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

(11) EP 1 840 025 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.10.2007 Bulletin 2007/40

(51) Int Cl.:
B63H 1/16 (2006.01) *B63H 21/17 (2006.01)*

(21) Application number: 07105268.2

(22) Date of filing: 29.03.2007

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: 31.03.2006 IT MI20060632

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(54) Electrical traction system

(57) Electrical traction system having a propeller group formed from an inner hollow cylinder (21) inside which at least one propeller (22) is fixedly connected coaxial to said cylinder, so that the propeller itself and the cylinder can rotate together around said axis. The system comprises a rotor of an electric motor inside which such an inner cylinder is coaxially arranged and a cylindrical stator (63) is fitted onto said rotor, in such a way making an electric motor in which the rotor is hollow and cylindrical and a propeller is arranged inside it that rotates with said rotor.

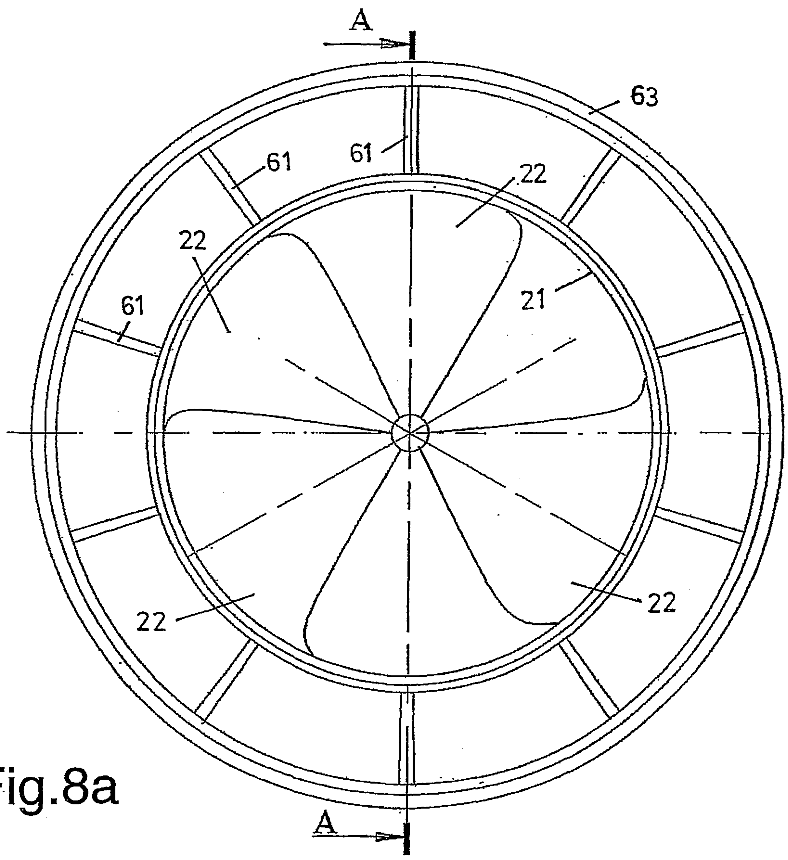

Fig.8a

EP 1 840 025 A2

Description

[0001] The present invention concerns an electrical traction system for example that can be used for shipping applications.

[0002] Currently, ship traction mainly makes use of the electrical field, since, unlike the traditional method in which the ship is propelled through a propeller and controlled through a rudder, the system of associating the propeller directly with an electric motor that is placed in the sea together with the propeller itself has been adopted.

[0003] For example, this method has been adopted for the cruise ship Queen Mary II where four propellers, associated with as many electric motors, take care of its navigation.

[0004] The propeller-electric motor association, which is placed directly in the sea, has substantial advantages:

- the drive shaft is reduced to a few centimetres;
- all of the types of gears necessary in normal traction are reduced;
- the rudder is superfluous since the propeller-electric motor unit, suitably arranged, can be rotated by 360° on its own vertical axis;
- overall vibrations and noise are reduced;
- the thrust of the propeller can be inverted without stopping it since it is sufficient to rotate the propeller-motor unit by 180° to obtain the desired result.

[0005] In particular, Queen Mary II has two fixed motors and two that can rotate, according to requirements, even by 360°; this type of selection substantially increases the manoeuvrability of the ship.

[0006] With the traditional propulsion method, the ship is only able to change its course with the rudder.

[0007] With the propeller-electric motor system it is possible to make the ship rotate upon itself even without it being in motion, since it is sufficient to rotate the propeller with respect to the axis of the ship and thus perform the necessary thrust making the propeller itself move.

[0008] This is a substantial advantage also during navigation since the possibility of deviation of the ship is no longer dependent upon the speed and the action of the rudder, but upon the thrusting force of the propellers; manoeuvrability substantially increases since the new propulsion system can move the thrust of the propellers and allow much tighter turns compared to ships having the traditional traction; for this reason the ship also becomes much safer with regard to the possibility of avoiding collisions.

[0009] The Applicant has observed that in electrical traction systems currently used the bulk at the back of the propeller is substantial and this mass disturbs the flow of water put in motion to ensure traction and therefore reduces the overall yield.

[0010] For very powerful groups, with this type of solution, the electric motor must necessarily be lengthened otherwise it is not possible to reach the necessary powers; for this reason the barycentre of the unit tends to move backwards, with respect to the propeller, increasing the overall mass of the metal structural work necessary to make the unit and unbalancing the symmetry of the figure with respect to the point of attachment of the group to the ship.

[0011] The Applicant has tackled the problem of reducing the bulk for the electrical moving systems of propellers or volutes, for example in the field of shipping but not only here.

[0012] The Applicant has made an electrical traction system using a propeller or volute in which the propeller or the volute are ducted in an inner cylinder also having the function of a rotor for an electric motor and an outer cylinder coaxial to such an inner cylinder having the function of a stator of the electric motor.

[0013] An aspect of the present invention concerns an electrical traction system characterised in that it comprises a propeller group formed from an inner hollow cylinder inside which at least one propeller is fixedly connected coaxial to said cylinder, so that the propeller itself and the cylinder can rotate together around said axis, a cylindrical rotor of an electric motor inside which such an inner cylinder is coaxially arranged provided with a propeller and a cylindrical stator fitted onto said rotor, in such a way making an electric motor in which the rotor is hollow and cylindrical and a propeller is arranged inside it that rotates with said rotor.

[0014] Further purposes and advantages of the system according to the present invention shall become clearer from the following description and from the attached drawings, provided purely as a non-limiting example, in which:

- figures 1a and 1b illustrate a view of the propeller of the system according to a first embodiment of the present invention;
- figures 2a and 2b illustrate a view of the propeller of the system according to a further embodiment of the present invention;
- figures 3a and 3b illustrate a view of the propeller of the system according to a further embodiment of the present invention;
- figures 4a and 4b represent a rotor of a permanent magnet motor according to the present invention;
- figures 5a and 5b represent a suitable stator for the rotor of the permanent magnet motor illustrated in figures 4a and 4b according to the present invention;
- figures 6a and 6b represent a rotor of a polyphase asynchronous motor according to the present invention;
- figures 7a and 7b represent a suitable stator for the rotor of the asynchronous motor illustrated in figures 6a and 6b according to the present invention;
- figures 8a and 8b represent the unit of the propeller of figures 1a and 1b, of the rotor of figures 6a and 6b and of the stator of figures 7a and 7b according

to the present invention;

- figure 9 illustrates the traction system according to the present invention applied as an example to a submarine.

[0015] With reference to the quoted figures, the traction system 1 according to the present invention is made through substantially three parts that can be assembled together. In particular, the system comprises a propeller group formed from an inner hollow cylinder inside which at least one propeller is arranged coaxial to said cylinder, so that the propeller itself and the cylinder can rotate together around said axis.

[0016] Outside of such a propeller group the system comprises a cylindrical rotor of an electric motor inside which such an inner cylinder is coaxially arranged provided with a propeller and a cylindrical stator fitted onto said rotor. In practice, the unit makes an electric motor in which the rotor is hollow and cylindrical and a propeller is arranged inside of it that rotates together with said rotor.

