May 15, 1923. 1,455,718

N. M. DELONG

HYDROPNEUMATIC DEVICE

Filed Dec. 16, 1921 3 Sheets-Sheet 1

Fig. 1.

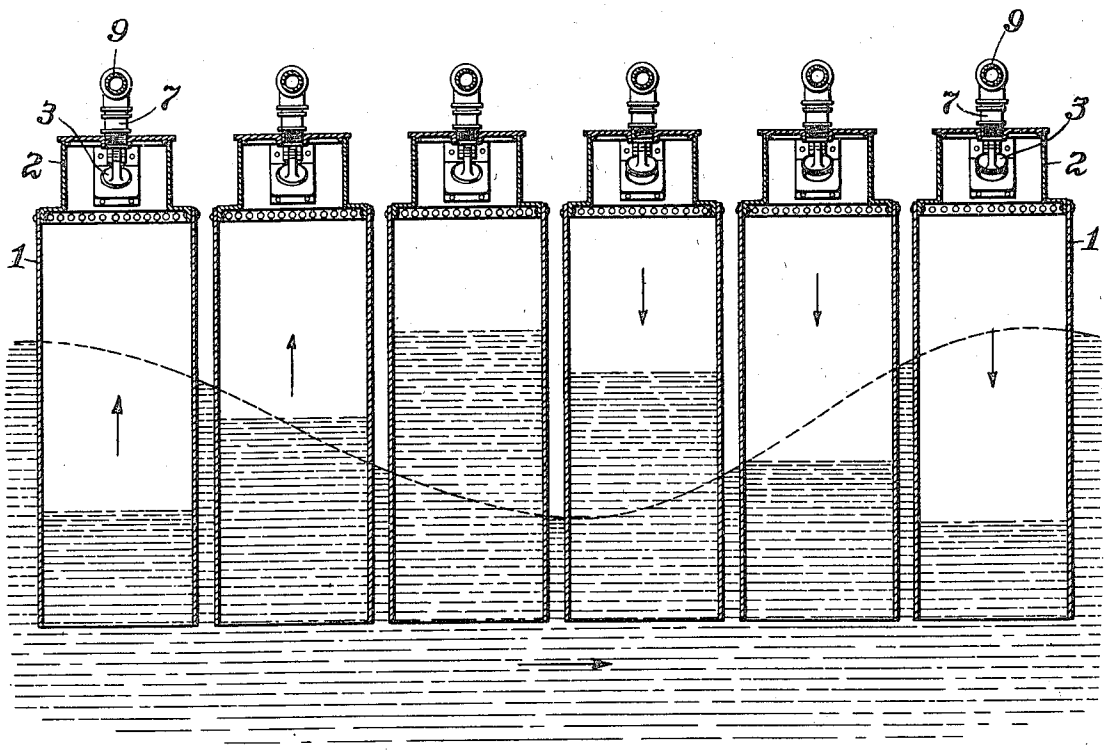

Fig. 3.

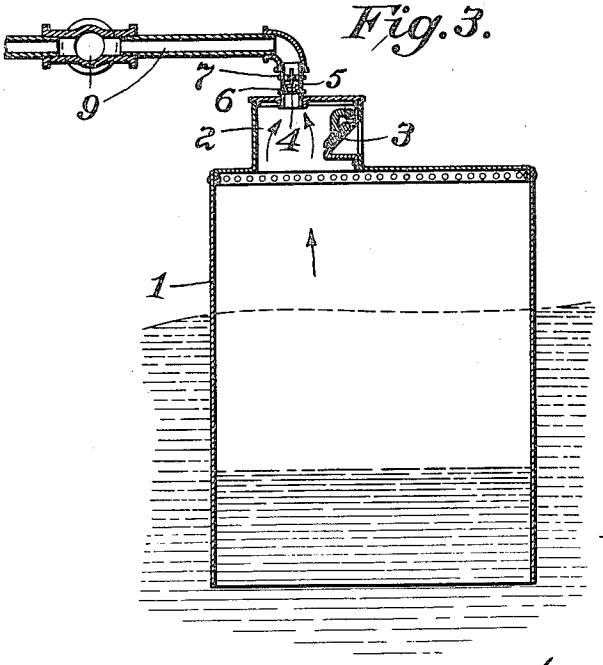

Fig. 3a.

