(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 634 084 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.09.2013 Bulletin 2013/36

(51) Int Cl.:
B63H 1/18 *(2006.01)*

(21) Application number: **12157439.6**

(22) Date of filing: **29.02.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **ABB Oy**
00380 Helsinki (FI)

(72) Inventors:
- **Kajava, Mikko**
  00990 Helsinki (FI)
- **Veikonheimo, Tomi**
  00890 Helsinki (FI)
- **Lyyjynen, Markku**
  02770 Espoo (FI)
- **Setälä, Tero**
  37150 Nokia (FI)

(74) Representative: **Hjelt, Pia Dorrit Helene et al**
Boco IP Oy Ab
Itämerenkatu 5
00180 Helsinki (FI)

(54) Arrangement and method in a ship

(57) The ship comprises a hull (200), at least one propulsion unit (100) comprising a propulsion engine (30), transmission means (40), at least one propeller (50) connected via the transmission means (40) to the propulsion engine (30), and a oscillation sensor (300) situated in the vicinity of the at least one propeller (50) in order to sense cavitation of the at least one propeller (50). The arrangement comprises further a control unit (400) for controlling the propulsion engine (30), said oscillation sensor (300) being connected to the control unit (400), whereby the output signal of the oscillation sensor (300) is analyzed in the control unit (400) in order to detect whether a worse degree cavitation is emerging, and indicate that a worse degree cavitation is emerging on a display unit at the navigation bridge and/or regulate the rotation speed and/or the power of the propulsion engine (30) when worse degree cavitation is emerging.

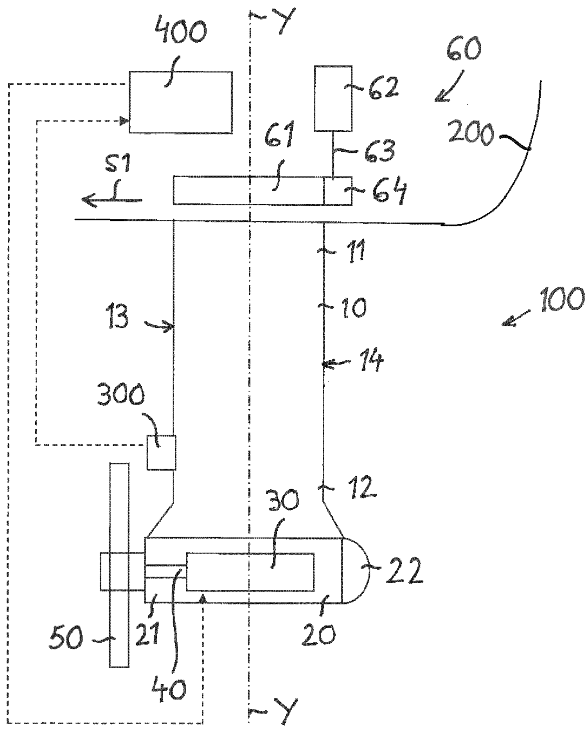

Fig. 1

EP 2 634 084 A1

Description

TECHNICAL FIELD

[0001] The invention relates to an arrangement in a ship according to the preamble of claim 1.

[0002] The invention also relates to a method in a ship according to the preamble of claim 12.

[0003] The arrangement and the method can be used in a ship comprising a hull, at least one propulsion engine, transmission means, at least one propeller connected via the transmission means to the at least one propulsion engine and a support structure comprising an upper portion being supported at the hull, a lower portion, and a front edge, a control unit for controlling the at least one propulsion engine.

[0004] The ship can have only one propulsion engine or two or more propulsion engines situated at the stern of the ship. The propeller can comprise a single propeller or two contra-rotating propellers.

[0005] The arrangement is suitable to be used especially in large ships e.g. cruisers, tankers transporting oil or liquefied natural gas, vehicle carriers, container ships and ferries.

BACKGROUND ART

[0006] JP patent publication No. 2004182096 discloses a pod-type propulsion apparatus comprising a support structure being pivotably attached to the hull of a ship and a chamber attached to the support structure. The chamber comprises a motor being connected to a first end of a shaft, the second opposite end of the shaft protruding from the front end of the chamber and being connected to a propeller. The rotation angle of the support structure is limited when the speed of the ship increases in order to prevent cavitation.

[0007] RU patent publication No. 2009957 discloses a device to reduce cavitation in a ship. The propeller at the stern of the ship is connected via a shaft to a motor within the hull of the ship. There are flexible casings with oscillation drives on the blades of the propeller. A cavitational noise sensor is located on the hull of the ship. An oscillation frequency control block for the flexible casings is connected in series with the noise sensor. The propeller shaft is fitted with a collector with brushes. The sensor generates a signal which is proportional to the acoustic radiations and feeds it as an input signal to the oscillation frequency control block. The oscillation frequency control block in turn generates a return signal to the drives for the flexible oscillation casings in order to reduce cavitational noise to the minimum.

