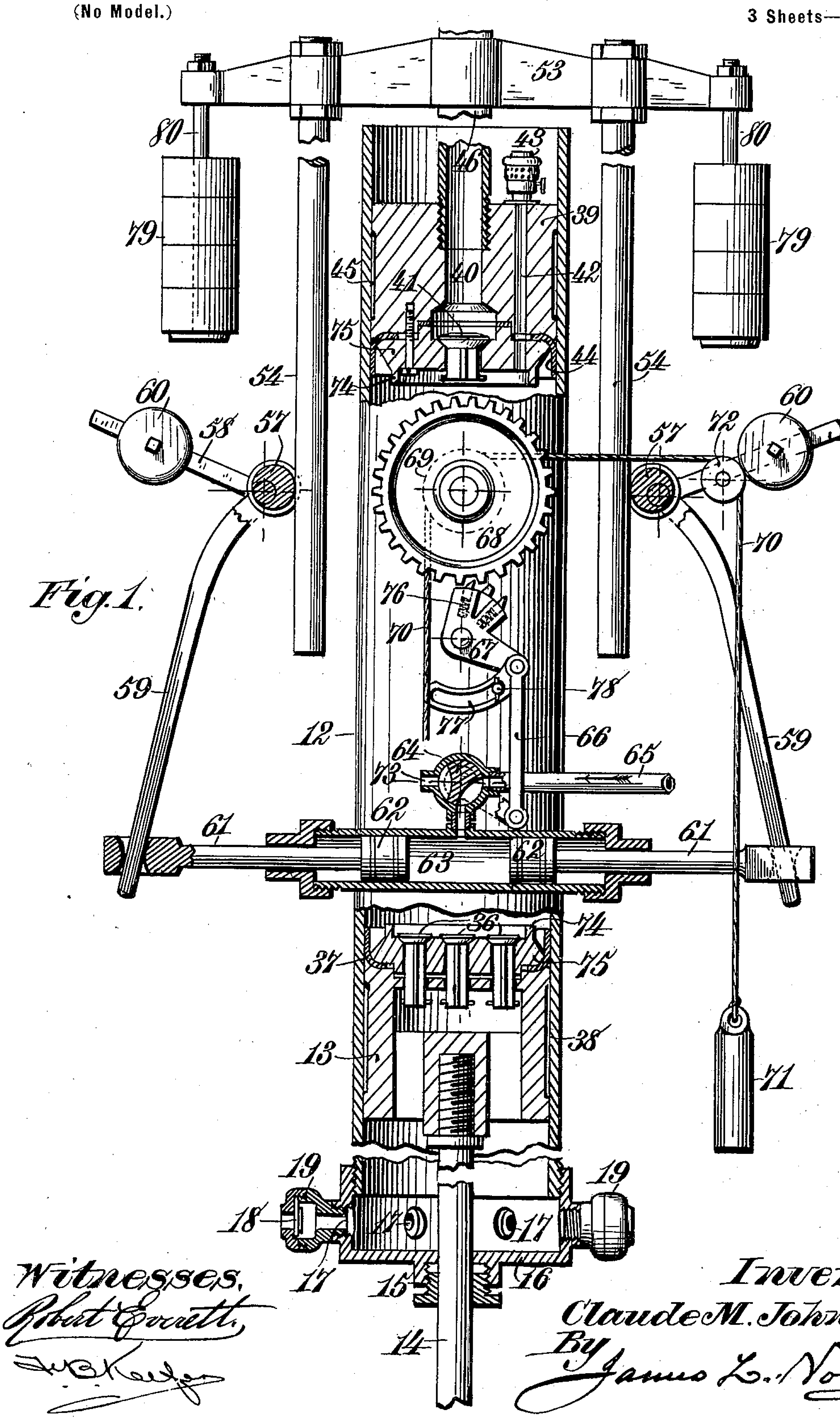
No. 639,735. Patented Dec. 26, 1899.

C. M. JOHNSON.

TIDE POWER AIR COMPRESSOR.

(Application filed Nov. 19, 1898. Renewed Sept. 30, 1899.)

(No Model.) 3 Sheets—Sheet 1.



