No. 627,533. Patented June 27, 1899.

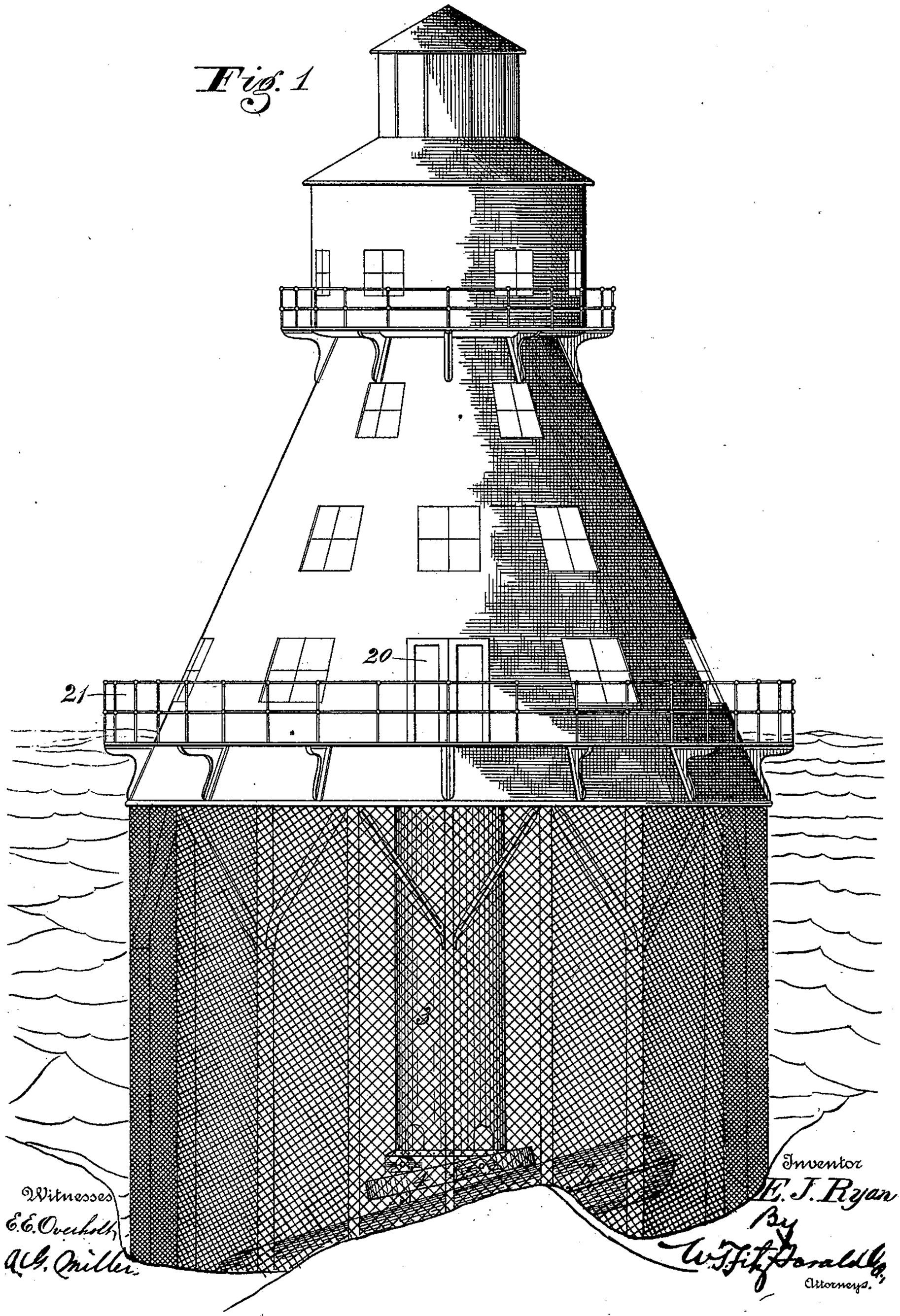
E. J. RYAN.

WAVE MOTOR.

(Application filed Mar. 19, 1898.)

(No Model.) 8 Sheets—Sheet 1.

Fig. 1



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(No Model.) 8 Sheets—Sheet 2.

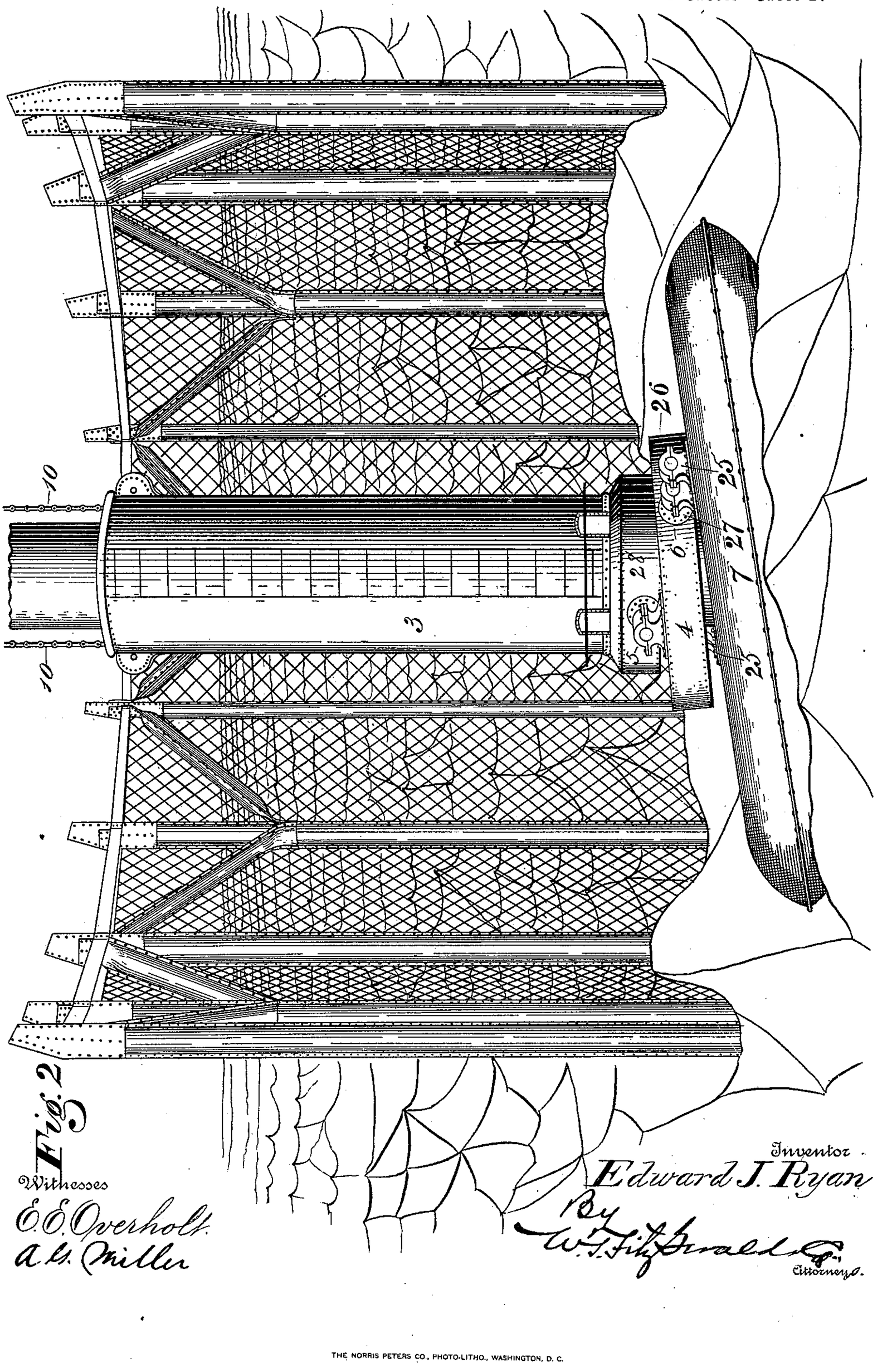

Fig. 2.

