No. 897,930. PATENTED SEPT. 8, 1908.

C. G. ROEHR.

WAVE, TIDE, AND CURRENT MOTOR.

APPLICATION FILED AUG. 30, 1907.

4 SHEETS—SHEET 1.

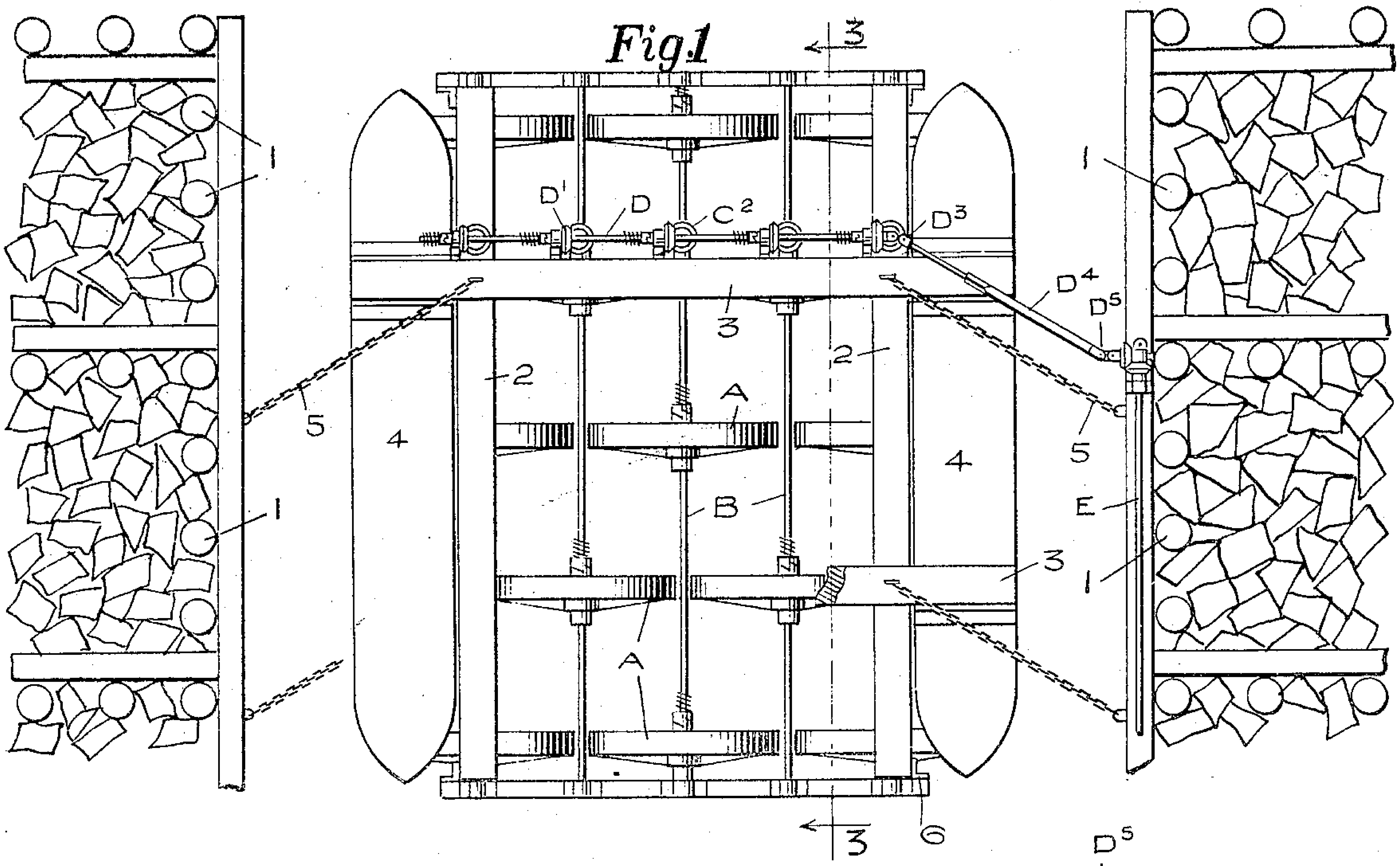

Fig. 1

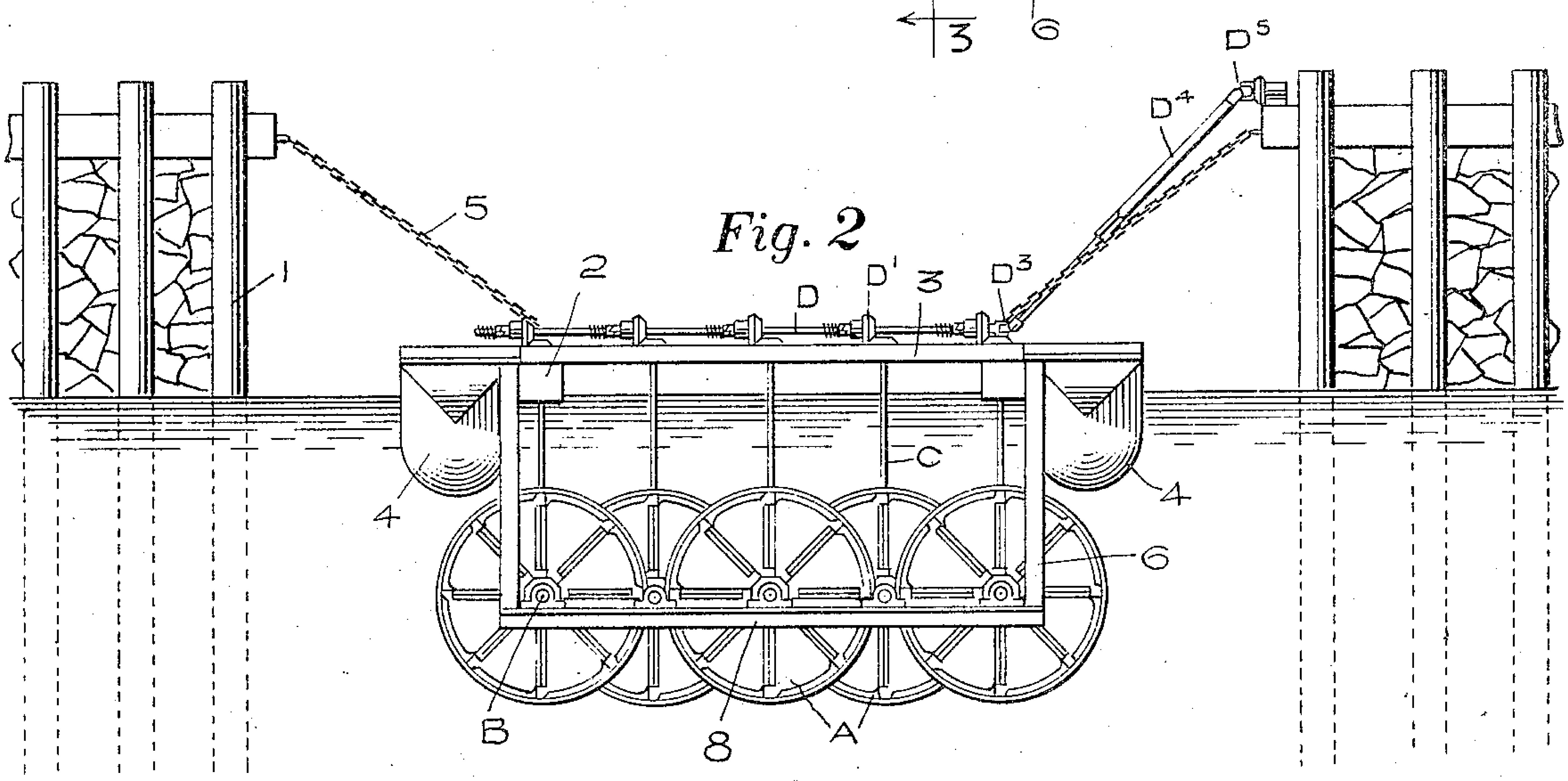

Fig. 2

WITNESSES:

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4 SHEETS—SHEET 2.

