No. 647,638.

Patented Apr. 17, 1900.

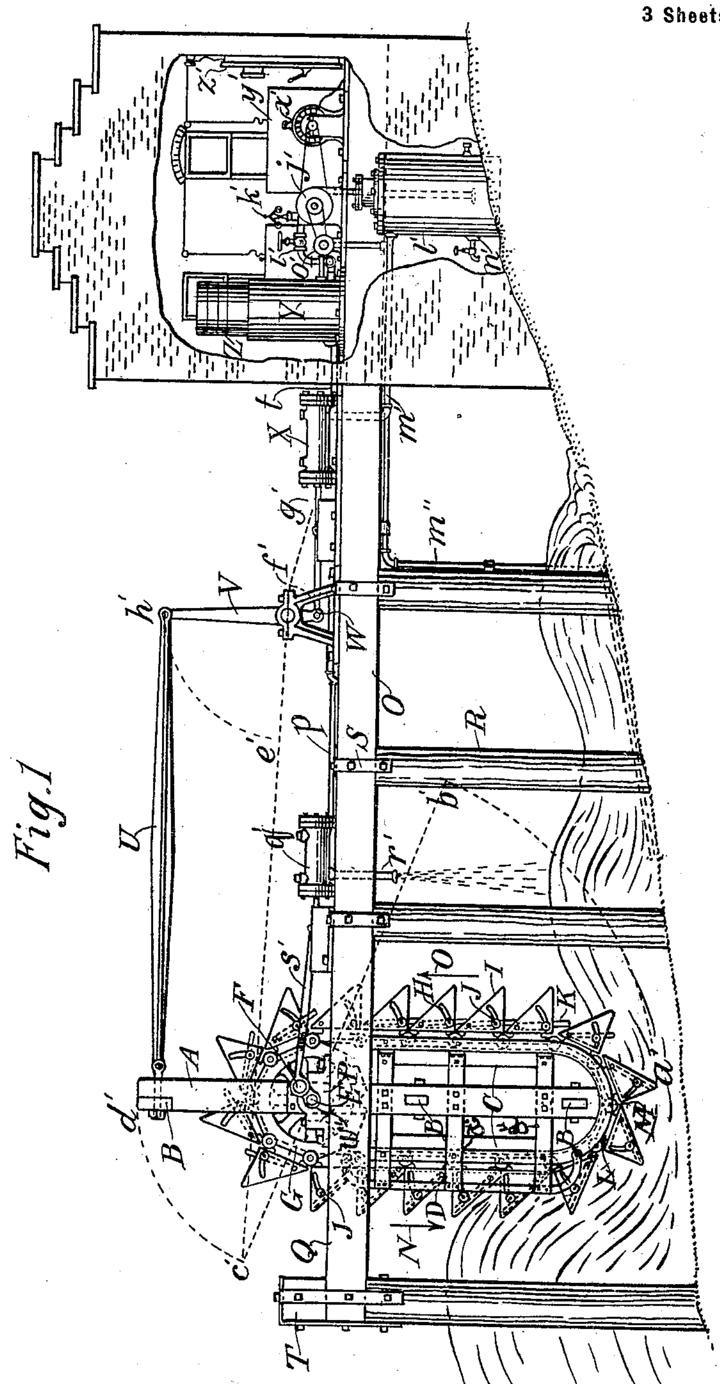
G. N. TODD.

WAVE MOTOR.

(Application filed Dec. 11, 1899.)

(No Model.)

3 Sheets—Sheet 1.



Witnesses

B. W. Pierce

Wm. J. Bissau

Inventor

George. N. Todd

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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(No Model.) 3 Sheets—Sheet 2.

