(No Model.) 2 Sheets—Sheet 1.

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HYDRAULIC MARINE MOTOR.

No. 366,768. Patented July 19, 1887.

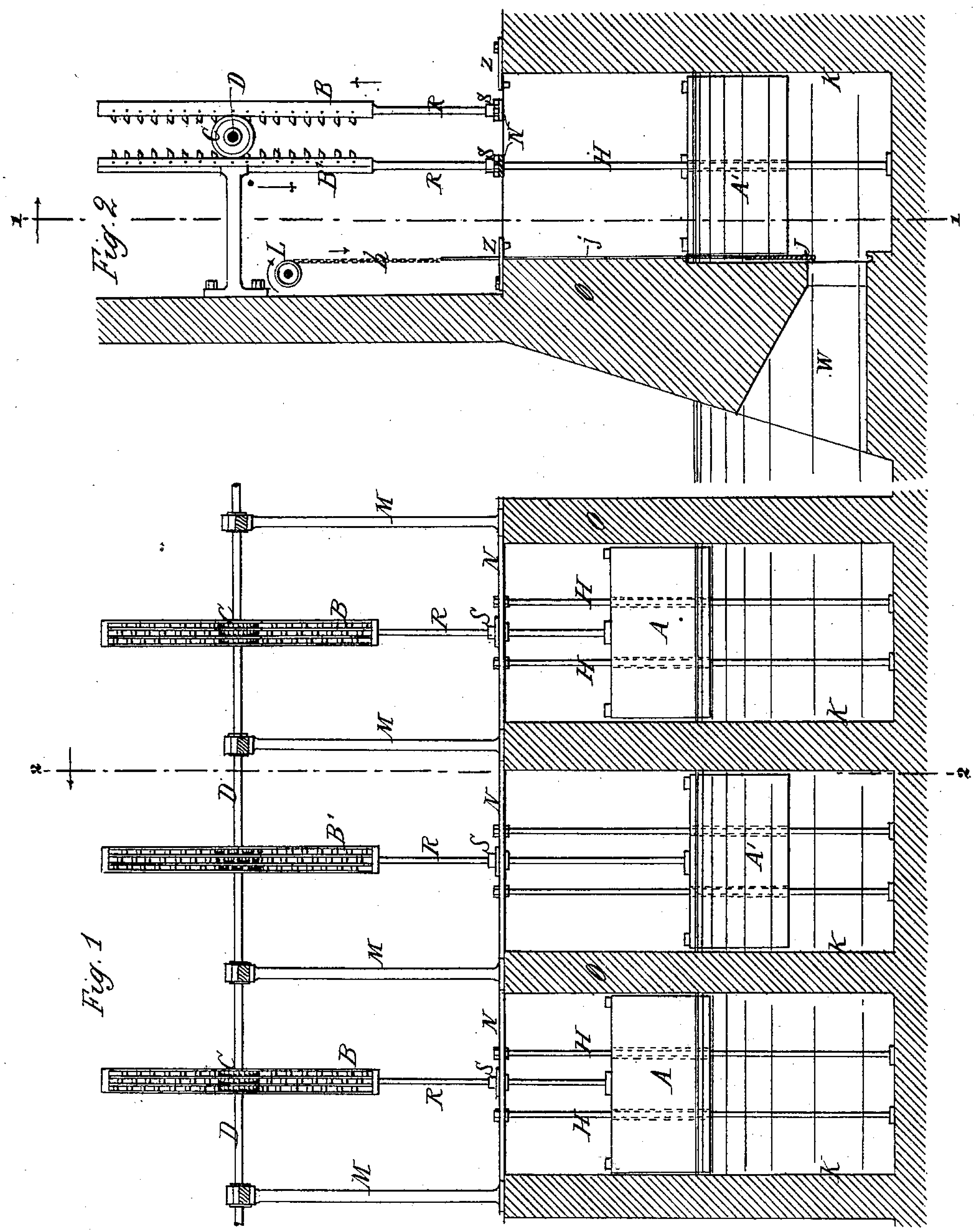

