied, the first air supplying means comprising a first compressed air source, an air control unit for setting pressure of compressed air from the compressed air source to a predetermined pressure and flow rate, a detecting piping for blowing off the compressed air passed through the air control unit directly to outside water without passing through the seal ring to detect the draft pressure, a first air relay for setting pressure of compressed air from the first compressed air source to predetermined output pressure corresponding to the air pressure in the detecting piping as a pilot pressure, and an air piping for applying the output pressure predetermined at the first air relay into the air chamber may be employed.

[0024] In this case, by setting the output pressure of the first air relay to a value higher than the air pressure in the detecting piping by the pressure corresponding to a tightening force of the garter spring, the air pressure of the air chamber can be set to the extent that air is blown off therefrom. On the other hand, when the output pressure of the first air relay is set to almost the same value as the air pressure in the detecting piping or slightly lower than that value, compressed air is not blown off from the air chamber and, hence, outboard leakage of the liquid lubricant out of the casing in association with its blowoff may be prevented in advance, and advantageously, the amount of air consumption may be reduced as low as possible.

[0025] In this case, since it is possible to carry out control in which air is not always blown off from the air chamber, compressed air having air pressure higher than that in the air chamber and varying corresponding to variations in draft pressure can be supplied into the pod by employing the second air supplying means comprising a second compressed air source, a second air relay for setting pressure of compressed air from the second compressed air source to a predetermined output pressure corresponding to the air pressure in the detecting piping as a pilot pressure, and a pressurized piping for applying the output pressure set at the second air relay into the pod, and by setting the output pressure of the second air relay slightly higher than the air pressure in the air chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a schematic side view of the pod propeller propulsion system according to the first embodiment;

Fig. 2 is a cross sectional side view of the sealing device according to the first embodiment;

Fig. 3 is a cross sectional view in the casing for illustrating a modification of the second lubricant chamber; and

Fig. 4 is a cross sectional side view of the sealing device according to the second embodiment.

[0027] Referring now to the drawings, the embodiment of the present invention will be described.

[0028] Figs. 1 to 3 show a first embodiment of a sealing device 1 according to the present invention.

[0029] As shown in Fig. 1, the sealing device 1 of this embodiment is designed for a pod propeller propulsion system 2. The propulsion system 2 comprises a pod 4 provided at a stern of a hull 3 as an example of a structure floating on the water so as to rotate freely about a vertical axis, a cylindrical casing 5 connected to the rear-side of the pod 4, and a propeller shaft 7 inserted coaxially into the casing 5 and connected to an electric motor 6 disposed in the pod 4.

[0030] The end of the shaft 7 on the front-side (right end in Fig. 1) is supported by a thrust bearing 8 disposed at the front portion of the pod 4 so as to rotate freely but not to move in the axial direction, and the end of the shaft 7 on the rear-side (left end in Fig. 1) is supported by a radial bearing 9 disposed at the rear end of the pod 4 so as to rotate freely. The end of the shaft 7 on the rear-side projects outside the pod 4, and a propeller 10 is fixed on the projected end.

[0031] The sealing device 1 of this embodiment is an external sealing device disposed outside the pod 4 on the rear-side thereof, while between the radial bearing 9 and the motor 6 in the pod 4 an internal sealing device 11 is provided.

[0032] As shown in Fig. 2, the sealing device 1 described above comprises the pod 4 provided at the stern of the hull 3 so as to rotate freely about the vertical axis, the cylindrical casing 5 connected to the rear-side of the pod 4, the propeller shaft 7 inserted coaxially into the casing 5 and connected to the electric motor 6 disposed in the pod 4, and a plurality of seal rings 12-15 in sliding contact with the outer periphery of the shaft 7 for sealing outside water W.

[0033] The propeller shaft 7 comprises a shaft body 16 connected directly to the motor 6, and a cylindrical liner 17 mounted on the axial portion of the shaft body 16 corresponding to the casing 5, wherein the lip of each seal ring 12-15 having a proximal end fixed on the inner peripheral surface of the casing 5 is in sliding contact with the outer peripheral surface of the liner 17.

[0034] The shaft 7 may be constructed only of the shaft body 16, without providing the liner 17.

[0035] In this embodiment, there are provided four seal rings 12-15 in total for defining an air chamber 20 within the casing 5 and lubricant chambers 21, 22 on the rear side and front side thereof.

[0036] The first seal ring 12 disposed at the rearmost position (left side in Fig. 2) and the second seal ring 13 disposed next to the first ring on the front-side are oriented in such a manner that the tip edges of the lips face toward the rear-side. The third seal ring 14 that is disposed at the third rearmost position and the fourth seal ring 15 disposed next to the third seal ring 14 on the front-side are oriented in such a manner that the tip edges of the lips thereof face toward the front-side (right side in Fig. 2). The lips of the seal rings 12-15 are all wound with ring-shaped garter springs 23 respectively.

