Harnessing wave power

Field of Invention

This invention relates to pumps and wings and their application to harnessing wave power but is not limited to that application

Background

Ocean Waves are disturbances in the surface of the oceans and are known as a source of power. Energy may be extracted from the oscillating surface and, for maximum efficiency; this requires a device that can extract energy from the wave on both the rise and fall of the surface and the horizontal movement of the waves.

Summary of the Invention

The present invention provides a pump having:

at least one pump chamber, the or each pump chamber having;

a wing located within the chamber and sealing against one or more walls of the chamber to delineate the chamber into first and second sub chambers;

the wing movable within the chamber whereby the volumes of the first and second sub chambers varies with the position of the wing in the chamber;

each sub chamber having an inlet and an outlet;

the inlets having one-way inlet valves whereby fluid may only pass through the inlet into the respective sub chamber;

the outlets having one-way outlet valves whereby fluid may only pass through the outlet out of the respective sub chamber.

In a preferred from of the invention each wing is mounted for rotation about an axis.

In a preferred form each chamber, in cross section, has an arcuate first side wall against which the wing seals.

Radial second side walls may extend from ends of the arcuate first side wall toward an apex.

Inlets and outlets may be provided in the second side walls.

In another broad form the invention provides a wave driven power station including:

a plurality of groups of pumps, each pump of each group having:

at least one pump chamber, the or each pump chamber having;

a wing located within the chamber and sealing against one or more walls of the chamber to delineate the chamber into first and second sub chambers;

the wing movable within the chamber whereby the volumes of the first and second sub chambers varies with the position of the wing in the chamber;

each sub chamber having an inlet and an outlet;

the inlets having one-way inlet valves whereby fluid may only pass through the inlet into the respective sub chamber;

the outlets having one-way outlet valves whereby fluid may only pass through the outlet out of the respective sub chamber,

wherein each group has at least one connecting member that connects directly or indirectly to the wing or wings of another group, whereby relative motion of the respective groups causes movement of the wings of the another group.

Preferably the outlets of the pumps supply pressurised fluid to a hydraulic motor. The hydraulic motor may be a turbine.

The pressurised fluid may be sea water. The hydraulic motor may discharge sea water to the sea rather than returning it to the pumps. The inlets may be open to the sea.

Alternatively the pumps may pump fluid, preferably sea water, to an elevated dam to be subsequently used to power a hydraulic motor under the action of gravity.

The groups of pumps are preferably arranged end on end but other arrangements are possible.

Where the groups of pumps are arranged end on end in a line, preferably they are anchored at one end of the line to an anchor point. More preferably the line is anchored so as to be movable about the anchor point.

In another broad form the invention provides a wave driven power station including:

at least one pump chamber, the or each pump chamber having;

a wing located within the chamber and sealing against one or more walls of the chamber to delineate the chamber into first and second sub chambers;

the wing movable within the chamber whereby the volumes of the first and second sub chambers varies with the position of the wing in the chamber;

each sub chamber having an inlet and an outlet;

the inlets having one-way inlet valves whereby fluid may only pass through the inlet into the respective sub chamber;

the outlets having one-way outlet valves whereby fluid may only pass through the outlet out of the respective sub chamber,

at least one connecting member that connects directly or indirectly to the wing, whereby relative motion of the connecting member relative to the chamber causes movement of the wing,

wherein,

the at least one connecting member is buoyant and, in use, is located in the wave zone of a body of water, wherein waves cause relative movement of the at least one connecting member relative to the chamber.

Preferably the wing is mounted on a shaft for rotation about an axis.

Preferably the at least one connecting member is connected to the shaft.

The at least one pump chamber is preferably mounted for vertical movement with the crests and valleys of the moving waves.

The at least one pump chamber is preferably mounted for vertical movement with the tides.

Preferably, in use, the at least one pump chamber is part of a floating assembly.

More preferably, in use, the at least one pump chamber is submerged.

The station may pump fluid directly to a hydraulic motor or may pump fluid to a first storage location, elevated with respect to the body of water.

