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(71) Applicant: **Grima, Paul**
Malta BKR04 (MT)

(72) Inventor: **Grima, Paul**
Malta BKR04 (MT)

(74) Representative: **Riccardi, Sergio**
Via M. Melloni, 32
20129 Milano (IT)

(54) **Oscillating hydrofoil propulsion and steering system**

(57) Oscillating hydrofoil propulsion and steering system provided for any kind of waterborne craft, comprising at least a pair of hydrofoil blades (1) movably fixed on casings (4). Said casings (4) are operatively driven by any kind of gearbox in order to transmit both the propulsion motion and the steering operation.

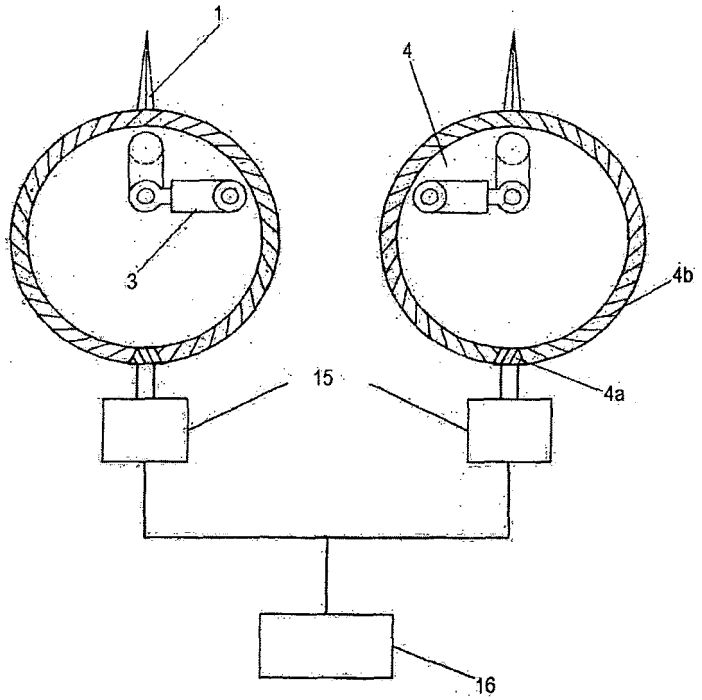

Fig. 1

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Description

[0001] The present invention relates to an oscillating hydrofoil propulsion and steering system, which is provided in general for waterborne crafts.

[0002] Current propeller and cycloidal propulsion systems have many known drawbacks. Many propellers, indeed, lose efficiency at speed and, if not properly designed, can be damaged by cavitation. Moreover propellers have limits since they produce propeller walk, especially when reversing, and propeller slip, which diminishes their efficiency. Propellers are very noisy and cause a lot of vibrations, especially at speed, and can be heard at great distances under water. It is also known that, on motorized sailing vessels, propellers cause undesired drag when the vessel is sailing, even if they are feathered. On the other hand, cycloidal propulsion systems can reach very limited speed.

[0003] Further propeller and cycloidal propulsion systems, provided on different waterborne crafts, can be lethal to swimmers and aquatic life due to the blade rotation under water. It is therefore imperative to switch their engines off, for example, during rescue operations. Propeller and cycloidal propulsion systems are also very vulnerable to hitting hard objects.

[0004] These drawbacks force some waterborne military vessels to a limited speed in stealth missions, and makes it hard to study some forms of marine life closely without disturbing the same.

[0005] Main object of the present invention is, therefore, to provide a propulsion and steering system which makes vessels faster and more fuel-effcient than either cycloidal-driven vessels or most propeller vessel.

[0006] Further object of the present invention is to provide a propulsion and steering system which makes vessels much more maneuverable than either cycloidal vessels or propeller vessels, without need of any bow or stern thruster, since it is able to make a vessel turn 360 degrees on the same spot or even move sideways and backwards or in any other direction. Thus a submarine equipped with the propulsion and steering system according to the present invention can move sideways and/or up and down without any forward motion, even without its ballast tank operation, staying level, and always in quite complete silence, since it should be free from propeller noise and vibrations. For motorized sailing vessels the propulsion and steering system according to the present invention may serve, while sailing under wind power, as a keel and/or rudder system.

[0007] Further object of the present invention is to provide a propulsion and steering system which is much safer for swimmers and aquatic life than propeller and cycloidal system, thus allowing for studying aquatic life closely without disturbing the same since there is no propeller noise and vibrations.

[0008] Further object of the present invention is to provide a propulsion and steering system which does not result as vulnerable as propeller and cycloidal systems to hitting hard objects.

[0009] Further object of the present invention is to provide a propulsion and steering system which can be made weedless and/or tangle-free, by which a vessel can avoid being entangled in submerged weeds, ropes or nets.

[0010] The oscillating hydrofoil propulsion and steering system according to the present invention can be applied suitably on all kinds of waterborne craft: model crafts, small boats, pedal power pleasured crafts, cabin cruisers, yachts, military stealth boats and ships, warships, submarines and supertankers.

[0011] A detailed description of the oscillating hydrofoil propulsion and steering system according to some embodiments of the present invention will be now provided with reference of the annexed drawings in which:

fig. 1 is a top view of the oscillating hydrofoil propulsion and steering system according to a first embodiment of the present invention;

fig. 2 is a top view of the oscillating hydrofoil propulsion and steering system according to a second embodiment of the present invention;

fig. 2a is an exploded view of the oscillating hydrofoil propulsion and steering system in fig. 2;

fig. 3 is a top view of the oscillating hydrofoil propulsion and steering system according to a third embodiment of the present invention;

fig. 3a is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3 showing a first member displacement;

fig. 3b is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3 showing a second member displacement;

fig. 3c is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3 showing a third member displacement;

fig. 3d is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3 showing a fourth member displacement;

fig. 3e is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3 showing a fifth member displacement;

fig. 3f is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 3;

fig. 3g is an exploded view of the oscillating hydrofoil propulsion and steering system in fig. 3;

fig. 4 is a top view of the oscillating hydrofoil propulsion and steering system according to a fourth embodiment of the present invention;

fig. 5 is a top view of the oscillating hydrofoil propulsion and steering system according to a fifth embodiment of the present invention;

fig. 5a is a top view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 5 showing the alternative member displacement;
fig. 6 is a top view of the oscillating hydrofoil propulsion and steering system according to a sixth embodiment of the present invention;
fig. 7 is a top view of the oscillating hydrofoil propulsion and steering system according to a seventh embodiment of the present invention;
fig. 8 is a perspective view of the oscillating hydrofoil propulsion and steering system according to the strut mounted embodiment of the present invention;
fig. 8a is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8;
fig. 8b is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 showing a first member displacement;
fig. 8c is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 showing a second member displacement;
fig. 8d is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 showing a third member displacement;
fig. 8e is a side view of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 showing a fourth member displacement;
figs. 9 to 9b show an arrangement of the strut mounted oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 suitable for a hydrofoil boat;
figs. 10 to 10b show an arrangement of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 suitable for a sailboat;
figs. 11 to 11b show an arrangement of the oscillating hydrofoil propulsion and steering system according to the embodiment in fig. 8 suitable for a submarine.

[0012] Referring now to fig. 1, a main drive unit 16 is shown, operatively connected to a pair of transmission units 15, each gearing a casing 4. Each casing 4, in turn, has arranged thereon an hydrofoil blade 1 by a flap mechanism 3. Said casings 4 are preferably mounted flush to any submerged or submersible portion of the outer surface of vessel (see fig. 3f). In such embodiment both the propulsion transmission and the steering operation are combined into each unit 15, governed by said unit 16, that generates a motion of the pinion 4a, gearing the crown wheel 4b, reciprocating for propulsion and continuous for steering, respectively.