[0008] JP patent publication No. 09136694 discloses automatic speed control of a water jet pump used in a ship. A pressure sensor detects the delivery pressure of the water jet pump when the ship is moving. A calculator calculates the number of revolutions that can be applied to the water jet pump in order to avoid cavitation generation in water current based on the output signal of the pressure detector. A signal selector compares the calculated number of revolutions and the number of revolutions indicated by a steering control unit. The signal selector outputs a control signal to a drive motor of the water jet pump by selecting the signal that indicates the smaller number of revolutions.

[0009] JP patent publication 09109991 discloses a cavitation prevention type ship fin stabilizer. The stabilizer includes a fin being pivotably supported to the hull through a shaft. A fin driving mechanism adjusts wing angle of the fin by turning the shaft. A water exhaust nozzle at the lower rear edge of the fin controls cavitation generation of the fin while cruising. A feed water pump supplies water and discharges water from the exhaust nozzle. An under water microphone situated after the fin, detects noise caused by the cavitation of the fin. A water injection controller controls the water injection from the exhaust nozzle by controlling the feed pump based on the noise detection signal of the microphone.

[0010] Cavitation occurs when liquid changes its phase into vapour at a certain flow region where local pressure is very low due to high local velocities. At least four different cavitation types relating to a rotating propeller in water can be distinguished: a) tip vortex from the suction side, which is regarded as normal operation until a certain level is exceeded, b) sheet cavitation at suction side, c) tip vortex from the pressure side, d) bubble cavitation.

[0011] The control bridge is at the stern of the ship i.e. 200 to 400 meters ahead of the aft in a big ship. The control bridge is also 15-40 meters above sea level. This means that the captain or navigating officer sitting on the navigation bridge do not normally feel or hear cavitation caused by the propellers at the aft of the ship. There is thus a need to make the captain and/or the navigating officer aware of situations where worse degree cavitation is emerging. Such situations might typically occur when the ship is suddenly accelerated with full power or when the propulsion unit and/or the ship is turned at big turning angels.

SUMMARY OF THE INVENTION

[0012] The obj ect of the invention is an arrangement and method to manage situations where cavitation occurs in a ship.

[0013] The arrangement in a ship according to the invention is characterized by the features in the characterizing portion of claim 1.

[0014] The method in a ship according to the invention is characterized by the features in the characterizing portion of claim 12.

[0015] The arrangement in a ship according to the invention comprises a hull, at least one propulsion unit comprising a propulsion engine, transmission means, at least one propeller connected via the transmission means to the propulsion engine, and an oscillation sensor situated in the vicinity of the at least one propeller in order to sense oscillations caused by cavitation of the at least one propeller. The arrangement comprises further a control unit for controlling the at least one propulsion engine, said oscillation sensor being connected to the control unit, whereby the output signal of the oscillation sensor is analyzed in the control unit in order to determine whether a worse degree cavitation is emerging, and indicate that a worse degree cavitation is emerging on a display unit at the navigation bridge and/or regulate the rotation speed and/or the power of the at least one propulsion engine when worse degree cavitation is emerging.

[0016] It is easier to recognize cavitation of the propeller when the oscillation sensor is situated near the origin of the phenomena i.e. near the propeller. When the propulsion unit is about to enter into an unwanted operation phase with harmful worse degree cavitation the control unit sends a warning to a display unit at the navigation bridge and/or controls the speed and/or the power of the propulsion engine.

[0017] When the measurement is done directly from the oscillations caused by the cavitation of the propeller, the amount of tuning parameters in the system is limited to a minimum. The only tuning parameters are sensitivity in the propeller blade frequency, the type of burst and the amplitude. The signal processing of the raw measurements is also rather simple, which means that the indication of worse case cavitation will be fast. The speed ramps of the propulsion unit are normally relative low, which means that there is plenty of time to react before more severe cavitation emerges.

[0018] First stage tip vortex cavitation is normal in operation e.g. in the case the ship drives at full speed. First stage tip vortex is also normally taken into account in hydrodynamic design and the operation efficiency of the propeller is not harmfully affected by first stage tip vortex. In case the cavitation gets worse, it will be harmful for the whole propulsion mechanics and may cause instant or long run damage. A worse class cavitation will result in a collapse of the efficiency of the propeller, which decreases the maneuverability of the ship dramatically.

