(No Model.) 2 Sheets—Sheet 1.

T. DUFFY.

WAVE POWER AIR COMPRESSOR.

No. 547,338. Patented Oct. 1, 1895.

Fig. 2.

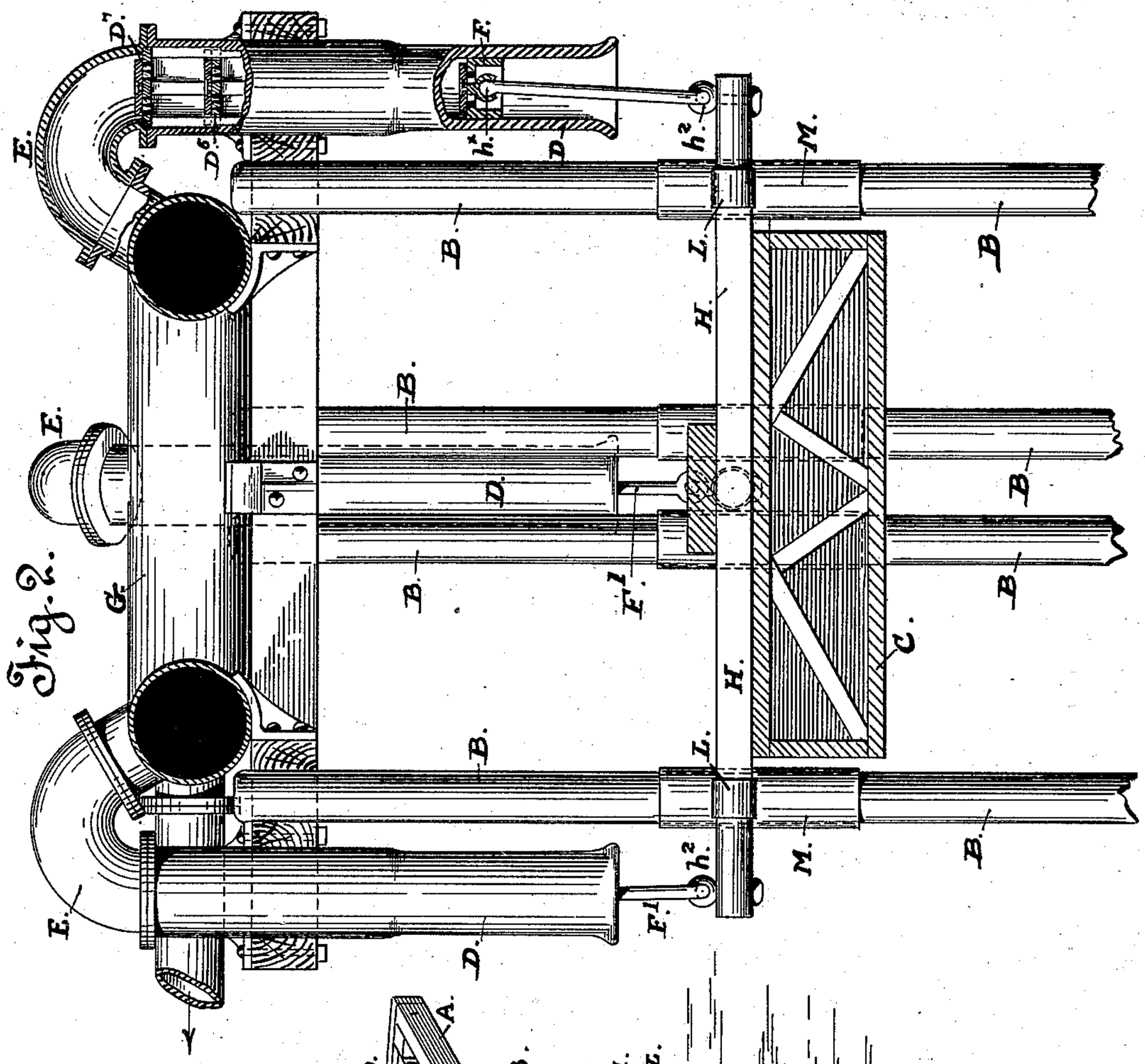
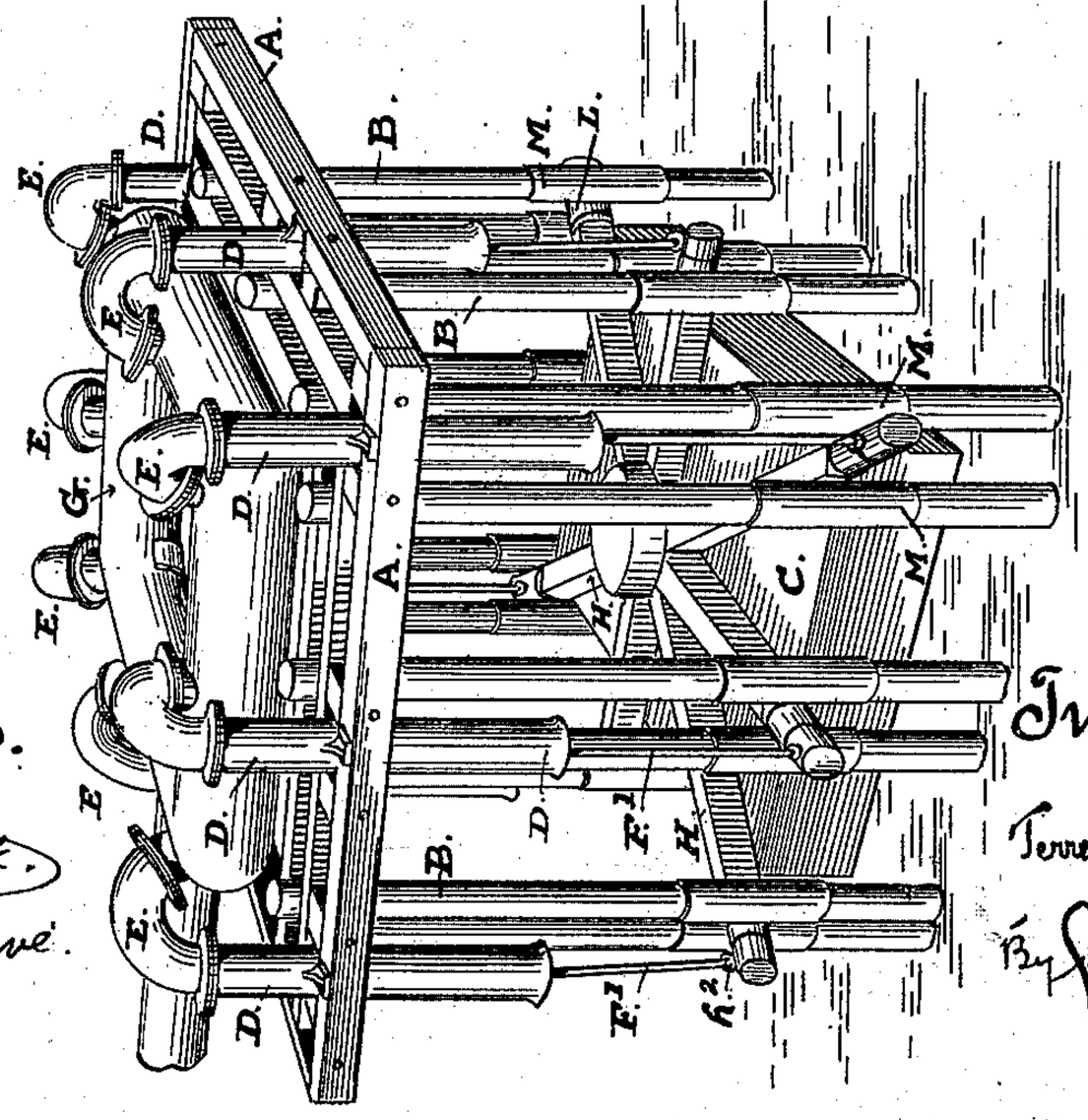