[0013] In fig. 2 there is illustrated a second embodiment in which the propulsion transmission and the steering operation are realized by two different mechanisms. The mechanism for the propulsion transmission comprises a pair of connecting rods 7 and a pair of harnesses 5 gearing each other. Each connecting rod 7 is hinged to the corresponding harness 5 that, in turn, is hinged to a casing 4. The connecting rods 7 are preferably a hydraulic or pneumatic rams and provide synchronous reciprocating motion to the casings 4 by said pair of harnesses 5. The mechanism for the steering operation, instead, comprises a shaft 11, a gearbox 8, a pair of telescopic shafts 9 and a pair of endless screws 12, each gearing the corresponding above described casing 4. The rotation of the shaft 11 is transmitted, through said gearbox 8, to each telescopic shaft 9 that, in turn, rotates each endless screw 12, thus rotating the corresponding casing 4.

[0014] Further embodiment is illustrated in fig. 3 that shows a propulsion transmission system different in respect of the previous embodiment. Each of said endless screws 12 is, indeed, hinged with a first end of an arm 14, hinged, in turn, at the opposite end with a shaft 13, by which the reciprocating motion is provided in order to generate the propulsion needed. Figs. 3a to 3f show different configurations of the propulsion and steering system assured by the above described embodiment. Fig. 3a shows the hydrofoil blade oscillation around its axis and the operation of the flap mechanism 3 that acts as shock absorber. Fig. 3b shows the rotation of the hydrofoil blades 1 thus diverging, when the shaft 13 moves towards the casings 4, whilst fig. 3c shows the rotation of the hydrofoil blades 1 thus converging, when the shaft 13 moves in the opposite direction. This reciprocating motion assures the oscillation of the hydrofoil blades 1 and therefore the propulsion of the vessel. Figs. 3d and 3e, instead, show two similar configurations, each of them corresponding to two different steering angles, 90 and 180 degrees respectively. The hydrofoil blades 1 reach said steering angles by rotating the shaft 11 that, through the gearbox 8 and the telescopic shafts 9, rotates the endless screws 12, each, as previously shown, gears a casing 4.

[0015] Fig. 4 shows a further embodiment according to the present invention in which a single casing 4, housing a pair of hydrofoil blades 1, is used, Such embodiment, if preferred, can be a much lighter, simple and less expensive variant, having a parallel motion linkage. Each hydrofoil blade 1 is mounted onto an arm 17, which is connected to a shaft 15 by a pair of arms 16. Said arms 16 are, indeed, hinged at their opposite ends between the shaft 15 and the arm 17. On said arm 17 is also arranged the member 3 which even acts as shock absorber. The reciprocating motion of the shaft 15 provides for the vessel propulsion, whilst the previously described endless screw mechanism provides for steering operation by the rotation of the shaft 11.

[0016] In yet another embodiment, illustrated in figs. 5 and 5a, the hydrofoil blades 1 may be movably attached directly to the outer surface of a vessel by hinges 20, without the use of any casing, and providing the steering

operation by the rotation of a shaft 18 acting on the transmission shaft 19.

[0017] Finally in figs. 6 and 7 multiple hydrofoil blades 1 are arranged on the same casing 4, using one of the previously described systems both for propulsion motion and steering operation.

[0018] Fig. 8 illustrates, in a perspective view, a strut mounted embodiment according to the present invention. Such embodiment differs from previously described embodiments by the fact that the casings 4 are formed on a strut 18 and back-to-back arranged. Said strut is rotatable in order to assure the steering operation of the vessel on which it is mounted. The embodiment in fig. 8 offers the further advantage of keeping vortices, generated during the propulsion motion of the hydrofoil blades 1, away from the surface of said vessel. It can be adapted to any planning or displacement hull, which does not result limited by the propulsion speed. A given vessel can also be equipped by one or more struts 18 each of which incorporating one or more oscillating hydrofoil systems according to the present invention. The height of the vessel hull from the water can be controlled and adjusted, as desired, by changing the angle of attack of the hydrofoil blades 1, depending on the weight of the same vessel and the desired speed. In order to assure the aforementioned features and advantages of the embodiment on fig. 8, a separate mechanisms are provided for propulsion motion and steering operation. With reference to figs. 8a and 8b, the strut 18 is provided with a pair of housing 20 and 21 for the casings 4 each, in turn, provided with a hole 4' and a hinge 4". The hole 4' houses the hydrofoil blade axle 1' which is also supported by the flap mechanism 3, whilst the hinge 4" is connected to a first end of a rod 19, the other end of which is hinged with an end of a yoke 5. Said yoke 5 is also hinged with a shaft 22 which has a reciprocating motion thus delivering the necessary oscillation to the hydrofoil blades 1. A ram 17, or any similar mechanism, which is fixed to said shaft 22 and can be electrically or hydraulically or even pneumatically driven, is hinged to one end of the yoke 5 in order to adjust the attack angle of the blades 1. Figs. 8c to 8e illustrate different displacements reachable by the hydrofoil blades 1 driven by the just described propulsion mechanism. Finally, the steering operation is assured by a motor 8 which controls a crown wheel on the strut upper perimeter, provided with a gearing profile.

[0019] In all the above described embodiments according to the present invention the flap mechanism member 3 can preferably be hydraulically, pneumatically or electrically remotely actively controllable or variable for optimum efficiency at any moment and in any condition as need be. Said flap mechanism 3 can also easily be locked or unlocked by way of a dogtooth 10 or hydraulic mechanism. Therefore, the resistance to flap can easily be varied hydraulically by opening or closing dedicated valves in the just above mentioned hydraulic mechanism.

Claims

1. A system for propulsion and steering of waterborne craft, comprising:

(i) at least a pair of hydrofoil blades (1),
(ii) at least one supporting member (3) fixed on each hydrofoil blade (1), and
(iii) at least one casing (4), connected to said supporting members (3),

characterized by the fact that said at least one casing (4) is arranged, on said waterborne craft, such that it can be either rotated by an angle between 0 and 360 degrees around its own axis, or oscillated among two different directions.

2. The system for propulsion and steering of waterborne craft according to claim 1, in which said supporting member (3) is a shock absorber.

3. The system for propulsion and steering of waterborne craft according to claim 1, in which said supporting member (3) is hydraulically remotely actively controllable or variable.

4. The system for propulsion and steering of waterborne craft according to claim 1, in which said supporting member (3) is pneumatically remotely actively controllable or variable.

5. The system for propulsion and steering of waterborne craft according to claim 1, in which said supporting member (3) is electrically remotely actively controllable or variable.

6. The system for propulsion and steering of waterborne craft according to claim 1, in which said flap mechanism (3) is able to be easily locked or unlocked by way of a dogtooth mechanism (10).

7. The system for propulsion and steering of waterborne craft according to claim 1, in which said flap mechanism (3) is able to easily be locked or unlocked by way of a hydraulic mechanism.

8. The system for propulsion and steering of waterborne craft according to claim 7, in which the resistance to flap can easily be varied hydraulically by opening or closing dedicated valves of said hydraulic mechanism.

9. The system for propulsion and steering of waterborne craft according to claim 1, in which said casing (4) is integral with a crown wheel, able to gear a pinion.

10. The system for propulsion and steering of water-

borne craft according to claim 1, in which said casing (4) is integral with a crown wheel, able to gear an endless screw (12).

11. The system for propulsion and steering of waterborne craft according to claim 4, in which said endless screw (12) is connected by a shaft (9) to a gearbox (8) driven by a shaft (11).

12. The system for propulsion and steering of waterborne craft according to claim 5, in which said endless screw (12) is also connected by an arm (14) to a longitudinally slidable shaft (13).

13. The system for propulsion and steering of waterborne craft according to claim 1, in which said casing (4) is hinged with an harness (5) operatively connected to a rod (7).

14. The system for propulsion and steering of waterborne craft according to claim 4, in which said supporting member (3) is a parallel linkage connected to a longitudinally slidable shaft (15).

15. The system for propulsion and steering of waterborne craft according to claim 1, in which said casing (4), arranged on a rotatable strut of said waterborne craft, is connected by a rod (19) to a yoke (5), slidable and rotatable on the lying plane of said casing (4).

