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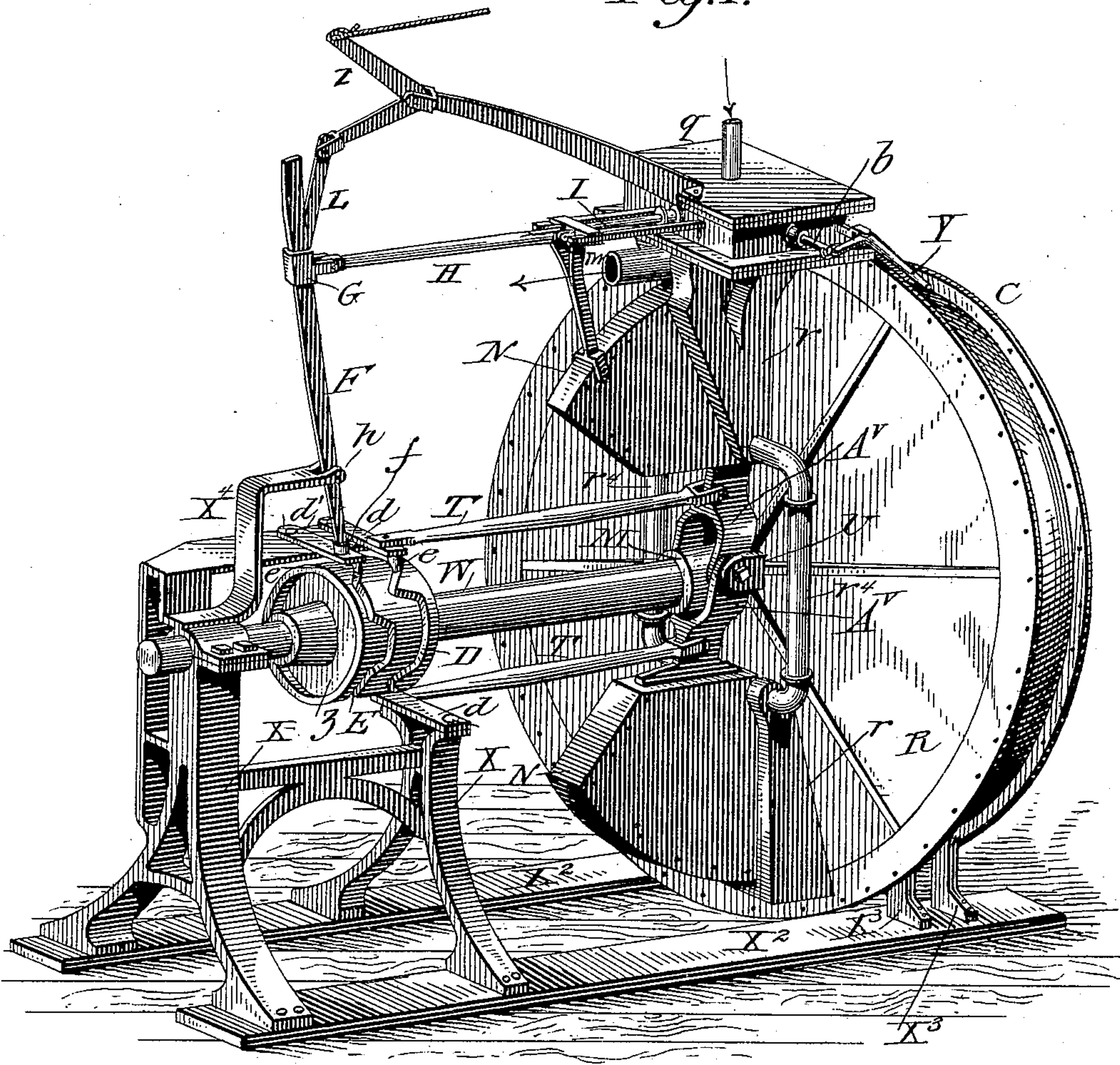
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W. E. LEONARD.
REVOLVING PISTON STEAM ENGINE.

No. 397,299.

Patented Feb. 5, 1889.

Fig. 1.



Witnesses.

J. W. Rulifson,
Wm. W. Rulifson.

Inventor.

Wm. E. Leonard

(No Model.)