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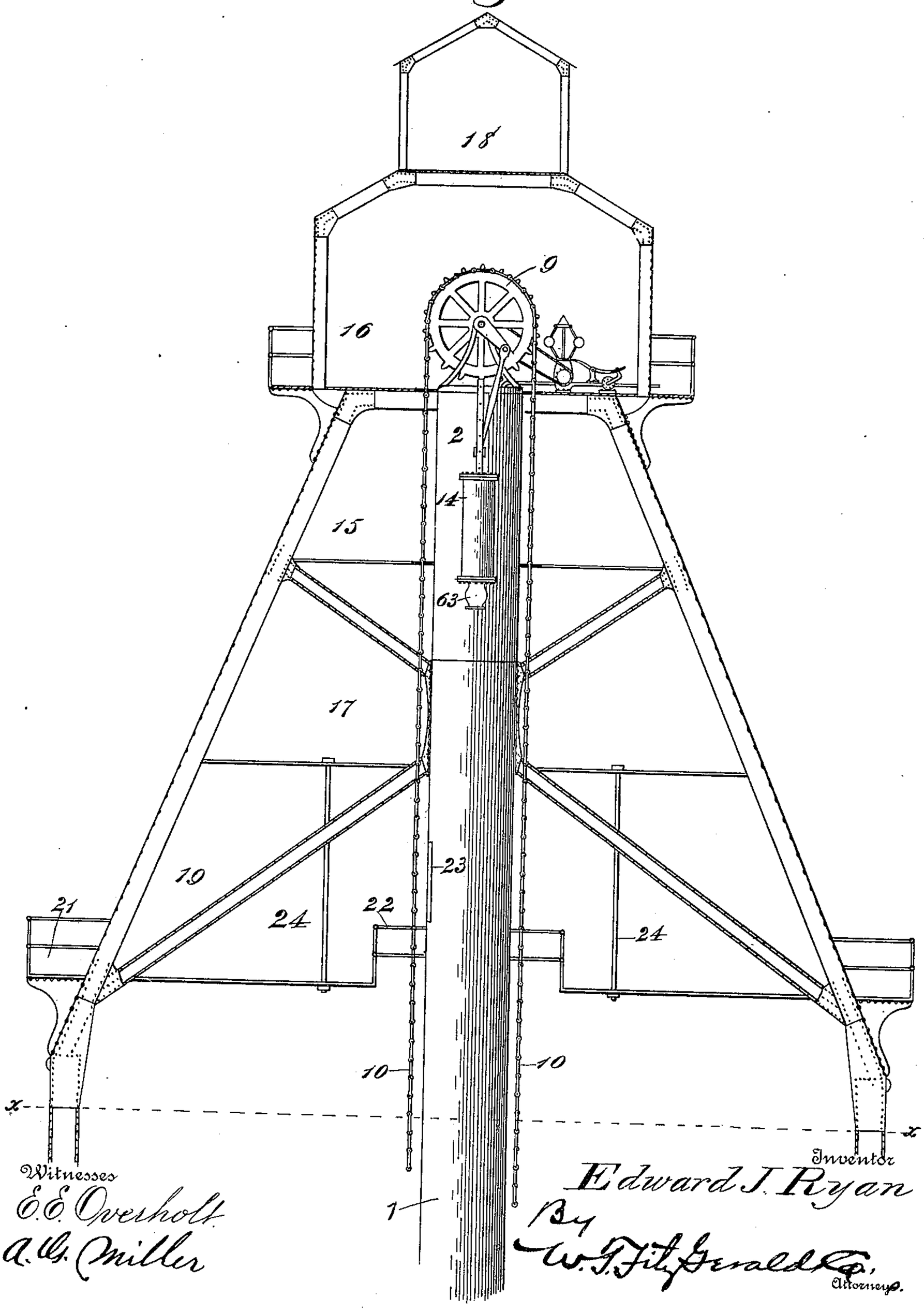
8 Sheets—Sheet 3.

Fig. 3



Witnesses

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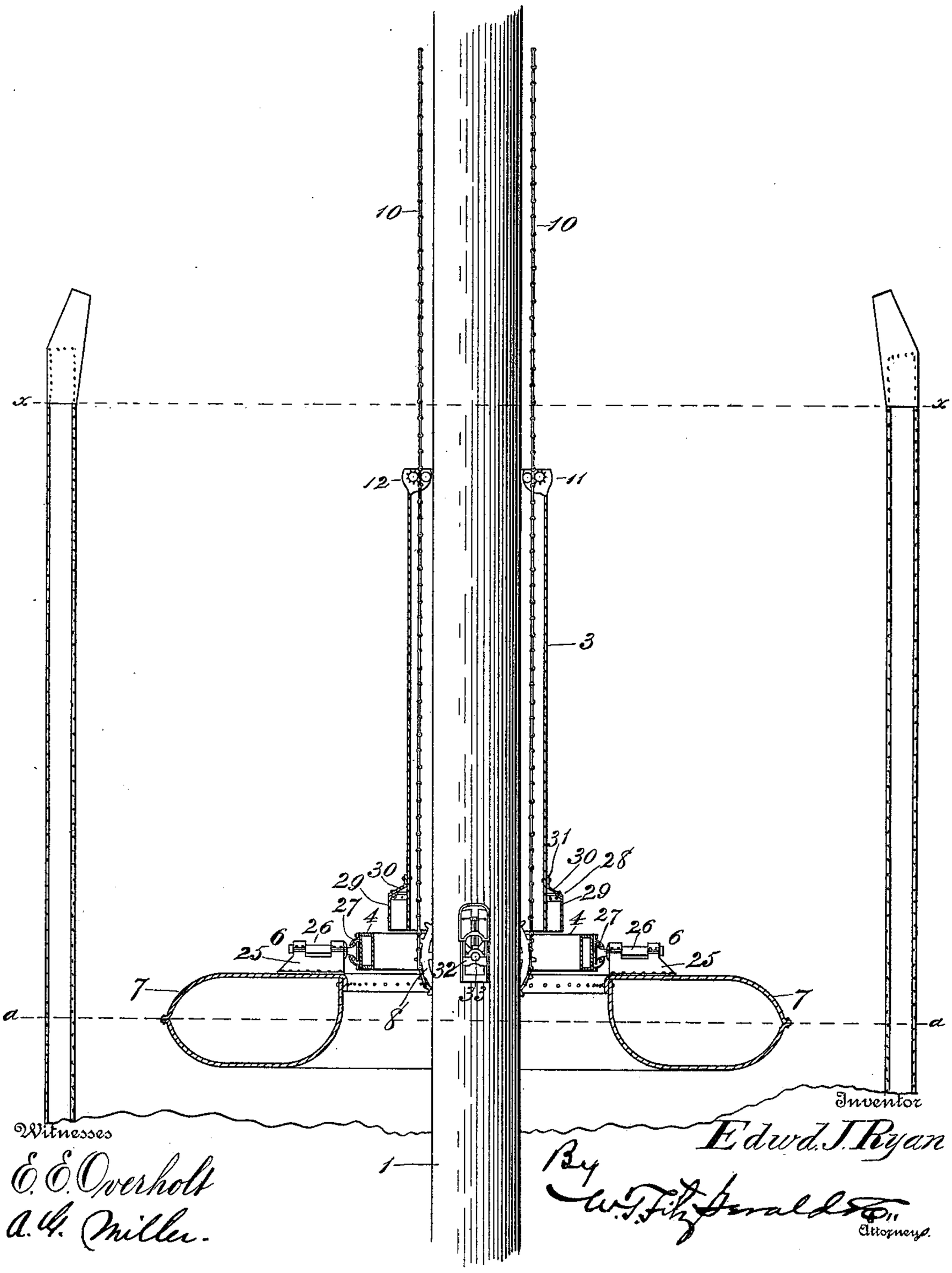
(No Model.) 8 Sheets—Sheet 4.

