(No Model.)

2 Sheets—Sheet 1.

J. G. DOWNIE.

STEAM ENGINE.

No. 407,338. Patented July 23, 1889.

Fig. 1.

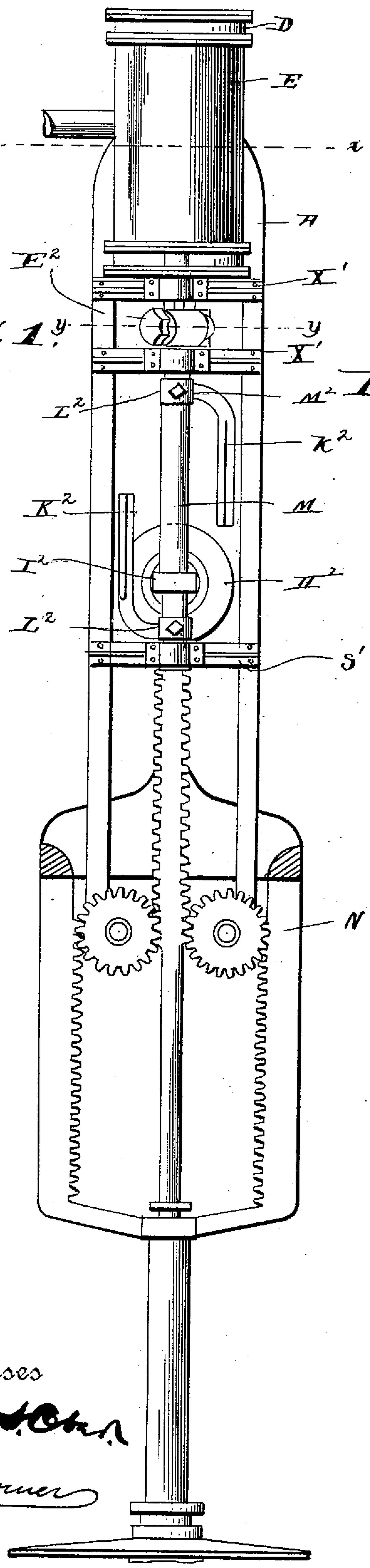
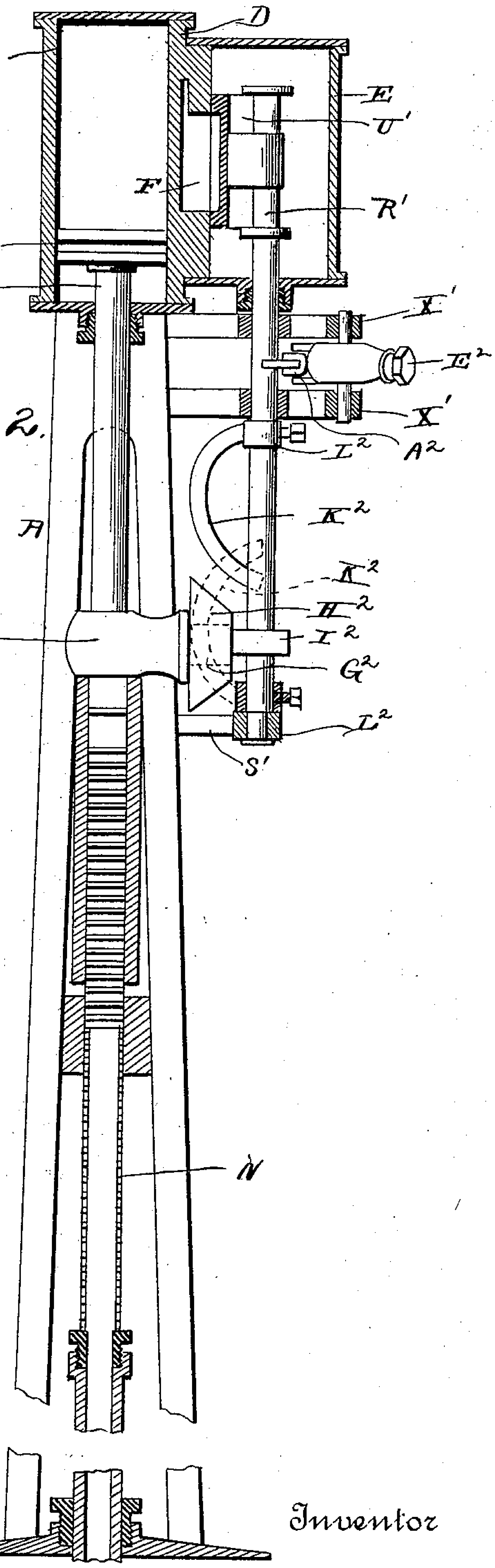


Fig. 2.



