

UNITED STATES PATENT OFFICE.

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WAVE-POWER APPARATUS.

No. 875,950.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that we, ALVA L. REYNOLDS and GEORGE A. REYNOLDS, both citizens of the United States, residing at Huntington Beach, in the county of Orange and State of California, have invented a new and useful Wave-Power Apparatus, of which the following is a specification.

It is of the objects of this invention to provide practical, durable, economic and effective means for obtaining constant and regular power from the intermittent and irregular force of the ocean waves; to avoid danger of breakage and destruction from excessive force of the waves; and to take advantage of the ebb and flow of the waves and the lateral movement of the water in every direction.

This invention is designed to utilize the horizontal component of the waves instead of the vertical or rise and fall, and for this purpose a vane hinged or pivoted on a vertical axis is used.

An object of the invention is to provide an automatic, vertically-adjustable vane which will rise and fall to conform to the variations of tides to obtain maximum power from a given size vane by keeping the submerged portion of the vane at all times in that portion of the water where the wave motion is the greatest.

The wave motion of a body of water is greatest at the surface of the body, and the horizontal component of the motion of the water for a limited depth below the surface will be effective as a unit alternately in one and another direction, while below such limited depth there may be cross or reversely-moving currents which would retard the movement of a body moving responsively to the upper unitarily-moving portion of the water body; or the water below such limited depth may have such a limited horizontal component as to act as a drag on a body submerged in both the upper and the lower portion of the liquid. For this reason the vane which is to receive the force of the wave should be submerged only to a certain depth in order to receive and transmit the greatest effective power for mechanical operations.

The accompanying drawings illustrate the invention.

Figure 1 is a perspective view of an apparatus embodying the invention. Fig. 2 is

a plan detail of a single unit of the apparatus. Fig. 3 is a plan section of one of the vanes.

The means upon which the waves act directly for imparting motion thereto, consist broadly in one or more vanes, as 1, partly or wholly submerged in the water and each connected to revolve on an upright axis which is located at or adjacent to one edge of the vane so that each vane will respond to the impulse of the wave acting thereon, each independently of the other.

2 designates an upright shaft mounted in suitable bearings 3, 4, and operatively connected with a pump, as 5, by any suitable means, as crank 6, pitman 7 and cross-head 8; the latter being connected with piston-rod 9 of the pump, which rod is held in position by guide 10.

The parts hereinbefore enumerated go to make up a single unit or wave motor, and the entire apparatus will usually be installed with a series of such motors connected and operating as a single plant for supplying power for mechanical operations as indicated by dynamo D and water-wheel W; the latter being driven by water delivered through nozzle N supplied from the pumps 5 through a main M which has a lateral connection L with an elevated tank T for equalizing the pressure and supply at the nozzle.

The pumps 5 may be of any suitable construction, and may be supplied with air chambers A and connected with the main M through pipes P that are controlled by check-valves C. Each of the pumps may be supplied through a suction-pipe S extending down into the body of water B and suitably provided with a foot-valve F.

The vanes may be of any suitable construction and mounted in any desirable manner; care being taken that they shall stand vertical in the water at one side of the axis around which they revolve. In the apparatus shown, each vane is in the form of a floating blade or panel vertically adjustable in guides 20 which may be in the form of an open frame-work having ways 30 in which the vertical edges of the vanes may move up and down.

In order to cause the vertically-adjustable vanes to automatically assume the position in which they will be acted upon most effectively by the waves, said vanes are constructed as floating panels, the specific gravity of each being such that its buoyancy

will hold it at a determined position relative to the surface of the water. It is evident that the vertically-sliding vanes may be constructed of any suitable material, as wood, or as sheet-metal in a hollow form.

The motors, pumps, and water-main may be supported in any suitable manner. For this purpose 50 designates piles supporting a pier superstructure 60 to which the upper bearings 4 are attached, and 70 designates turnbuckle rods for supporting the lower bearings 3, the same being connected by collars 80 with the piles 50 near the bed of the body of water. By means of the turnbuckle construction in connection with the collars, it is made possible to appropriately support the lower bearings at the requisite level in the water, in a cheap and satisfactory manner without liability of such bearings being undermined or broken by the action of the waves.

The main weight of each vane, its frame and shaft, will be supported by the upper bearing that is sustained by the pier; the lower bearing being intended more particularly to hold the lower end of the shaft appropriately in place to keep the shaft in vertical position.

The collars or bands which secure the turnbuckle rods may be slidable on the piles, and in practice the lower bearing may be adjusted to the appropriate level by lowering the collars with the turnbuckle frame and lower bearing attached thereto, and then tightening the turnbuckle until the bearing is firmly fixed where desired; the collars being drawn tightly against the piles.

The shaft may pass through and move freely up and down in the lower bearing, the purpose of which is to serve as a stay rather than as a support for the shaft; but we do not limit the invention to any particular form of bearing for either the top or bottom of the shaft.

90 designates a gate at the nozzle which can be partly or wholly closed at any time without loss of power, as the water not delivered through the nozzle will pass on to the storage-tank, and from thence to the nozzle when needed.

