(No Model.) 2 Sheets—Sheet 1.

L. G. COOK

HYDROPNEUMATIC ENGINE.

No. 272,656. Patented Feb. 20, 1883.

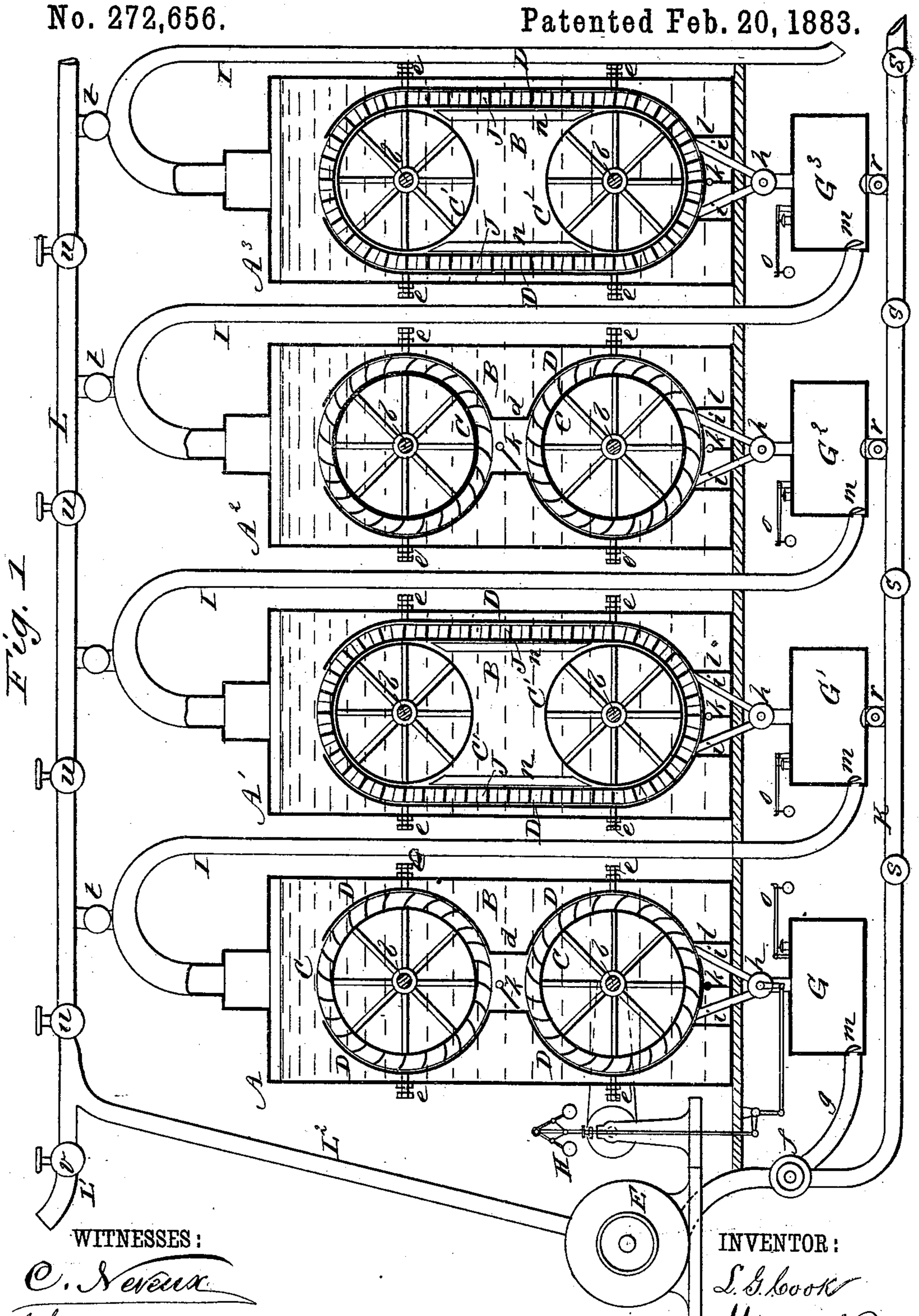

Fig. 1.

