R. Y. BOVEE.

WATER LIFT AND AIR COMPRESSOR.

APPLICATION FILED FEB. 23, 1909.

995,112.

Patented June 13, 1911.

3 SHEETS—SHEET 1.

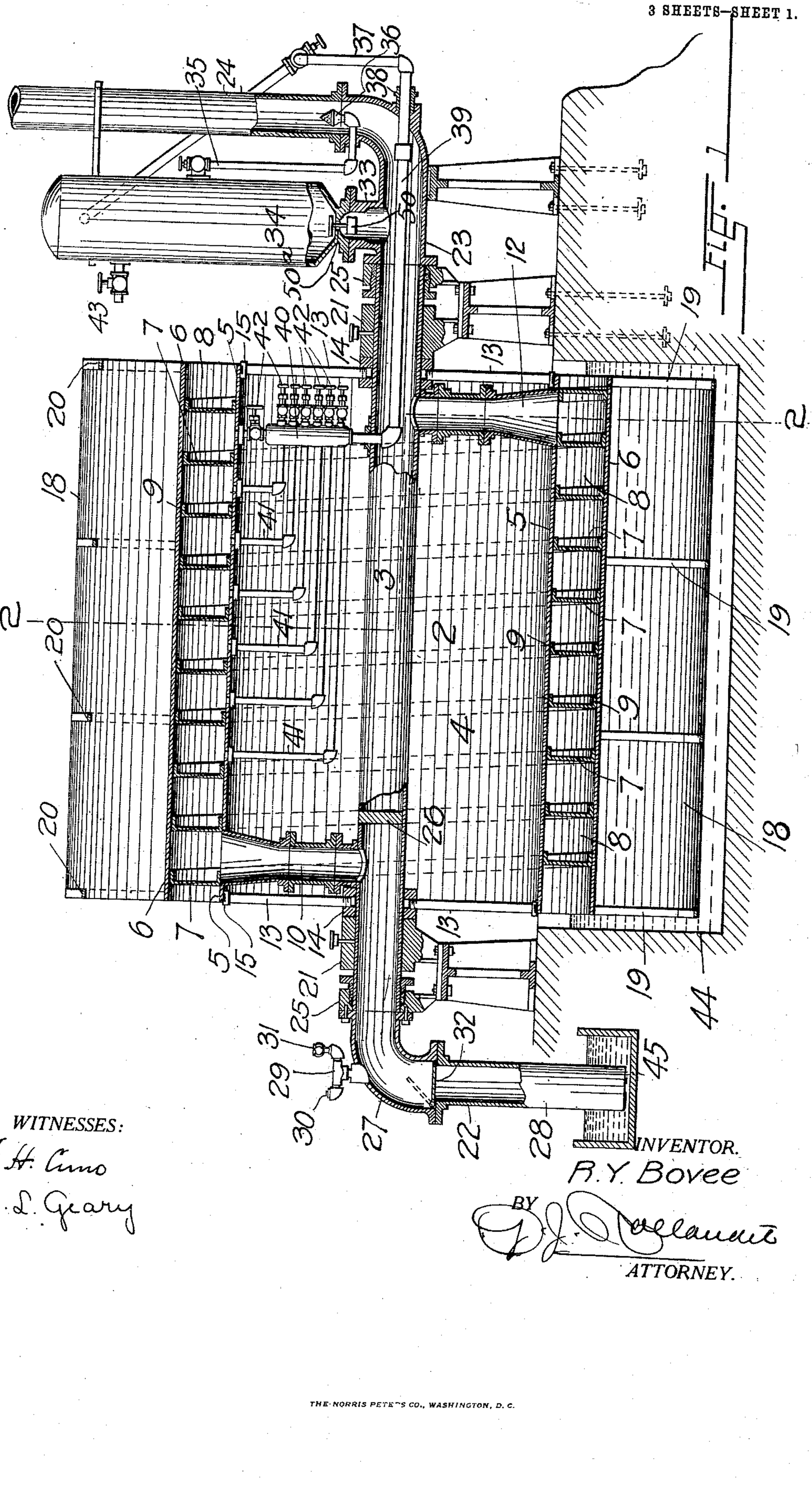

FIG. 1.