[0037] The chamber defined between the second seal ring 13 and the third seal ring 14 is used as an air chamber 20 the inside of which is pressurized by compressed air, and a chamber defined between the second seal ring 13 which is the rear-side one of a pair of seal rings 13, 14 defining the air chamber 20 and the first seal ring 12 that is disposed further on the rear-side thereof is used as the first lubricant chamber 21 which is to be filled with a high viscosity lubricant 24.

[0038] In other words, the first lubricant chamber 21 is filled with the lubricant 24 formed of grease or the like that is highly viscous to the extent that it cannot be blown off outside the casing even by compressed air blown off from the air chamber 20.

[0039] A chamber defined between the third seal ring 14 which is the front-side one of a pair of seal rings 13, 14 defining the air chamber 20 and the fourth seal ring 15 disposed further on the front-side thereof is used as the second lubricant chamber 22 which is filled with a liquid lubricant 25 having sufficient fluidity by liquid supplying means 37 described later.

[0040] The sealing device 1 of this embodiment comprises a first air supplying means 26 for supplying compressed air into the air chamber 20, and a second air supplying means 27 for supplying compressed air having air pressure higher than the air pressure P1 in the air chamber 20 and varying corresponding to variations in draft pressure P into the pod 4.

[0041] The first air supplying means 26 comprises a first compressed air source 28 including a compressor and the like disposed in the hull 3, an air control unit 29 for setting pressure of compressed air from the first compressed air source 28 to the extent that air is blown off outside the casing from the second seal ring 13 on the rear-side out of a pair of seal rings 13, 14 defining the air chamber 20, and an air piping 30 introducing compressed air passed through the air control unit 29 to the air chamber 20.

[0042] The air control unit 29 is provided with a pressure reducing valve 31 and a flow regulating valve 32 connected at a downstream side thereof. In this embod-

iment, the first compressed air source 28 supplying compressed air of 7-8 (kg/cm²) is used and then the air pressure is reduced by the pressure reducing valve 31 to about 2-3 (kg/cm²). Concurrently, the flow rate of compressed air is set to approximately 10-40 (NI/min.) by the flow regulating valve 32 to supply compressed air at a constant flow rate to the air chamber 20, so that compressed air is regularly blown off outside the casing from the lip of the second seal ring 13.

[0043] Since the tightening force of the garter spring 23 of the seal ring 13 is generally 0.1 (kg/cm²), the air pressure P₁ in the air chamber 20 is set to P+0.1 (kg/cm²) by the blowoff of compressed air described above, where the draft pressure at the center of the propeller shaft 7 of outside water W is P (kg/cm²), and thus the air pressure P₁ is controlled to vary corresponding to variations of the draft pressure P with regularly keeping a level higher than the draft pressure P by a constant pressure difference.

[0044] On the other hand, the second air supplying means 27 comprises a second compressed air source 34 including a compressor and the like disposed in the hull 3, an air relay 35 for setting pressure of compressed air from the second compressed air source 34 to a predetermined output pressure with the air pressure in the air piping 30 as a pilot pressure, and a pressurizing piping 36 for applying the output pressure set at the air relay 35 to the interior of the pod 4.

[0045] Therefore, by setting the output pressure of the air relay 35 slightly higher than the air pressure P₁ in the air chamber 20, compressed air having air pressure higher than the air pressure P₁ in the air chamber 20 and varying corresponding to variations in draft pressure P can be supplied into the pod 4.

[0046] In this embodiment, the output pressure of the air relay 35 is set to a value 0.2 (kg/cm²) higher than the pilot pressure, and thus the pressure in the pod 4 can be maintained at $P_1 + 0.2(\text{kg/cm}^2) = P + 0.3(\text{kg/cm}^2)$, in other words, at a pressure constantly 0.3(kg/cm²) higher than the draft pressure P.

[0047] The sealing device 1 of this embodiment comprises the liquid supplying means 37 including an oil pump and the like for supplying the liquid lubricant 25 into the second lubricant chamber 22, and a drain circuit 38 connected to the air chamber 20 for collecting the liquid lubricant 25 leaked into the air chamber 20 during the supply thereof or outside water W within the pod 4 or the hull 3. The drain circuit 38 is constructed of a discharge pipeline 39 connected to the air chamber 20, and a drain tank 40 disposed in the hull 3 or the pod 4.

[0048] The liquid supplying means 37 may be constructed to pump the liquid lubricant 25 little by little at a constant flow rate, or to pump the liquid lubricant 25 intermittently at constant intervals. Though the drain tank 40 and the liquid supplying means 37 may be disposed in the pod 4 if it has any room for them, it is preferable to dispose them in the hull 3 so that the pod 4 can be miniaturized.

[0049] The operation of the sealing device 1 in the above-described construction will now be described.