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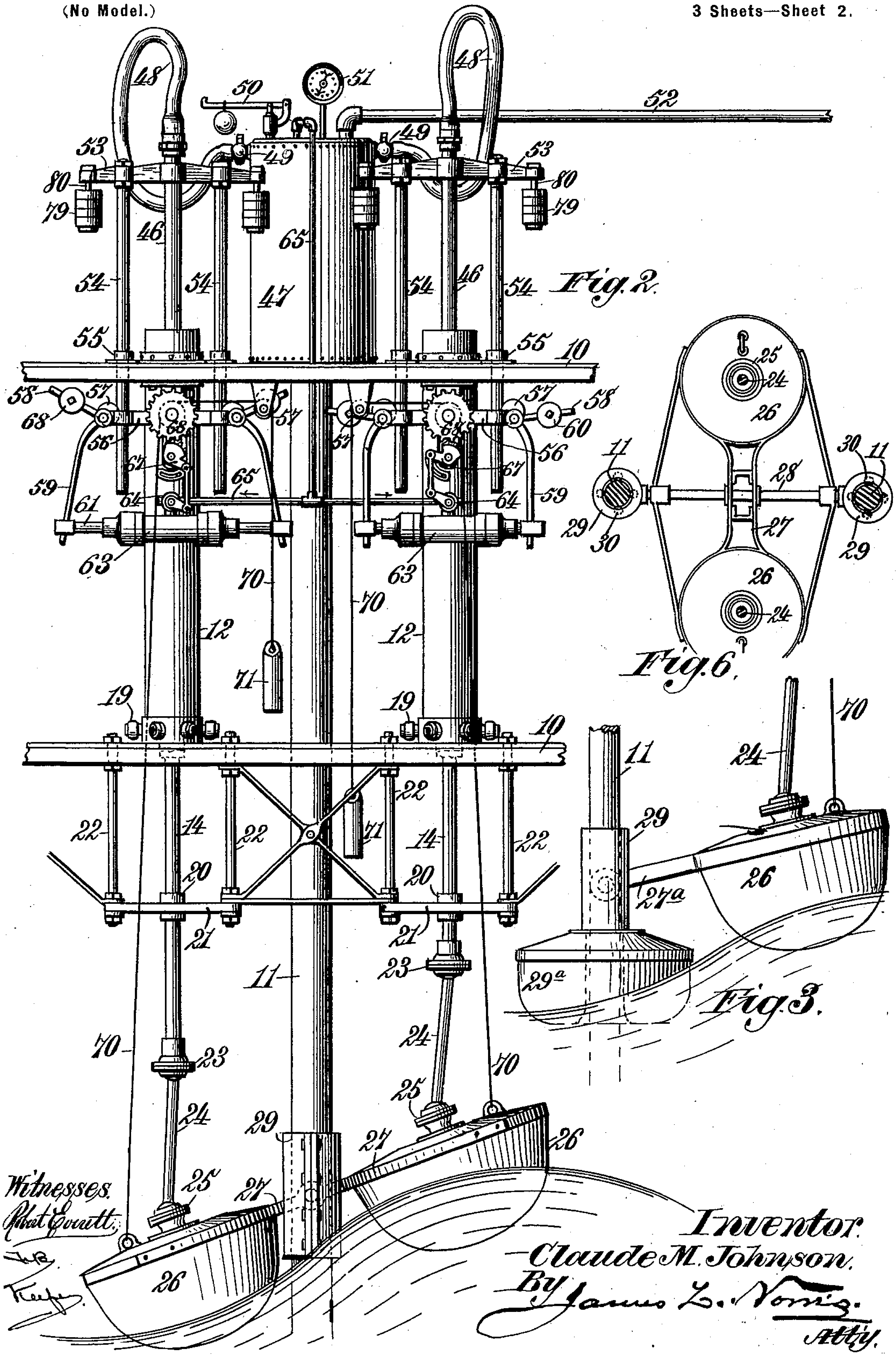

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Fig. 4.