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3 SHEETS—SHEET 2.

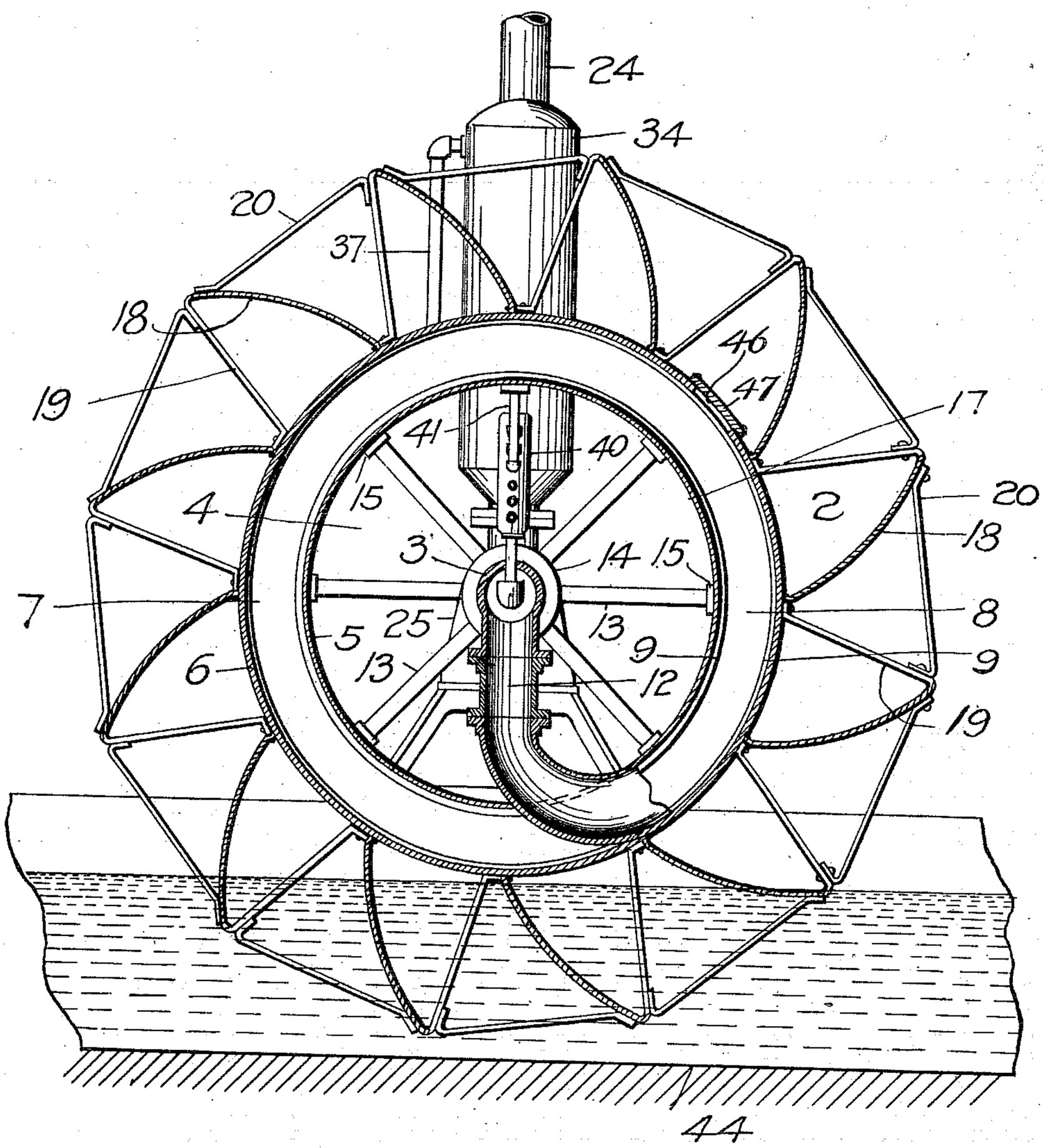


FIG. 2

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3 SHEETS—SHEET 3.