[0019] The best position of the oscillation sensor for sensing the tip vortex of the propeller is on a support structure situated behind the propeller in the driving direction of the ship at a place where the tip vortex 'rope' hits the support structure. The support structure is behind the propeller in a normal pulling type propulsion unit i.e. in a propulsion unit where the propeller is at the front end of the chamber.

[0020] The support structure creates a different density in the hydrodynamic environment as the propeller blade passes in front of the support structure. The tip vortex and the support structure affect together. The interaction between the tip vortex and the support structure will create propeller blade frequency bursts when the tip vortex gets worse. This point is the borderline to start actions in propulsion control for avoiding more severe cavitation.

[0021] There could be a possibility to disabled the control unit in certain conditions by a separate buttom on the steering bridge.

[0022] The invention can advantageously be used in large ships e.g. cruisers, tankers transporting oil or liquefied natural gas, vehicle carriers, container ships and ferries. The power of the propulsion unit in such large ships is in the order of at least 1 MW.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Some specific embodiments of the invention are described in the following in detail with reference to the accompanying figures, in which:

Figure 1 shows an arrangement according to the invention in a ship comprising a pod propulsion unit.

Figure 2 shows an arrangement according to the invention in a ship comprising a rudderpod unit.

Figure 3 shows an arrangement according to the invention in a ship comprising a conventional axial propulsion unit.

DETAILED DESCRIPTION OF SOME SPECIFIC EMBODIMENT

[0024] Figure 1 shows an arrangement according to the invention in a ship with a pod propulsion unit.

[0025] The arrangement comprises a propulsion unit 100 situated at the stern of the ship. The propulsion unit 100 comprises a support structure 10, a chamber 20, a propulsion engine comprising a first electric motor 30, a shaft 40, and a propeller 50. The support structure 10 has an upper portion 11, a lower portion 12, a front edge 13 and a rear edge 14. The upper portion 11 of the hollow support structure 10 is pivotably attached to the hull 200 of the ship. The chamber 20 is stationary attached to the lower portion 12 of the hollow support structure 10. The shaft 40 has a first end which is connected to the first electric motor 30 and a second end protruding from the front end 21 of the chamber 20 and being connected to the propeller 50. The propeller 50 is thus situated at the front end 21 of the chamber 20. The first electric motor 30 can be an induction motor or a synchronous motor. The propeller 50 can comprise a single propeller or two contra-rotating propellers. The driving direction of the sip is shown by the arrow S1 in the figure.

[0026] The propulsion unit 100 comprises further a turning mechanism 60 for turning the propulsion unit 100 in relation to the hull 200 of the ship around a turning axis Y-Y. The turning mechanism 60 is situated within the hull 200 of the ship and comprises a gear rim 61 and a second electric motor 62. The shaft 63 of the second electric motor 62 is connected to a pinion gear 64 and the pinion gear 64 is connected to the circumference of the gear rim 61. The upper portion 11 of the support structure 10 is connected to the gear rim 61. The second electric motor

62 will thus rotate the pinion gear 63, which rotates the gear rim 61, which rotates the support structure 10 and thereby the propulsion unit 100. The second electric motor 62 can be an induction motor or a synchronous motor. There can naturally be two or more second electric motors 62 situated around the circumference of the gear rim 61.

[0027] The arrangement comprises also a control unit 400 for controlling at least the first electric motor 30 and alternatively also the second 62 electric motor. The control unit 400 will control the first 30 and the second 62 electric motors based on the commands from the navigation bridge. The rotation speed of the electric motors 30, 62 can be controlled e.g. by frequency converters.

[0028] The arrangement for cavitation indication comprises further an oscillation sensor 300 being situated on the front edge 13 of the support structure 10. The oscillation sensor 300 is situated on the front edge 13 of the support structure 10 at a height corresponding to the position of the tip of the propeller 50 blade in the situation when the tip of the propeller 50 blade during the rotational movement is passing in front of the front edge 13 of the support structure 10. The oscillation sensor 300 is connected to the control unit 400. This position of the oscillation sensor 300 is optimal in view of sensing especially tip vortex created by the rotating propeller 50.

[0029] Figure 2 shows an arrangement according to the invention in a ship comprising a rudderpod unit.

[0030] The arrangement comprises a propulsion unit 100 situated at the stern of the ship. The propulsion unit 100 comprises a support structure 10, a chamber 20, a propulsion engine comprising a first electric motor 30, a shaft 40, a propeller 50, and a rudder 70. This arrangement corresponds to the pod arrangement of figure 1 except for the rudder 70 and the fact that the support structure 10 is in the rudderpod stationary supported at the hull 200 of the ship. The rudder 70 is pivotably supported around a turning axis Y-Y.

