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(54) **WAVE POWERED PROPULSION SYSTEMS FOR SUBMARINES AND QUASI-DIPPED WATERCRAFTS**

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(57) **ABSTRACT**

The wave powered (WP) propulsion systems developed in great amount for boats are not in use because of small

effectiveness caused by rocking process reducing propellor stroke relatively water. Submarines and special quasi-dipped watercrafts deprived of this disadvantage. Their bodies keeps stable the propellers mounted on conning towers or special props owing to the body's great mass. This factor multiplies the WP propellor effectiveness meeting Navy and Merchant fleet requirements.

The invention includes designs of:

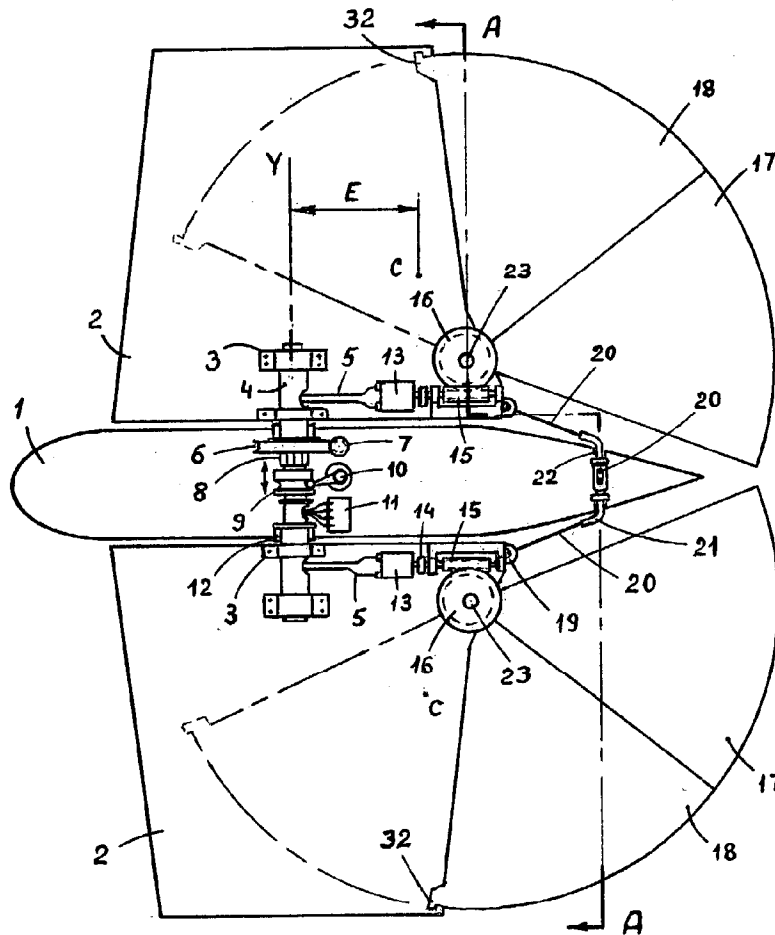
spare WP propulsion plant embedded into submarine diving rudders or folded into pockets of the submarine sail,

quasi-dipped watercraft carrying multiple foil WP propulsion system,

quasi-dipped tug towing submerged tank,

self optimized foil propellor.

Experiences with submarine models equipped by the WP propellers have shown excellent results. Expected velocities for submarine 4-7 knots, for the quasi-dipped watercraft 5-15 knots. The folded spare WP propulsion plant does not interrupt submarine functioning.