[0050] In this embodiment, since the first air supplying means 26 supplies compressed air into the air chamber 20 in the casing 5 that is connected to the rear side of the pod 4, the sliding load on the lips of the respective seal rings 13, 14 defining the air chamber 20 is reduced, thereby improving durability of the seal rings 13, 14. Especially, in this embodiment, since compressed air is regularly blown off from the second seal ring 13, the lip of the ring 13 is hardly brought into sliding contact with the outer peripheral surface of the propeller shaft 7, thereby significantly increasing the lifetime of the second seal ring 13.

[0051] On the other hand, since the second air supplying means 27 is constructed to supply compressed air having air pressure higher than the air pressure P₁ in the air chamber 20 and varying corresponding to variations in draft pressure P in the pod 4, even when outside water W enters into the air chamber 20 by reducing the sliding load on the lips of the seal rings 13, 14 as described above, further leakage of outside water W into the pod 4 is effectively prevented.

[0052] As is described thus far, according to the sealing device 1 of this embodiment, the sliding load on the lips of the seal rings 13, 14 may be reduced by supplying compressed air into the air chamber 20 disposed on the rear side of the pod 4 by the first air supplying means 26 while effectively preventing leakage of outside water W into the pod 4 by means of the second air supplying means 27. Therefore, durability of the seal rings 13, 14 may be improved without inducing breakdown or corrosion of the internal equipment of the pod 4.

[0053] According to this embodiment, since the liquid supplying means 37 for supplying the liquid lubricant 25 into the second lubricant chamber 22 is provided and the drain circuit 38 is connected to the air chamber 20, even when the liquid lubricant 25 or outside water W leaks into the air chamber 20, they can be collected within the hull. Therefore, the seal ring 14 may be maintained in a lubricated state while preventing environmental pollution in association with the blowoff of the liquid lubricant 25 outside the casing.

[0054] In addition, in this embodiment, since the lubricant 24 in the first lubricant chamber 21 is highly viscous to the extent that it cannot be blown off outside the casing, the lubricant 24 is prevented from being scattered outside the casing even when the pressure of compressed air is increased to the extent that air is blown off from the air chamber 20, and thus environmental pollution may be prevented in advance. In addition, the axial dimension of the sealing device 1 may be reduced since it is not necessary to provide an additional seal ring on the rear-side for preventing oil leakage.

[0055] Fig. 3 shows a modification of the second lubricant chamber 22.

[0056] In this modification, the fourth seal ring 15 constituting the second lubricant chamber 22 is disposed in

such a manner that the tip edge of the lip thereof faces toward the rear-side. In this case, since the second lubricant chamber 22 is defined between a pair of seal rings 14 and 15 the tip edges of the lips of which face with each other, leakage of the liquid lubricant 25 into the pod 4 may be prevented more effectively.

[0057] As a matter of course, in this construction, it is necessary to provide a safety valve 41 on the second lubricant chamber 22 to prevent the internal pressure of the second lubricant chamber 22 from increasing too much due to a pressure force of the liquid supplying means 37. In this case, the relief pressure of the safety valve 41 should be set to a level approximately 0.2 (kg/cm²) higher than the air pressure P2 in the pod 4.

[0058] Fig. 4 is a second embodiment of the sealing device 1 according to the present invention.

[0059] The major difference between the first embodiment and the second embodiment is that the first embodiment is constructed to blow off compressed air through the seal ring, while the second embodiment is constructed in such a manner that the air pressure in the air chamber can be varied by blowing off compressed air toward outside water without passing through the seal ring. Other structures are almost the same.

[0060] Therefore, only the points that differ from the first embodiment are focused here, and the members of the same construction or the same operation are designated by the same reference numerals and not described here again.

[0061] As shown in Fig. 4, the first air supplying means 26 of this embodiment comprises a first compressed air source 43 including a compressor and the like disposed in the hull 3, and an air control unit 44 for setting pressure of compressed air from the compressed air source 43 to a predetermined pressure and a flow rate, a detecting piping 45 for blowing off compressed air passed through the air control unit 44 directly toward outside water W without passing through the seal rings 12, 13 to detect the draft pressure P, a first air relay 46 for setting pressure of compressed air from the first compressed air source 43 to a predetermined output pressure with the air pressure in the detecting piping 45 as a pilot pressure, and an air piping 47 for applying the output pressure predetermined at the first air relay 46 into the air chamber 20.

[0062] The air control unit 44 of this embodiment comprises a pressure reducing valve 48, a flow regulating valve 49 connected at the downstream side thereof, and the first air relay 46. While the discharge port of the detecting piping 45 is disposed at the proximal portion of the casing 5 in the figure, the discharge port may be disposed on the pod 4 or the hull 3.

