A. L. REYNOLDS.

WAVE POWER SYSTEM.

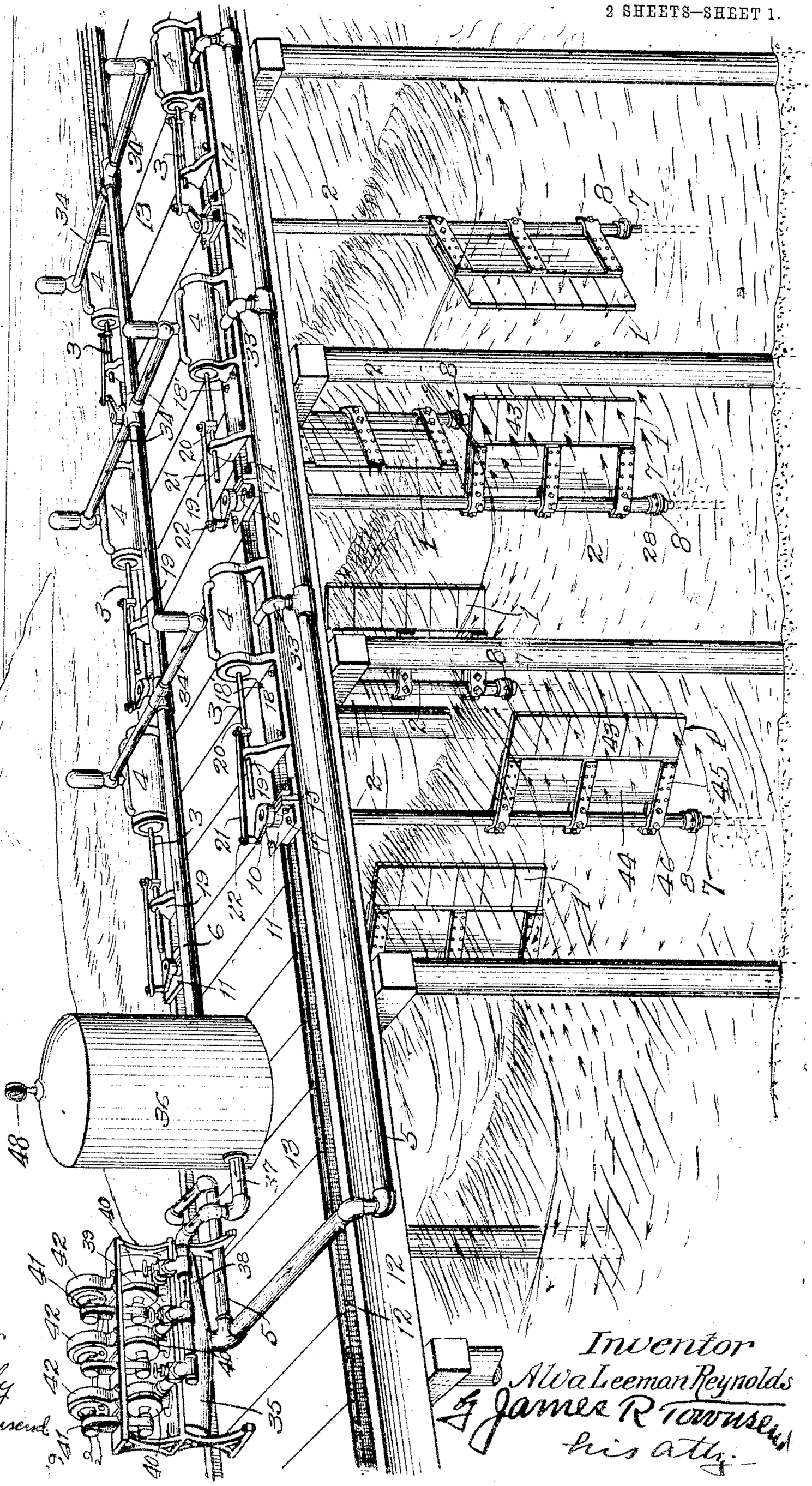
APPLICATION FILED MAY 6, 1909.

988,508.

Patented Apr. 4, 1911.