[0017] Figures 1a and 1b, 2a and 2b and 3a and 3b illustrate three possible embodiments for such a propeller group and in particular in figures 1a and 1b the propeller group 2 is formed from an inner cylinder 21 and from three blades 22, which occupy at least half the available surface, arranged on three axes staggered by 120° and fixed onto the cylinder; the cylinder is in turn fixed through suitable shackles 23 to a rotor of the electric motor. Figures 2a and 2b illustrate a propeller group 2' formed from three distinct propellers 22' but fixedly connected to the same shaft and the same cylinder 21'. Each propeller is formed from four blades, with accentuated hydrodynamic shape, preferably with a structure that is much longer than it is wide; in total there are twelve blades and they have the purpose of optimising the yield of the overall propeller; this propeller structure could advantageously replace the propellers of maximum size currently foreseen (a size that is around eight metres and over in diameter) and that are made at this time for high powers, but with very long processing times and high costs.

[0018] The cylinder 21' is in turn fixed through suitable shackles 23' to a rotor of the electric motor.

[0019] Figures 3a and 3b represent a propeller group 2" formed from a propeller with four blades 22" that can swivel since they are hinged and equipped with rollers, on which they slide, on the central hub and they are commanded by a suitable eccentric lever 24 on the end part of the blade.

[0020] The cylinder 21" is in turn fixed through suitable shackles 23" to a rotor of the electric motor.

[0021] Figures 4a and 4b illustrate a cylindrical rotor 3 of a permanent magnet electric motor with transversal flow having a plurality of magnets 31 positioned through the help of locking sectors 32 having the poles 33 fixed onto the inner central part of the cylinder.

[0022] On the two sides of the magnets the excitation coils of the stator are arranged and the rotation of the propeller is obtained from the interaction of the two.

[0023] Moreover, on the inner surface of the rotor, shackles 34 matching those arranged on the inner cylinder of the propeller group can be seen.

[0024] Figures 5a and 5b illustrate the unit of the stator 4 that can be coupled with the rotor of figure 4, without the excitation coils for the sake of ease of representation. In particular, the stator is made with many modules that are the same as each other, fixed by baffles 41 arranged between the two concentric locking cylinders 42, which support the excitation coils 43 with the polar expansions 44; the ferromagnetic modules are preferably made from sintered material, in order to also be able to use high frequencies to optimise the electrical yield.

[0025] Figures 6a and 6b illustrate a rotor 5 for a polyphase asynchronous motor, in which ring cages 51 and radial fittings 52 for them are highlighted. Moreover, on the inner surface of the rotor, shackles 54 matching those arranged on the inner cylinder of the propeller group can be seen.

[0026] Figures 7a and 7b illustrate the stator 6, supported by brackets 61 that are welded to a support ring 62 in turn locked onto the outer ring 63 that supports the stator, and that corresponds to the asynchronous rotor of figures 6a and 6b; in this case a rotating magnetic field is made using a polyphase system with the electrical windings distributed in the suitable recesses 64, formed in the ferromagnetic body 65.

[0027] Figures 8a and 8b represent the unit of the propeller of figures 1a and 1b of the rotor of figures 6a and 6b and of the stator of figures 7a and 7b according to the present invention.

[0028] In particular, the rotor is assembled, the propeller-holding cylinder assembled with the rotor-carrying cylinder and the two cylinders are inserted one inside the other and suitably attached to each other. A single unit is thus obtained: propeller-rotor of the electric motor. At this point the propeller-rotor group is inserted into the stator of the asynchronous electric motor obtaining the ship traction system visible in figure 8. The two cylinders, asynchronous motor stator and rotor-propeller, are joined together preferably through rolling bearings, which allow the rotor to slide with respect to the stator.

[0029] The selection of the two cylinders is not essential since, again in the field of the present invention, it is possible to use a single cylinder having fixed, in the inner wall, a propeller and, in the outer wall, the rotor of the electric motor. The selection of the two cylinders shortens the overall processing times since it is possible to work simultaneously on propeller and rotor.

[0030] The unit of the various elements (propeller group, rotor and stator) is arranged in a suitable support cover, is placed, in the case in which the system of the present invention is applied to a ship, under the hull of the ship substantially in the position foreseen for traditional traction systems.

[0031] For example in figure 9 the traction system 1 according to the present invention is applied to a submarine S, under the hull and in the traditional position in which the propellers are arranged.

[0032] The system according to the present invention has the special feature of being symmetrical in the planes perpendicular to each other quoted previously. In this way the electric motor completely circles the propeller, which is made to rotate by the rotor of the electric motor itself.

[0033] The propeller is located inside the electric motor so, at its rear, there is no mass that can disturb the flow of water; in this way the maximum possible thrust is obtained.

[0034] The structure that supports the propeller and the electric motor is made, in the front part, preferably funnel-shaped and has the task of conveying the flow of water towards the propeller; it is therefore possible to increase the number of rotations of the propeller compared to traditional systems, since the flow of liquid is not able to escape at the side of the propeller itself. The liquid is thus completely expelled from the rear part, with an increase in thrust compared to a normal propeller and thus taking on the advantages of ducted propellers compared to traditional propellers. The diameter of the electric motor is quite large compared to known systems since it must support the propeller inside it.

[0035] This is a characteristic of the invention, since the increase in diameter corresponds to an increase in the circumference of the motor and therefore the possibility of increasing the number of magnetic poles that can be used for the formation of the power of the motor itself; moreover, the greater the diameter, the greater the mechanical torque applied to the propeller. In particular, if the diameter of the electric motor is doubled, the linear availability for arrangement of the magnetic poles is also doubled for the same number of revolutions of the motor, and since the distance travelled is also doubled, the power of the motor itself becomes four times the power of the original motor.

[0036] In other words, if one wishes to keep the power unchanged, it is possible, in this case, to reduce the number of revolutions/seconds to one quarter; in this way it is possible to completely eliminate the gears for reducing the number of revolutions per second and obtain a propeller-electric motor unit that is much more elastic and with a greater overall yield than he system used previously.

[0037] A higher linear development of the motor also allows a better dissipation of the heat produced by the Joule effect in the electrical circuits of the stator.

[0038] With regard to the type of electric motor that can be used according to the present invention there is a very wide possibility of choice. For example, if the system for producing electrical energy on the ship is alternating with variable frequency it is possible to use a synchronous motor that starts up at low frequency and is taken to the desired frequency for the operation and for the power that has been designed. Equally, it is possible to use a conventional asynchronous motor, even if the weight-power ratio is better for a synchronous motor. It is also possible to use a transverse magnetic flux motor and with the provision of one or more inverters a unit can be obtained with a yield that can be optimised both in terms of yield and, all in all, also in terms of the overall construction, maintenance and management costs of the machine. With transversal flux machines and permanent magnets it is possible to reduce to the minimum the losses by Joule effect; by using sintered magnetic circuits, a high current frequency combined with many magnets made with rare earths it is possible to optimise the yield and obtain electric machines with a very high power/machine mass ratio.

Claims

1. Electrical traction system **characterised in that** it comprises
   a propeller group (2, 2', 2") formed from an inner hollow cylinder (21, 21', 21") inside which at least one propeller is fixedly connected coaxial to said cylinder, so that the propeller itself and the cylinder can rotate together around said axis,
   a cylindrical rotor (3, 5) of an electric motor inside which such an inner cylinder is coaxially arranged provided with a propeller and a cylindrical stator (4, 6) fitted onto said rotor, in such a way making an electric motor in which the rotor is hollow and cylindrical and a propeller is arranged inside it that rotates with said rotor.

2. System according to claim 1, wherein such a propeller group (2) comprises an inner cylinder (21) and three blades (22), which occupy at least half the available surface, arranged on three axes staggered by 120° and fixed onto such a cylinder.

3. System according to claim 1, wherein such a propeller group (2') comprises three distinct propellers (22') fixedly attached to the same shaft and the same cylinder (21'), each propeller being formed from four blades.

4. System according to claim 1, wherein such a propeller group (2") comprises a propeller with four blades (22") able to swivel since they are hinged and equipped with rollers, on which they slide, on a central hub and they are commanded by a suitable eccentric lever (24) on the end part of the blade.

5. System according to claim 1, wherein the cylinder (21, 21', 21") is fixed through suitable shackles (23, 23', 23") to matching shackles arranged on the inner surface of the rotor of the electric motor.