[0063] In the first air supplying means 43 described above, by setting the output pressure of the first air relay 46 to a value higher than the air pressure in the detecting piping 45 by a pressure corresponding to a tightening force of the garter spring 23, the air pressure of the air

chamber 20 can be set to the extent that compressed air is blown off therefrom as in the case of the first embodiment.

[0064] According to the first air supplying means 43 of this embodiment, the output pressure of the first air relay 46 may be set to almost the same value as the air pressure in the detecting piping 45 or slightly lower than that value. In this case, since compressed air is not blown off from the air chamber 20, leakage of the liquid lubricant 25 out of the casing in association with its blow-off may be prevented in advance, and advantageously, the amount of air consumption may be reduced as low as possible.

[0065] On the other hand, the second air supplying means 27 comprises a second compressed air source 50 including a compressor and the like disposed in the hull 3, a second air relay 51 for setting pressure of compressed air from the second compressed air source 50 to a predetermined output pressure with the air pressure in the detecting piping 45 as a pilot pressure, and a pressurized piping 52 for applying the output pressure set at the second air relay 51 into the pod 4.

[0066] Therefore, according to the second air supplying means 27, by setting the output pressure of the second air relay 52 to a value slightly higher than the air pressure P1 in the air chamber 20, compressed air having air pressure higher than the air pressure P1 in the air chamber 20 and varying corresponding to variations in the draft pressure P may be supplied into the pod 4.

[0067] The present invention is not limited to the respective embodiments described above, and various modifications are possible. For example, the construction in which the first seal ring 12 is omitted and thus the first lubricant chamber 21 is not provided is also applicable.

[0068] It should be noted that the pod propeller propulsion system 2 provided on the stern portion of the hull 3 as described above may be provided also on the bow portion or central portion of the hull 3, or various structures floating on the water including an excavation plant of offshore oil fields, floating aerodromes, and the like.

[0069] As is described thus far, according to the present invention, since compressed air can be supplied to the air chamber provided at the rear portion of the pod while effectively preventing outside water from being leaked into the pod, durability of the seal ring may be improved without inducing breakdown or corrosion of the internal equipment of the pod.

[0070] The present invention relates to a sealing device, which can be utilized to seal around the shaft of the pod propeller propulsion system provided at the rear portion of the hull so as to rotate freely about the vertical axis.

[0071] A sealing device for pod propeller propulsion systems according to the present invention comprises: a pod (4) provided on a structure (3) floating on the water so as to rotate freely about a vertical axis; a cylindrical

casing (5) connected to the rear-side of the pod (4); a propeller shaft (7) inserted coaxially into the casing (5) and connected to an electric motor (6) disposed in the pod (4); a plurality of seal rings (12, 13, 14, 15) in sliding contact with the outer periphery of the shaft (7) for sealing outside water (W); first air supplying means (26) for supplying compressed air into an air chamber (20) defined between a pair of adjacent seal rings (13, 14) out of the plurality of seal rings (12, 13, 14, 15); and second air supplying means (27) for supplying compressed air having air pressure higher than air pressure (P1) in the air chamber (20) and varying corresponding to variations in draft pressure (P) into the pod (4).

Claims

1. A sealing device for pod propeller propulsion systems, comprising:

a pod (4) provided on a structure (3) floating on the water so as to rotate freely about a vertical axis;
 a cylindrical casing (5) connected to the rear-side of the pod (4);
 a propeller shaft (7) inserted coaxially into the casing (5) and connected to an electric motor 6 disposed in the pod (4); and
 a plurality of seal rings (12, 13, 14, 15) in sliding contact with the outer periphery of the shaft (7) for sealing outside water (W);

characterized in that the sealing device further comprising:

first air supplying means (26) for supplying compressed air into an air chamber (20) defined between a pair of adjacent seal rings (13, 14) out of the plurality of seal rings (12, 13, 14, 15); and
 second air supplying means (27) for supplying compressed air having air pressure higher than air pressure (P1) in the air chamber (20) and varying corresponding to variations in draft pressure (P) into the pod (4).

2. A sealing device for pod propeller propulsion system as set forth in Claim 1, further comprising:

liquid supplying means (37) for supplying a liquid lubricant (25) into a lubricant chamber (22) defined between the front-side seal ring (14) out of the pair of seal rings (13, 14) for defining the air chamber (20) and the seal ring (15) that is disposed further on the front side; and

a drain circuit (38) connected to the air chamber (20) for collecting the liquid lubricant (25) or outside water (W) leaked into the air chamber (20) within the structure (3).