Fig. 4



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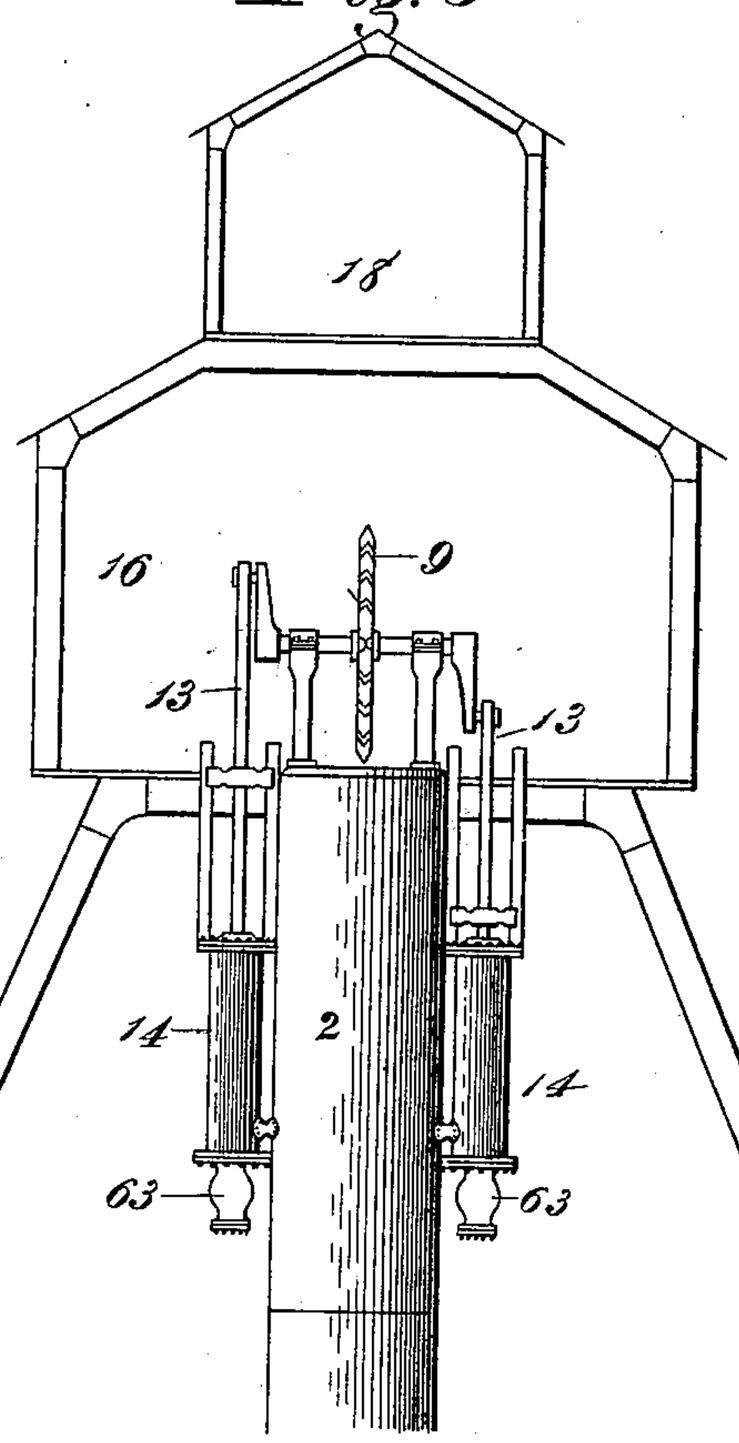
8 Sheets—Sheet 5.

Fig. 5



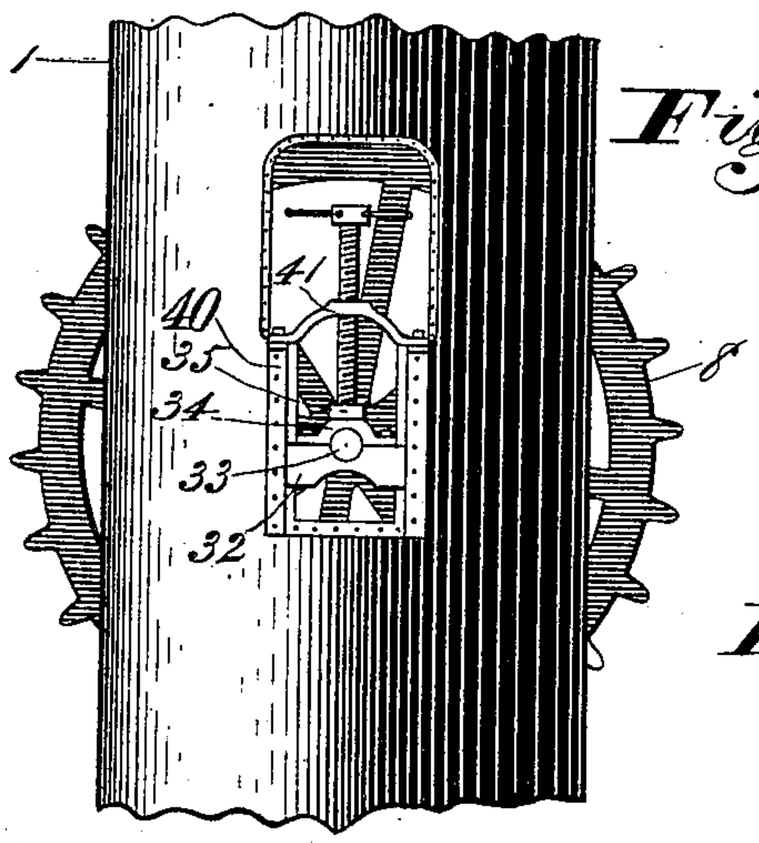


Fig. 6

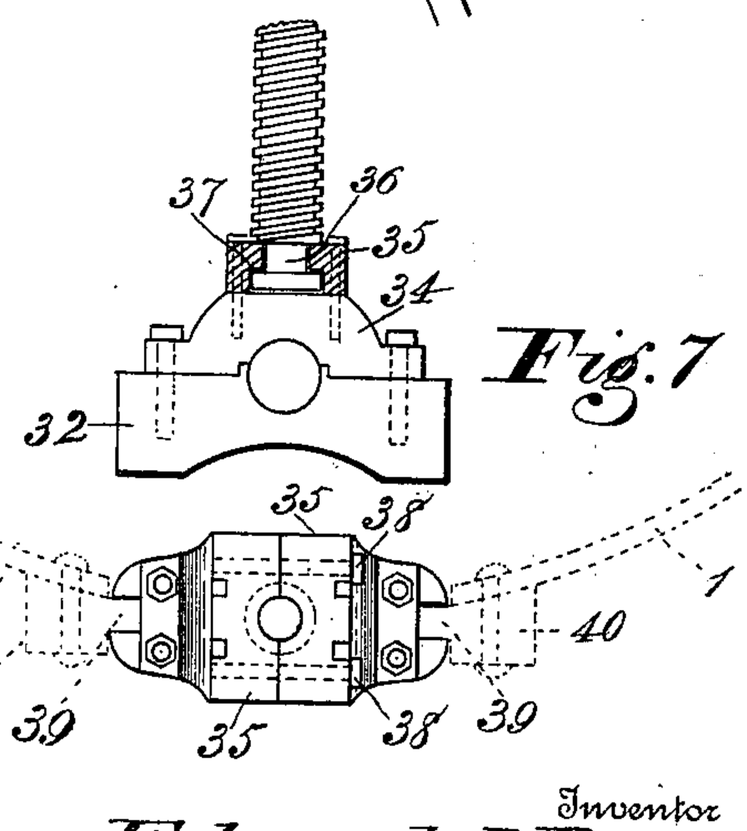


Fig. 7

Fig. 8

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(No Model.)