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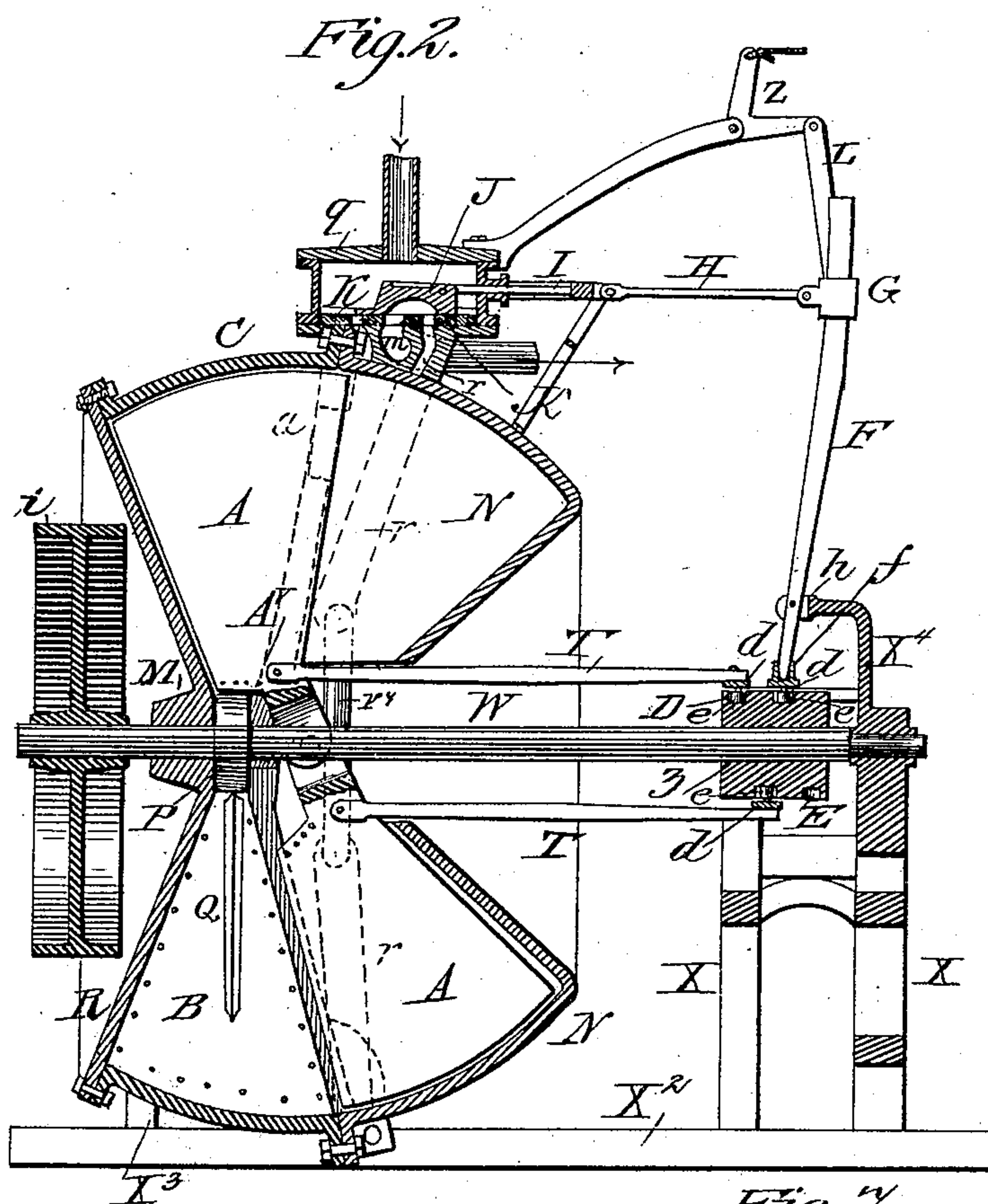
