W. K. BOWERMAN.

WAVE MOTOR.

APPLICATION FILED JAN. 11, 1909.

974,948.

Patented Nov. 8, 1910.

2 SHEETS—SHEET 1.

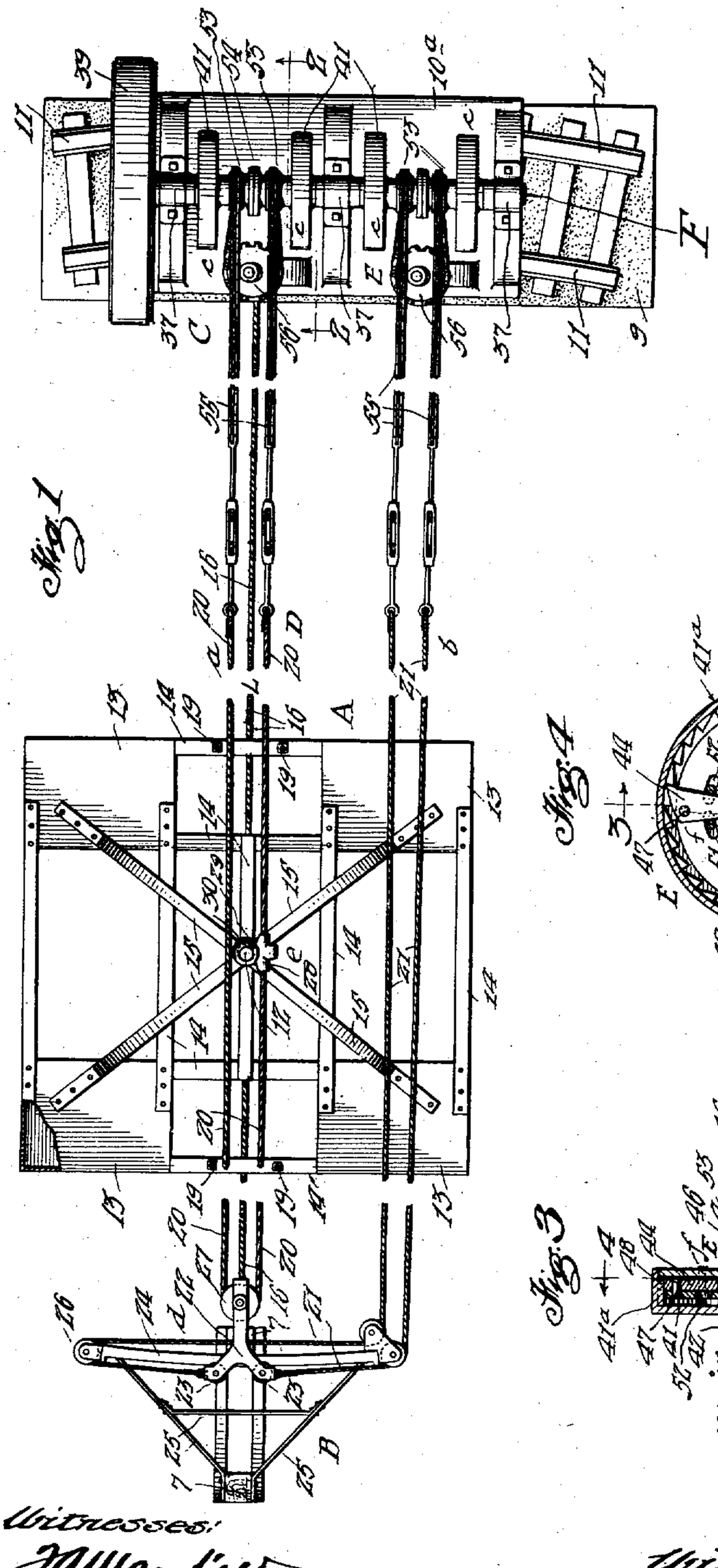

Fig. 1

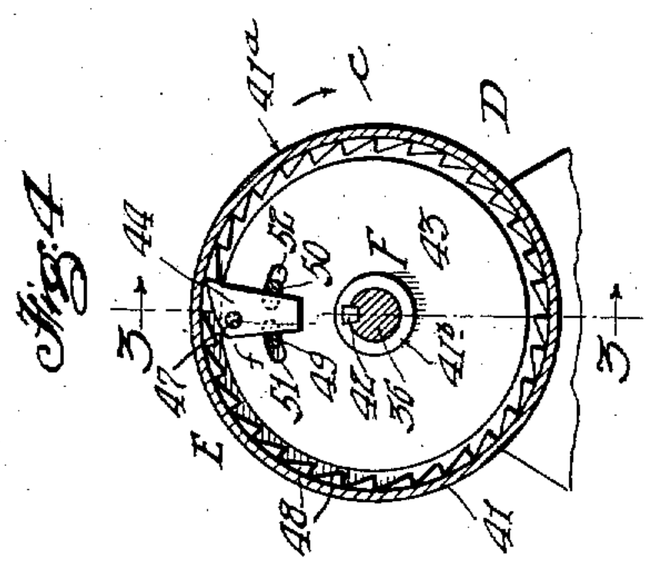

Fig. 4

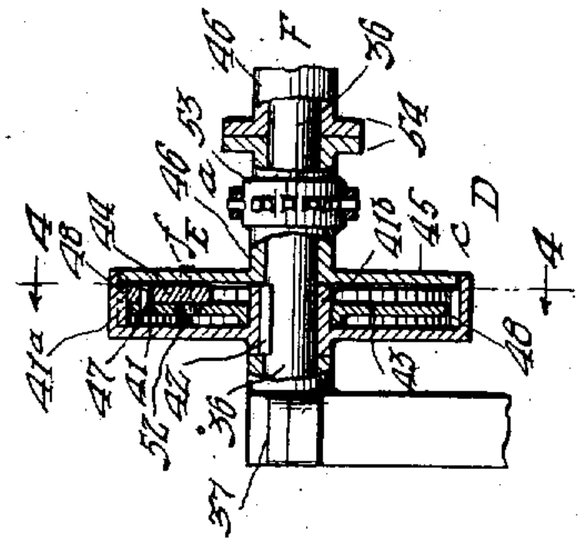

Fig. 3

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2 SHEETS—SHEET 2.

Fig. 6

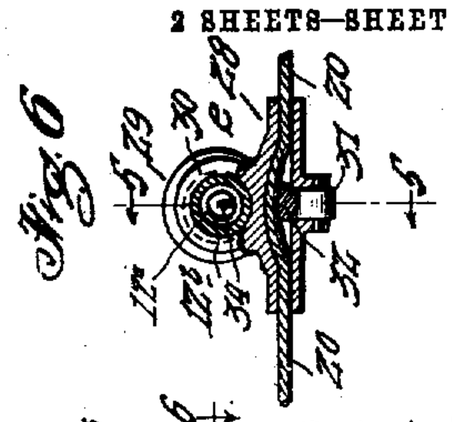

Fig. 5

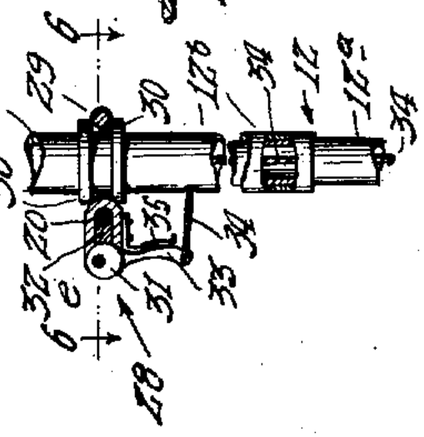

Fig. 2

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UNITED STATES PATENT OFFICE.

WILLIAM KING BOWERMAN, OF LOS ANGELES, CALIFORNIA.

WAVE-MOTOR.

974,948. Specification of Letters Patent. Patented Nov. 8, 1910.

Application filed January 11, 1909. Serial No. 471,796.

To all whom it may concern:

Be it known that I, WILLIAM KING BOWERMAN, a subject of the King of Great Britain, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Wave-Motors, of which the following is a specification.

This invention relates to wave motors; and it has for its object to provide improved means and mechanism for utilizing the power of agitated bodies of water, by translating the irregular movement of the waves thereof into the positive movement of a shaft or other machine, element, or element for driving machinery; and which improved mechanism and apparatus will, as intended, be superior in point of relative inexpensiveness and simplicity of construction, facility of installation and control, durability under adverse conditions, economy in operation and general efficiency and serviceability.

With the above and other objects in view the invention consists in the novel provision, construction, formation, combination, association and relative arragement of parts, members and features, all as hereinafter described, shown in the drawings, and finally pointed out in claims.