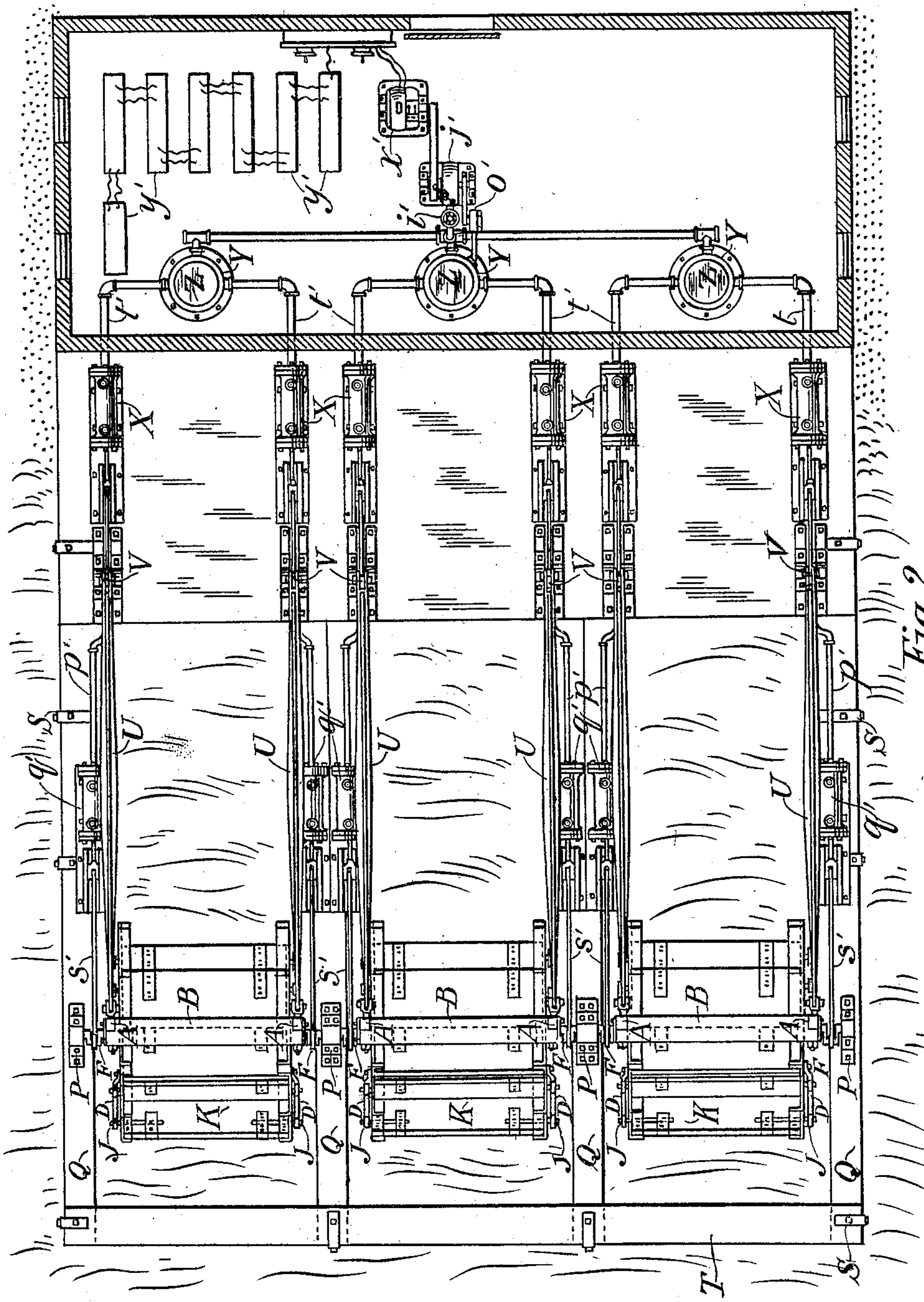

Fig. 2

Witnesses

B. W. Pierce

Wm J. Blinson

Inventor

George. N. Todd

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 3

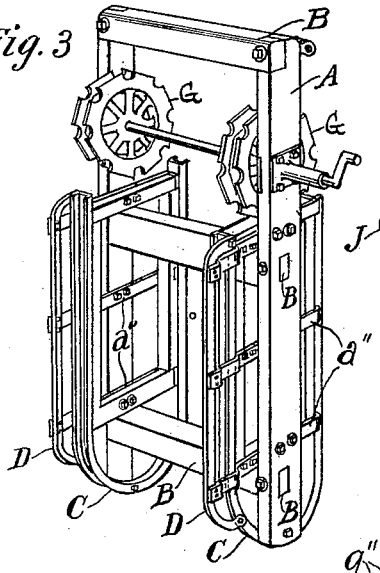
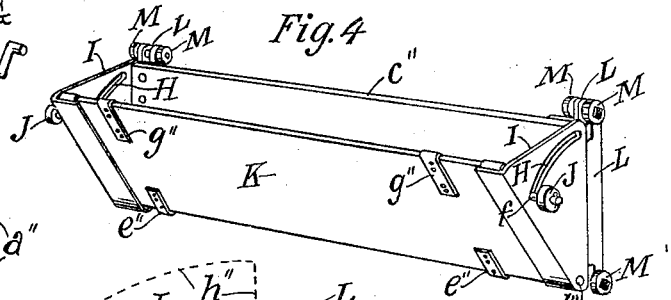