16. The system for propulsion and steering of waterborne craft according to claim 8, in which said supporting member (3) is connected to a hydrofoil blade (1) axle (1').

17. A system for propulsion and steering of waterborne craft, comprising at least a pair of hydrofoil blades (1) each rotatably fixed to the hull or submerged or submersible part of said waterborne craft and linked to a shaft able either to slide longitudinally or to rotate around a vertical axis.

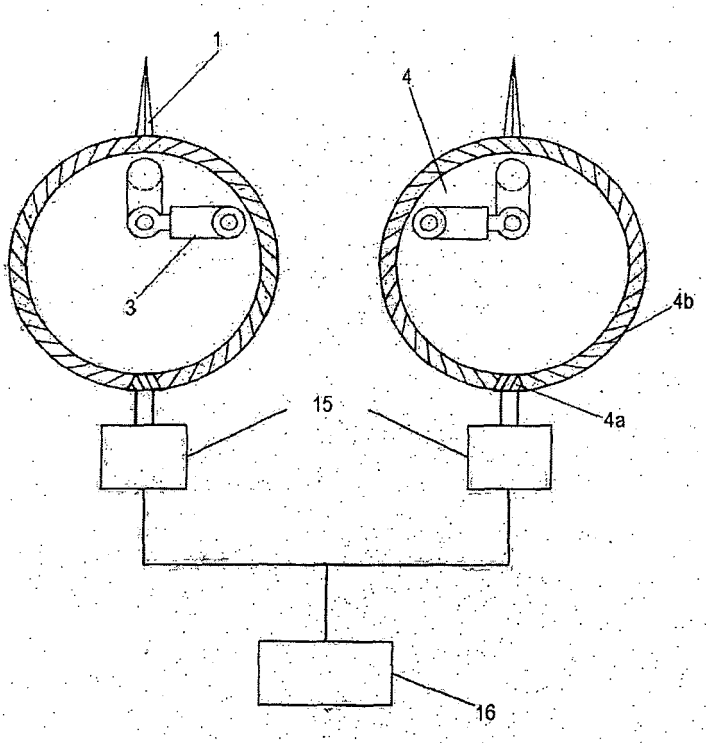

Fig. 1

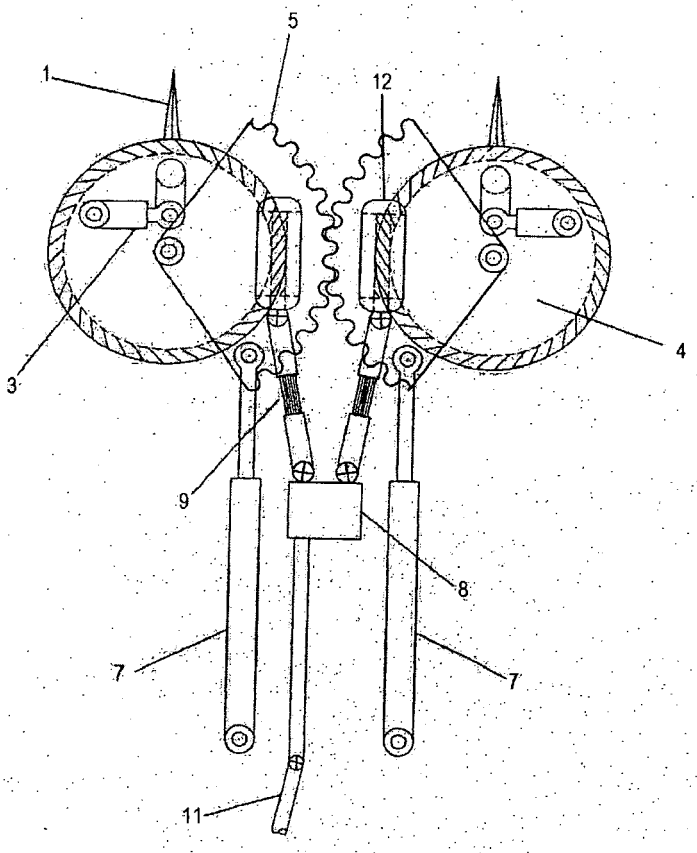

Fig. 2

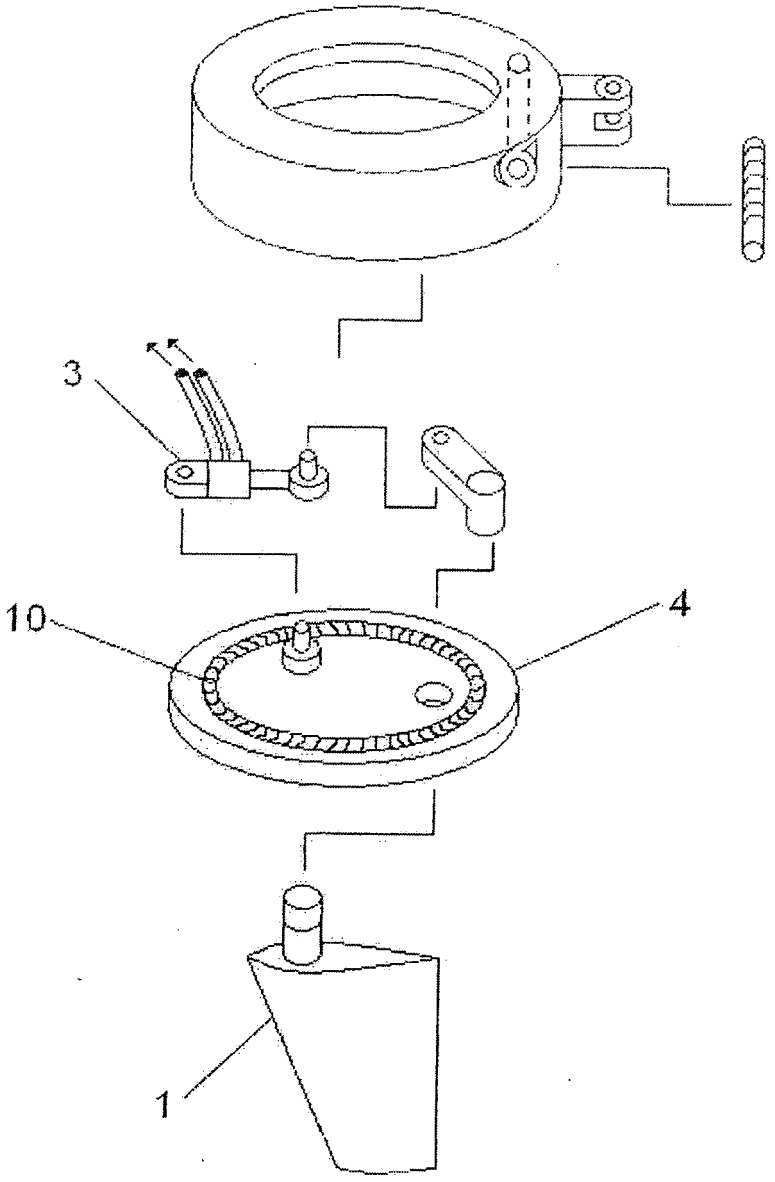

Fig. 2a

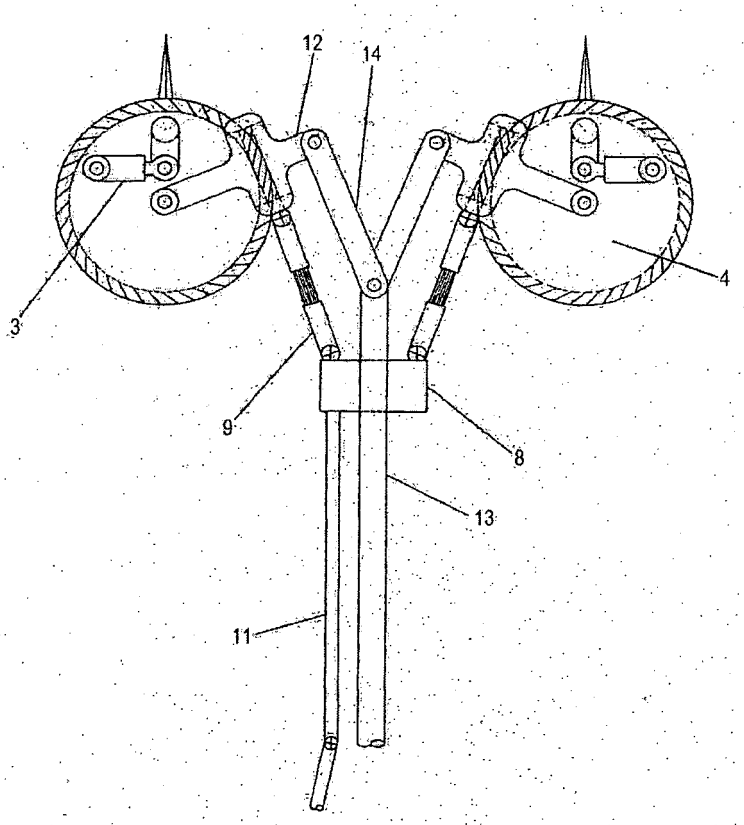

Fig. 3

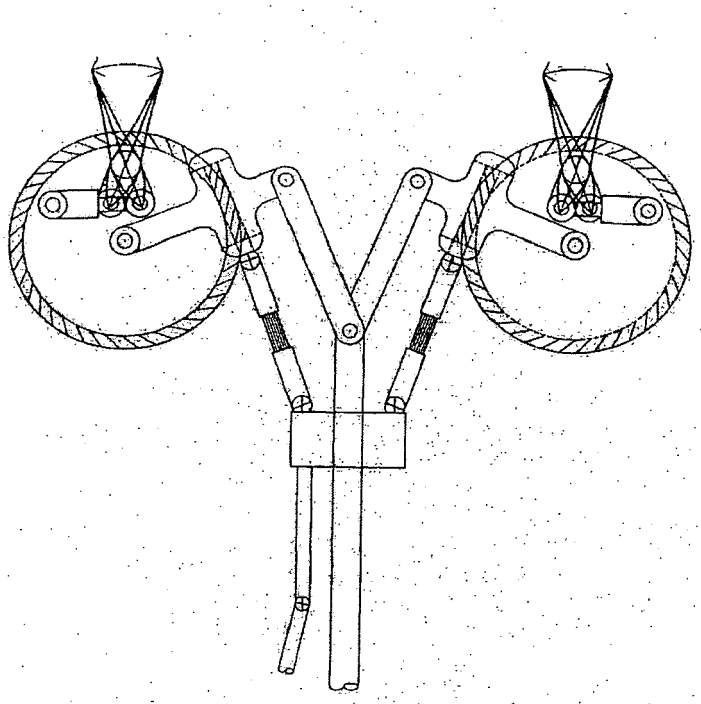

Fig. 3a

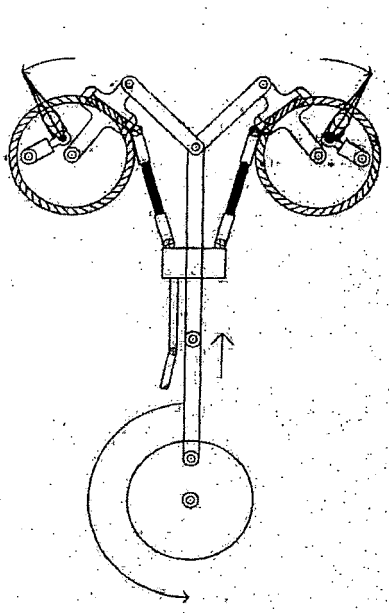

