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(54) **Propulsion arrangement in a ship**

(57) The arrangement comprises a propulsion unit (100) comprising a hollow support structure (10) being stationary attached to the hull (200) of a ship, a chamber (20) having a longitudinal central axis (X-X), and being stationary attached to the support structure (10), driving means (30) and transmission means (40) for driving a propeller (30) situated at a front end (21) of the chamber (20), and a pivotable rudder (60) situated after the support structure (10) and the chamber (20), said rudder (60) having a turning axis (Y-Y) in proximity with a front edge (63) of the rudder (60). The arrangement is **characterized in that** a rear end (22) of the chamber (20) comprises an outwardly curved protrusion (23) extending into a corresponding inwardly curved cavity (66) formed at a front edge (63) of the rudder (60), and that the rudder (60) comprises a cone (67) having a base and an apex (A1), the base of the cone (67) surrounding the inwardly curved cavity (66) at the front edge (63) of the rudder (60) and the apex (A1) being within the rudder (60) or beyond the rear edge (64) of the rudder (60).

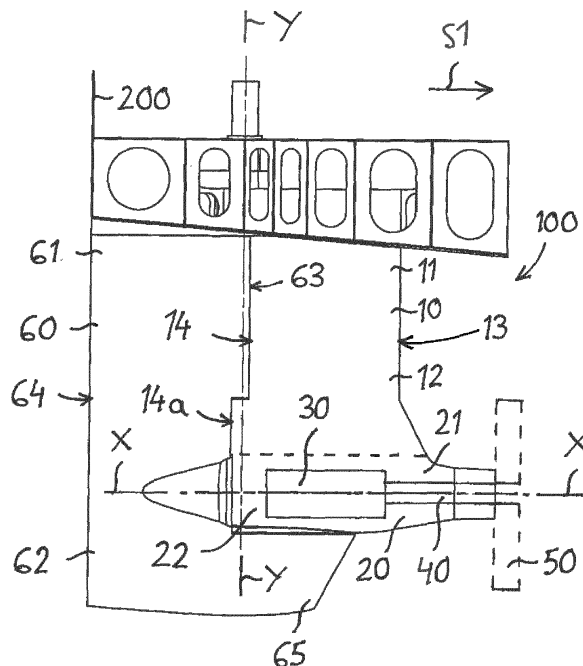


Fig. 1

Description

TECHNICAL FIELD

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

[0002] The propulsion arrangement is based on a so called rudderpod propulsion unit comprising a stationary support structure attached to the hull of the ship, a chamber attached to the support structure and a pivotable rudder situated after the support structure and the chamber. The arrangement comprises further driving means and transmission means for driving a propeller situated at the front edge of the housing. The propeller can comprise a single propeller or two contra-rotating propellers.

[0003] The ship can either have only one propulsion unit or two or more propulsion units situated at the stern of the ship symmetrically in view of the center line of the hull of the ship.

[0004] Propulsion units are used especially in large ships e.g. cruisers, tankers transporting oil or liquefied natural gas, vehicle carriers, container ships and ferries. The power of such a propulsion unit is at least 1 MW.

BACKGROUND ART

[0005] The rudderpod prior art propulsion units comprises a stationary support structure attached to the hull of the ship, a chamber attached to the support structure and a pivotable rudder situated after the support structure and the chamber. The rudderpod comprises further driving means and transmission means for driving a propeller situated at the front edge of the housing. The interface between the stationary support structure and the pivotable rudder as well as the interface between the stationary chamber and the pivotable rudder forms a discontinuity point for the water flowing along the side surface of the support structure and the chamber.

[0006] Such discontinuity points might cause cavitation especially when the ship travels with high speeds e.g. with speeds exceeding 20 knots. The interface between the stationary support structure and the pivotable rudder has traditionally been made smooth by making the cross section of the rear edge of the support structure inwardly curved and the cross section of the front edge of the rudder outwardly curved in a corresponding way. The front edge of the rudder will thus fit smoothly into the rear edge of the stationary support structure. Said interface will form a smooth connection also when the rudder is deflected to either side as the front edge of the rudder will be within the rear edge of the stationary support structure all the time.