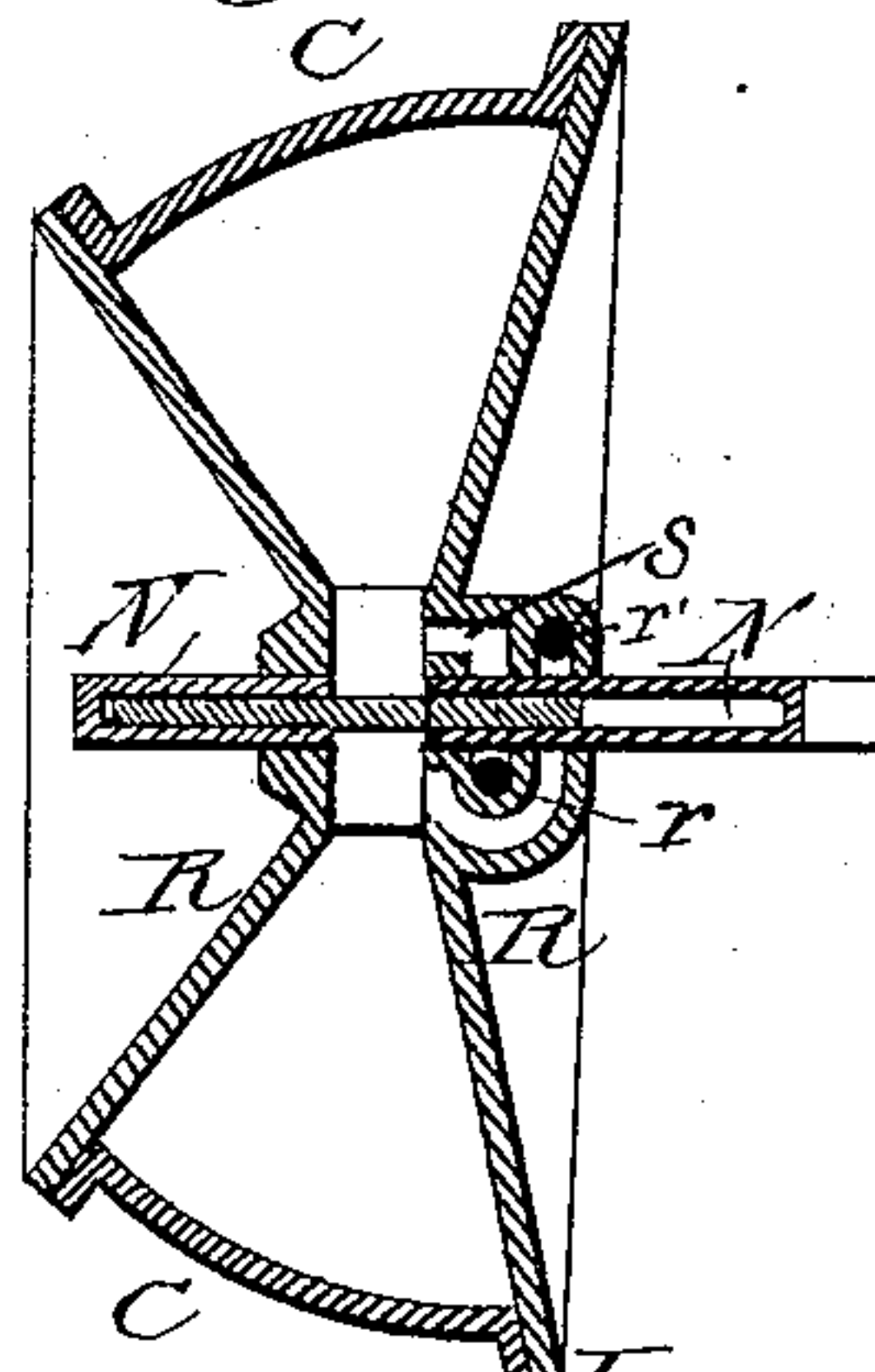
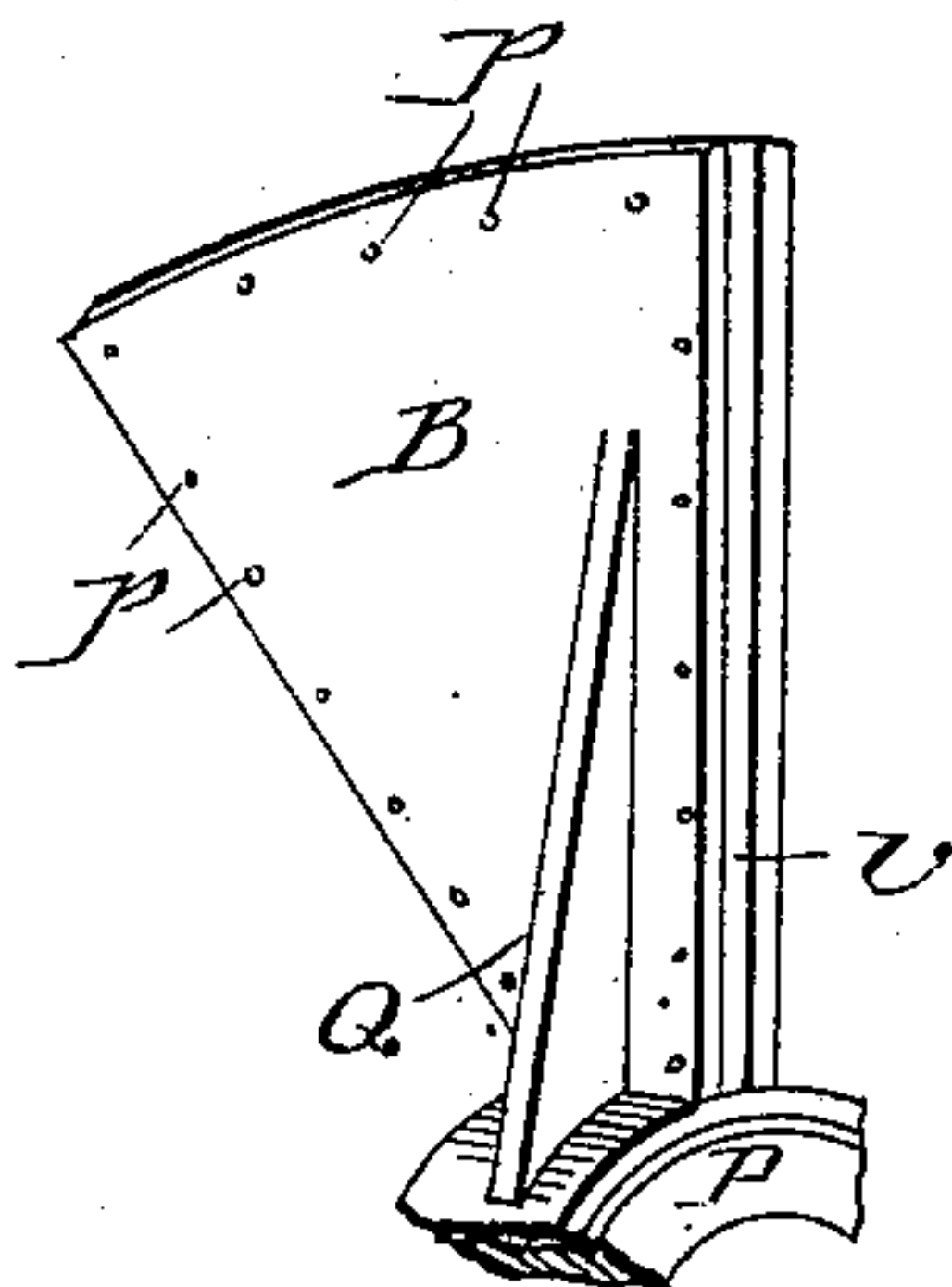
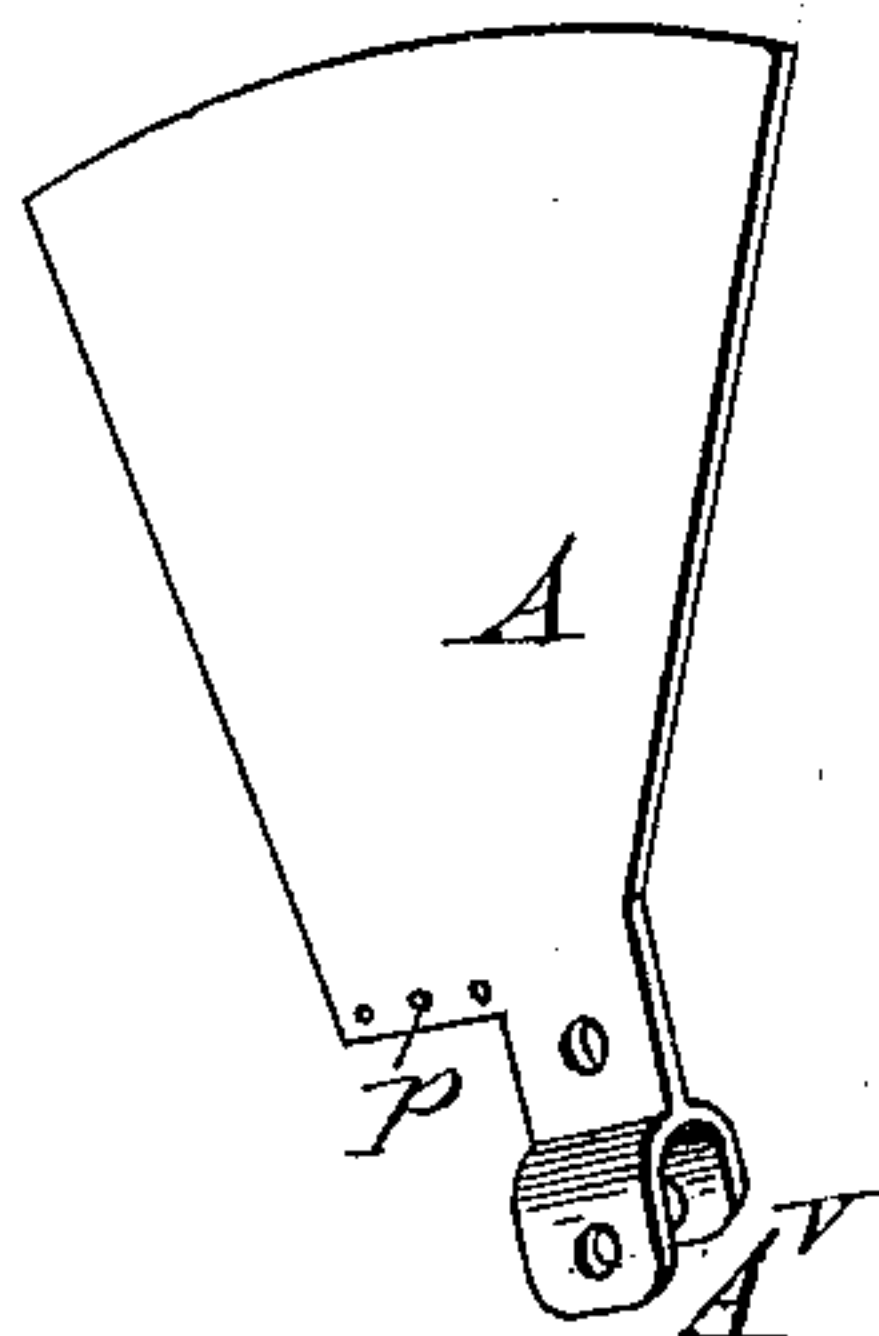