Fig. 4



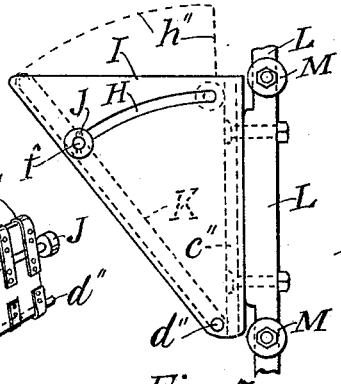
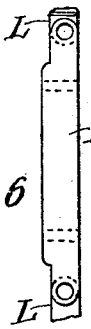


Fig. 6



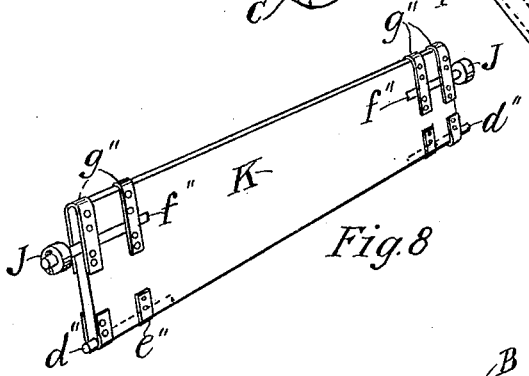
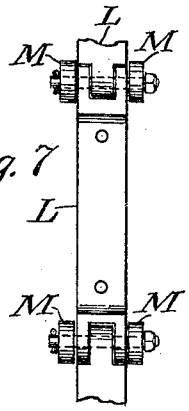


Fig. 8

Fig. 5

Fig. 7



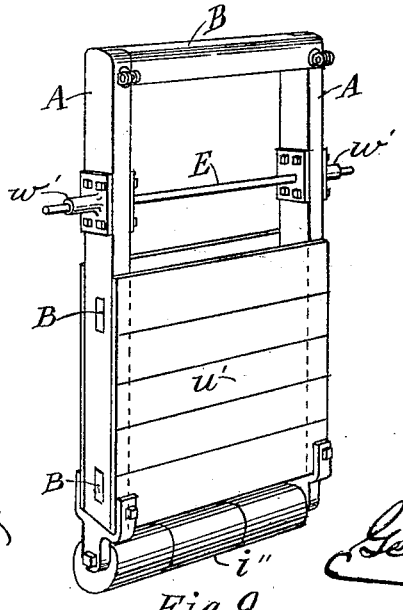


Fig. 9

Witnesses

B. W. Pierce

Inventor

George N. Todd

UNITED STATES PATENT OFFICE.

GEORGE N. TODD, OF LOS ANGELES, CALIFORNIA.

WAVE-MOTOR.

SPECIFICATION forming part of Letters Patent No. 647,638, dated April 17, 1900.

Application filed December 11, 1899. Serial No. 739,981. (No model.)

To all whom it may concern:

Be it known that I, GEORGE N. TODD, a citizen of the United States of America, residing at Los Angeles, in the county of Los Angeles and State of California, have invented certain new and useful Improvements in Wave-Motors; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference thereon marked, which form a part of this specification.

This invention relates to a novel combined pendulum-lever and rotary wave-motor arranged and adapted to operate independent pumps by its combined leverage and rotary powers, and thereby other mechanical devices.

The primal object of this invention is to form a combined pendulum-lever and rotary wave-motor arranged and adapted to obtain power from the waves by motions of the pendulum-lever part and also obtain additional power from the rotary motion of mechanism arranged to rotate upon said pendulum-lever.

The second object is to obtain a steady uniform regular governed power from the inconstant wave power by means of a wave-motor actuated by the waves and tides, causing said wave-motor to pump air into a compressor provided with water-jackets for exhausting the heat of said compressed air and to then expand said compressed air in an engine, obtaining regular power therefrom for the generation of electricity by dynamos and operating other devices, the said compressed air being exhausted from said engine into a reservoir wherein its greater expansion reduces it to liquid air.

