No. 817,347.

PATENTED APR. 10, 1906.

F. STARR.

WAVE MOTOR.

APPLICATION FILED JULY 22, 1905.

4 SHEETS—SHEET 1.

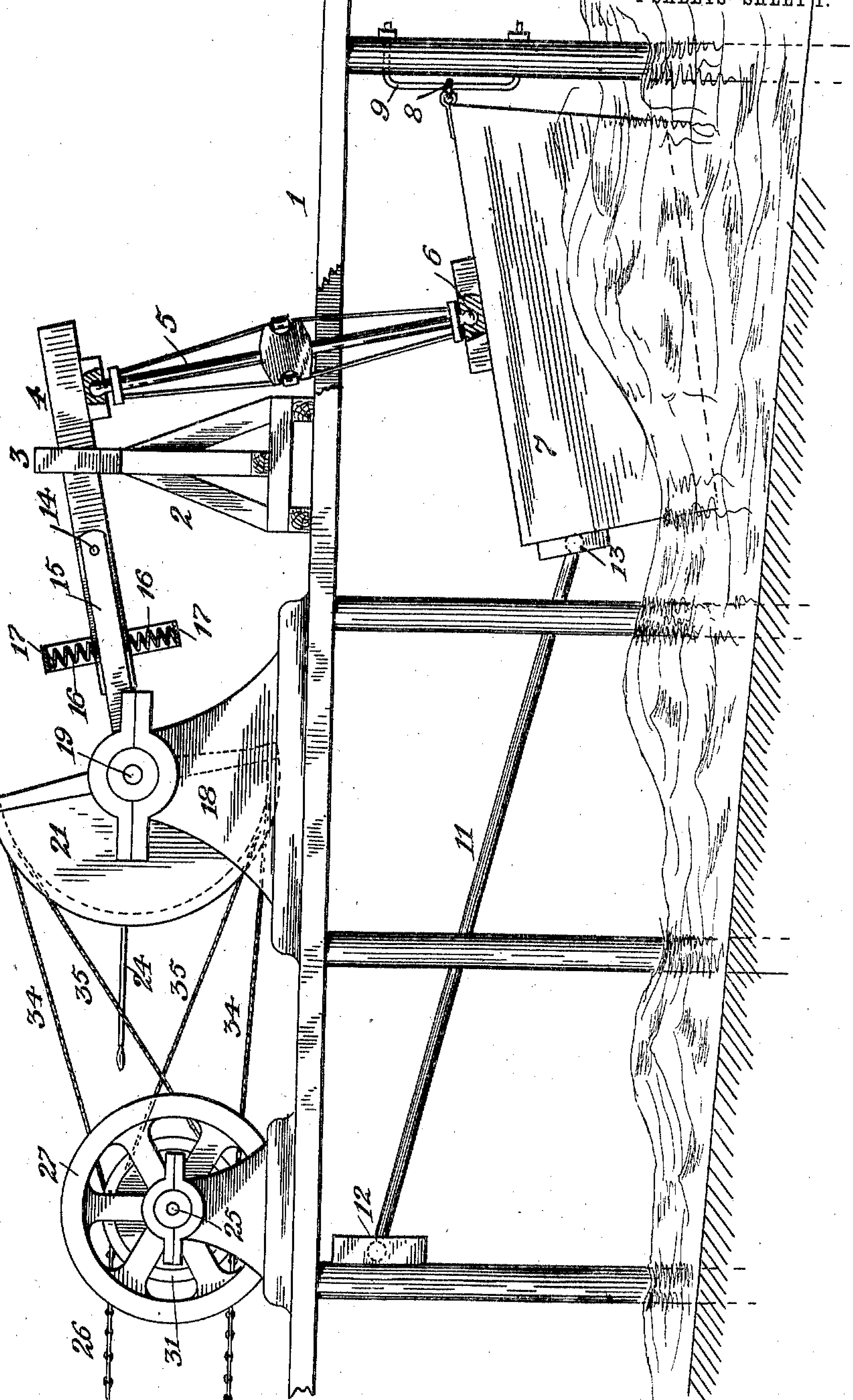

Fig. 1.