2 SHEETS—SHEET 1.

Fig. 1



Witnesses
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Fig. 4

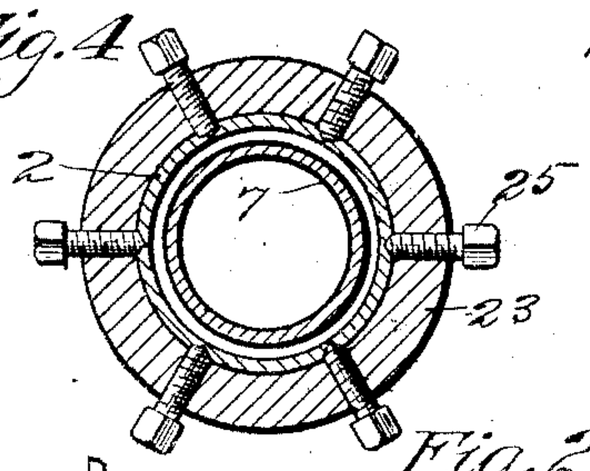

Fig. 2

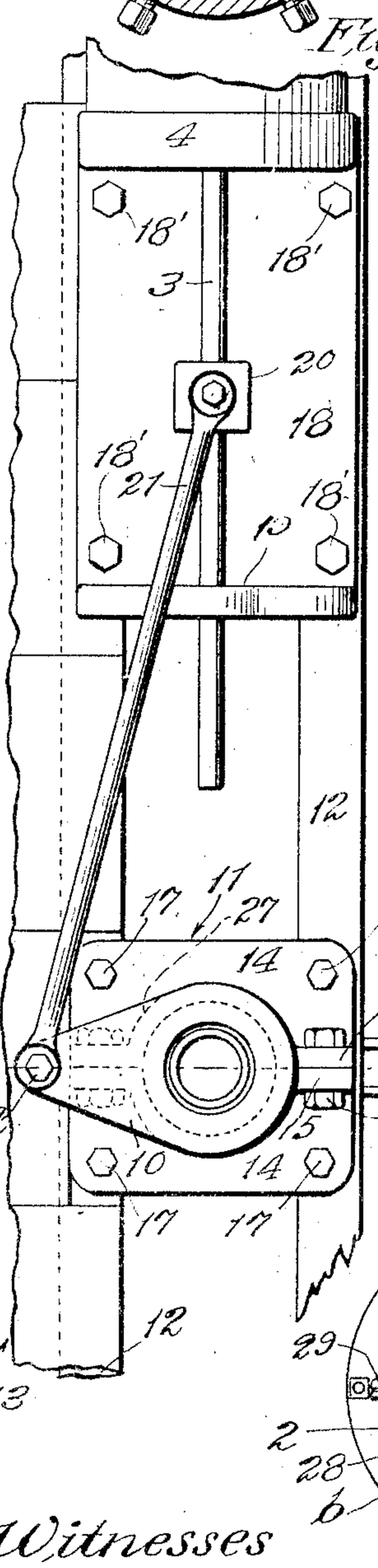

Fig. 3

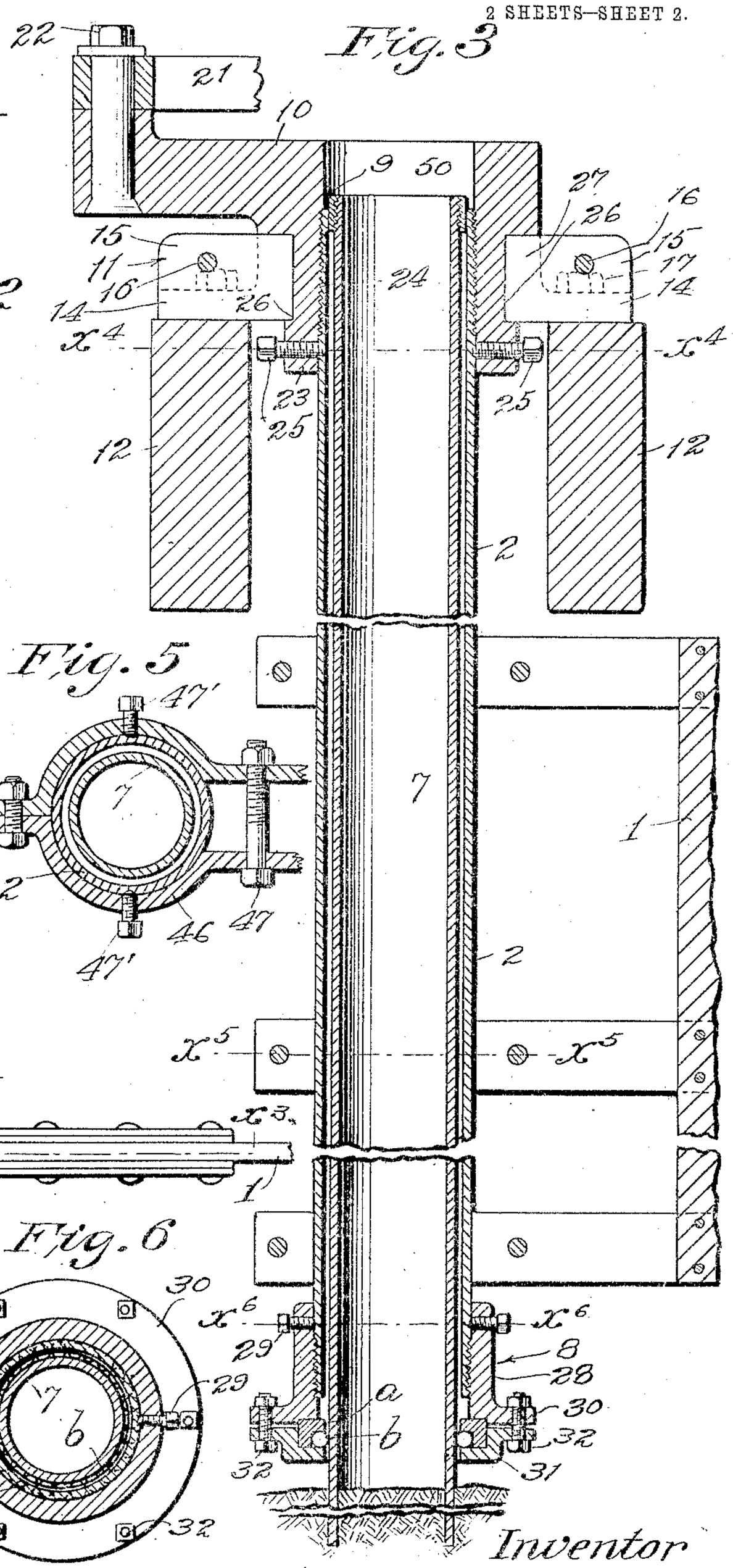

Fig. 5

Fig. 6

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UNITED STATES PATENT OFFICE.

ALVA LEEMAN REYNOLDS, OF HUNTINGTON BEACH, CALIFORNIA, ASSIGNOR TO THE GLOBE WAVE POWER AND ELECTRIC COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

WAVE-POWER SYSTEM.

988,508. Specification of Letters Patent. **Patented Apr. 4, 1911.**

Application filed May 6, 1909. Serial No. 494,505.

To all whom it may concern:

Be it known that I, ALVA LEEMAN REYNOLDS, a citizen of the United States, residing at Huntington Beach, in the county of Orange and State of California, have invented new and useful Improvements in Wave-Power Systems, of which the following is a specification.

This invention relates to a wave power system in which the force of the ocean-waves is received by vanes and thence transmitted to pumps which supply a fluid under pressure to a power-machine.

Objects of this invention are: To make provision for compensating for the inequalities of the wave-motion without employing an elevated reservoir; to minimize the cost of installation; to maximize strength and durability; to simplify and facilitate the work of installing in the water and of dismantling and removing from the water for purposes of renewal or repair; to provide comparatively cheap, simple and economical means for mounting the vanes and transmitting the power therefrom to the pump; to provide a wave-motor construction that is applicable to piers already built; to provide a wave-motor unit which may be readily applied to and removed from the docks and piers already built.

The invention may be variously constructed, and I do not limit the same to specific forms.

The invention includes the complete apparatus and also the combinations and parts more particularly described in the subjoined detail description.

The accompanying drawings illustrate the invention.

Figure 1 is a perspective view of a wave-power system constructed in accordance with this invention. The waves are distorted, being shortened for clearness of description. Fig. 2 is a fragmental plan detail showing the top of parts of a single unit. Fig. 3 is a fragmental detail in vertical section on line x^3, Fig. 2. Fig. 4 is a section on line x^4, Fig. 3. Fig. 5 is a plan section on line x^5, Fig. 3. Fig. 6 is a section on line x^6, Fig. 3.

