Hydro Column.

The invention is a, Self Priming Gravity Wave water Pump incorporating a Submerged Column Platform, the pump is powered by Wave Energy, the column can be tethered or located by a pivot or fixed in the water bed. The submerged column platform can be incorporated into an additional submerged column chamber to operate as a Hydraulically Controlled Tidal and Storm Adjustable Column platform incorporating the Self Priming Self Adjusting Reciprocating Double Acting Gravity Wave Pump.The Gravity Wave Pump is a wave energy converter using wave energy in the form of wave movement to displace a float to lift the pumps piston, and uses gravity causing a weight to push the piston down. The pump could pump water to a Head of up to 100 metres or more and could pump pressures in excess of 150 pounds per square inch when adjusted accordingly.

The pump is almost fully submerged, it is designed to pump water at pressure using buoyancy displacement to lift the pumps piston as the wave height increases, and using gravity in the form of a heavy weight to push the pumps piston down as the wave passes. The submerged column forming a submerged platform to support the nearly fully submerged self adjusting pump can be rigidly fixed, mounted on a pivot, or tethered. The water can be pumped to a water tower in the water or on land, or can be pumped to a shore based reservoir in the region of 100 metres above the water source, where it could drive water turbines to produce hydro electricity, or to drive machinery, or a reverse osmosis plant before the water is returned to its original source. Pressures are increased by increasing the buoyancy and the weight attached to the same size of pump to obtain higher heads of water. The number of individual pumps can be increased to increase the volume of water at the water requirement, only the buoyant float and impact protection ring and possibly the weight, are visible above the surface, therefore there is only a very minor aesthetic pollution, all the hydraulic action and lubrication in connection with the pump utilises the water source passing through the pump, no oils are used, therefore it is 100% free of oil pollution.

Advantage.

The low profile floats of the pumps are not very conspicuous in the surrounding water.

The task of laying (manufactured onshore) weighted tethered submerged air captive column platforms and pumps on the water bed, is much easier and more economical than building unsightly expensive fixed structures offshore on the water bed.

Water craft would probably gain less damage from inadvertantly colliding with tethered pumps than colliding with rigid structures.

The pumps are lubricated by the water they pump.

The advantage of very simple similar components of identical pumps, mean they be can be mass produced at much lower cost than wind turbines, there are no gearboxes or hydraulic oils involved in the pumps, and the pumps can be lifted, disconnected, replaced, reconditioned, reconnected and resited individually, or in small groups with little or no interruption to the electricity supply, and no spill pollution from the disconnection of the pumps.

The similar specification pumps are used as individual pumping units which makes placing them under water easier, they may or may not be linked or group linked, by rigid or flexible pipes weighted on the water bed, which convey the pumped water at pressure to a water tower, or shore based reservoir of up to 100 metres head or more.

The advantage of pumping water to a head means the stored water becomes an available energy source which has the advantage of being controllable, with an at a glance known stock of potential kilowatt hours available, especially to fulfill an emergency requirement.

The wave energy source is the sun and the wind, this source of energy is also used to power wind turbines, but the head of stored water supplied by the gravity wave pumps can be used as available clean energy to drive water turbines after the wind drops.

Hydro produced electricity is a known and proven art, the advantage of a high head of water means a high speed water turbine, directly driving a generator without a gearbox, at an onshore facility greatly reduces generator maintenance costs and there are fewer moving parts.

Onshore access to build and maintain a generating facility greatly reduces the initial and on going costs.

Examples of the invention will now be described by referring to the accompanying drawings.

Figure 1A shows a rigidly fixed gravity wave pump used in lower wave locations.

Figure 2A shows a pivoting gravity wave pump secured to a weight.

Figure 3A shows a tethered gravity wave pump secured to a weight.

Figure 4A shows a tethered adjustable column wave pump.

Figure 5A shows a pivoted gravity wave pump secured to the water bed.

Figure 6A shows the air and flood valves in the float.

Figure 7A shows the spherical valves and valve seats of the pump.

Description.

The Gravity Wave Pump in it's simplest form is shown in figure 1A, the non buoyant non adjustable near vertical column platform 22 constructed of wood, metal, concrete, or composite materials or other materials, is secured rigidly into or piled into the sea bed, river bed lake bed or reservoir bed 31 at a pre-determined fixed height which is below mean height of the available water surface height 01. At the top of this column is a fixed flange 16, attached to the flange by means of bolts through a matching flange 15, is fixed a submerged, self adjusting to the surrounding water level, gravity wave pump 9.