WITNESSES:

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3

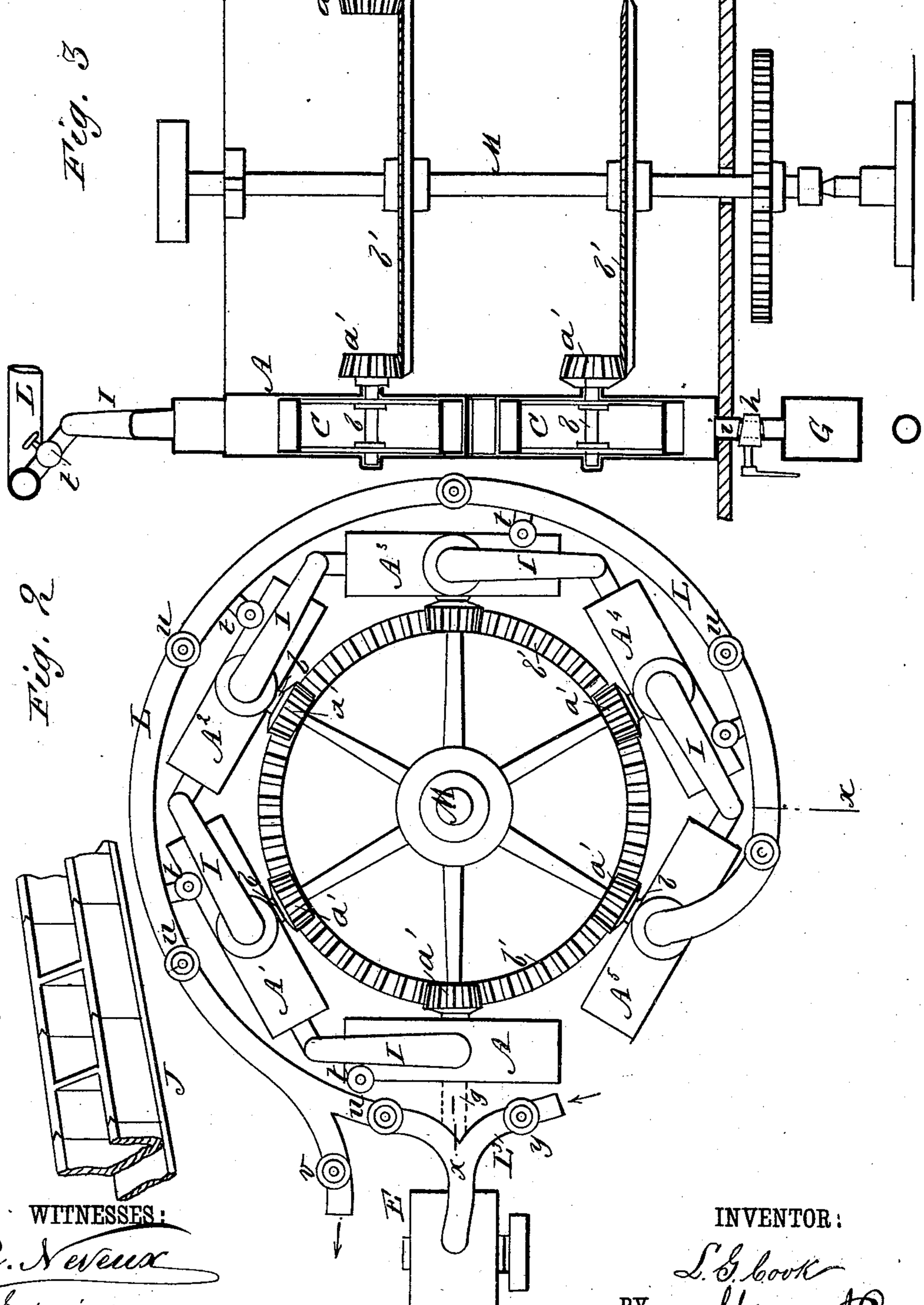

Fig. 2

Fig. 4

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UNITED STATES PATENT OFFICE.

LEVI G. COOK, OF MAPLEVILLE, RHODE ISLAND.

HYDROPNEUMATIC ENGINE.

SPECIFICATION forming part of Letters Patent No. 272,656, dated February 20, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, LEVI G. COOK, of Mapleville, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Hydropneumatic Engines, of which the following is a full, clear, and exact description.

This invention relates to a method of and apparatus for utilizing atmospheric air, or other air or gas under pressure, subject to percolation or passage up through a column or body of still water or liquid, or metal in a liquid state, such as quicksilver, to the driving or rotation of a series of submerged wheels, from the shafts of which the power obtained may be transferred as required; and it consists in certain combinations of devices or details for advantageously working and controlling the apparatus, as hereinafter fully described, and pointed out in the claims.

Reference is to be had to the accompanying drawings, forming part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 represents a vertical section of an apparatus constructed in accordance with the invention, showing the same as arranged in a straight line or plane. Fig. 2 is a plan of the same when arranged to assume a circular form and to give motion to a vertical shaft in central relation thereto. Fig. 3 is a vertical transverse section on the irregular line *x x* in Fig. 2; and Fig. 4, a perspective view, upon an enlarged scale, of an endless belt of buckets, in part, used in the apparatus.