[0007] KR patent application No. 2004101837 discloses a steering system for a ship to minimize resistance of bulb by providing stator fins designed suitably for counter-current. A propeller unit is attached at the stern of the hull of the ship and a rudder is attached pivotably to the hull of the ship after the propeller in the travelling direction

of the ship. A non-spherical cap is attached at the rear of the propeller. The rudder comprises a stationary part attached to the bottom of the ship and a pivotable blade part attached to the stationary part. The rudder comprises further a bulb in the blade part, said bulb being situated after the non-spherical cap of the propeller. The streamlined bulb comprises a plurality of stator fins protruding from the peripheral portion of the bulb.

[0008] UA patent No. 79592 discloses a propeller steering system of an air-cushion vessel. The system consists of a pylon with symmetrical aerodynamic profile mounted on the upper deck of the vessel. The propulsion engine is installed on the upper end of the pylon in a pod. An aerodynamic rudder is installed at the stem end of the pylon. The rudder has a stationary part and a pivotable part situated after the stationary part. The cross section of the rear edge of the stationary part has an inwardly curved form and the cross section of the front edge of the pivotable part has a corresponding outwardly curved form. This means that there will be a smooth transition for air passing along the side edges of the stationary part to the pivotable part even in situations when the pivotable part is deflected.

25 SUMMARY OF THE INVENTION

[0009] The object of the invention is to improve prior art rudderpod propulsion arrangements in ships.

[0010] The propulsion arrangement according to the invention is characterized by the features in the characterizing portion of claim 1.

[0011] The propulsion arrangement comprises at least one propulsion unit situated at the stern of the hull, said at least one propulsion unit comprising a hollow support structure having an upper portion, a lower portion, a front edge and a rear edge, said upper portion being stationary attached to the hull, a chamber having a longitudinal central axis, a front end and a rear end, said chamber being stationary attached to the lower portion of the support structure, driving means and transmission means for driving a propeller situated at the front end of the chamber, and a rudder having an upper portion, a lower portion, a front edge, a rear edge, and a turning axis in proximity to the front edge of the rudder, the rudder being situated after the support structure and the chamber in the travelling direction of the ship so that the front edge of the rudder is in close proximity with the rear edge of the support structure and with the rear end of the chamber.

[0012] The propulsion arrangement according to the invention is **characterized in that** the rear end of the chamber comprises an outwardly curved protrusion extending into a corresponding inwardly curved cavity formed in the front edge of the rudder.

[0013] The rudder comprises a cone having a base and an apex, the base of the cone surrounding the inwardly curved cavity at the front edge of the rudder and the apex being within the rudder or beyond the rear edge

of the rudder.

[0014] The arrangement according to the invention will minimize cavitation problems that could arise due to discontinuities in the interface between the rear end of the chamber and the front edge of the rudder. The curved interface and the cone allows a smooth continuation of the water flow over the interface during normal course keeping steering angles in the range of -7.5 degrees to + 7.5 degrees. The interface between the two curved surfaces is smooth and the gap between the curved surfaces can be made small. This small gap can due to the curved interface be retained also when the rudder is deflected from the neutral position to an angle in the range of - 7.5 degrees to + 7.5 degrees, which is a typical course keeping rudder angle when driving with high speeds.

[0015] The invention can be used in large ships provided with at least one propulsion unit at the stem of the ship, 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

[0016] Some specific embodiments of the invention are described in the following in detail with reference to the accompanying figures, in which:

Figure 1 shows a vertical, longitudinal cross section of a propulsion unit according to the invention.

Figure 2 shows a transverse cross section of the propulsion unit shown in fig. 1.

Figure 3 shows a horizontal cross section of the support structure and the rudder of the propulsion unit.

Figure 4 shows a horizontal cross section of the chamber and the rudder of the propulsion unit.