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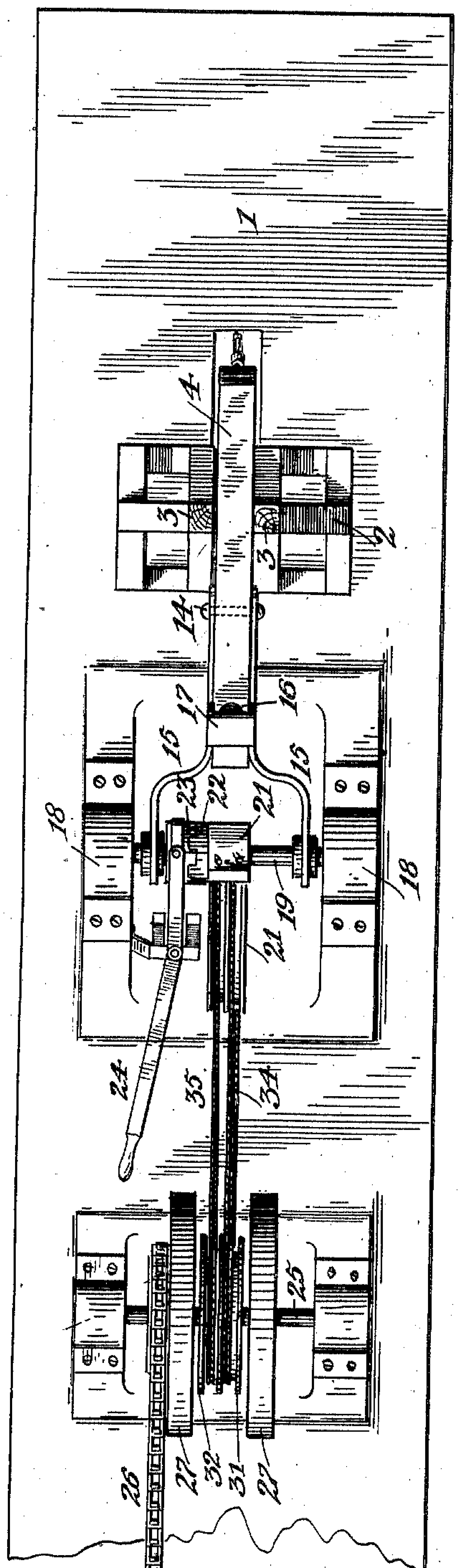

Fig. 2.