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Fig. 10

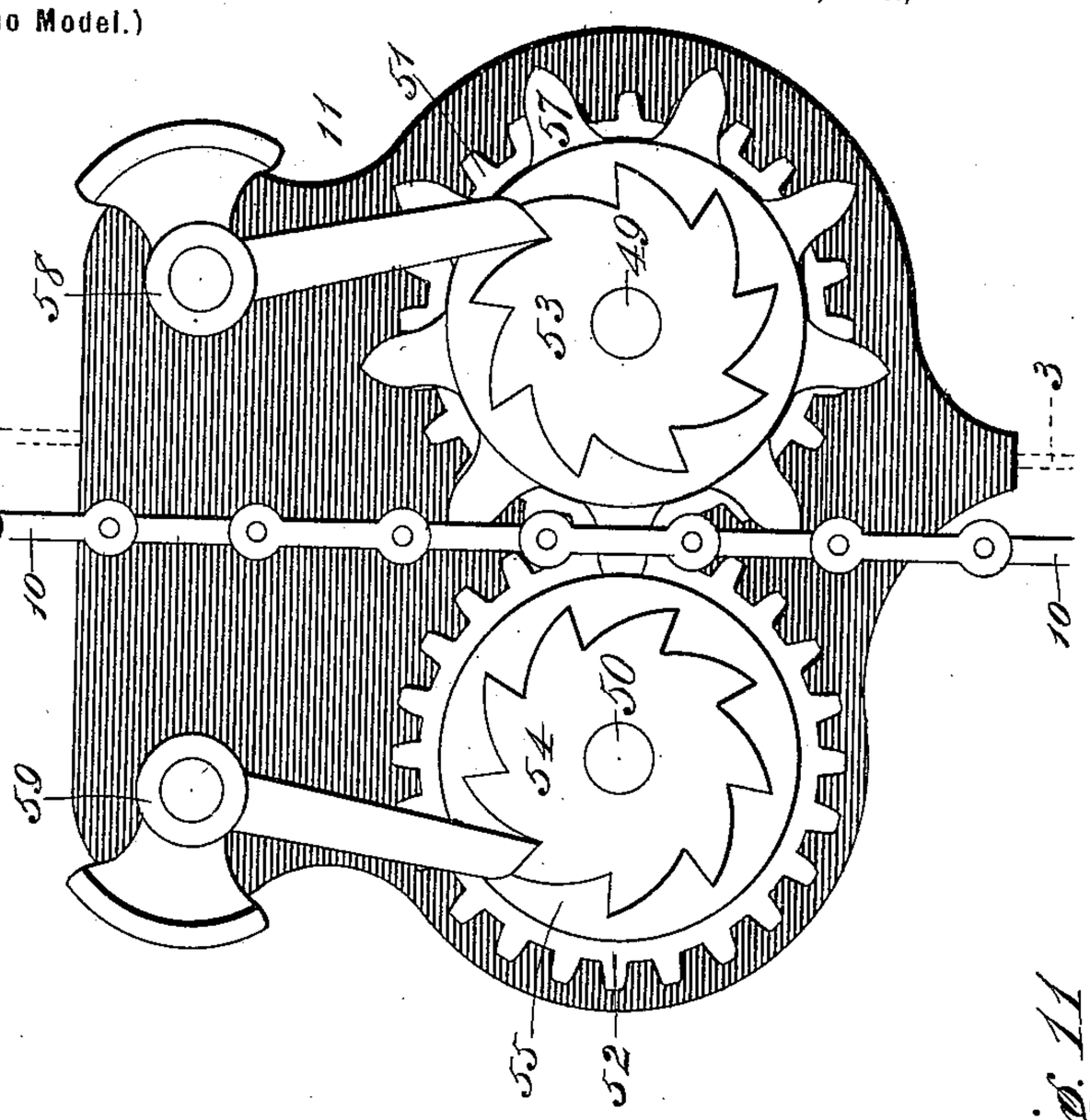


Fig. 11

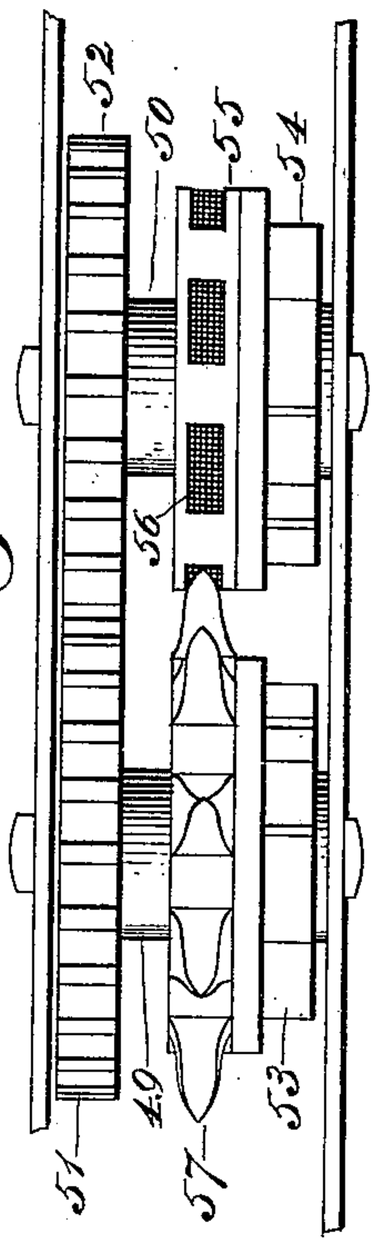
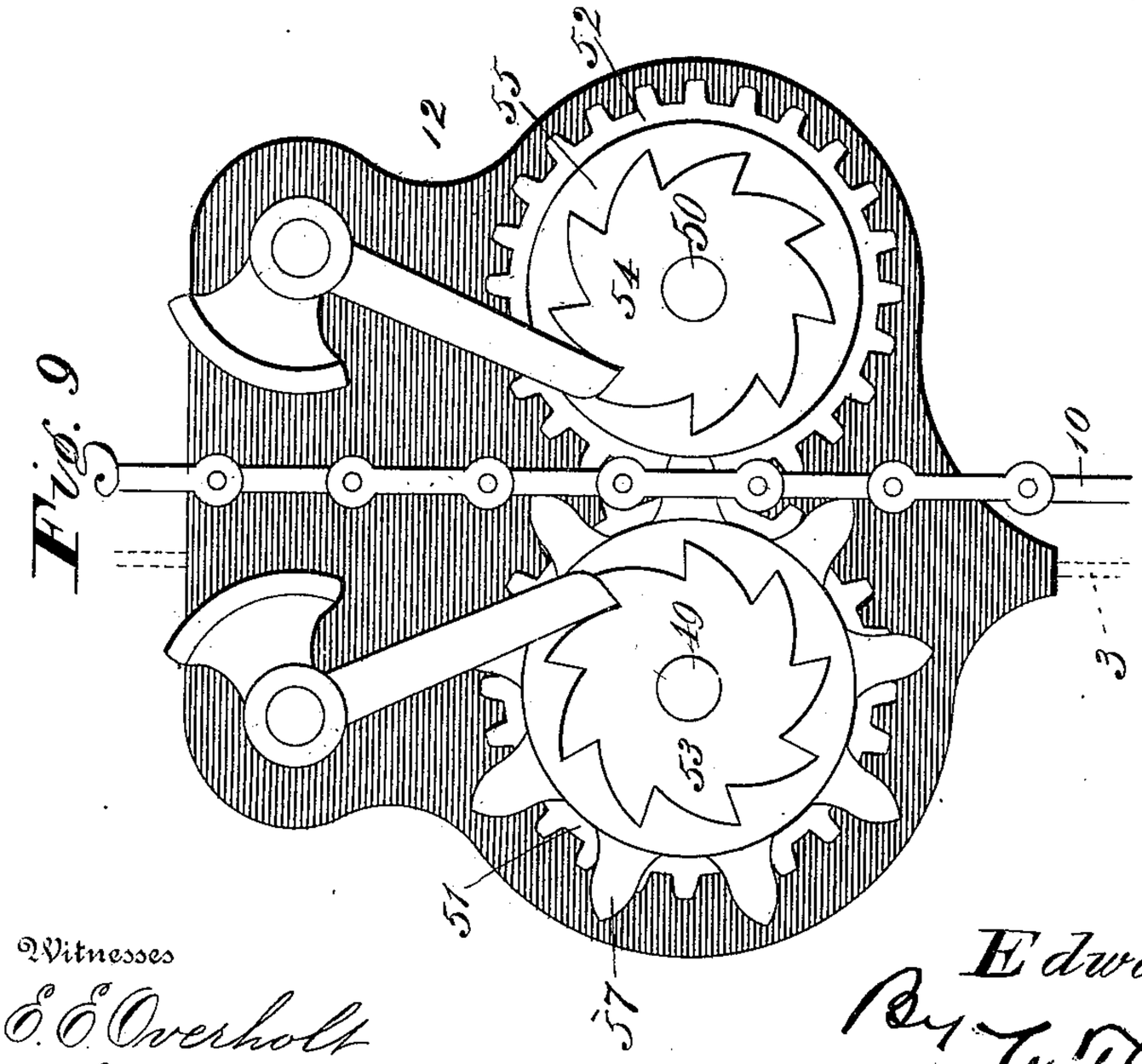


Fig. 9



Witnesses

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(No Model.) 8 Sheets—Sheet 7.