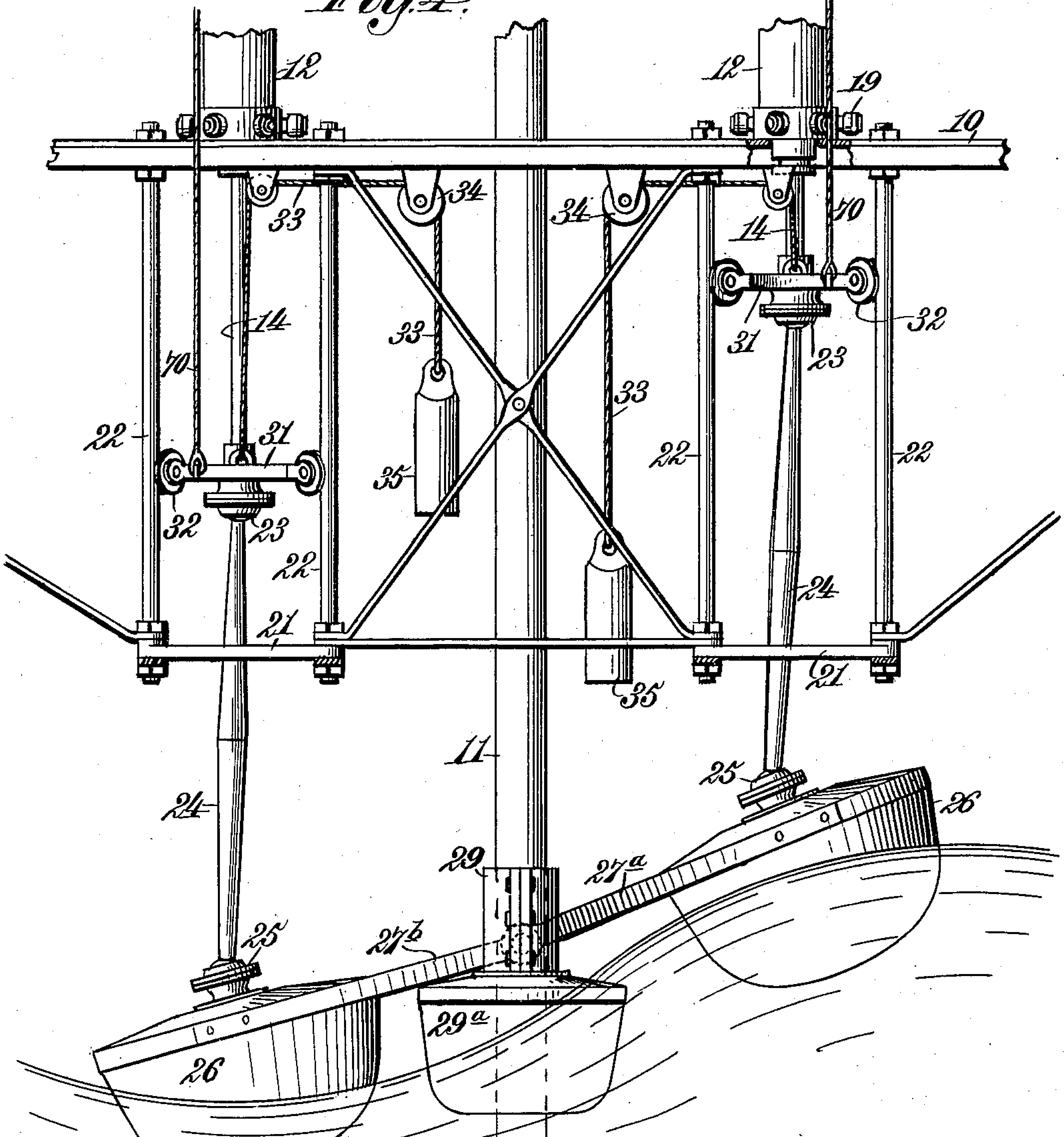
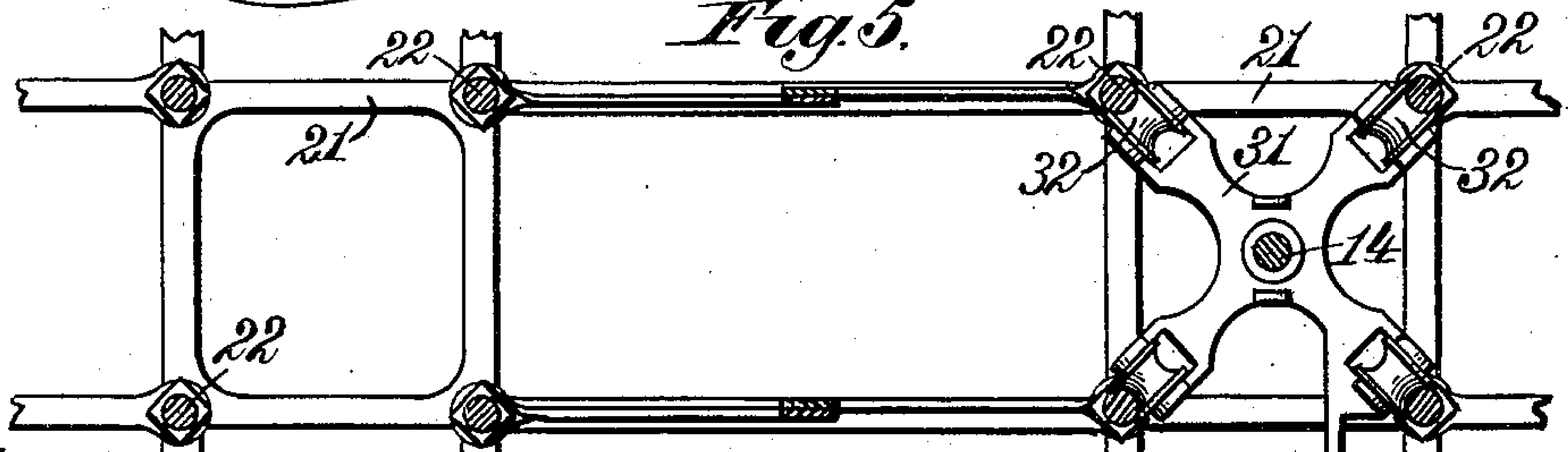


Fig. 5.