Fig. 3b

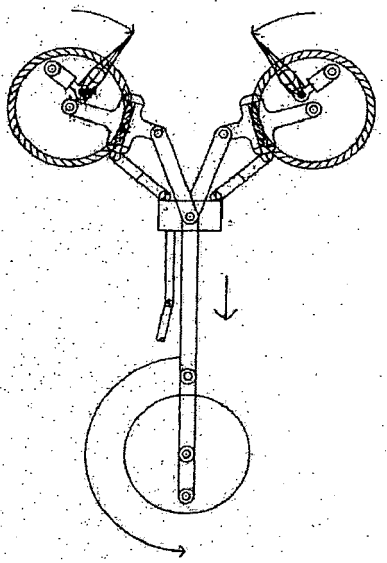

Fig. 3c

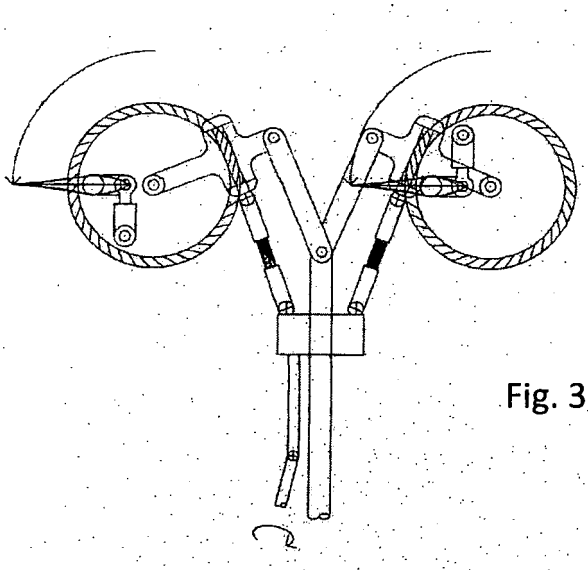

Fig. 3e

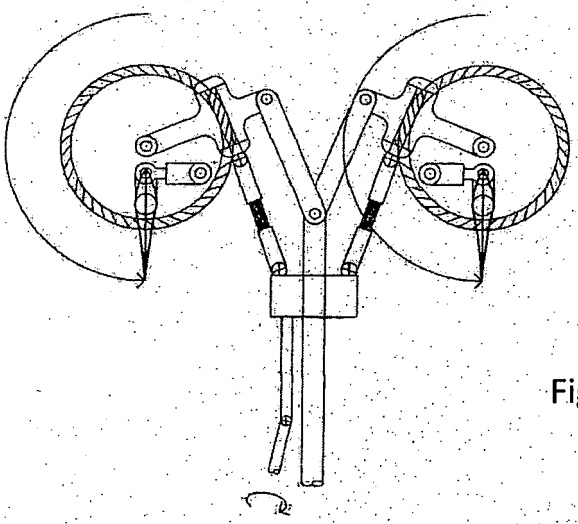

Fig. 3f

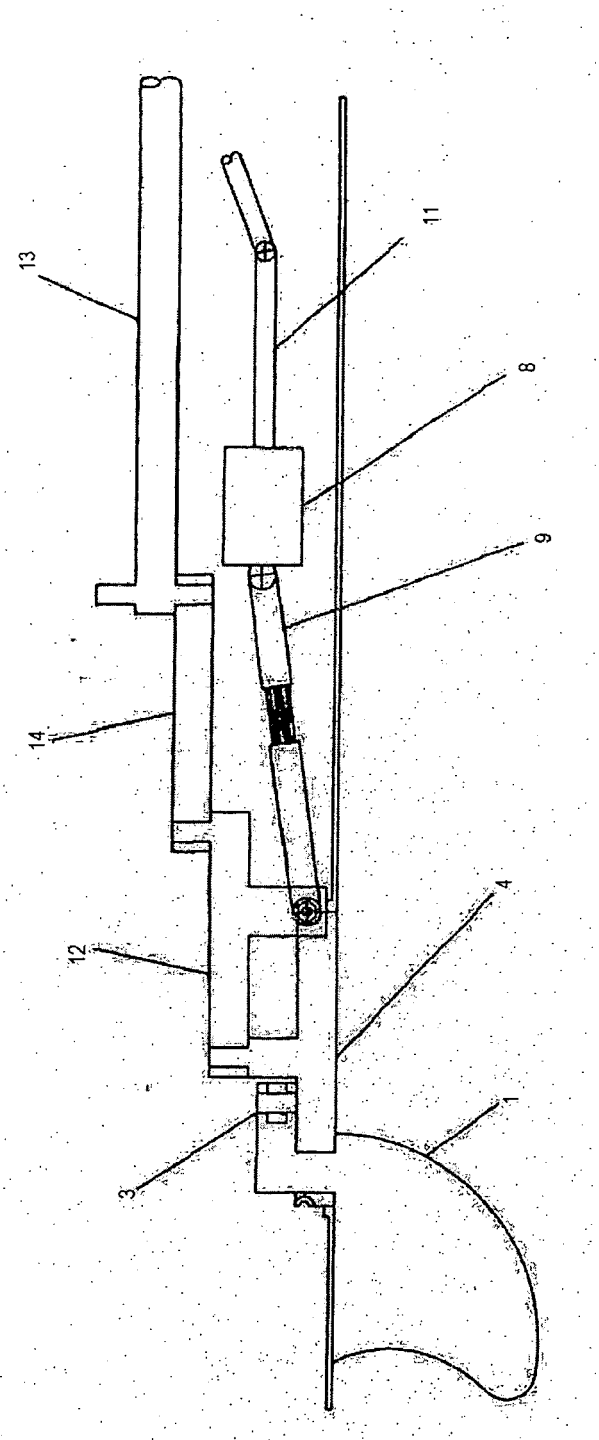

Fig. 3f

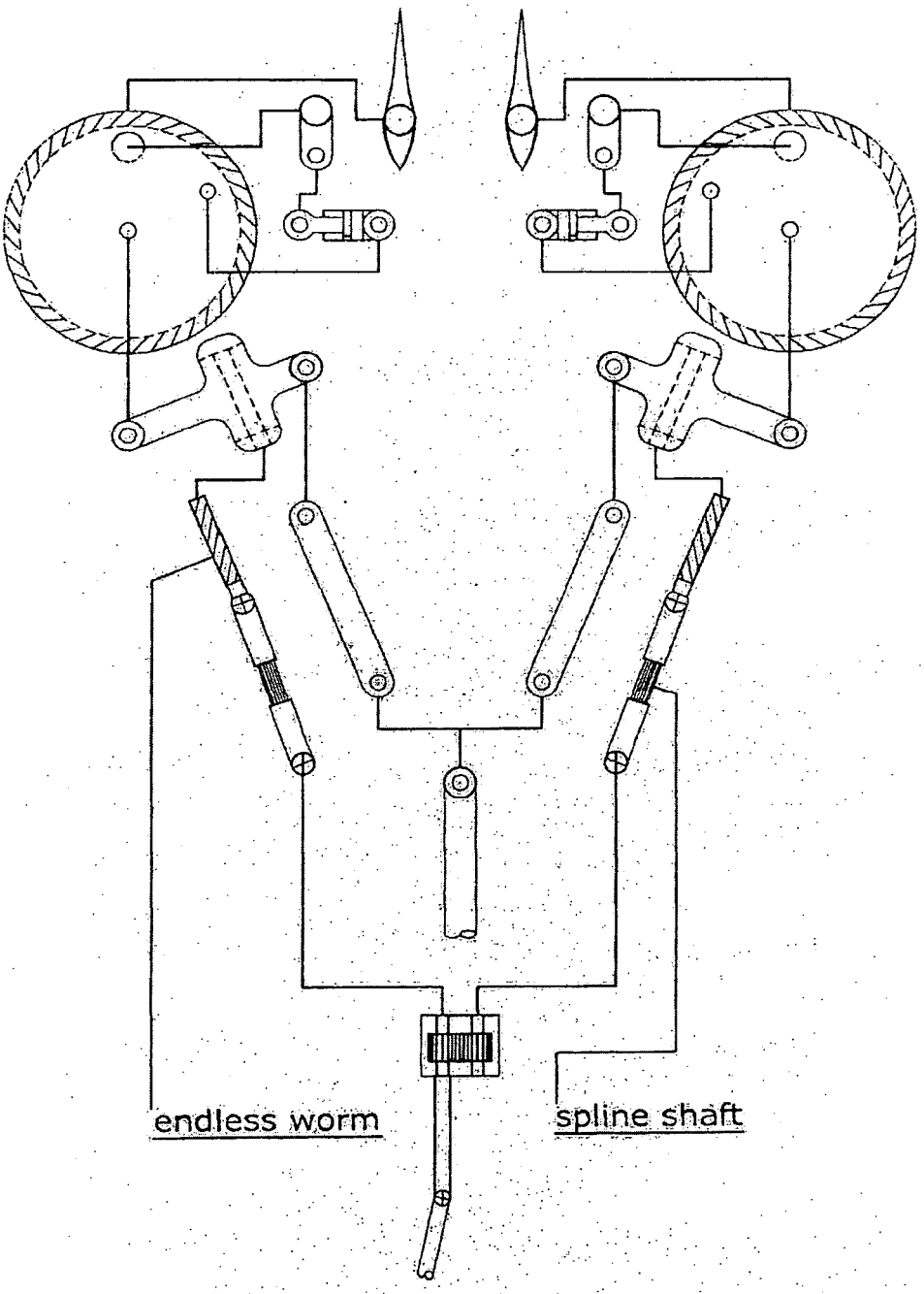

Fig. 3g

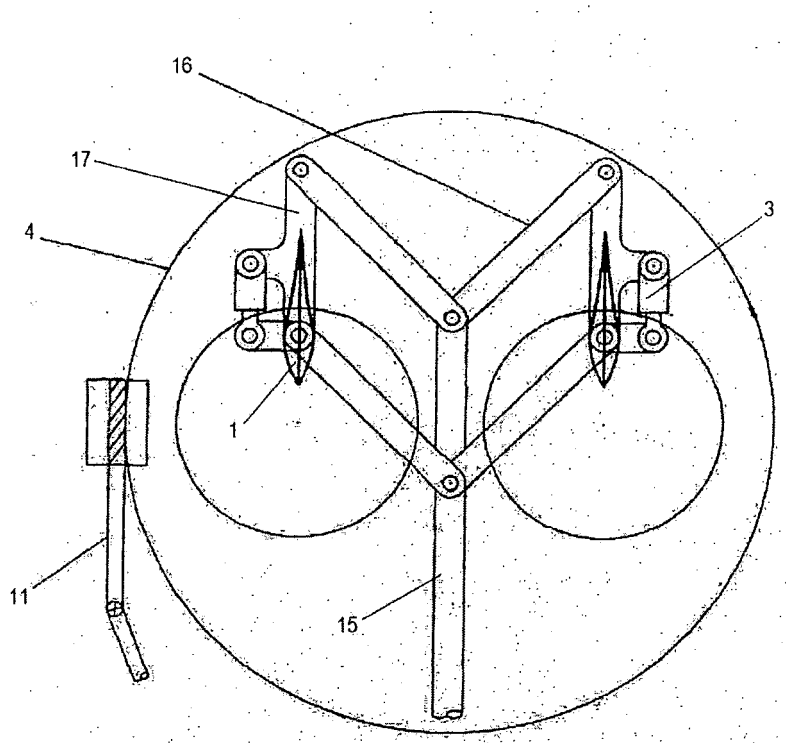

Fig. 4

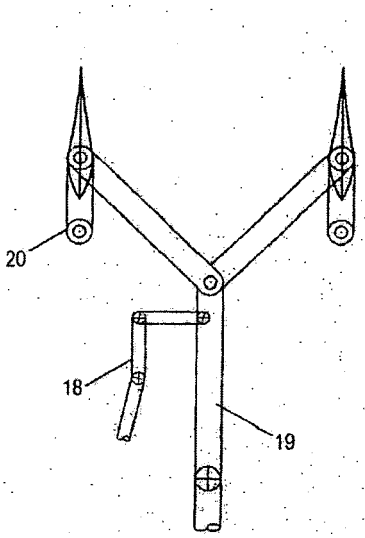

Fig. 5