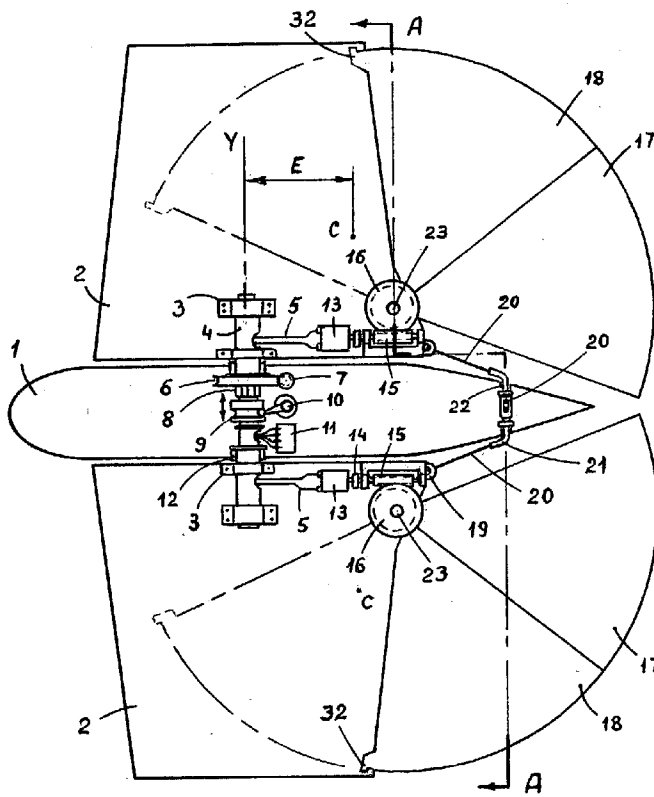


FIG. 1

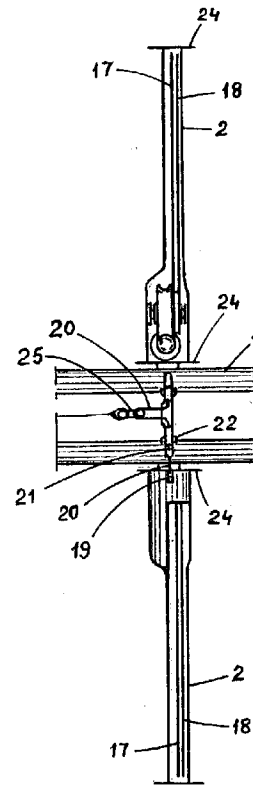


FIG. 2

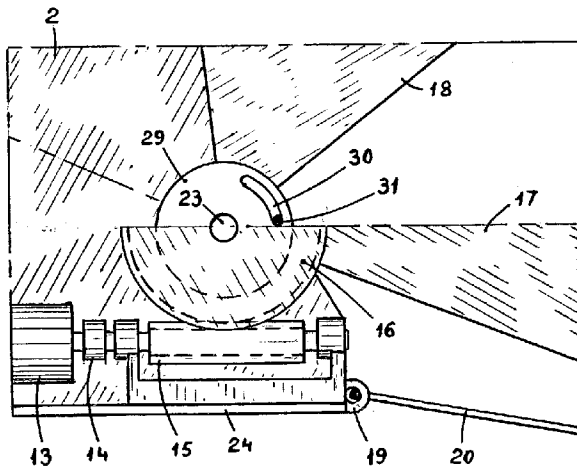


FIG. 3

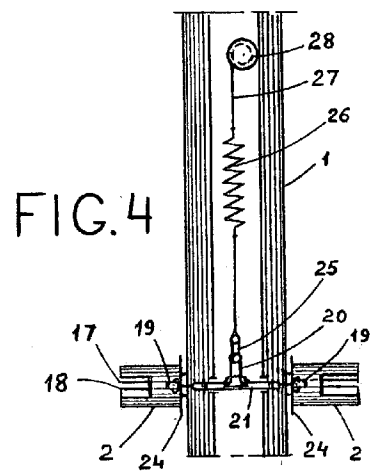


FIG. 4

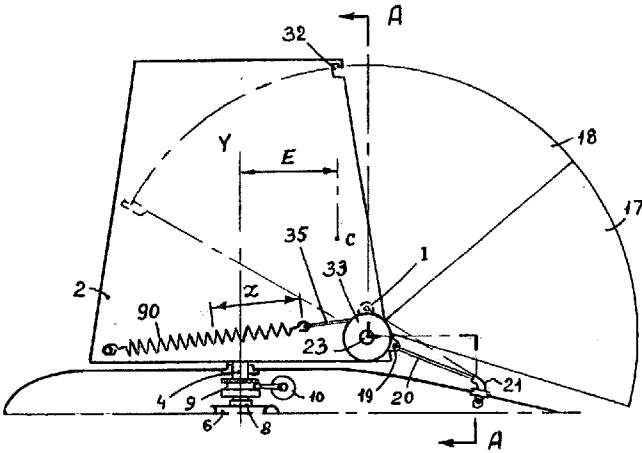


FIG. 5

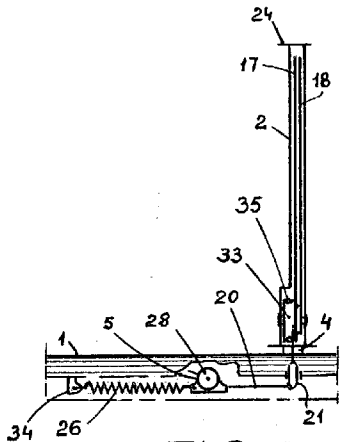


FIG. 6

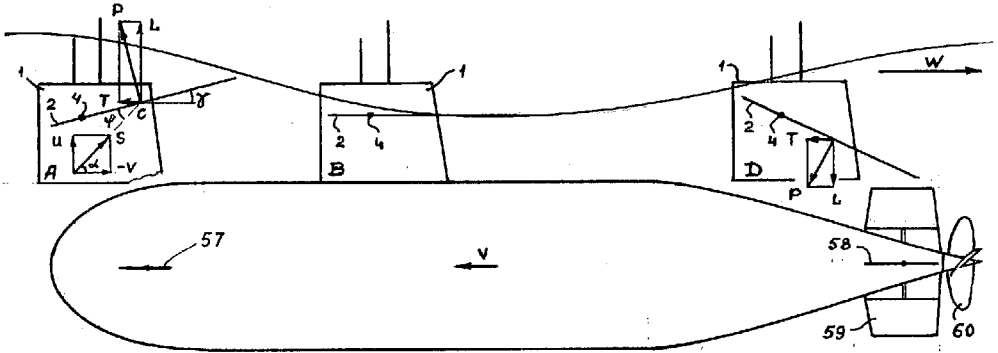


FIG. 7

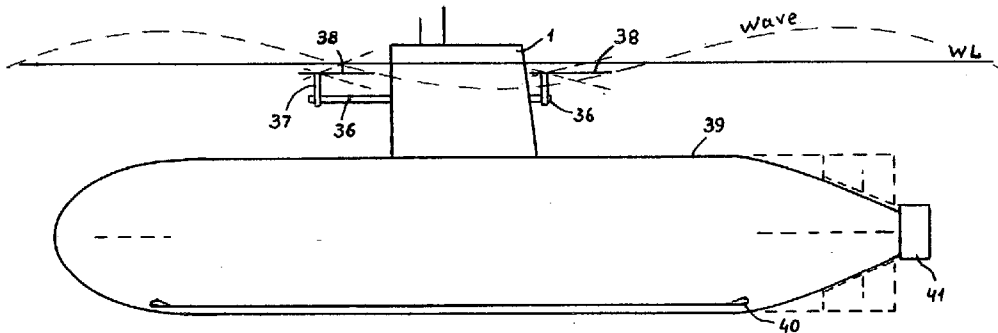


FIG. 8

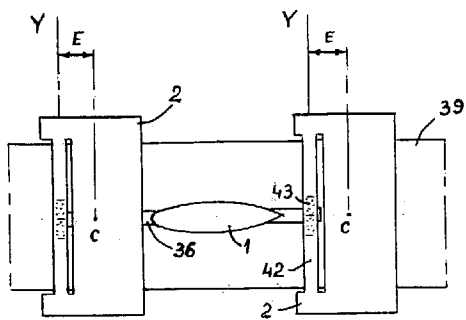


FIG. 9

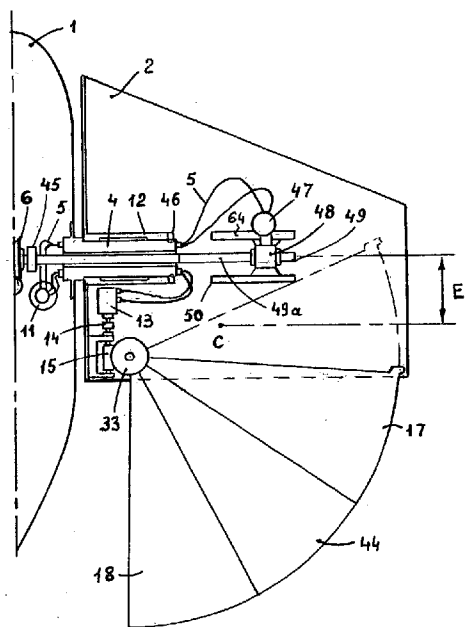


FIG. 10

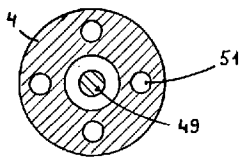


