BUOYANT SEALED WAVE ENERGY CONVERSION SYSTEM WITH HYDRAULIC MEANS

FIELD OF INVENTION

The present invention relates to a wave energy conversion system for converting river, sea or ocean wave power to useful electrical power.

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BACKGROUND OF THE INVENTION & PRESENT STATE OF THE ART

Sea or ocean wave power is one of the major sources of renewable energy which is largely untapped worldwide. This is mainly due to the difficult and harsh seawater environment as seawater tends to have corrosive and fouling effects on buoyant, floating or underwater man-made structures.

At present, most wave power systems incorporate hydraulic systems and buoyant, floating or submerged bodies which move in relation to one another to absorb the wave energy and generate hydraulic power which is then converted to electrical power. Other installations include underwater turbines with propellers which rotate according to the direction of the underwater currents. However, all these installations incorporate moving parts or hydraulic members which are exposed to the open seawater environment and will deteriorate over time, requiring regular and extensive maintenance works.

Examples of such installations include US patents 6476511 and 4686377 which use buoyant cylinders to generate hydraulic power from the hydraulic rams which interconnect these buoyant cylinders. WO applications 2005/038247 and 2005/038249 use a plurality of floating arms to generate hydraulic power when the floating arms move against a fixed overhead structure. US patent 4781023 uses a floating platform to generate hydraulic power when the floating platform moves against a submerged structure.

WO application 2006/129310 uses floating buoys which move up and down against a fixed submerged structure to generate hydraulic power. And WO application 2007/019608 uses sea-bed mounted paddles to generate hydraulic power when the paddles move with the tidal waves and against the sea-bed mounted structure.

OBJECTS OF THE PRESENT INVENTION

It is an object of the present invention to create a wave energy conversion system whereby all moving parts and systems for generating hydraulic and electric power are sealed and protected in a buoyant sealed enclosure.

It is another object of the present invention to create a wave energy conversion system which does not require a large or complicated external support or mooring structure.

It is also another object of the present invention to create a wave energy conversion system consisting of buoyant sealed enclosures which can be easily connected physically and electrically to another similar buoyant sealed enclosure to form a row or an array of such buoyant sealed enclosures.

It is a further object of the present invention to create a wave energy conversion system which is modular and requires minimal maintenance.

It is yet another further object of the present invention to create a wave energy conversion system which can be used on the open seas, rivers or oceans.

It is also yet another further object of the present invention to create a wave energy conversion system which can be a portable and stand-alone unit for use inside a boat or floating body.

SUMMARY OF THE PRESENT INVENTION

The present invention creates a wave energy conversion system whereby all the moving parts and means for generating hydraulic and electric power are sealed in a water-tight and air-tight buoyant sealed enclosure and protected from the harsh open seawater environment.

The buoyant sealed enclosure of the present invention contains at least one ram weight which is connected to at least one hydraulic piston assembly, preferably a dual-action piston assembly. Depending on the design and size of the buoyant sealed enclosure, the ram weight can weigh at least ten (10) kilograms, mounted on wheels and made to travel at least one (1.0) meter by gravity in a linear forward and backward motion along a fixed axis inside the buoyant sealed enclosure as the buoyant sealed enclosure sways with the waves. Alternatively, both opposite ends of the ram weight can each be connected to a different hydraulic piston assembly.

The wave energy is absorbed by the linear forward and backward motion of the ram weight which drives the dual-action hydraulic pistons linked to a hydraulic system which can include shock absorbers, pressure accumulators, valves, reservoir tank, heat-exchanger and a hydraulic motor. The hydraulic motor then drives an electric generator to generate electricity which is then regulated and stored in a battery or transmitted out of the buoyant sealed enclosure via a power cable. Depending on the size of the buoyant sealed enclosure and the hydraulic systems, the electric generator can be sized to produce electrical power outputs varying from 10 kilo-Watts to 250 kilo-Watts.

Multiple assemblies of the ram weights and hydraulic pistons can be installed such that each ram weight moves along the same or different axis in a linear forward and backward motion. This is to spread out the ram weights and increase the stability of the operation of the buoyant sealed enclosure.

Additional features like overhead sails, underwater fins and floats can be attached to the external body of the buoyant sealed enclosure to amplify the motion of the buoyant sealed enclosure on the waves. Also, multiple buoyant sealed enclosures can be physically and electrically connected together to form a row or an array of the buoyant sealed enclosures.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and objects of the present invention are summarized but not limited to the following drawings, the full scope of which are embodied in the appended claims of the present invention :-

FIGs. 1A and **1B** show the top and side elevation views respectively of the internal compartments of a buoyant sealed enclosure.