6. System according to claim 1, wherein such a rotor is a cylindrical rotor (3) of a transverse flux and permanent magnet electric motor having a plurality of

magnets (31) positioned through the help of locking sectors (32) and having the poles (33) fixed onto the inner central part of the cylinder.

7. System according to claim 6, wherein such a stator (4) is made with many modules that are the same as each other, fixed by baffles (41) arranged between two concentric locking cylinders (42), which support the excitation coils (43) with the polar expansions (44).

8. System according to claim 1, wherein such a rotor (5) is a rotor for a polyphase asynchronous motor having ring cages (51) and radial fittings (52) for them.

9. System according to claim 8, wherein such a stator (6) is made from a support ring (62) and from an outer ring (63) connected together through brackets (61), on which electrical windings are arranged distributed in suitable recesses (64), formed in the ferromagnetic body (65) to form a polyphase system.

10. System according to claim 1, wherein the propeller, rotor and stator group is arranged in a suitable support cover and is placed, in the case in which the system is applied to a ship, under the hull of the ship itself.

11. System according to claim 10, wherein the structure that supports the propeller and the electric motor is made, in the front part, funnel-shaped and has the task of conveying the flow of water towards the propeller.

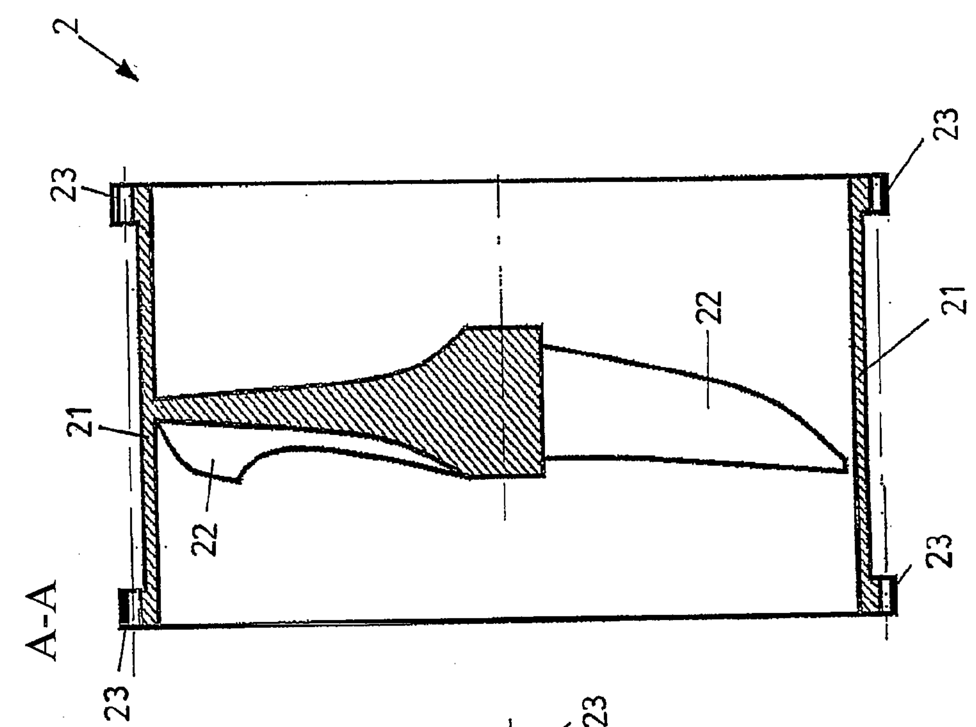

Fig.1b