[0031] Figure 3 shows an arrangement according to the invention in a ship comprising a conventional axial propulsion unit. This arrangement has no pod arrangement outside the hull 200 of the ship. The propulsion unit 100 comprises a propulsion engine 30 within the hull 200 of the ship, a shaft 40 having a first end connected to the propulsion engine 30 and a second end extending through an opening at the rear end of the hull 200 and being connected to a propeller 50 situated outside the hull 200. The propulsion engine 30 could be e.g. a diesel engine or an electric motor. The rudder 70 is situated after the propeller 50 in the driving direction S1 of the ship. The rudder 70 is further pivotably supported around a turning axis Y-Y.

[0032] An oscillation sensor 300 is situated on the front edge 71 of the support structure 70 i.e. the rudder 70 at a height corresponding to the position of the tip of the propeller 50 blade in the situation when the tip of the propeller 50 blade during the rotational movement is passing in front of the front edge 71 of the rudder 70. The oscillation sensor 300A could alternatively be attached to the bottom of the hull 200 of the ship as also shown in the figure. The position of the oscillation sensor 300A on the hull 200 would in such case be in a radial direction above the tip of the blade of the propeller 50.

[0033] It is advantageous to have the oscillation sensor 300 attached to a support structure, which is situated behind the propeller 50 in the driving direction of the ship. The oscillation sensor 300 will in such a position sense effectively especially tip vortex of the propeller 50. A suitable support structure to attach the oscillation sensor 300 is e.g. the support structure for the pod or a rudder, but it could be any support structure situated behind the propeller 50 in the driving direction S1 of the ship. In the case of a pod unit having the propeller 50 at the rear end of the chamber 20, a separate support structure is needed behind the pod for the oscillation sensor 300.

[0034] The propeller 50 could be formed of a single propeller or of two contra-rotating propellers.

[0035] The oscillation sensor 300, 300A could be e.g. a pressure sensor, an acoustic sensor, or an acceleration sensor.

[0036] When the oscillation sensor 300 is situated on the support structure 10, 70 after the propeller 50 in the driving direction S1 of the ship, the optimal position is at a base height position corresponding to the height of the tip of the blade of the propeller 50 when the tip of the blade is in an uppermost position. The allowed vertical deviation V1 from the base height position is equal to or less than ± 25% of the diameter D1 of the propeller 50. An oscillation sensor 300 situated on a support structure 10, 70 after the propeller 50 measures cavitation propagating backwards from the propeller 50.

[0037] When the oscillation sensor 300A is situated on the hull 200 above the propeller 50 in the redial direction, the base longitudinal position is exactly above the tip of the propeller 50 blade when the tip of the blade is in an uppermost position. The allowed horizontal deviation H1 of the base longitudinal position is equal to or less than 50% of the diameter D1 of the propeller 50. An oscillation sensor 300A situated in a radial position above the propeller 50 measures cavitation propagating in the radial direction from the propeller 50.

[0038] The oscillation sensor 300, 300A must be positioned so that it is sensitive to cavitation emerging from the propeller 50.

[0039] The control unit 400 could be a separate unit or it could be integrated into some other control unit in the ship.

[0040] The invention could also be implemented in a ship having two or more propulsion units. E.g. a ship provided with two propulsion units at the aft of the ship would need an oscillation sensor for each propeller and a control circuit for each propulsion motor.

[0041] The examples of the embodiments of the present invention presented above are not intended to limit the scope of the invention only to these embodiments. Several modifications can be made to the invention within the scope of the claims.

Claims

1. Arrangement in a ship comprising:

- a hull (200),
- at least one propulsion unit (100) comprising a propulsion engine (30), transmission means (40), at least one propeller (50) connected via the transmission means (40) to the propulsion engine (30), and
- an oscillation sensor (300) situated in the vicinity of the at least one propeller (50) in order to sense oscillations caused by cavitation of the at least one propeller (50),

characterized in that the arrangement further comprises:

- a control unit (400) for controlling the at least one propulsion engine (30), said oscillation sensor (300) being connected to the control unit (400),

whereby the output signal of the oscillation sensor (300) is analyzed in the control unit (400) in order to determine whether a worse degree cavitation is emerging, and indicate that a worse degree cavitation is emerging on a display unit at the navigation bridge and/or regulate the rotation speed and/or the power of the at least one propulsion engine (30) when worse degree cavitation is emerging.

2. Arrangement according to claim 1, **characterized in that** said oscillation sensor (300) is attached to the front edge (14, 71) of a support structure (10, 70) protruding downwards from the hull (200), said support structure (10, 70) being positioned after the propeller (50) in a driving direction (S1) of the ship.