Fig.3

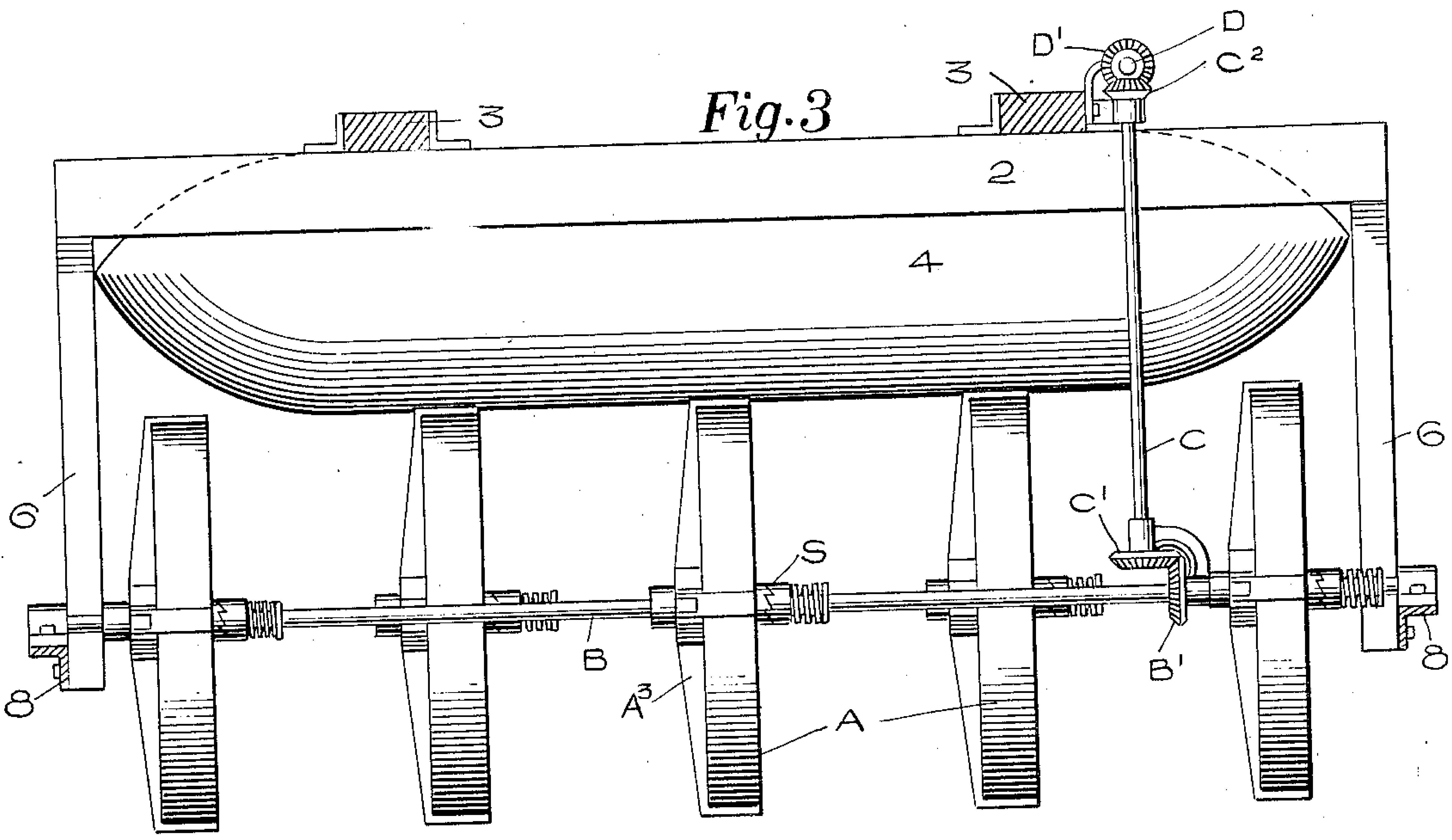


Fig.5

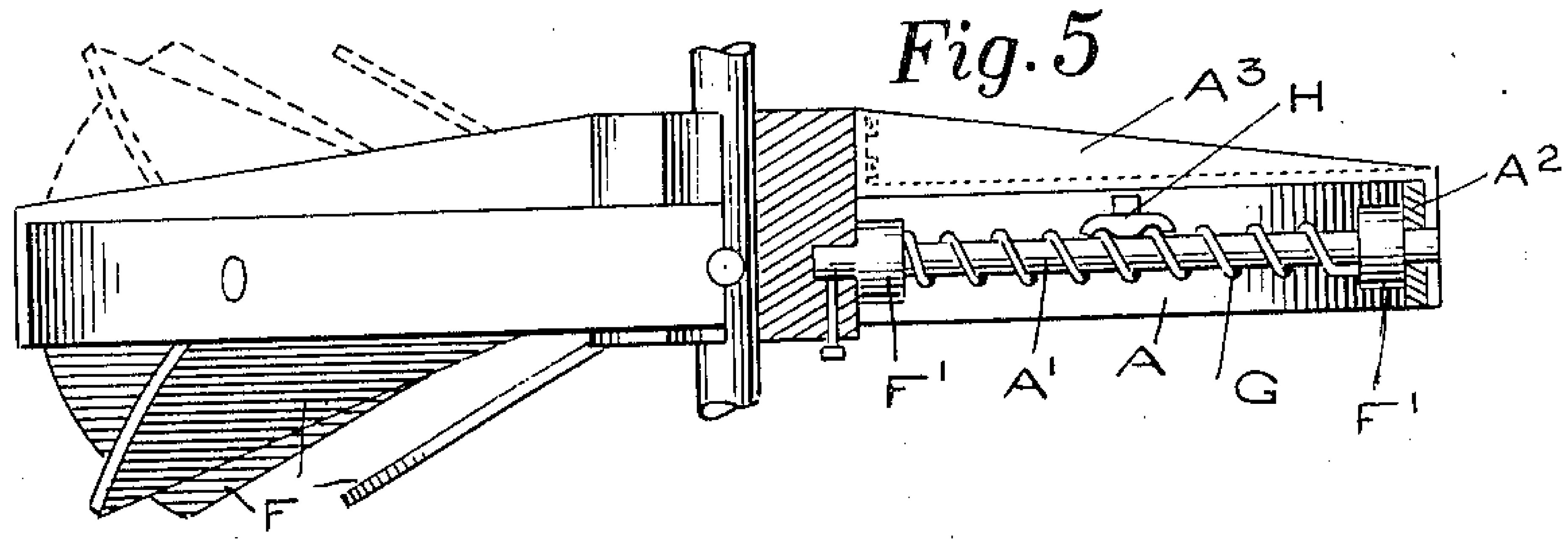
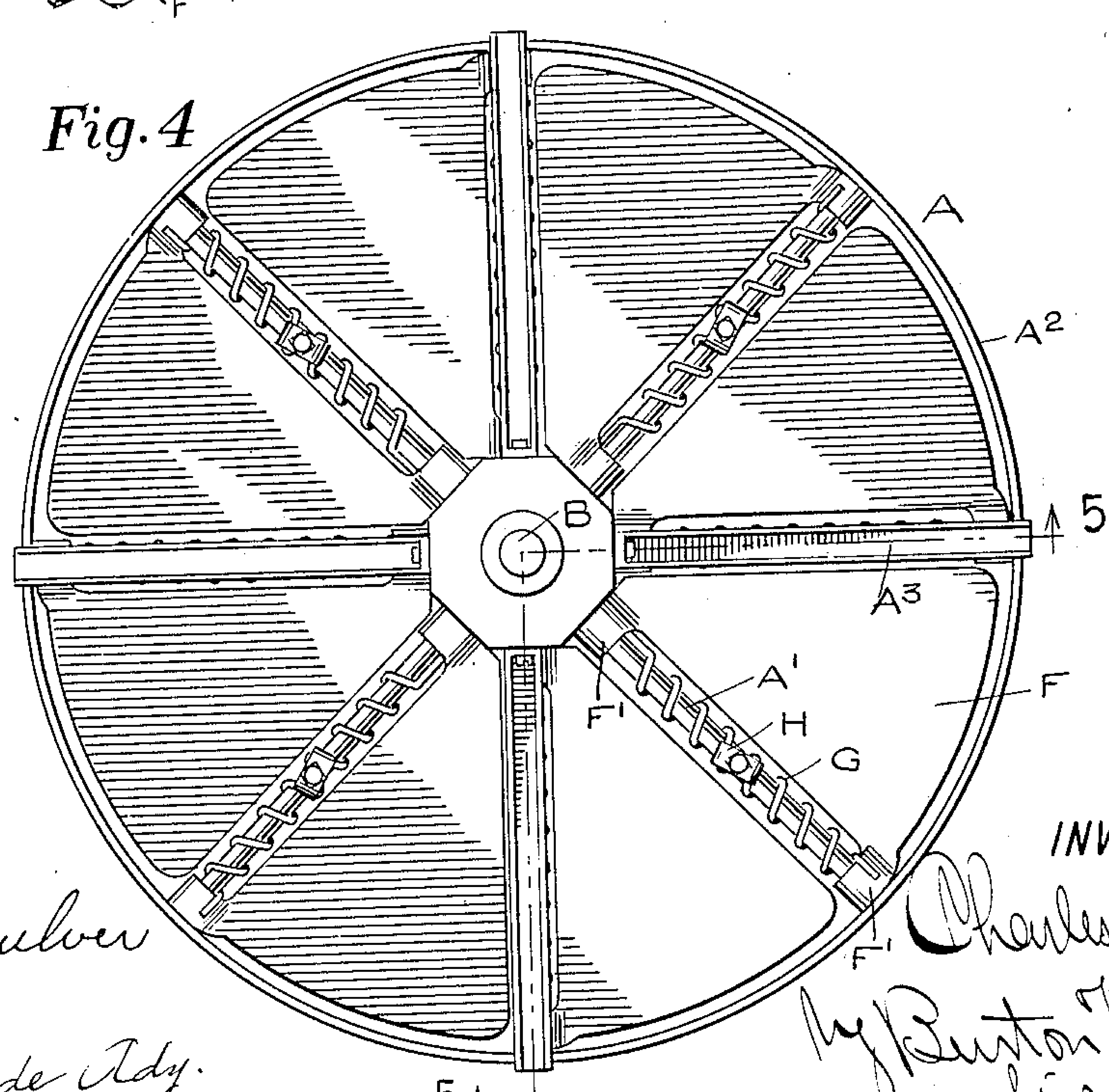