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UNITED STATES PATENT OFFICE.

CLAUDE M. JOHNSON, OF LEXINGTON, KENTUCKY.

TIDE-POWER AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 639,735, dated December 26, 1899.

Application filed November 19, 1898. Renewed September 30, 1899. Serial No. 732,239. (No model.)

To all whom it may concern:

Be it known that I, CLAUDE M. JOHNSON, a citizen of the United States, residing at Lexington, in the county of Fayette and State of Kentucky, have invented new and useful Improvements in Wave or Tide Power Air-Compressors, of which the following is a specification.

This invention relates to a wave or tide power air-compressor, and has for its object to furnish a simple, efficient, and economical air-compressing apparatus, in which the motive power may be supplied by one or more floats or buoyant bodies arranged to oscillate or rise and fall with the undulatory movements or pulsations of the tide and waves in such manner as to operate a pump or pumps for compressing and storing air to be subsequently utilized in driving other motors or pumps or other machinery and for various purposes in the arts.

My invention consists in an air-compressing apparatus comprising a cylinder, a lower piston, an upper gravity-piston coacting with the lower piston to compress the air admitted to the pump-cylinder, and a brake to hold the gravity-piston elevated during descent of the lower piston, and to release the gravity-piston on ascent of the lower piston.

The invention also consists in the combination, with a receiver for compressed air and a motor—such as a buoy or float, free to rise and fall with the tide and actuated by the waves—of an air-compressing pump (one or more) that comprises a lower piston connected with the float or buoyant motor, an upper gravity-piston coacting with the lower piston to compress the air admitted to the pump-cylinder and deliver it to the receiver, and a brake controlled from the motor to arrest descent of the gravity-piston, so as to hold it elevated during descent of the lower piston, and release it on ascent of said lower piston.

My invention further consists in features of construction and novel combinations of parts in an air-compressing wave-power, as hereinafter described and claimed.

In the annexed drawings, illustrating the invention, Figure 1 is a partly-sectional elevation of my improved air-compressing pump with its lower piston, upper gravity-piston, and air-brake mechanism for controlling descent of the gravity-piston. Fig. 2 is an elevation of the air-compressor as arranged for operation by wave-power at any stage of tide. Fig. 3 shows a modification in the form of the float mechanism as adapted for operating a single air-compressor pump. Fig. 4 is a detail elevation showing a counterbalanced guide-carriage connected with the float-operated piston-rod. Fig. 5 is a horizontal section of guide-frame, showing the guide-carriage of one piston-rod in plan view. Fig. 6 is a horizontal section above the floats of a wave-power air-compressor.

In the installation of a tidal or wave power air-compressing plant, such as contemplated by my invention, there may be erected at a suitable elevation above the water a scaffold, framework, or staging 10, that may constitute part of a pier or wharf. This scaffold or staging 10 should be located at a convenient point for utilizing the motion of the waves and tide as a source of power, and it comprises securely-placed posts or piles 11, that are disposed at suitable intervals. The pier, staging, or scaffold 10 should be constructed to afford adequate support for a number of stationary vertically-arranged air-pump cylinders 12, each of which has a length sufficient to accommodate the required movements of the pump-pistons, hereinafter described, and permit an automatic vertical adjustment of the same within each cylinder according to variations of the tide in its different stages.

In each pump-cylinder 12 the lower piston 13, Fig. 1, may have a rigidly-attached piston-rod 14, extended downward through a stuffing-box 15 on a removable cap or head 16, with which the lower end of the pump-cylinder may be provided. When a lower cylinder head or cap 16 is employed, it may be formed with a series of air-inlet ports 17, having flap-valves 18, Fig. 1, arranged to permit the entrance of air to the lower end of the cylinder on ascent of the piston 13 and adapted to prevent its exit through said inlet-ports 17 when the piston falls. The flap-valves 18 are conveniently mounted in casings 19, that are preferably removable or constructed to afford access to said valves when desired. If preferred, the valved cap or head 16 may be dispensed with and the lower end of the cylinder 12 be left wholly open to the atmosphere.

For each rigidly-attached piston-rod 14 there may be provided a guide-sleeve 20, Fig. 2, supported in a frame 21, secured to vertical rods 22, depending from the staging or scaffold on which the pump-cylinders 12 are erected. The stuffing-box 15, Fig. 1, also affords a guide for the rigidly-attached piston-rod. Each piston-rod 14 may have its lower end connected by a ball-and-socket joint 23, Fig. 2, with a pitman 24, which may connect by a similar universal joint 25 with a float or buoy 26 of any suitable construction that shall be adapted for the utilization of tide and wave power in the effective and economical operation of the air-compressor pump.