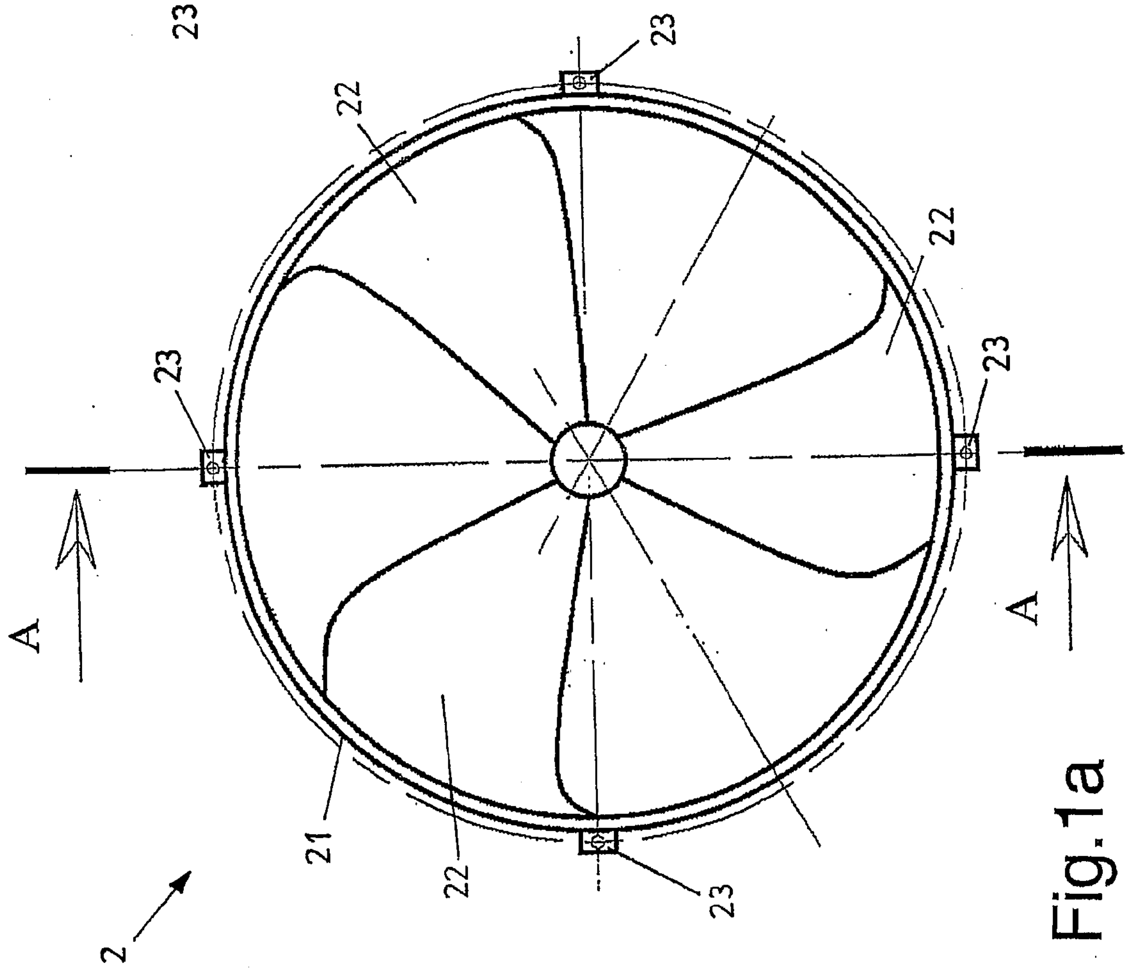

Fig.1a

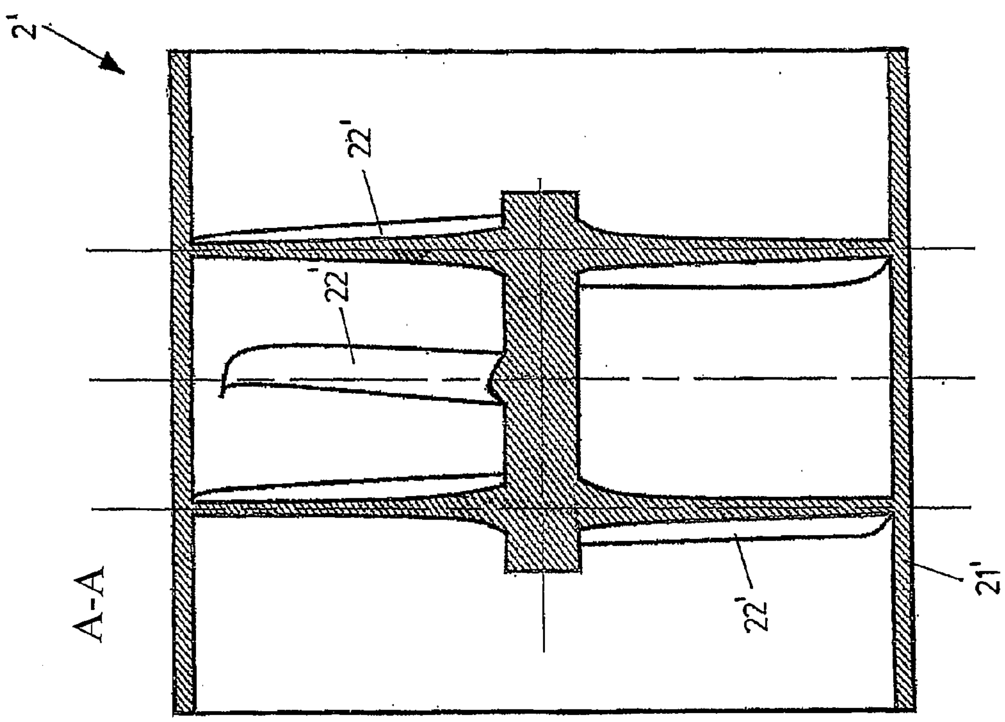

Fig.2b

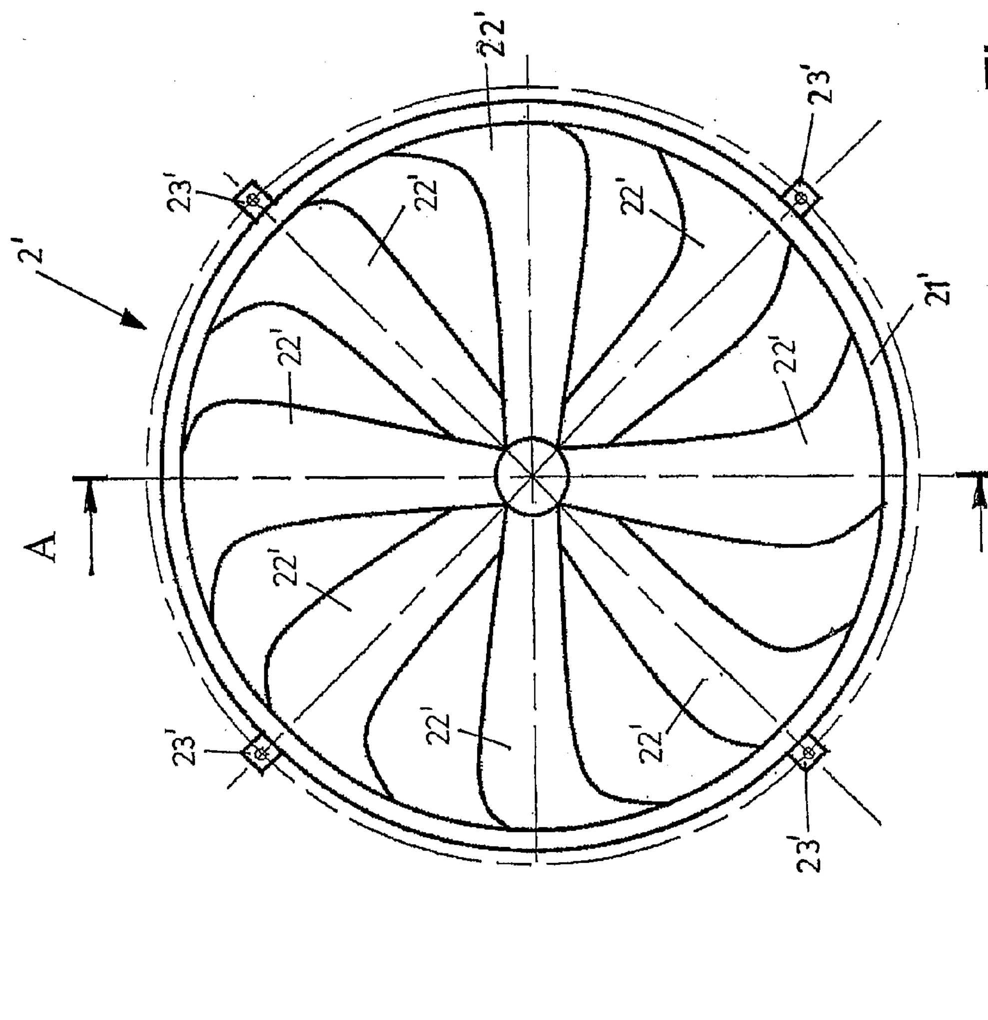

Fig.2a

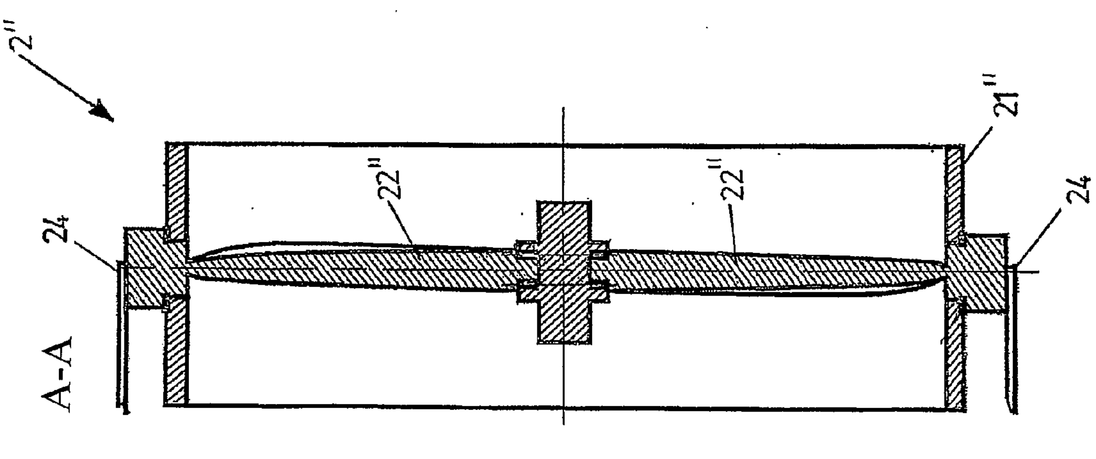

Fig.3b

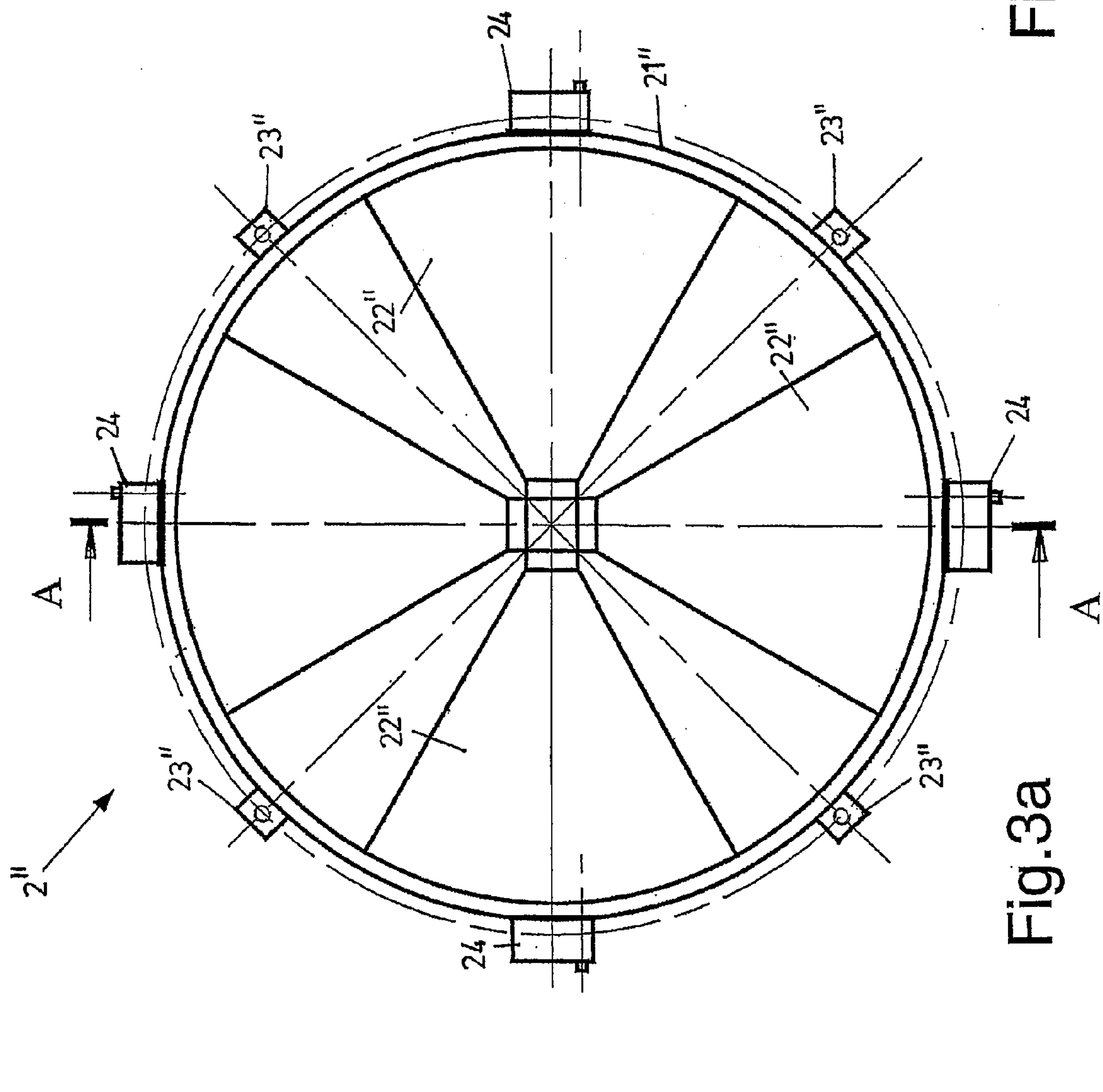

Fig.3a

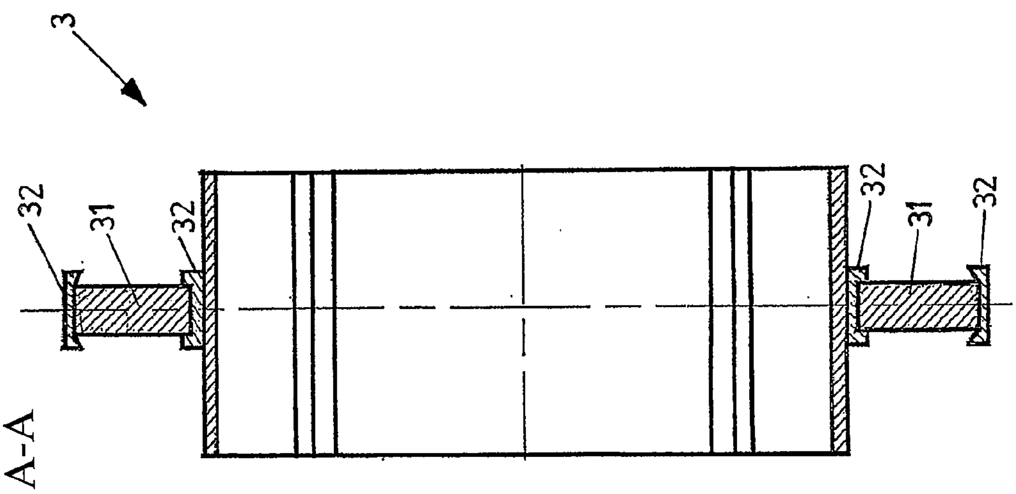

Fig.4b

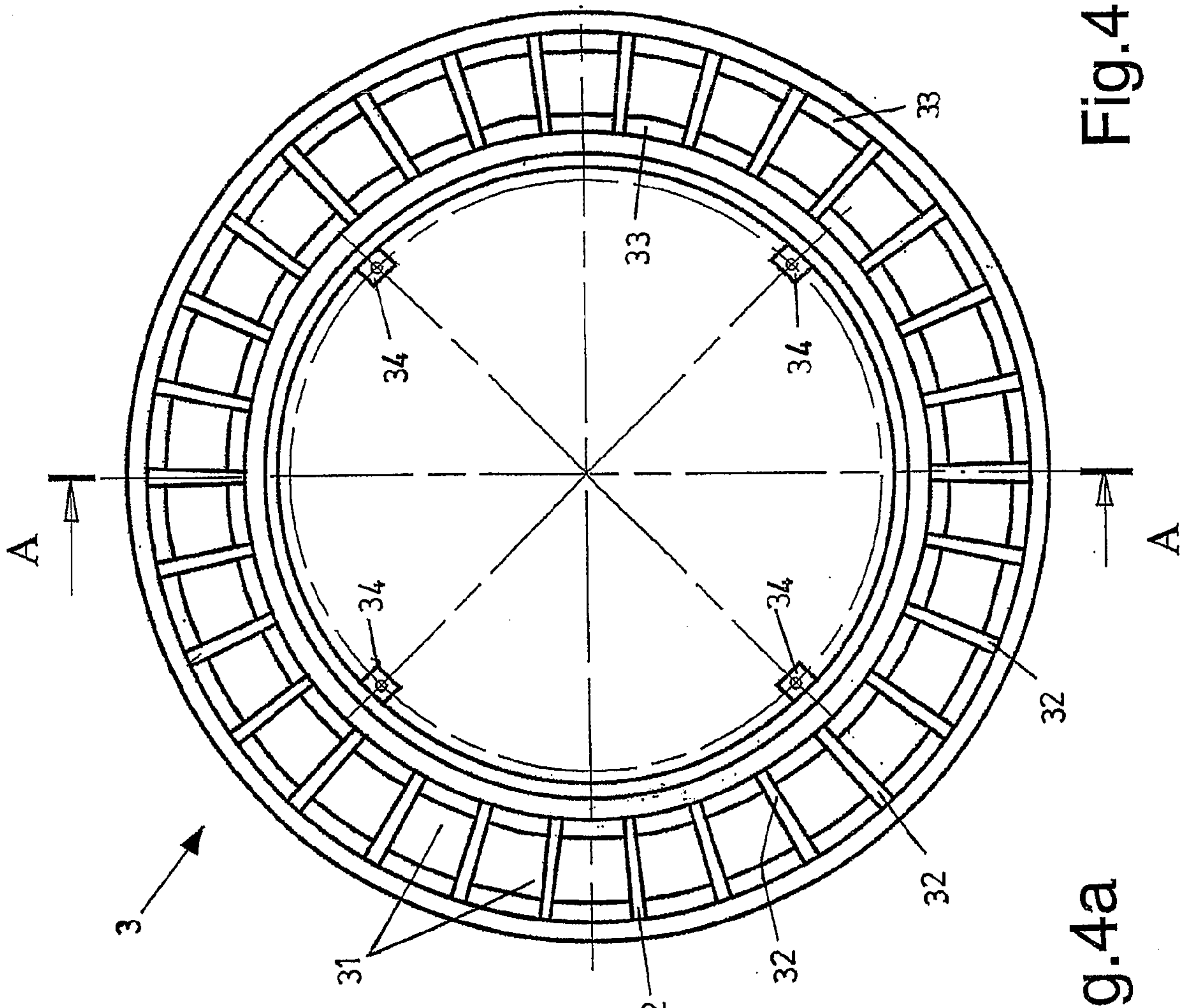

Fig.4a

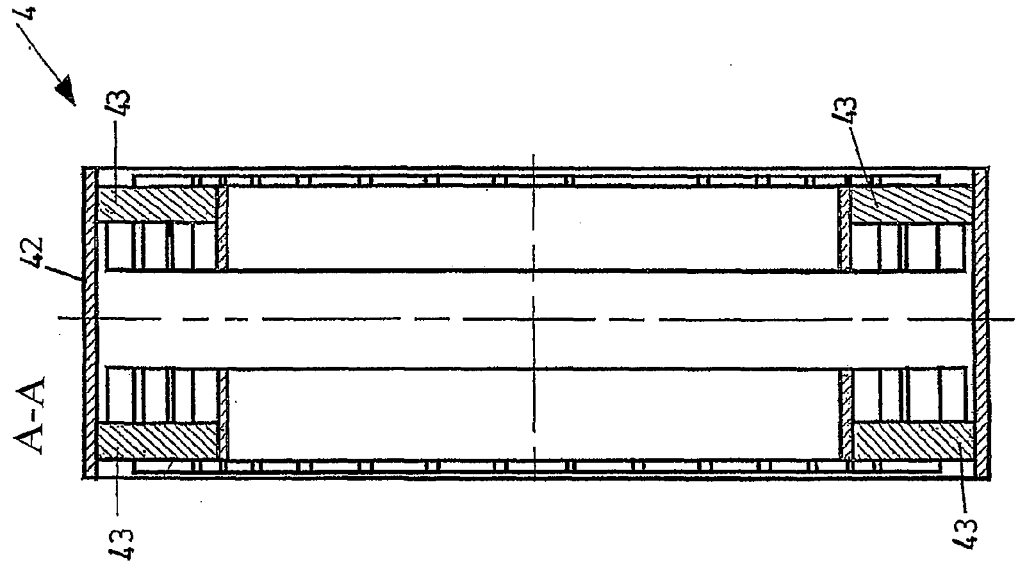

Fig.5b