Fig.4



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4 SHEETS—SHEET 3.

Fig. 9

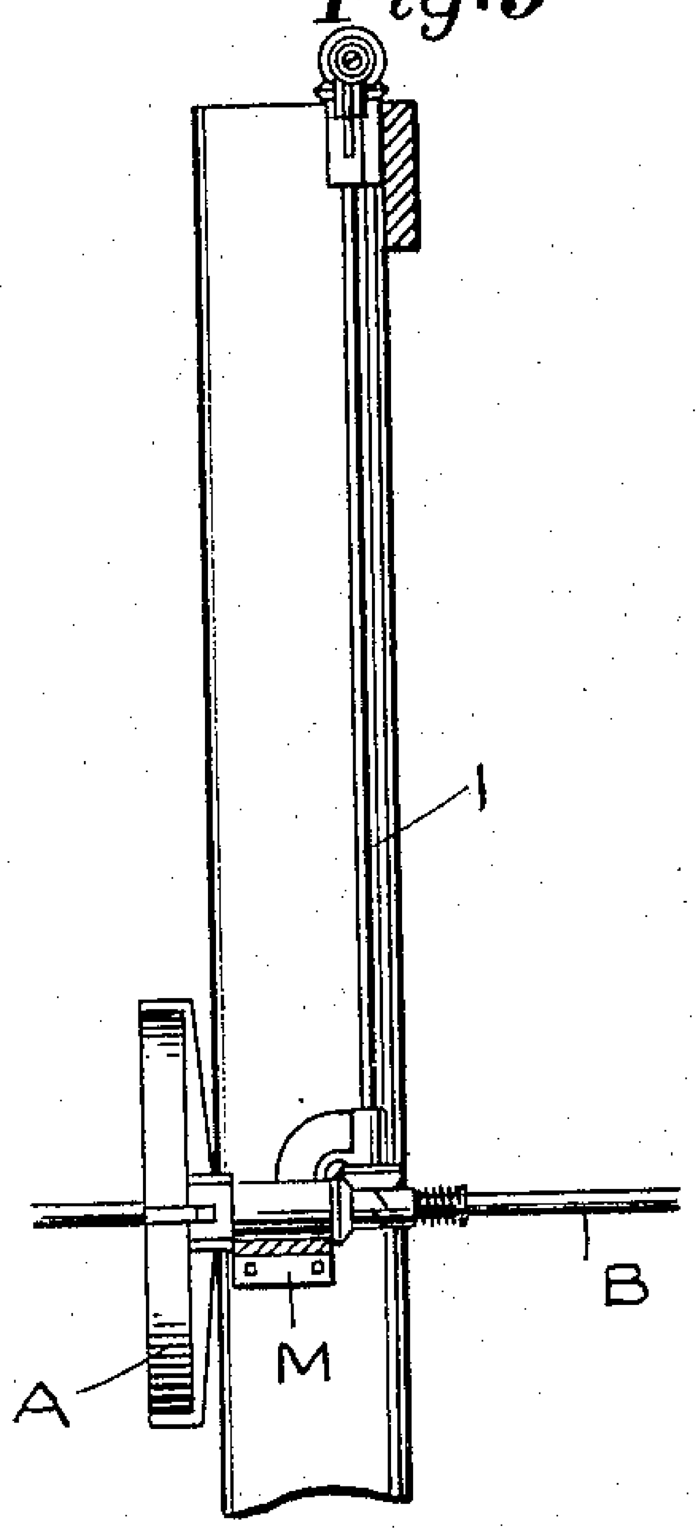


Fig. 8

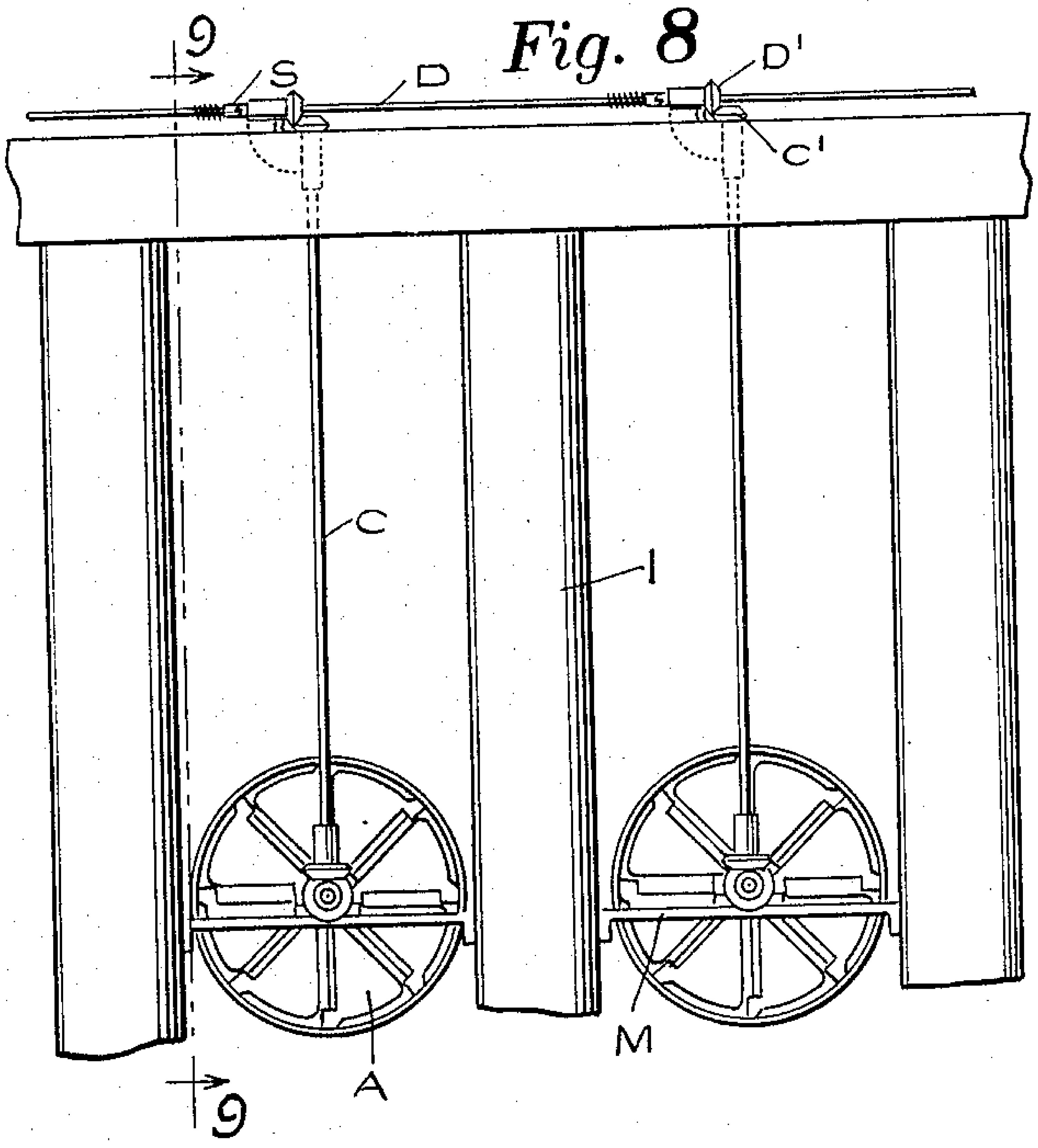
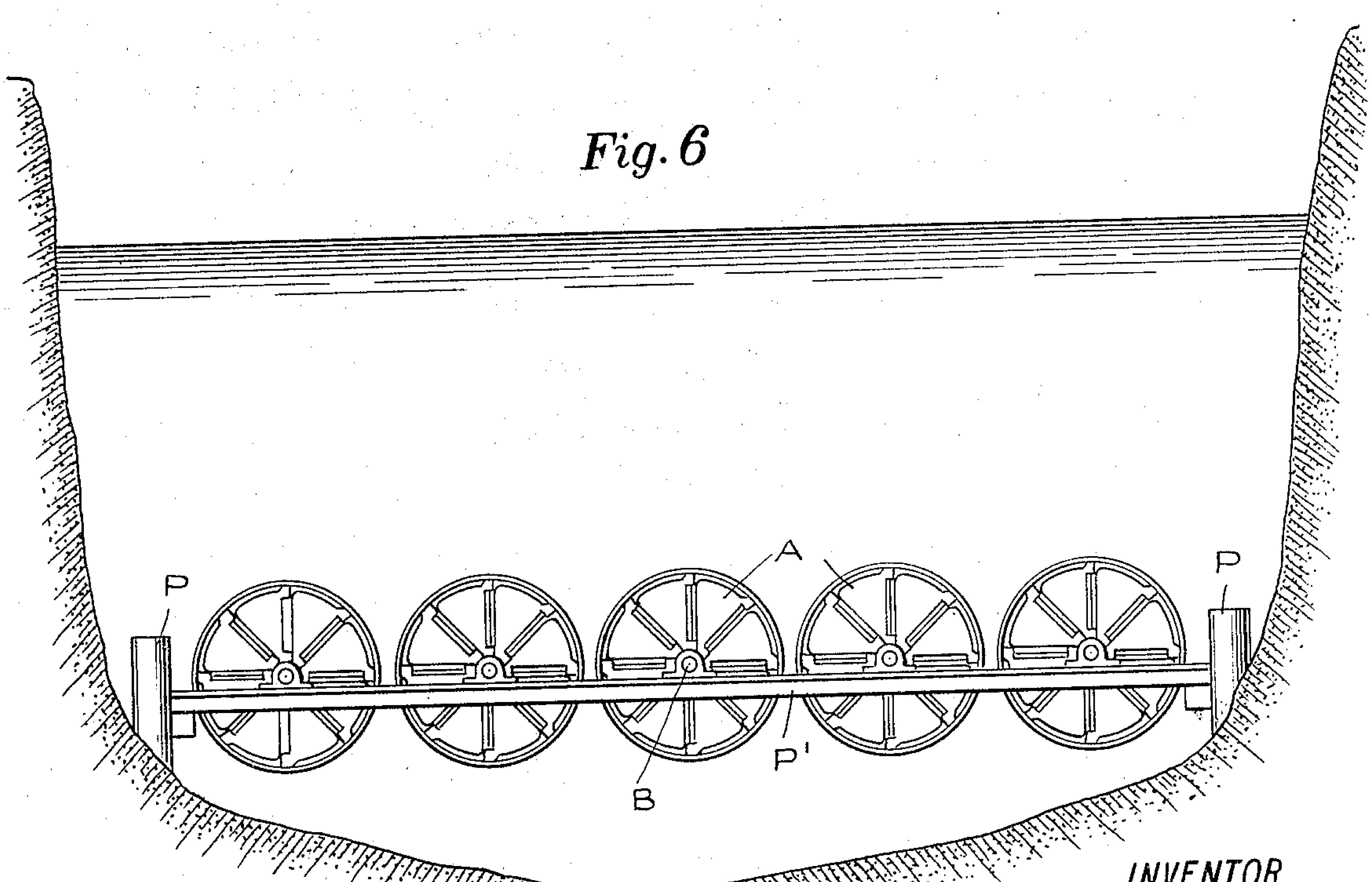