The station may include a second storage location, with the first storage location, elevated with respect to the second storage location.

In another broad form the invention also provides a turbine having a rotor mounted for rotation about a longitudinally extending first axis with blades mounted on the rotor,

wherein the blades are mounted for rotation about a radially extending axis relative to first axis between first and second positions,

wherein fluid flow along the first axis in a first direction causes the blades to take the first position and drive the rotor in a first rotational direction, and

wherein fluid flow along the first axis in a direction opposite to the first direction causes the blades to take the second position and drive the rotor in the first rotational direction.

The fluid is preferably air and more preferably compressed air.

The turbine may be incorporated into a power station, The station having a passageway with at least one first opening in communication with a body of water having an variable surface, the turbine located in the passageway, whereby variation of the surface of the body of water adjacent the at least one first opening causes movement of fluid in the passageway and through the turbine.

In a preferred embodiment the body of water is an ocean or sea.

Preferably the at least one first opening is located at or near the surface. The at least one first opening may be located so that the opening or openings are always below the surface.

The at least one first opening may be located so that at least part of at least one first opening is above the surface for at least part of the time.

Where the at least one first opening comprises at least two first opening one or more of the openings maybe provided with valves, whereby the opening may be selectively opened and closed.

In another form the invention provides a motor comprising:

at least one arm mounted for reciprocal motion about a first axis;

an input member mounted for motion about a second axis;

ratchet means interconnecting the at least one arm and the input member whereby rotation of the input member about the second axis in only one rotary direction is cause by the reciprocal motion of the at least one arm;

an output member mounted for motion about a third axis, and

spring means interconnecting the input and output members, whereby rotation of the input member causes rotation of the output member.

The motor may include a governor or speed regulator.

The motor may include an electrical generator connected, directly or indirectly, to the output member.

Two or more of the first, second and third axes may be parallel. Two or more of the first, second and third axes may lie end on end.

The output member may be mounted for rotation about the input member.

Brief Description of the Drawings

Figure 1 is an end cross-sectional view of a pump according to a first embodiment of the invention.

Figure 2 is perspective view of a wave driven power station using the pump of figure 1.

Figure 3 is side view of the part of The station of figure 2.

Figure 4 is plan view of the part of The station of figure 2.

Figure 5 is another side view of the part of The station of figure 2

Figure 6 is schematic view of another power station using the pump of figure 1.

Figure 7 is a cross-sectional view of a pump or turbine according to a second embodiment of the invention.

Figure 8 is another cross-sectional view of the pump of figure 7.

Figure 9 is schematic view of a power station using the pump of figure 7.

Figure 10 is a axial-sectional view of a generator that may replace the pump of figure 1 in the wave driven systems figures 2 to 6.

Figure 11 is a cross-sectional view of the generator of figure 10 taken at line AA in figure 10.

Figure 12 is a cross-sectional view of the generator of figure 10 taken at line BB in figure 10.

Figure 13 is a cross-sectional view of the generator of figure 10 taken at line CC in figure 10.

Detailed Description of Preferred and other Embodiments

Figure 1 shows a cross section through a pump 10 according to the invention.

The pump 10 has a chamber 12 defined an arcuate first side wall 14 and two second side walls 16 that extend from the ends of the side wall 14 toward circular apex 18.

Mounted in apex 18 is a wing assembly 20, comprising shaft 22 and wing 24. The shaft rotates in the apex 18. The wing 24 extends to the arcuate side wall 14 and end sealing member 26 engages and seals against the side wall 14 in a slidable manner. The wing thus delineates the chamber 12 into sub chambers 28 and 30. It will be appreciated that the wing 24 will also seal against the walls at either end of the chamber 12.

Rotary motion of the wing about its axis of rotation thus cases the volumes of the sub chambers 28 and 30 to vary with its rotational position.

The side walls 16 have inlets 34 and outlets 36.

The inlets 34 have one-way inlet valves 32 whereby fluid may only pass through the inlet into the respective sub chamber. In this embodiment the one way valves 32 are simple reed (or flap) valves. Other one way valves may be used.