3. A sealing device for pod propeller propulsion system as set forth in Claim 1 or Claim 2, wherein a lubricant (24) having a high viscosity to the extent that it cannot be blown off outside the casing (5) even by compressed air blown off from the air chamber (20) is filled in the lubricant chamber (21) defined between the rear-side seal ring (13) out of the pair of seal rings (13, 14) defining the air chamber (20) and the seal ring (12) disposed further on the rear side.
4. A sealing device for pod propeller propulsion system as set forth in any one of Claims 1 to 3, wherein the first air supplying means (26) comprises:

a first compressed air source (28);
 an air control unit (29) for setting the pressure of compressed air from the compressed air source (28) to the extent that air is blown off outside the casing (5) from the rear-side seal ring (13) out of the pair of seal rings (13, 14) defining the air chamber (20); and
 a air piping (30) for introducing the compressed air passed through the air control unit (29) into the air chamber (20).

5. A sealing device for pod propeller propulsion system as set forth in Claim 4, said second air supplying means (27) comprises:

a second compressed air source (34);
 an air relay (35) for setting pressure of compressed air from the second compressed air source (34) to a predetermined output pressure with the air pressure in the air piping (30) as a pilot pressure; and
 a pressurizing piping (36) for applying the output pressure set at the air relay (35) to the interior of the pod (4).

6. A sealing device for pod propeller propulsion system as set forth in any one of Claim 1 to 3, wherein the first air supplying means (26) comprising:

a first compressed air source (43);
 an air control unit (44) for setting pressure of compressed air from the compressed air source (43) to a predetermined pressure and flow rate;
 a detecting piping (45) for blowing off the compressed air passed through the air control unit (44) directly to outside water (W) without passing through the seal ring (13) to detect the draft pressure (P);
 a first air relay (46) for setting pressure of compressed air from the first compressed air source (43) to a predetermined output pressure with the air pressure in the detecting piping (45) as

a pilot pressure; and
an air piping (47) for applying the output pressure predetermined at the first air relay (46) into the air chamber (20).

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7. A sealing device for pod propeller propulsion system as set forth in Claim 6, wherein said second air supplying means (27) comprises:

a second compressed air source (50);
a second air relay (51) for setting pressure of compressed air from the second compressed air source (50) to a predetermined output pressure with the air pressure in the detecting piping (45) as a pilot pressure; and
a pressurizing piping (52) for applying the output pressure set at the second air relay (51) into the pod (4).

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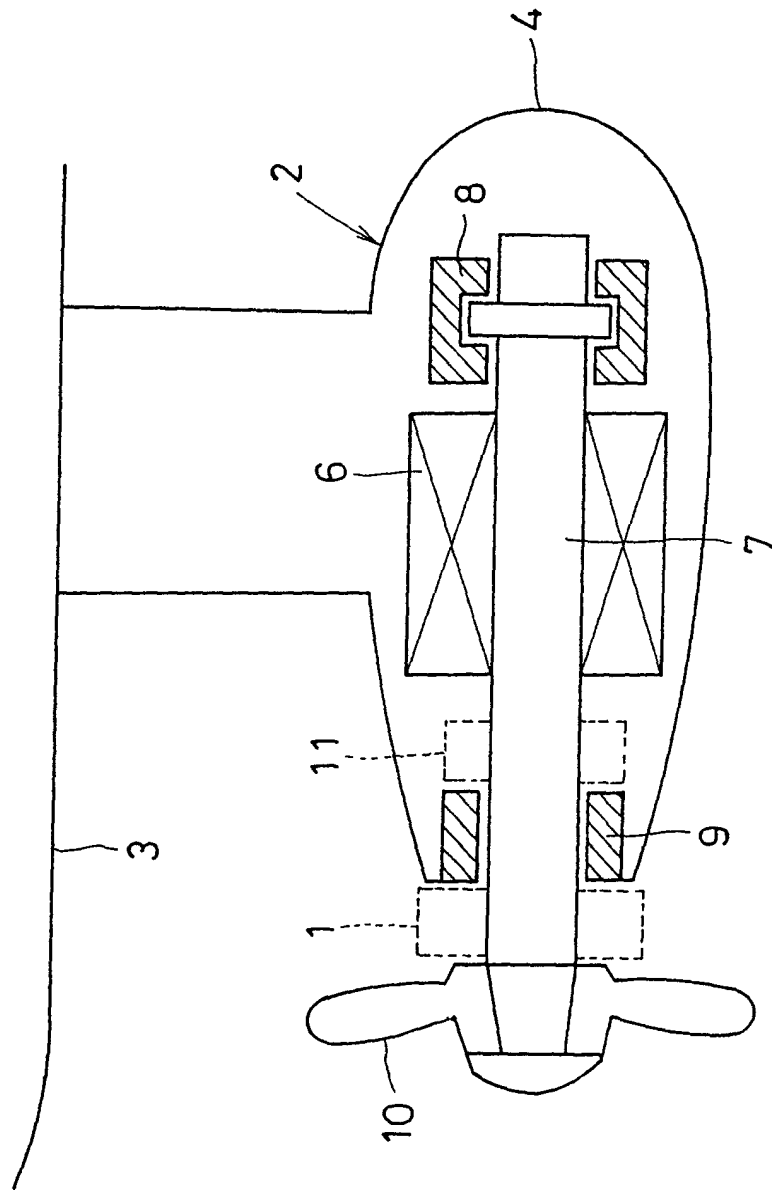
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FIG.1