Fig. 6.

Fig. 5.

Fig. 7.



Witnesses.
J. W. Rulifson.
Wm. W. Rulifson

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Wm. E. Leonard

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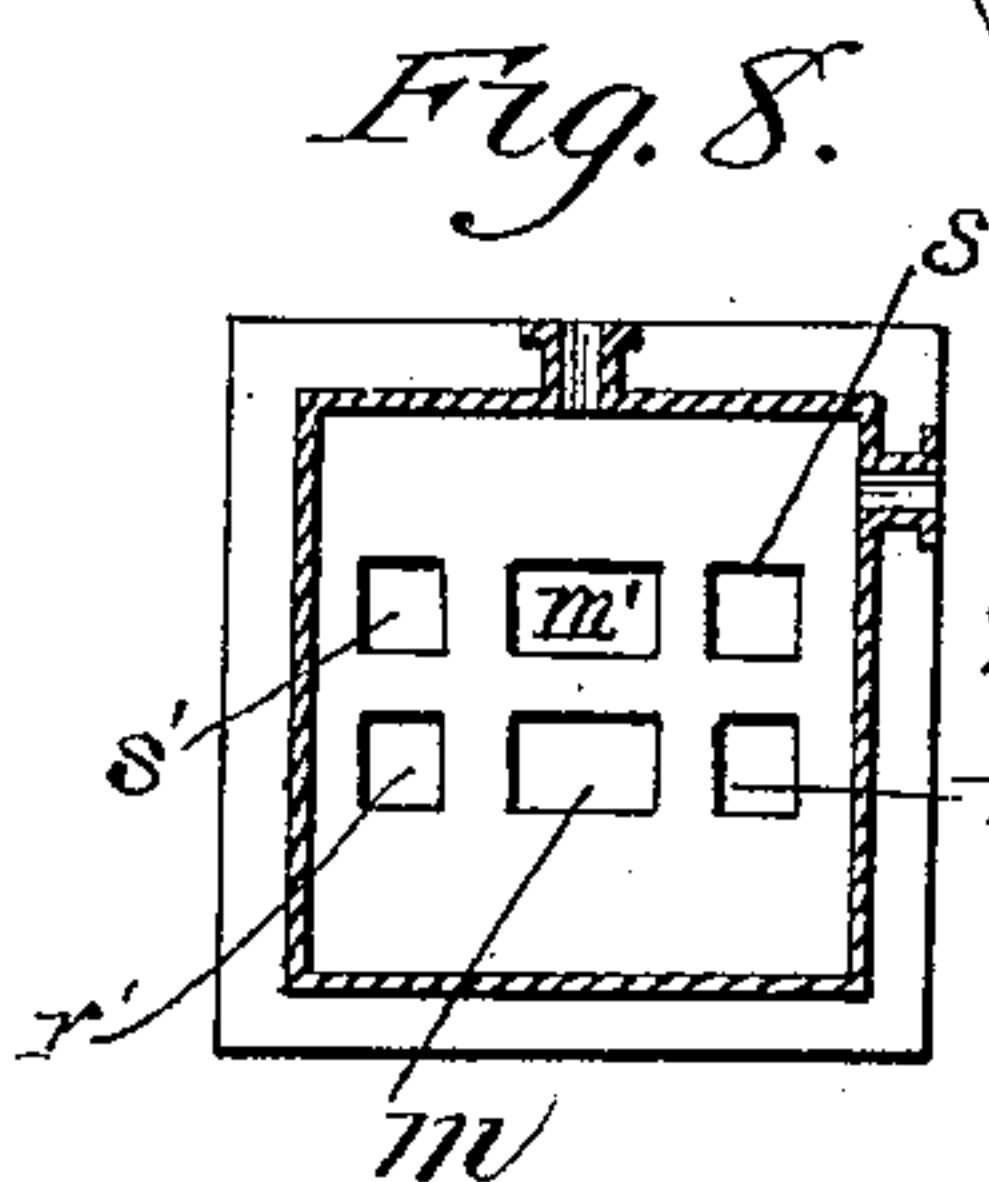