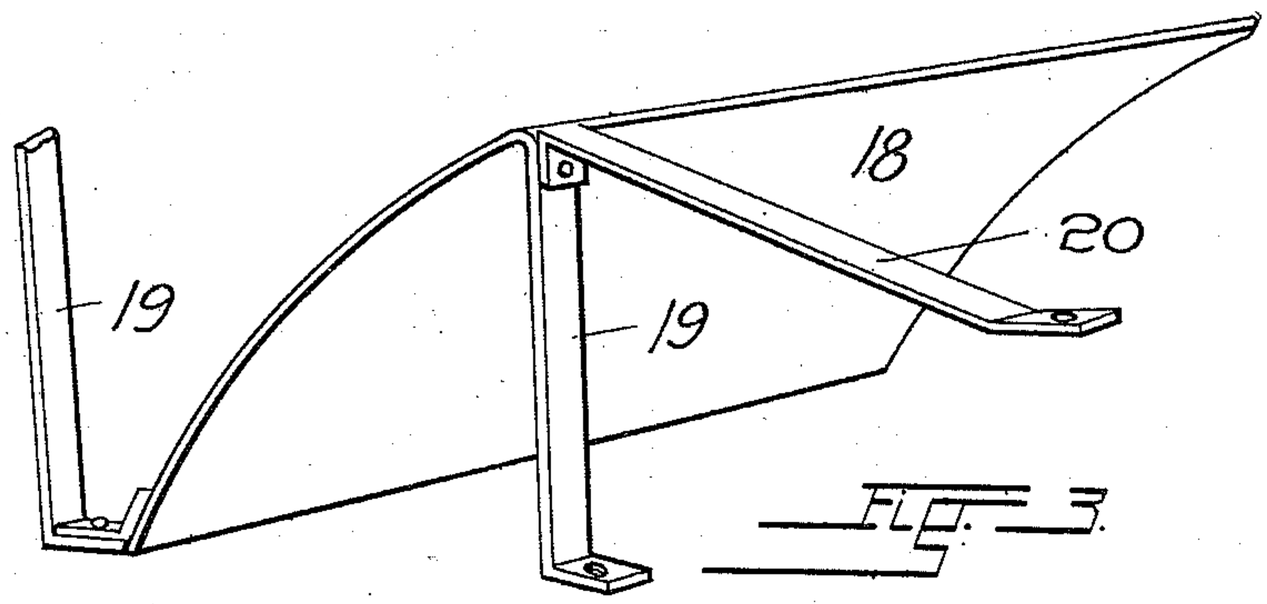
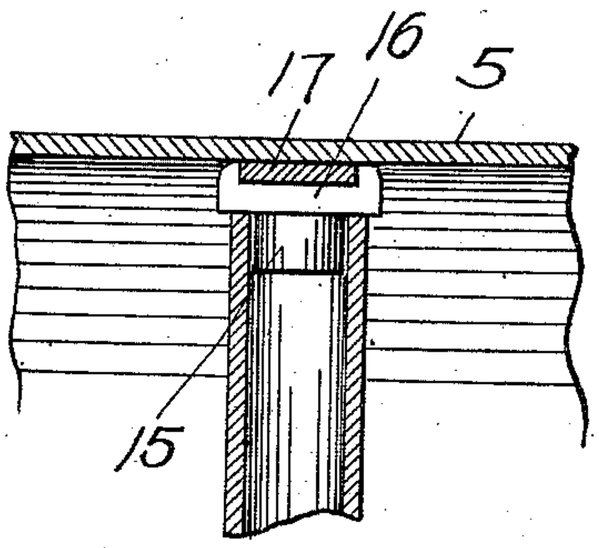



FIG. 3.



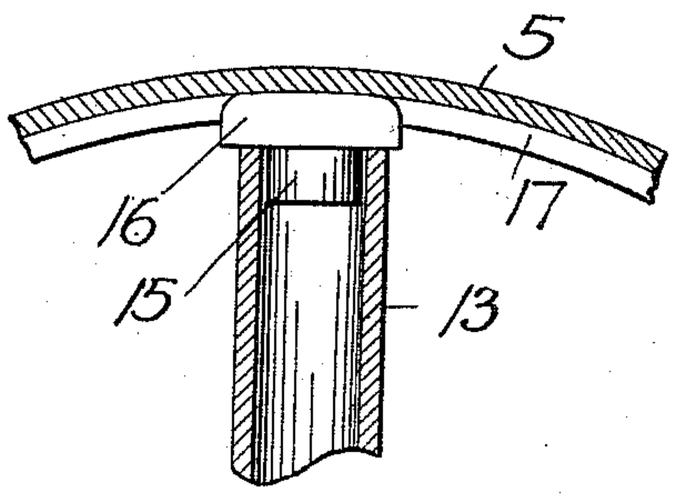




FIG. 4.

