No. 656,645. Patented Aug. 28, 1900.

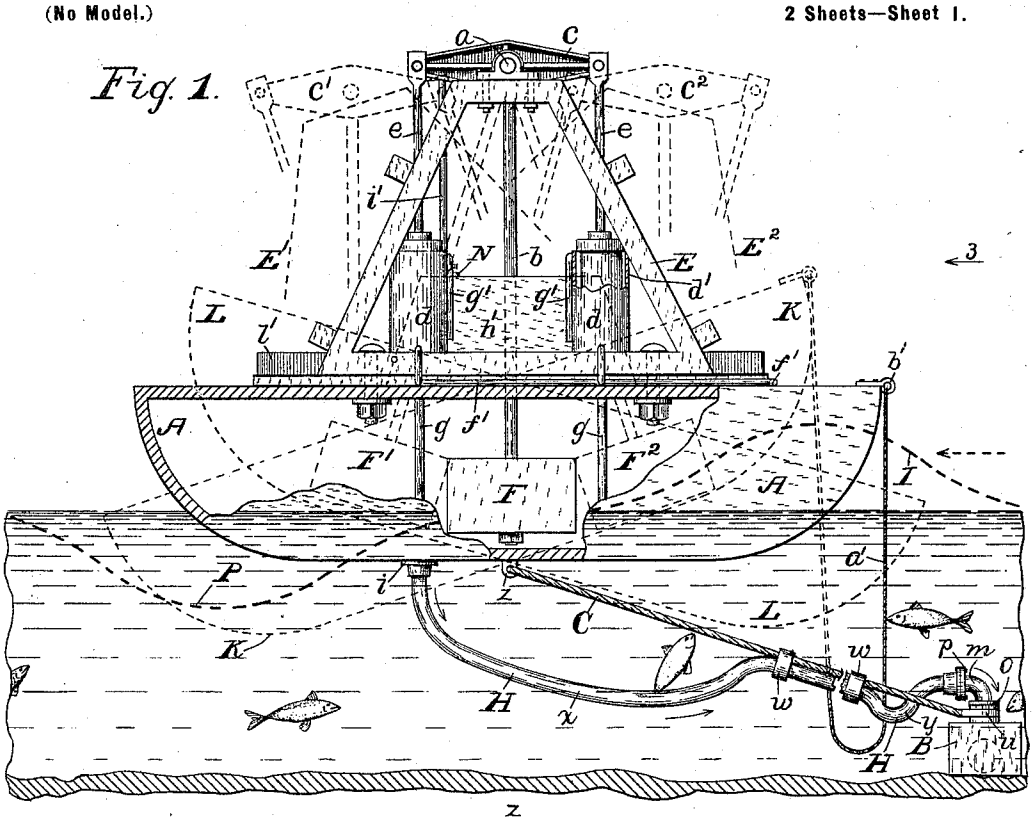
G. W. HOFF.

WAVE MOTOR.

(Application filed May 17, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.