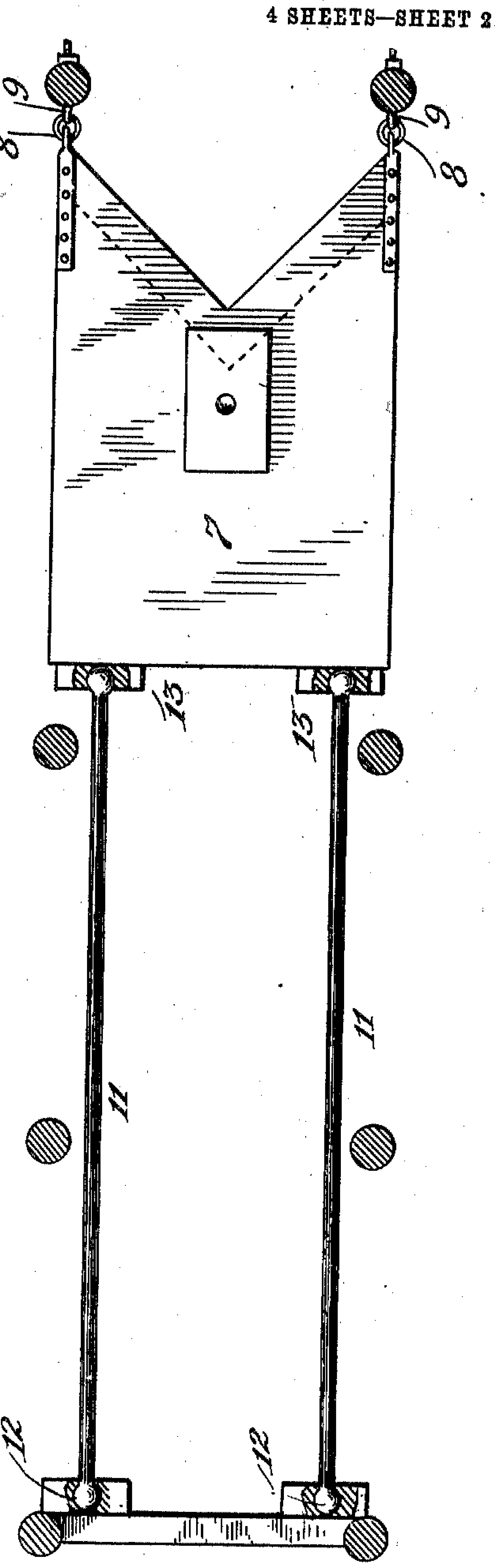

Fig. 3.

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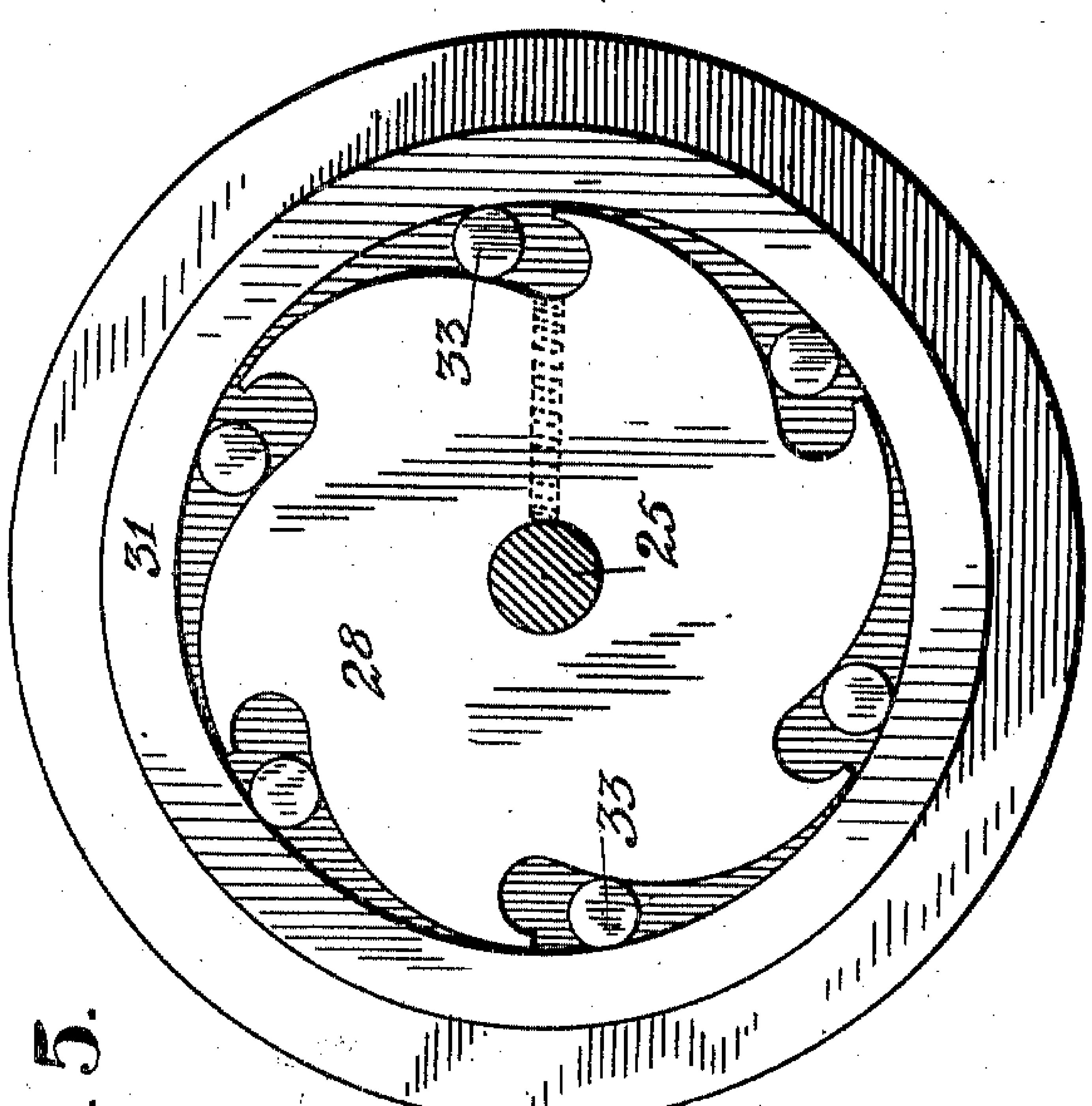