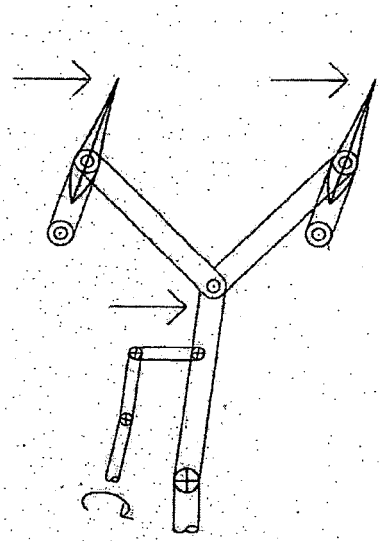

Fig. 5a

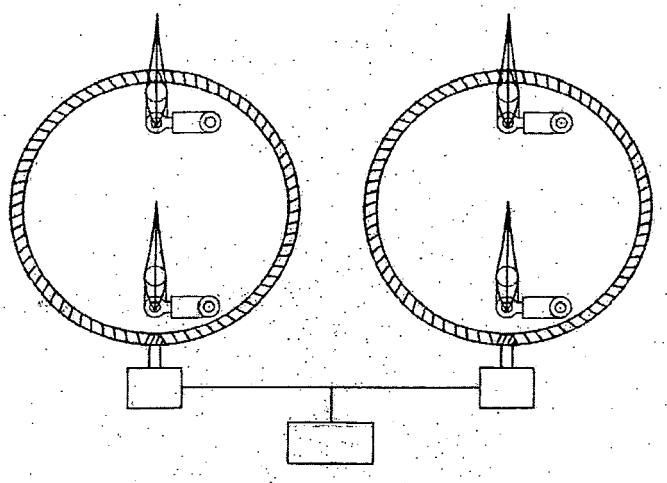

Fig. 6

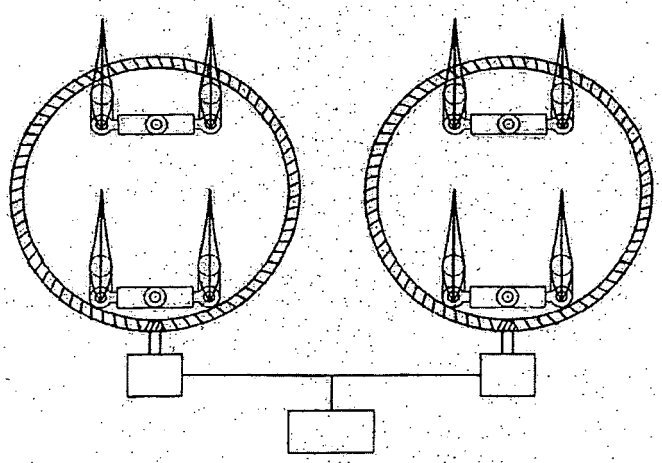

Fig. 7

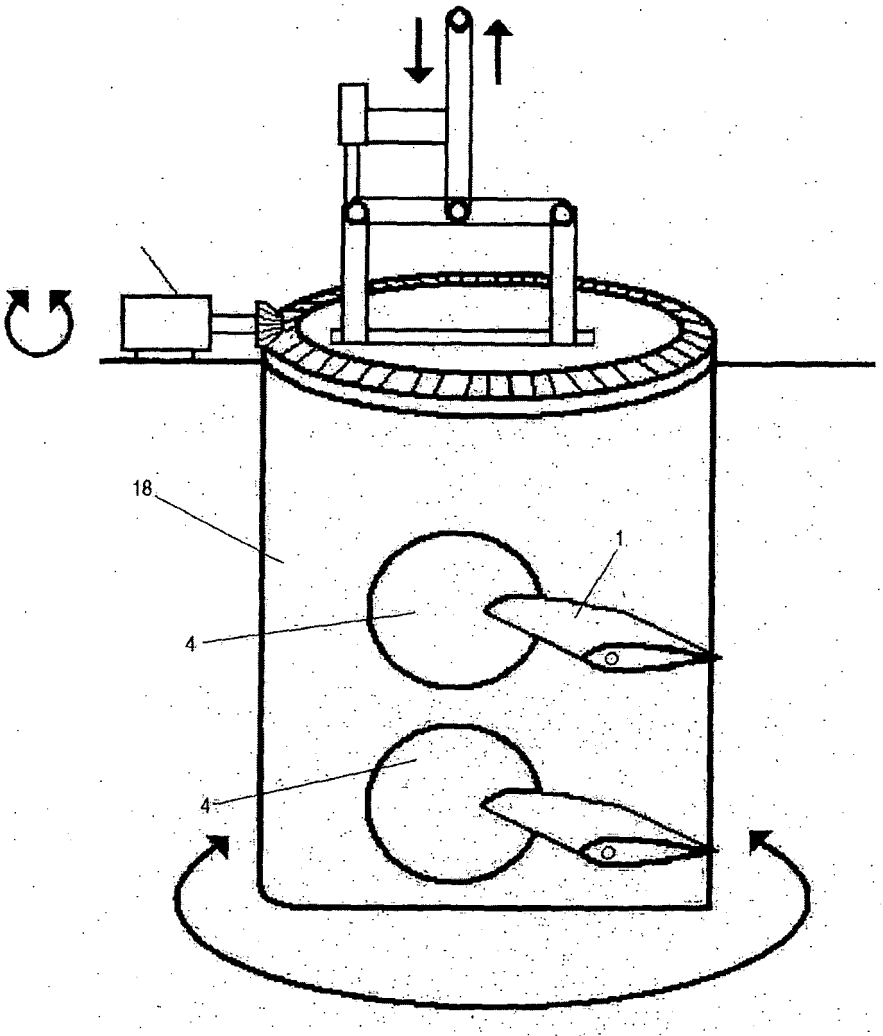

Fig. 8

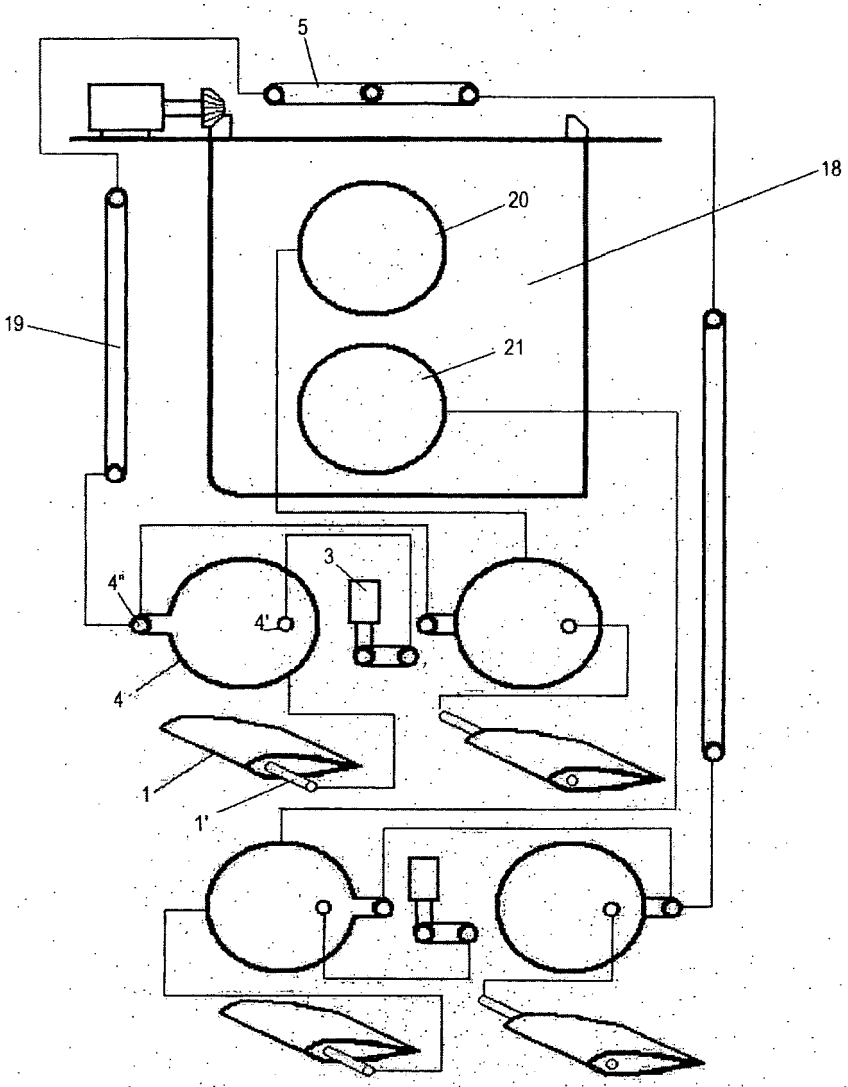

Fig. 8a

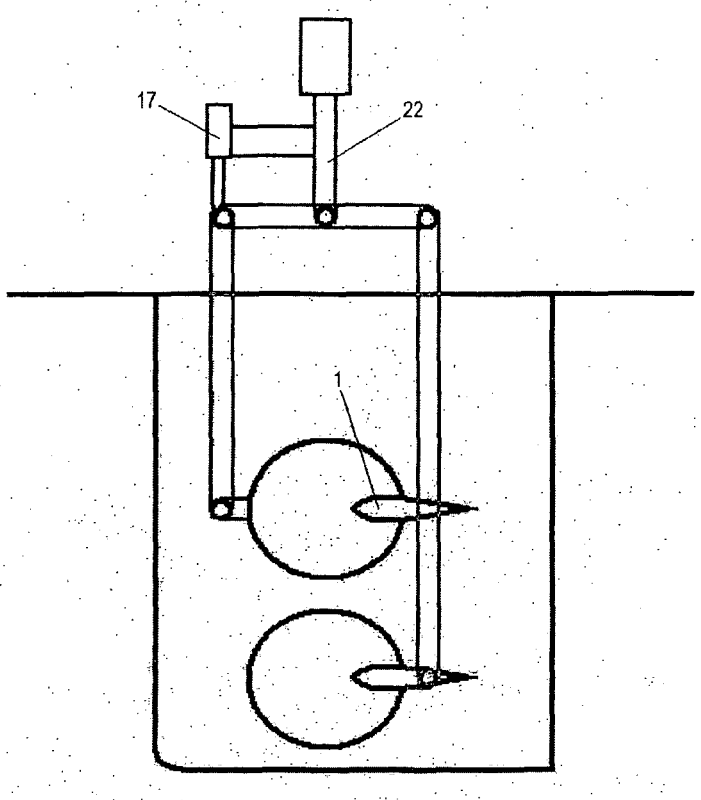

Fig. 8b

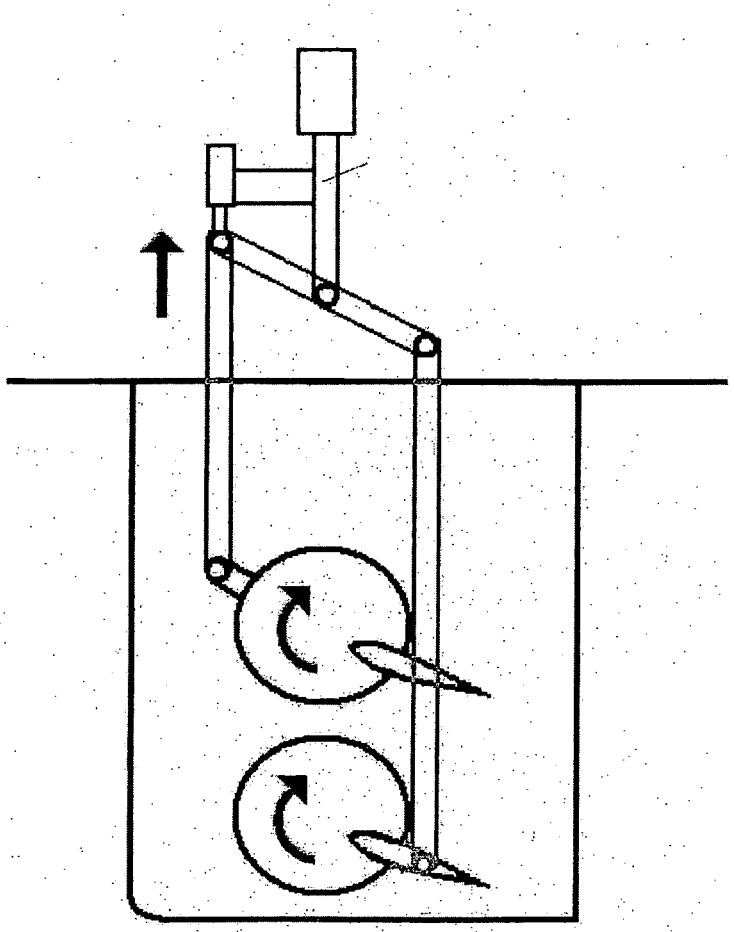

Fig. 8c

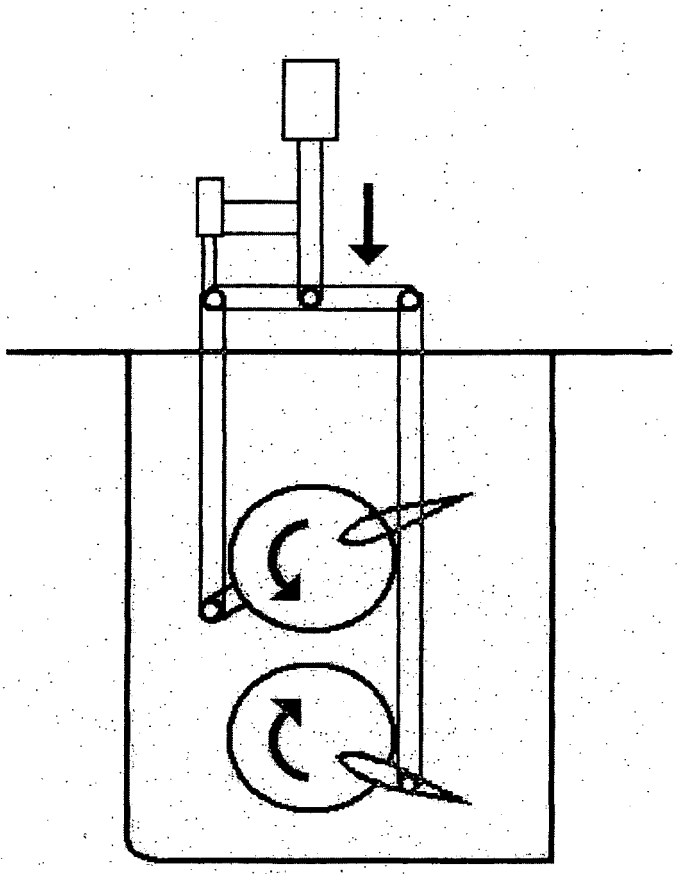