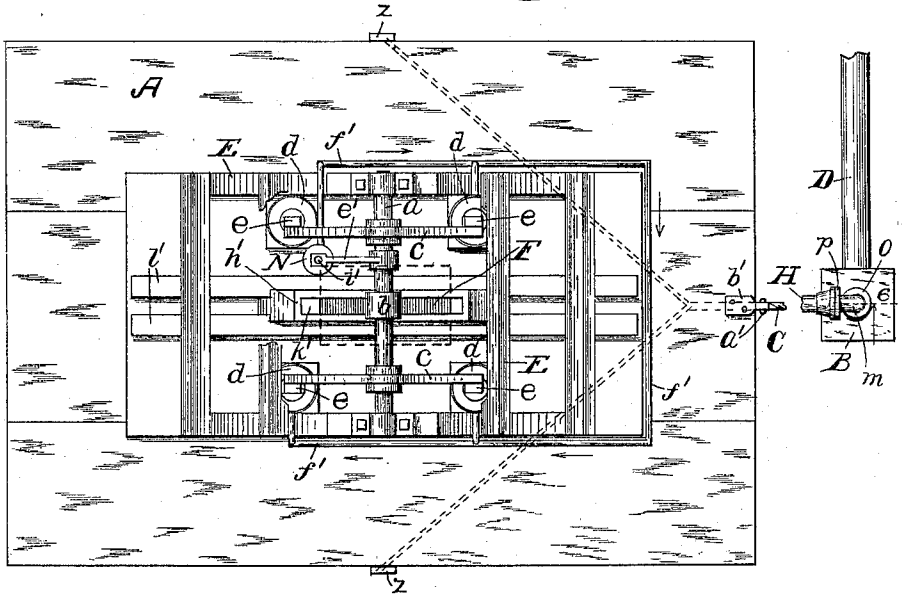


Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

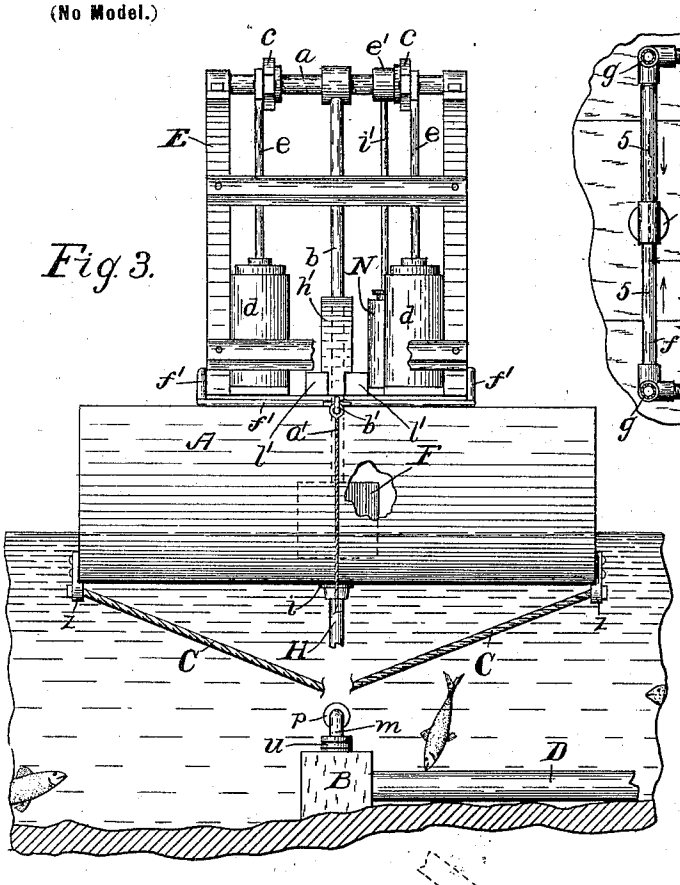

Fig. 3.

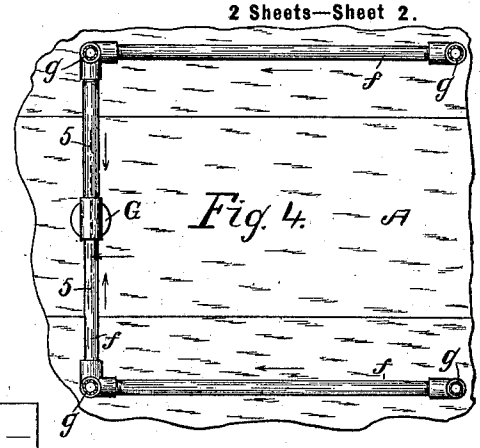

Fig. 4.

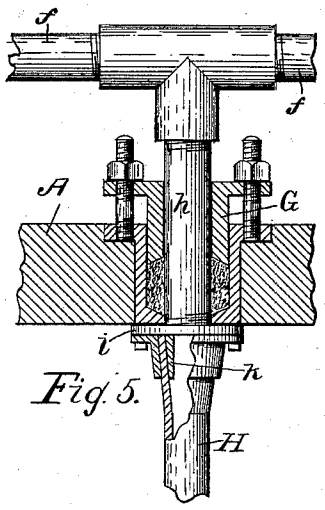

Fig. 5.

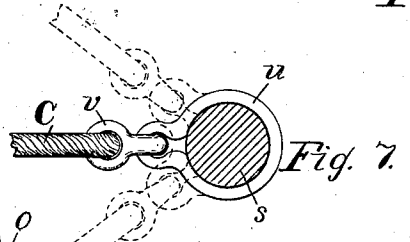

Fig. 7.