The pump 9 in figures 1A 2A 3A 4A 5A 6A can be constructed of metal or composite materials. The float 2 with impact protection 1 in figures 1A 2A 3A 4A 5A 6A can be constructed of metal or composite materials or concrete or other materials, the float 2 can be secured by a pivot or can be rigidly secured to the reciprocating connecting member 5, which is approximately half the diameter of the piston, this connecting member 5 passes through a special scraper water seal 6 at the top of the cylinder 9 and is connected to the piston 12, it self adjusts to the surrounding water level by means of the buoyancy displacement of the float 2, the travel of it's designated self adjustment is decided by the hydrography data of a chosen site combined with design parameter's which govern the length of the cylinder 9, and it's corresponding connecting member 5, the limit of the pistons travel is protected by impact protection buffer's 4 and 11. The pump is a self priming double acting reciprocating pump, and consist's of a connecting member 5 connected to a double acting piston 12 in a cylinder 9, with self activating hydraulic inlet valves 7 and 14, as shown in (Figure 7A) which close on to weed and debris cutting, narrow edged valve seats 07 and 014 and self activating hydraulic outlet valves 8 and 13, which also close on to weed and debris cutting narrow edged valve seats 08 and 013, into a common manifold 10.

The weight 3 in figures 1A 2A 3A 4A 5A 6A which can be water ballasted, or constructed from concrete or composite materials or metal or other materials, or a container containing a heavy aggregate.The weight 3 can be secured to the reciprocating member 5 by a pivot, or rigidly secured, to the reciprocating connecting member 5, the weight 3 is raised near vertically by the energy of a wave meeting the buoyant float 2, which lift's the piston 12 which draws water in through inlet valve 14, it forces at pressure water through outlet valve 8. As the wave passes, the weight 3 returns the piston 12 down, drawing water through inlet valve 7, and forces at pressure water through outlet valve 13, this once up stroke and once down stroke of the piston 12 is one complete cycle, and keeps the cylinder charged with water at any time whilst the pump is in its intended submerged state. From outlet valve 8 and outlet valve 13 the water passes at a pre determined maximum pressure through the manifold 10, controlled by a pressure relief valve 101 into outlet pipe 17, where it continues at pressure to the water requirement. A 100 metre head from the pump is possible.

The distance the piston 12 travels up the cylinder 9 is the distance the buoyant float 2 and weight 3 rise near vertically in a wave, the distance the piston 12 travels down the cylinder is the distance the buoyant float 2 and weight 3 fall near vertically in the trough after the wave passes. The pump 9 designed length would be matched to the wave height hydrographical records of its intended geographical siting, a pump on a fixed column 22 as shown in figure 1A would only be sited in a geographical location of lower wave heights than pumps of figure 4A siting. Protection buffer 11 limits upward travel of the piston at which point the float 2 and weight 3 lie submerged until an excessive wave passes by, protection buffer 4 limits downward travel upon which the weight 3 and float 2 would rest if the trough exceeded in depth beyond the stroke of the piston12. Immediately after excessive waves or excessive troughs pass, the self priming submerged pump self activates and re-commences pumping water.

The submerged air captive columns 22 in Figures 2A 3A 4A 5A 6A and adjustable flooded column 23 in Figure 4A can be constructed of metal or composite materials or other materials. The Gravity Wave Pump 9 in figure 2A is attached to the submerged air captive column platform 22, the submerged air captive column platform is vertically controlled by a pivot or fulcrum or shackle 30 at the columns base fitted to a weight 29, which must be heavy enough and the pivot or fulcrum or shackle strong enough to restrain the total upward lift of all the buoyant components 2 21 22, and pivot or fulcrum or shackle 30 must likewise be strong enough when secured to the sea bed or river bed or lake bed or reservoir bed 31, (as in figure 5A). Shown in Figure 2A at the upper end below the flange 16, the submerged air captive column platform 22 is supported nearly vertical in the water by a constantly submerged air captive collar 21, attached equally around the submerged air captive column platform 22, this air captive collar 21 must be of a volume to displace a weight of water greater than the submerged weight, (if any) of the air captive column platform 22, plus the combined submerged weight of the pump 9 and its entire components 1 2 3 4 5 6 7 8 9 10 101 11 12 13 14 15 16 17.

The Gravity Wave Pump 9 in Figure 3A is attached to the submerged air captive column platform 22 the submerged air captive column platform 22 is vertically controlled by a tether 28 attached at the upper end to the columns base and tether 28 at its lower end secured to a concrete or metal weight 29 resting on the sea bed or river bed or lake bed or reservoir bed 31, or tether 28 secured to the sea bed or river bed or lake bed or reservoir bed 31, the tether can be chain 28, or steel cable or rope or other tether, the chain 28 or steel cable or rope or other tether can be adjusted to suit the geographical siting depth of the mean water level, this means a site of a greater depth can be practical and economical to site the wave pump assembly. At its upper end below the flange 16 the submerged air captive column 22 is supported nearly vertical in the water by a constantly submerged air captive collar 21, attached equally around the submerged air captive column platform 22, this air captive collar 21 must be of a sufficient volume to displace a weight of water greater than the submerged weight (if any) of the submerged air captive column platform 22, plus the combined submerged weight of the pump 9 and its entire components 1 2 3 4 5 6 7 8 9 10 101 11 12 13 14 15 16 17 28. The tether 28 must be strong enough and weight 29 must be heavy enough to restrain the total upward lift of all of the buoyant components 2 21 22.