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Fig. 5

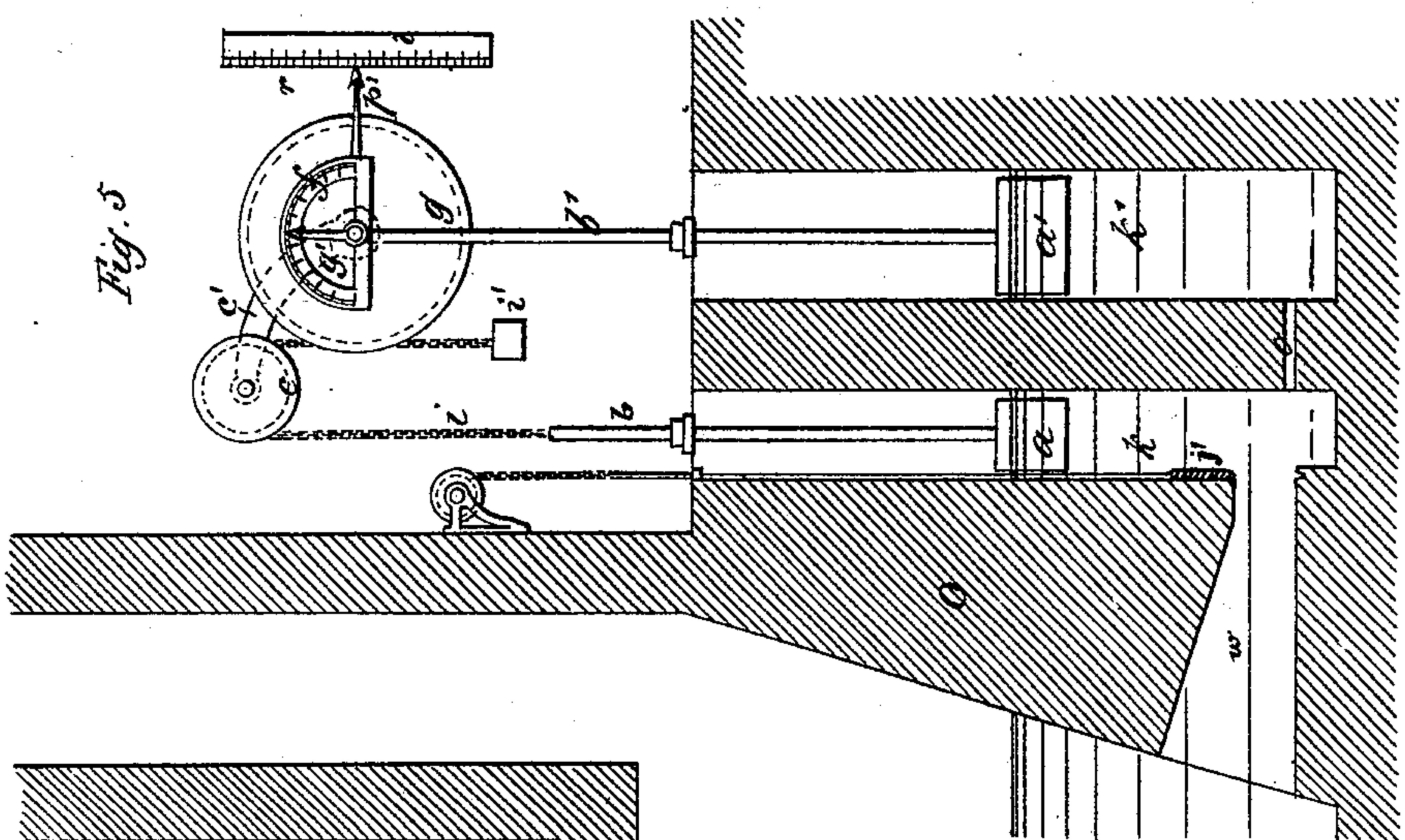