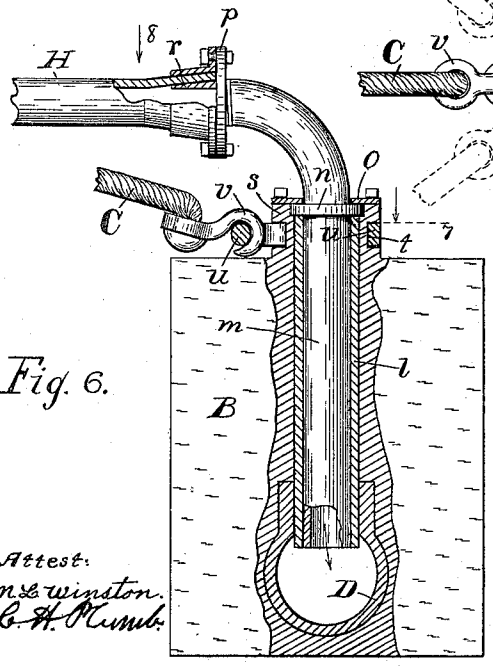

Fig. 6.

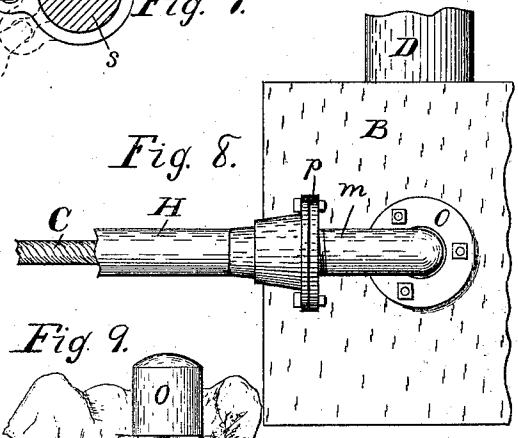

Fig. 8.

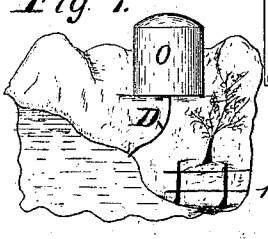

Fig. 9.

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UNITED STATES PATENT OFFICE.

GEORGE W. HOFF, OF ROCHESTER, NEW YORK.

WAVE-MOTOR.

SPECIFICATION forming part of Letters Patent No. 656,645, dated August 28, 1900.

Application filed May 17, 1900. Serial No. 17,023. (No model.)

To all whom it may concern:

Be it known that I, GEORGE W. HOFF, of Rochester, in the county of Monroe and State of New York, have invented a new and useful Improvement in Wave-Motors, which improvement is fully set forth in the following specification and shown in the accompanying drawings.

My invention relates to devices designed for the purpose of utilizing the power of undulating water, the same being hereinafter fully described, and more particularly pointed out in the claims.

The body of this device is in the nature and form of a float or boat placed to ride upon the water, being anchored to the bottom and secured in such a manner that it may swing freely around its holding in any direction, so as to be at all times headed toward the wind. This device is designed more particularly to be used near or in the vicinity of land and in moderately-shallow water, where the latter is liable to be more continuously undulated or boisterous. A pendulous weight held by the boat is caused to swing to and fro as the boat is pitched by the passing waves, which weight serves to operate force-pumps for the purpose of compressing air in a connected aerometer or receiver on the adjacent shore. In practice, or usually, a number of these boats are associated, independently anchored, but coacting, all having pipe connections either with a main submerged air-conduit leading to the aerometer or independently connected with said aerometer, as found most convenient.