Fig. 1.



Witnesses.

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Marcus S. Levé.

Inventor.

Terrence Duffy.

By Smith & Abbott

his Attys.

(No Model.) 2 Sheets—Sheet 2.

T. DUFFY.

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No. 547,338. Patented Oct. 1, 1895.

Fig. 3.

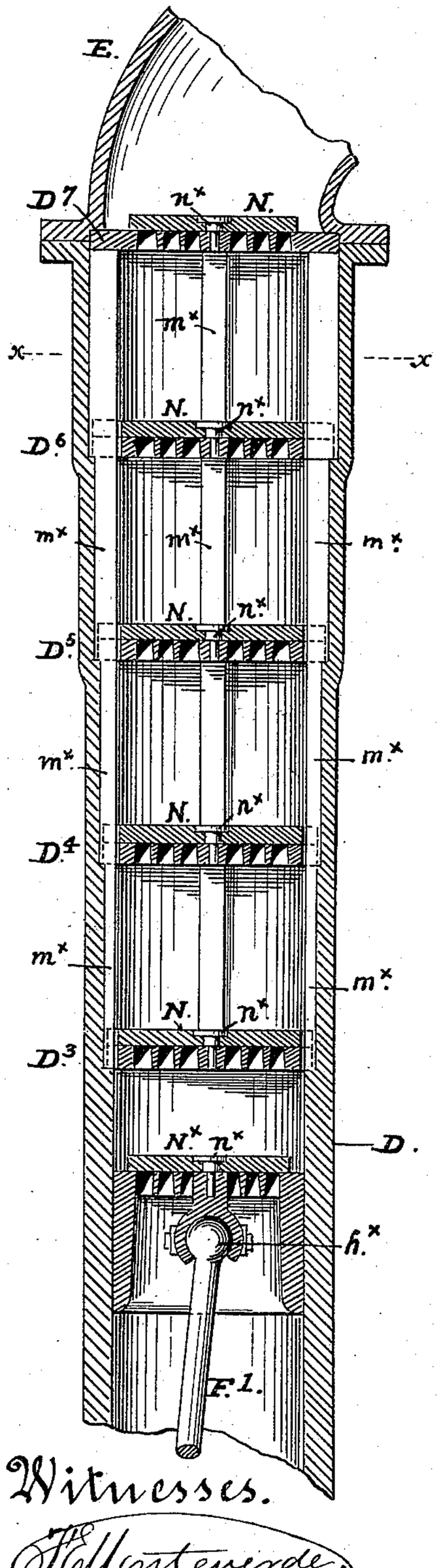


Fig. 4.

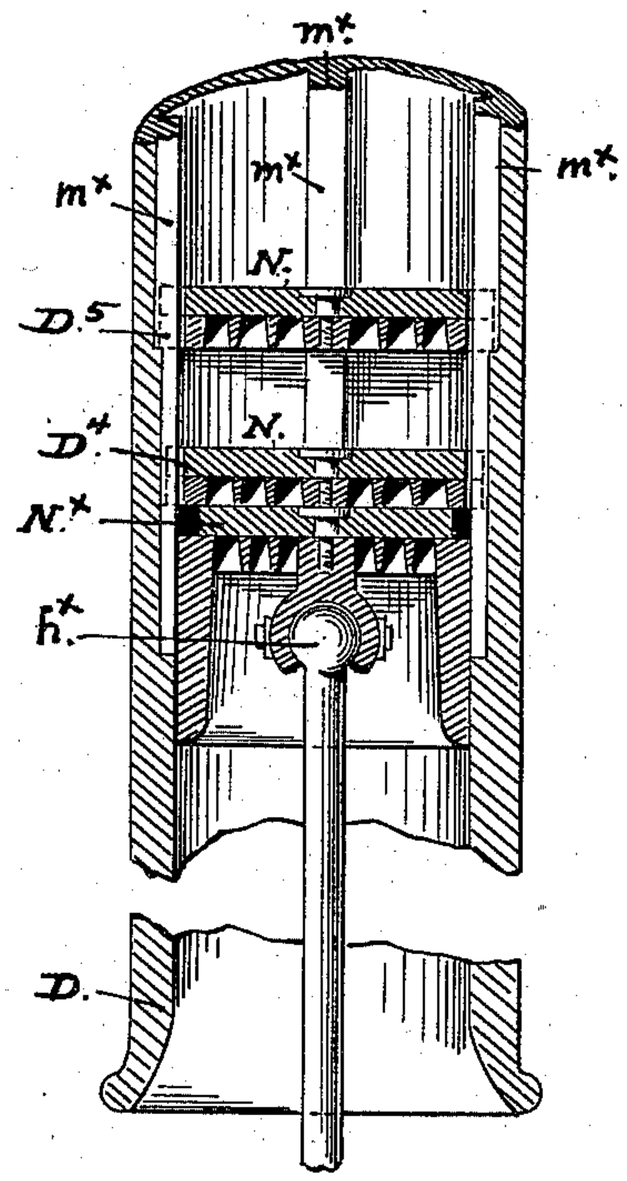
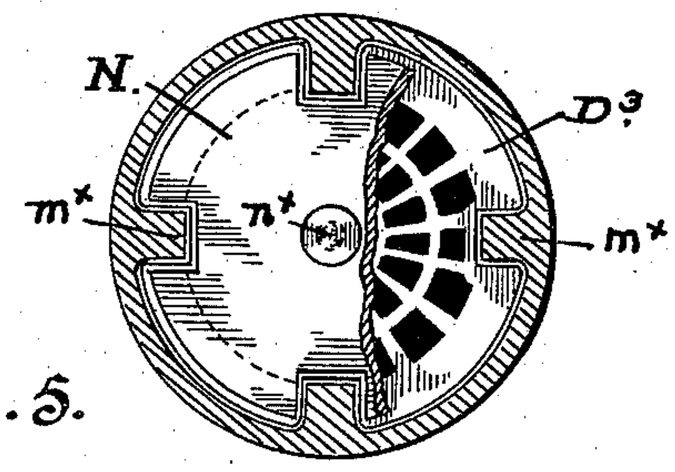