Fig. 6



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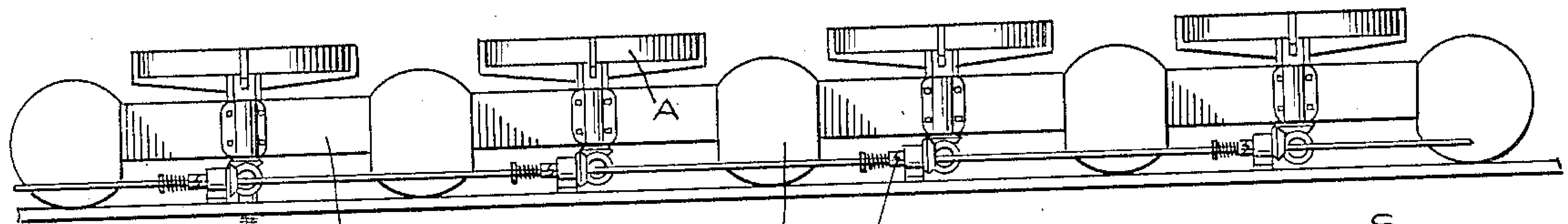
WAVE, TIDE, AND CURRENT MOTOR.

APPLICATION FILED AUG. 30, 1907. 4 SHEETS—SHEET 4.