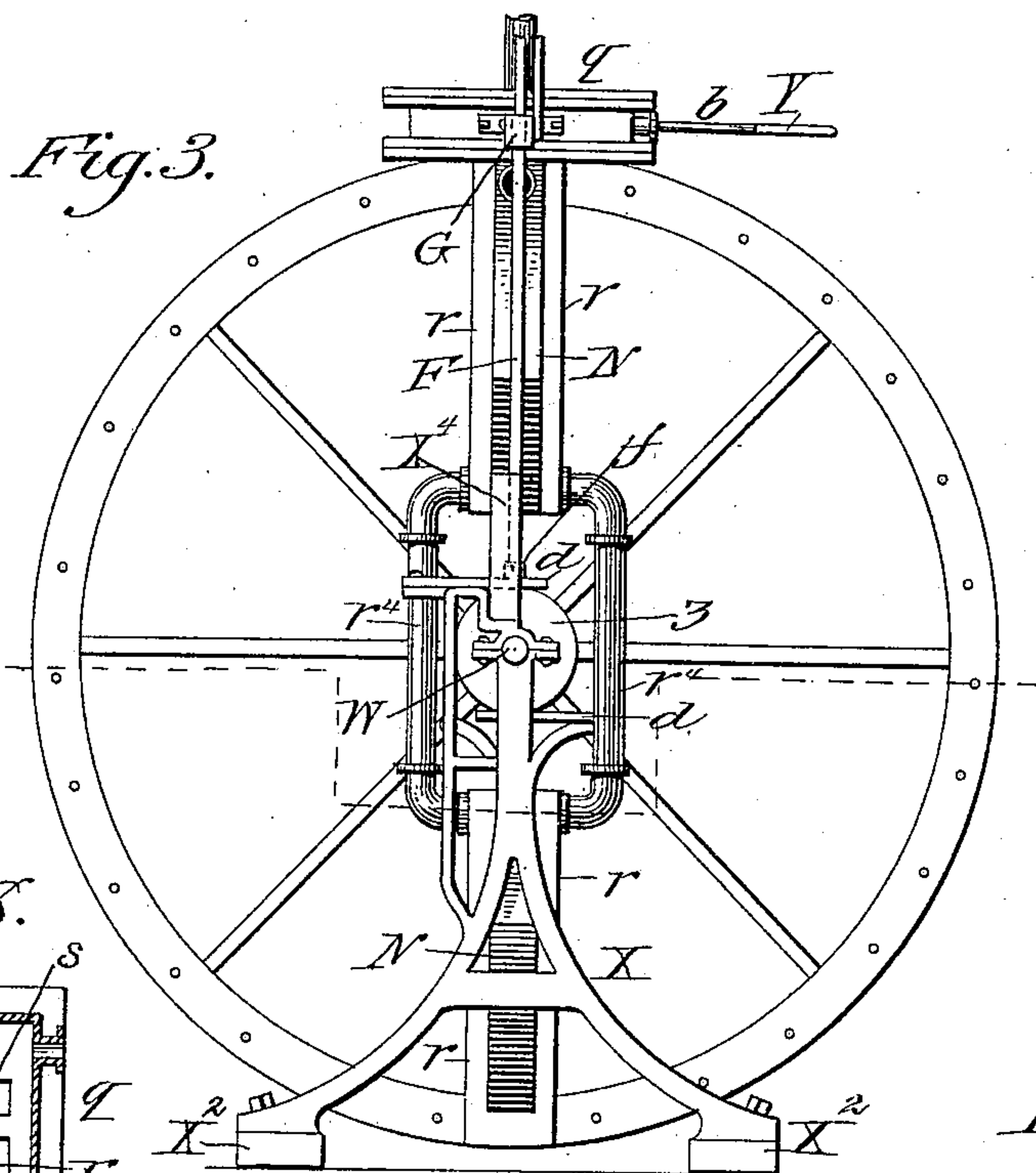
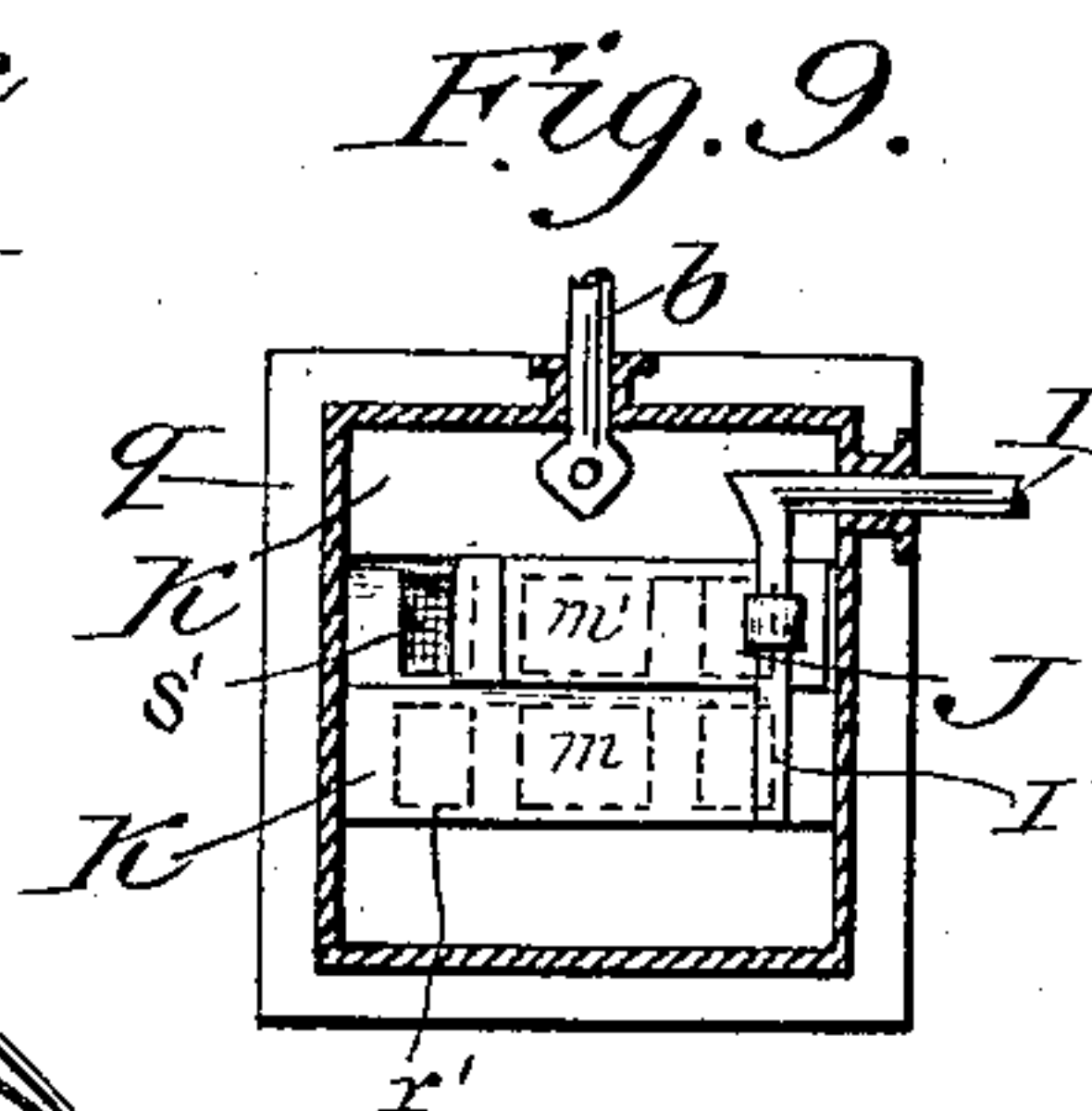
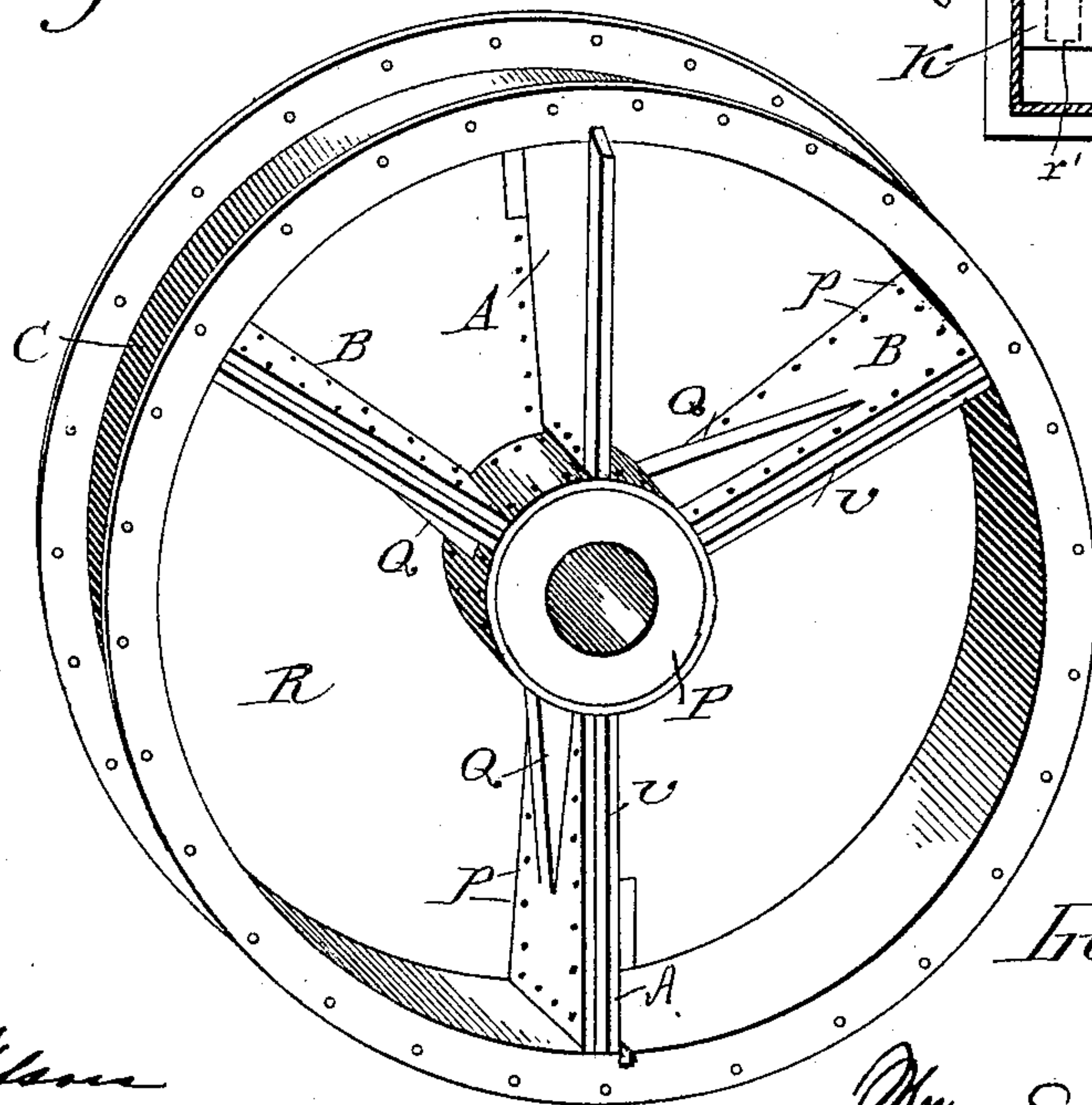