Fig. 5.



Witnesses.

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UNITED STATES PATENT OFFICE.

TERRENCE DUFFY, OF SAN FRANCISCO, CALIFORNIA.

WAVE-POWER AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 547,338, dated October 1, 1895.

Application filed May 17, 1895. Serial No. 549,680. (No model.)

To all whom it may concern:

Be it known that I, TERRENCE DUFFY, a citizen of the United States, residing in the city and county of San Francisco and State of California, have invented certain new and useful Improvements in Wave-Power Air-Compressors, of which the following is a specification.

My invention relates to improvements made in apparatus for utilizing the force or power of the waves in compressing and storing air for a motive power, to drive machinery, and to perform other work in the various arts and manufactures; and the invention consists in certain novel construction and combination of stationary frame, perpendicularly-moving float, air-compressing pumps, and storage-chamber, producing a simple, durable, and continuously-operating air-compressing apparatus, as hereinafter explained and pointed out in the claim, reference being had to the accompanying drawings, forming part of this specification.

In the said drawings, Figure 1 is a perspective view of an apparatus constructed according to my invention with eight pumps. Fig. 2 is a vertical section. Fig. 3 is a vertical section of one pump. Figs. 4 and 5 are detail views.

A A B B indicate the principal parts of a stationary framework in which the uprights B B are formed of piles driven firmly into position in pairs and united by the horizontal timbers A into a stiff frame. Such a structure may be a part of a pier or a wharf extending into deep water or a part of a break-water, where the same may be found feasible. Where the apparatus is located on a rough shore, it is better to place the structure outside the line of breakers, in order that it may receive the regular beats or pulsations of the waves or the swells as they follow one another toward the shore. This framework of the structure may be extended along the line of the shore for any desired distance, according to the magnitude of the power which is to be supplied, and in such case the apparatus will consist of a number of floats C and a number of pumps D D in gangs or sets connected to and operated by a separate float, the pumps of each float being coupled to a common tank or receiver, and these receivers connected to a common tank or tanks.

The float C is a hollow structure with a flat bottom and perpendicular sides framed to secure suitable strength and stiffness with proper buoyancy. It is made rectangular in form, and the breadth, in most cases, exceeds in measurement the length; and as the action of the float is the most successful when the distance from the front edge, or that side which is presented to the waves, to the rear edge, or that side which is next the shore is less than the shortest linear distance between the crests of the waves, the length of the float should be less than the intervals between the waves, because the perpendicular rising-and-falling movement is best secured when one wave or swell clears the inshore end of the float by the time the following wave or swell reaches the front end of the float. This tends to secure the uniform and even stroke and action of all the pumps. Generally this distance does not exceed forty feet under ordinary conditions of weather, and that measurement may be taken as the average intervals between waves or swells. The extent of the perpendicular movement of the float will vary with the size or height of the waves or swell, and consequently the pumps are of such special construction that they operate under all variations in the length of stroke of the piston. At every rise and fall of the float, whatever the extent of its perpendicular movement, the pumps take in some air and effect some compression, and thus do some work.