FIGs. 2A and **2C** show how the ram weight moves by gravity as the buoyant sealed enclosure moves correspondingly as shown in **FIGs. 2B** and **2D** respectively. Power cables are not shown.

FIGs. 3A and **3B** show two possible installations of multiple ram weight and piston assemblies inside a buoyant sealed enclosure.

FIGs. 4A, 4B and **4C** show how two separate and different sections of multiple ram weight and piston assemblies can be incorporated into a single buoyant sealed enclosure. The power cable is not shown.

FIGs. 5A and **5B** show how three buoyant sealed enclosures can be linked together to form a row of buoyant sealed enclosures. Power cables are not shown.

FIG. 6 shows how external fixtures like a sail and an underwater fin can be attached to the external body of the buoyant sealed enclosure to amplify the movement of the buoyant sealed enclosure on the waves and to improve the aesthetics of the buoyant sealed enclosure. The power cable is not shown.

DETAILED DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

FIGs. 1A and **1B** show the top and side elevation views respectively of the internal compartments inside a buoyant sealed enclosure **1.** The buoyant sealed enclosure **1** is air-tight and water-tight and can be easily constructed by those people experienced in building boats or pleasure crafts. The buoyant sealed enclosure **1** floats on the water surface at all times and sways with the river, sea or ocean waves **7**.

A ram weight **2** is connected at one end to the piston **4** of the hydraulic piston assembly **3**, which preferably shall be of the dual-action piston type. Depending on the desired operating conditions, the weight of the ram weight **2** can vary from 10 kilograms to 100 kilograms.

During operation, as the buoyant sealed enclosure **1** sways with the waves 7, the ram weight **2** is moved by gravity in a linear forward and backward motion along the fixed axis **5**, pushing and pulling the piston **4** respectively, thus creating hydraulic pressure inside the piston assembly **3**. Depending on the size of the buoyant sealed enclosure **1**, the linear distance travelled by the ram weight **2** can vary from 1 meter to 10 meters. And to facilitate the movement of the ram weight **2**, wheels **6** can be added to the ram weight **2**. Shock absorbers (not shown) can be incorporated to cushion the impact of the ram weight **2** on the piston assembly **3** at the end of the travel distance of the ram weight **2**.

The hydraulic pressure created in the piston assembly **3** is then transmitted to a hydraulic system **10** through hydraulic pipes **9**. The hydraulic system **10** can be located in another compartment **8** below the piston assembly **3** and can consist of pressure accumulators, shock absorbers, directional valves, regulating valves, reservoir tank, heat-exchanger, gears and gauges. A person skilled in hydraulic and mechanical systems will be able to design such a hydraulic system **10**.

The hydraulic system **10** operates a hydraulic motor **11** which in turn operates an electric generator **12** to generate electricity. Depending on the size of the hydraulic system **10**, the size of the electric generator **12** can vary from10 kilo-Watts to 250 kilo-Watts. Means (not shown) to regulate the electricity generated by the said electric generator **12** can include electronic circuits, batteries and voltage, frequency and current regulators. The electricity generated is then transmitted to the outside the body of buoyant sealed enclosure **1** through a power cable **13**.

FIG. 2A shows how the ram weight **18** moves by gravity in the direction **23** as the buoyant sealed enclosure **14** moves in the upward direction **16** with the waves **15** as shown in **FIG. 2B**. The piston **19** then compresses the hydraulic oil in the section **21** inside the dual-action piston assembly **20**, creating the hydraulic pressure inside the dual-action piston assembly **20**.

Conversely, **FIG. 2C** shows how the ram weight **18** moves by gravity in the reverse direction **24** as the buoyant sealed enclosure **14** moves in the downward direction **17** with the waves **15** as shown in **FIG. 2D**. The piston **19** then compresses the hydraulic

oil in the section **22** inside the dual-action piston assembly **20**, creating the hydraulic pressure inside the dual-action piston assembly **20**.

Various multiple piston assemblies can be incorporated inside a buoyant sealed enclosure in order to achieve maximum power output from the buoyant sealed enclosure and to increase the stability and movements of the buoyant sealed enclosure as the buoyant sealed enclosure sways with the waves.

FIG. 3A shows how both opposite ends of the ram weight **27** can each be attached to two different pistons **30, 31** of the respective piston assemblies **28, 29** inside the sealed enclosure **25**. As shown in **FIG. 3A**, the ram weight **27** has moved by gravity in the direction **26**.