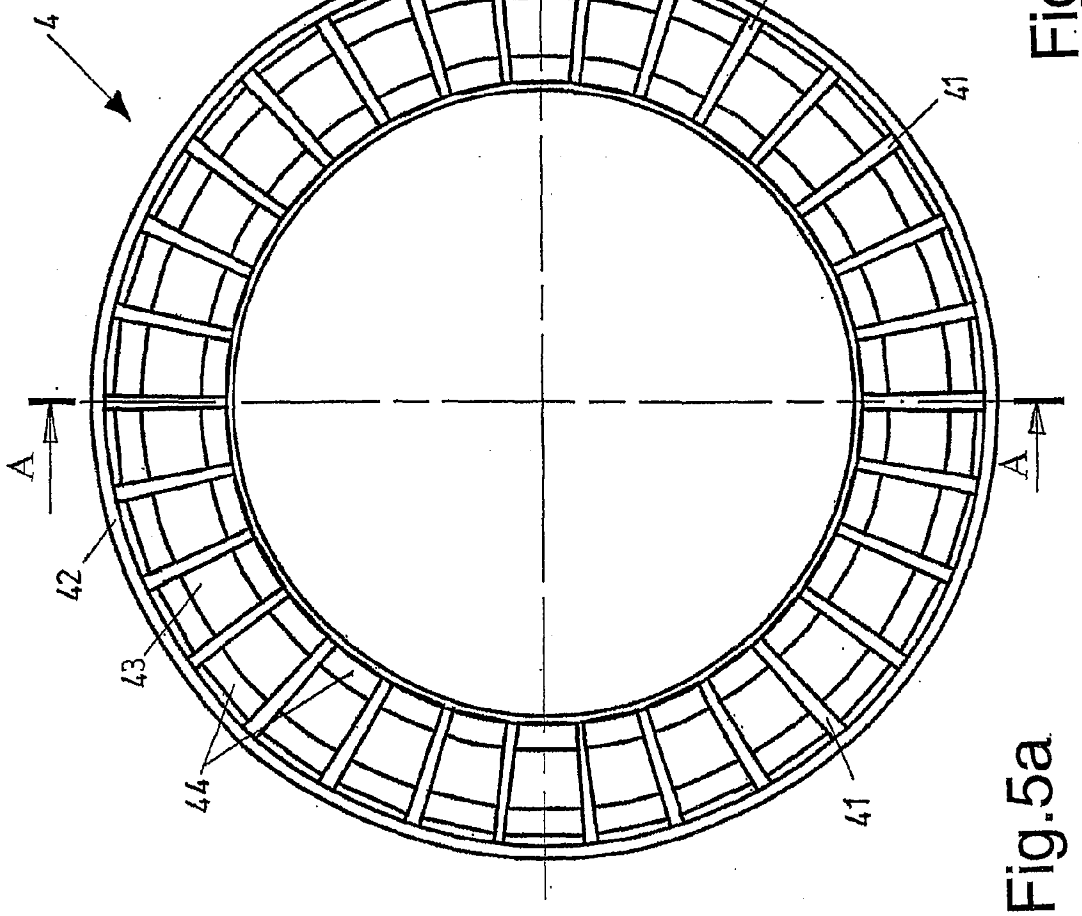

Fig.5a

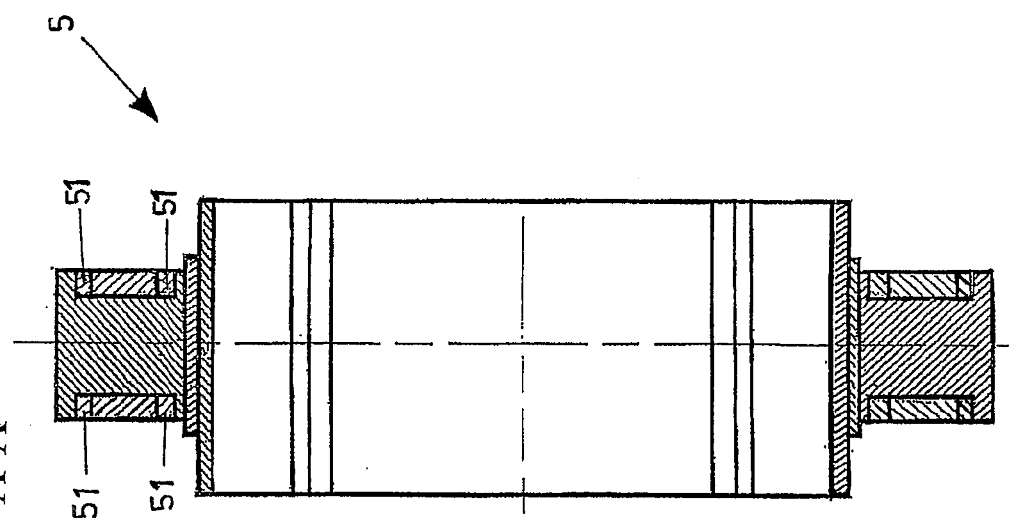

Fig.6b

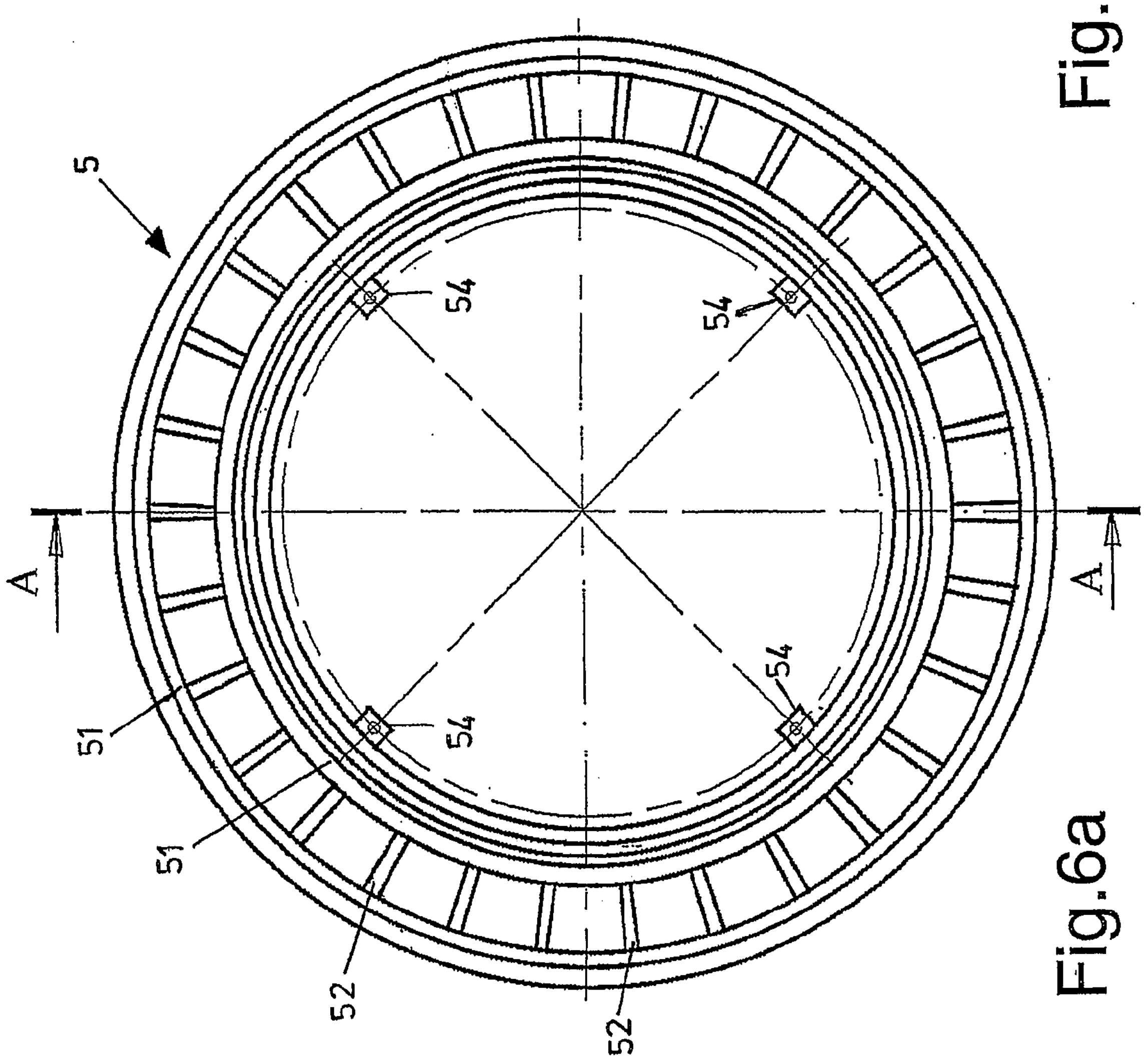

Fig.6a

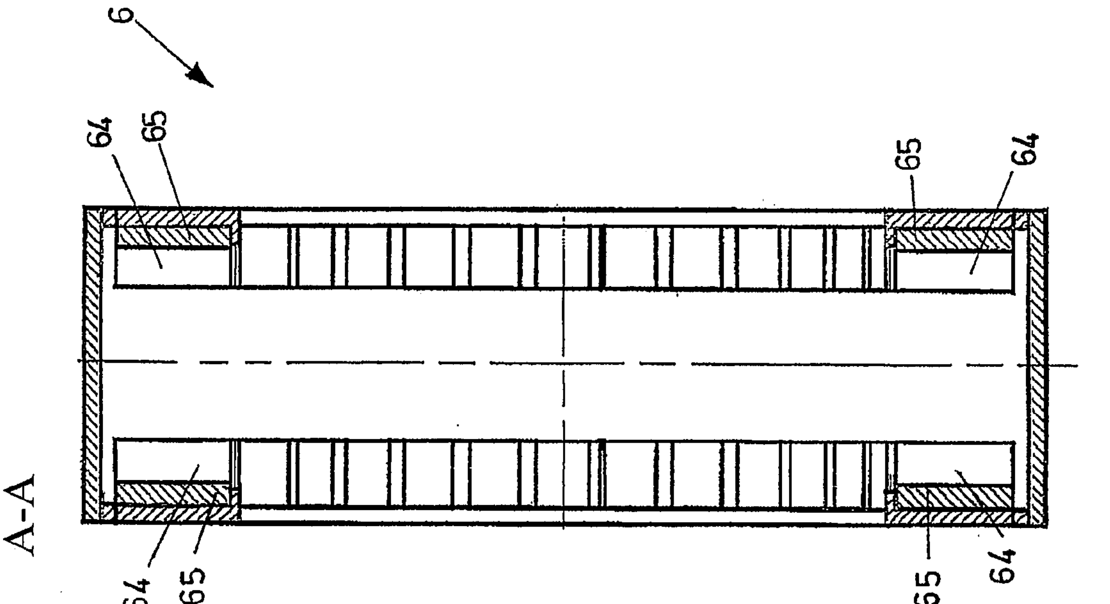

Fig.7b

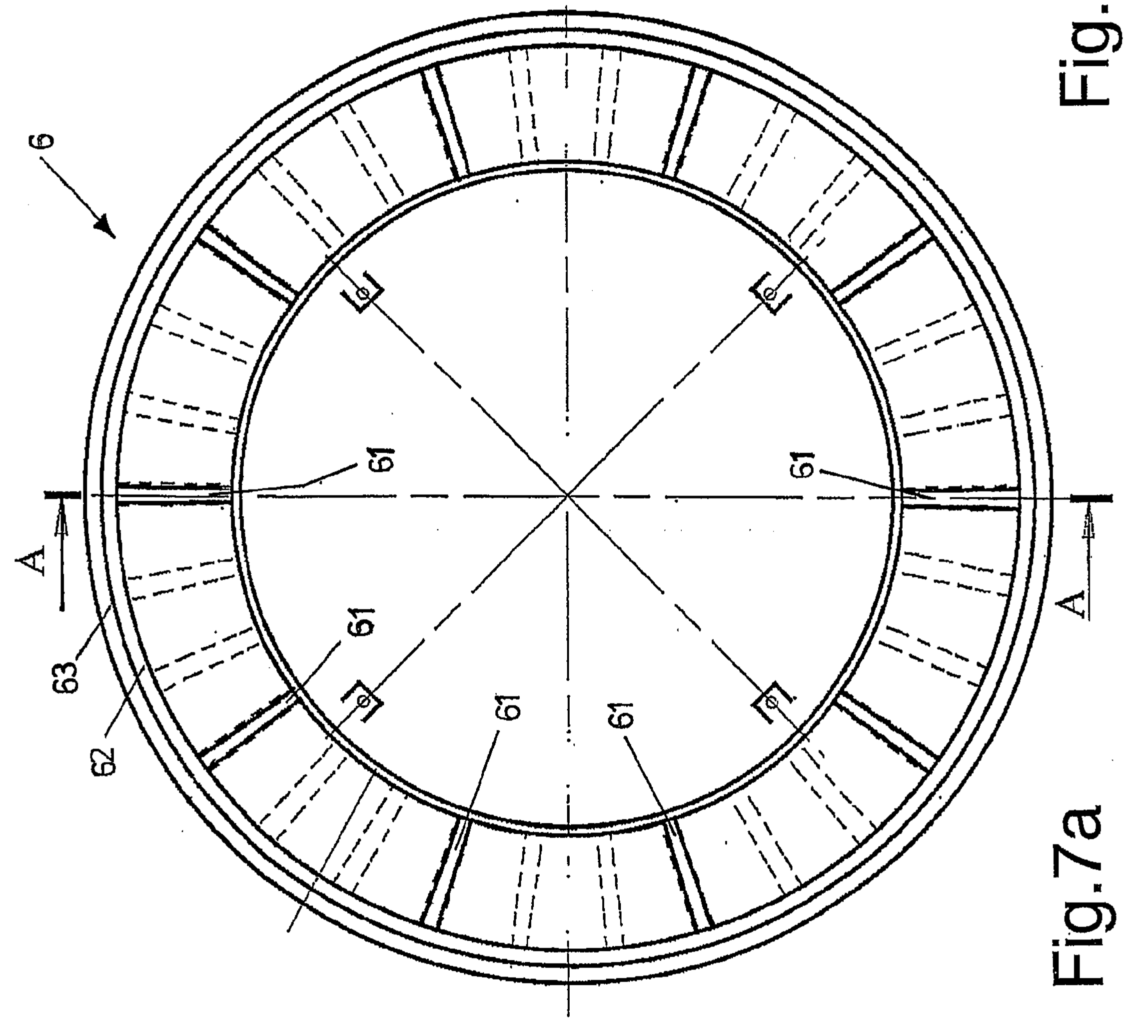

Fig.7a

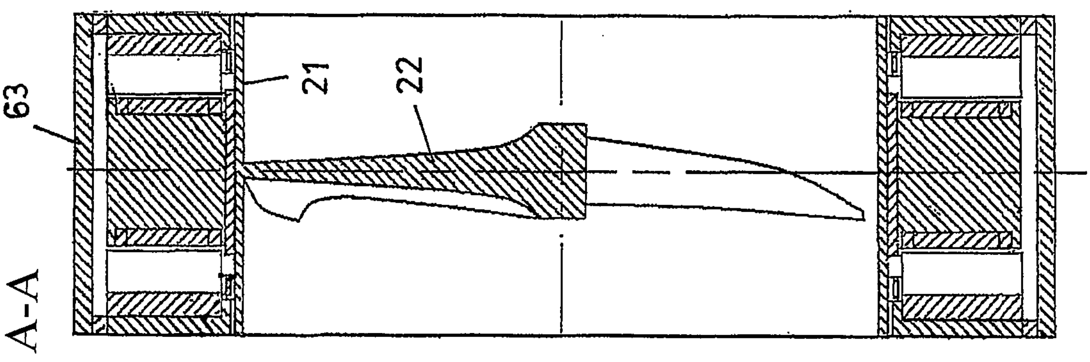

Fig.8b

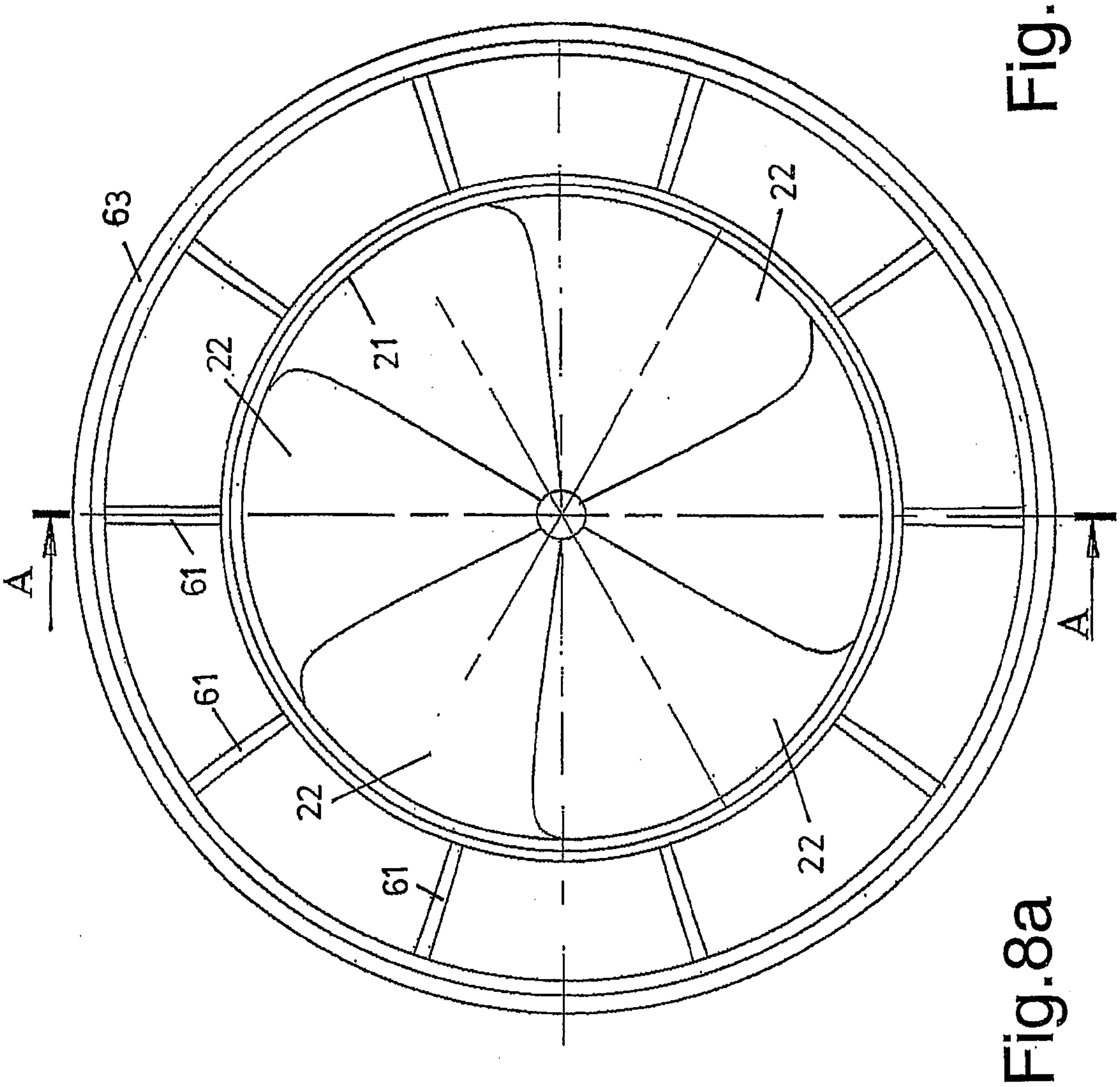

Fig.8a

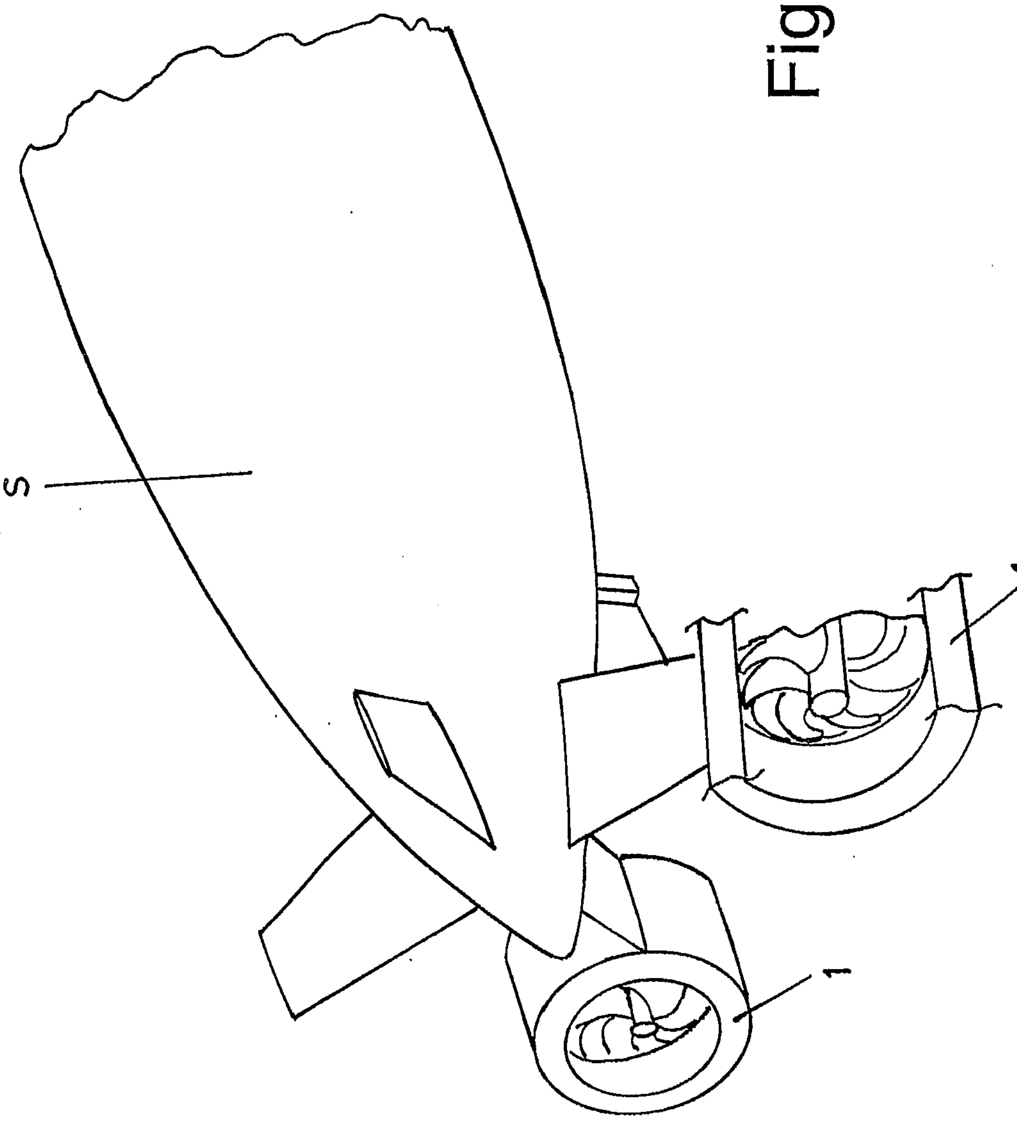

Fig. 9