DETAILED DESCRIPTION OF SOME SPECIFIC EMBODIMENTS

[0017] Figure 1 shows a vertical, longitudinal cross section of a propulsion unit according to the invention. The arrangement comprises a propulsion unit 100 situated at the stem of the ship. The propulsion unit 100 comprises a support structure 10, a chamber 20, a driving means i.e. an electric motor 30, a transmission means i.e. a shaft 40, a propeller 50 and a rudder 60. 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 stationary attached to the hull 200 of the ship. The chamber 20 has a front end 21 and a rear end 22. 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 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 and rotates around a longitudinal central axis X-X of the chamber 20. The electric motor 30 can be an induction motor or a synchronous motor. The support structure 10 and the chamber 20 is thus fixed to the hull 200 of the vessel, which means that the propeller 50 will remain in a fixed position in relation to the hull 200 of the ship all the time.

[0018] A rudder 60 is situated at the rear edge 14 of the support structure 10 and at the rear end 22 of the chamber 20. The rudder 60 has an upper portion 61, a lower portion 62, a front edge 63 and a rear edge 64. The rudder 60 is pivotably connected to the hull 200 and the chamber 20 by means of a turning axis Y-Y in the proximity of the front edge 63 of the rudder 60. The rudder 60 is formed so that it forms a smooth continuation of the support structure 10 and the chamber 20. The lower portion 62 of the rudder 60 has a protruding part 65 extending below the chamber 20 from the rear end 22 of the chamber 20 to a distance from the front end 21 of the chamber 20. A steering gear, which is not shown in the figure, rotates the rudder 60 around the turning axis Y-Y based on the commands from the navigation bridge. The figure also shows the travelling direction S1 of the ship.

[0019] The longitudinal central axis X-X of the chamber 20 and the turning axis Y-Y of the rudder 60 are advantageously perpendicular to each other. The turning axis Y-Y of the rudder 60 is advantageously vertical, which means that the longitudinal central axis X-X of the chamber 20 is horizontal. The turning axis Y-Y of the rudder 60 could, however, also be inclined and the longitudinal axis X-X of the chamber 20 could also be inclined. The turning axis Y-Y of the rudder 60 need not to be exactly perpendicular to the longitudinal axis X-X of the chamber 20, the angle between said axes could slightly differ from 90 degrees. It would also be possible to put the turning axis Y-Y of the rudder 60 slightly on the side so that the turning axis Y-Y of the rudder 60 would not cross the longitudinal central axis X-X of the chamber 20.

[0020] The driving means i.e. the electric motor 30 could naturally also be situated within the hull 200 of the ship. This would mean that transmission means would be needed in order to transfer rotation power from the electric motor 30 to the propeller 50. The horizontal shaft 40 could be connected e.g. with a first pinion gear to a vertical shaft extending from the chamber 20 into the hull 200 of the ship. The upper end of the vertical shaft would then be connected with a second pinion gear to a shaft of the electric motor 30.

[0021] Figure 2 shows a transverse cross section of the propulsion unit shown in fig. 1. The transverse cross section of the chamber 20, the support structure 10 and the rudder 60 is seen in this figure. The figure shows that the connection between the housing 20 and the support structure 10 is formed with a smooth rounding R0. This smooth rounding R0 reduces tension in the connection

between the housing 20 and the support structure 10. The width W1 of the rear edge 14 of the support structure 10 and the front edge 63 of the rudder 60 is declining from the top towards the bottom.