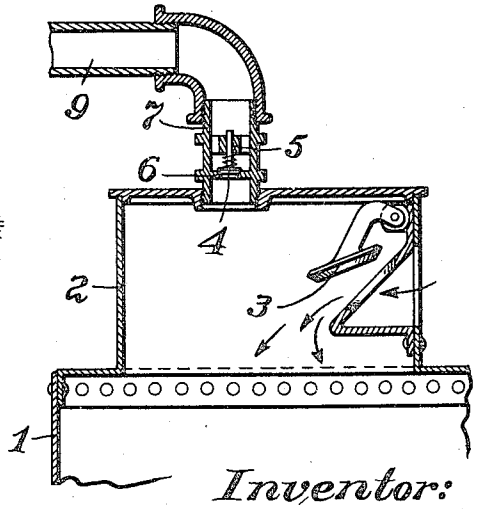

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Fig. 2.

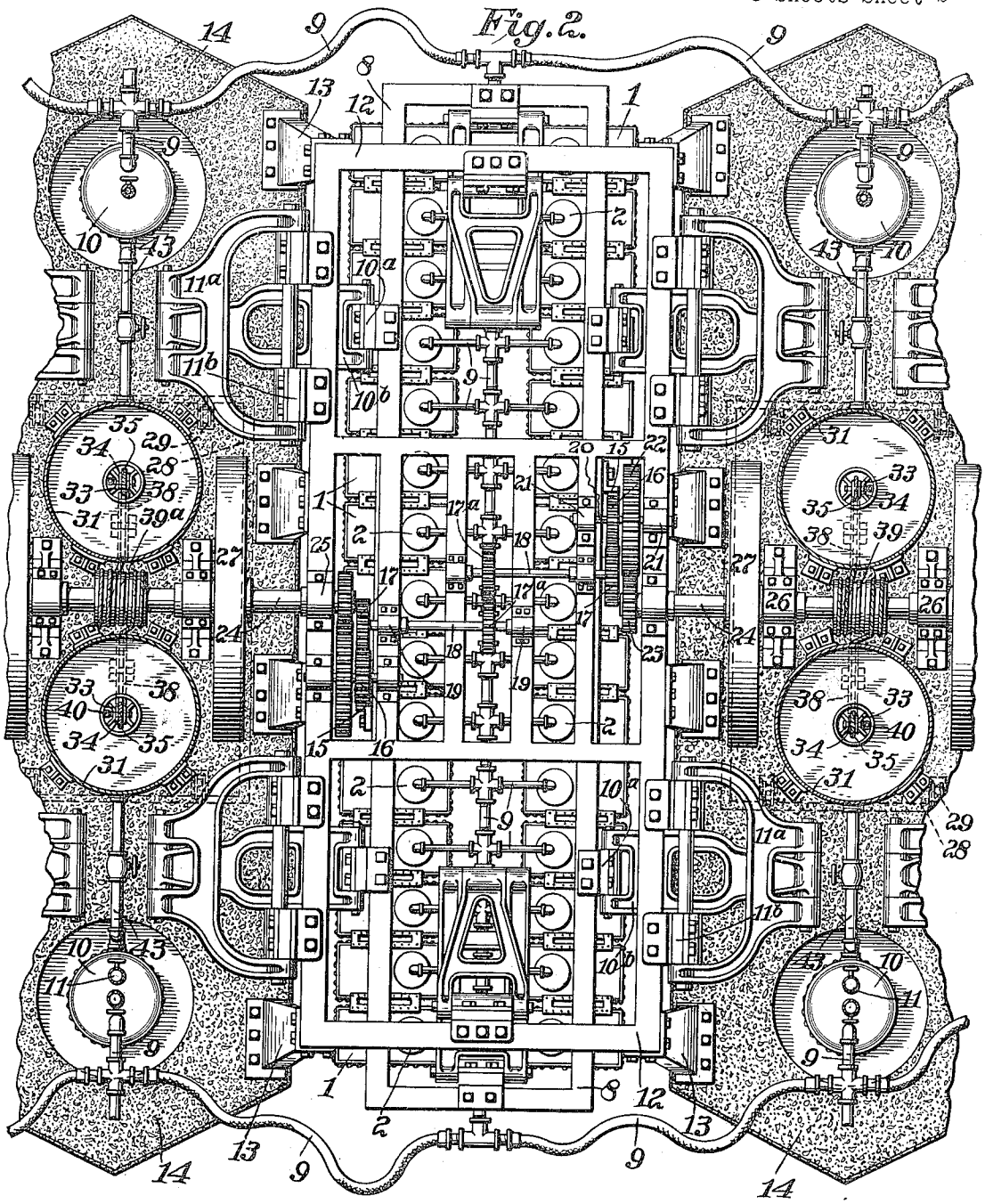

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Fig. 6.

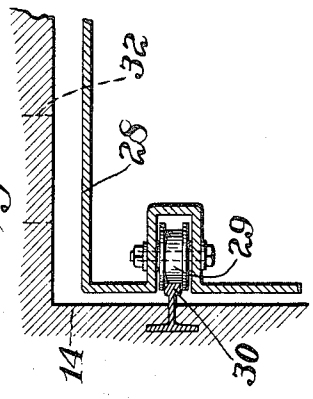

Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE.

NELSON M. DELONG, OF WASHINGTON, DISTRICT OF COLUMBIA.

HYDROPNEUMATIC DEVICE.

Application filed December 16, 1921. Serial No. 522,816.

To all whom it may concern:

Be it known that I, NELSON M. DELONG, a citizen of the United States, and resident of Washington, District of Columbia, have invented certain new and useful Improvements in Hydropneumatic Devices, of which the following is a specification.

My present invention relates to a hydropneumatic device of the type actuated by the force of the waves, and aims to produce means whereby the energy of the rise and fall of said bodies may be utilized to pump or otherwise transmit air under pressure into a suitable container from which it may be removed in any desired manner for the performance of useful work.

The primary object of my invention is to provide a device of the character described which will be automatic in its action, requiring a minimum amount of human attention, which will be efficient in operation, and which may be readily constructed and maintained in proximity to a locality where such waves occur.

With these and other objects in view, my invention comprises a series of chambers open at the bottom which are insertable into the surf to a desired depth, with appropriate inlet and outlet ports at the top of said chambers so that the trapped air as it is forced upward by the water seeking its level within the chamber as the crest of a wave passes a chamber, will find its way into a suitable reservoir, from