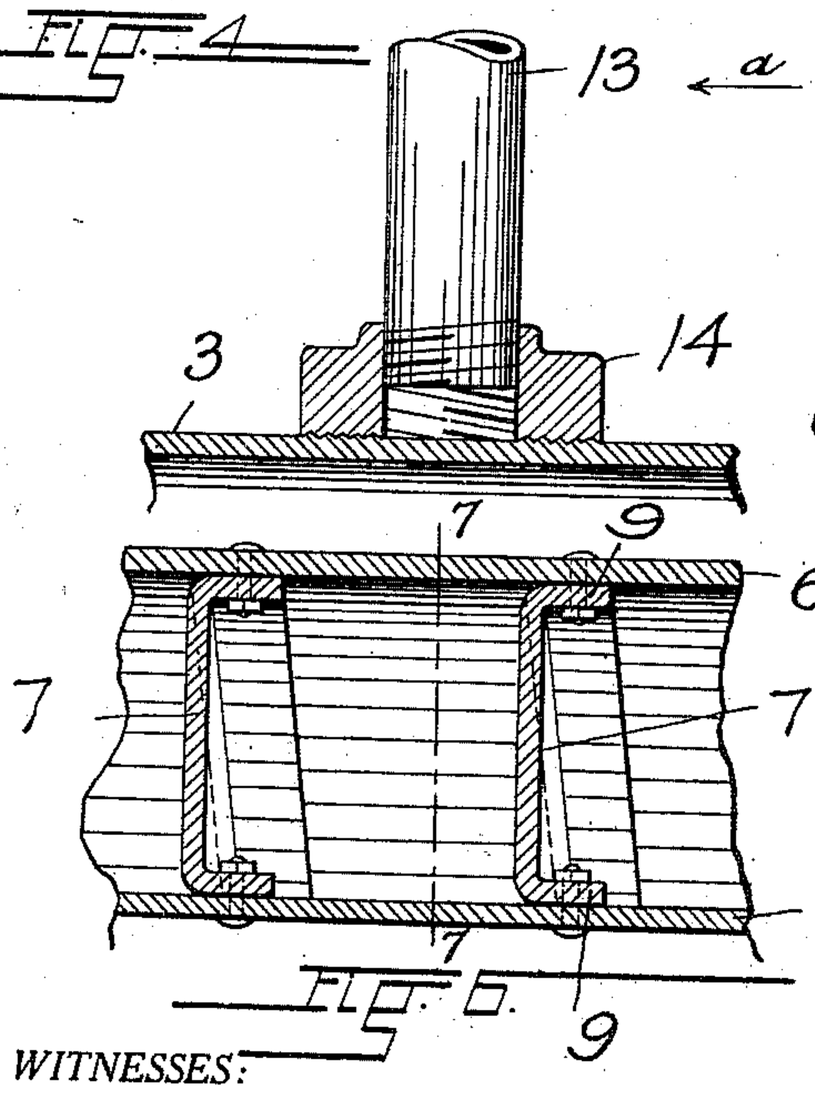



FIG. 6.

FIG. 5.