3. Arrangement according to claim 2, **characterized in that** the oscillation sensor (300) is situated on the front edge (14, 71) of the support structure (10, 70) at a base height position corresponding to the height of the tip of the blade of the at least one propeller (50) when the tip of the blade is in an uppermost position, whereas a vertical deviation (V1) which is equal to or less than ± 25% of the diameter (D1) of the propeller (50) is allowed from the base height position.

4. Arrangement according to claim 1, **characterized in that** said oscillation sensor (300A) is situated at the bottom of the hull (200) in a position above the propeller (50).

5. Arrangement according to claim 4, **characterized in that** the oscillation sensor (300A) is situated in a radial direction above the propeller (50) at a base longitudinal position exactly above the tip of the propeller (50) blade when the tip of the blade is in an uppermost position, whereas a horizontal deviation (H1) of the base longitudinal position which is equal to or less than 50% of the diameter (D1) of the propeller 50 is allowed from the base longitudinal position.

6. Arrangement according to claim 1, **characterized in that** the arrangement further comprises:

a support structure (10) being pivotably supported at the hull (200) around a turning axis (Y-Y) and comprising a hollow body, and

- a turning mechanism (60) comprising at least one second electric motor (62) for turning the support structure (10) and thereby the chamber (20) in relation to the hull (200) of the ship in order to steer the ship, whereas:
- the at least one propulsion engine (30) comprises a first electric motor (30) situated in a chamber (20) having a front end (21) and a rear end (22), said chamber (20) being stationary attached to the lower portion (12) of the support structure (10),
- the transmission means (40) comprises a shaft (40) having a first end and a second end, said first end of the shaft (40) being connected to the first electric motor (30) and said second end of the shaft (40) protruding from the front end (21) of the chamber (20) and being connected to the at least one propeller (50), and
- said oscillation sensor (300) is situated at the front edge (11) of the support structure (11) behind the at least one propeller (50) in a driving direction (S1) of the ship.

7. Arrangement according to claim 1, **characterized in that** the arrangement further comprises:

- a support structure (10) being stationary attached to the hull (200) and comprising a hollow body,
- a rudder (70) situated after the support structure (10) and the chamber (20) in the driving direction (S1) of the ship, said rudder (70) being pivotably supported at the hull (200) around a turning axis (Y-Y), whereas:
- the propulsion engine (30) comprises a first electric motor (30) situated in a chamber (20) having a front end (21) and a rear end (22), said chamber (20) being stationary attached to the lower portion (12) of the support structure (10),
- the transmission means (40) comprises a shaft

(40) having a first end and a second end, said first end of the shaft (40) being connected to the first electric motor (30) and said second end of the shaft (40) protruding from the front end (21) of the chamber (20) and being connected to the propeller (50), and
- said oscillation sensor (300) is situated at the front edge (11) of the support structure (11) behind the at least one propeller (50) in a driving direction (S1) of the ship.

8. Arrangement according to claim 1, **characterized in that** the arrangement further comprises:

- a rudder (70) being pivotably supported at the hull (200) around a turning axis (Y-Y), said rudder (70) being positioned after the propeller (50) in a driving direction (S1) of the ship, whereas:
- the propulsion engine (30) comprises a first electric motor or a diesel engine (30) situated within the hull (200) of the ship,
- the transmission means (40) comprises a shaft (40) having a first end and a second end, said first end of the shaft (40) being connected to the propulsion engine (30) and said second end of the shaft (40) protruding from the rear end of the hull (200) and being connected to the propeller (50), and
- said oscillation sensor (300) is situated at the front edge (11) of the rudder (70) behind the at least one propeller (50) in a driving direction (S1) of the ship.

9. Arrangement according to claim 8, **characterized in that** the oscillation sensor (300) is situated on the front edge (71) of the rudder (70) at a base height position corresponding to the height of the tip of the blade of the at least one propeller (50) when the tip of the blade is in an uppermost position, whereas a vertical deviation (V1) which is equal to or less than $\pm$ 25% of the diameter (D1) of the propeller (50) is allowed from the base height position.

10. Arrangement according to any of claims 1 to 9, **characterized in that** the ship is a cruiser, a tanker transporting oil or liquefied natural gas, a vehicle carrier, a container ship or a ferry.

11. Arrangement according to any of claims 1 to 10, **characterized in that** the power of the at least one propulsion unit (100) is at least 1MW.