In the drawings:—Figure 1 is a top plan view, partly broken away, and parts being omitted for clearness of illustration, of a wave motor embodying the invention; Fig. 2 is a similar view in side elevation and partly in section upon the line 2—2, Fig. 1; the wave motor being illustrated as installed in position for operation; Fig. 3 is a detail fragmentary, vertical, sectional view, of certain features of the construction, taken upon the line 3—3, Fig. 4, and looking in the direction of the accompanying arrows; Fig. 4 is a similar view taken upon the line 4—4, Fig. 3, and looking in the direction of the appended arrows; Fig. 5 is a fragmentary elevation of the particular elements of the construction shown in Figs. 1 and 2, the same being partly in section upon the line 5—5, Fig. 6, and looking in the direction of the appended arrows; and, Fig. 6 is a sectional view taken upon the line 6—6, Fig. 5, and in a plane at right angles to that viewed in Fig. 5, looking in the direction of the appended arrows.

Corresponding parts in all the figures are denoted by the same reference characters.

Referring with particularity to the drawings, the improved wave motor comprises a float A suitably sustained in proper position in a sea or other body of water, so as to be subjected to the action of the waves; B designates a fixed seaward support; C designates an adjustable land support; and D designates transmission means for conducting the movements and gyrations of the float A to power mechanism E upon the land support C; which power mechanism translates the energy taken from the transmission means D into movement of a power shaft F from which operative connections G extend to a power consumer or transformer H, which may also be mounted upon the land support C.

K designates adjusting means for the float A, and L designates operative connections between the adjusting means K and the float A; said operative connections also extending to the fixed support B. The transmission means D comprises means *a* for conducting primary gyrations of the float A, and means *b* for conducting secondary gyrations of the float A; the primary gyrations being considered those acting substantially in a line of movement extending between the support B and the support C, and the secondary gyrations being considered as those performed substantially in a line rectangular to that traversed by the float A in the said primary gyrations of the latter. The power mechanism E comprises improved means *c* for converting movement of the transmission means D into movement of the power shaft F; said means *c* constituting an improved clutch peculiarly adapted to the operative conditions concerned.

A particular provision, construction, and combination of parts, members and features, of the wave motor embodying the invention, is as follows:—

The fixed seaward support B may consist of a rigid column or tower 7 built of structural metallic shape, as shown, or otherwise suitably organized to withstand the stress of impacting waves and forces of the elements; and said column or tower 7 is located at a predetermined distance from the shore of the body of water with respect to which the wave motor is installed, rising from the bed 8 of the body of water of which the bank or shore is designated at 9. The adjustable end support C consists of a wheeled support 10

mounted upon tracks 11 installed upon the banks or shore, and having a curvature, the arc of which has the column or tower 7 as a center. The float A rises in and projects from the surface of the body of water at a predetermined point between the column or tower 7 and the wheeled support 10, being provided with a mast 12 associated with the means *a* of the transmission means D. The float A comprises a plurality of buoyant bodies 13 preferably assembled in a square with the said bodies at the corners of the same, said bodies being rigidly connected by cross-braces 14 and upright braces 15 extending from the bodies 13 into connection with the mast 12, which latter is stepped in a lower cross brace 14 and is braced by passage through an upper brace 14, as clearly shown in Figs. 1 and 2.

The construction last described of the float A permits the water to surround all of the bodies 13 and act positively upon the same which all jointly operate to rock the mast 12; which latter comprises a lower section 12^a and an upper section 12^b telescoped together; the section 12^b being operatively connected with the means *a* of the transmission means D.

The adjusting means K control the position of the float A through the operative connections L which comprise a rope or cable 16, the ends of which are connected with the float A substantially at its center of oscillation, as at 17, at the base of the mast 12; said rope or cable passing about a pulley 18 connected with the column or tower 7 and extending thence to the adjusting means K upon the support 10. The end portions of the rope or cable 16 pass respectively between the members 19 of the pairs of spaced uprights at opposite sides of the float A, and which are connected with the cross braces 14; said pairs of uprights 19 being opposed to each other and opposed respectively to the column or tower 7 and the support 10.