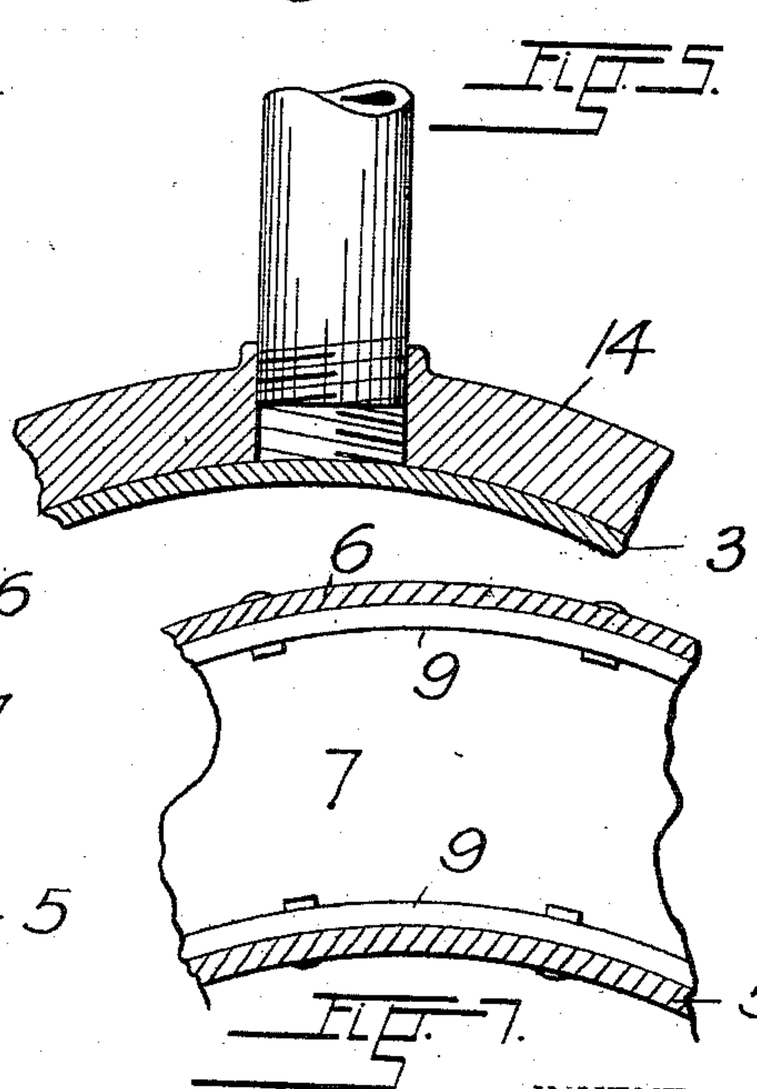



FIG. 7.

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# UNITED STATES PATENT OFFICE.

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## WATER-LIFT AND AIR-COMPRESSOR.

995,112. Specification of Letters Patent. **Patented June 13, 1911.**

Application filed February 23, 1909. Serial No. 479,366.

*To all whom it may concern:*

Be it known that I, RANSOM Y. BOVEE, a citizen of the United States of America, residing at Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Water-Lifts and Air-Compressors, of which the following is a specification.

This invention relates to a combined water-elevator and hydraulic air-compressor and its main object resides in the provision of an apparatus of the class named in which simplicity of construction and consequent cheapness in manufacture, is combined with great practicability in use, and which, being automatic in its action, will lift a large amount of water to a considerable height, with a small expenditure of energy.

The compression of air, during the operation of the apparatus, occurs simultaneously with the conveyance and elevation of the water, and said air may be used as an auxiliary agent to lift the water in the stand pipe included in the construction, as a means to counteract the pressure of fluid in the said pipe upon that being conveyed thereinto, or as a motive agent for the operation of independent mechanical contrivances.

A further significant object of my invention resides in the provision of a water-elevator in which water and air are continuously taken in at the receiving end of the apparatus to be conveyed to the stand pipe, a feature which greatly advances the capacity of the device, and other objects of the invention, relating principally to its construction, will be fully brought out in the following description, reference being had to the accompanying drawings in the various views of which like parts are similarly designated and in which—

Figure 1, represents a vertical, central section through the apparatus, Fig. 2, a transverse section taken along the line 2—2 Fig. 1, Fig. 3, a perspective view of an end portion of one of the floats by means of which the rotative element of the apparatus is impelled, Fig. 4, an enlarged, partly sectional elevation of one of the spokes and adjacent parts comprised in said element, Fig. 5, a sectional elevation looking in the direction of the arrow *a* Fig. 4, Fig. 6, an enlarged sectional view of a portion of the helicoidal partition and the cylinders connected thereby, which form part of the element above referred to and Fig. 7, a fragmentary sectional view taken along the line 7—7 Fig. 6.