The third object is to produce a wave-motor consisting of a pendulum-lever frame provided with an endless chain of troughs journaled to rotate upon said pendulum-frame and to obtain power from the waves swinging said pendulum-lever frame, and also filling, sinking, and rotating said troughs by said waves.

The fourth object is to provide a wave-motor with an endless chain of troughs arranged to open on one side of said chain to be filled with water and to fold flat on the opposite side, thereby reducing the frictional travel of said endless chain of troughs through the water when rotated by the waves.

The fifth object is to form a series of pens by driving rows of piles into the ocean bed or bottom, securing the tops thereof together with longitudinal and cross-tie timbers by means of iron straps or stirrups spiked down, and to pivot a series of pendulum-lever wave-motors in said pens in an upright or vertical position, to provide said pendulum-lever with weights or a load to swing, and to connect said pendulum-lever to operate a pump or other mechanical device by the swinging to and fro of said lever by the waves.

The sixth object is to provide a power-house and mechanism connected to a wave-motor, whereby the inconstant power of the wave motions may be stored up, governed, and used as a constant, uniform, and regular power for general purposes.

The seventh object is to provide a collapsible trough for a wave-motor.

These several objects are obtained by the devices illustrated in the accompanying drawings, in which—

Figure 1 is a side view of my invention with the wall of the power-house broken away to show the interior mechanism. Fig. 2 is a plan view thereof. Fig. 3 is a perspective plan view of the pendulum-lever frame. Fig. 4 is a perspective plan view of one of the collapsible or folding troughs. Fig. 5 is an end view thereof. Fig. 6 is a side detail view of the chain-link. Fig. 7 is a plan view thereof. Fig. 8 is a perspective plan view of the trough-folding front board. Fig. 9 is a perspective plan view of a modification of the pendulum-frame.

Similar letters of reference indicate the same parts in the several drawings and the several figures thereof.

Referring by letter to the accompanying drawings, in Fig. 1, A indicates two vertical timbers secured together by cross-tie timbers B B B, forming the pendulum-lever frame. Secured to said frame are channel-iron guide-bars C and cam-bars D, a drive-shaft E, provided with cranks F, chain-sprockets G being secured fast to said drive-shaft E, by means of which an endless chain of troughs