The air-compressor pumps are preferably arranged in pairs, with a float or buoy 26 beneath each pump. Each pair of floats or buoys may be mounted in or secured to a single oscillatory frame 27, having a horizontal axle 28, Fig. 6, that is free to rock in suitable bearings provided on vertically-movable sleeves 29, surrounding two adjacent piles or posts 11, the said sleeves being fitted with roller-bearings or ball-bearings 30, so as to be capable of sliding freely up and down with the rise and fall of the tide. Thus the floats 26 will ride on the waves during all variations of tide movement. By connecting the pistons 13 of two adjacent pumps with floats 26, that are mounted in a single oscillatory frame 27, as in Fig. 2, these pistons will rise and fall in precise alternation with each other, so that compression of air will occur in one pump-cylinder while the other is receiving its supply or charge.

In Fig. 3 there is shown a wave-motor arrangement comprising only one piston-actuating float or buoy 26, having its oscillatory frame 27^a pivotally connected with a vertically-sliding sleeve 29 to rise and fall with the tide, as before described, while the single float and its frame are free to oscillate in such manner as to operate the connected air-compressor pump independently of any others with which it may be grouped. The lower end of the vertically-movable sleeve 29 is in this case preferably secured to an annular float or buoy 29^a, Fig. 3, that will cause the sleeve 29 to respond more readily to requirements of the single pivotally-attached motor-float 26 in all variations of tidal movement.

Instead of connecting the lower piston 13 of two immediately-adjacent air-compressor pumps with floats 26, that are attached to opposite ends of the same oscillatory frame 27, as already mentioned with reference to Fig. 2, it may be preferable to provide an independent oscillatory frame 27^a 27^b for each float 26, as shown in Fig. 4, both frames being pivotally connected with the same vertically-sliding sleeves 29, sustained by buoys 29^a, as above described. By this means each pump will be permitted to operate independently of the other. In each case the posts or piles 11 serve as guides for the rising and falling sleeves 29, and thus the piston-actuating floats 26 are conveniently anchored in position for utilizing their oscillatory movements to the best advantage in the development of wave-power, while they are also free to rise and fall with the tide.

When the pump-piston 13 is provided with a rigidly-attached piston-rod, there may be secured to said piston-rod a vertically-traveling guide-carriage 31, Figs. 4 and 5, provided with guide-pulleys 32, that are arranged to run along the vertical guide-rods 22, forming part of the frame that is suspended from the scaffold on which the pump is supported. This arrangement for guiding the piston-rod may be preferable in some cases, and in order to assist the float 26 in raising the piston and float connections there may be attached to the guide-carriage 31 a rope 33, which passes over a pulley 34 and supports a weight 35 to counterbalance the guide-carriage and impart a steadiness of movement to the piston 13 as it rises and falls with the oscillations of the float 26 as effected by the waving, rolling, or tumbling motion of the water.

As shown in Fig. 1, the lower piston 13 is provided with suitable air-passages, controlled by a valve or valves 36 for admitting air to the air-compression space in the cylinder 12 above said piston. This piston 13 may be provided with any suitable packing 37, and it may be formed intermediate its ends with a circumferential recess 38 to prevent binding.

Each pump-cylinder is provided with a weighted upper piston 39, Fig. 1, which by gravity coacts with the lower piston 13 in compressing the air admitted to the cylinder 12 through the valve or valves of the lower piston. This gravity-piston 39 is provided with a central vertical air-outlet port or passage 40, having its lower end enlarged to accommodate a valve 41 of any appropriate character. If desired, the gravity-piston may be provided with a relief-passage 42, having a safety-valve 43 at the top. The gravity-piston should be provided with suitable packing 44, Fig. 1, and it may have a circumferential recess 45 intermediate its ends to prevent binding and facilitate rapid descent of said gravity-piston in coacting with the ascending lower piston for the compression of air, as hereinafter described. In its up-and-down movements the gravity-piston 39 carries with it a vertically-extended pipe 46, that is secured to said piston at the upper end of the valved outlet-passage 40 for carrying off the compressed air to a place of storage or use. This pipe 46 may have a length sufficient to extend any required distance beyond the open upper end of the pump-cylinder. As the pipe 46 is to ascend and descend with the piston 39 there should be provided a flexible connection of some appropriate kind between said pipe and a stationary compressed-air receiver 47, Fig. 2, which may be supported on the scaffold 10 or located in any convenient situation. Such connection between the pipe 46 and compressed-air receiver

47 may be effected by means of flexible tubing 48 of sufficient length to connect at all times with the receiver 47 during the required movements of the gravity-piston. A check-valve 49, Fig. 2, is provided at each inlet to the compressed-air receiver. If desired, this compressed-air receiver may have a safety-valve 50 of any appropriate character, and a pressure-indicator 51 may be also provided. Several receivers or tanks for storage of compressed air may be connected with the initial receiver 47 by means of a pipe 52, or this pipe may be employed for direct supply of compressed air to the point where it is to be utilized.