Fig. 15

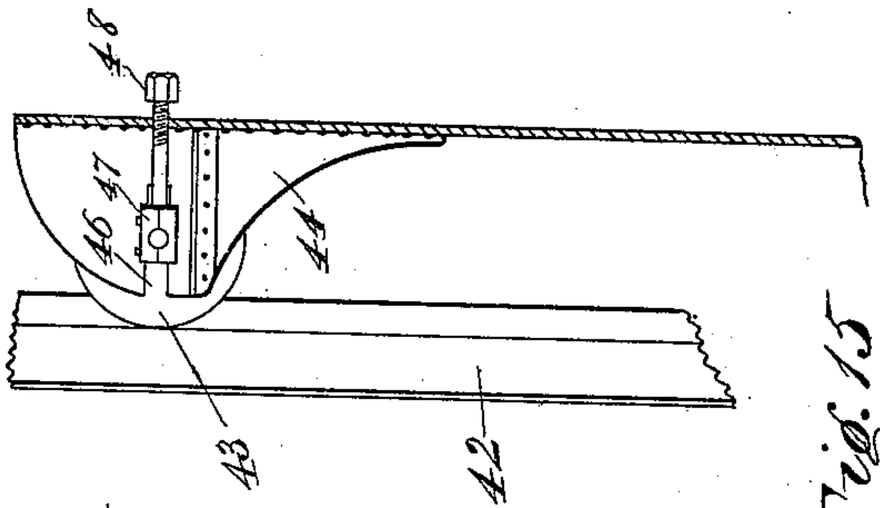

Fig. 16

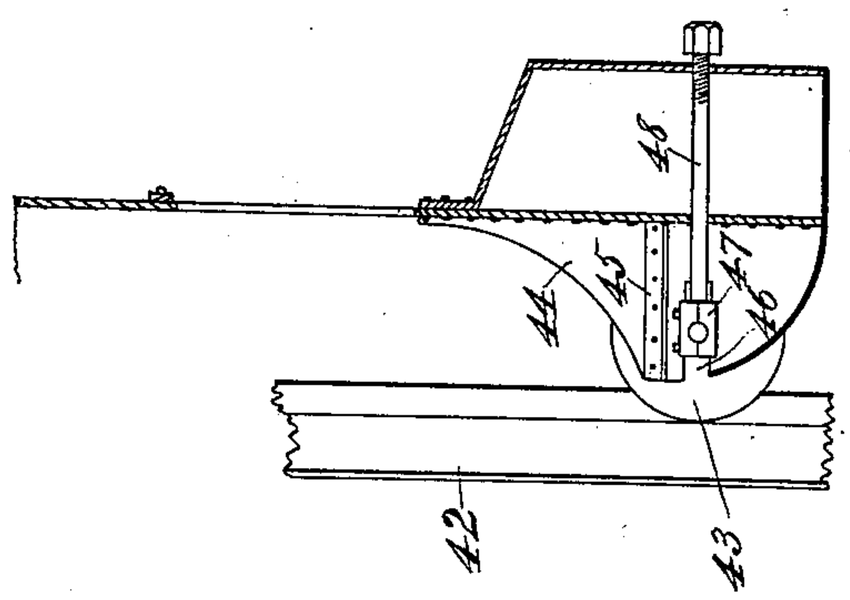

Fig. 14

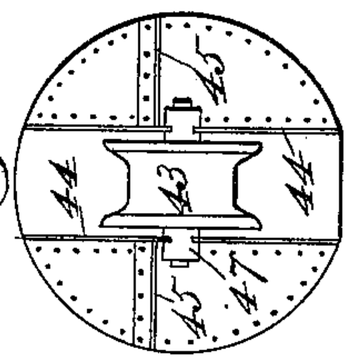

Fig. 12

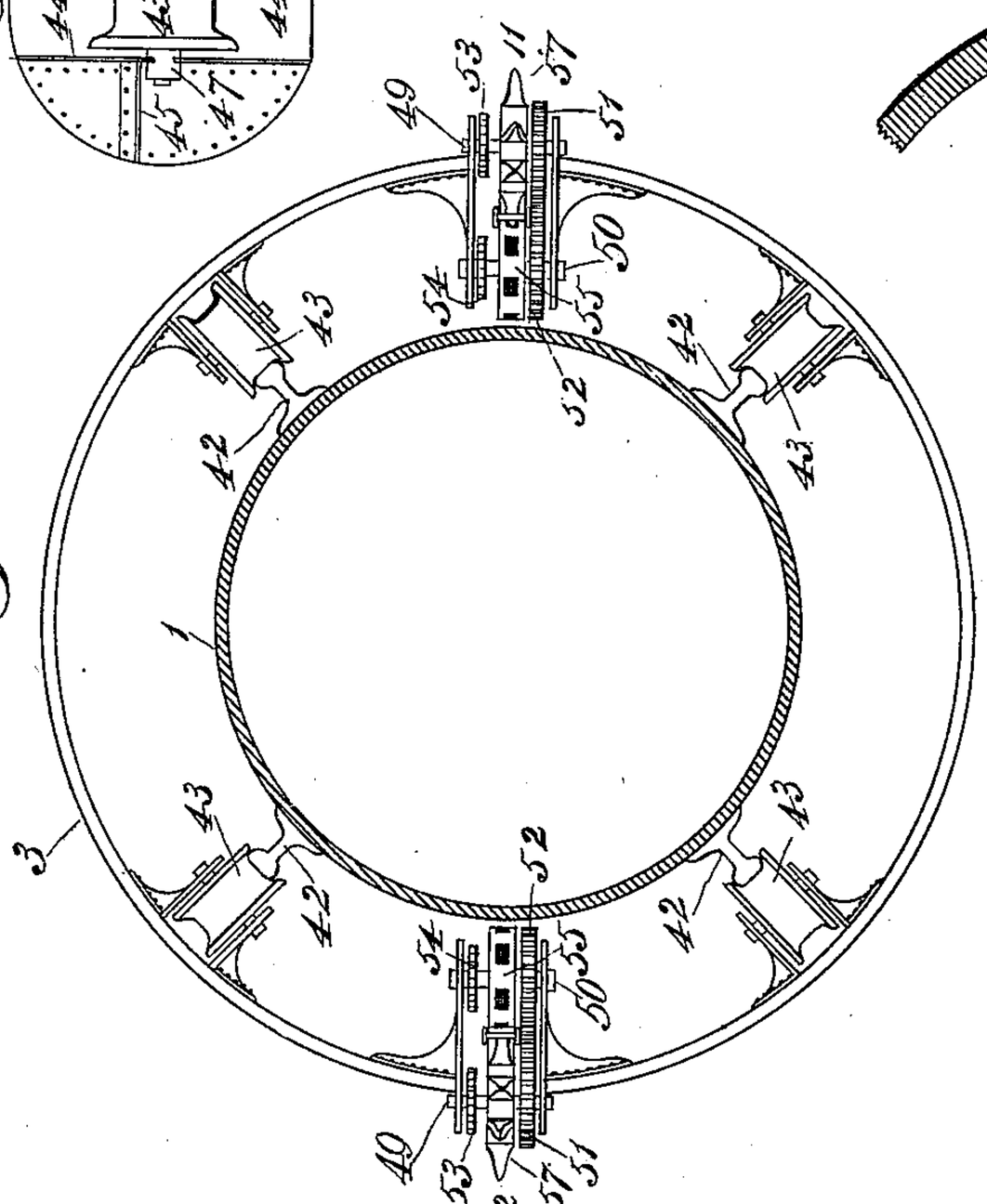

Fig. 17

Fig. 13

Fig. 18

Witnesses

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8 Sheets—Sheet 8.