Fig. 8d

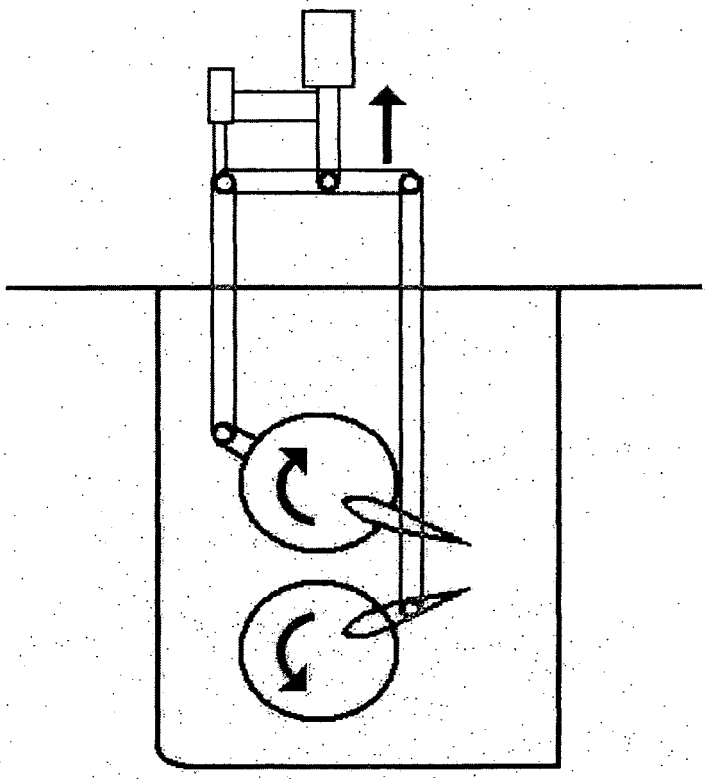

Fig. 8e

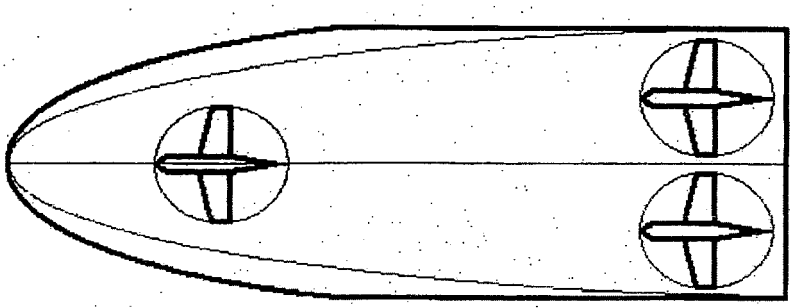

Fig. 9

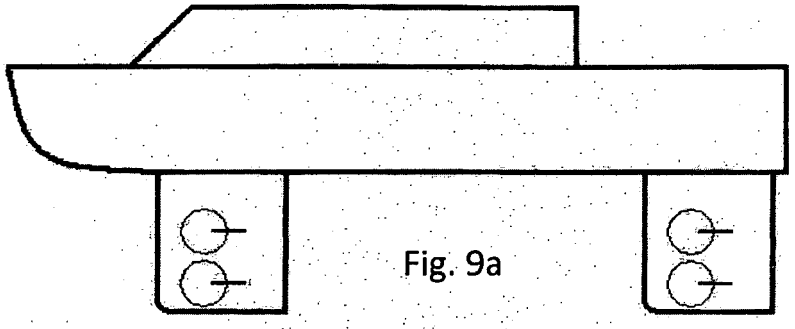

Fig. 9a

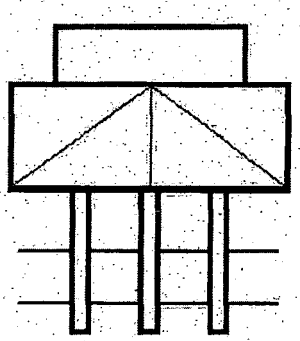

Fig. 9b

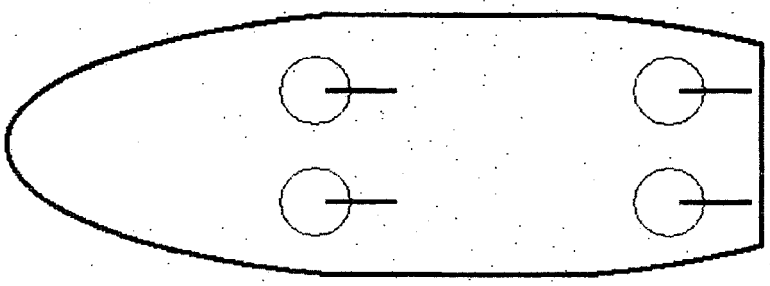

Fig. 10

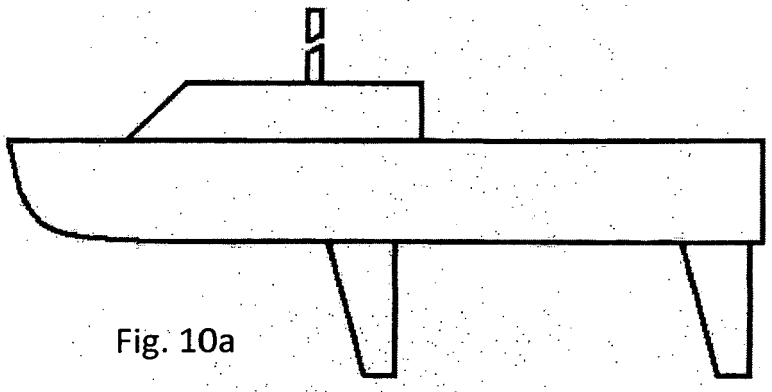

Fig. 10a

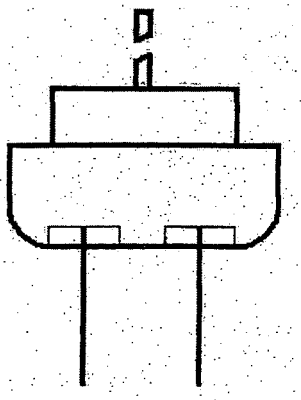

Fig. 10b