Similarly, outlets 36 have one-way outlet valves 38 whereby fluid may only pass through the outlet out of the respective sub chamber. Again these are simple reed (or flap) valves but other one way valves may be used.

Thus, as the wing 24 rotates in one direction it expels fluid from a first sub chamber whilst drawing fluid into the second sub chamber. Rotation in the opposite direction expels fluid from the second sub chamber whilst drawing fluid into the first sub chamber.

Rotation of the wing is via linkage or drive member(s) 40 attached to the end or ends of shaft 22.

Referring to figures 2 to 5 there is shown a chain 100 of pumps 10 for collecting energy from waves.

The chain 10 comprises a number of pump assemblies 102 joined end on end.

Each pump assembly 102 includes pump 10, suitable floats 104 and connecting arms 106.

The floats 104 cause the respective pump to move generally with the water surface 105 and so move vertically up and down with the waves.

One end of each arm 106 is rigidly connected to apex 18 of a pump and extends to the adjacent pump. The other end of the arm is connected to the shaft 22 of that adjacent pump. The pump assemblies 102 are thus free to move up and down relative to their adjacent neighbours.

Vertical displacement of one pump relative to the adjacent pump thus causes rotation of the wing in the connected pump and associated fluid pumping.

The length of the arms 106 may be selected for the selected location to match average wavelength at that location.

The chain 100 is preferably anchored to the sea floor at 120 so as to rotate as needed. The elongate nature of the chain will tend to cause the chain to self-align with the waves.

In the embodiment shown the inlets 34 are open to the sea whilst the outlets 36 are connected via flexible pipeline 108 to hydraulic motor and electrical generator set 110. In this embodiment the hydraulic motor 110 is a turbine.

As the waves pass the chain, the individual pump assemblies rise and fall relative to their neighbours, thus pumping pressurized sea water to the hydraulic motor and electrical generator set 110.

In this embodiment the hydraulic motor and electrical generator set 110 is located on a raft 122 adjacent the anchor point. If desired a single hydraulic motor and electrical generator set 110 may receive pressurised fluid from a number of pump chains 100. If desired, the hydraulic motor and electrical generator set 110 may be located on the land.

The use of sea water as the pumped fluid avoids the need for a return line to the pumps and the hydraulic motor may discharge directly back to the sea. However, if it is desired to use a fluid other than sea water, a return line system may be provided to return fluid to the pumps 10.

Figure 6 shows a shore based power system 200 utilising the pumps of the invention.

A pumping assembly 202 is provided with one or more pumps 10. These pump(s) are mounted on base 204. The base 204 is provided with floats or buoyancy tanks 206.

Guide rods or poles 208 are secured in the sea floor and engage base 204 constrain the base (and pumps 10) to vertical movement. The floats 206 raise and lower the assembly 202 with the tides. In this implementation the floats 106 are sized and arranged so that the pumps 10 are located below the water surface. The assembly 202 is preferably located sufficiently far below the surface that the floats 206 are not disturbed by the passing waves and so the assembly 202 is relatively stationary relative to the waves.

Connected directly or indirectly to the shaft 22 of each pump is a “wave wing” 214. This wave wing 214 is buoyant and extends into the wave zone. As waves pass the wave wing it rises and falls with the waves and so causes oscillating rotation of the pump 10. The range of angular movement of the wave wing 214 is up to about 160 degrees whilst the range of movement of the pump wing 24 is about 90 degrees. Accordingly, the wave wing 214 and shaft 22 are connected via gears 216. The wave wing 214 may be connected directly to the shaft 22. The range of movement of the wave wing 214 need not be greater than that of the pump wing 24.

In this embodiment the inlet 34 of the pump 10 is open to the sea and the outlet 36 of the pump is connected via flexible pipeline 218 to shore based pipeline 220. Sea water is pumped to reservoir 220 located vertically above the sea level. Sea water may be accumulated and used to drive a hydraulic motor and electrical generator set (not shown), as needed. Again, if it is desired to use a different fluid a return pipeline to the pump inlets is required. In addition, as the system accumulates fluid at an elevated height, a separate holding tank as around sea level would be required, to store sufficient fluid to be pumped to the elevate storage reservoir 220.