The means *a* of the transmission means D comprise a rope or cable 20 as do the means *b* comprise a rope or cable 21. Both of said ropes or cables are operatively connected with an adjustable support *d* mounted upon the fixed seaward support B at the top of the column or tower 7; and said adjustable support *d* comprises a carriage 22, the wheels 23 of which operate upon a fixed track or rail 24 mounted at the top of the tower 7 and firmly secured in connection therewith by braces 25. The track or rail 24 extends in an arc having the adjustable land support C as a center. The rope or cable 21 passes about pulleys 26 mounted at the ends of the track or rail 24; the ends of said rope or cable being connected with the carriage 22. The rope or cable 20 of the means *a* passes about a pulley 27 connected with the carriage 22. The strands of the cable 20 embrace between them the mast 12; and the strands of the cable 21 pass above the float A, or at least at one side of the mast 12. Both of said cables 20 and 21 extend between the supports B and C being operatively connected with the power mechanism E and the means *c* for converting movement of the transmission means D into movement of the power shaft F.

The member 12^b of the mast 12 is provided with a clutch *e* for locking the rope or cable 20 to the mast 12, and said clutch comprises a sleeve 28 through which one strand of one of the ropes or cables 20 passes, said sleeve being provided with a collar 29 surrounding the mast section 12^b between flanges 30 thereon, permitting the sleeve to swing upon the mast. The sleeve 28 is provided at one side with a pivoted cam 31 bearing upon a frictional device 32 within the sleeve, and adapted to press the latter against the rope or cable 20 to lock the same against movement through the sleeve. The cam 31 has a depending arm 33 from which extend operating means consisting of a cord or rope 34, which traverses the interior of the tubular telescoping sections 12^a and 12^b of the mast to the lower end of the latter whence it extends shoreward to the support C. A spring 35 connected with the sleeve 28 bears upon the arm 33 exerting tension upon the cam 31 to hold the frictional device 32 against the cable 20 and lock the same to the sleeve and mast 12. A pull upon the landward end of the cord or rope 34 operates against the spring 35 to release the rope 20 from the pressure of the frictional device 32 and permit free play of the rope or cable 20 with relation to the mast.

The power shaft F comprises a horizontal shaft 36 supported to extend longitudinally of the wheeled support 10, as in bearings 37 mounted upon said support, or upon an upper supplemental support 10^a, superposed upon the support 10 by suitably braced uprights 38. The shaft 36 is provided at one end with a belted pulley 39 operatively connected with any suitable power consumer or transformer H, as, for instance, an electric generator 40 which may be mounted upon the wheeled support 10 adjacent to the adjusting means K. The power mechanism E comprises a horizontal shaft 36 and the means *c* for converting movement of the transmission means D into movement of the power shaft F or the horizontal shaft 36; and said means *c* constitute each a clutch, in function and operative effect, there being two such clutches *c* mounted upon the shaft 36 and combined with the rope or cable 20; as well as two such clutches *c* mounted upon the shaft 36 and operatively combined with the cable 21; and each of said clutches act to vary movement of one strand of its respective rope or cable into a constant move-

ment of the shaft 36; the strands of each rope or cable moving oppositely. Thus, the clutches of each pair of the same move in opposite directions, two of the four clutches moving in one direction and the other two in the opposite direction and causing the rotation of the shaft 36 in a constant direction, so as to positively operate the generator 40 through the belted pulley 39.

Each of the clutches *c* mounted upon the horizontal shaft 36, comprises a casing 41 keyed to the shaft 36, as at 42; a circular disk 43 loose upon the hub 41[b] of casing 41 and carrying a dog 44; and a disk 45 loose upon the shaft 36 and mounted thereon through the agency of a sleeve 46 rotatably surrounding the shaft 36 and receiving its actuation from the respective means *a* or *b*. The dog is pivotally mounted, as at 47, at one face of the disk 43, and between the same and the disk 45, and is arranged to coact with an annular series of teeth 48 formed within the casing 41, which is provided with a peripheral flange 41[a] inclosing the disk 43, the dog 44, and the disk 45 at their peripheral portions; the disk 45 serving with said casing 41 and its flange 41[a] to completely house the dog and disk 43; and the series of teeth 48 being formed upon the inner surface of the flange 41[a]. The casing 41 is also provided with an inner annular flange 41[b] encircling the shaft 36, and constituting a bearing for the circular disk 43, which is bored to fit the same and revolve thereon.

f designates actuating means for the dog 44; and the same comprises two pins 49 and 50, respectively, which are spaced apart and set in the disk 45, straddling the dog 44 and received within curved openings, 51 and 52, respectively, in the disk 43.