[0022] Figure 3 shows a horizontal cross section of the support structure and the rudder of the propulsion unit. The cross section of the rear edge 14 of the upper portion 11 of the support structure 10 has an inwardly curved form and the front edge 63 of the upper portion 61 of the rudder 60 has a corresponding outwardly curved form. A cross section of a portion of the rear edge 14a of the support structure 10 above the chamber 20 has, however, an outwardly curved form and the front edge 63 of the rudder has a corresponding inwardly curved form. This is due to the fact that space is needed within the support structure 10 in order to have access to do maintenance work within the rear end 22 of the chamber 20. The curved form is advantageously circular. The outwardly curved edges are situated within the inwardly curved edges. There is thus a smooth interface between the rear edge 14 of the upper portion 11 of the support structure 10 and the front edge 63 of the upper portion 61 of the rudder 60. The water passing along the side surfaces of the upper portion 11 of the support structure 10 and further along the side surfaces of the upper portion 61 of the rudder 60 will not confront any major discontinuities. The flow path for the water passing along said side surfaces will be smooth. The distance between the outwardly curved front edge 63 of the upper portion 61 of the rudder 60 and the inwardly curved rear edge 14 of the upper portion 11 of the support structure is small so that there will be only a small gap at the side surfaces between the support structure 10 and the rudder 60.

[0023] Figure 4 shows a horizontal cross section of the chamber and the rudder of the propulsion unit. The rear end 22 of the chamber 20 comprises an outwardly curved protrusion 23. The front edge 63 of the rudder 60 comprises a corresponding inwardly curved cavity 66. The protrusion 23 at the rear end 22 of the chamber 20 fits into the cavity 66 at the front edge 63 of the rudder 60. The rudder 60 comprises further a cone 67. The base of the cone 67 surrounding the protrusion 23 is at the front edge 63 of the rudder 60 and the apex A1 of the cone 67 is within the rudder 60 or beyond the rear edge 64 of the rudder 60. The cone 67 would be truncated at the rear edge 64 of the rudder 60 in case the apex A1 is situated beyond the rear edge 64 of the rudder 60. The transverse cross section of the cone 67 could be circular or an elliptical. The cone 67 could contract only from the side surfaces. The outer surface of the cone 67 protrudes from the side surfaces of the rudder 60. There is thus a smooth interface between the rear edge 22 of the chamber 20 and the front edge 63 of the rudder 60. The water passing along the side surfaces of the chamber 20 and further along the side surfaces of the lower portion 61 of the rudder 60 will not confront any major discontinuities. The flow path for the water passing along said side surfaces will be smooth. The distance between the protrusion 23

at the rear end 22 of the chamber 20 and the cavity 66 at the front end 63 of the rudder 60 is small so that there will be only a small gap at the edges of the interface between the rear end 22 of the chamber 20 and the front edge 63 of the rudder 60. This small gap can due to the curved interface be retained also when the rudder 60 is deflected from the neutral position to an angle in the range of - 7.5 degrees to + 7.5 degrees, which is a typical course keeping rudder 60 angle when driving with high speeds.

[0024] This curved interface between the rear end 22 of the chamber 20 and the front edge 63 of the rudder 60 as well as the cone 67 in the rudder 60 will minimize cavitation problems. Such cavitation problems could be caused by discontinuities in the interface between the rear end 22 of the chamber 20 and the front edge 63 of the rudder 60 when the ship is driving at high speeds. This curved interface and the cone 67 allows a smooth continuation of the water flow over the interface during normal course keeping steering angles in the range of -7.5 degrees to + 7.5 degrees.

[0025] The protrusion 23 and the cavity 66 could advantageously be formed as a hemisphere. The transverse cross section of the protrusion 23 and the cavity 66 of the chamber would in such case be circular. The transverse cross section of the protrusion 23 and the cavity 66 could on the other hand be elliptical. The sides of the chamber 20 would in such case be a little bit suppressed. The cavity 66 would in such case be adapted to the elliptical protrusion 23 in order to achieve a smooth interface when turning the rudder 60. The transverse cross section of the protrusion 23 and the cavity 66 could on the other hand form a curve, which is not a circle or an ellipse. The interface between the protrusion and the cavity could be formed of curves having a free form and being adapted to work together when turning the rudder 60 so that the interface between the chamber 20 and the rudder 60 remains smooth. The transverse cross section means a cross section taken in a plane being perpendicular to the longitudinal central axis X-X of the chamber 20. A horizontal cross section of the protrusion 23 and the cavity 66 will always be circular. A horizontal cross section of the protrusion 23 and the cavity 66 forms arcs of a circle. The centre of the circle is on the turning axis Y-Y.