Fig. 4.



Witnesses.

J. W. Rulifson
Wm. W. Rulifson.

Inventor.

Wm. E. Leonard.

UNITED STATES PATENT OFFICE.

WILLIAM E. LEONARD, OF LINCOLN, NEBRASKA.

REVOLVING-PISTON STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 397,299, dated February 5, 1889.

Application filed December 12, 1887. Serial No. 257,694. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. LEONARD, a citizen of the United States, residing at Lincoln, in the county of Lancaster and State of Nebraska, have invented certain new and useful Improvements in Rotary Concentric-Piston Steam-Engines, of which the following is a full, clear, and exact specification.

My invention relates to that class of engines in which a series of arms or pistons fixed to a central shaft revolve within a concentric cylinder or casing, subject to the pressure of the steam which acts between them, and gates or diaphragms which are movable into and out of the cylinder in the proper manner to permit the passage of the pistons thereby.

In the accompanying drawings, Figure 1 is a perspective view of my complete engine. Fig. 2 is a vertical axial section through the same. Fig. 3 is a side elevation of the same. Fig. 4 is a perspective view of the cylinder or casing, with one side or head removed to expose the internal gates and pistons to view. Fig. 5 is a perspective view of one of the pistons. Fig. 6 is a perspective view of one of the gates or diaphragms. Fig. 7 is a horizontal section through the cylinder and steam-ports through the line $x x$ of Fig. 3. Fig. 8 is a horizontal section of the steam-chest with the valves removed to expose the ports. Fig. 9 is a similar view of the valves in position.

In the drawings, X^2 is a base-frame provided with uprights X^3 , which rigidly support a short cylinder or ring, C, the axis of which is horizontal. The cylinder is closed by two side plates or heads, R, bolted rigidly thereto, as shown in Figs. 1, 2, and 7, and strengthened by ribs R^5 , these heads being dished or depressed centrally, so that at the middle they are but slightly separated. A shaft, W, is passed horizontally through the center of the cylinder and its heads, and sustained by boxes or bearings M on the latter and by a bearing on a standard, X, which rises rigidly from the base-frame. Within the cylinder the shaft has fixed upon it a hub, P, fitting closely between and against the cylinder-heads and provided with three equidistant radial pistons or arms, Q, each of which spans the space be-

tween the cylinder-heads and fits at the outer end closely to the inner surface of the cylinder. These pistons are provided with grooves v , containing packing material, and with perforations p , communicating with said grooves, through which the steam acts on the packing, as in other engines. The arrangement is such that the pistons may revolve freely around the axis of the shaft to effect its rotation.

In order to divide the interior of the cylinder into separate steam-chambers and so confine the steam that it may act on one side only of the piston, I provide at diametrically-opposite points two gates, diaphragms, or abutments, A A', each consisting of a metal plate, so pivoted and arranged that it may swing into and out of the cylinder in the direction of its axis so as to span for the time being the space between the cylinder-heads and confine the steam on one side of the respective pistons, and thereafter to withdraw entirely from the cylinder that the pistons may successively pass in the course of their rotation. These gates swing outward through slots in the inner cylinder-heads into receiving-chambers N, formed on or bolted to the outside of the head, as shown, the parts being suitably fitted to prevent the leakage of steam.

Each gate has its inner end forked to straddle the shaft, as shown at A, and pivoted to lugs U on the cylinder-head. The gates are opened and closed at different times by pitmen T, joined one to each gate, and each connected in turn to a lever, d , pivoted on the frame and provided with a roller or stud, e , entering a sinuous groove, D, in a hub, z , fixed on the main shaft. This cam-groove is so shaped that each gate is opened or withdrawn immediately in advance of and closed immediately behind each of the pistons.