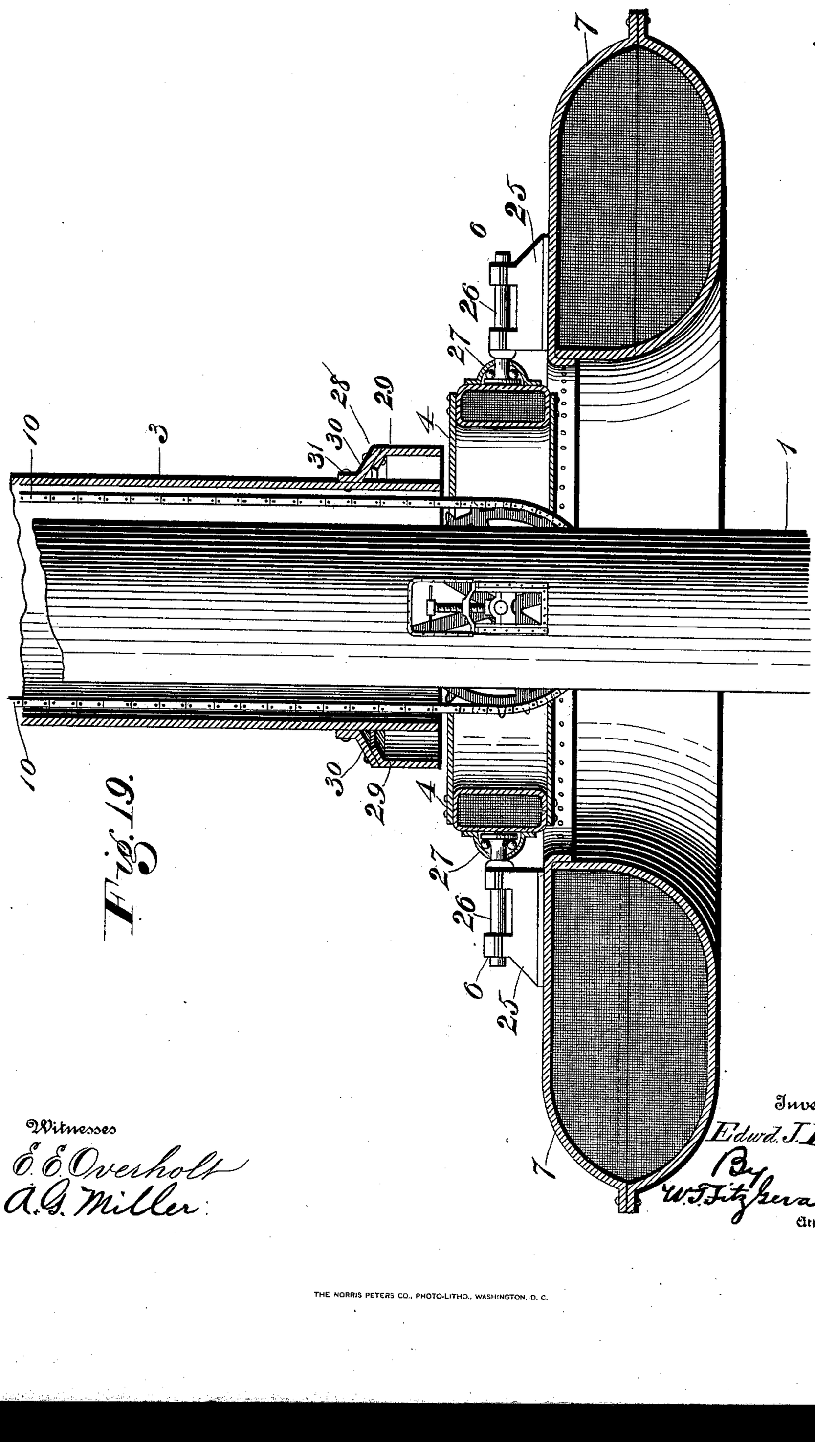

Fig. 19.

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UNITED STATES PATENT OFFICE.

EDWARD J. RYAN, OF MILLTOWN, MAINE, ASSIGNOR OF ONE-HALF TO HENRY FRANCIS BARRY, OF SAME PLACE, AND WILLIAM C. RENNE, OF CALAIS, MAINE.

WAVE-MOTOR.

SPECIFICATION forming part of Letters Patent No. 627,533, dated June 27, 1899.

Application filed March 19, 1898. Serial No. 674,464. (No model.)

To all whom it may concern:

Be it known that I, EDWARD J. RYAN, a citizen of the United States, residing at Milltown, in the county of Washington and State of Maine, have invented certain new and useful Improvements in Wave-Motors; and I do hereby 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.

My invention has relation to water-motors, and more especially that class of water-motors known as "tide-powers."

The object of my invention is to provide a mechanism which will utilize the rise and fall of the waves to operate machinery. In the present instance my preferred method of obtaining this result is to apply the force of said waves for the operation of air-pumps for the storing of a large quantity of compressed air in an air tank or reservoir. Said air is to be used for running compressed-air engines, which engines in their turn operate dynamos.

The advantages, operation, and construction of my invention will be described in the appended specification and pointed out in the claims, the accompanying drawings forming a part of this application, in which—

Figure 1 is a side elevation showing the part above water of my invention as it will appear when completed. Fig. 2 is a perspective view showing the float and the manner of attaching it to the truck-tube by means of universal joints. It also illustrates the construction of the lower part of the frame. Figs. 3 and 4 form a sectional view of Fig. 1, the former of the upper part and the latter of the lower part. The two figures may be considered one figure to be united on the line $x\,x$. Fig. 5 shows the relative position of the twin pumps and air-tank. Fig. 6 shows the lower sprocket-wheel as it appears in operative position with means for adjusting the axle of the same to give proper tension upon the sprocket-chain working thereon. Fig. 7 is a side elevation, partly in section, of the bearing of said axle, showing the manner of attaching the adjusting-screw thereto. Fig. 8 is a top plan view of said bearing with the adjusting-screw omitted. Figs. 9 and 10 are side elevations of the chain-gripping devices carried by the truck-tube, the front plates of said devices being removed that their internal mechanism may appear. Fig. 11 is a top plan view of Fig. 9 with the gravity-dogs and sprocket-chain omitted. Fig. 12 is a top plan view illustrating the relative location of the trucks, their tracks, and the chain-gripping devices when in operative positions. Fig. 13 is a sectional view of one of the trucks. Fig. 14 is a front elevation of one of the trucks in its mounting as seen from the inside of the tube. Fig. 15 is a side elevation of one each of the top and bottom trucks, illustrating the means for adjusting the same to the rails upon which they travel. Fig. 16 is a top plan view further illustrating the means for making said adjustment. Fig. 17 is a sectional view of one of the twin air-pumps employed. Fig. 18 is a top plan view of the lower valve-casing of said pump.

My motor is erected in the ocean a few miles off the coast, where there is always a roll or swell in the water. It is built upon a stone or concrete foundation at the bottom of the ocean and extends a suitable distance above the high-water mark. It is provided with suitable sills and braces and sufficient ballast to cause it to stand firm and secure in any storm. The methods employed for accomplishing this are such as are well known and commonly used by engineers doing this kind of work and for this reason are neither illustrated nor described.

To prevent confusion, the same numerals will be used to represent the same parts throughout the various figures of the drawings.

In materializing my invention numeral 1 designates the central stationary tube, which is securely anchored at the bottom of the ocean and extends upward to the dynamo-room near the top of the tower. In the top of this tower is located the air tank or reservoir 2.

The numeral 3 designates the outer tube, which will hereinafter be referred to as the "truck-tube." Said tube 3 encircles the central tube a short distance above the surface of the water. To the lower end of said tube is connected the hoop 4 by the journals and

bearings 5. On a line at right angles to that passing through the journals 5 are the journals and bearings 6, which connect said hoop with the float 7, which rests upon the surface of the water, Fig. 2. Said float is substantially a hollow ring, its shape being like that of a pneumatic life-preserver. Located within the central tube, just above the surface of the water, is the lower sprocket-wheel 8, and just above and over the top of said tube is the upper sprocket-wheel 9. These two wheels carry the endless sprocket-chain 10.

It will be observed that the combined operation of the journals and bearings 5 with the journals and bearings 6 constitutes gimbals or joints admitting of a universal movement, which permits the float 7 to receive a wave and gracefully ride it from whatever direction it may come.

The dotted line *a a* in Fig. 4 shows the water-line or surface of the water.

Located, preferably, in the upper end of the outer tube 3, on opposite sides of said tube, are the chain-grips 11 and 12, the former being adapted to grip the chain if said grip is carried upward and the latter of which likewise grips the chain when it (the grip) is moved downward. Said grips are further so constructed and related to each other that when the endless chain is gripped by either one and caused to rotate the movement of said chain will not be resisted by the other, as will be hereinafter more fully explained.

When the float 7 is lifted by a wave, (being connected with the truck-tube 3, as already explained,) said tube will also be lifted, and as it goes up it of course carries its gripping devices upward with it. The upward grip 11 upon this upward movement of the truck-tube grasps the right side of the chain and carries it upward, which causes the top sprocket-wheel 9 to rotate. When the wave has passed, the float falls downward again by gravity, and as it falls down the grip 12 in like manner grips the opposite side of the chain and draws it downward with it and causes said sprocket-wheel to further rotate in the same direction, so that said wheel is kept rotating so long as the motion of the waves causes the float 7 and the tube 3, connected therewith, to rise and fall.