FIG. 11

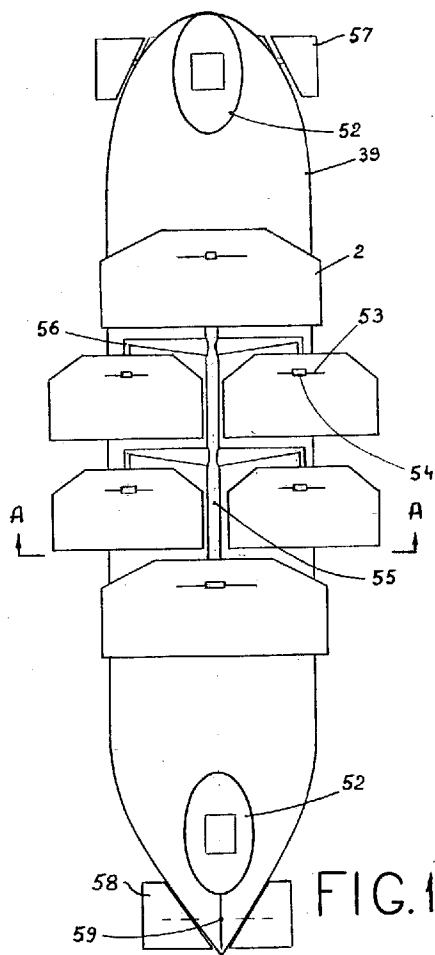


FIG. 12

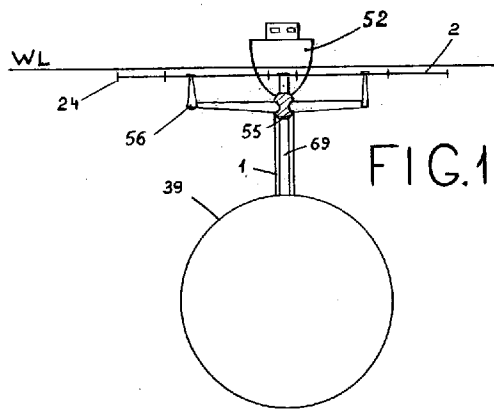


FIG. 13

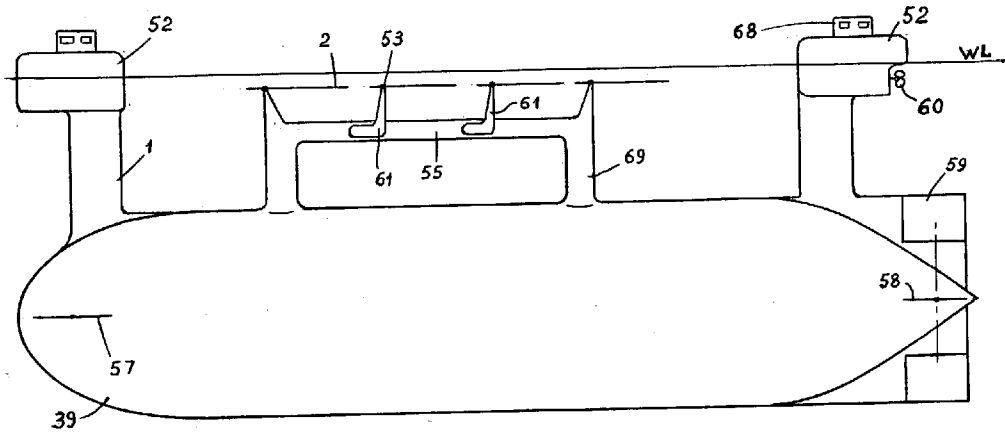


FIG.14

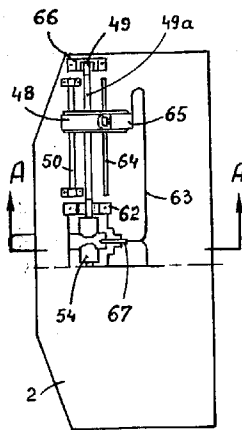


FIG. 15

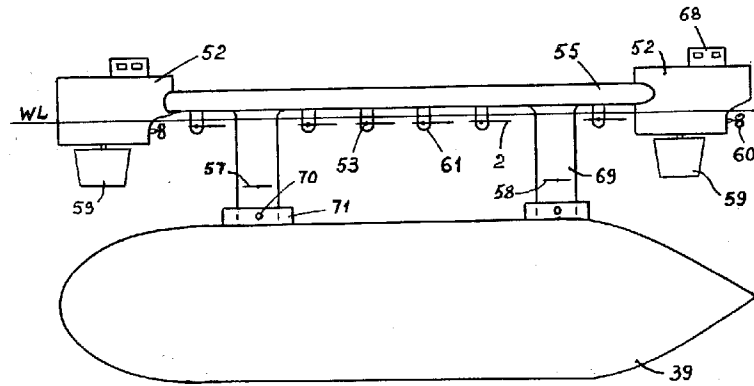


FIG. 17

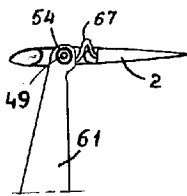


FIG.16

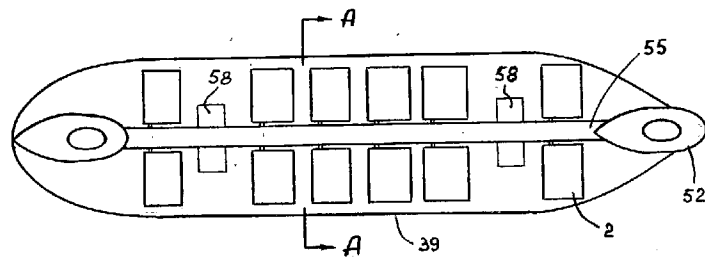


FIG. 18

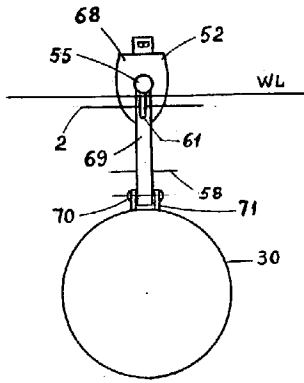


FIG. 19

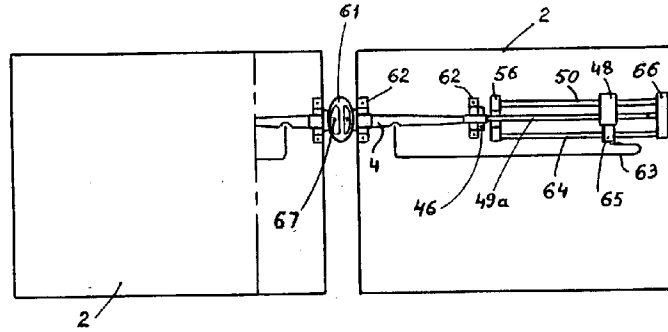


FIG. 20

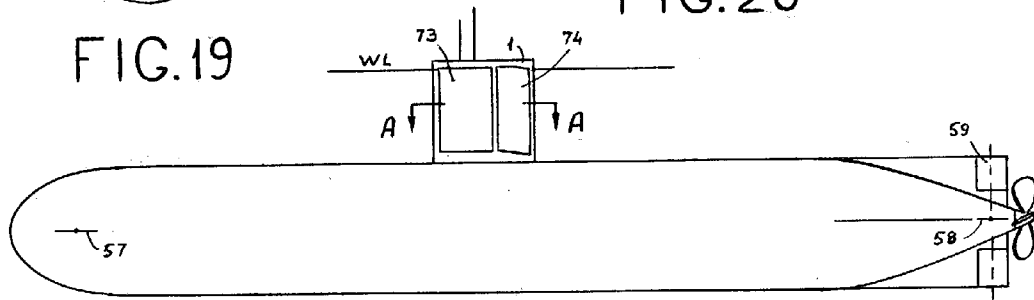