The system comprises a plurality of working units, each unit comprising a vane 1 rigidly fixed to a rotatably-mounted sleeve in the form of a pipe 2 that is connected by suitable means with the piston-rod 3 of a pump 4 which is preferably a double-acting pump connected with mains 5, 6, of a water-system hereinafter to be more fully described.

A stationary pile 7 which is preferably a metal pipe inside the outer pipe or sleeve 2, and the lower end of which is driven into the ocean-bed in any suitable manner, holds upright the outer pipe 2 which carries the vane 1 upright. A foot-bearing 8 and a head-bearing 9 of any suitable forms are between the pipes 7 and 2 to allow the outer pipe to rotate fully and freely around the inner pipe.

In the drawings, the foot-bearing is shown as a ball-bearing and the head-bearing is shown as a collar fixed onto the inner pipe 7, the outer pipe or sleeve being slidable endwise as well as rotatable on the inner pipe.

10 designates a crank fixed to the upper end of the outer pipe or sleeve 2 and carried by a bearing 11 that is mounted on sills 12 which may be a part of a pier 13 that forms a frame for supporting the outer pipes or sleeves of all of the working units of the system.

The crank-bearing 11 may be formed of duplicate plates 14, 14, each provided with upwardly-projecting ears 15 that are fastened together by bolts 16, said plates being secured to the sills 12 by bolts 17. The bed-plate 18 of the pump 4 of each unit may be fastened by bolts 18′ to the same sills 12 upon which the crank-bearing is fastened; said sills forming a bed to hold the pump and the crank in true relation with each other.

The piston-rod 3 may extend from the pump through a bearing 19 and may be connected by a wrist-block 20 and the connecting-rod 21 with the crank-pin 22.

The crank 10 is provided with a downward hollow extension 23 which is internally screw-threaded as shown at 24, and is screwed tightly onto the upper end of the outer pipe or sleeve 2, and is secured against unscrewing by means of set-screws 25. Said downward extension is provided with an annular gain 26 into which is fitted a collar 27 formed on the upper face of the plates

14 so that the crank is supported by said collar; said crank in turn supporting the outer pipe or sleeve 2.

The foot-bearing 8 may be a ball-bearing thimble formed in sections, the upper section 28 being internally threaded and screwed onto the lower end of the outer pipe and held against unscrewing by the set-screws 29. Said section 28 may be provided with a flange 30 at its lower end to which the flanged ball-bearing cup 31 is secured by bolts 32 to support the cone *a* and also the anti-friction balls *b* that engage the outside of the pile 7 which pile is externally smooth and cylindrical.

The pumps 4 are respectively connected with the mains 5, 6, by suction-pipes 33 and pressure-pipes 34; the suction-pipes being connected with the supply-mains 5, and the pressure-pipes being connected with the pressure-main 6. The supply-mains 5 lead from a sump or reservoir 35, and the pressure-main 6 leads into an air-pressure tank 36 which in turn discharges into a pressure-main 37 that is connected with a manifold 38 which in turn is connected by valved nozzles 39 with water-wheels 40 that in turn are respectively connected by suitable means as the belts 41 with the electrical generators 42.

The water-motors discharge into the sump 35 from which the water returns to the supply-mains 5.

The vanes 1 may be constructed of any suitable material. In the drawings each is shown as being constructed of a number of planks 43 extending horizontally and secured together at one end by upright reinforcing plates 44 upon which are fastened straps 45 that are bolted thereto and are provided at their free ends with bends 46, to form clamps that are tightened by bolts 47 and fixed firmly by set-screws 47′.

The motion of the particles of water in a wave is from the trough toward the crest, and consequently the vanes submerged in the wave are forced by the wave-action toward the crest of such wave, moving seaward to meet the wave as it approaches, and moving shoreward toward the crest of the wave as the wave passes. This movement of the vane is transmitted through the outer pipe or sleeve 2 to the crank 10 and thence to the piston of the pump, all of the vanes being acted upon by each wave as it moves toward the shore. The short arrows in Fig. 1 are intended to indicate the direction in which the water particles are moving in the depicted waves. The several vanes will therefore operate in more or less irregular succession and the pump-pistons will thereby be variously operated; and at each movement of a piston water will be forced onward through the system of pipes. The water is thus forced under pressure into the pressure-tank 36 which at the outset is full of air, and the pressure of the water compresses the air in the tank which is provided with a gage 48 to indicate such pressure. The water issues under this pressure, through the main 37 to the manifold 38, and may there be discharged through the nozzles controlled by the valves 39 to drive the water-wheels 40.