which the air may be taken as desired for any useful purpose. The invention also includes means for adjustment of the aforementioned chambers for a certain state of the tide which includes an enlarged open bottomed tank being mounted for vertical movement and secured to any number of series of chambers as mentioned above, the vertical motion of the tank being controlled by the amount of air which is allowed to enter said tank, thus causing increased buoyancy in the case of increased contained air or a decreasing buoyancy when a portion of the contained air is allowed to escape into the atmosphere.

The invention further consists of the novel arrangement, combination and construction of parts more fully hereinafter described, and with reference to the accompanying drawings which are to be taken as illustrative only of a form of device found satisfactory by me and to which I do not wish to be limited inasmuch as various modifications and changes may occur to those skilled in this art, and may be practiced without departing from the spirit of my invention.

In these drawings—

Figure 1 is a vertical sectional view through a series of the chambers in which the energy of the waves is made to transmit the initial movement to the air.

Fig. 2 is a plan view of the chambers of Fig. 1 and the air reservoirs and associated mechanism.

Fig. 3 is a vertical section of an individual energy chamber showing the arrangement of intake and exhaust valves.

Fig. 3ª is an enlarged fragmental view similar to Fig. 3 but with the valves in shifted position from that shown in said figure.

Fig. 4 is a vertical section through adjustment tank and compressed air reservoirs.

Fig. 5 is an enlarged sectional view on line 5—5 of Fig. 4, and

Fig. 6 is an enlarged fragmental section on line 6—6 of Fig. 4.