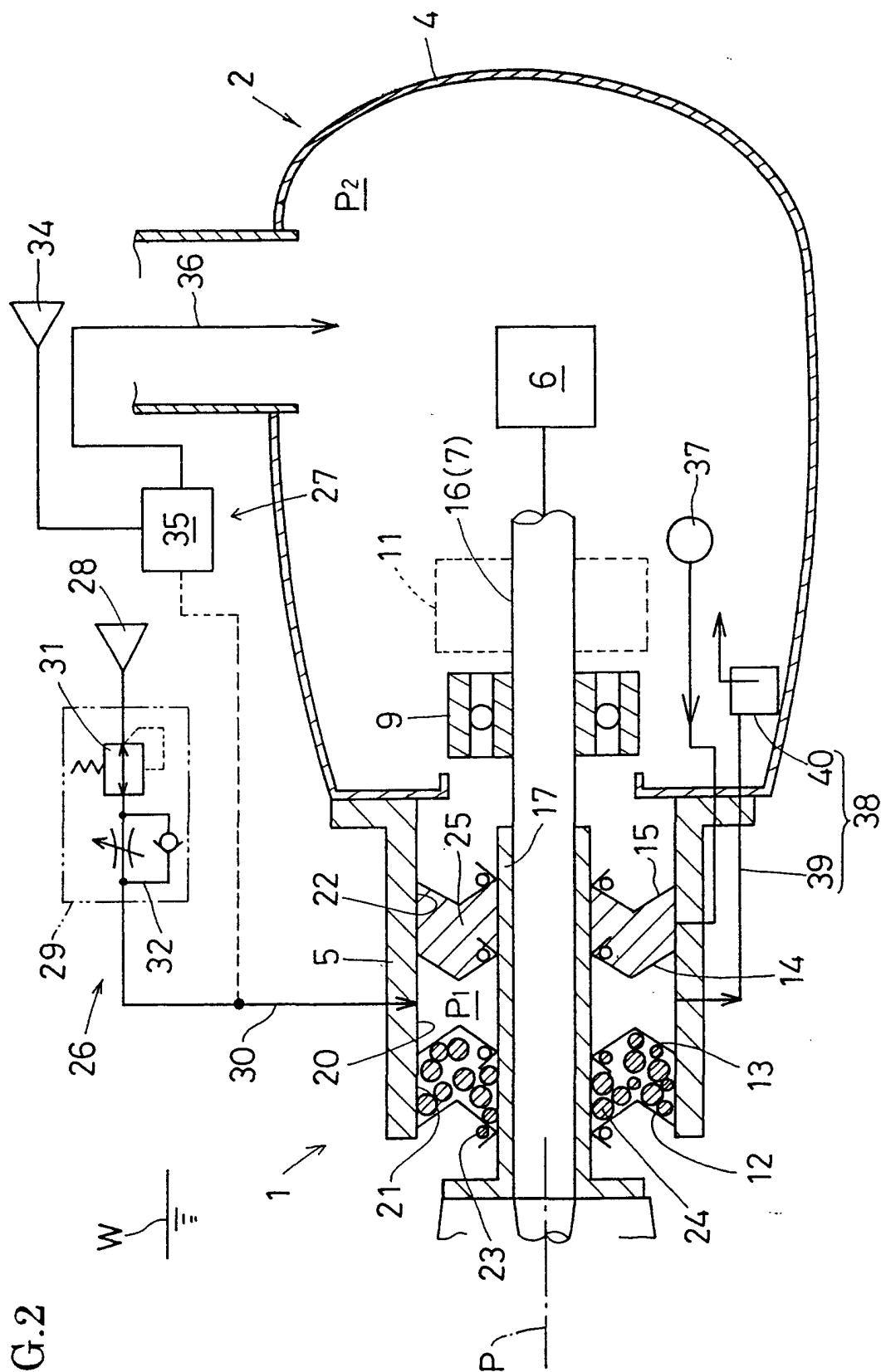


FIG. 2

FIG.3