Fig. 3

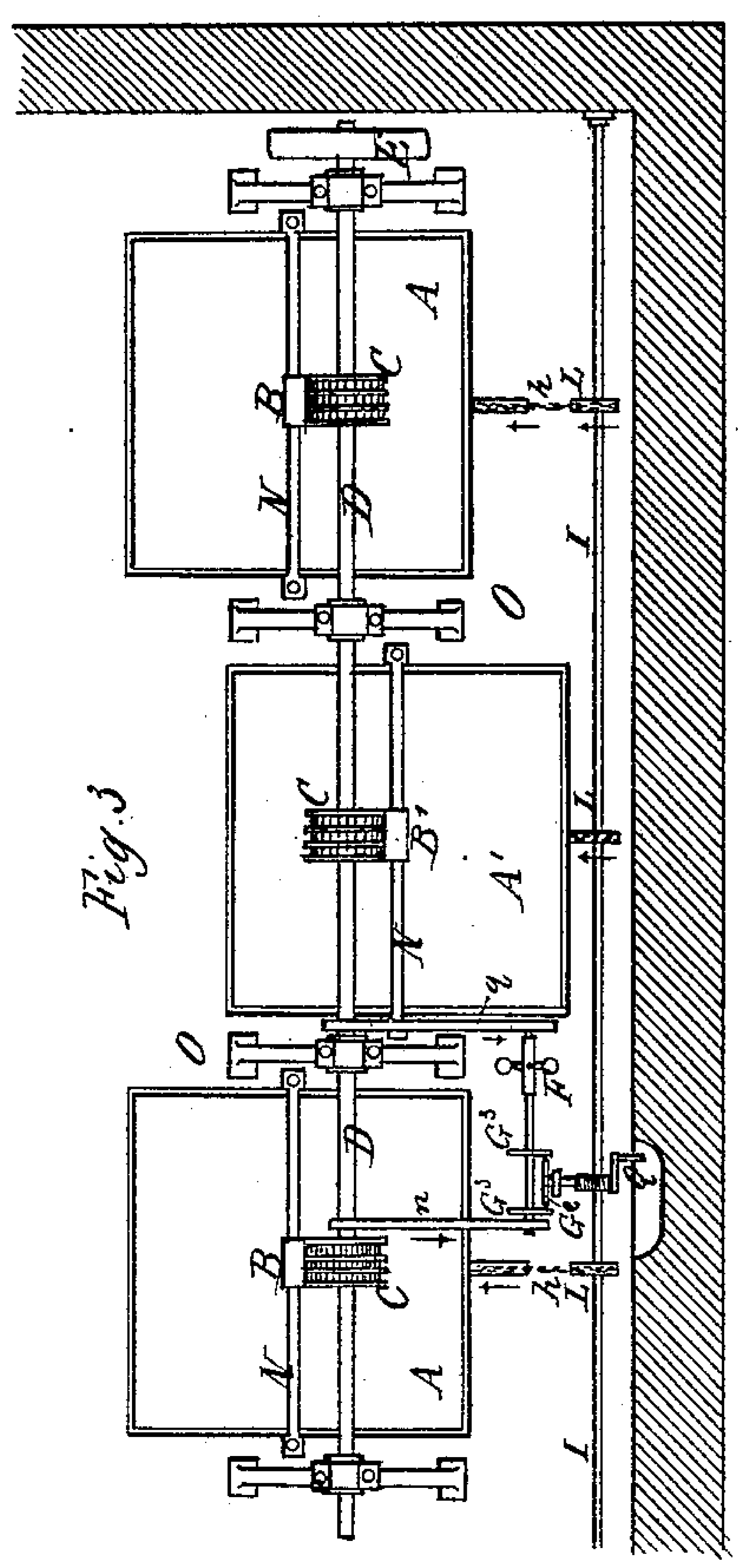
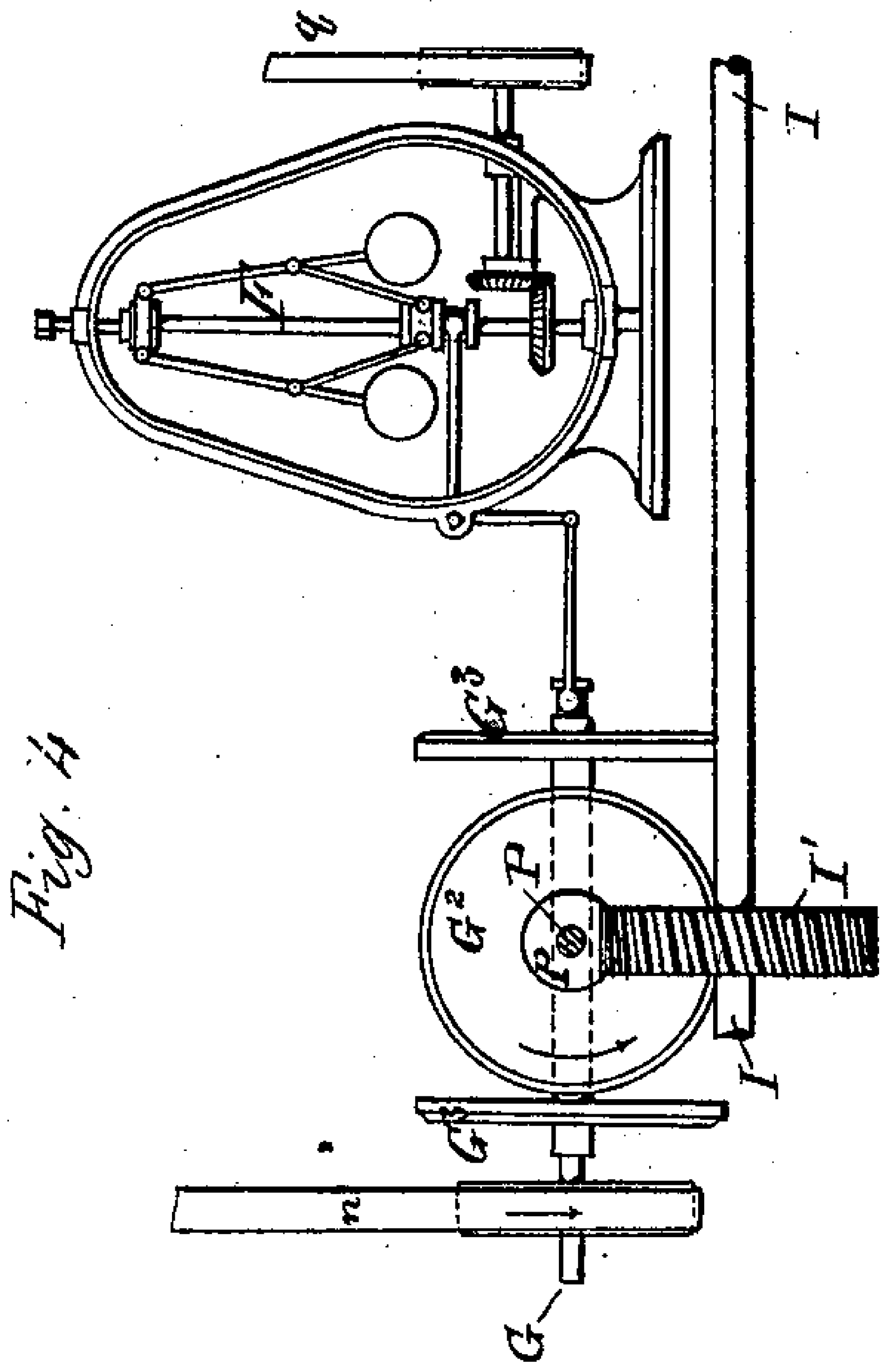