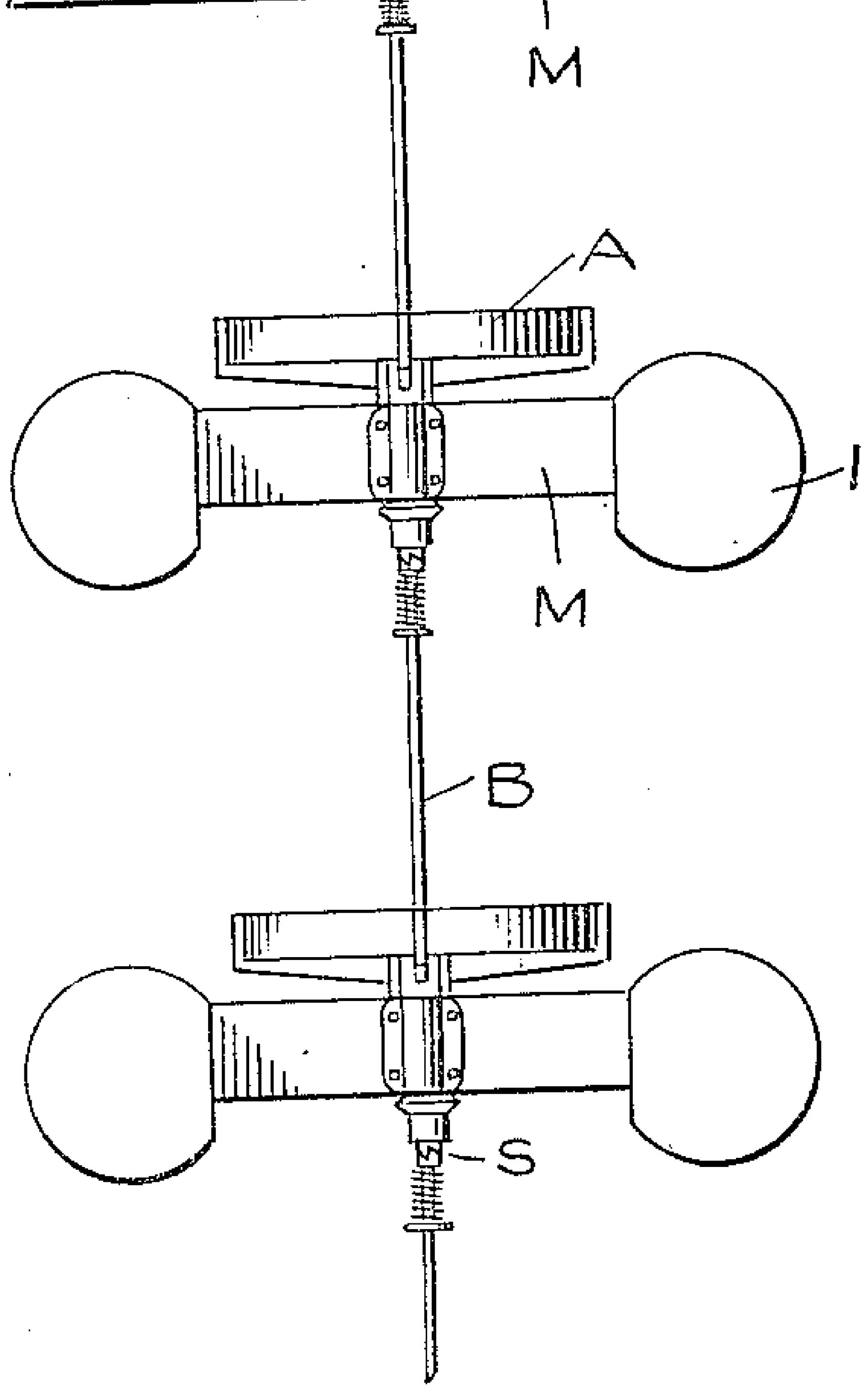


Fig. 7

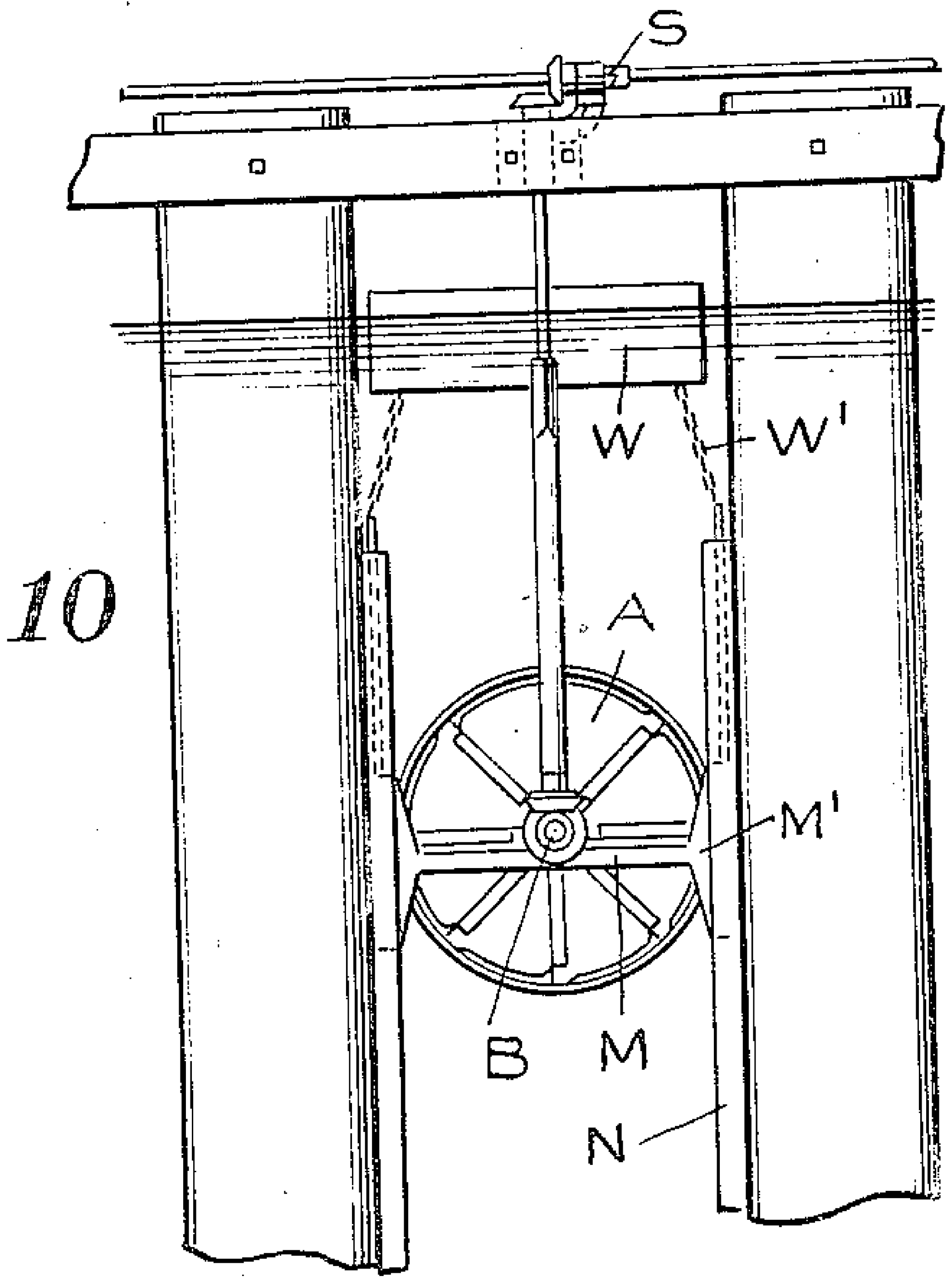


Fig. 10

Fig. 11

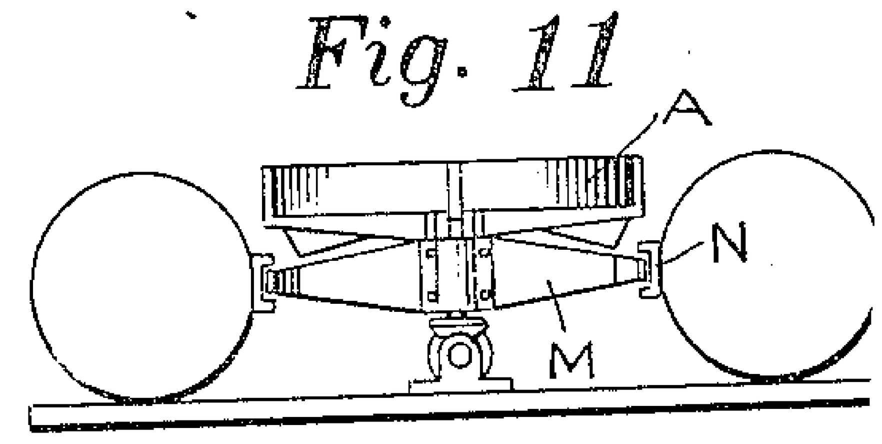


Fig. 12