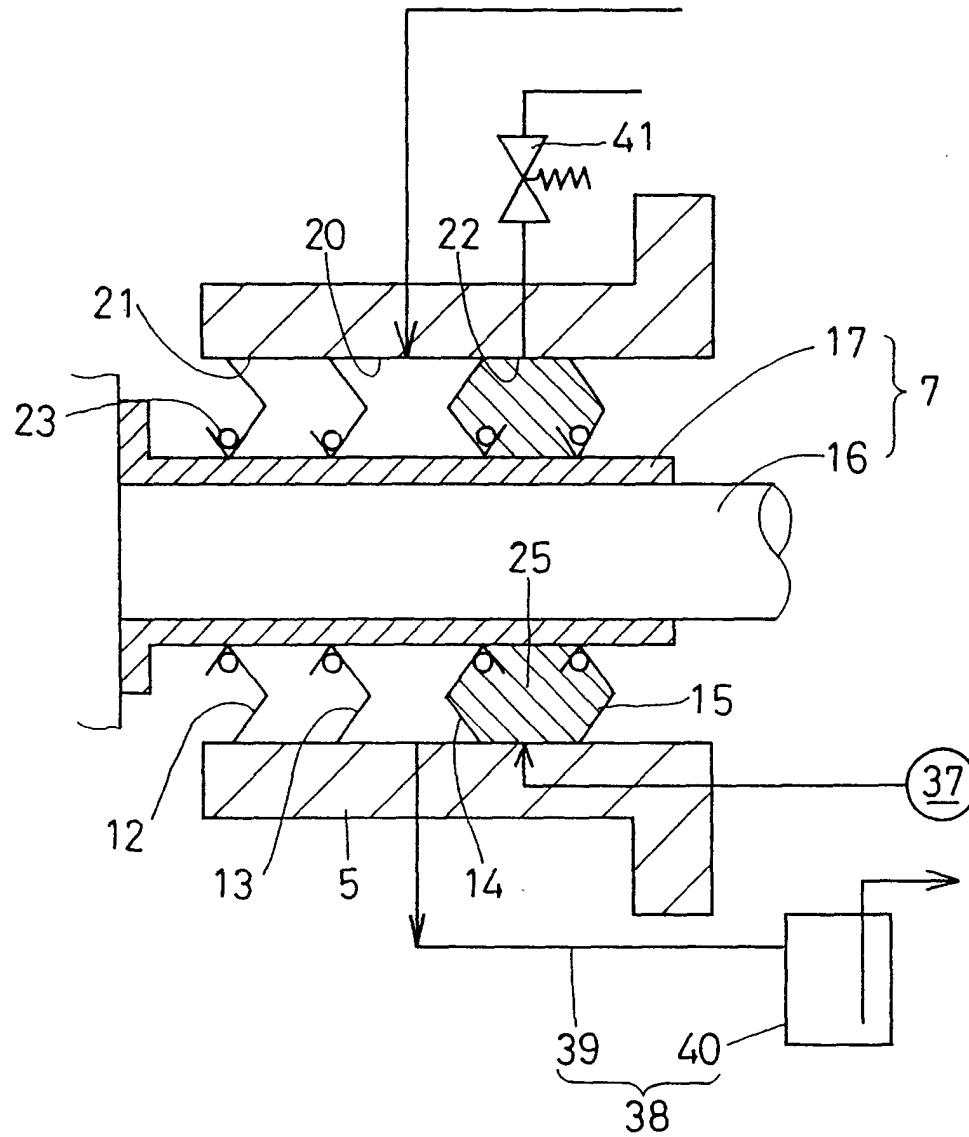
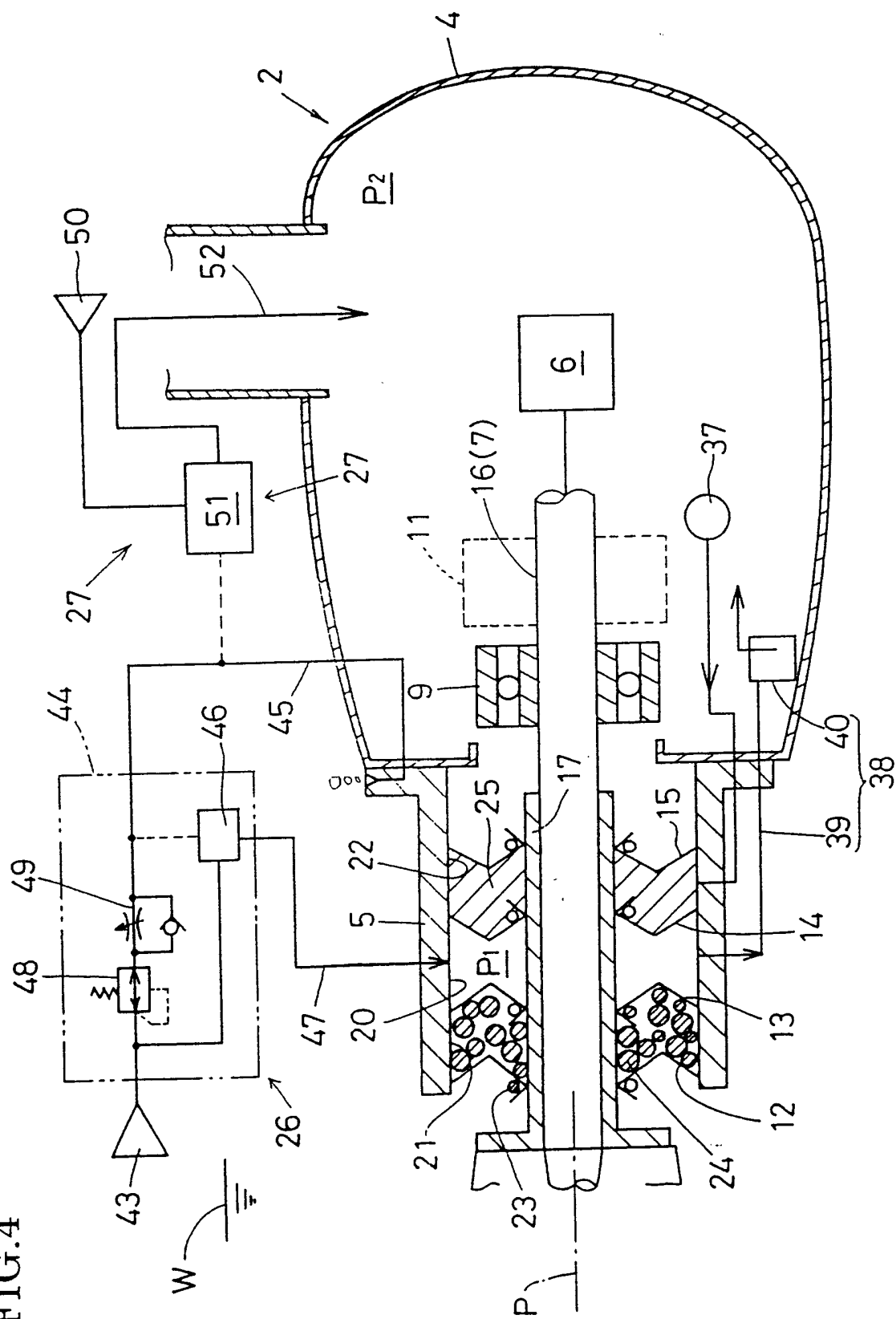