are arranged to travel around and upon said pendulum-frame, the troughs being formed to fold up or collapse by means of hinging the front or outer board K of each trough and providing said board K with a rod, shaft, or shafts passing through slots H, formed in the metal end pieces I of each trough, the said rod or shafts being provided with anti-friction or cam rollers J, by which arrangement the front board K of each trough will fall flat against the back board of the said trough when on one side of the endless chain, presenting the appearance of two flat boards folded together and provided with slotted metallic triangular end pieces I, and when on the other side of the chain the said board K will fall outward, held by its rods or shafts in the slots H of the end pieces I, the cam-rollers J of said rods or shafts rolling upon the cam-bars D, holding the boards K rigidly extended to form a trough or bucket until said cam-bar D is passed by, when said board K immediately falls of its own weight, folding flat against the back board of the trough when on the opposite side of the chain away from said cam-bars D. The said troughs are each bolted through their back boards to chain-links L, provided with rollers M, forming an endless chain of carriages which roll in the channel-way of the channel-iron tracks or bars C and are caused to travel in an endless procession by means of the waves falling into and pushing downward and against the open troughs in the direction of the arrow N, said troughs emptying out the water by collapsing and folding up, thereby traveling free from friction through the water on the opposite side in the direction indicated by the arrow O, the said travel of the said troughs thereby rotating the chain-sprocket wheels G, and thereby the shaft E and its cranks F. The said shaft E is journaled to rotate in bearings P, bolted to longitudinal timbers Q, supported upon parallel rows of piles R, driven into the ocean bed or bottom, the said timbers and piles being secured together by iron clamps or stirrups S and by as many cross-timbers T as may be necessary to form strong pen-like supports, in each of which the said combined pendulum-lever rotary wave-motor is journaled, arranged, and adapted to be swung to and fro in said pens, as a pendulum-lever, by the action of the ocean waves rushing, dashing, and beating against it, and simultaneously at the same time obtain from said waves a rotary motion through the rotation or travel of said endless chain of troughs, caused by the water of said waves falling into said troughs, sinking, forcing, and driving said trough around, thereby rotating the said chain-wheel sprocket G and the shaft E and its cranks F at great speed in one common continuous rotation in the direction of the arrows N and O, while simultaneously at the same time a reciprocating motion is obtained from the pendulum-lever by its being swung by the said waves to and fro in the direction indicated by the dotted lines a' and b' and b' and c' and c' and d'. The said reciprocating motion is utilized by means of a walking-beam or lever U, pivoted at one end to the top of the pendulum-lever at d' and at the other end to a vertical lever V at the top thereof at h'. The lower end W of said lever is pivoted to a shaft linked to a cross-head or slide-block g', connected to the piston-shaft of a double-acting compressor air-pump X, whereby air is compressed through cooling-pipes into a compressor Y, provided with weights Z, by which the said air is compressed to any desired degree and forced out through a valve i' into and rotating a rotary engine j', the speed of which is controlled by a governor k'. The said expanding air is exhausted from said rotary engine into a reservoir l', wherein it expands its full limit and is thereby transformed into liquid air, and such quantity of said air in said reservoir as is not liquefied is drawn off through the pipe m' into the pump X, to be again recompressed by said pump and compressor Y and again forced through said rotary engine into said reservoir l', a suitable outlet n' being arranged whereby the liquid air may be drawn off for use as a refrigerant and for other purposes. The said reservoir l' is provided with and surrounded by a vacuum-chamber from which the air is pumped out to form a vacuum or condition of cold surrounding said reservoir. The said compressor Y is surrounded by a jacket forming a hollow space and the air-pipes sleeved in other liquid or cooling pipes l'. Water or other cooling agent is pumped by a rotary pump into said jacket of said compressor and through said liquid pipes l', inclosing the air-pipes, and into a cooling-jacket surrounding the air-pump X, and through cooling-pipes p', likewise inclosing air tubes or pipes connecting with double-acting air-pumps g' and their water-jackets, flowing out through a waste-pipe r. The said air-pump g' being driven by link-shafts s', connected to the cranks F of the drive-shaft E, thus a volume of air is being constantly pumped and compressed into the main compressor Y by the pumps g', driven by the rotation of the trough-chains of the wave-motor and another independent volume of air is at the same time being pumped by the said pendulum-lever and its reciprocating motion through the air-pumps X, thus obtaining double duty from the wave-motor through the reciprocating motion of its pendulum-lever and the rotation of its endless chain of troughs.

In stormy weather the said wave-motor is free to swing up to or about the dotted line c' to b', in which case the walking-beam U moves down to the dotted line c' to e', and the vertical lever V is drawn down to the dotted line e' to f', and the link-shaft is drawn up to the line f' to g'.

It will be understood that the pendulum-lever may be formed of the vertical bars A A

and the cross-bars B B B and used alone as a wave-motor when boarded up to receive the wash of the waves and provided with weights and that the reciprocating motion and power would be obtained therefrom without the additional rotary motion by dispensing with the trough endless chain and its channel-bars C and its braces and cam-bars D when desired to form a simple but much less effective wave-motor, as illustrated in Fig. 9, in which is seen the boards u' and the roller-weights v', secured on a shaft at the bottom. An important item of the pendulum-lever is its stud-spindles w', which are bored for the passage of the shaft E, whereby the weight of the pendulum-frame is supported on its own spindles w', journaled to swing in the block-bearings P, and the weight of the endless trough-chain and sprocket-wheels G is suspended on its own axle or shaft E, the cranks F of which are keyed upon it outside of the said bearing-blocks P or otherwise arranged.

In the transmission of power generated and stored a dynamo x' is driven from the rotary engine j' and electricity thereby generated and stored in storage batteries y' or conducted through wires and proper switch-boards z' to any desired point for general use. A series of three or more of said wave-motors and mechanism are arranged and connected to a power-house on the shore, so as to form a wave-motor power, electric, and liquid-air plant, as further illustrated in Fig. 2. The details of the pendulum-lever frame are illustrated in Fig. 3, showing the manner of bolting the two vertical pieces A A together by the cross-timbers B B B and the manner of forming and securing thereto the cam-arms D D and the channel-iron pieces C C by braces a''. Fig. 4 illustrates one of the troughs, c'' being the back board, which is bolted to the chain-links L L, each provided with rollers M, forming carriages, the triangular end pieces I being formed of sheet metal and bolted, with the back board c'', to the links L, the folding board K being pivoted in each end of said metal end pieces I by stud-shafts d'', secured to said board by metal clamps e'', and is further pivoted by shafts f'', secured to said board K by iron clamps g'', the said shafts f'' being arranged to slide in curved slots H in the metal end pieces I I, as further seen in Figs. 5 and 8. It will be thus seen that the said board K will move inward or outward from the back board c'' on the curved dotted line h'', according to whether the mouth of the trough sets up or down. Setting up, the board K falls outward in the slot H and forms a trough or water-bucket. Setting downward, the board of its own gravity folds up against the back board c''. The shaft f'' is provided with cam-rollers J, which, rolling up the cam-arms D D, hold the board K inward, forming a trough or water-bucket until the said cam-arms are already passed, as already described. Figs. 6 and 7 further illustrate the chain-link carriages to which the troughs are bolted to form an endless chain. It will also be understood that each trough sets close up against the other, so as to present a closed wall of water-buckets for the waves to dash upon and fall into.