In practice, any number of units may be employed, and their parts may be of any size or proportions deemed advisable. The vanes will preferably be of such specific gravity that they will ordinarily be nearly, but not quite, submerged, and the length of said vanes will be such that they will extend down into the water only such distance as may be determined by experiment to be the best adapted to allow the waves to act most effectively upon the vanes to cause them to revolve on their axes. As the waves ebb and flow, the several vanes will operate independently of each other in response to the waves.

It will be readily seen that these motors or vanes may be attached to air compressors, and the power utilized in such manner as is deemed advisable.

Any rotary motion imparted to a vane will be transmitted to the operating mechanism on the pier.

The movement of the water in one direction will cause the vane to swing around in response thereto until such motion of the water ceases or until the vane has swung into parallelism therewith. In the latter case the vane ceases to move until a change of direction occurs in the water acting thereon; then the vane will swing in another direction. By reason of this operation the vanes may act effectively in both high and low seas, the force of the wave always tending first to operate the vane and then, if excessive, to throw the vane out of the way of the direct force of the wave, which force will then be effective only upon the comparatively small surface of the shaft, whereby the liability of destruction by high seas is reduced to a minimum.

Each vane is mounted to revolve in an unobstructed path throughout an entire circle so as to act responsively to every impulse of the wave in every direction, and to come to rest in a line with the moving current whenever the movement of said current continues after the vane is in such line.

What we claim is:—

1. A wave motor comprising a plurality of vertical vanes movable by wave impact and free to revolve in a complete circle, a support for said vanes and power-developing means connected with said vanes.

2. A wave motor comprising a plurality of vertical vanes movable by wave impact and free to revolve in a complete circle, means for pivotally securing said vanes in the path or force of waves, and power-developing means connected with said pivot means.

3. A wave motor comprising a plurality of vertical shafts, vanes on said shafts arranged in the path of the ebb and flow of waves, and free to revolve in a complete circle and means connected with said shafts for developing power.

4. The combination with a suitable support, of a plurality of shafts vertically disposed in said support, vanes secured to said shafts, said vanes being partly or wholly submerged in water in an unobstructed path and free to revolve completely and each adapted to respond to wave impetus independently of each other.

5. The combination with a suitable support, of a plurality of shafts journaled in said support, vertical vanes secured to said shafts, said vanes being vertically adjustable according to the rise and fall of the water.

6. The combination with a suitable support, of a plurality of vertical shafts jour-

naled in said support, guides on said shafts and panels in said guides, said panels being adapted to respond to wave impulses, and to rise and fall with the rise and fall of the tide.

5 7. The combination with a suitable support, of vertically disposed shafts journaled in said support, guides fixed to said shafts, floating panels in said guides, and means connected with said shaft for developing power.

10 8. A wave motor comprising a suitable support, a plurality of vertical shafts journaled in said support, guide frames fixed to said shaft having ways, floating panels in said ways arranged to respond independently of each other to wave impetus, pitmen connected with said shaft, pumps connected with said pitmen, and a water main connected with said pumps.

20 9. A wave motor comprising a vane pivoted on a vertical axis and adapted to receive the impact of the waves, and an adjustable stay for the lower end of the axis.

25 10. A wave motor comprising a vertically-movable vane, means for pivoting said vane on a vertical axis to revolve unobstructedly in the path of waves, and power-producing means connected with said vane.

30 11. A wave motor consisting of a guide having a vertically-disposed floating vane arranged in the path of waves, and power-developing means connected with said vane.

35 12. A vertically-disposed shaft, a guide on said shaft having ways, a floating vane in said ways, and means for pivoting the shaft to hold said vane in the path of waves.

13. A wave motor consisting of a guide having a floating vane, means for disposing said vane in the path of waves, and power-developing means connected with said vane.

40 14. The combination with a suitable support of a vertically disposed and vertically

movable vane carried by said support and secured on a vertical axis in the path of waves, and power receiving means operable by said vane.

45 15. A wave motor comprising a vane secured on a vertical axis and located in the path of waves, a support for said vane comprising a shaft, upper and lower bearings for said shaft, a support for the upper bearing, adjustable connections to support the lower bearing, and means for increasing the tension of said connections.

55 16. The combination with a support consisting of piles and a superstructure on said piles, a shaft a guide on said shaft, a vertically movable floating vane in said guide, upper and lower bearings for said shaft, connections between said lower bearings and piles, and means for tightening said connections.

60 17. A vertically disposed vane, a shaft, a bearing for the lower end of said shaft, and means for permitting of the raising and lowering of said bearing.

65 18. The combination with a plurality of wave motor units comprising pumps, of a main to receive water from such pumps, a water wheel, a nozzle to deliver water from the main to such wheel, a pressure reservoir, a connection between the main and the reservoir and a gate between the connection and the nozzle.

70 In testimony whereof, we have hereunto set our hands at Los Angeles California this 9th day of March 1907.

ALVA L. REYNOLDS.
GEORGE A. REYNOLDS.

In presence of—

JAMES R. TOWNSEND,
M. BEULAH TOWNSEND.