FIG.4





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 6239

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 209 497 A (PIETSCH GUENTER ET AL) 11 May 1993 (1993-05-11) * column 1, line 63 - line 68; figures * * column 3, line 38 - column 6, line 47 *	1-7	B63H23/32 B63H25/42 B63H5/125
A	US 5 683 278 A (HILLIG HOLGER ET AL) 4 November 1997 (1997-11-04) * column 4, line 6 - line 57; figures *	1-7	
A	DE 38 15 655 A (BLOHM VOSS AG) 16 November 1989 (1989-11-16) * abstract; figures *	1-7	
A	EP 0 590 867 A (KVAERNER MASA YARDS OY) 6 April 1994 (1994-04-06) * claim 1; figures *	1-7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B63H F16J
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 15 February 2002	Examiner Moya, E
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03 82 (P04001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 12 6239

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15-02-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5209497 A	11-05-1993	DE 4028048 A1	12-03-1992
		CN 1059589 A ,B	18-03-1992
		FI 914178 A ,B,	06-03-1992
		GB 2247724 A ,B	11-03-1992
		JP 5133476 A	28-05-1993
		NL 9101462 A ,B,	01-04-1992
		SE 503561 C2	08-07-1996
		SE 9102540 A	06-03-1992
		RU 2018752 C1	30-08-1994
		US 5267736 A	07-12-1993
US 5683278 A	04-11-1997	DE 4434261 A1	28-03-1996
		CN 1129182 A ,B	21-08-1996
		JP 2832427 B2	09-12-1998
		JP 8301186 A	19-11-1996
		NL 1001270 C2	12-11-1996
		NL 1001270 A1	25-03-1996
		RU 2108266 C1	10-04-1998
DE 3815655 A	16-11-1989	DE 3815655 A1	16-11-1989
		CN 1041030 A ,B	04-04-1990
		GB 2218162 A ,B	08-11-1989
		JP 2011969 A	17-01-1990
		JP 8006818 B	29-01-1996
		NL 8901132 A ,B,	01-12-1989
		SE 501939 C2	26-06-1995
		SE 8901613 A	08-11-1989
EP 0590867 A	06-04-1994	FI 924334 A	29-03-1994
		CA 2107202 A1	29-03-1994
		DE 69302348 D1	30-05-1996
		DE 69302348 T2	26-09-1996
		DK 590867 T3	12-08-1996
		EP 0590867 A1	06-04-1994
		ES 2087662 T3	16-07-1996
		JP 6191484 A	12-07-1994
		NO 933441 A	29-03-1994
		RU 2097266 C1	27-11-1997
		SG 43165 A1	17-10-1997
		US 5403216 A	04-04-1995