[0026] The form and dimensions of the protrusion 23 and the cavity 66 have been adapted to each other so that there is only a small gap between the outer surface of the protrusion 23 and the inner surface of the cavity 66. The radius R1 of the cavity 66 at the front edge 63 of the rudder 60 is a little bit smaller than the radius R2 of the protrusion 23 at the rear end 22 of the chamber 20 due to the gap between the outer surface of the protrusion 23 and the inner surface of the cavity 66. The centre of the cavity 66 at the front edge 63 of the rudder 60 is close to the point where the longitudinal central axis X-X of the chamber 20 and the turning axis Y-Y intercept. The outer surface of the cavity 66 protrudes from the side surfaces

of the rudder 60 especially at the front edge 63 of the rudder 60. The radius R1 of the cavity 66 at the front edge 63 of the rudder 60 is typically in the range of 500 to 1500 mm. The clearance between the protrusion 23 at the rear end 22 of the chamber 20 and the cavity 66 at the front edge 63 of the rudder 60 should be minimized. Said clearance will in practice be in the range of 20 to 100 mm. The width W1 of the front edge 63 of the upper part 61 of the rudder 60 is typically in the range of 500 to 3000 mm, narrowing from the top towards the bottom of the rudder 60. The width of the part of the rudder 60 that is situated below the housing could be less than 500 mm and even near zero at the bottom of the rudder 60.

[0027] The chamber 20 could be formed as a cylinder i.e. having a circular or elliptical transverse cross section. The radius R2 of the protrusion 23 at the rear end 22 of the chamber 20 could be bigger than the radius of the rear end 22 of the chamber 20. This would mean that the center of the cavity 66 at the front edge 63 of the rudder 60 would be a little bit inwards into the chamber 20 from the point where the longitudinal central axis X-X of the chamber 20 and the turning axis Y-Y intercept. The bigger turning radius of the cavity 66 would mean that the chamber 20 could be a little bit longer before the curved protrusion 23 begins.

[0028] The propeller 50 shown in figure 1 can comprise a single propeller or two contra-rotating propellers.

[0029] 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. A propulsion arrangement in a ship comprising a hull (200), said propulsion arrangement comprising at least one propulsion unit (100) situated at the stern of the hull (200), said at least one propulsion unit (100) comprising:
 - a hollow support structure (10) having an upper portion (11), a lower portion (12), a front edge (13) and a rear edge (14), said upper portion (11) being stationary attached to the hull (200),
 - a chamber (20) having a longitudinal central axis (X-X), 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),
 - driving means (30) and transmission means (40) for driving a propeller (50) situated at the front end (21) of the chamber (20), and
 - a pivotable rudder (60) having an upper portion (61), a lower portion (62), a front edge (63), a rear edge (64), and a turning axis (Y-Y) in proximity to the front edge (63) of the rudder (60),

the rudder (60) being situated after the support structure (10) and the chamber (20) in the travelling direction (S1) of the ship so that the front edge (63) of the rudder (60) is in close proximity with the rear edge (14) of the support structure (11) and with the rear end (22) of the chamber (20), **characterized in that:**

- the rear end (22) of the chamber (20) comprises an outwardly curved protrusion (23) extending into a corresponding inwardly curved cavity (66) formed in the front edge (63) of the rudder (60), and
- the rudder (60) comprises a cone (67) having a base and an apex (A1), the base of the cone (67) surrounding the inwardly curved cavity (66) at the front edge (63) of the rudder (60) and the apex (A1) being within the rudder (60) or beyond the rear edge (64) of the rudder (60).