In Fig. 9 the modification of the pendulum-frame is adapted to obtain a reciprocating-lever motion alone from its leverage, its weight, and added weights i'', but cannot produce such power as in the preferred combined pendulum-lever and rotary wave-motor described and illustrated in Figs. 1 and 2.

In the operation of my invention the wave-motor is set down in the water deep enough to always be in the water in either high or low tides and to swing pendent from the timbers Q, being pivoted thereto above the highest tide. The waves rushing shoreward dash against the endless chain of troughs, swinging the motor shoreward on the line a' to b', and filling the troughs with water sink and push them down and around, causing the endless chain to travel rapidly around on its rollers upon the channel-irons down in the direction of the arrow N and up in the direction of the arrow O, rotating the sprocket-wheels G and the shaft E and its cranks F, thus working the connecting air-pumps g', driving and compressing air through the pipes p' into the pipe t' and into the compressor Y, which is provided with suitable valves whereby the air is forced in under the great weight and pressure of the pendulum-lever swinging to and fro, and thereby producing a reciprocating motion actuating the walking-beam U and lever V, and thereby driving the air-pump X, forcing air from it through the pipe t', thereby lifting the great weights Z of the compressor Y, which are designed to balance the great weight of the wave-motor, and when the latter falls back to its original vertical position the valve of the compressor closes and the great weights Z rest upon the inclosed air, compressing it under great pressure to a desired degree. This balance-lifting of the great weights Z of the compressor by the great weight of the wave-motor acting as a balance through the leverage of the trough-chain X enables the rapidly-rotating trough-chain to pump great quantities of air into the compressor Y, while its weights Z are thus balance-lifted by the swing of the great weight of the motor. In the rotation of the endless chain of troughs it will readily be seen that the folding boards K lie folded against the back boards c'' in the travel of the chain upward, as indicated by the arrow O, and in traveling over the sprocket-wheel G that they fall outward of their own weight and form thereby a trough or water-bucket, and as soon as their rollers J roll upon the cam-arms D they are held thus extended as troughs against any power of the waves to close them until after they pass the said cam-arms D, when they are forced to fold up again, and

thus save the frictional passage of their extended surface up through the water. The air in the compressor being under the desired pressure is allowed to expand in the rotary engine j', thereby rotating it at a speed controlled by a governor k'. The said air is then exhausted into the vacuum-reservoir l', wherein its full expansion is reached, transforming it into liquid air, which may be drawn off for use as a refrigerant and other purposes. The dynamo x' is driven by the rotary engine j', and the thereby power is transmitted through electricity to any desired point for general purposes. The rotary engine j' also drives a rotary pump o', which pumps water from the ocean through a pipe m'' into the water-jacket surrounding the pump X, and thence through pipes into the jacket of the pump g' and out the pipes r' back into the ocean again. This circulation of water serves to carry off the heat caused by the compression of the air.

It will be obvious that a wave-motor to be of practical value must be provided with a means for converting the inconstant and variable power of the waves into a steady uniform controllable power and store said power for use when said waves are calm and without motion sufficient to actuate the wave-motor. This object is obtained in my invention by means of a hydraulic or air compressor Y, provided with weights Z, which weights are balanced by the swinging pendent weight of the pendulum wave-motor and caused to rise by the leverage power of the weight of the said pendulum wave-motor (being swung back and forth by the waves) actuating a pump or pumps and forcing water or air into said compressor, thereby lifting its weight by the weight of said pendulum-lever, the valve of the compressor Y opening and closing to the rising and falling motions of its weights Z, caused by the rising and falling motions of its balance-weight of the pendulum-lever wave-motor. I prefer the use of air instead of water in converting and storing the power of the waves into a steady uniform motion and power for the reason that it can be compressed and a great power stored in a smaller space and the air expanded and exhausted through an engine and converted into liquid air, and I desire to claim such features thereof as may be permissible in this application, and in another separate application which I shall file claim the mechanism for compressing, storing, expanding, and liquefying air and obtaining power therefrom.