In order to admit the steam into or out of the spaces or chambers within the cylinder between the rear faces of the pistons and the gates, I provide a peculiar valve mechanism, so constructed that the motion of the engine may be reversed at will by admitting the steam on the right or left of the gates—that is to say, before or behind them, as demanded.

The construction is as follows: A steam-

chest, *g*, constantly filled with live steam, is mounted at the top of the cylinder and provided in the bottom with two live-steam ports, *r r'*, and an intermediate exhaust-port, *m*. The live-steam ports *r r'* are continued until they open into the cylinder just forward of the respective gates or diaphragms *A A'*, while the exhaust-port leads to the air or to a discharge-pipe. These three ports are used when the engine runs in one direction and operate in connection with a reciprocating **D**-valve, *J*, which acts to direct the steam through the ports *r r'* alternately into the cylinder and from the cylinder through said ports alternately to the exhaust-port in a manner which will be understood by every mechanic familiar with ordinary slide-valve engines. To drive the engine in the reverse direction, I provide a second and similar series of ports, *s s'* and *m'*, the first two leading from the chest into the cylinder behind the respective gates or diaphragms. The port *m'* delivers the exhaust-steam. I move this second series of ports in connection with the same slide-valve, *J*, which controls the first series; and in order that this may be done the valve is made adjustable laterally, or, in other words, at right angles to its path of reciprocation, so that it may be moved from a position over one set of ports to a like position over the other set. To effect this lateral adjustment of the slide-valve which causes the reversal of the engine, and at the same time close that series of ports which is for the time being out of use, I provide the large reversing-valve *K*, movably seated in the steam-chest and grooved or slotted at its middle to receive and guide the slide-valve. This large valve is movable at right angles to the line of travel of the slide-valve, and has at opposite sides of the latter wide imperforate faces which act alternately to cover the idle ports. The reversing-valve is provided with a stem, *b*, projecting to the exterior of the chest and attached to a handle-lever, *Y*, or equivalent operating devices, by which the reversing-valve may be conveniently shifted. The slide-valve is actuated by a reciprocating stem, *I*, projected through the chest and provided at its inner end, as in Fig. 9, with a wrist or arm, *I'*, lying at right angles thereto and passing loosely through an ear on the slide-valve, so as to maintain its connection while permitting the slide-valve to be adjusted laterally for reversing purposes.

The steam-ports *r* and *s* are in the present instance continued through or formed in part by pipes *r'*, which are curved outward to escape the shaft; but they may be formed in any other manner.

The ports may be carried through the chambers *N*, as shown, to the cylinder, or they may lie wholly outside of steam-chambers, as preferred, the only requirement being that they shall conduct the steam from the steam-chest

into the cylinder on opposite sides of the gates or diaphragms.

The slide-valve stem *I* is attached to a suitably-guided cross-head and connected by rod *H* to an adjustable slide, *G*, on a lever, *F*, pivoted to a rigid arm, *X*, and connected at its lower end to a lever, *d'*, which is in turn pivoted to the frame and provided with a stud or roller, *f*, seated in a cam-groove, *E*, in the before-mentioned hub *z* on the main shaft. This combination of parts gives the required reciprocation to the slide-valve, causing it to direct the steam into and out of the one series of ports or the other, according to the direction in which the engine is running.

The slide *G* is connected by links *L* to an elbow-lever, *Z*, on a fixed arm, so that by moving the last-named lever the slide may be moved on the lever *F* to or from its fulcrum, and thus the throw of the main valve and its point of cut off vary, as desired.

I am aware that rotary piston-engines have been variously constructed with gates or abutments arranged to slide in guides in right lines across the interior of the cylinder. By pivoting the gates at the inner end, so that they receive support from the pivots, I am enabled to reduce the wear and friction, and to operate them by connections located near the axis and having short movement, so that the operating-cams and pendent parts may be small and compact.

Having thus described my invention, what I claim is—

1. In a rotary-piston engine, the cylinder, the central rotary shaft and its pistons, and the pivoted gates movable axially across the cylinder, in combination with the grooved cam on the central shaft and the gate-operating pitman connected with said cam.

2. In a rotary-piston engine, the cylinder, the central shaft and its three pistons, the two gates pivoted near the center of the cylinder and arranged to swing across its interior in the direction of its axis, the steam-chest with ports leading to the cylinder, the slide-valve, cams on the main shaft, and connections from one cam to the gates and from the other cam to the valve, whereby the gates are opened in advance of and closed behind the pistons and the steam admitted to and delivered from the cylinder at the required times.

3. In combination with the cylinder, pistons, gates, and steam-chest provided with ports leading to the cylinder on opposite sides of the gates, the slide-valve adjustable at right angles to its working-path that it may be brought over either series of ports at will, and a second valve, substantially as shown, for closing those ports which are for the time being out of use, whereby the motion of the engine may be reversed at will.

4. In a rotary engine, and in combination with the two independent series of ports to permit reversal of the engine, the main sliding valve *K*, adapted to close the two series

of ports alternately, and the slide-valve mounted in the valve K and adjustable laterally therewith, whereby it may be caused to operate with either series of ports at will.

5 5. In a rotary engine, the cylinder having the concave heads, in combination with the central shaft and its pistons, the gates pivoted to swing through and across the cylinder in the direction of its axis, and the external gate-receiving chambers, N.

10 6. The cylinder, the shaft and its pistons,

and the gates, in combination with the steam-chest and its connecting-ports, the slide-valve, the rod H, connected thereto, the slide G, to which the rod is connected, the lever F, the 15 cam on the main shaft to actuate the lever, and the lever Z, to move the slide.

WILLIAM E. LEONARD.

Witnesses:

J. W. RULIFSON,

WM. W. RULIFSON.