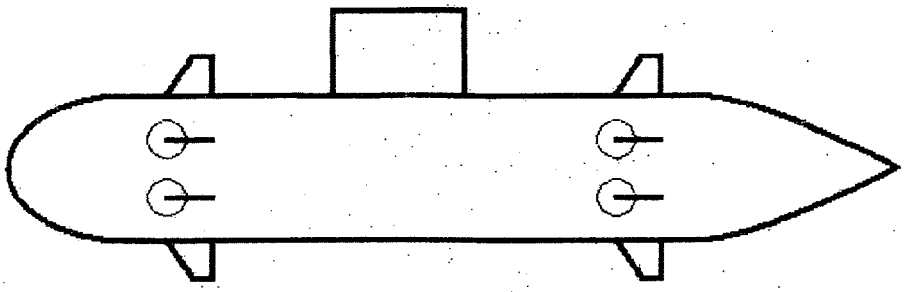

Fig. 11

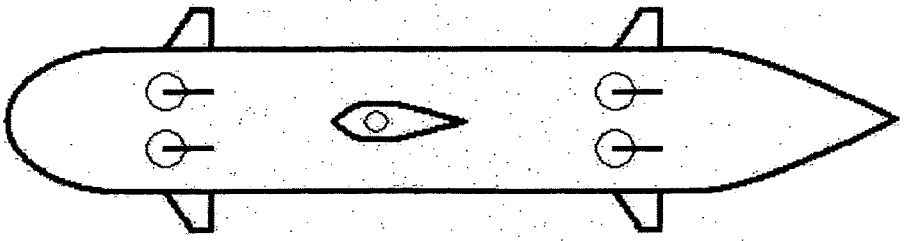

Fig. 11a

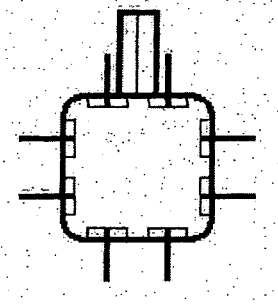

Fig. 11b

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EUROPEAN SEARCH REPORT

Application Number
EP 08 07 5013

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 July 2008	Brumer, Alexandre

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