Fig. 5.

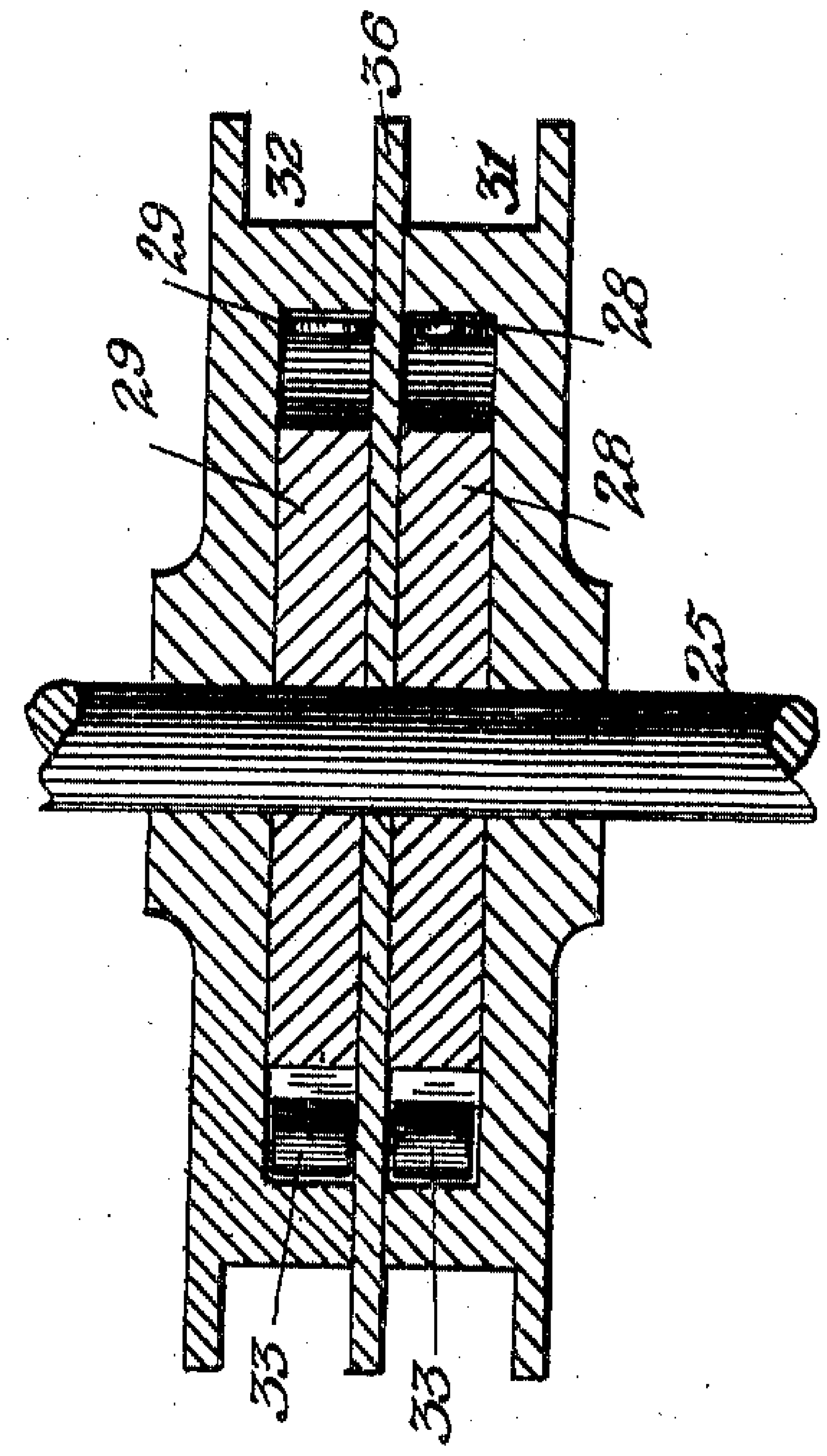

Fig. 4.

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