Referring to the various parts by numerical reference characters the numeral 2 designates the revoluble element of my improved apparatus, which consists of a horizontally disposed tubular shaft 3 upon which a drum 4 is concentrically mounted. The drum 4 consists of two concentric cylinders 5 and 6 which are connected by a strip 7 which winds helicoidally through the annular space 8 between the two cylinders from one end of the drum to the other. The outer cylinder 6 is constructed with a longitudinally extending opening 46 which renders the annular space 8 accessible and which is normally covered by a plate 47. The strip 7 is formed at its opposite edges with longitudinal flanges 9 which, respectively, engage the opposite surfaces of the two cylinders and which are secured thereto by means of rivets or analogous fastening means. The annular space 8 of the drum connects at its ends with the interior of the tubular shaft 3, by means of radially extending inlet and outlet conduits 10 and 12, and the portion of the element including the conduct 10, will in the following description, be named the receiving or ingress end, while the opposite portion, containing the conduit 12, will be termed the delivery or egress end.

The drum 4 is mounted upon the shaft 3 by means of two series of radially extending, tubular spokes 13, whose inner, threaded extremities are secured in correspondingly threaded apertures in hubs 14 which are carried upon the shaft, while their opposite ends are provided with plugs 15 whose transversely grooved heads 16 straddle one of two bands 17, which are secured upon the interior surface of the drum respectively in juxtaposition to its ends. The spokes 13 being thus longitudinally adjustably fastened, may be effectively employed to center the drum in relation to the shaft, when the parts are being assembled. The drum 4 is furthermore provided with a number of curved float-boards 18 which are equidistantly and longitudinally secured upon its circumferential surface.

The boards 18 whose inner edges engage the exterior surface of the drum are formed with integral stays 19 which, extending inwardly from their outer edges, are secured

upon the drum 4 preferably contiguous to the inner edge of the next succeeding float and the several floats are connected at their outer portions by means of transverse braces 20.

The extreme portions of the shaft 3, which project beyond the ends of the drum 4, are rotatably mounted in journal bearings 21 and communicate, respectively, with a suction pipe 22, at the receiving end of the element 2, and at its opposite or delivery end, with a conduit 23 whose outer, upwardly turned end connects with a stand-pipe 24 in which the water is raised during the operation of the apparatus.

The junctures between the ends of the rotative shaft 3 and the stationary conduits 22 and 23 are rendered impervious by the use of stuffing boxes 25 of suitable construction, and the tubular shaft 3 is stopped by means of a plug 26 at a point in proximity to the conduit 10 and between it and the delivery end of the shaft, for the purpose of directing the flow of water entering the shaft through the pipe 22, into the said conduit. The suction pipe 22 is preferably composed of two sections, the upper one 27 of which consists of an elbow which connects the shaft 3 with the straight section 28 whose lower extremity extends into the source from which the fluid to be raised through the instrumentality of the apparatus, is derived.

Secured upon the elbow 27 by means of a nipple, is a tee 29 one branch 30 of which is normally plugged and is intended for the attachment of a priming pump, by which the water elevator is put in working condition at the initial period of the operation, while the opposite branch connects with a valve 31 which controls the flow of air into the shaft 3.

A foot-valve 32 disposed within the conduit 22, intermediate the section 28 and the elbow 27, has for its purpose the stopping of the said conduit while the process of priming is carried on.

The conduit 23 at the egress end of the apparatus is formed, at a point intermediate its extremities, with an upwardly ranging flanged branch 33 which connects with the orifice of an upright, cylindrical tank 34 which constitutes the reservoir in which the air conveyed together with the water, is collected and compressed. To prevent water from being drawn with the air, into the reservoir, I provide a float valve 50 which normally closes the orifice of the pipe 33 by engagement with a seat $50^a$ formed therein. A valve controlled pipe 35, leads from the interior of the reservoir into that of the stand-pipe, and connects with a foraminous nozzle 36, by means of which the water contained in the stand pipe, may be aerated for the purpose of accelerating its upward motion. The air-reservoir 34 connects furthermore, by means of a valve controlled conduit 37, whose outer extremity projects through a stuffing box 38, into the conduit 23, with a pipe 39 which is axially disposed within the shaft 3. The end of the pipe 39, opposite to that which movably connects with the conduit 37, extends transversely through an aperture in the wall of the shaft 3, to connect with a head 40, from whose interior a number of pipes 41 lead respectively to the various convolutions of the helicoidal passage formed in the annular space 8, by the winding strip 7. The flow of air into the several pipes 41, opening within the head 40, is controlled by means of needle valves 42 whose ends are seated within the respective orifices of the pipes, and which, being of a construction well known in the art, have not been shown in detail. A valve controlled outlet 43, on the reservoir 34, is adapted to connect the latter with a motor or other mechanical contrivance adapted to be impelled by the use of compressed air.