FIG. 21

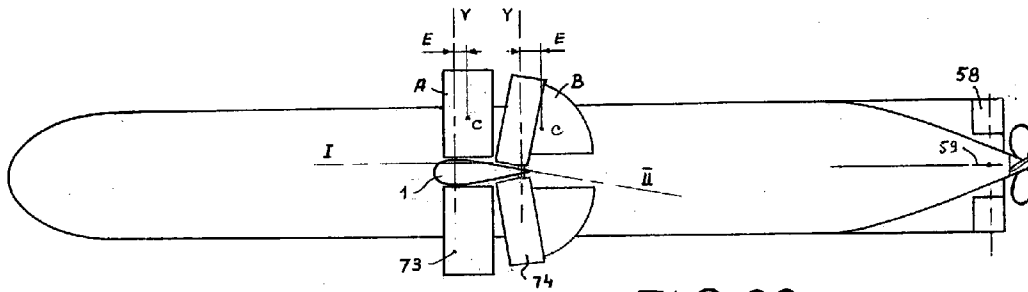


FIG. 22

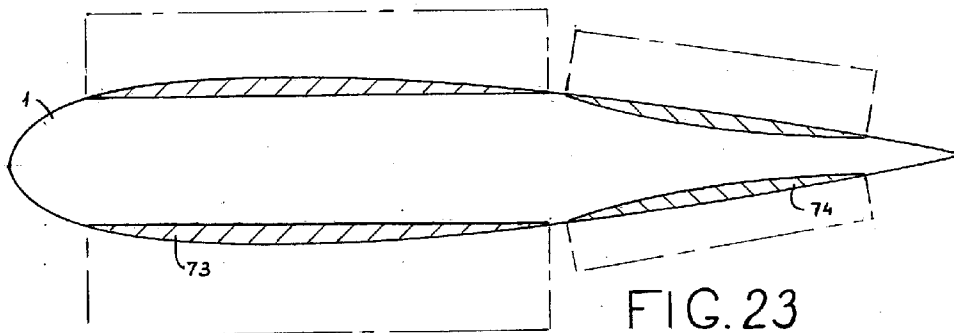


FIG. 23

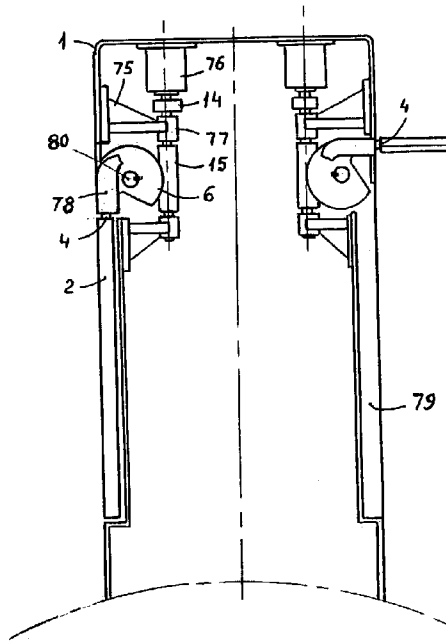


FIG. 24

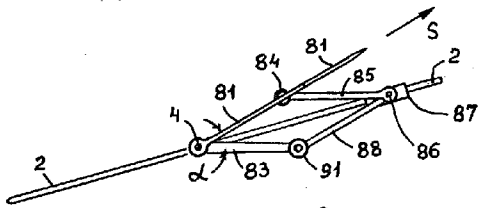


FIG. 26

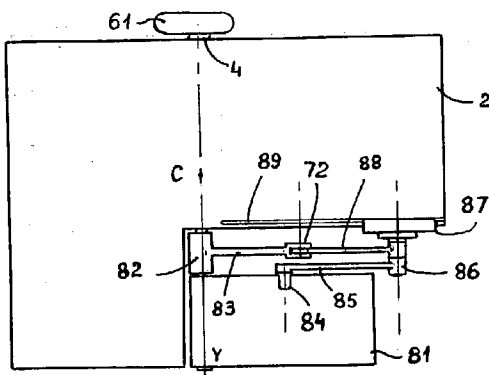


FIG. 27

FIG. 25

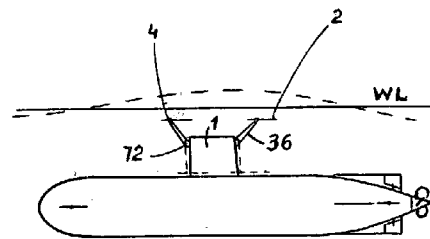
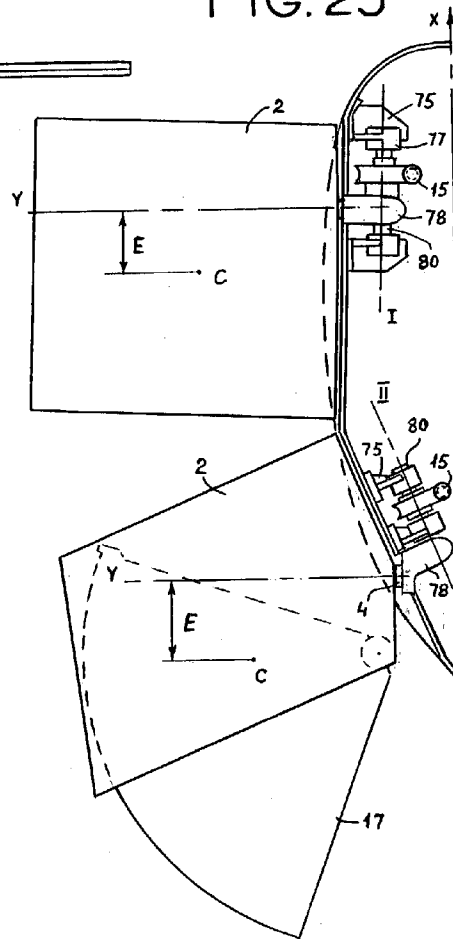


FIG. 28

WAVE POWERED PROPULSION SYSTEMS FOR SUBMARINES AND QUASI-DIPPED WATERCRAFTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The invention has no analogues.