Fig. 4



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UNITED STATES PATENT OFFICE.

JOSEPH ELIAS, OF BEYROOT, SYRIA.

HYDRAULIC MARINE MOTOR.

SPECIFICATION forming part of Letters Patent No. 366,768, dated July 19, 1887.

Application filed September 30, 1886. Serial No. 215,032. (No model.) Patented in Turkey May 10, 1886, No. 64.

To all whom it may concern:

Be it known that I, JOSEPH ELIAS, a subject of the Sultan of Turkey, and a resident of Beyroot, Syria, have invented certain new and useful Improvements in Hydraulic Marine Motors, (for which Letters Patent in Turkey were granted May 10, 1886, No. 64,) of which the following is a specification.

The object of this invention is to provide a mechanism for utilizing the power of the waves of the sea. My invention is to be distinguished from that class of wave-power motors which owe their action to the superficial movement of the waves, since in my apparatus it is from the pressure exerted by the water at a considerable depth below the surface that the power is derived. I so construct the apparatus that the moving parts are protected from the irregular and sometimes dangerous shocks of the waves, while at the same time a normal communication with the depths of the water is maintained to such effect that the dynamic energy resulting from the force of the waves is collected and rendered useful.

My apparatus consists, essentially, of two or more floats—preferably several—each occupying a separate chamber in which it may freely rise and fall, and each chamber being in communication with the sea at a suitable depth. The floats carry racks gearing with toothed wheels on a revolving shaft, or other equivalent mechanical connections may be applied in such manner that on the rising and falling of the floats the shaft is rotated. The floats are of two kinds, being respectively light and heavy. The light floats are very buoyant and are so connected as to drive the shaft when ascending, while the heavy floats are nearly submerged and act by their weight to drive the shaft during their descent. By this means all lost motion is avoided.

I provide for regulating the apparatus by means of a governor, and also a dynamometer for indicating the operation and denoting the tide-levels.

The accompanying drawings illustrate my invention in detail.

Figure 1 is a front elevation in section on the line 1 1 in Fig. 2. Fig. 2 is a side elevation in section on the line 2 2 in Fig. 1. Fig. 3 is a plan partly in horizontal section. Fig. 4 is a front elevation of the governing apparatus on a larger scale; and Fig. 5 is an elevation of the indicating apparatus, the masonry being in vertical transverse section.

Let A A′ designate the floats, and K K the chambers. These chambers are formed in masonry O, are of any desired number, and are in communication with the water of the sea by the openings W, so that the water inside the chambers naturally seeks the same level as that of the sea outside. These openings should be at such a depth as to be always below the level of the sea, even at low tide. For the Mediterranean I place them 1.40 meters beneath the mean level; but this depth must be varied for different places, depending on the amount of rise and fall of the tides and upon other circumstances.

The floats A A′ are made preferably of sheet-iron or iron plate, and are so mounted as to be free to rise and fall in the chambers K K with the rise and fall of the water-level therein. Each float is guided by two vertical rods, H H, fixed at their lower ends to the bottom of the chamber and at their upper ends to a cross-frame, N. The float has two corresponding tubes fixed in its interior, and through which these rods extend. Any other suitable arrangement of guides may be adopted. The floats A A are the light floats, being entirely empty, and consequently having great buoyancy. The floats A′ A′, on the contrary, are the heavy floats, being heavily ballasted either by being partly filled with water or by being otherwise weighted, so that they are nearly submerged.

D is the motor-shaft of the apparatus, mounted in bearings in fixed frames M M and revolved by the rising-and-falling movement of the floats. A belt-pulley, E, is fixed on this shaft for the purpose of transmitting the power to other machinery that is to be driven.

The floats A A and A′ A′ rise and fall simultaneously with the variations of the water-levels in the chambers, and in so doing act upon this motor-shaft in alternate manner. During the ascending movement the buoyant floats A A alone act to revolve the shaft, the others being passive; but during the descending movement the ballasted floats A′ A′ alone act and the others are passive. This result is attained by the interposition between each of the floats and the shaft of some kind of single-acting mechanical connection, so that when the float is moving in one direction it engages the shaft, and when moving in the other direction it disengages itself, and by relatively reversing this single-acting mechanism for the respective floats, so that the engagement is in one direction for the heavy floats and in the opposite direction for the light floats. Any suitable or practicable known "mechanical movement" may be employed as this mechanical connection; but the most convenient and simple mechanism for the purpose is the one shown, which I will proceed to describe.