The Gravity Wave Pump 9 in figure 4A is attached to the submerged Adjustable air captive column platform 22. The submerged flooded column 23 is vertically controlled by a pivot or fulcrum or shackle (as the pivot on column 22 in Figures 2A and 5A), or a tether 28 as in Figure 4A, attached to the column 23 base, and tether 28 secured to a concrete or metal weight 29, resting on the sea bed or river bed or lake bed or reservoir bed 31, or tether 28 secured to the sea bed or river bed or lake bed or reservoir bed 31, the tether can be chain 28 or steel cable or rope or other tether, the chain 28 or steel cable or rope or other tether can be adjusted to suit the geographical siting depth of the mean water level, this means a site of a greater depth can be practical and economical to site the wave pump assembly.

Figure 4A shows at the upper end below flange 16 that the submerged flooded column platform 23 is supported nearly vertical in the water by a constantly submerged air captive collar 21, attached equally around the submerged flooded column 23, the air captive collar 21 must be of a sufficient volume to displace a weight of water greater than the submerged weight of the submerged flooded column platform 23, plus the submerged weight (if any) of the submerged adjustable air captive column platform 22, plus the combined submerged weight of the pump 9 and its entire components, 1 2 3 4 5 6 7 8 9 10 101 11 12 13 14 15 16 17 18 19 20 24 25 26 27 28. The tether 28 must be strong enough and weight 29 must be heavy enough to restrain the total upward lift of all of the buoyant components 2 21 22 in a fully submerged situation.

Figure 4A shows the adjustable air captive column platform 22 which can rise up from the secured submerged flooded column platform 23 as an extending near vertical column platform supporting the gravity wave pump 9. The vertically extending column platform 22 allows the pump 9 to continually self position vertically by means of the buoyancy displacement of the float 2 positioning its self at the surface level of the surrounding water or height of the tide, this enables the pump to gain maximum use of the available waves at any height of the tide 01. Figure 4A shows how the captive air column platform 22, can move up or down through guide bearing 20 which is fixed to the upper inner wall of flooded column chamber 23 and scraper water seal 19 which is located at the top of column chamber 23, fixed around and to the base of column 22 there is a guide bearing 24 which travels up and down the internal walls of the flooded chamber of column 23.

Figure 4A shows how the vertical movement of the captive air column 22 is governed by a pressure relief outlet valve 26, and a suction relief inlet valve 25, at the base of the submerged flooded column platform 23, these valves control the resistance of water being drawn in to the flooded chamber of column 23 and the pressure of water being expelled from the flooded chamber of column 23, this situation creates a hydraulic lock to hold column 22 in the required position at a load value corresponding to a predetermined setting of the valves which will be greater than the force required by the pump 9 working at its highest pressure but at a setting that allows the float 2 or weight 3 to adjust the column 22 position without the float 2 being pulled completely under the water before it sucks inlet valve 25 open allowing water to enter chamber 23, and at a setting that does not hold the weight 3 air bourne above the water 01 before it pressurises outlet valve 26 allowing some water to expel from chamber 23. The valve governed hydraulic lock holds column 22 in a position that allows the gravity wave pump 9 to operate within its normal self adjusting stroke, however if the piston in the pump 9 hits buffer 11 due to tidal increase or a higher wave, the extreme lifting force of the greater water displacement imposed on float 2 will open inlet valve 25 allowing more water to enter chamber 23 allowing column 22 to rise until the valve 25 closes due to less suction because the float 2 has reached normal displacement, similarly if the weight 3 forces buffer 4 on to the top of pump 9 the additional load will cause pressure relief outlet valve 26 to open allowing water to evacuate chamber 23 allowing column 22 to fall vertically until the float 2 displacement returns to normal and outlet valve 26 closes, (there is also a protection buffer 27) the gravity wave pump 9 is then in the correct position to operate normally up to its highest pressure, but can always fine tune its position vertically if a higher wave or a deeper trough passes through.