STATEMENT REGARDING FEDERALLY SPONSORED R & D

[0002] The author created the invention by himself with own means in duty free time.

REFERENCE TO A MICROFICHE APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

[0004] Endeavor: Most efforts developing or improving existing submarine propulsion systems are directed basically on two kinds of them: nuclear and diesel systems. In both cases a submarine needs some type of fuel with nuclear or chemical ingredients. Usage the second one limits a range of a submarine independent operating distance. Both types of the propulsion systems never become absolutely reliable and noiseless.

[0005] Here we suggest the new kind submarine propulsion system, which was not considered before. It is a WP propulsion system. This asserts clear that a submarine needs contact with waving water surface or with subsurface layer, i.e. it does not certainly need to emerge fully. Rather it emerges only by its conning tower, a part of it or without coming to the surface remaining on the periscope depth to be invisible.

[0006] The first reason of emerging is a critical situation (emergency), which a submarine turns out finally loosing the standard propulsion. The second one is necessity to economize fuel for future attacks. In this case a submarine chooses hidden or remote water areas and time of bad weather accompanied by waving to make a voyage. The waving powers propulsion and also creates additional conciliation.

[0007] The other situation can happen when some emergency deprives a submarine to run out of aquatic region of a strange state. This violation can be ruinous for a submarine. The same situation but inside neutral or own waters also requires spare remedies helping a submarine overcome the motion loss.

[0008] Experience with submarine's models propelled by wave energy was so exciting that it has made us to develop architecture of quasi-dipped watercrafts with the WP propulsion system. Abundance wave energy in seas makes possible to build them as the watercrafts with everlasting propellant. They can live in seas "perpetually" deriving sea energy for own propulsion as well as for power supply its services.

[0009] The unmanned robotic submarine or quasi-dipped watercrafts can be used also as a marine mobile instruments for variety of goals: scientific researches, coast guard observation, mines which changes waiting position to meet hostile convoy or a single ship. Even though it can pursuit some

slow object to take an action. Equipped with sensors they can also find some source of environmental pollution or other dangers.

BRIEF SUMMARY OF INVENTION

[0010] All previous attempts to use wave energy for propulsion are related to the water surface vessels. Many of these are failed because the water surface ships do not provide proper conditions for a wave-powered (WP-) propeller like a hydrofoil attached to a board under water pivotally elastically with eccentricity of a pivot axis and a foil hydrodynamic head center. It is because the created hydrodynamic head is too small to propel a ship owing to ship rocking making the hydrofoil follows to the wave motion. For propulsion the most important thing is hydrofoil motion of water masses relatively hydrofoil. The ship rocking eliminates the great part of this relative motion.

[0011] Submarines have huge advantage in compare with the water surface ships. They are rocking with small amplitudes or do not rock at all. They are rather rolling instead pitching or heaving when they emerge at a sail (conning tower) or periscope depth. The submarine sail is located near the middle keeps its depth very stable. It is the best platform to mountain a foil wave-powered (WP-) propeller because:

[0012] a) water masses run the maximum stroke relative the WP-propeller;

[0013] b) the submarine body is the very inertial stop for the hydrofoil propeller;

[0014] c) the submarine has not wind load at this depth because nothing is above water;

[0015] d) the submerged submarine experiences less hydrodynamic water resistance.

[0016] So the hydrofoil obtains the maximum possible hydraulic pressure from waving water masses and the submarine has minimum water resistance and zero wind load. These are great advantages and it is why the submarine WP propulsion system is a few times more effective than the analogous system mounted on the surface ships.

[0017] Here we consider two ways of equipping the submarines with the hydrofoil WP propulsion system. The first one uses the existing diving rudders mounted on sides of the sail. The second one uses additional folding hydrofoils that only unfolded when they used for direct designation to propel a submarine with wave power.

[0018] Acting submarine models emerging with its sail at half have shown excellent results. They run with velocity that can satisfy anyone.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF DRAWINGS

[0019] **FIG. 1.** Diving rudders combining the wave powered hydrofoil propellers using the spring/cord mechanism providing elasticity of propeller deflection (view from above).

[0020] **FIG. 2.** Diving rudders combining the wave powered hydrofoil propellers (section AA of **FIG. 1**).

[0021] FIG. 3. Mechanism opening the fan-like foil extension (view from above).

[0022] FIG. 4. Mechanism tightening the spring which provides elasticity of the foil deflection.

[0023] FIG. 5. Mechanism combining both previous mechanisms (view from above).

[0024] FIG. 6. Mechanism combining both previous mechanisms (section AA of FIG. 5).

[0025] FIG. 7. Force interaction of a foil WP-propellor with waves.

[0026] FIG. 8. Submarine model made of a bottle with the WP propulsion system (side view).

[0027] FIG. 9. Submarine model made of a plastic bottle (middle part, view from above).

[0037] FIG. 23. Profiles of the foils and the sail (section AA of FIG. 21).

[0038] FIGS. 24, 25. Mechanisms folding and opening the foils of a submarine WP propulsion system (front and upper views).

[0039] FIGS. 26, 27. Hydrofoil self deflected to optimal angle by auxiliary foil by water flow (side and above views).

[0040] FIG. 28. Invisible fully submerged submarine with WP propulsion system.

NUMERIC SYSTEM SIGNING ELEMENTS AND PARTS OF SYSTEMS

[0041]

Tens	Units			
0:0	1- sail,	2- rudder (foil),	3- mounting,	4- shaft (axle),
:5- hose,	6- worm wheel,	7- worm,	8- spline shaft,	9- slide clutch,
1:0- clutch drive,	1- distributor,	2- bearing,	3- drive,	4- muff,
:5- worm,	6- worm wheel,	7- lead foil,	8- slave foil,	9- lug,
2:0- cord,	1- guide pipe,	2- bearing,	3- drive,	4- side guard,
:5- connection,	6- spring,	7- cord,	8- winding dram,	9- inner disk,
3:0- groove,	1- pin,	2- hook,	3- pulley,	4- hook,
:5- belt,	6- arm,	7- post (holder),	8- foil,	9- tank,
4:0- sinker,	1- plug,	2- strip,	3- glue bond,	4- inner foil,
:5- bearing,	6- stop nut,	7- hydro device,	8- carriage,	9- torsion,
5:0- guide,	1- hole,	2- float,	3- axle,	4- mounting,
:5- boom,	6- cantilever,	7- stabilizer,	8- stabilizer,	9- rudder,
6:0- screw,	1- post,	2- bearing,	3- ware,	4- rack,
:5- drive,	6- bearing,	7- lead-in,	8- house,	9- post,
7:0- bolt,	1- nest,	2- hinge,	3- foil,	4- foil,
:5- support,	6- drive,	7- bearing,	8- cantilever,	9- pocket,
8:0- shaft,	1- foil,	2- bush,	3- arm,	4- bearing,
:5- link,	6- bush,	7- slider,	8- link,	9- guide,
9:0- spring,	1- hinge.			