For the purpose of sustaining the gravity-piston 39 in an elevated position during descent of the lower piston 13 there is provided a brake mechanism which may be controlled from the lower piston or its motor. This may be accomplished in a variety of ways. As shown in Figs. 1 and 2, a cross-head 53 is secured to the vertically-extended air-pipe 46 of the gravity-piston 39 and moves therewith. Each cross-head 53 carries depending arms 54, one on each side of a pump-cylinder. These depending arms 54 may be of any suitable length and are passed through guides 55, Fig. 2, preferably located on the scaffold 10 and in brackets 56, projecting from the pump-cylinder. In the brackets 56 or at any suitable points adjacent to the arms 54 there may be arranged eccentrics 57, with each of which are connected levers 58 and 59 for controlling the bite of said eccentrics on or against the depending cross-head arms 54, so as to constitute a brake for the gravity-piston. The levers 58 carry adjustable weights 60 and are so arranged as to normally turn the gripping or frictional surfaces of the eccentrics 57 away from the depending arms 54, thereby releasing the brake and permitting the gravity-piston 39 to descend. The levers 59 connect with the outer ends of piston-rods 61, attached to pistons 62, placed in the opposite ends of a horizontally-arranged brake-cylinder 63, that may be supported in any convenient manner in front of a pump-cylinder. A three-way valve 64 is connected with the cylinder 63 at a point between the two pistons 62 for the purpose of controlling communication between said cylinder and an air-pipe 65, that leads from the compressed-air reservoir. This three-way valve 64 is actuated through lever connection 66 from a toothed segment 67, which is oscillated by a spur-gear 68, having thereon a pulley 69, (shown by dotted lines in Fig. 1,) over which a cord or rope 70 is passed. One end of the rope 70 has attached thereto a weight 71, and the other end of said rope may be secured to the piston-actuating float 26, as in Figs. 2 and 3, or to the guide-carriage 31 of the piston-rod 14, as in Fig. 4; or the said rope 70 may be connected in any suitable manner, so as to actuate the brake-controlling valve 34 in accord with the movements of the lower piston. A guide-pulley 72, Fig. 1, may be arranged at any convenient point for the rope 70 to run on in actuating the valve-gear. The brake-controlling mechanism is so arranged that as the lower piston 13 starts downward the rope 70 will revolve the pulley 69 and attached spur-gear 68 in such direction as will cause the segment-gear 67, lever 66, and valve 64 to be actuated in a proper manner for admitting compressed air to the brake-cylinder 63, Fig. 1, thereby forcing the pistons 62 outward, and consequently swinging the levers 59 in the same direction, so as to make the eccentrics 57 bite against the cross-head arms 54, and thus sustain the gravity-piston 39 in an elevated position. During descent of the lower piston 13 its valve or valves 36 will rise under the pressure of air beneath, and consequently air will be thus admitted into the space above the lower piston, between it and the elevated gravity-piston. On the upward stroke of the lower piston 13 its valve or valves 36 will close down, and the three-way valve 64 will be turned in such direction as to cut off further access of air to the brake-cylinder and permit exhaust to the atmosphere through a relief-port 73, with which said valve is provided. The weighted levers 58 will now be free to turn the eccentrics 57 in such direction as to release the cross-head arms 54, and this will permit the gravity-piston 39 to fall rapidly toward the ascending lower piston 13, thus positively coacting with said lower piston in the compression of air previously admitted to the pump-cylinder. It will be understood, of course, that both pistons 13 and 39 should be so accurately fitted to the pump-cylinder or be supplied with such packing as will insure proper piston action with no undue leakage. The opposing faces of the two pistons are preferably provided with annular projections 74, Fig. 1, of sufficient diameter to surround and protect the piston-valves and prevent full contact of the opposing piston-faces throughout their whole area. These annular projections 74 may be formed on detachable piston-faces 75, that are preferably provided for convenience in forming the valve-seats and to secure the piston-packing in place. The compressed air lifts the valve 41 of the upper piston and passes through the pipe 46 to the compressed-air receiver. In completing its upward stroke the lower piston 13 supports the gravity-piston 39 and returns it to an elevated position in the pump-cylinder. Now as soon as the lower piston again begins to descend the three-way valve 64 is immediately actuated, through its controlling mechanism or valve-gear, in such direction as to admit compressed air from the pipe 65, Fig. 1, into the brake-cylinder 63, thereby causing the pistons 62 and levers 59 to turn the eccentrics 57 into position for gripping the cross-head arms 54, thus holding up the gravity-piston until the lower piston again rises.