Referring more particularly to the drawing wherein like numerals refer to like parts throughout the several views, the embodiment of my invention illustrated includes a series of energy chambers 1, having open bottoms adapted to be submerged in the surf, having a valve chamber 2 with a suitable inlet valve 3 preferably of the large capacity quick acting type. An outlet valve is also provided and may include a movable plunger 4 suitably carried within a spacing member 5, the plunger being adapted to be moved chamberward against its seat 6 within the delivery pipe 7 in order to close the same.

A flexible pipe 9 connects the several delivery pipes 7 of the energy chambers 1 with a storage reservoir 10 which is also provided with a valved outlet 11 which may be either manually or automatically controlled.

There may be several such storage tanks for each series of energy chambers and it is preferable that several or all storage tanks be intercommunicative in order to more readily establish a uniform pressure, so that a mean condition will obtain throughout the system.

The energy chambers 1 are preferably spaced apart from each other and arranged in series rigidly connected to a frame 8, pivotally supported through hinge parts 10^a 10^b and hinge parts 11^a, 11^b to an upper frame 12 which is rigidly supported upon uprights 13 to a suitable pier 14 of cement or like construction which will give the needed rigidly. It will thus be noticed that frame 12 is permanent while frame 8 is allowed a certain vertical movement, such movement between extreme collapsed position of hinge parts 11^a and 10^b and the extreme expanded position thereof being equal to the difference in tide levels in any given locality.

Suitably mounted upon frame 8 is a vertical rack 15 meshing with gear train 16, 17, the latter gear being carried upon axle 18 journaled in bearings 19 on frame 12, said axle also carrying a similar gear 17^a. Shaft 20, journaled at 21 upon frame 12, carries gear 22 meshing with pinion 23 which is carried by drum shaft 24 journaled on frame 12 at 25 and on pier 14 at 26. A balance wheel 27 of sufficient weight to respond to a variance in tide levels only, but which will not be responsive to wave action is provided on shaft 24. Thus, as shaft 24 is held against rotation by the weight of balance wheel 27, except through a difference of tide levels, frame 8 carrying the energy chambers is also held against vertical movement by wave action because of the positive connection between the rack 15 carried by the frame, and the balance wheel.

Means must be provided to raise and lower the energy chambers according to the state of the tide and one form of device which has been found satisfactory consists of a regulating tank 28 having an open bottom, mounted for vertical movement as by means of rollers 29 engaging the track 30, which is placed within a recess in pier 14 and which recess is situated under bulkheads 31 for a purpose more fully hereinafter described.

This pier is provided with a suitable number of perforations 32 which will allow water freedom of access to and exit from the recess, but which perforations are of such a nature that the level of water inside the recess will change only with the state of the tide, and will not be responsive to individual wave action.

Adjustment tank 28 is provided with an upwardly extending framework 33 carrying pulley 34 adapted to receive cable 35. This cable is made secure at one end as by expansion bolt 36 embedded in pier 14, then passing around pulley 37, also mounted upon the pier, around the pulley 34, also around additional pulley 38, suitably mounted to wind eventually upon drum 39, carried by shaft 24. A like mechanism is arranged on the other side of the tank 28, the only qualification being that its cable 35^a shall also wind upon drum 39 on the same side as cable 35.

Thus, it will be seen that movement of the adjustment tank 28 will, through framework 33, impart motion through cable 35, 35^a and cause a rotation of drum 39, which through gear train 23, 22, 16, the latter gear being in mesh with vertical rack 15, will cause a corresponding movement, when the gears are in proper ratio, to frame 8 with its energy chambers. A duplicate vertical rack and gear train are arranged on the opposite side of frame 12 which will impart a like movement to a similar drum 39^a controlling an adjustment tank similar to tank 28. Obviously this series of frames and adjustment tanks may be repeated as conditions necessitate.

It is necessary that the cubic capacity of air in adjustment tank 28 above the water level will be greater than the combined capacity of energy chambers 1 above the water level at any given time in order that the movement of the energy chambers may be controllable from the adjustment tank.