Figure 4A shows the vertical positioning of captive air column 22 could also be controlled by connecting a pressure water pipe to inlet valve 25, which could be controlled from a land based control room or floating control room automatically or manually controlled by forcing water, at a controllable pressure in to the flooded column chamber 23 to hydraulically raise column platform 22, and by connecting a small bore high pressure pipe carrying a controllable air or water pressure to pneumatically or hydraulically operate valve 26, to release water from column chamber 23 to lower column platform 22, or lock column platform 22 down on buffer 27 in the event of a storm, assisted by flooding the weighted float 2 utilising the valves 02 and 002 and dual air pressure line in Figure 6A.

In Figure 4A the float 2 must have a displacement capability of lifting the piston 12 at a water pressure necessary to achieve the required head of water, plus lifting the submerged air captive column 22 hydraulically through the preset inlet limiting valve 25 in chamber 23, and all the following components 1 3 4 5 6 7 8 9 10 101 11 12 13 14 15 16 17 18 24, the float 2 must be of little greater displacement than necessary to achieve the above lifting force, as it is necessary for the float 2 in figure 4A to submerge by being held under the surface by the fully extended components of the pump 9, and column 22 in the event of very high waves.

In Figures 2A 3A 4A 5A 6A the submerged air captive collar 21 acts as a lateral shock absorber to the submerged column platform, absorbing side impacts to the pumps float 2 and weight 3 from the waves or water craft, by allowing the submerged columns 22 and 23 to tilt at various angles, before the collar 21 self uprights the columns again to near vertical. The vertical damping, absorbing vertical shock loadings to the pump 9 and its components, happens naturally in pumping a fluid such as water through the hydraulic valves via a wave energised float.

The float 2 in Figures 1A 2A 3A 5A 6A must have a displacement capability of lifting the pumps piston 12 at a water pressure necessary to achieve the required head of water plus the following components 1 3 4 5 11 12, the float 2 must be of little greater displacement to achieve the above as it is necessary for the float 2 in Figures 1A 2A 3A 5A 6A to submerge by being held under the surface by the fully extended components of the pump 9 in the event of very high waves.

In certain situations when required, the float 2 in Figures 1A 2A 3A 5A 6A can be flooded with water and submerged to ride out a storm in the closed down position, if fitted with the flood valve 02 drain valve 002 and dual air pressure line 34 as shown in figure 6A, which could be controlled manually or automatically from a control room on shore in the event of a storm.

Hydro Column
Claims
1. to 6.

1. A Self Priming Gravity Wave Water Pump, utilising a reciprocating double acting piston powered by gravity and wave energy, incorporating a fully submerged air captive column piston platform, vertically self positioned and hydraulically positioned to suit the water surface height or tidal height, incorporated within a fully submerged vertical flooded chamber column, which is supported at a station fixed vertically from the water bed by means of a fully submerged substantial air captive support collar attached to the flooded chamber columns upper end, and a tether in the form of a chain or cable or rope or other tether attached to the flooded chamber columns lower end, extending down and attached to the water bed, or a tether in the form of a chain or cable or rope or other tether, extending down and attached to a weight on the water bed.

2. A Self Priming Gravity Wave Water Pump according to claim 1, in which the fully submerged substantial air captive support collar attaches to and supports the fully submerged flooded chamber column vertically, at a station fixed vertically by the tether, the submerged substantial air captive support collar, will be of sufficient displacement to oppose and overcome the downward forces imposed by the pumps piston on its gravity downward stroke and all other relevant heavier than water elements of the water pump and incorporated column platform and tether.

3. A Self Priming Gravity Wave Water Pump according to claims 1, 2, in which the incorporated fully submerged flooded chamber column has at least one scraper water seal sealing the flooded chamber column to the air captive column piston platform, the flooded chamber column has at least two guide bearings within the chamber, the flooded chamber column has fitted to its chamber at least one self controlled or controllable water inlet depression adjustable relief valve, and at least one self controlled or controllable water outlet pressure adjustable relief valve, these valves control the pressure and depression in the flooded chamber, and the hydraulic lock on the air captive column piston platform contained within the flooded chamber, this allows controlled vertical positioning and locking of the air captive column piston platform, the controllable valves allow a controller, manual or electronic, the additional advantage of being able to raise or lower the air captive piston platform, and lock it down in storm conditions via pressure pipes and hydraulic or pneumatic valve controls operating from a floating or shore based control station.

Hydro Column
Claims
1. to 6.

4. A Self Priming Gravity Wave Water Pump according to claim 1, in which the double acting pump, has a weighted surface float connected to a vertically reciprocating member, which is connected to a double acting piston in a cylinder, which has a manifold with at least two inlet valves and at least two outlet valves.

5. A Self Priming Gravity Wave Water Pump according to claim 4, in which spherical valves of the pump close on to very narrow valve seats to act as debris cutters and weed cutters.

6. A Self Priming Gravity Wave Water Pump according to any of the preceding claims in which the components are made from metal, or composite materials, or recyclable materials.