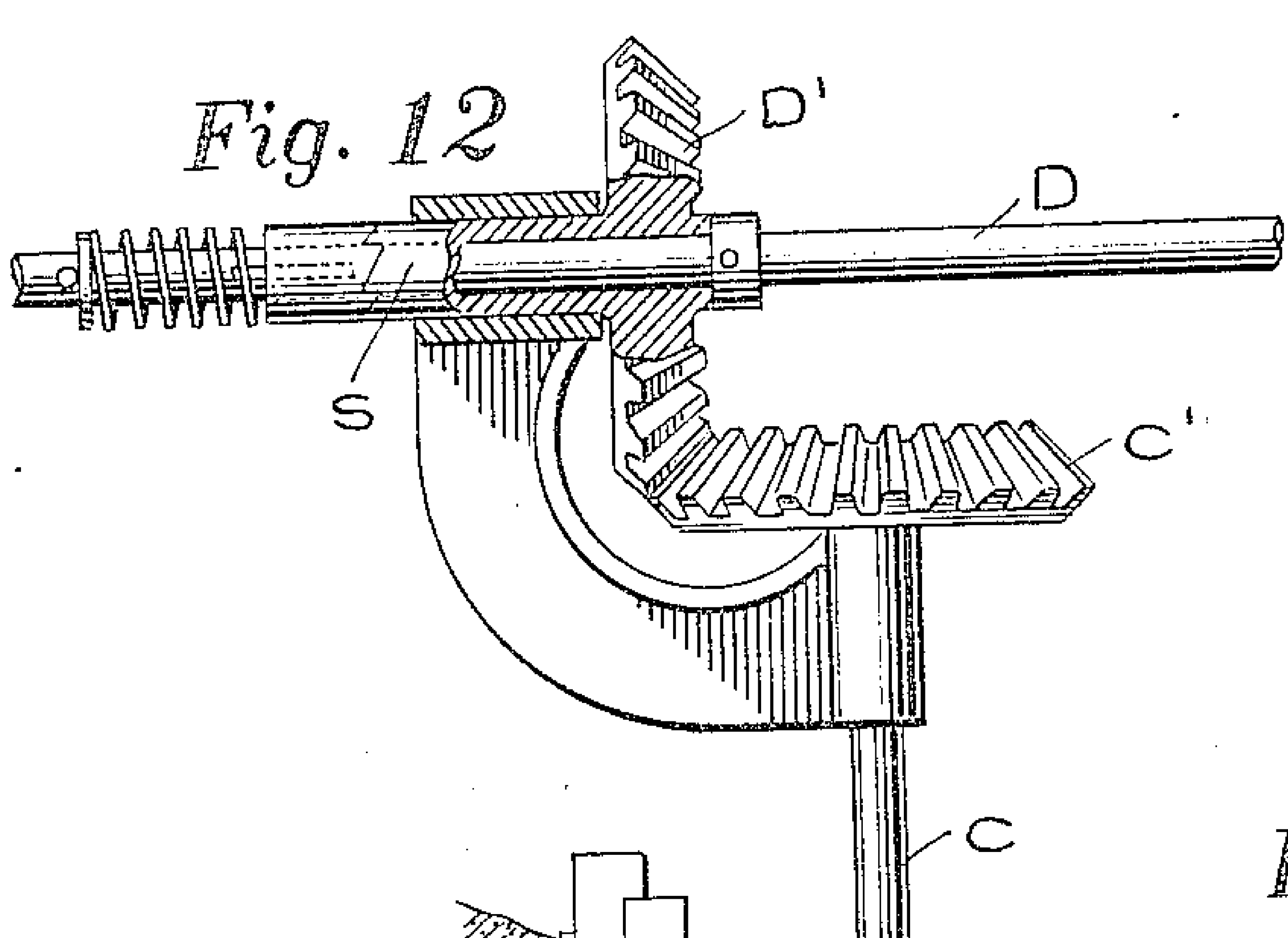
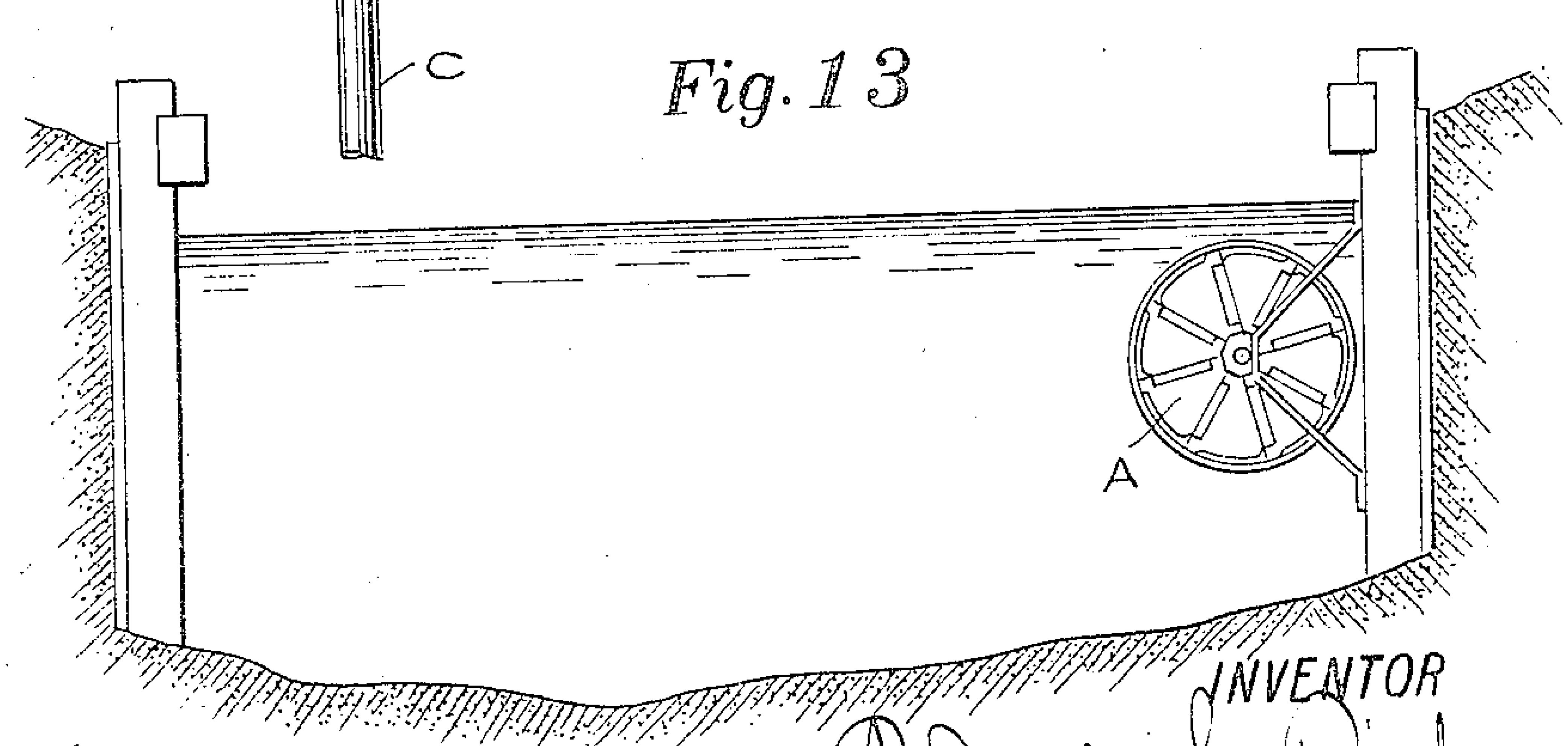


Fig. 13



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UNITED STATES PATENT OFFICE.