12. Method in a ship comprising:

- a hull (200),
- at least one propulsion unit (100) comprising a propulsion engine (30), transmission means (40), at least one propeller (50) connected via the transmission means (40) to the propulsion engine (30), and
- an oscillation sensor (300) situated in the vicinity of the at least one propeller (50) in order to sense oscillations caused by cavitation of the at least one propeller (50),

characterized in that the method comprises the steps of:
- measuring cavitation of the at least one propeller (50) with the oscillation sensor (300),
- feeding the output signal of the oscillation sensor (300) to a control unit (400),
- analyzing the output signal of the oscillation sensor (300) in the control unit (400) in order to detect cavitation of the at least one propeller (50) and to determine whether a worse degree cavitation is emerging,
- indicating that a worse degree cavitation is emerging on a display unit at the navigation bridge and/or regulating the rotation speed and/or the power of the propulsion engine (30) when worse degree cavitation is emerging.

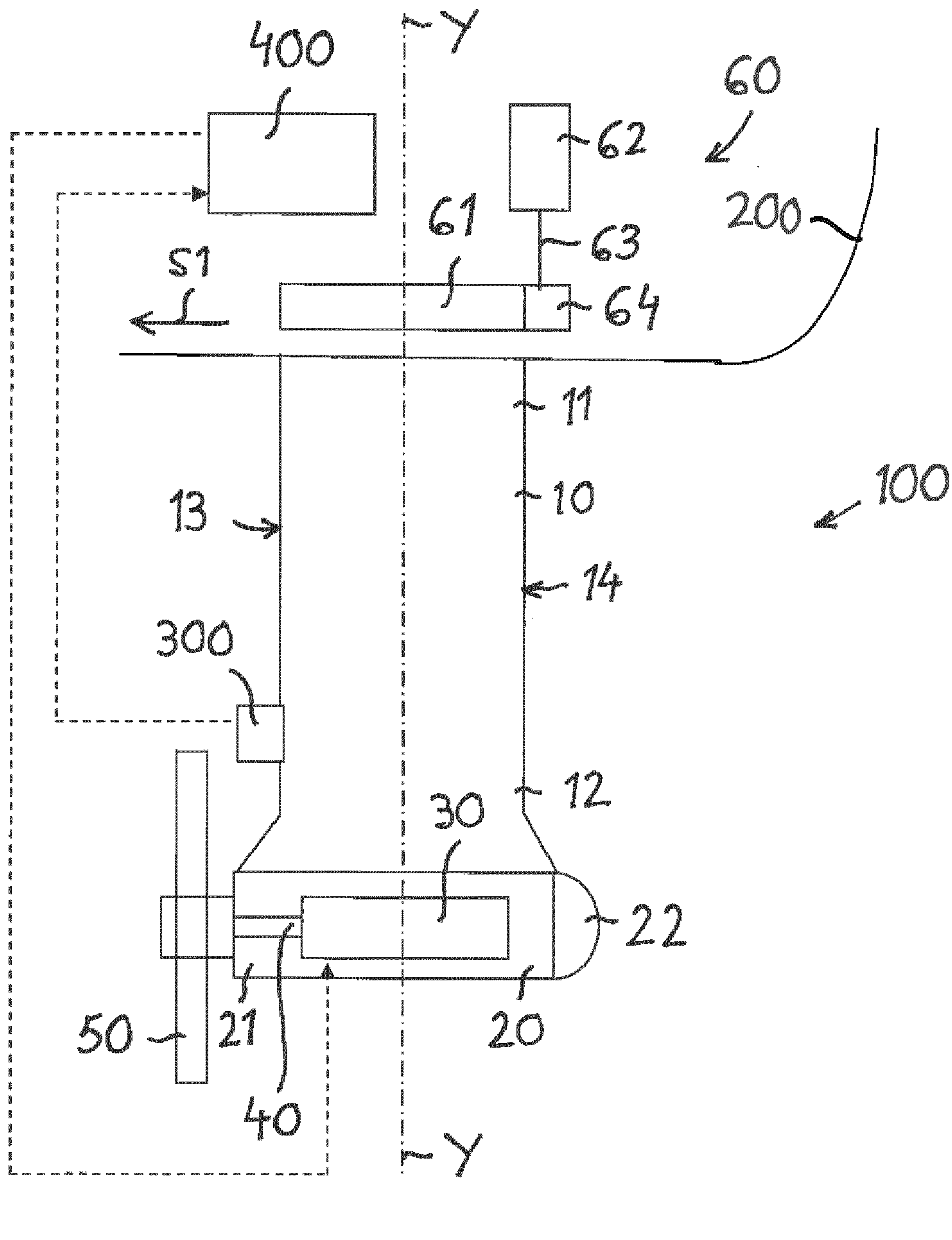

Fig. 1

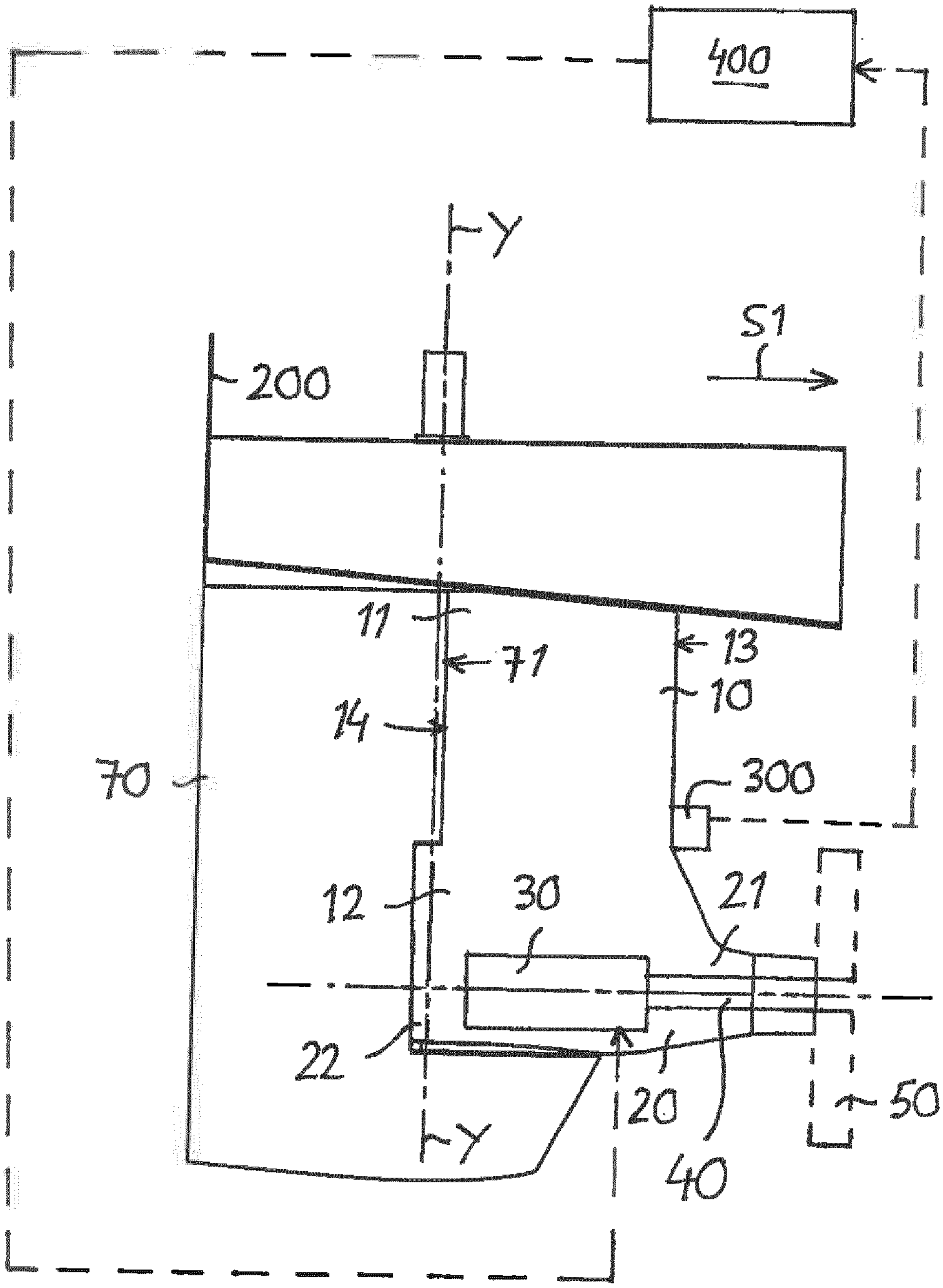

Fig. 2

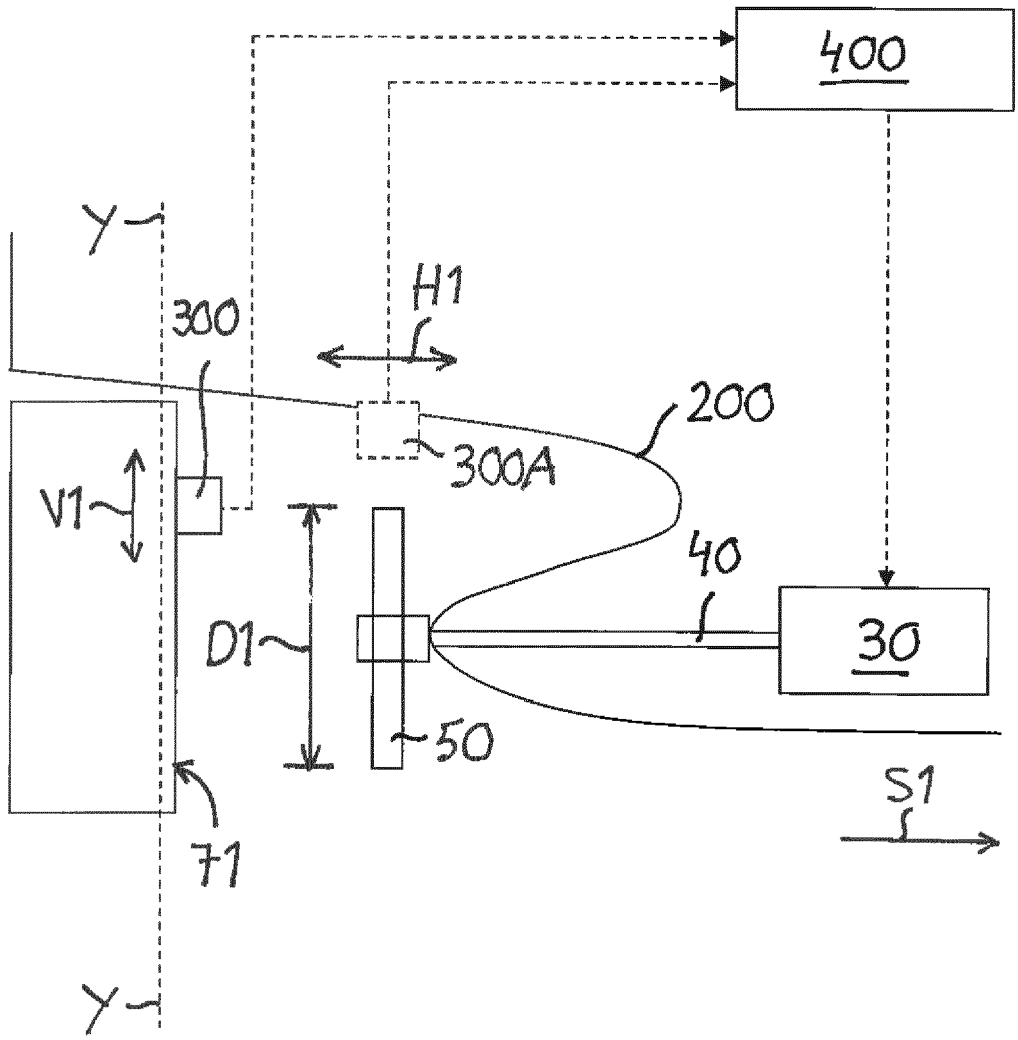

Fig. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 15 7439

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	RU 2 009 957 C1 (KHALIULLIN YURIJ MIKHAJLOVICH [RU]) 30 March 1994 (1994-03-30) * abstract; figures 1,2 * -----	1	INV. B63H1/18
A	US 2002/185046 A1 (MOTSENBOCKER MARVIN A [US]) 12 December 2002 (2002-12-12) * page 4, paragraph 33 - page 5, paragraph 41; figures 1-5 * -----	1	
A	DE 42 13 635 A1 (MITSUBISHI ELECTRIC CORP [JP]) 29 October 1992 (1992-10-29) * column 3, line 16 - column 5, line 3; figures 1-4 * -----	1	
A	US 2003/060094 A1 (MOTSENBOCKER MARVIN A [US]) 27 March 2003 (2003-03-27) * page 8, paragraph 62 - page 9, paragraph 67; figures 1-4 * -----	1	
A	US 2007/017284 A1 (SADASIVAM VINODKUMAR [US]) 25 January 2007 (2007-01-25) * page 2, paragraph 19 - page 3, paragraph 37; figures 1-3 * -----	1	TECHNICAL FIELDS SEARCHED (IPC) B63H
A	WO 2008/155448 A1 (ABB OY [FI]; VAESNKAE KLAUS [FI]) 24 December 2008 (2008-12-24) * page 4, line 7 - page 7, line 23; figure 3 * -----	1	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	19 July 2012	Lendfers, Paul

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 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 15 7439

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-07-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
RU 2009957 C1	30-03-1994	NONE	
US 2002185046 A1	12-12-2002	NONE	
DE 4213635 A1	29-10-1992	DE 4213635 A1	29-10-1992
		JP 4325734 A	16-11-1992
		US 5190487 A	02-03-1993
US 2003060094 A1	27-03-2003	NONE	
US 2007017284 A1	25-01-2007	NONE	
WO 2008155448 A1	24-12-2008	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2004182096 B **[0006]**
- RU 2009957 **[0007]**
- JP 09136694 B **[0008]**
- JP 09109991 B **[0009]**