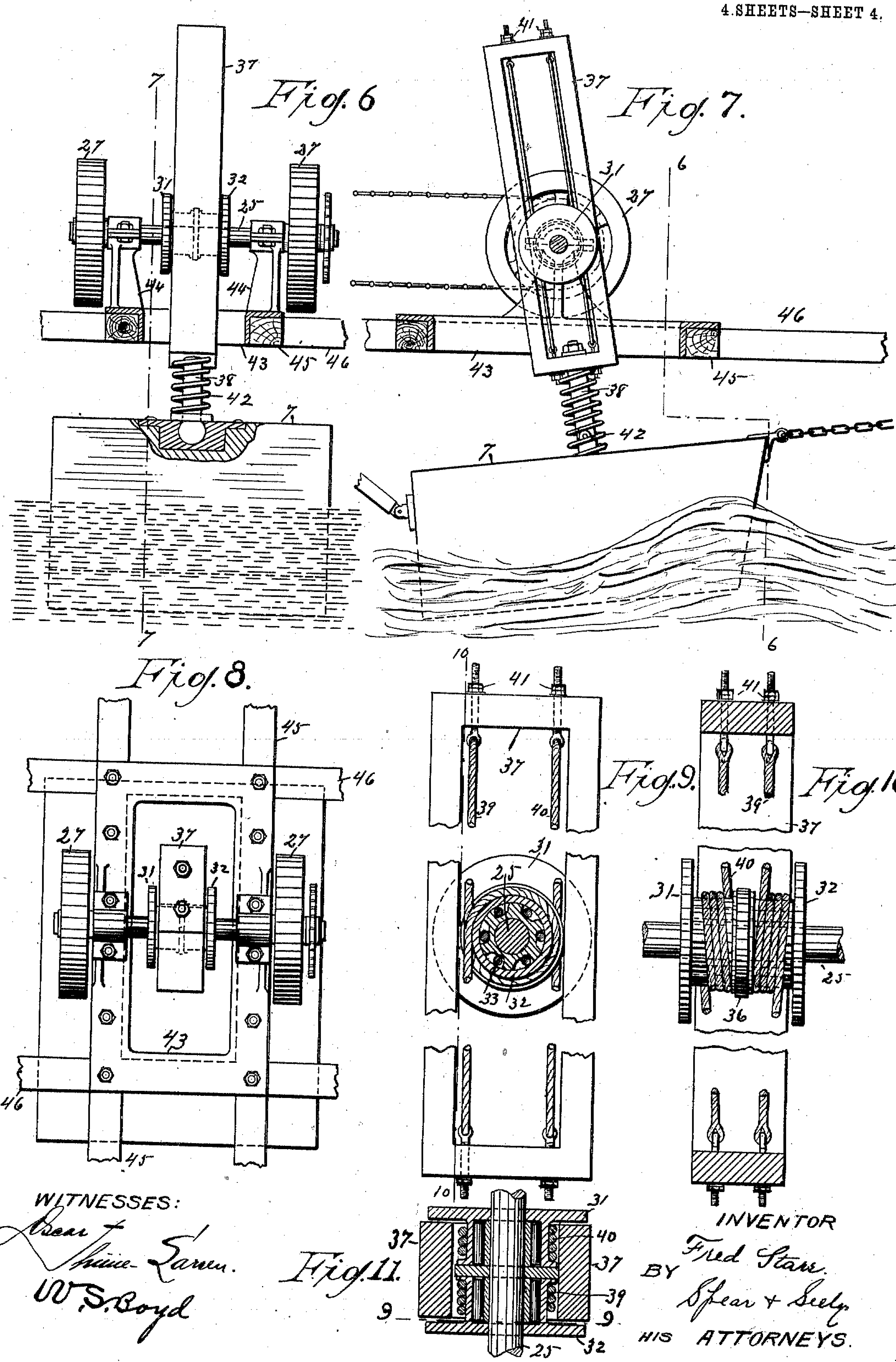
4 SHEETS—SHEET 4.