When the wave-power runs high, all of the valves 39 may be opened, thus putting the water-wheels into operation to drive the dynamos 42; and the electricity thus generated may be led off through the cable 49 to the place of use or to a storage-battery, not shown, where it may be stored until required for use.

When the wave-action becomes less forceful, the power transmitted by the waves will decrease, and thereupon one or more of the valves 39 may be closed, thus to maintain a determined pressure in the pressure-tank 36. The motor-units are all therefore made to operate at all times under practically uniform pressure.

In the drawings only three water-wheels are shown, but it is to be understood that the number of water-wheels and electric generators as well as that of the pumping-units may be increased indefinitely or that in small plants only a single water-wheel and its connected dynamo may be employed.

To dismantle a unit, the connecting-rod 21 may be disconnected from its crank and the bolts 16 and 17 may be removed, and a tackle attached to the crank 10, and the plates 14 may be moved sidewise out of the way and the unit drawn up along the pile 7 and out of the water, the vane being turned so that it may be drawn up between the sills. To install a vane the reverse operation would be performed.

The upper portion 50 of the bore of the crank may be of the same diameter as the bearing-collar 9 so that when the sleeve is returned downwardly the bore 50 may slip down smoothly on the bearing-collar 9 which may engage both the inside of the sleeve 2 as well as the inside of the bore 50. In the drawings the vanes are shown located close to the bed of the ocean, but it is to be understood that the proper location of the vane may be determined by the engineer in such manner as to secure the greatest efficiency from the wave-action. It is found in practice that the best results are secured when the vane is fully submerged.

The vane may be adjusted up or down the sleeve 2 by loosening the clamp-bolts 47, then moving the vane as desired, and then again tightening the clamp-bolts 47.

The foot-bearing 8 should be located as close to the bed of the ocean as possible so that the strain will come upon the pile near the ground.

I claim:—

1. A wave power system comprising a supply-main, a pressure-main, an air-pressure tank connected to receive water from and return it to said supply-main, a sump, a plurality of water-motors arranged to discharge into the sump, a plurality of valve-controlled nozzles connected with the pressure-main to respectively supply said water-motors, electric generators connected with the water-motors respectively; a plurality of piles, sleeves on said piles respectively, vanes, a vane being on each sleeve and operable by wave-action, each sleeve being rotatably mounted on its pile, and pumps, the pistons of which are operatively connected with the sleeves respectively to receive power therefrom, said pumps being connected with the supply and pressure mains to receive water from the former and to discharge water into the latter.

2. The combination with a pile, of a sleeve on the pile, head and foot bearings between the sleeve and the pile, a vane on the sleeve, and means fastened to the head of the sleeve to transmit power therefrom.

3. The combination with a pile, of a sleeve rotatably mounted on the pile, a vane to rotate the sleeve, and means to transmit power from the sleeve.

4. An inner pipe, an outer pipe mounted to rotate on the upper part thereof, power-transmitting means at the upper end of the outer pipe to transmit power therefrom, a vane fixed to the lower portion of the outer pipe, and a bearing at the upper end of the outer pipe to support the power-transmitting means and the outer pipe.

5. The combination with a pile, of a sleeve provided at its lower end with a ball-bearing thimble having balls to engage the pile, a bearing between the head of the sleeve and the pile, a crank fixed to the head of the sleeve, a bearing to support the crank, a vane fixed to the sleeve, and means to transmit power from the crank.

6. The combination with two bearing-plates, of a crank provided with a gain in which said plates are seated, means to hold the plates together, means to support the plates, a pile, a sleeve carried by the crank and rotatable on the pile, and a vane fixed to the sleeve to turn the same.

7. An outer pipe rotatably mounted on an inner stationary pile, a vane secured to the lower end of the outer pipe, bearings to sustain the outer pipe in position, and means to transmit power from the upper end of the outer pipe.

In testimony whereof I have hereunto set my hand at Los Angeles, California, this 1st day of May, 1909.

ALVA LEEMAN REYNOLDS.

In presence of—

JAMES R. TOWNSEND,
M. BEULAH TOWNSEND.