Each pump is constructed of a long cylinder secured in upright position between the piles in the frame and connected at the upper end by an elbow E with an air chamber or tank G on the top of the structure. The lower end of the cylinder is open, and a piston F, fitted into this lower portion, is connected with the float by a piston-rod F′, one end of the rod being connected to the piston by a ball-and-socket joint $h^{\times}$, and the lower end attached to one of the top bars H on the float. These bars extend across the top of the float, and to their projecting outer ends are attached the piston-rods, each by a swivel h^{2} or a similar loose joint. This projecting

end of each cross-bar sets between a pair of piles in the stationary frame and is fitted to play easily up and down between such upright guides without binding. At the same time the lateral movement or play of the float in the frame is limited by the bars before mentioned. Each bar at this end is finished round and is covered by a metal sleeve or ring L, fitted to turn on it loosely, so that it will revolve when coming in contact with one or the other of the piles, and that portion of the two piles with which this sleeve comes in contact in the perpendicular play of the float is sheathed with metal, as indicated at M M, to prevent wear of the surfaces of contact. Above the lower portion of the cylinder in which the piston plays at low tide the interior space is divided into a number of compartments by horizontal gridirons or valve-plates D^3 D^4, &c., provided with openings, each fitted to move up and down, and each plate is slotted and fitted to play on the stationary guide-bars $m^\times$ $m^\times$ that are fixed on the inside of the cylinder. A rubber disk N, on the top of the plate over the openings, forms a flexible valve to close the openings and control the passage of air through the plate. This disk is secured at the center by a bolt $n^\times$, but is detached at all other points. The piston has similar openings in its head for passage of air, and is fitted with a flexible disk or flap $N^\times$, attached in the center. All these valve-plates have seats at the bottom of their respective cylinder spaces or sections in which they play upon the ledges, which are formed by the difference between the diameters of one section and the one next below it, and the cylinder is thus divided into valved chambers or sections that communicate one with the other from the bottom to the top through the vertically-movable plates. The object of this construction is to increase and reduce the working length of the pump, according to the changes of the tides and the consequent variation in the working position of the float, for as the tide rises the working position of the float in the stationary frame is necessarily higher, and the piston, being directly connected to the float by a rigid rod, is set higher up in its cylinder, thereby changing its working position in the cylinder and causing it to reciprocate in one or more of the cylinder-sections next above. This will be understood by referring to Figs. 3 and 4 of the drawings, in which one view shows the working position at low tide, while the other represents the piston working in a higher section or space of the cylinder, into which it is raised by the elevation of the float under the rise of the tide. In this last-mentioned change of working position the piston raises the plate next above it off its seat and carries it on the top during its reciprocations, sufficient space around the margin of the piston, between it and surrounding sides of the cylinder, being afforded by the increased diameter of the higher section over the lower section, for the air to pass around the piston on the downstroke and to pass through the plate and lift the rubber disk upon it on the upstroke. This construction secures a continuous action of the pumps in all the rising and falling movements of the float and some degree of compression under all variations in the length of stroke, so that there is practically no loss in the power even under the smoothest swell that will produce a perpendicular movement of the float, for at low tide and under ordinary strokes of the piston the lowermost valve will be raised and dropped as the piston moves up and down, while as the tide rises the piston will move upward in the cylinder and cause one or more of the valve-plates above to be lifted and carried according to the length of perpendicular movement of the float. As the pressure of air in the chambers or sections becomes greater in the lower ones, it raises the rubber valve, and thus passes upward from one chamber to the other until it finally passes the topmost valve and into the tank G. In addition to this, the greatest movements of the float under the roughest sea or the heaviest swell to which it may be exposed will work the pumps without injury to the apparatus, as there is a cushion of air continuously above the piston-head acting with a resistance that increases as the piston reaches the top of its stroke and thus prevents or takes up any violent shock at such times. This construction of pump is indeed a material part of the apparatus and contributes to the successful working. The common chamber or tank G is connected by a pipe with a receiver or an accumulator, which may be located on the shore, or at any desired distance from the motor, and to which the parts or localities to be supplied with compressed air may be connected by suitable pipes.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

The combination, with the stationary framework composed of upright piles in pairs that form guides for a float, the float having projecting bars working between the guides, the pump-cylinders fixed in upright position in the frame over said bars, the vertically movable pistons connected to the float by rigid piston-rods, and the movable valve-plates dividing the cylinders into chambers or compartments and having openings covered by flexible, upwardly acting-valve-disks; the said cylinders being composed of sections increasing regularly in diameter one over the other from the bottom to the top of the cylinder, substantially as hereinbefore described.

In testimony that I claim the foregoing I have hereunto set my hand and seal.

TERRENCE DUFFY. [L. S.]

Witnesses:
EDWARD E. OSBORN,
CHAS. E. KELLY.