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HIS ATTORNEYS.

UNITED STATES PATENT OFFICE.

FRED STARR, OF SAN FRANCISCO, CALIFORNIA.

WAVE-MOTOR.

No. 817,347. Specification of Letters Patent. Patented April 10, 1906.

Application filed July 22, 1905. Serial No. 270,884.

To all whom it may concern:

Be it known that I, Fred Starr, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Wave-Motors, of which the following is a specification.

My invention relates to means for deriving power from the motion of waves, and particularly to a simple, cheap, and effective apparatus for that purpose.

One object of my invention is to convert wave-motion into a steady and uniform rotary movement of a power-shaft.

Another object is to provide connections between the float which forms the primary power-transmitter and the power-shaft, which will prevent any shock or jar in the transmission.

Another object is to provide a novel kind of double-acting clutch mechanism for directly converting the erratic motions of the float into a continuous motion expressed by a rotary shaft.

My invention also includes details of construction which need not here be explained, but which are fully hereinafter described and are shown in the accompanying drawings.

In the drawings, Figure 1 is a side elevation of one form of the apparatus. Fig. 2 is a plan view. Fig. 3 is a plan view of the float and its connections. Fig. 4 is a section of the double-acting clutch. Fig. 5 is a side elevation of the same. Fig. 6 is an end elevation of a different form of mechanism embodying my invention, taken on the line 6 6 of Fig. 7. Fig. 7 is a side elevation of the same on line 7 7 of Fig. 6. Fig. 8 is a top plan view. Fig. 9 is a vertical sectional view of the clutch-actuating mechanism on line 9 9 of Fig. 11. Fig. 10 is a vertical sectional view of the same. Fig. 11 is a transverse sectional view taken through the center of the clutch.

The drawings are not intended to show correct proportion or distances, but are only illustrative of mechanical constructions and connections, some parts being exaggerated in size and some reduced for convenience in delineation.

In the form of mechanism illustrated in Figs. 1 to 5, inclusive, 1 is a wharf or pier, beneath which there is an unobstructed flow of the waves. Upon this wharf is a structure 2, having guides 3 3, in which plays the beam 4. In one end of this beam is mounted, by a ball-joint or other universal mounting, a connecting-rod 5, which is free to move in all directions. The rod 5 extends down through the wharf and is universally jointed, as shown at 6, to the buoyant float 7, which is of any suitable capacity and of such shape as to respond to the lifting power of the waves to the best possible advantage. The end toward the sea is preferably deeply recessed, as shown in Fig. 3, and the sides of the recess are inclined beneath, as indicated by dotted lines in Fig. 3, in order that the incoming waves may exert to some extent a lifting action upon inclined or wedge-shaped surfaces. Each seaward corner of the float has loose links or chains 8, which work loosely upon guides 9 on the piles or other pier-supports. At the shore end of the float are rods 11, which are universally jointed to the float, as shown at 13, and which extend forward and are again similarly jointed to pier-supports, as shown at 12. Thus the float has a free movement up and down and can accommodate itself in all directions to the rise and fall and general erratic movement of the waves without excessive strain upon any of the connections.