Having thus described the mechanical construction of my improved apparatus, I will now proceed to explain its operation.

The apparatus is mounted upon the bearings 21 and other suitable supports, above a stream or channel of running water so that the floats 18 extend below the surface thereof, and the lower extremity of the suction pipe 22 is placed either in the stream itself, or in a lateral or sluiceway connected therewith.

In Fig. 1 of the drawings, the stream or channel is designated by the numeral 44 and the sluice leading therefrom by the numeral 45. At the initial period of the operation one or more convolutions at the receiving end of the helicoidal passage, formed in the annular space 8 by the strip 7, are supplied with water by means of a priming pump attached to the connection 30. The element 2 is now made to rotate, by the direct action of the water running through the channel 44, upon the curved floats 18, with the result that the water contained in the convolutions at the receiving end of the helicoidal passage, is conveyed toward the egress end of the element 2. The vacuum resulting from the movement of the body of water in the passage, causes the water flowing through the sluice 45, to be drawn up through the suction pipe 22 and the ingress conduit 10, into the helicoidal passage, while a quantity of air, regulated by means of the valve 31, is synchronously introduced thereinto. As the water and air enter the annular space 8, the liquid will by gravitation, fill the lower parts of the convolutions of the helicoidal passage, while the air ascends to the upper portions thereof, with the result that the stream of fluid, being conveyed through said passage by the rotative motion of the element 2, will be composed of alternate bodies of water and air, respectively contained in the lower and upper portions of the heli-

coidal conduit. The stream, progressing through the passage is transmitted, by means of the egress conduit 12, into the interior of the tubular shaft 3, whence the water flows into the connection 23 to subsequently rise in the therewith communicating stand pipe 24, while the air is collected and compressed in the reservoir 34.

To obtain the maximum lifting efficiency of the alternate bodies of water and air moving through the spiral conduit, the ends of all the water-bodies should be substantially in one plane extending obliquely with respect to the horizontal or the perpendicular. In case said ends were in the perpendicular, the body of water would flow over into the preceeding convolution and thus decrease the efficiency of the machine by back-pressure, and if the ends of the water body were in the horizontal, its effect upon the column rising in the stand pipe would be *nil* for the reason that the efficiency of each water-body depends on its "head" or the difference in elevation of its two ends. As the bodies of water approach the stand pipe, the intermediate bodies of air are proportionately compressed with the result that the ends of the bodies, nearest the stand pipe, will approach the perpendicular while those of the bodies nearer the suction end of the device, being influenced by the pressure exerted by said bodies of compressed air, will move toward the horizontal. It will thus be seen that while all the bodies of water lose in efficiency as they are closer to the suction-end of the core those nearest the stand-pipe are in danger of overflowing, into the preceding columns. Now, by equalizing the bodies of air between the various water bodies which can be accomplished only by increasing their volume in ratio to their degree of compression, I can by proper manipulation of the valves controlling the pipes 41 through which the supplemental air is introduced into the convolutions, shift the bodies of water so that their ends are substantially in one plane which extends obliquely between the horizontal and the perpendicular, under which condition the efficiency of the device is increased from 25 to 30 per cent.

To counteract the pressure of the water contained in the stand-pipe upon the alternate bodies of air and water conveyed through the helicoidal passage, the bodies of air may be increased in volume by opening the valves of the conduits 41 in ratio to the degree of compression of said bodies in the respective convolutions with which they connect, it being understood that the density of the air in the reservoir 34 exceeds that of the body of air in the last convolution, the degree of pressure of which is greater than that of the preceding bodies.