Figure 7 shows cross section of a fluid pump 300 according to another aspect of the invention. The pump 300 has an elongate shaft 302 which rotates about its axis 304. A circular rim 306 is mounted to the shaft and rotates with the shaft.

As best seen in figure 8, blades 318 are pivotally mounted to the shaft 302 and the rim 306 for rotation about axis 320. In use airflow is along the axis 304. The blades 318 are mounted so that when viewed along their length (i.e. looking radially from the shaft to the rim or vice versa) they may pivot from one side of the axis 304 to the other. Stops 322 limit the amount of rotation of the blades.

When fluid flows in one direction the wings are rotated to lie in a first position and cause the shaft to rotate in a first rotational direction. When the airflow is in the opposite direction the wings rotate to lie in the other direction. This change causes the rotational forces generated to retain in the first rational direction. The shaft thus rotates in the one direction independently of the direction of air flow.

Figure 9 shows a power plant 400 that utilises the pump of figures 7 and 8. In this embodiment a shaft, tunnel or passageway 402 is created in the shore 404 that extends to the sea and opens into the sea. The other end 408 of the passageway 402 is open to the air. As the water level 406 within the passageway 402 rises air is expelled from the end 408 of the passageway and when it falls air is drawn into the passageway via end 408.

Located in the passageway, preferably at the upper end for ease of installation and maintenance are one or more pumps 410 as shown in figures 7 and 8 that drive generators 412.

The rise and fall of the water level in the passageway 402 may be driven purely by the tides and independent of the waves. However, preferably the system mimics natural blow holes in that wave action causes a rise and fall of the water level 406. The opening 405 is preferably below low tide level 414.

The movement of water surface 406 in the passageway may vary with tide level. Accordingly, the passageway may be provided with one or more vertically spaced openings (not shown) that are opened or closed depending on the tide – at high tide lower openings may be closed and upper openings open and vice versa at low tide.

Figures 10 to 13 inclusive schematically show a generator assembly 500 that may replace the pump 10 of figure 1 in the wave driven systems figures 2 to 6.

The generator assembly 500 has an sealed casing 502 with a central axle 504. A bank of spiral spring members 506 have radially inner ends 508 connected to axle 504. Radially outer ends 510 of spring members 506 are connected to drum 512 which is also mounted for rotation about axis 508.

The wave wing 515 drives arm 514, which oscillates with an approximate maximum radial movement of 160 degrees and transfers its oscillating movement via ratchet mechanism 517 comprising ratchet cog wheel 516 and ratchet pawls 518 to cause rotation of central axle 504. and store the pulses of power in the bank of springs. The oscillating motion of the arm causes the axle 504 to only rotate in one direction. The pawls and/or ratchet cog wheel 516 may be configured to cause rotation of the axle 504 in the same direction with movement in both directions.

Drum 512 is caused to rotate due to the tension in the springs. The end 520 of drum 512 includes a radially inwards directed gear wheel 522 that engages gear wheel 524, which in turn is connected to flywheel 526 and generator 528. Regulator/governor 530 acts to smooth changes in rotational speed. The pulses of wave power cause an oscillating movement of wing arm 512. This in turn causes a pulsing or step like rotation of the axle 504 which the springs temporarily store and transfer to generator 528.

If the wing arm does not drive rotation of the axle 504 in a first direction when the wing arm is moving in either direction, the ratchet mechanism 515 may be provided with a second ratchet mechanism between the axle 504 and the casing 502 that prevents rotation in the opposite direction. The second ratchet prevents the axle 504 unwinding when the wing arm is rotating opposite the first direction.

Unless the context clearly requires otherwise, throughout the description and any claims the words “comprise”, “comprising”, and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

The features of the invention described or mentioned in this document may be combined in any combination of features where features are not mutually exclusive.

It will be apparent to those skilled in the art that many obvious modifications and variations may be made to the embodiments described herein without departing from the spirit or scope of the invention.