The beam 4 is preferably made in two parts, hinged together at 14 in order to relieve the connection from excessive strain transmitted through the beam. The other part of the beam comprises the side bars 15 15, which are outwardly and forwardly turned, as shown. A yoke-frame 17 is secured to the bars 15, which forms stops for the outer ends of the springs 16, one above and one below, and which are interposed between the said yoke-frame and the beam 4. Thus the two parts of the beam are pivoted together and are also held in line by springs which can yield to excessive pressure. The resistance of the springs is such that normally the parts 4 and 5 will operate as one beam; but when required by excessive motion the springs will yield slightly up or down and will slightly flex the jointed parts of the beam while still transmitting the power. I consider this a valuable feature of my invention.

Standards 18 are secured upon the pier, in which is journaled an oscillating shaft 19. The forward ends of the bars 15 are bent outwardly and are secured to shaft 19, so that the said shaft will be oscillated by motion derived from the movement of the beam 4.

Fixed upon shaft 19 is a quadrant 21, which receives from it an oscillating motion. This quadrant has two parallel peripheral grooves, as shown in Fig. 2. The hub of the quadrant is provided with a member 22 of a clutch, with which engages another similar member 23, which slides upon and oscillates with the shaft 19. The member 23 is connected with an operating-lever 24 for shifting the clutch members into and out of engagement. So long as such members are in engagement the whole apparatus works continuously, and the purpose of the lever 24 is to disconnect the driven mechanism from the float and beam.

Beyond the quadrant is mounted the driven shaft 25, which is the power-shaft for compressing air or for driving any class of machinery for any purpose. This shaft is journaled in bearings and revolves continuously in the same direction, so as to transmit power. A pulley or sprocket-wheel on the shaft carries the power-transmitting band or chain 26, which extends to air-compressing mechanism or any other kind of machinery to be driven. The shaft also carries the fly-wheels 27, which give an even steady movement to the machinery. Mounted upon the shaft 25 and keyed or otherwise secured to it are two disks 28 29, having peripheral curvilinear recesses, as shown in Fig. 5. Surrounding each of said disks and loose on the shaft are flanged pulleys 31 32. In each of the recesses of the disks 28 29 is a roller 33, which when seated in the bottom of its recess leaves the recessed disk and surrounding pulley free, but otherwise acts as a clutch between the two, as shown in Fig. 5. The pulleys 31 32 are adapted to receive ropes or cables 34 35, which are given as many turns as may be necessary upon them and are then carried back into the parallel grooves of the quadrant and are secured at its ends. The cable 34 is for direct transmission from the quadrant to pulley 31; but the cable 35 is crossed between the quadrant and the pulley 32. A disk 36 is interposed between the pulley 31 and 32 in order to close the ends of the recesses, and so form chambers for the rollers.

To the quadrant 21 is imparted motion from the waves, transmitted through the float and its connections, and no matter how erratic the original motion of the float may be the said quadrant is necessarily compelled to oscillate. When it oscillates forwardly, as shown in Fig. 1, the direct rope connection 34 is brought into action and gives a positive pull to the pulley 31, squeezing its rollers between such pulley and the adjacent interior disk 28, and so giving a forward motion to such disk and to the shaft upon which it is secured. The reverse motion of the quadrant, so far as the rope 34, pulley 31, and disk 28 are concerned, is an idle motion, because the rollers simply roll back into their enlarged curvilinear seats without any clutching action. On the same forward motion (indicated in Fig. 1) the crossed-rope connection 35 gives the pulley 32 a negative pull, putting its rollers out of action. When, however, the quadrant oscillates in the opposite direction, the crossed-rope connection gives the positive pull to pulley 32, brings its rollers into clutching relation with the disk 29, and impels the shaft forwardly in the same manner. Thus any motion of the float transmitted to the quadrant is converted into a continuous movement of the shaft 25, which, aided by its fly-wheels, runs steadily and uniformly and operates as a driving-shaft for any purpose for which power may be required.

It will be noticed that I have at all times a continuous exertion of power transmitted to the shaft 25. In wave-motors generally there are times during which a falling float transmits no power. In the present case the float whether rising or falling is at all times exerting its weight for conversion into power.