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WAVE, TIDE, AND CURRENT MOTOR.

No. 897,930. Specification of Letters Patent. Patented Sept. 8, 1908.

Application filed August 30, 1907. Serial No. 390,707.

To all whom it may concern:

Be it known that I, Charles G. Roehr, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Wave, Tide, and Current Motors, of which the following is a specification, reference being had to the drawings forming a part thereof.

The purpose of this invention is to provide an apparatus adapted to take advantage of back-and-forth or changing movements such as result from tides upon shores through which running streams emerge to the tide water where the tide may reverse the current of the stream during the incoming of the tide for greater or less distances and correspondingly varying lengths of time during each twenty-four hours. The other situations in which the same conditions of currents of periodically changing direction arise are such as the formation of channels transverse to the tide movement which are formed by openings through breakwaters and by oceanward extending piers producing more or less extended canals through which the tide movement is converted into distinct current movements with periodic diurnal changes of direction.

The invention consists in the features of construction described and illustrated as indicated in the claims.

In the drawings:—Figure 1 is a plan view of an apparatus embodying this invention shown in position between two parallel docks which are indicated by their supporting piers forming a channel opening oceanward. Fig. 2 is an end elevation of the structure shown in Fig. 1. Fig. 3 is a section at the line 3—3 on Fig. 1. Fig. 4 is an end view of one of the motor devices, a multiplicity of which are embodied in the entire structure shown in Figs. 1 and 2. Fig. 5 is a detail section at the line 5—5 on Fig. 4. Fig. 6 is an elevation or face view of a modified structure designed to be anchored at the bottom of a channel for utilizing the current. Fig. 7 is a plan view showing an arrangement of motor devices embodying this invention interposed between piles of a breakwater. Fig. 8 is an elevation of the same. Fig. 9 is a section at the line 9—9 on Fig. 8. Fig. 10 is an elevation showing a slight modification of the construction shown in Fig. 8. Fig. 11 is a plan view of the same. Fig. 12 is a partly sectional detail elevation of a gear bearing bracket and clutch duplicated at several places in the structures illustrated in the preceding figures. Fig. 13 is an elevation showing the mounting of a single motor shaft with motor thereon at the side of a channel, leaving the remainder open for navigation.

The piers, 1, 1, shown in Figs. 1 and 2, may be taken as indicating the presence of any means, whether natural or artificial, which would form the boundaries of a channel presenting its mouth to the ocean tide, so that the tide would be transformed into a rapid current through such channel, the direction of which would be reversed periodically with the change of tides. A floating structure, which may be called a raft, indicated by the frame timbers 2, 2, and 3, 3, constructed or provided in any manner so as to float and carry the operating structure hereinafter described, such capacity of floating being effected, for example, by means of floats, 4, 4, at opposite sides, will be restrained within the channel by flexible means, as chains, 5, adapting it to accommodate itself to the height of the tide. Provision for this accommodation will also cause the entire raft structure to assume various positions longitudinally in the channel, according to the direction of the current and height of the tide; for any variation in the height of the tide causing a change of level between the float and the point at which the chains are connected to the fixed structure, as the piers, will vary the amount of slack which will be taken up by the longitudinal displacement of the raft one way or the other from the points at which the chains are thus secured to the fixed structure. This raft carries a downwardly extended frame structure, represented by the vertical frame bars, 6, 6, and transverse bars, 8, 8, designed to carry the motor devices which are to be operated by and derive their power from the current. The entire motor organization comprises a multiciplicity of these devices distributed so as to have their water-receiving areas occupying as large a proportion as possible of the total area within whose boundaries they are contained of the transverse section of the current; and also so as to receive, each from those in advance of it, the water emerging through the latter in order to derive motive power from the current to as large a percentage as possible of its dynamic energy. Each of these motor devices consists of a vaned wheel, hereinafter more particularly described. In the drawings there are shown five transverse rows of these vaned wheels, A, the first or foremost row—counting from either end of the raft, each end being in turn the foremost—comprising three such wheels, the alternate transverse rows having two wheels, the wheels of the entire group being in horizontal plan located in staggered arrangement. This arrangement results in five fore-and-aft rows of wheels, the outside and the middle row having each three wheels and the two intermediate rows each two wheels, all the wheels of each such row being axially in line, so that they can be, and in the drawings are illustrated as being mounted on one fore-and-aft shaft. The five fore-and-aft shafts, B, B, B, B, B, are journaled on the transverse frame bars, 8, and at any convenient point, or, if desired, more than one point in their length, these longitudinal shafts have fast on them bevel-gears, B^1, meshing with bevel-gears, C^1. The vertical shafts, C, which extend up to the top of the raft and are there provided with bevel-gears, C^2, meshing with bevel-gears, D^1, all on the same transverse shaft, D, from which power may be transmitted through toggle joints, D^3, telescoping shaft, D^4, and toggle joint, D^5, to a shaft, E, mounted in fixed bearings on the pier or bank of the channel. By this means all the power derived from all the vaned wheels is aggregated upon the one final shaft, D, and transmitted to the shaft, E, mounted in fixed bearings. When the power is to be employed for operating apparatus located on the raft, the toggle joint and telescoping shaft will obviously be unnecessary.

Each of the motor devices consisting of the vaned wheel, A, is of the character shown in Figs. 3 and 4, and is substantially similar to one of the motor devices shown, described and claimed in my pending application No. 382,195, filed July 5, 1907, for wave and current motor, the essential difference in the mode of use of the device being that in that application the vaned wheel is shown mounted for horizontal rotation and vertical movement in the direction of its axis; in applying it to the present purpose it is mounted for rotation in a vertical plane about a horizontal axis, and is exposed, as described, to the horizontal movement of the current instead of being moved vertically through the water.

I will now describe the construction of the motor wheel. It is a spider or skeleton wheel comprising radial spokes, A^1, connected by the encompassing band or rim, A^2, for bracing them in the plane of rotation. Preferably also for bracing them against the current in each direction, oblique braces, A^3, are provided extending in both directions from four points on each rim to the shaft, B, thus rendering the entire wheel structure as rigid as possible against distortion of the spokes, which are the pivots of the vanes,—out of their proper planes transverse to the current and also out of the proper respective radial positions in such plane. On each of the spokes or radial arms, A^1, there is pivotally mounted a vane, F, which is free to swing from a position in which it extends obliquely in one longitudinal direction from the plane of rotation of the wheel to a position extending obliquely in the opposite direction from the same plane. One of these positions is shown in full line and the other in dotted line in Fig. 4. The provision for checking the vanes at these oblique positions preventing them from swinging to positions at right angles to the current where their capacity for causing rotation would be reduced to zero is preferably spring-controlled, so that the resistance to movement away from direct transverse position increases with the deflection, the tension of the spring being sufficient to resist such deflection to an extent sufficient to develop the full power which can be obtained from the movement of the current against the vane. A slight current will thus deflect the vane to a minimum extent at which such slight current will produce its maximum effect in the rotation of the wheel. A stronger or more rapid current will deflect the vanes to a greater extent, causing them to stand more nearly parallel to the direction of the current, the rotary movement being thus automatically maintained at substantially the same speed throughout varying force of the current, because if the current should swing the vane to position parallel with the current movement, all power to produce rotary movement would thereby be lost, and the spring would immediately retract the vane into oblique position; and such spring would therefore hold the vane at a position corresponding to the relation of the force of the current to the work bing done. The most convenient form of the yielding stop for the purpose consists in a spring, G, coiled about the radial arms or spokes, A^1, engaged at the one end upon one side and at the other end upon the other side by the pivot eye, F^1, of the vane, the spring being secured to the spoke, A^1, at the middle point of its length by any convenient means, as a clamp, H. It will be seen that the swinging of the vane in one direction brings into action one-half of the spring for yieldingly resisting deflection of the vane, and its swinging in the other direction brings into action the other half of the vane for yieldingly resisting its deflection in the opposite direction.