FIG. 3B shows how two ram weights **33, 34** can each be attached to two different piston assemblies **36, 37** respectively such that the weight of the ram weights **33, 34** are spread out evenly inside the sealed enclosure **32**. As shown in **FIG. 3B**, the ram weights **33, 34** have moved by gravity in the direction **35**.

FIGs. 4A, 4B and **4C** show how two separate and different compartments **39, 40** consisting multiple ram weight and piston assemblies can be incorporated into a single buoyant sealed enclosure **38**. The power cable is not shown. As the buoyant sealed enclosure **38** sways with the waves **41**, the ram weights **44** inside compartment **39** move along the fixed axis **43** which is perpendicular to the fixed axis **42** for movements of the ram weights **44** inside compartment **40**.

This will enhance the stability of the buoyant sealed enclosure **38** and increase its movement on the waves **41**, thereby increasing the hydraulic and electrical power outputs from the buoyant sealed enclosure **38**.

FIGs. 5A and **5B** show how three buoyant sealed enclosures **45**, **46**, **47** can be linked together by flexible joints or links **49**, **50** to form a row of buoyant sealed enclosures **45**, **46**, **47**. The interconnecting power cables are not shown. This will further increase the movements of the sealed enclosures **45**, **46**, **47** as the joints or links **49**, **50** act as levers as the sealed enclosures **45**, **46**, **47** sway with the waves **48**.

FIG. 6 shows external fixtures like a sail **54** and an underwater fin **53** can be attached to the external body of the buoyant sealed enclosure **51** to amplify the movement of the buoyant sealed enclosure **51** on the waves **52**. The sail **54** will improve the aesthetics of the buoyant sealed enclosure **51** and further amplify the movement of the buoyant sealed enclosure **51** as the sail **54** catches the wind **55**. The power cable is not shown.

The buoyant sealed enclosure in this present invention can also be incorporated as part of the design or body of a boat or another floating body. It can also be designed as a stand-alone portable unit which can then be used inside a boat or floating body. No proprietary information, parts or specialized skills are required to create and implement the present invention. A person skilled in the trades mentioned will be able to design and construct all aspects of the present invention.

CLAIMS:

1. A wave energy conversion system having at least one buoyant sealed enclosure, each said buoyant sealed enclosure containing:-
   - at least one ram weight connected to at least one hydraulic piston assembly
   - whereby the said ram weight is moved by gravity in a linear forward and backward motion along a fixed axis inside the said buoyant sealed enclosure
   - hydraulic means connected hydraulically to the said hydraulic piston assembly to drive a hydraulic motor and an electric generator
   - means to regulate and transmit the electricity generated by the said electric generator out of the said buoyant sealed enclosure.

2. The said wave energy conversion system in **Claim 1** wherein the said buoyant sealed enclosure is air-tight and water-tight.

3. The said wave energy conversion system in **Claim 2** wherein the said ram weight can be fixed with wheels or rollers to facilitate the said linear forward and backward motion of the said ram weight along the said fixed axis.

4. The said wave energy conversion system in **Claim 3** whereby both opposite ends of the said ram weight can each be attached to a different said hydraulic piston assembly.

5. The said wave energy conversion system in **Claim 4** wherein multiple assemblies of the said ram weights and the said hydraulic piston assemblies can be installed such that each said ram weight is moved along the same or different axis in the said linear forward and backward motion.

6. The said wave energy conversion system in **Claim 5** wherein the hydraulic piston assembly can be of a single-action or dual-action type.

7. The said wave energy conversion system in **Claim 6** wherein the said hydraulic means can include pressure accumulators, shock absorbers, directional valves, regulating valves, reservoir tank, heat-exchanger, gears, gauges and piping.

8. The said wave energy conversion system in **Claim 7** wherein the said means to regulate the electricity generated by the said electric generator can include electronic circuits, batteries and voltage, frequency and current regulators.

9. The said wave energy conversion system in **Claim 8** wherein additional external features like overhead sails, underwater fins and floats can be attached to the external body of the said buoyant sealed enclosure.

10. The said wave energy conversion system in **Claim 8** whereby multiple units of the said buoyant sealed enclosure can be physically and electrically connected to another said buoyant sealed enclosure to form a row or an array of the said buoyant sealed enclosures.

11. The said wave energy conversion system in **Claim 8** whereby the said buoyant sealed enclosure can be incorporated as part of another floating structure or body.

12. The said wave energy conversion system in **Claim 8** whereby the said buoyant sealed enclosure can be designed as a stand-alone portable unit for use inside a boat or another floating body.