On the shaft D are fixed toothed gear-wheels C C, one for each float. These wheels are in mesh with vertical racks B B B′ B′, which are connected by rods R R with the respective floats. The rods R R are guided in boxes S in the cross-frames N N. The racks B B, which are connected to the light floats A A, engage the wheels C C on one side, while the racks B′ B′, which are connected to the heavy floats A′ A′, engage the wheels C C on the opposite side. Each of the racks has its teeth pivoted to it and beveled, as shown in Fig. 2, so that the teeth are rigid when it is moving in one direction and positively engage and turn the wheel, but when moving in the opposite direction the teeth are deflected and produce no effect. The racks B are rigid in rising, but in descending their teeth are displaced in passing the wheel, and do not resist its continued forward revolution. The racks B′ are of the same construction, but inverted. To give greater strength and a smoother movement, the racks are made in three ranges or rows of teeth, the teeth being set successively in advance of one another, as shown in Fig. 1. The wheels C are likewise of three rows of teeth.

Prior to my invention wave-power motors have been made in which the floats are double-acting—that is, in which each float acts upon the shaft both during its ascent and descent. In all such motors there is a great loss of power and speed through what may be called "lost motion" or "backlash." For example, in ascending the resistance of the machinery to be propelled holds down the floats to a deeper submergence than the normal, and when the pressure of the wave ceases and the reaction begins the float does not begin to exert any downward pressure until after the water has subsided sufficiently to leave the float in equilibrium, and even then the subsidence must continue until a sufficient weight of the float is out of water to equal the resistance of the machinery before any motive effect will be produced. To make this more clear, let us suppose that in order to move the machinery to be driven the float has to be lifted out of the water in descending or pressed down into the water in ascending one foot beyond its normal position. Then at the turn of the ascending wave the float is depressed one foot, and hence the water has to descend two feet before the float exerts an effective downward pressure. Then at the turn of the descending wave the effective downward pressure ceases, and the wave has to ascend two feet before the float exerts a sufficient upward pressure again. Thus the float is in great measure impotent during a considerable part of the time. If we imagine that the waves rise and fall only four feet, we perceive that during one-half the time the floats are practically powerless, while if the rise and fall is only two feet the floats become altogether ineffective.

My present invention entirely avoids this source of loss, since the floats act only in one direction. By their being divided into two classes and acting at alternate times the propulsive pressure is as nearly continuous as is possible in motors of this nature.

The openings W W of the respective chambers are provided with sliding doors or valves, one of which is shown at J in Fig. 2. These are for the purpose of reducing more or less the area of the openings, in order to reduce, when necessary, the violence or amplitude of the movements of the floats. Each valve J is fixed to a rod, *j*, which is suspended from a chain, *h*, which is passed over and fastened to a pulley or drum, L. The several drums L L are fixed on a shaft, I, which may be turned in order to open or close all the valves J J simultaneously. This shaft may be turned either by hand or by an automatic regulating mechanism. (Shown in Fig. 4.) The shaft I carries a worm-wheel, I′, which meshes with a worm, *p*, on a short horizontal shaft, P, on which shaft is fixed a crank, Q, for turning the parts by hand. On the opposite end of shaft P is fixed a friction-wheel, G^2, (or a bevel-gear,) which may mesh at any time with either one or other of two similar friction-wheels, (or gears,) G^3 G^3, on a shaft, G. This shaft is rotated by a belt, *n*, from the main shaft D, and is capable of sliding longitudinally in its bearings, so as to bring either of its wheels G^3 G^3 into engagement with the wheel G^2, and thereby to revolve the shaft P in one direction or the other, and consequently to revolve the shaft I and open or close the valves J J. The longitudinal movement of the shaft G is effected by a centrifugal governor, F, of any suitable kind, (such as a ball-governor, as shown,) which is driven from the main shaft D by a belt, *q*. If the shaft D revolves too rapidly, the governor-balls fly outwardly and move the shaft G to the right, the shafts P and I are turned in the direction of the arrows, and consequently the valves J J are lowered, thereby reducing the area of the openings W W and decreasing the movement of the floats. When the shaft D revolves too slowly the contrary effect is produced.