When the channel in which the tide motor above described is to be located is deep enough to afford the necessary depth of water for navigation in addition to the vertical space necessary to accommodate the entire motor device and its supporting frame-work, such frame-work may be anchored or secured in any suitable manner at the bottom of the channel with the motor devices above instead of below it. Such construction is shown in Fig. 6. The detail structure of the frame-work is substantially the same as that shown in Figs. 1 to 3, except that it is inverted. Stud piles, P, P, may be set in the bottom of the channel and a suitable frame structure built thereon, represented by the transverse bar, P¹, in Fig. 6, on which are mounted the bearings of the shaft of the motor wheels, located, as illustrated, at sufficient distance above the bottom of the channel to prevent the frictional retardment of the current from detrimentally affecting its speed at the level at which the motor wheels are located for exposure to such current.

This invention may be applied for the purpose of developing power from the current movement through openings in any obstruction opposed to the wave movement,—as, for example, between the piles of an open breakwater,—where, although the passage that is bounded laterally by two adjacent piles is very short, nevertheless, the wave movement of the body of water in which the breakwater is interposed produces distinct current movement through the breakwater between the piles, the velocity of the current varying with the violence of the wave action, and the frequency of alternation or reversal of movement varying according to the wave length. This situation is materially different from that which results from tide action creating a current in a river channel in which the periodic changes are diurnal, for in the case of a current through the piles of a breakwater, the periodic movement being in proportion to the wave length, may be only a few seconds instead of many hours, as in the case of the tide. In such situations as that presented by the breakwater consisting of piles between which the water derives a current movement when the wave movement is broken by the piles, a single motor wheel suitably held in each interval between piles may communicate movement to a shaft common to a plurality of such individual motor devices and extending along the entire row of piles so as to become the means of transmitting the movement and power derived from all the motor devices for continuous rotary movement of such common shaft. Such a structure is shown in Figs. 7 and 8. In this situation, if the tide is absent or is to be ignored, as may be done, and only the wave movement is to be taken into account, the motor device consisting of the wheel, A, with its features of construction identical with that already described and shown in detail in Figs. 4 and 5, is mounted on fixed bearings, M, M, which may be secured to the piles at a sufficient depth to keep the motor wheel, A, at all times submerged,—thus allowing, if desired, for change of tide, the device being in that case mounted below low water level. A bevel gear on the shaft of each wheel meshes with a bevel-gear on a vertical shaft, pertaining to each motor device, and bevel-gears on the upper ends of said vertical shafts mesh with corresponding bevel-gears all on the one shaft extending longitudinally with respect to the row of piers for accumulating the power derived from the motor devices on such common shaft.

Instead of securing the bearings of the motor wheels in this construction at a fixed location on the piles they may be mounted for movement up and down between guide-ways and connected with a float or other suitable means for keeping the motor wheel only just sufficiently submerged to get the full benefit of the current throughout all changes of height of the water when the device is located in water subject to tide or to other marked changes of height. The advantage of this is that the current in such situations is greatest near the surface and may even be limited to a comparatively small depth from the surface so that a wheel fixedly mounted at a position to get the benefit of the current movement at low water level would be in still water,—entirely below the current movement,—at a stage of high water. Such construction is shown in Fig. 10, in which the shaft bearing bar, M, has its vertically extended ends, M¹, channeled and guided on vertical guide ribs, N, N, a float, W, being connected with the frame bar, preferably by flexible means, as the chains, W¹, so that slight or minor fluctuations at the surface need not necessarily be communicated to the bar nor change the adjustment of the motor wheel.

It will be understood that where the situation makes it convenient to do so, or where it is not desirable to occupy the entire body of the channel with the motor wheels, a single line of wheels arranged tandem on the same shaft may be employed, and may be located either in the middle or at one side of the channel, the latter construction being indicated in Fig. 9. And this method may be employed in such situations as that to which Figs. 7 and 8 relate that is, at openings through breakwaters where the breakwater itself is wide enough from outer to inner side to make the opening constitute a channel which will accommodate a plurality of wheels arranged thus tandem on a shaft extending thus transversely of the breakwater. An instance of this sort is shown at the left hand side of Fig. 7, and requires no further particular description.

In order that the maximum speed as well as the maximum power may be derived from any group of motor wheels from which connections extend to a common power shaft in any of the arrangements above shown, in view of the varying force and rapidity of the current at different points of its cross-section where it reaches different wheels, and in view also of the fact that the rapidity of the water movement may be diminished after passing through the first transverse row of wheels and may thereby attack the subsequent rows with less force and in a manner to develop less speed, it may be desirable to interpose one-way driving clutches between the motor wheels respectively and the common power shaft so that the greatest speed which can be communicated by any one or more of the wheels may at all times be given to the power shaft, those wheels which derive less speed thereby not becoming a drag upon those having greater speed. Such clutch connections are shown in all the different forms of the device, each of the wheels which are mounted tandem on the same shaft in the form shown in Figs. 1, 2 and 3 being connected by one-way driving clutches, S, to the shaft, and the bevel-gears, D^1, on the transverse shaft, D, are similarly connected to said shafts, D, by such clutches, S.

In the form of the device shown in Figs. 7 and 8, clutches, S, connect the bevel-gears, D^1, on the transverse shaft, D, in the same manner; and in the structure shown at the left hand part of Fig. 7, having several motor wheels arranged tandem on the same shaft, each of the motor wheels is connected to the shaft by a clutch, S, as in the form shown in Fig. 1. It will be understood that the point at which the clutch connection is made may be varied so long as it is interposed between the motor wheel and the power shaft which is common to a plurality of wheels; also that the omission of such clutches would not be inconsistent with the invention, and especially they may be omitted on the motor wheels arranged tandem on the same shaft without materially affecting the result.

I claim:—

1. In a wave, tide or current motor, a motor device comprising a submerged motor wheel; submerged bearings on which it is mounted with its axis disposed longitudinally with respect to the tide, wave or current movement, such motor wheel comprising a plurality of vanes pivoted for oscillation both ways from the plane of rotation of the wheel; elastically yielding means resisting their deflection in either direction from said plane, and power-communicating devices from the shaft of said wheel extending above the current.

2. A wave, tide and current motor comprising a plurality of submerged motor wheels; submerged bearings on which such wheels are mounted with their axes all disposed longitudinally with respect to their tide, wave or current movement; a structure above water connected with said bearings and a common power shaft mounted on such upper structure; means for communicating movement from the motor wheel shafts to said common power shaft, each of said motor wheels comprising a plurality of vanes pivoted for oscillation both ways from the plane of rotation of the wheel, and springs which yieldingly resist the deflection of said wheels either way from said plane.

3. A wave, tide and current motor device comprising a submerged motor wheel having its shaft journaled longitudinally with respect to the direction of water movement; means for transmitting power from such shaft upward to a point above the water surface, such motor wheel comprising vanes pivotally mounted for oscillation from a position trending obliquely in one direction to a position trending obliquely in the opposite direction from the plane of rotation of the wheel, and elastically yielding means resisting the deflection of said vanes in either direction from said plane.

4. A wave, tide or current motor comprising a submerged motor wheel; submerged bearings for the same on which such wheel is mounted with its axis longitudinal with respect to the water movement; means restraining said bearings against movement of travel with the water; means for transmitting power from the shaft of such wheel to a point above the water level, such wheel comprising radial arms and spokes; vanes pivotally mounted on said arms or spokes for oscillation both ways from the plane of rotation of the wheel, and springs carried by the spokes and reacting on the vanes for yieldingly resisting the deflection of the latter in either direction from said plane of rotation.

In testimony whereof, I have hereunto set my hand at Chicago, Illinois, this 9th day of August, 1907.

CHARLES G. ROEHR.

Witnesses:
CHAS. S. BURTON,
M. GERTRUDE ADY.