Each of the sleeves 46 is provided with a sprocket wheel 53 which is fast thereon; said sprocket wheels 53 being included within the power mechanism E; there being two such sprocket wheels for the respective clutches of the means *a* and two such sprocket wheels for the respective clutches of the means *b*. The ends of the respective sleeves 46 are provided with opposed flanges 54 constituting bearings and permitting relative movement of the said sleeves. A separate sprocket chain 55 is trained about each pair of sprocket wheels 53 and an adjacent idler sprocket wheel 56; said sprocket chains 55 being respectively incorporated within the ropes or cables 20 and 21 of the means *a* and *b*. The idlers 56 serve to guide the sprocket chains truly, and cause said sprocket chains to oppositely actuate the sprocket wheels 53 of each pair of clutches *c*.

The adjusting means K comprise a windlass 57 mounted upon the wheeled support 10 and controlling adjustment of the rope or cable 16 of the operative connections L, and whereby said rope or cable may be moved to adjust the float A and its attendant features with respect to the position of the latter with relation to the seaward support B. The rope or cable 16 may be provided with a weight 58 connected with the lower or more submerged strand of the same; said weight imposing a strain upon said rope or cable, in case the float would be driven shoreward by an excessive wave or waves, the weight 58 thus returning the float structure to its original position, thereby subjecting the cable 20 to supplemental movement in addition to the movement caused by the oscillation of the float.

The operation, method of use and advantages of the improved wave motor constituting the invention will be readily understood from the foregoing description, taken in connection with the accompanying drawings, and the following statement:—

The proper working conditions of the mechanism and apparatus for utilizing the power of the agitation of the body of water within which the float A is installed, are maintained by determining the location of the float at the proper point between the support B and the land support C, and by moving the land support upon the bank or shore so that the proper angularity shall exist between the general shore-line and the line of extension of the transmission means D. The latter angularity relates to the direction of the wave movement with respect to the shore or bank. It is preferable that the seaward side or end of the float A meet the wave movement directly or head on, so to speak. This insures the translation of the wave movement substantially into the primary gyrations of the float A and the mast 12, such gyrations being substantially in a plane corresponding to the direction of wave movement. The means *a* then cause the actuation of the power mechanism E and clutches *c* to operate the power shaft F. Secondary gyrations of the float and mast are translated into movement of the means *b* and the consequent actuation of the power mechanism E and clutches *c* to turn the said power shaft. Under ordinary conditions both the primary and secondary gyrations will be present, and both means *a* and *b* will be active to actuate the power mechanism E. It is apparent that each of said means *a* and *b* may be separately employed. The primary gyrations cause opposite endwise reciprocations of the strands of the rope or cable 20; and the secondary gyrations cause opposite endwise reciprocations of the strands of the rope or cable 21. The movement of each rope or cable in one direction causes positive actuation of one of the clutches *c*, through the means *f*, to turn the power shaft F in the forward direction and actuate the power consumer or transformer H.

The clutch *e* operatively connects one

strand of the rope or cable 20 with the mast 12, or the upper section thereof; the telescoping of the two mast sections accommodating the rise and fall of the float A. The endwise movement of the strands of the rope or cable 21 are caused by the traverse of the track 24 by the carriage 22. Each clutch *c* operates so that the casing 41 shall move in but one direction, together with the power shaft 36, such casing being turned in one direction by its dog 44 and series of teeth 48; the dog being engaged with the teeth by the pin 51 when the disk 45 moves in one direction, and being disengaged from said teeth by the pin 50 when the disk 45 moves in the opposite direction. The inertia of the disk 43 carrying the dog 44 permits the disk 45 to lead the disk 43 so that the pin 51 may throw the dog into engagement with the teeth 48.

The float A, being composed of a plurality of buoyant bodies 13, which are spaced apart so as to permit the wave movement to successively act upon the same, is insured of a substantially continuous activity; and each contacting wave acts upon more than one of the bodies 13, first actuating the more seaward body or bodies and finally the more landward body or bodies. The pairs of spaced uprights 19 co-act with the rope or cable 16 to keep the float A substantially head on with the advancing wave movement.

The clutch *e*, controlling operative connections of the rope or cable 20 with the mast 12 is controlled by the operating cord or rope 34 which is led ashore from the base of the tubular or hollow mast 12 to a suitable point of control, and upon the wheeled support 10.

From the above recitation it will be noted that the float A is designed and adapted to utilize a large percentage of the total wave movement affecting the same; and that said float may be properly positioned to meet obtaining working conditions, through its adjustment and the adjustment of the wheeled support 10; between which latter and the fixed seaward support B the transmission means D extend and are securely sustained. The power mechanism E is designed to effectually translate all of the motion of the transmission means into motion of the power shaft F and actuation of the power consumer or transformer H.