[0028] FIG. 10. Diving rudders combining the WP- propellers using the torsion spring providing elasticity of the propellor deflection (view from above).

[0029] FIG. 11. Section of cantilever axle 4 (FIG. 10) holding the diving rudder pivotally.

[0030] FIG. 12. Quasi-dipped watercraft equipped with multi foil WP propulsion system (view from above).

[0031] FIG. 13. Quasi-dipped watercraft with multiple foil WA propulsion system (Section AA of FIG. 12).

[0032] FIG. 14. Quasi-dipped watercraft with multi foil WP propulsion system (side view).

[0033] FIG. 15. Mono WP-propellor held by the center of its deflections (view from above).

[0034] FIG. 16. Mono WP-propellor held by the center of its deflections (side view).

[0035] FIGS. 17, 18, 19. A tug equipped with WP propulsion system and designated to tow a submerged barge or tank (side view, view from above, section AA of FIG. 18).

[0036] FIGS. 21, 22. Submarine equipped with collapsing WP propulsion plant.

[0042] Letter's denotes: L—vertical component of hydrodynamic head (lift force), T—horizontal component of hydrodynamic head (thrust), P—hydrodynamic head (pressure); V—submarine velocity, S—total velocity vector of water masses motion relatively the wing, U—vertical component of the vector S, W—wave's velocity; C—center of exerting hydrodynamic head, E—eccentricity; WP—wave powered, O/C—opening/closing.

DETAILED DESCRIPTION OF INVENTION

[0043] 1. Submarine wave powered (WP) propulsion system. Basic design. Claim 1.

[0044] The basic design of submarine WP propulsion system (FIG. 8) consists of two elastically deflecting foils 38 attached to a submarine sail with arms 36 and holders 37. On tested submarine model the holders has held the foils 38 with glue bond 43 (FIG. 9) via elastic strip 42 functioning as a torsion. Because the eccentricity E presents here the wave hydraulic head P deflects the foils around axis's Y creating vertical and horizontal components of the force P. Tremendous inertia forces of the body mass 39 equilibrate the vertical components L while the horizontal components T are thrusts propelling the submarine model.

[0045] Notice.

[0046] The scheme of thrust generation is shown also for a submarine using its expandable diving rudders 2 (FIG. 7)

as spare WP propulsion plant. We see three positions of the submarine sail 1. If the wave moves to right (with velocity W) then an ascending wave front angles the expanded rudder up on the angle γ owing to the water masses rising with the relative velocity S. The vector S is a sum of the vertical component U and horizontal component -V (as a matter of fact it is a reversed submarine velocity V). To get the hydraulic head $P > 0$ it is necessary to provide the angle $\Phi > 0$ between the rudder 2 plane and the vector of relative velocity S. The optimal deflection angle $\gamma = \Phi = \alpha/2$, where α —angle slope of the water flow (velocity vector S) relative horizon. This is a foil deflection rule.

[0047] When the relative position of the sail and the wave is that as shown by fragment B the expanded rudder 2 takes a horizontal position because in a wave base the velocity vector S directs horizontally ($\alpha = 0$). When the relative position of the sail and a wave is that as shown by fragment D the rudder is deflecting down. But the created trust T continues to push the submarine forward.

[0048] The model made of a wooden sail 1 stuck to a plastic bottle 39 filled with water and a metal sinker 40, effectively speeds up and runs when waving. The basic submarine WP propulsion system design, as it is assumed, contains the WP propulsion system with the arm 36 lifting and lowering the hydrofoil propellers 2 (FIG. 28). Thus the WP propulsion system can be propel the submarine being fully under water (invisible) or having some contact with water surface if it is needed for observation or for something else.

[0049] 2. Spare WP propulsion plant expanding diving rudders functionality.

[0050] 2.1. Initial design. Claim 2

[0051] It is an alluring idea to expand submarine diving rudder functionality for spare wave powered propulsion. Such system as expected can propel a submarine with velocity 2-4 knots, 4-5 knots, and 5-6 knots when sea is rough, very rough, and high. The diving rudder combined with spare WP propulsion plant consists of the rudder wing 2 held by the shaft 4 with the mountings 3 (FIG. 1) is shown in suggestion that an upper cover is removed (opened).

[0052] Let's see how the hypothetical control diving system works. When the sliding clutch 9 is shifted by the drive 10 to right it engages the spline part 8 of the worm wheel 6 set freely on the shaft 4. Because the clutch muff 9 is also engaged with the shaft 4 via spline part of the shaft 4 it transmits the wheel 6 revolution to the shaft 4 and so to the rudder wing 2 inclining it as necessary for diving.

[0053] When the clutch muff 9 disengaged from the worm wheel 6 the shaft 4 and so the hydraulic head can turn the wings 2 if there is eccentricity E between the deflecting axis Y and hydraulic head center C. The eccentricity rises when the additional foil surfaces 17 and 18 are opened with worm mechanism 15, which turns the hollow worm disk 16. The foil 17 attached to it pulled out of the rudder wing 2 drawing out also the foil 18 which is attached to the second disk 29 inserted to the first one (FIG. 3).

[0054] Both disks rotate around common pin 23. Freedom of relative rotation of disks is limited by length of groove 30 in lower disk 29 where the pin 31 fixed in the first upper (worm) disk 16 can move. This is why after the foil 17

pulled out it also pulls out the foil 18. At end of this process the hook 32 stops further motion of the foils 17, 18 and the drive 13 revolving the worm 15 is stopped too. The back process requires backward revolution of the drive 13 controlled by switching oil pressure in armored hoses 5. These hoses lay from the oil distributor 11 through hollow shaft 4 to the hydraulic drives 13. After foils pulling out the hydraulic head center C and axis Y have eccentricity E (FIG. 1) allowing the hydraulic head to deflect the extended wings. But according to the foil deflection rule (see the Notice above) the deflecting angle γ should be the half of inclination of vector S. To make it automatically the wings are linked to the mechanism providing the foil deflection rule with the cords 20 attached to eyes 19 and passing inside the sail 1 via the guide pipe 21 able to swing in bearing 22. Usually the cord 20 sag giving to wings freedom to be turned by the diving control system.

[0055] When the spare WP propulsion plant works the cords 20 are taut by the spring 26 (FIG. 4) stretched enough by winding dram 28 which is has been revolved as necessary. The spring allows the wings to be deflected greater from neutral position by the greater hydraulic head. If the control rule is not accomplished the tension of the spring 26 is adjusted by a drive of the winding dram. To accomplish this control the system should contain angle pick-ups and an automated control system realizing the described algorithm.