In the accompanying drawings, A A′ A^2 A^3 indicate a series of covered wells or tanks of any desired depth, and which may either be arranged in a straight line or plane, as shown in Fig. 1, or in a circular form, as shown in Figs. 2 and 3, the arrangement represented in Fig. 1 being substantially the same as that shown in Figs. 2 and 3 when straightened out. These tanks A A′ A^2 A^3—of which there may be any number, not less than two in a series, arranged side by side or consecutively on the same level, or thereabout—it is proposed to nearly fill with water or other liquid, B, including quicksilver, which may be preferred on account of its superior density and as affording a fuller development of the power; but it will suffice here to generally refer to such liquids as water. When water is used, it may have alcohol mixed with it to keep it from freezing. Arranged within these tanks are any number of submerged bucket-wheels, or devices for developing or communicating the power which is derived from the passage of compressed air or gas of any suitable kind up through the liquid in the tanks, and so that it acts upon or against said submerged devices. The first tank, A, is represented as fitted with a pair of submerged vertical bucket-wheels, C C, situated one above the other, as in a former application for patent by me, which has been allowed. The wheels are fast on horizontal shafts *b*, arranged to project through stuffing-boxes in one side of the tank or well A, for the purpose of communicating power from said wheels.

D D are upright curbs or concaves, arranged to circumscribe the wheels C C on opposite sides of their axes, and connected—that is, the opposite curbs of both wheels—by a neck or duct, *d*. These opposite segmental curbs are adjustable toward or from their respective wheels by means of adjusting-screws *e e*, to provide for the wheels working in close connection, but free from absolute contact with them, in order that there may be no wasteful escape of air or gas past the wheels.

E is a blower or air-forcing device for passing air or hydrogen or other gas under pressure, but which it will suffice to denominate "air," up through the liquid in the tank A. To this end the blower E is caused to deliver or compress the air within an air box or chamber, G, when a cock, *f*, in a connecting-pipe, *g*, is opened for the purpose. From said compressed-air box, which is arranged below the tank A, the air is passed through a valve, *h*, controlled by a governor, H, driven by the engine into and through either one of two diverging conductors *i i*, according to the direction in which it is required to run the wheels C C. These conductors connect at their upper ends with openings in the lower curbs, D D, on opposite sides of a vertical line passing through the axes of the wheels C C, and arranged between them is a flap-valve or deflector, *k*, that is arranged within a neck or chamber, *l*, and serves to prevent any air which

may leak past the delivery end of the discharging-conductor from passing to act in a contrary direction on the lower wheel C, said flap-valve being operated by the pressure of such air on it and caused to close against the other conductor. The air forced by the blower, working against the pressure of the liquid in the tank A, percolates up through the water in either conductor *i*, and acts either directly or indirectly through the water upon the buckets of the lowermost wheel C to rotate it, the curb D on the side of the discharging-conductor *i* preventing the ineffective diffusion of said air away from the rising portion of the wheel. After having acted upon the lowermost wheel C, the air passes to act in a similar manner upon the next wheel C above it, the neck or connection *d* serving to conduct the air thereto, and a pivoted pendent deflector, *k*, within said duct *d* automatically operating by the pressure of the water to prevent the air from acting in a contrary direction on the upper wheel, and to direct it onto the rising side of said wheel. Any number of these wheels C C may be arranged in the tank A, to be similarly operated upon in succession by the air, as, by reason of its lighter specific gravity and pressure imparted to it, it percolates through the denser still liquid in the tank.

Instead of allowing the air after it has performed its duty upon one set of wheels in the tank A to pass off to the atmosphere or to be returned directly to the blower, unless so required, I cause the compressed air collecting in the upper part of the tank A to be conducted by a pipe, I, down to a second compressed-air box or chamber, G′, from whence it is passed by a valve, *h*, and one or other of two diverging conductors *i i*, having a pivoted deflector, *k*, between them, to act either directly or indirectly through the liquid, as before, upon an endless belt, J, of buckets arranged around upper and lower wheels, C C′, mounted on horizontal shafts *b b*, and which have their direction in motion controlled by the admission of the air to either one of the conductors *i i*. This endless belt of buckets J is supported internally between the wheels by guides or backing-strips *n*, and is inclosed on both its exterior sides by curbs or outer guides, D D, leaving an escape-opening between them at top, and adjustable by screws *e e* toward the ends of the buckets. By this arrangement the air is confined to act directly or indirectly through the water upon the buckets, and by the use of the endless belt of buckets much power is obtained with very little friction.

The same method of utilizing the escaping air collecting in the upper portion of the tank A′ of still liquid may be repeated, by means of dip-pipes I I, air-boxes G^2 G^3, and appliances as before described, successively in the tanks A^2 A^3, and so on indefinitely for any number of tanks and motors, or mechanical driving devices arranged within the still liquid therein, and which may either be bucket-wheels or endless belts of buckets, or both.