I do not desire to be understood as limiting myself to the specific provision, construction, combination, association, and relative arrangement of parts, members and features shown and described; but reserve the right to vary the same in adapting the improvements to varying conditions of use, without departing from the spirit of the invention or the terms of the following claims.

Having thus described my invention, I claim and desire to secure by Letters Patent:—

1. Improved means for utilizing power of the waves, comprising an adjustable land support, a seaward support, a float disposed between said supports, a power consumer or transformer upon the land support, and transmission means extending between said supports and operatively connected with said float.

2. Improved means for utilizing power of the waves, comprising a land support, a seaward support, a float disposed between said supports, a power consumer or transformer upon the land support, and transmission means extending between said supports and operatively connected with said float; a clutch providing such operative connection.

3. Improved means for utilizing power of the waves, comprising power transmission means, a power consumer or transformer operated by the same, and a float provided with a telescoping mast operatively connected with the transmission means.

4. Improved means for utilizing the power of the waves, comprising a power consumer or transformer, a float, and transmission means for operating the power consumer or transformer; said transmission means being operatively connected with the float and comprising means respectively for conducting primary and secondary gyrations of the float.

5. Improved means for utilizing power of the waves, comprising a power consumer or transformer, a float, and transmission means for operating the power consumer or transformer; said transmission means being operatively connected with the float and comprising means respectively for conducting primary and secondary gyrations of the float; said primary and secondary gyrations being substantially in planes cutting each other.

6. In improved means for utilizing power of the waves, a float responsive to wave motion and comprising a plurality of connected buoyant bodies separated by a space open to wave traverse; said buoyant bodies being arranged substantially at the corners of rectangular formation.

7. In improved means for utilizing power of the waves, a float, responsive to wave motion and comprising a plurality of connected buoyant bodies separated by a space open to wave traverse; said buoyant bodies being arranged substantially at the corners of the rectangular formation; and a telescoping mast projecting upwardly from said buoyant bodies.

8. In improved means for utilizing power of the waves, a float responsive to wave movements, adjusting means for the same,

and operative connections between the float and the adjusting means, said operative connections being connected with the float substantially at the center of oscillation of the same.

9. In improved means for utilizing the power of the waves, a float responsive to wave movements and provided with a mast, adjusting means for the float, and operative connections extending between the float and the adjusting means and connected with the float substantially at the center of oscillation of the same and at the base of the mast.

10. In improved means for utilizing the power of the waves, two supports, a float disposed between the supports, adjusting means for the float upon one of the supports, and operative connections between said adjusting means and the other support and the float; there being guides upon the float for said operative connections.

11. Improved means for utilizing the power of the waves, comprising two supports, a float disposed between the supports and responsive to wave movements, a power consumer or transformer upon one support, and transmission means extending between the supports and power consumer or transformer and the float.

12. Improved means for utilizing power of the waves, comprising two supports, a float disposed between the supports, a power consumer or transformer upon one support, and transmission means extending between the supports and the power consumer or transformer and the float; said transmission means comprising means respectively for conducting primary and secondary gyrations of the float; and one of said last named means comprising a carriage movable upon one of said supports, and a rope or cable connected with said carriage and guided by said last named support; said rope or cable being connected with said power consumer or transformer.

13. In improved means for utilizing power of the waves, a float, power mechanism, a shaft, and transmission means between the float and the power mechanism; said transmission means comprising oppositely moving members; and said power mechanism comprising clutches upon said shaft operated by said transmission means; each of said clutches comprising a member fixed upon the shaft, a member loose upon the shaft, an intermediate member loose upon the shaft, a dog carried by said intermediate member and acting to turn said member fixed upon the shaft, and actuating means carried by said first named member loose upon the shaft and controlling said dog.

14. In improved means for utilizing the power of the waves, a float, power mechanism, a shaft, and transmission means between the float and the power mechanism; said transmission means comprising oppositely moving members; and said power mechanism comprising clutches upon said shaft operated by said transmission means; each of said clutches comprising a member fixed upon the shaft, a member loose upon the shaft, an intermediate member loose upon the shaft, a dog carried by said intermediate member and acting to turn said member fixed upon the shaft, and actuating means carried by said first named member loose upon the shaft and controlling said dog; said actuating means comprising pins straddling said dog.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM KING BOWERMAN.

Witnesses:

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