2. A propulsion arrangement according to claim 1, **characterized in that** a centre of the cavity (66) at the front edge (63) of the rudder (60) is close to a point where the longitudinal central axis (X-X) of the chamber (20) and the turning axis (Y-Y) of the rudder (60) intercept.
3. A propulsion arrangement according to claim 1 or 2, **characterized in that** the protrusion (23) and the cavity (66) is hemispheric.
4. A propulsion arrangement according to claim 1 or 2, **characterized in that** a transverse cross section of the protrusion (23) and the cavity (66) is elliptical.
5. A propulsion arrangement according to any of claims 1 to 4, **characterized in that** a transverse cross section of the cone (67) is elliptical.
6. A propulsion arrangement according to any of claims 1 to 5, **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.
7. A propulsion arrangement according to any of claims 1 to 6, **characterized in that** the power of the at least one propulsion unit (100) is at least 1MW.

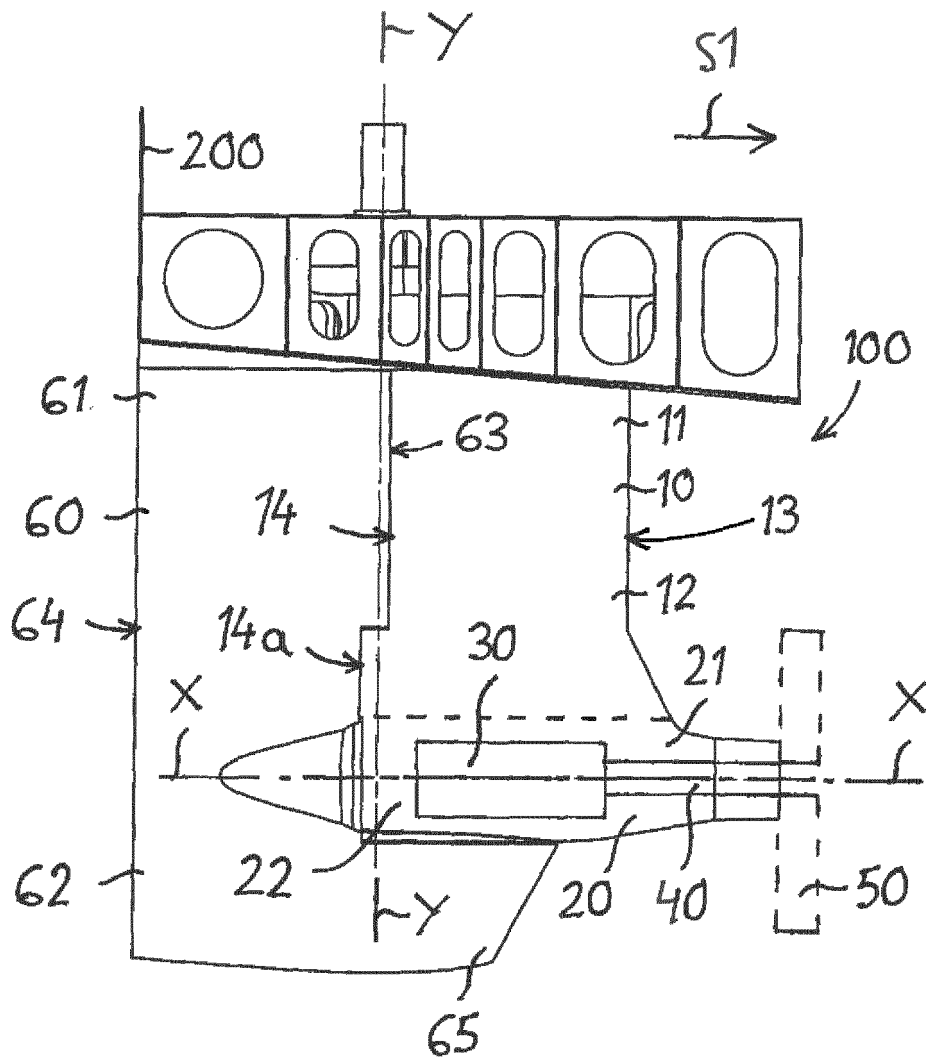


Fig. 1

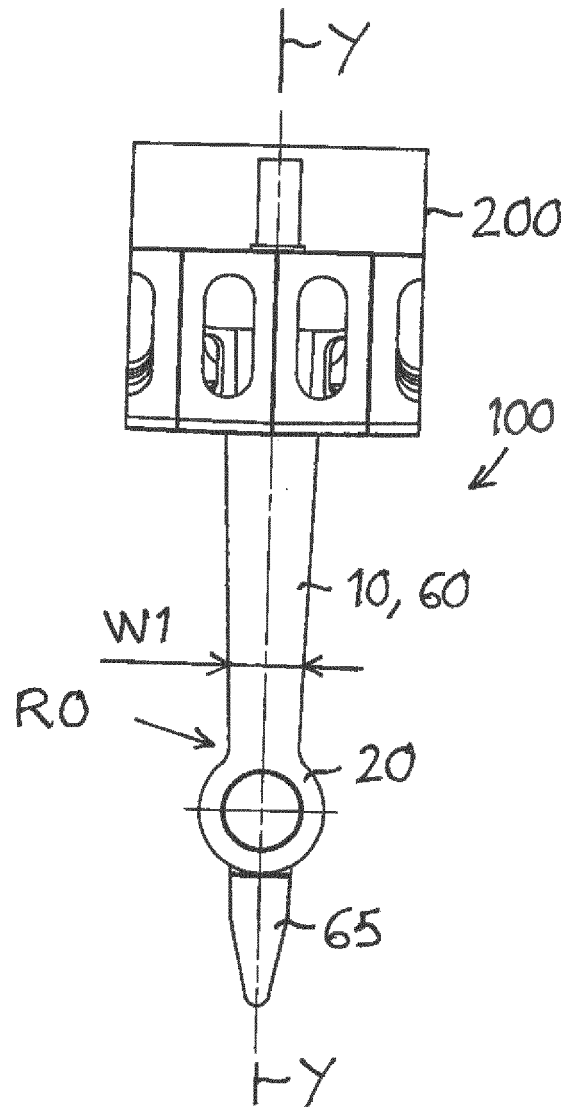


Fig. 2

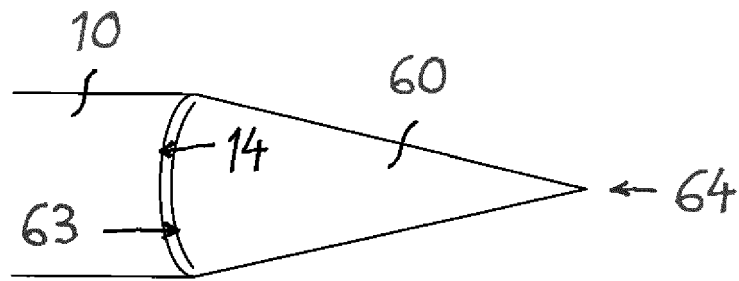


Fig. 3

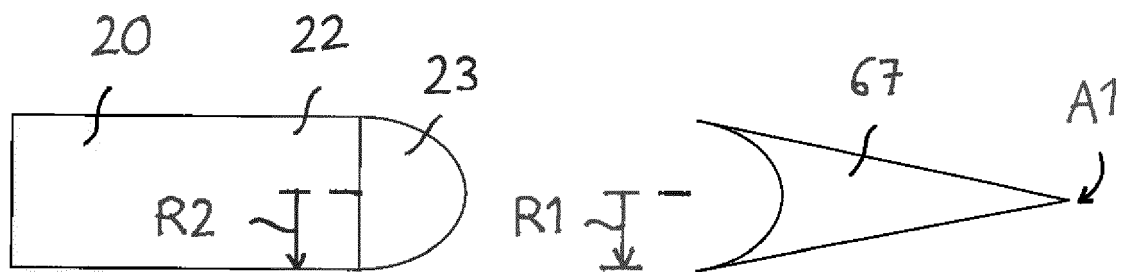


Fig. 4



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Application Number
EP 12 15 4664

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 July 2012	Examiner De Sena Hernandorena
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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