Having described my invention, what I claim is—

1. A combined pendulum-lever and rotary wave-motor; and means for obtaining a reciprocating motion and a rotary motion therefrom.

2. A pendulum-lever and rotatable mechanism arranged and adapted to form a combined pendulum-lever wave-motor and a rotary wave-motor; means for obtaining a motion and power from said pendulum-lever; and means for obtaining another motion and power from said rotatable mechanism through the action of the waves and tides thereon.

3. A series of piles driven down into the ocean bed or bottom in parallel rows and secured together by timbers, forming a pen; a pendulum-lever pivoted in said pen above, and pendent down into, the water, and arranged and provided with a rotary mechanism, both said pendulum-lever and said rotary mechanism being arranged and adapted to be actuated by the waves and tides; forming a combined pendulum-lever wave-motor and rotary wave-motor.

4. A series of piles driven down into the ocean bed or bottom in parallel rows and secured together by timbers, forming a series of pens; a series of pendulum-levers pivoted in said pens above, and pendent down into, the water, and provided with rotary mechanism, being arranged and adapted to be actuated by the waves and tides, forming a series of combined pendulum-lever wave-motors, and rotary wave-motors, arranged in one common structure.

5. A series of piles driven down into the ocean bed or bottom in parallel rows and secured together by timbers, forming a pen; a pendulum-lever pivoted in said pen above, and pendent down into, the water, and provided with a rotatable endless chain of troughs; both said pendulum-lever and said endless chain being arranged and adapted to be actuated by the waves and tides, forming a combined pendulum-lever wave-motor and a rotary wave-motor.

6. A series of piles driven down into the ocean bed or bottom in parallel rows and secured together by timbers, forming a series of pens; a series of pendulum-levers pivoted in said pens above, and pendent down into, the water, and provided with a series of pendulum-levers and trough-chains; both said series of pendulum-levers and said endless chains being arranged and adapted to be actuated by the waves and tides, forming combined pendulum-lever wave-motors and rotary wave-motors arranged in one common structure.

7. A pendulum-lever frame pivoted to a support above the water and pendent from said support down into said water; a rotatable endless chain secured to said pendulum-lever frame; means whereby both said pendulum-lever frame and said endless trough-chain, are arranged and adapted to be actuated by the waves and tides, forming a combined lever wave-motor and a rotary wave-motor.

8. A wave-motor consisting of an endless chain, provided with troughs or water-buckets, the outer board of which is arranged to be automatically extended out, and folded back in thereby opening and collapsing said troughs.

9. A wave-motor consisting of a frame; a

rotatable chain, secured to said frame, and provided with troughs or water-buckets and means for opening said buckets or troughs on one side of said frame and collapsing, folding or closing the said buckets or troughs on the other side of said frame.

10. A pendulum-frame; a rotatable endless chain secured to said frame and provided with folding-troughs or water-buckets or blades, all arranged and adapted as a combined pendulum wave-motor and a rotary wave-motor.

11. A trough or water-bucket for a wave-motor consisting of a back board c'' and metallic end pieces I provided with curved slots H; a front board K provided with shafts or rods f'' working in said slots H and also provided with cam-rollers J, the said board K being pivoted by stud-shafts d'' in said end pieces I, and adapted to fold back against the back board c'', or extend out to form a trough or water-bucket as desired.

12. A frame provided with cam-arms D; a rotatable endless chain secured to said frame; a series of troughs or water-buckets secured to said chain and provided with folding boards K, and cam-rollers J, arranged to alternately roll on and off said cam-arms D in the rotation or travel of said endless chain, thereby opening said troughs or water-buckets on one side of said frame, and collapsing them on the other side of said frame; all being arranged and adapted to form a wave-motor.

In testimony whereof I affix my signature in the presence of two witnesses.

GEORGE N. TODD.

Witnesses:
JAMES P. CLARK,
SUSIE M. GRAY.