In the form of mechanism shown in Figs. 6 to 11, inclusive, the float 7 is connected to the lower end of a rectangular yoke or frame 37 by means of a rod 38, universally jointed to the float. The side pieces of the frame are located upon opposite sides of the clutch and between the flanges of the pulleys 31 and 32. The ropes 39 and 40 are wound around the pulleys in the same manner as shown and described for the other form of mechanism, but their ends are secured to the ends of the frame 37 instead of to the quadrant 21. The ropes are drawn taut by means of bolts 41 at the upper end of the frame, and the frame 37 is just loose enough to be moved freely by the float in any direction, whether reciprocatory or by longitudinal or transverse oscillation. In this manner the desired amount of friction may be secured between the ropes and the surfaces of the pulleys to prevent slippage without any strain whatever being placed upon the bearings of the shaft 25 or of the pulleys, which cannot be done with the first form of connection. A spring 42 is preferably placed around the rod 38 between the float and the end of the frame 37 to take up the shock upon the frame by the too sudden upward movement of the float.

The support for the frame and operating mechanism is preferably in the form of a rectangular single-piece casting 43, which is provided with standards 44 and is rigidly secured to the pier, which is preferably formed of cross-ties 45 and 46.

As the vertical movement of the float will be transmitted to the pulleys direct in this form of connection by the frame and ropes and indirectly in the other, it is evident that the result will be the same without the intervention of any cogs or other gearing to wear or get out of order, thus permitting of the power of the ever constantly-moving waves to be efficiently utilized by either form of construction of my wave-motor, and it is also evident that the clutch mechanism can be utilized for changing reciprocatory to rotary motion in other forms of mechanism, and I claim it for such purposes.

Having thus described my invention, what I claim as new is—

1. In a wave-motor, a stationary structure, a driving-shaft thereon having a double clutch mechanism, a float exposed to the waves, a member universally jointed to the float and movable vertically in relation to the structure, and a loose or flexible connection between said member and the clutch, all constructed and arranged so that the power-shaft derives a continuous rotation in the same direction from the erratic movement of the float transmitted through said freely-moving member.

2. In a wave-motor, a stationary structure, a driving-shaft thereon having a double clutch mechanism, a float exposed to the waves, a member universally jointed to the float so as to have both reciprocating motion and free oscillation in all directions, and a loose or flexible connection between said member and the clutch, all constructed and arranged so that the power-shaft derives a continuous rotation in the same direction from the erratic movement of the float transmitted through said freely-moving member.

3. In a wave-motor, a stationary pier or structure, a float beneath the same exposed to wave action, a substantially rectangular frame having a universal-joint connection with the float and being freely movable in all directions, a power-shaft on the structure, separate loose pulleys on said shaft inclosed by said frame, and a double-acting clutch upon said shaft; whereby the motions of the float transmitted through said frame, cause said shaft to rotate continuously in the same direction.

4. In a wave-motor, a float having its seaward end provided with a V-shaped recess having inclined sides whereby the water is collected and exerts a wedging and lifting action within said recess.

5. In a wave-motor, a float, a motor-shaft provided with a rigid member, a two-part flanged casing loosely mounted on the shaft and inclosing said member, each of the casing parts being adapted to engage with the rigid member while the other casing part is rotating in the opposite direction, a frame flexibly connected with the float at one end and having its sides upon opposite sides of the casing, and cables connected with the ends of the frame and encircling said casing parts in opposite directions and retained thereon by the flanges of the casing.

6. In a wave-motor, a float, a motor-shaft provided with a rigid member, a two-part flanged casing loosely mounted on the shaft and inclosing said member, each of the casing parts being adapted to engage with the rigid member while the other casing part is rotating in the opposite direction, a frame flexibly connected with the float at one end and having its sides upon opposite sides of the casing, cables connected with the ends of the frame and encircling said casing parts in opposite directions and retained thereon by the flanges of the casing, and eyebolts for adjusting the tension of the cables independently of each other.

In testimony whereof I have affixed my signature, in presence of two witnesses, this 16th day of June, 1905.

FRED STARR.

Witnesses:

M. R. Seely,

W. S. Boyd.