In case of any sudden increase in the force of the waves the floats might be thrown upward too forcibly before the governing mechanism would have time to work. To reduce any shocks that might thereby be caused, I have provided buffer-springs *z z*, fixed to the foundation at the top of the chambers in position to be struck by the floats in their ascent.

Fig. 5 shows a dynamometer or indicating device for showing the energy that is being developed at any time. A small float, *a*, is arranged to move freely up and down in correspondingly small chamber *k*, which is in communication with the sea by an opening, *w*. Another float, *a'*, is free to rise and fall in a second chamber, *k'*, which is in communication with the chamber *a* (or with the sea direct) through a conduit, *o*, of such small area that the level of water in the chamber *k'* does not perceptibly rise and fall with the waves, but remains at the mean level of the waves, rising and falling only with the tides. The float *a'* has a rod, *b'*, which carries at its upper end a dial, *f*, and a pointer, *p'*. This pointer moves up or down along a graduated scale, *r*, and thus indicates the tide-level. The rod *b'* bears the axis of a pulley, *g*, and has a rigid arm, *c'*, which bears a sheave *c*. The float *a*, which rises and falls with the waves, has a rod, *b*, to which is attached a chain, *i*, which rises, passes over the sheave *c*, and then around the pulley *g*, and at its end has a weight, *i'*, to keep it taut. The axis of the pulley *g* carries a hand, *g'*, which, as the float *a* rises and falls with the waves, oscillates over the dial *f*. The amplitude of its oscillations furnishes an indication of the power being generated. The opening *w* is provided with a valve, *j'*, by which its area may be adjusted.

Any desired number of floats, A A', may be employed, according to the location and to the power required, and they may be arranged to drive any number of shafts D.

My invention may be variously modified in proportions and materials and by the substitution of mechanical equivalents, as will be well understood.

My machine is not limited in its application to tidal waters, but may be used with inland lakes and other bodies of water forming waves.

I claim as my invention—

1. A marine motor consisting of the combination of two (or more) floats, a rotary shaft, and single-acting connecting mechanism intervening between said floats, respectively, and said shaft, and relatively reversed for the respective floats, whereby the said shaft shall be driven by the ascent of one float and by the descent of the other, and whereby each float shall exert a pressure to revolve said shaft while moving in one direction and shall be free while moving in the opposite direction, substantially as set forth.

2. A marine motor consisting of the combination of two (or more) floats, one of which is relatively light or buoyant and the other is heavy or ballasted, with a rotary shaft and communicating mechanism intervening between said floats, respectively, and said shaft, and adapted to drive said shaft during the ascent of the light float and during the descent of the heavy float, whereby the light float descends freely and the heavy float ascends freely, substantially as set forth.

3. The combination, with the rising and falling floats, the rotary shaft, and the toothed wheels on said shaft, of racks carried by said floats and engaging said wheels, constructed with pivoted teeth beveled on one side in order to engage said wheels when moving in one direction and free themselves therefrom when moving in the other, substantially as set forth.

4. Two or more float-chambers communicating with the sea by submerged openings, combined with valves adapted to close said openings, floats in said chambers adapted to rise and fall, a rotary shaft driven by said floats, and a governing mechanism adapted to open or close said valves more or less in proportion to the variations in speed of said shaft, substantially as set forth.

5. The combination, with float-chambers and floats therein, of buffer-springs arranged to receive the shock of the forcible ascent of the floats, substantially as set forth.

6. The combination, with a wave-float motor, of a mean-level indicator consisting of a float-chamber communicating with the sea by a small conduit, a float therein, a graduated scale, and a pointer actuated by said float, substantially as set forth.

7. The combination, with a wave-motor, of a power indicator consisting of a float-chamber communicating with the sea by a submerged opening, a float therein adapted to rise and fall, a graduated dial or scale, a hand moving along said dial, and connection between said hand and said float, whereby the hand is caused to move back and forth proportionally to the movements of said float, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JOSEPH ELIAS.

Witnesses:

CONSTANTINE E. KHOURI,
ANTHOUN J. MESSARA.