It is desirable that means independent of tide action be provided to actuate the vertical motion of the adjustment tank in order to initially adjust the submergence of the mechanism, or if it is desired to completely submerge or float the entire device. One form of means I have shown to consist of a flexible pipe 40 connected to valved outlet 11 of compressed air reservoir 10. Pipe 40 connects with adjustment tank 28 in any manner which will allow vertical movement of the tank, and yet will maintain an air tight connection, such as slip joint 41. A suitable outlet 42 which may be of any automatic nature or if desired manually controlled, may be provided in tank 28, to allow the contained air to escape into the atmosphere. With this construction by opening valved outlet 11 in the compressed air tanks 10, pressure may be forced upon the water in adjustment tank 28, thereby expelling an amount, causing an added buoyancy to this tank which through its cable and associated gears will cause a like upward movement of frame 8 containing the energy tanks. If outlet 42 in the adjustment tank be opened, allowing the air to escape through the valve 42^a, the tank will sink, which because of its connection to the energy tanks, will cause a

like movement therein, which movement may be checked when the chambers have reached the proper submergence.

It may be found desirable in order to secure a more uniform pressure from the compressed air tanks 10 to the pneumatic machinery, to provide a bulkhead such as is shown at 31 connected to the bottom of tank 10 by pipe 43. As the compressed air is removed from the system to the pneumatic machinery, water from the bulkheads will flow into the tank 10, thus maintaining a steady pressure. The bulkheads 31 have been shown for convenience surrounding the framework 33, but obviously may be constructed in other forms.

The operation of the device is as follows:

The energy chambers are first adjusted to a proper submergence according to the state of the tide by a manipulation of valved outlet 11 in the compressed air reservoir which will conduct air to the adjustment tank; or outlet 42 in said tank may be opened, thus releasing air from the tank, according to the necessity of raising or lowering the energy chambers. This degree of submergence having been secured, the waves in passing the chambers as shown in Fig. 1, cause a movement of the water inside the chambers, and said water in seeking its level, forces air through the valve chamber 2 and the outlet valve therein, through flexible pipe 9 to the compressed air reservoirs 10, there to be used for any desired purpose. When the peak of the wave has passed a particular energy chamber, the level of the water will tend to fall and will cause inlet valve 3 to actuate, thus relieving the vacuum within the chamber and causing a corresponding fall in the level of the water in the chamber.

The cycle of operations is then complete.

I claim—

1. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air and automatic means remote from said chamber to raise and lower said chamber according to the state of the tide.

2. The device of claim 1, and means responsive to change in tide level to increase or decrease the submergence of the chamber.

3. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a rigid base.

4. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a second frame, said second frame being secured to a rigid base.

5. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a rigidly mounted second frame, and means to prevent movement between the frames.

6. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a rigidly mounted second frame, and means to prevent movement between the frames, said means including a rack and pinion.

7. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a rigidly mounted second frame, and means to prevent movement between the frames, said means including a rack and pinion, and a drag on said pinion.

8. A hydropneumatic device adapted to be actuated by the force of waves including a submergible chamber having a water entrance, an outlet in said chamber for the exit air displaced by said entering water, and means to collect said air, said chamber being secured to a frame hingedly connected to a rigidly mounted second frame, and means to prevent movement between the frames, said means including a rack and pinion, and a drag on said pinion, said drag comprising a balance wheel connected through a gear train to said pinion.

9. In combination, a device for pumping a fluid by utilizing the energy of waves and means remote from the pumping device operable through a differential tide level for raising or lowering said device a vertical distance corresponding to the said differential tide level.

10. The device of claim 9, said means including a tank mounted for reciprocal movement.

11. The device of claim 9, said means including a tank having an aperture therein through which water may enter when the tank is partially submerged.

12. The device of claim 9, said means including an open bottomed tank.

13. The device of claim 9, said means including a buoyant tank.

14. The device of claim 9, said means including a tank provided with means to raise or lower the same.

15. The device of claim 9, said means including a buoyant tank with means to increase or decrease the buoyancy thereof.

16. The device of claim 9, and means to prevent undesired actuation of said raising and lowering means.

17. The device of claim 9, and means to prevent undesired actuation of said raising and lowering means, said prevention means including a balance wheel.

In testimony whereof I affix my signature.

NELSON M. DELONG.