[0056] The spare WP propulsion plant can be closed at any time. For that we need to do: first, retract the foils 17, 18 with drives 13 by reversing it via the oil distributor 11; second, switch on the clutch 9 with the clutch drive 10; third, set the dram 28 free to release tension of the spring 26 giving the cord 20 to sag.

[0057] There are three steps making diving rudders ready to function in the standard mode of operation.

[0058] 2.2. Simplification of the first design (p.2.1.) by removing the worm mechanism.

[0059] Collapsing the foils 17, 18 can be done with spring 90 (FIG. 5) if the cord 20 sags. In this case the spring 90 contracts by length x as well as the cord 35 move in the same distance to left rewinding from the pulley 33. This pulley 33 holds the foil 17, embraces the lower disk 29 (FIG. 3) and makes the foils 17, 18 to interact similar as the worm disk 16 does. But instead the worm mechanism 15 here is used the winding pulley 28 driven with embedded hydraulic or electric drive supplied via flexible armored cables 5. The pulley 28 is suspended via the spring 26 on the hook 34.

[0060] When the WP-propellor opens the drive 10 shifts the clutch muff 9 to right disconnecting it from the spline cylinder 8 of the worm wheel 6 giving the diving rudder (wing) 2 freedom. Then the winding pulley 28 pulls the cord 20 and stretches the spring 26. The cord 20 turns the pulley disk 33 by the lug 19, which initially resides on the position I. To do this the string 26 should be harder then the spring 90. After opening the foils the tension force of the spring 26 can be much stronger to meet the power of the hydraulic head and to keep right the foil deflection rule.

[0061] To close the WP-propellor we need to release tension of the spring 26 by reversing the pulley 28 in order to sag the cord 20. This causes the pulley 33 to turn back in initial angle position so, as the lug will stay in position I and the spring 90 contracts by the length x. Probably we need

here to measure angle position of the diving rudder with a rudder angle pick up in order to start controlling the rudder from initial position differ than the neutral position.

[0062] 2.3. Design of the spare WP-propellor with the torsion deflecting spring.

[0063] This design assumes the diving rudder 2 able to swing rotary around motionless cantilever-axle 4 using the bearing bush 12 connected with the wing 2 hard. The wing 2 is fixed on the axle 4 with the nut 46. The axle 4 is hollow and allows the torsion shaft 49 go through it. When the WP-propellor is collapsed, here is no eccentricity E to create the couple of the forces turning the wing 2 except the torque issued by the worm wheel 6 fixed on the torsion shaft 49. The bearing 45 and the anti spin bush 48 hold the shaft 49. In turn the guide 50 and rack guide 64 hold the anti spin bush 48. This allows the control diving system to deflect the wings 2 as needed by turning the worm wheel 6.

[0064] To open the WP-propellor the diving control system should fix the wings 2 in neutral position. Then the distributor 11 directs the pressured oil via channels 51 (FIG. 11) of the axle 4 into hoses 5 (FIG. 10) such way as the drive 13 opens the foils 17, 44, 18 with the worm mechanism 15. As a result the extended wing area shifts his center to new position C creating the needed eccentricity E. Now the hydraulic head can deflect the wings making it to turn (oscillate) around the axle 4. But the torsion 49 hinders the wings to deflect accomplishing the foil deflection rule, i.e. allowing the wings to angle only half of the water flow slope α .

[0065] Depending of the wave power the hydraulic head changes the value of torque applied to the wings. It requires adjustment of the torsion 49 resistance that is accomplished by the anti spin bush 48 slid along spline part 49a of the torsion 49 by the drive 47. Said drive uses the rack guide 64 and the slide guide 50 to do so. The more powerful waving the shorter distance between the worm wheel 6 and the bush 48.

[0066] 3. Spare WP propulsion plant for submarine having an even sail. Claim 3.

[0067] Submarines of this class (with an even sail) should be equipped by independent WP propulsion plant with the folded foil WP-propellers (FIGS. 21-25). When a submarine runs using an ordinary propulsion system the WP-propellers are folded and resided in the pockets 79 (FIG. 24) of the sail. When waving and submarine runs under the WP propulsion plant its propellers 73, 74 are opened (FIG. 22). The rear propellers 74 in turn opens its foil extensions B in order to capture more water area carrying wave energy. Also these opened foil extensions B shift the center C of hydraulic head of each rear WP-propellor back creating the eccentricity E needed for propulsion process. Roman digits II and I show the axis's which the WP-propellers turn around when folding and opening (FIG. 22).

[0068] To make the submarine sail with streamline form, when it is rigged with the WP propulsion plant, the sail 1 pockets and the propellers wings 73, 74 are made with shapes (profiles) adjoining each to other (FIG. 23).

[0069] A mechanism opening/closing the WP-propellers consists of a worm drive (drive 76, muff 14, prop 74, bearing 77, worm 15, worm wheel 6, shaft 80) and a cantilever 78

fixed on the shaft 80 and holding the propellor 2 via the shaft 4. The O/C-mechanism opens or folds the WP-propellers by turn them around axis's II and I with the shafts 80. As a result a cantilever 78 lifts or lowers the propellor 2 via a shaft 4 (FIG. 25). To provide the perpendicularity of the foil deflection axis's Y to the diameter axis X the shafts 4 can be tilted to the axis I or axis II respectively (FIG. 25). It makes the propellers to work the most effectively.

[0070] The mechanism opening the embedded foil extension 17 and the mechanism controlling foil elastic deflection are similar to these shown in FIGS. 1, 3, 10 and described in p. 2.1 or p.2.3.

[0071] The spare submarine WP propulsion plant disclosed here is more powerful than that is disclosed in the p.2 because it has 4 WP-propellers catching greater water area filled with wave energy. Such spare submarine WP-plant as expected can propel a submarine with velocity 3-4 knots, 4-6 knots, and 6-7 knots when sea is rough, very rough, and high.

[0072] 4. Quasi-dipped watercraft equipped with the WP propulsion system. Claim 4

[0073] Spare submarine WP propulsion plant concept using great inertia of the submarine body as reliable stabilized support for the foil WP-propellers opens the new ways for building the WP propulsion systems in conjunction with the quasi-dipped watercrafts (FIG. 12). Having positive ability to float, which is almost equaled to zero, the quasi-dipped watercrafts can carry the basic WP propulsion system much more powerful than the spare submarine WP propulsion plant limited by the propelling foil areas.

[0074] The shown quasi-dipped watercraft design (FIGS. 12, 13, 14) takes the body 39 shaped similar to the submarine body and inherits the horizontal stabilizers 57, 58 and vertical course rudder 59 from a submarine. The standard propulsion plant 60 (FIG. 14) driven by an ordinary engine installed in the rear float (looking like a boat) can be small and to play auxiliary role providing some maneuvers when sea is quiet. On the other hand the multi wing WP propulsion system, catching energy from great water area, is powerful enough to propel the quasi-dipped watercraft as expected with the velocities 5-15 knots.