On either end of the shaft of the sprocket-wheel 9 is mounted a crank, the two cranks being disposed at one hundred and eighty degrees to each other. Said cranks, by means of the connecting-rods 13, are adapted to operate the twin air-pumps 14, located on opposite sides of the air-tank 2, into which they pump air when they are in operation. This air is used to run compressed-air engines, which in their turn run dynamos, so that the force of the waves is ultimately converted into electricity. With the construction shown, Fig. 3, room 15 is deemed the most suitable place for locating the compressed-air engines. Room 16 likewise forms a suitable compartment for the location of dynamos, while room 17 may be used for living-compartments. From the dynamos in room 16, if desired, wires may run down the outside of air-tank 2 and enter through suitable apertures the inside of the central tube and run down said tube to the bottom of the ocean and thence to any point on land to which it may be desired to convey the electricity. Storage batteries may also be provided, so that in very calm weather there will be stored up power for use. Suitable stairways or ladders (not shown) are provided to form a passage-way from one room to another. Room 18 is intended for a light-house to be provided with brilliant electric lights from the dynamos within and on the top of said house is to be erected a powerful whistle to be operated when needed by air from the compressed-air tank. The lower compartments 19 are provided with the doors 20, which open to the promenade 21 on the outside of the tower just above the eave of the roof. The upper room 16 is likewise surrounded with a smaller promenade. Said promenades are thoroughly provided with suitable railing and supported by suitable brackets, as shown. Compartment 19 is provided with a large central opening, through which truck-tube 3 may freely pass when the sea runs high, said opening, however, being surrounded with the railing 22. Opposite the top of said railing is the door 23, which forms a means of access to the inside of central tube 1. From said door a ladder may, it is obvious, extend down the inside of said tube to near the surface of the water. When it is desired to reach the lower sprocket-wheel for adjusting or oiling, this ladder (not shown) is used as a means of descent. On the outside of truck-tube 3 a ladder likewise extends from the top nearly to the bottom. This ladder is reached by means of a suitable ladder (not shown) let down from railing 22. Hereby a means is provided for reaching the joints 5 and 6 when it is desired to oil or repair them and also the lower trucks, which are located immediately beneath the manholes 23. A suitable rail surrounds the tube a few feet from its bottom as a means of safety for the operator. The air-tank is provided with a pressure-gage and a safety-valve. (Not shown.) I further provide a safety-governor constructed on the principle of the ordinary steam-engine governor, which operates to open a valve in a pipe connected with the air-tank and release a certain quantity of air when the pumps are acting with too great rapidity on account of a high sea.

The different floors are of course provided with suitable openings for the free passage of the endless chain, and the lower floor being of greater diameter than any of the others and having a large opening in its central part for the passage of the truck-tube, which prevents it from being supported by the central tube, is supplied with necessary support

by means of the floor-hangers 24, which consist of iron or steel rods of suitable size, which rods depend from the floor above.

It will of course be understood that I will employ any desired material in the construction of the various parts of my invention; but it is thought that for the piles, braces, and tubes, and, in fact, nearly all the parts of my invention, steel will be the most suitable material to use, as it combines the maximum of strength with the greatest lightness and durability. Steel bolts will be very largely used in uniting the various parts together. This is especially true of the parts under water. As will be seen from Figs. 1 and 2, that part of my water-tower between the eave of the roof and the water is surrounded by a netting made of very strong wire or small rods. This netting extends downward a few feet below the low-water mark, so that no driftwood or other foreign substance that may be afloat upon the water shall get entangled or come in contact with the operating mechanism of my water-motor. It will be found most expedient to have this netting made in frames constructed of thin strips of metal and of such shape and size as to fit snugly between the piles and braces, so that said frame may be secured to the outer flanges of said piles and braces by means of bolts. This, however, is simply mentioned as a matter of expediency, as I reserve the right to employ any method I may choose in connecting the wire-netting to my water-tower.

Having now described the general construction and operation of my invention, I will proceed to more particularly describe certain details of the various parts.

The two shaft-bearings 25 are rigidly attached to the top of the float 7 at opposite sides thereof. Said bearings carry the journals 26, the inner ends of which are conical in shape and work within the ball-bearing case 27, said case being rigidly attached to the hoop 4. Each of said ball-bearing cases 27 is provided with ball-bearings, as shown in Fig. 4, which reduces the friction to a minimum at this point. The other pair of journals connecting the hoop with the truck-tube is also provided with ball-bearings. The hoop 4 may be made either solid or hollow, as the needs of the case may require; but it is thought that ordinarily it will best serve the purposes for which it is intended when made hollow and of material similar to that used in the float.

It will be observed that the lower part of the truck-tube is provided with the base 28, which consists of the vertical sides 29, somewhat larger in diameter than that of the truck-tube, the inwardly-inclined face 30, and the flange 31, which snugly receives the outside diameter of the truck-tube and is securely riveted thereto. The upper pair of journals connecting the truck-tube with the hoop is attached to this base.

Figs. 6, 7, and 8 clearly illustrate the means employed to adjust the lower sprocket-wheel to the sprocket-chain. The numeral 32 designates the bearing of the journal 33 of said wheel. The cap 34 of said bearing is secured in proper position by bolts, and to the top of this cap is further secured by bolts the block 35, said block being made in two parts, as illustrated in Fig. 8. This block has a central bore of sufficient diameter to receive the neck 36 of the adjusting-screw, the lower part of said bore being made of still larger diameter, having the offset 37, said larger diameter being adapted to receive the head or swell provided on the extreme lower end of the adjusting-screw. Since said cap is made in two sections, the two sections thereof are placed in their proper position around the collar 36 of the adjusting-screw and are then bolted together by the bolts 38, as clearly illustrated in Fig. 8. As will be further seen from Figs. 6 and 8, the bearing 32 is provided at its ends with the grooves 39, which receive the tongues of the blocks 40, as shown by dotted lines in Fig. 8, and said blocks are properly riveted to the tube at the edge of the opening therein, as shown in Fig. 6, where said bearings are located. The arched cross-bar 41, which rests upon the upper end of said blocks 40, is provided at its center with a threaded aperture, which receives the adjusting-screw, and it is clearly apparent from Fig. 6 that said adjusting-screw, being attached to the bearing of journal 3, as already explained, will when turned in one direction raise said bearing and when turned in the opposite direction lower the same. The adjusting-screws are two in number, one on each side of the central tube to accommodate the two ends of the sprocket-shaft.

Fig. 12 illustrates my preferred means for reducing the friction in the upward-and-downward movement of truck-tube 3 upon the central stationary tube. That part of the central tube which is traversed by the truck-tube 3 is provided on its outer circumference with a suitable number of vertical rails 42, rigidly attached thereto. The tube 3 is provided on its inner side with a series of trucks 43, located a sufficient distance from each other along the entire length of said outer tube, said trucks being provided with flanges and adapted to coöperate with said rails, so that when said tube is moved up and down by the force of the waves the friction caused by the horizontal travel of said waves is greatly reduced. It is believed that for practical purposes one set of trucks at the bottom and another at the top of said tube 3 will be sufficient for all ordinary requirements. I prefer to face the trucks with compressed fiber or other suitable material in order that their motion upon the rails may be as noiseless as possible. Fig. 13 illustrates the groove which I provide between the flanges of said trucks for the purpose of receiving this facing. Figs. 15 and 16 illustrate a means which may be employed for adjusting said trucks

to their respective tracks. Fig. 15 shows a side elevation of one of the top and bottom trucks with this adjusting mechanism, while Fig. 16 shows a top plan view of the upper truck provided with this means of adjustment. The vertical braces 44 are securely riveted to the inner side of the truck-tube and are further secured in this position by the horizontal braces 45, said braces 44 being provided with the horizontal slots 46. Within said slots are located the bearing-blocks 47, in which are mounted the journals or axles of the trucks. Said bearing-blocks are made in two sections, as illustrated in Fig. 15, said sections being securely held together when in their operative position by bolts. The outer ends of said blocks are provided with recesses similar to those in blocks 35 of the adjusting arrangement for the lower sprocket-wheel. (See Fig. 7.) This recess receives the inner end of the adjusting-bolt 48, which is provided with a swell or head similar to that of the adjusting arrangement of the sprocket-wheel just referred to. It will be clearly seen that by the proper rotation of said bolts 48 the desired adjustment may be readily obtained. As will be seen from Fig. 16, each truck is provided with two of these adjusting-screws, one for each end of its journal.