The pipes *g* and I may each be provided with foot-valves *m m*, to retain the air in the boxes G G′ G^2 G^3 when the blower is stopped, and each of these boxes, if desired, be fitted with a safety-valve, *o*.

The air delivered by the blower E may either first be transmitted by the pipe *g* to act upon the motor or wheels in the first tank, A, and afterward be utilized in the other tanks, as described, or it may be transmitted to any one or more of the subsequent tanks direct by means of a supply-pipe, K, to which the air from the blower may be admitted by the valve *f*, instead of to the pipe *g*, and which pipe K is connected with the air-boxes G′ G^2 G^3 by valves *r*, and provided intermediately of said boxes with valves *s*, to admit of such varied supply of air to the tanks that will be found very convenient in case of the motors in any one or more of them breaking down, or as other circumstances may require. The air or gas, after it has done its duty in the tanks, or any of them, may either pass off to the atmosphere or be returned to the blower to be used over again. For this purpose, and to provide for the separate or joint working of the motors in the tanks, said tanks or their connecting-pipes I are put in or out of connection by valves *t* with a general delivery-pipe, L, having valves *n* arranged in between the connections or valve *t*, and terminating at its outer end in a discharge branch, L′, communicating with the atmosphere and controlled by a stop-cock, *v*, also terminating in a branch or pipe, L^2, leading to the blower, for returning the air thereto by closing the valve *v*.

When the blower is not used to work the same air over and over again, then the blower must be supplied with air from the exterior by a separate pipe controlled by an independent valve, as shown in Fig. 2, and indicated by the letters L^3 and *y*.

Fig. 2 shows the same system or method of working as does Fig. 1; but in Figs. 2 and 3 a series of tanks, A A′ A^2 A^3, &c., of which there may be any number, are represented as arranged circularly around a central shaft, M, and as showing the shafts *b* of the wheels in each of said tanks as communicating driving motion to said central shaft by means of bevel-pinions *a′* on said shafts *b* and bevel-wheels *b′* on the shaft M, thus obtaining the effective driving force of all the motors in the tanks upon a single shaft. Such driving force may, however, be divided, if desired, and the motor in each tank be utilized separately; or the motors in the several tanks may be made to work partly in concert or collectively by other means when the several tanks are arranged in the same straight line or plane, as shown in Fig. 1.

When bands J of buckets are used in the tanks, then the buckets should be constructed to open and close joints at their meeting edges, when passing round the wheels which carry them, by making said edges of male and female V-shape, as represented in Fig. 4, to

prevent leakage of the air at the joints of the buckets.

The denser the still liquid in the tanks and the less specific gravity the air or gas which rises therein, the greater will be the propelling-power on the wheels. Hence in some cases I propose to use quicksilver as the still medium and hydrogen gas as the active agent.

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

1. In a hydropneumatic engine, the combination of two or more still-liquid tanks, A A′ A^2, one or more motors arranged in each of said tanks for operation by air or gas under pressure rising through said liquid, and one or more pipes, I, arranged to connect the upper portion of one tank with the bottom of the next succeeding tank or chamber connected therewith, whereby the air or gas collecting in the upper portion of one tank is transmitted for further utilization within a succeeding tank, substantially as specified.

2. In a hydropneumatic engine, the combination, with one or more rotating wheels or motors arranged within a still-liquid tank for operation by air or gas under pressure rising through said liquid, of the diverging ducts *i i* and valve *h* controlling the same, for reversing the action of the motors, when required, by conducting the air or gas to act upon the opposite sides of the axes of the motors, essentially as described.

3. The combination of one or more automatic deflectors, *k*, with the wheels or motors C C or C′ C′ J and the curbs D D, substantially as and for the purposes herein set forth.

4. In combination with the wheels or motors C C or C′ C′ J and still-liquid tank or tanks in which said motors work, the curbs or guides D D, made adjustable toward or from said motors on opposite sides of their axes, essentially as described.

5. In a hydropneumatic engine, the combination, with a blower, E, or other air or gas forcing means, and with a series of connected still-liquid tanks, A A′ A^2 A^3, having motors arranged within them for operation by air or gas from the blower, as described, of the chambers G G′ G^2 G^3, the supply-pipes *g* K, the valves *f r*, the delivery-pipe L, with its branches L′ L^2, the connections *t*, and the valves *u v*, substantially as and for the purposes herein set forth.

6. In a hydropneumatic engine, the combination of a circular series of connected still-liquid tanks, a series of motors within said tanks for operation by the continuous flow of the air or gas within said tanks successively, a driving-shaft arranged to occupy a central portion relatively to said tanks, and gears connecting said central shaft with the motors in the tanks, essentially as specified.

LEVI G. COOK.

Witnesses:
EDMUND H. SMITH,
JOHN A. BAILEY.