It will thus be observed that my improved apparatus, eliminating and counteracting all forces disadvantageous to the upward motion of the water, will raise the latter to a considerable height, while the accumulation and compression of the amount of air, essential in the operation, is a factor which not only enhances the efficiency of the device, but may be employed for other purposes such as the supply of motive power as hereinbefore explained.

What I claim and desire to secure by Letters Patent is:—

1. A device of the class named comprising a helicoidal conduit rotative about a horizontal axis, a suction pipe communicating with one of its ends, a stand-pipe communicating with the opposite end of the conduit, an air reservoir having an inlet interposed between the conduit and the stand pipe, whereby the air leaving the conduit with the fluid, may be separated therefrom before the latter reaches the stand pipe, and valve controlled pipes respectively connecting the various convolutions comprised in said conduit, with said reservoir.

2. A device of the class named comprising a helicoidal conduit rotative about a horizontal axis, a suction pipe communicating with one of its ends, a stand-pipe communicating with the opposite end of the conduit, an air reservoir and valve-controlled pipes, respectively connecting the various convolutions comprised in said conduit, with said reservoir.

3. A device of the class named comprising a rotatable horizontal continuous hollow shaft, a helicoidal conduit, concentrically mounted thereon and communicating at its extremities with the interior thereof, a stationary, downwardly extending suction pipe and a stand-pipe having impervious connections respectively, with opposite ends of the shaft, an air-inlet in the upper portion of the suction pipe, an air reservoir whose lower portion communicates with the connection between the stand pipe and the respective end of the conduit, valve controlled pipes leading from the various convolutions comprised in the conduit, an outlet leading from the reservoir, and means of communication between said pipes and said outlet.

4. In a device of the class named, a revoluble element including a horizontal hollow shaft and a helicoidal conduit concentrically mounted thereon and communicating at its extremities with the interior thereof, a stationary, downwardly extending suction pipe, and a stand-pipe having impervious connections, respectively with opposite ends of the shaft, an air inlet in the upper portion of the suction pipe, an air reservoir whose lower portion communicates with the connection between the stand-pipe and the respective end of the conduit, an air conduit fixedly associated with the element, valve controlled pipes opening into the various

convolutions comprised in the conduit, in communication with said air conduit, and a connection between the latter and the reservoir.

5. A device of the class named comprising in combination, a revoluble element including a horizontal, hollow shaft, a hollow cylinder concentrically mounted thereon and having a helicoidal passage winding along its inner surface, floats longitudinally secured upon the circumferential surface of the cylinder, conduits connecting opposite ends of said passage with the interior of the shaft, a downwardly extending suction pipe and a stand pipe, imperviously connected, respectively with opposite ends of the shaft, an air-inlet in the upper portion of the suction-pipe, an air reservoir whose lower portion communicates with the connection between the stand-pipe and the respective end of the shaft, a valve-controlled pipe connected with the reservoir and having a foraminous outlet within the stand-pipe, valve-controlled pipes opening into the various convolutions comprised in said passage, a conduit connected with the opposite ends of said pipes, and a valve controlled connection between said conduit and said reservoir.

6. In a device of the class named, in combination, a helicoidal conduit rotative about a horizontal axis, a suction pipe communicating with one of its ends, a stand pipe connected with its opposite end, and means for introducing air separately into each convolution comprised in said conduit.

7. In a device of the class described, a helicoidal conduit rotative about a horizontal axis, and having an inlet and an outlet respectively at its opposite ends, and means for introducing air separately into the convolutions of the said conduit.

8. In a device of the class described, a helicoidal conduit rotative about a horizontal axis, and having an inlet and an outlet respectively at its opposite ends, and an air-reservoir connected separately with the several convolutions of the said conduit.

9. In a device of the class described, a helicoidal conduit rotative about a horizontal axis and having an inlet and an outlet respectively at its opposite ends, an air-reservoir connected with the said outlet whereby air leaving the conduit with the fluid is separated therefrom, and valve controlled connections between the reservoir and the convolutions of the conduit for the introduction of air thereinto.

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

RANSOM Y. BOVEE.

Witnesses:
M. L. GEARY,
G. J. ROLLANDET.