Referring to the drawings, Figure 1 is a side elevation of the device as in action, parts being broken away and other parts shown in various positions by full and dotted lines. Fig. 2 is a plan, parts being broken away. Fig. 3 is an end view of the device, seen as indicated by arrow 3 in Fig. 1, parts being broken away and omitted. Fig. 4 is a plan of a portion at the inside of the bottom of the boat, showing the arrangement of the outflow air-pipes. Fig. 5 is an elevation of parts, showing the method of continuing the air-pipe through the bottom of the boat, parts being broken away and the section taken on the dotted line 5 5 in Fig. 4. Fig. 6 shows the anchor-block and the conduit and the method of connecting the cable with the former and the air-conductor with the latter, parts being broken away and vertically sectioned, as on the dotted line 6 in Figs. 2 and 8. Fig. 7 is a horizontal section of the upper part of the anchor-block, taken on the dotted line 7 in Fig. 6, parts being shown in various positions by full and dotted lines. Fig. 8 is a plan of the anchor-block and associated parts, seen as indicated by arrow 8 in Fig. 6. Fig. 9 shows the aerometer and pipe connection on shore. Figs. 1, 2, 3, and 9 are drawn to scales smaller and Figs. 5 to 8, inclusive, to a scale larger than that of Fig. 4.

Referring to the parts shown, A is the boat or body of the device, which may be made of any suitable material and of a form best calculated to ride the waves.

B is a heavy anchor-block, preferably of iron, resting at the bottom of the water, to which the boat is connected by cable C.

D, Figs. 2, 3, 6, and 9, is an air-conduit resting at the bottom of the water with its head held in the block B, as shown, and leading to an aerometer O on the shore, this conduit being preferably an iron pipe of common kind.

E, Figs. 1, 2, and 3, is a frame mounted upon the deck of the boat for holding a stout cross rock-shaft *a* at the top.

F is a heavy weight adapted to swing within the body of the boat, pending from the shaft *a*, to which it is rigidly connected by a suspending-rod *b*, and which causes the shaft to rock in its bearings upon the frame E as the boat is pitched by the passing waves.

c c are equal walking-beams rigid with the rock-shaft *a*.

d d are a series of air-force pumps of common construction in two pairs placed, respectively, under the four overhanging ends of the walking-beams *c c*.

e shows rods connecting the walking-beams with the pistons of the respective air-pumps *d*.

f, Fig. 4, is a series of horizontal outflow air-pipes near the inner bottom of the boat connected with the respective pumps *d* by vertical pipes *g*. (See Fig. 1.)

h, Fig. 5, is a branch pipe connected with the outflow-pipes *f* and extending vertically down through a stuffing-box G in the bottom of the boat. At its lower projecting end this pipe *h* is provided with a flange *i*, threaded

thereon and bearing against the under surface of the boat, to the extreme lower end *k* of which pipe is connected by simple means a flexible hose or conductor H, Figs. 1, 6, and 8, for the outwardly-moving air.

The conduit D, Fig. 6, is preferably cast in the anchor-block B, a branch sleeve *l* being first inserted through the side of the conduit in vertical position, as shown, and with the conduit cast in the block. A metal swivel-pipe *m* is fitted to turn in horizontal directions in the sleeve *l*, said pipe extending downward to and opening into the conduit. This swivel-pipe is formed with a collar *n*, resting in a chamber in an upwardly-projecting part *s* of the anchor B, a holding-ring *o*, Figs. 6 and 8, secured to the block above said collar, serving to prevent the swivel-pipe from moving upward out of the block. Above the collar *n* the swivel-pipe *m* is bent to a horizontal position and provided at its extreme overhanging end with a threaded flange *p*, the lower end of the submerged conductor H being secured to the projecting end *r* of the swivel-pipe, as shown.

From the foregoing description of the various pipes and their connections it will be understood that there is a continuous unbroken air-passage between each air-pump *d* and the conduit D and aerometer O on the adjacent shore.

The upward-projecting part *s* of the anchor-block B is formed with a horizontal groove *t*, Fig. 6, in which is placed a circular body or ring *u*, Figs. 1, 3, 6, and 7, adapted to turn in horizontal directions upon its seat. To this movable ring or holder *u* the anchor-cable C is secured by some simple means—as, for example, a hook *v*. Now from the fact that the ring *u* may turn freely in either direction upon the anchor-block and that the pipe *m* may likewise turn freely in either direction in its seat in the sleeve *l* of the anchor-block it follows that the boat may be swung by the wind anywhere upon the surface of the water around its anchorage without disturbing the air-pipe connections between the air-pumps and the conduit D.