In constructing the valve-gear segment 67, Fig. 1, its first and last teeth are made longitudinally yielding, being normally pressed outward by springs 76, and the outer ends of these teeth are each beveled off on the outer side, as shown, so that each spring-pressed tooth will yield inwardly when engaged by the spur-gear 68 in one direction of revolution. By this construction the toothed segment 67 will receive from the spur-gear 68 only such degree of movement as is necessary to effect a full operation of the three-way brake-valve 64 in the proper direction for applying or releasing the air-brake, as the case may be, and a further revolution of the spur-gear 68 in the same direction will not affect the brake-valve. It may be preferable to provide the toothed segment 67 with a slotted arc extension 77, Fig. 1, to engage a stop-pin 78 for limiting the throw of the brake-valve 64 in each direction of movement.

Any desired weight may be given to the gravity-piston, as by direct application to the piston itself, in its construction or attachments. For instance, adjustable or removable weights 79, Figs. 1 and 2, may be suspended by means of rods 80 from the ends of the cross-head 53, so that the weight can be regulated as required, it being desirable that this gravity-piston should coact with the lower piston promptly and effectively in the air-compressing operation.

Obviously various modifications may be made in the construction and application of a suitable brake mechanism for the gravity-piston.

If desired, the lower end of the pump-cylinder 12 may be open or constructed without a head, like the upper end of said cylinder, and the said lower piston may then have its rod or pitman 24 flexibly connected both to the piston and to its actuating-float. By providing a pump-cylinder of sufficient length to correspond with the extremes of tide movement the pistons 13 and 39 will readily operate at any height of water, whether the tide is high or low.

This power apparatus may be conveniently operated on wharves or piers or wherever there is any wave motion of the water. The movement of water may be also utilized in various ways for actuating the lower pump-piston, and from this lower piston the brake mechanism of the gravity-piston can obviously be controlled by various mechanical devices.

The apparatus affords a convenient and economical means for the compression of air, and obviously the compressed air can be employed as a motive power in various kinds of machinery or for driving dynamos to generate electric energy that can be transmitted to required points, whether for lighting or power.

What I claim as my invention is—

1. The combination with a cylinder, and a lower piston, of a gravity-piston arranged in said cylinder above the lower piston, a brake for the gravity-piston, and mechanism for controlling said brake to hold the said gravity-piston elevated during descent of the lower piston and to release the gravity-piston on ascent of the lower piston, substantially as described.

2. The combination with a cylinder, and a lower piston in said cylinder, of a gravity-piston arranged in said cylinder above the said lower piston, a motor for actuating the lower piston, a brake for the gravity-piston, and mechanism for controlling said brake from the motor, to hold the gravity-piston elevated during descent of the lower piston and to release the gravity-piston on ascent of the lower piston, substantially as described.

3. The combination with a cylinder, and a lower piston in said cylinder, of a gravity-piston arranged in said cylinder above the said lower piston, means for varying the weight of the gravity-piston, and a brake to hold the gravity-piston elevated during descent of the lower piston and to release the gravity-piston on ascent of the lower piston, substantially as described.

4. The combination with a cylinder, and a lower piston, of a gravity-piston arranged in said cylinder above the lower piston, an air-brake for the gravity-piston, a brake-controlling valve, and mechanism for operating said valve from the movements of the lower piston, to hold the said gravity-piston elevated during descent of the lower piston and to release the gravity-piston on ascent of the lower piston, substantially as described.

5. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, and an upper gravity-piston, substantially as described.

6. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, an upper gravity-piston provided with a brake to hold the said gravity-piston elevated during descent of the lower piston, and means for releasing said brake on ascent of the lower piston, substantially as described.

7. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, an upper gravity-piston provided with air-brake mechanism, and means for controlling the operation of said brake mechanism to hold the gravity-piston elevated during descent of the lower piston and permit the fall of said gravity-piston on ascent of the lower piston, substantially as described.

8. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, an upper gravity-piston provided with brake mechanism, and means for controlling the operation of said brake mech-

anism from the float and connected lower piston, to hold the gravity-piston elevated during descent of the lower piston and permit the fall of said gravity-piston on ascent of the lower piston, substantially as described.

9. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float and provided with an air-inlet valve, an upper gravity-piston through which the pump is in communication with the compressed-air receiver, an air-brake to hold the said gravity-piston elevated during descent of the lower piston and permit fall of said gravity-piston on ascent of the lower piston, a brake-valve, and mechanism for controlling the operation of said valve from the float with which the lower piston is connected, substantially as described.

10. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, an upper gravity-piston through which the pump is in valved communication with the compressed-air receiver, a compressed-air brake for the gravity-piston, a three-way valve to control the operation of said brake, a pivotally-mounted toothed segment connected with the valve arm or lever, and gearing actuated from the float, to oscillate the said segment for operating the brake-valve, substantially as described.

11. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave motion, of an air-compressing pump having a lower piston connected with said float, an upper gravity-piston through which the pump is in valved communication with the compressed-air receiver, an air-brake for the gravity-piston, a three-way valve to control the operation of said brake, a pivotally-mounted toothed segment having a lever connection with the brake-valve, a spur-gear meshed with said segment, a pulley on said spur-gear, a cord or rope attached to the float and carried over said pulley, and a weight at the free end of said cord, substantially as described.

12. The combination with a receiver for compressed air, and a float or buoyant body to be actuated by wave and tide, of a post having thereon a vertically-movable sleeve to which said float is pivotally connected, and an air-compressing pump in communication with the compressed-air receiver and provided with an upper gravity-piston and with a lower piston that is connected with said float, substantially as described.

13. The combination with a receiver for compressed air, and air-compressing pumps in communication with said receiver and each provided with a lower piston and an upper gravity-piston and with brake mechanism for said gravity-piston, of posts having vertically-movable sleeves thereon, an oscillatory frame mounted on said sleeves, floats attached to said frame to rise and fall with the tide and be actuated by wave motion, universally-jointed connections between said floats and the lower pump-pistons, and means for controlling the operation of the brake mechanism from the floats, substantially as described.

14. The combination with a compressed-air receiver, and an air-compressing-pump cylinder having a lower valved piston, of a gravity-piston arranged in said cylinder above the lower piston and provided with a valved outlet-port in communication with said compressed-air receiver, an air-brake for the gravity-piston, a brake-controlling valve, and mechanism for operating said valve with the movements of the lower piston, to hold the said gravity-piston elevated during descent of the lower piston and to release the gravity-piston on ascent of the lower piston, substantially as described.

15. The combination with a compressed-air receiver, and an air-compressing-pump cylinder having a lower valved piston, of a gravity-piston arranged in said cylinder above the lower piston and provided with a valved outlet-port in communication with said compressed-air receiver, brake mechanism for the gravity-piston, said mechanism comprising a brake-cylinder and its pistons, a valve for controlling communication between said brake-cylinder and the compressed-air receiver and to permit exhaust from said cylinder to the atmosphere, valve-gearing, and means for operating said valve-gearing with the movements of the lower pump-piston, substantially as described.

16. The combination with a compressed-air receiver, and an air-compressing-pump cylinder having a lower valved piston, of a gravity-piston arranged in said cylinder above the lower piston and provided with a valved outlet in communication with said compressed-air receiver, a cross-head supported by the gravity-piston and provided with depending arms on opposite outer sides of the pump-cylinder, eccentrics adapted to grip said depending arms, weighted levers projecting from said eccentrics and adapted to release them from frictional braking engagement with the depending arms of the piston cross-head, a brake-cylinder having pistons in its opposite ends with the piston-rods projecting from the ends of said cylinder, levers connecting said piston-rods with the said eccentrics, a valve for controlling admission and exhaust of compressed air to and from the brake-cylinder, and mechanism for operating said valve with the movements of the lower piston, substantially as described.

17. The combination with a compressed-air receiver, and an air-compressing-pump cylinder having a lower valved piston, of a gravity-piston arranged in said cylinder above the lower piston and provided with a valved outlet, a vertical air-pipe connected with said outlet and in flexible connection with the

compressed-air receiver, a cross-head carried by said air-pipe and having arms depending on opposite outer sides of the pump-cylinder, removable weights suspended from said cross-head, eccentrics adapted to have a frictional braking engagement with the depending cross-head arms, weighted levers to normally hold the eccentrics from engagement with said depending arms, a brake-cylinder having pistons in its opposite ends, levers connecting said pistons with the said eccentrics, a valve for controlling admission and exhaust of compressed air to and from the brake-cylinder, and mechanism for operating said valve with the movements of the lower piston, substantially as described.

18. The combination with vertical stationary air-pump cylinders, and pistons, of a counterbalanced guide-carriage attached to each piston-rod, a guide-frame for the guide-carriages, piles having vertically-sliding sleeves thereon, an oscillatory frame or frames pivotally connected with said sleeves, floats secured in said oscillatory frame or frames, and pitman connections between the floats and the pump-pistons, substantially as described.

19. The combination with a pump-cylinder, and a piston provided with a valved inlet, of a gravity-operated piston provided with an outlet from the pump-cylinder, substantially as described.

20. The combination with a pump-cylinder, and a float-operated piston, of a gravity-operated piston, and a brake for said gravity-operated piston, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

CLAUDE M. JOHNSON.

Witnesses:
GEO. W. REA,
F. B. KEEFER.