[0075] The best thing of it is absence of substantial wind action. The floats 52 holding the quasi-dipped watercraft buoyant have neglect surface opened to the wind. So the wind almost has no influence toward to the quasi-dipped watercraft. The worth thing is that the floats 52 may dive under each essential wave. It causes necessity to make the crew houses watertight.

[0076] 5. Underwater wave powered (WP-) tug. Claim 5.

[0077] The underwater WP-tug disposes on the water surface (FIG. 17) while its barge made as a streamlined tank shaped similar to the submarine body 39 (without stabilizers, rudders and screw) disposes under water. The submarine barge 39 is hermetically closed and possesses the buoyancy value approximately equaled to zero. Connection between the WP-tug and the barge 39 is provided with posts 69 and the bolts 70 fixing the posts inside of the nests 71. After connecting the composite watercraft installation behaves itself as the quasi-dipped watercraft (p.4).

[0078] The WP-tug itself consists of two floats 52 connected each with other by the boom 55, which can be made hollow (as a pipe) providing passes and communications between the floats as well as supporting the propellers close to the water surface for the better acceptance of the wave energy. Also the boom 55 holds the posts 69, connecting to and supporting the underwater barge 39. The stabilizers 57 and 58 may support horizontal stabilization. If the floats 52 are effective enough the stabilizers 57 and 58 may not be present. The rudders 59 mounted on the floats 52 provide the course handling.

[0079] One or both floats 52 may be rigged with the auxiliary propulsion plants 60. It provides the WP-tug with the possibility to maneuver separately from the barge or together when sea is quiet.

[0080] It is clear that this tug and its barge can be converted to the quasi-dipped watercraft by making the connection between them permanent and trough providing some communications between them and possibly making the barge part inhabited.

[0081] 6. Some additional designs of the WP-propellers.

[0082] 6.1. The mono foil WP-propellor.

[0083] The WP propulsion system of the WP-tug requires the WP-propellers of simpler design (FIGS. 15, 16) than we used for the spare submarine WP propulsion plant (p.2) because it does not requires the foil collapsing. The only we need here is to control the foil deflection resistance which provides the foil deflection rule (see the Notice in p.1) for variable wave force. The foil (wing) 2 initially can turn around the torsion 49 into bearings 62, 66. But the carriage 48, set on the torsion spline part 49a, does not allow the foil 2 freely revolve around the torsion 49. The foil 2 can only oscillate around the torsion 49 exploiting its elasticity.

[0084] The signals that provided via the flexible ware 63 could enforce the carriage 48 to slide along the torsion 49 and the guide 50. For this the carriage drive uses the rack 64. This changes length of the twisted part of the torsion 49 as well as it changes the torsion elasticity resistance, supporting the foil deflection rule.

[0085] 6.2. The coupled WP-propellers design.

[0086] The other design of the WP-propellor (FIG. 20) combine two individual foils (wings) resided on the common post 61. This paired design increases effectiveness of the WP-propellor because each individual foil catches own area of wave motion. If two areas caught by single foil then energies from them can partially annihilate each other reducing total result.

[0087] Here the cable lead-in passes through hollow motionless shaft 4 to feed the drive of the carriage 48, which changes length of the twisted part 49a of the torsion 49. Said torsion continues the motionless shaft 4 carrying the foil 2 with the bearings 62. The foil 2 is fixed on the shaft 4 with the nut 46.

[0088] We assume that this paired propellor is used for the WP-tug (FIGS. 17, 18, 19).

[0089] 6.3. Self controlled WP-propellor. Claim 6.

[0090] The self controlled WP-propellor accomplishes automatically the foil deflection rule. It is set on the motionless shaft 4 and consists of two foils 2 and 81. The foil 2 is a working foil creating the thrust and its center C of the hydraulic head disposes on the foil deflection axis Y making the eccentricity equal to zero. The hydraulic thrust can not turn this foil because of it. The other auxiliary foil 81 set on the same shaft 4 and it is able to be turned by the hydraulic head as a weather vane and it can keep so the direction of the water flow relative the shaft 4.

[0091] Between both foils the lever mechanism is set to divide the auxiliary foil deflection a by two and to incline the basic foil 2 to resulting angle $\alpha/2$. This mechanism consists of the arm 83 set through its bush 82 on the motionless shaft 4 with a key providing hard connection the arm 83 with the shaft 4 making the arm 83 motionless too. When a wave deflects the auxiliary foil 81 it pulls (FIG. 26) the link 85. This link in turn pulls the sliders 87 via the pin 86 welded to the slider 87 while the link 88 restrains it pulling it to the hinge 91 held motionless by the motionless arm 83. As a result of two equal actions from the links 85 and 88 the slider 87 moves along bisector of the angle α , i.e. the foil 2 occupy the bisector of the angle α accomplishing the foil deflection rule.

[0092] Any new water mass flow direction automatically corrects the position of the working foil 2. So the considered WP-propellor is really auto optimized.

[0093] Wave powered propulsion systems for submarines and quasi-dipped watercrafts

What I claim as my invention is:

1. Submarine wave powered (WP) propulsion system consisting of two elastically deflected foils attached to extremities of a submarine sail along a central line with inclining arms able to rise or to lower said foils parallel themselves and providing their usage wave powered propellers from various depths closest to water surface.

2. Spare submarine WP propulsion plant embedded to and expanding from diving rudders to convert them to the WP propellers functioning in the water subsurface layer when waving; after the usage the plant is retracted back into the rudders to continue standard mode of operation.

3. Independent spare submarine WP propulsion plant with WP-propellers folding into submarine sail side pockets in standard submarine mode operation and opening from them in order to catch wave energy propelling the submarine; the rear WP-propellor may have foil extension increasing quantity of caught wave energy boosting the submarine.

4. Quasi-dipped watercraft providing the best conditions for installation and operation multi foil WP propulsion system able to consume maximum quantity of the wave energy; said watercraft moves at a maximum speed because it also has minimum area of its parts jutted out of the water and experiencing wind head.

5. Wave powered (WP) tug working in conjunction with towed submarine tank (barge), which provides great inertia needed to support constant vertical disposition of the WP-propellers creating thrust via own elastic inclination deflecting backward water masses moving up and down by wave motion.

6. Wave powered (WP-) propellor with self controlled optimal inclination respecting to water mass movement direction; the WP-propellor consists of two foils (propelling and auxiliary) installed on a motionless shaft; the auxiliary

foil works as weather vane and tilts the propelling balanced foil to half own inclination via lever mechanism.

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