The conductor H, Fig. 1, which constitutes a section of the air-pipe between the pumps and the aerometer, is joined or secured side by side to the cable C by suitable bands or holders *w w*, so that both may move together as the boat is swung by the wind from place to place upon the water. This conductor is purposely connected with the bottom of the boat at a point in rear of the cable connections *z z* therewith, so as to avoid danger of being injured when the boat tilts forward. In case it were attached to the boat forward of the line of the fastenings *z z* of the cable it might be caught and injured between the latter and the boat during a forward pitching of the boat. When secured, as shown, the conductor is always under or beneath the cable and so out of the way of the latter.

The pipe or conductor H is longer than the cable C, and at each end of the former there is left a surplus or slack part *x y* to drop or sag, as shown, so that there can in no case occur a strain upon the end connections of the conductor. Near the boat the cable is divided, as indicated by dotted lines in Fig. 2 and shown in Fig. 3, the branches being connected with eyes or holders *z z* at either side of the boat and at the bottom thereof, as shown. By this means the boat is prevented from being rolled or turned over sidewise by gusts of wind. There is also a cable *a'* secured to a holder *b'* at the bow of the boat and to the cable C at its lower end, which prevents a "head on" gale from tipping the boat over endwise or backward.

It is understood that when the boat pitches backward and forward from the action of passing waves the weight F, Fig. 1, will swing relatively to the position shown by dotted lines F' and F² alternately. This will cause the shaft *a* to turn alternately forward and backward, causing the air-pumps on either side of the shaft to alternately force air into the aerometer. For instance, if an approaching wave I (see heavy dotted lines) at the bow of the boat and trough P at the stern tilt the boat backward to the position shown by dotted lines at K the weight F will swing relatively back, (see F',) causing the shaft *a* to rock forward and depress the pistons of the two forward pumps *d*. A contrary formation of the water under the boat—*i. e.*, a wave at the stern and succeeding trough at the bow—will cause the boat to pitch forward or to the position shown by dotted lines at L. This will cause the weight to swing to its forward position F² and turning the shaft *a* backward depress the pistons in the two rear pumps. The position of the frame E when the boat is tilted backward is shown by dotted lines E', the walking-beams being in the positions shown by dotted lines at *c'*, and when the boat is in its forward tilted position the frame E will occupy the position shown by dotted lines E², the walking-beams being represented by the dotted lines *c²*. The suspending-rod *b* of the weight F is at all times kept vertical by the action of gravity, and the walking-beams are always horizontal, and in the actions of the parts above described the boat in reality moves the pumps upon the respective pistons instead of the weight moving the pistons in the pumps. These actions of the boat and the contained parts being indefinitely repeated by the undulating water will cause air to be forced into the aerometer in rapidly-repeated quantities and so maintain the air therein at a high pressure. This compressed air may be used to drive engines or for any other purpose for which compressed air is useful.

From the fact that the compressing of the air tends to heat the pump-cylinders I prefer to inclose them in ordinary jackets *d'* and employ a simple water force-pump N, Figs. 2 and 3, to force cold water within the jackets

around the cylinders. This pump is conveniently worked by an arm e', rigid with the shaft a and connecting plunger-rod i', this pump, like the air-pumps d, being operated by the tilting of the boat. This water-pump is of a kind in common use, drawing water in the ordinary manner and forcing it through pipes f', Figs. 1, 2, and 3, into the jackets at the bottoms thereof, where heat is most liable to occur, the overflow being provided for in any convenient manner—as, for example, small discharge-pipes g' g', Fig. 1.

The boat or hull A is tightly decked over and made water-tight and practically non-sinkable, the only opening into its interior being through the space k', Fig. 2, where the rod b vibrates between parallel horizontal timbers l' l', and this opening is boxed, as shown at h', Figs. 1, 2, and 3. This boxing is extended sufficiently high to prevent water being thrown into the opening k', as waves may break across the deck of the boat during rough weather.

The stuffing-box G, Fig. 5, prevents the ingress of water at the place where the air-pipe h passes through the bottom of the boat to connect with the conducting-pipe H beneath.

The aerometer may O be of any suitable form or kind adapted to receive and hold air under pressure.