My chain-gripping devices, preferably located in the top of truck-tube 3, on opposite sides thereof, being rigidly secured thereto, as illustrated in Fig. 12, are two in number. The upward grip is illustrated in Fig. 10 and the downward grip in Figs. 9 and 11. The two grips are exactly alike in construction and principle, with this one difference: that in the one the ratchets and gravity dogs or pawls are so located with reference to each other that when the grip moves upward it carries the sprocket-chain with it, while the other grip carries the chain with it when it moves downward. Each of the grips is provided with the sprocket-shaft 49 and the roller-shaft 50. Each of said shafts is further provided with cog-wheels 51 and 52, rigidly attached thereto, which are of equal size and mesh with each other, causing said sprocket-wheel and roller to always move uniformly together, and in case one of the dogs or ratchets should be broken the other dog will through the mediation of the cog-wheels still cause the grip to reliably perform its work. Said shafts 49 and 50 are further provided with the ratchets 53 and 54, which are also rigidly secured to said shafts. The rollers 55 are each provided with the apertures 56, adapted to receive the ends of the cogs of the sprocket-wheels 57, so that said sprocket-wheels may be located sufficiently close to their respective rollers to only allow the sprocket-chain to pass conveniently between them. By this means it will be impossible for the sprocket-chain to slip over the end of the cog with which it may happen to be in engagement at any time when a sudden jerk or strain is imposed upon it.

In the case of the upward grip, Fig. 10, it will be observed that the ratchet-wheels and their gravity-dogs 58 and 59, coöperating therewith, are so arranged with respect to each other that when the tube 3 moves upward, carrying said grip with it, the tendency of the sprocket-wheel to revolve and run up the chain is prevented by said dogs, and the chain is consequently carried up with the grip, which, as previously specified, imparts rotation to the upper sprocket-wheel, which is connected with the air-pumps. It will be clearly seen from Fig. 9, without further explanation, that when the truck-tube descends, carrying with it its grip, downward grip 12 will grasp the chain and carry said chain downward with it, thus imparting further rotation to said sprocket-wheel just referred to. Furthermore, it is manifest that when one side of the endless chain is carried upward a certain distance the other side will be drawn downward an equal distance, and it will be seen from Figs. 9 and 10 that when the upward grip grasps the chain and carries one side of it up there is nothing to prevent the sprocket-wheel of the downward grip from freely revolving in a direction which permits this necessary movement of that side of the chain. It is likewise manifest that when the down-grip carries its side of the chain with it there is nothing in the construction of the other grip to prevent its sprocket-wheel from freely revolving and allowing its side of the chain to move upward the required distance. When it is desired to stop the pumps, all that is necessary is to disengage the gravity-dogs from their respective ratchets and turn each one of them over. The upper or weighted ends of said dogs, which when in the position illustrated in Figs. 9 and 10 tend to hold them in engagement with their ratchets, will then hold them in a disengaged position, and hence the upward and downward movement of the truck-tube 3 will impart no rotation to the endless chain.

Fig. 17 shows the construction of one of my air-pumps. It consists of the cylinder 60, provided with the ordinary piston 61 and piston-rod 62. To the lower end of said cylinder is rigidly attached the valve-casing 63, in which is located the ball-valve 64. The lower end of said casing 63 is provided with the cap 65, having a central aperture 66, at the upper end of which is located the valve-seat 67. It will be observed that when the piston 61 moves upward its tendency will be to produce a vacuum in the lower end of cylinder 60. This tendency causes the air to pass in through opening 66, lifting the valve 64, and on up through opening 68 in the top of said valve-casing into the cylinder. When the piston 61 begins to descend, ball-valve 64 prevents the air from escaping at the point it entered and forces ball-valve 69, located in the exit-port 70 of the pump, from its seat and passes through the apertures 71 into the air-tank 2, the edge of which is shown by dotted lines, with which said pump is properly connected

by bolts 72, as shown. The valve 69 in the exit-port is normally held to its seat by the spring 73 and operates, as already shown, to freely permit the passage of air from the pump into the air-tank and prevents the air when once in the tank from escaping at that point. The block or cap 74 affords a means of access to the valve 69 and the spring 73.

It will be observed from Fig. 5 that the cranks which operate my pumps are so disposed with reference to each other that while one pump is forcing air into the air-tank the other is simply receiving air from outside. This will permit the pumps to work when there is only slight disturbance of the water. If, however, my tower is located in a place where there is always an abundance of power readily obtainable from the waves, I will make my pumps double-acting, placing a receiving and an exit port at the upper end of the cylinder as well as at the lower end, in which case one pump will be made to do double the work that it now performs.

Having thus fully described the principles involved in my invention and having illustrated means by which said principles may be applied to actual use, I yet do not wish to limit myself to the exact showing made, but desire protection on all that comes clearly within the spirit and scope of my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In water-power machines, a central tube, a truck-tube surrounding the same, an encircling hoop, a float resting on the water and journaled to said hoop, the latter being journaled to the truck-tube, and devices connected to the latter for the conveyance of power, all arranged as set forth.

2. In water-power machines, a stationary central tube, a movable truck-tube surrounding the same, a concentric hoop journaled to said truck-tube, and a float journaled to said hoop at right angles to the truck-tube, whereby said truck-tube will always move vertically, all arranged as set forth.

3. In water-power machines, a stationary central tube having rails upon its outer surface, an encircling truck-tube provided with friction-rollers coöperating with said rails, a float pivotally connected to said truck-tube, an endless sprocket-chain carried by said fixed tube and extending from the upper to the lower end thereof and suitable clutch mechanism carried by said truck-tube for cooperating with said chain to the end that the same will be moved as the float rises and falls, all arranged as set forth.

4. In water-power machines, a stationary center tube having vertical rails, an encircling truck-tube provided with friction-rollers coöperating with said rails and means to adjust said rollers, a float and means to convey power attached to said truck, all combined as set forth.

5. In water-power machines, a center tube provided with rails, an encircling truck-tube provided with plates carrying an adjustable journal having friction-rollers coöperating with said rails, said contacting parts of the rollers being covered with an elastic material to deaden the sound and a float for operating the truck-tube, as set forth.

6. In water-power machines, a center tube provided with guides, journal-bearings adjustable on the guides and encircling a journal carrying a sprocket-wheel, means to adjust said bearings, a concentric truck-tube carrying pawl-and-ratchet mechanism and a sprocket-chain connected to the sprocket-wheel, said pawl-and-ratchet mechanism cooperating with said chain, and a float connected to the truck-tube whereby the sprocket-chain will be gripped by the pawl mechanism and operated thereby, all combined as set forth.

7. In water-power machines, a truck-tube, a float connected therewith, pawl-and-ratchet mechanism having a sprocket-wheel and a wheel having peripheral recesses coöperating with said sprocket-wheel to grip a sprocket-chain passing between said wheels, all combined as set forth.

8. In water-power machines, the combination of a float, a fixed vertical tube, a movable truck-tube interposed between and cooperating with said tube and float, a sprocket-chain mounted on said vertical tube, and gripping devices carried by said truck-tube whereby the chain will be alternately grasped upon one side of the tube during the upward movement of the float and upon the opposite side during the downward movement thereof, substantially as specified and for the purpose set forth.

9. In water-power devices, a vertical tube connected to a float and operated thereby, said tube carrying pawl-and-ratchet mechanism provided with gripping-wheels located on opposite sides of the tube, the pawls of one set coöperating with the outer periphery of the ratchets and the pawls of the other set coöperating with the inner periphery of its ratchets, a sprocket-chain passing between said gripping-wheels, whereby said chain will be alternately elevated and depressed, all combined as set forth.

10. In water-power machines, a truck-tube, a float connected therewith by ball-bearing joints, an outer tube having gripping mechanism located on its top, a center tube carrying an adjustable sprocket-wheel provided with a sprocket-chain passing through said grip mechanism and extending around an upper sprocket-wheel operating an air-compressing pump, all arranged as set forth.

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

EDWARD J. RYAN.

Witnesses:

SAMUEL O. TURNER,

JOHN JOHNSTON.