What I claim as my invention is—

1. A wave-motor consisting of a floating body or boat adapted to be tilted by the action of the supporting-water, provided with a pendulous weight and force-pumps, and a rod for connecting said weight directly to a rock-shaft, and the latter to the pumps, substantially as shown and described.

2. A wave-motor consisting of a floating body adapted to be rocked by the supporting-water, provided with a pendulous weight disposed within the boat below the deck thereof, in combination with a series of pumps, a rock-shaft actuated by the weight, a rod rigidly connected with the weight and to said rock-shaft and mechanism connecting said rock-shaft and the pumps, substantially as and for the purpose set forth.

3. The combination, in a wave-motor, of a boat, a frame on the boat, a shaft held by the frame, a weight suspended from the shaft and having its rod rigidly secured thereto, said weight being disposed below the deck of the boat, pumps on the boat and beams on the shaft connected with the pumps, substantially as specified.

4. A device for utilizing the power in sea-waves, consisting of a boat and pumps carried thereon, in combination with a pendulous weight suspended from the boat and adapted to swing within the boat, a rod rigidly connected to said weight, a rock-shaft to which said rod is connected, and mechanism connecting said rock-shaft and the pumps, substantially as shown and described.

5. A device of the kind described, consisting of a boat, pumps on the boat, and a movable weight to operate the pumps, in combination with an anchor-block, a submerged swiveled main pipe held by the anchor-block, and a cable connecting the boat and the anchor-block, and pipe connections for the pumps and said main pipe, substantially as specified.

6. In a wave-motor, a boat, an anchor-block, a conduit cast therein, a pipe swiveled in said block, a movable part or holder supported by the anchor-block and adapted to turn thereon, and a cable connecting the boat and said holder, substantially as shown and for the purpose specified.

7. In a wave-motor, a boat, pumps thereon and means to operate them, and an anchor-block, and a holding-body resting movably thereon, a main pipe held by the anchor-block, a pipe swiveled in said block and connections for the boat and said holding-body, and for said pumps and the main pipe, substantially as and for the purpose specified.

8. In a wave-motor, a boat, pumps on the boat and means to operate them, an anchor-block and a holding-body movable thereon and embracing the same and seated in a recess therein, a main pipe or conduit held by the anchor-block, a cable connecting the boat with said holding-body, and connecting-pipes for the pumps and said conduit, a section of said connecting-pipes and the cable being held together side by side, substantially as shown and described.

9. In a wave-motor, a boat, pumps on the boat and means to operate them, and a submerged anchor-block and a holding-body movable thereon, in combination with a main pipe or conduit held by the anchor-block, a pipe swiveled in said block at right angles to said conduit, a cable connecting the boat with said holding-body, and connecting-pipes for the pumps and said conduit, a section of said connecting-pipes and the cable being held together side by side, there being a slack or loose part of said pipe-section at either end of the cable, substantially as and for the purpose specified.

10. In a wave-motor, a boat, pumps thereon and means to operate them, and outflow-pipes leading from the pumps out of the boat, in combination with an anchor-block and a conduit held thereby, a swivel-pipe held by the anchor-block and piercing the conduit and adapted to turn in its seat, a cable connecting the boat and the anchor-block and pipe connection between said outflow-pipes and the swivel-pipe, substantially as shown.

11. In a wave-motor, a boat, pumps thereon and means to operate them, and outflow-pipes leading from the pumps out of the boat, in combination with an anchor-block, a conduit held thereby, a sleeve in said anchor-block, a swivel-pipe held in said sleeve and opening into said conduit and adapted to turn in said sleeve, a connection for the boat and said anchor-block, and pipe connection between said outflow-pipes and the swivel-pipe, substantially as specified.

12. A wave-motor comprising a boat, pumps on the boat and means to operate them, an anchor-block and an air-conduit, a cable connecting the boat and the anchor-block, and pipe connection between the boat and the conduit, said pipe being secured to the boat back of the fastenings of the cable, substantially as and for the purpose set forth.

In witness whereof I have hereunto set my hand this 15th day of May, 1900, in the presence of two subscribing witnesses.

GEORGE W. HOFF.

Witnesses:
ENOS B. WHITMORE,
M. L. WINSTON.