Witnesses

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

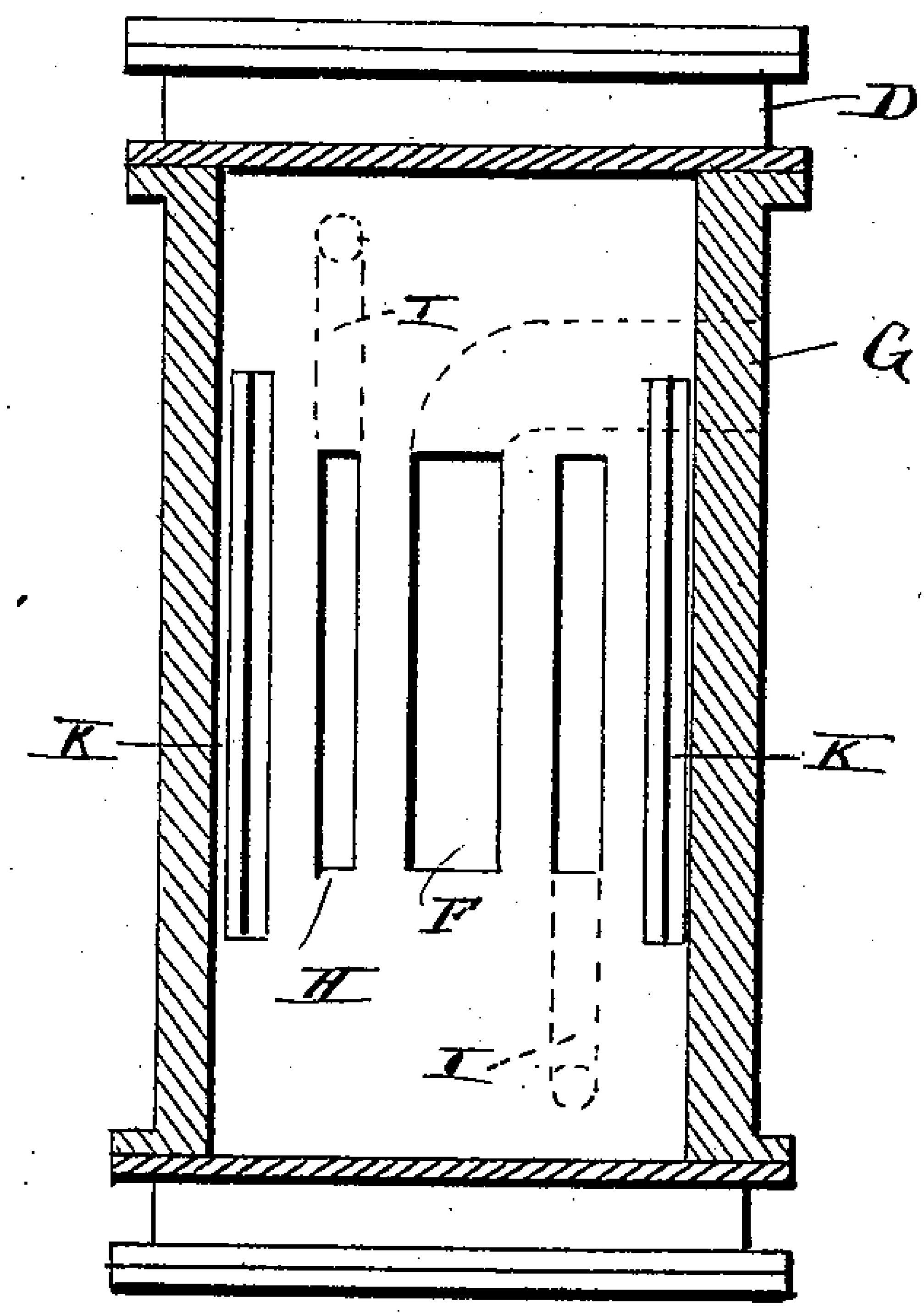


Fig. 4.

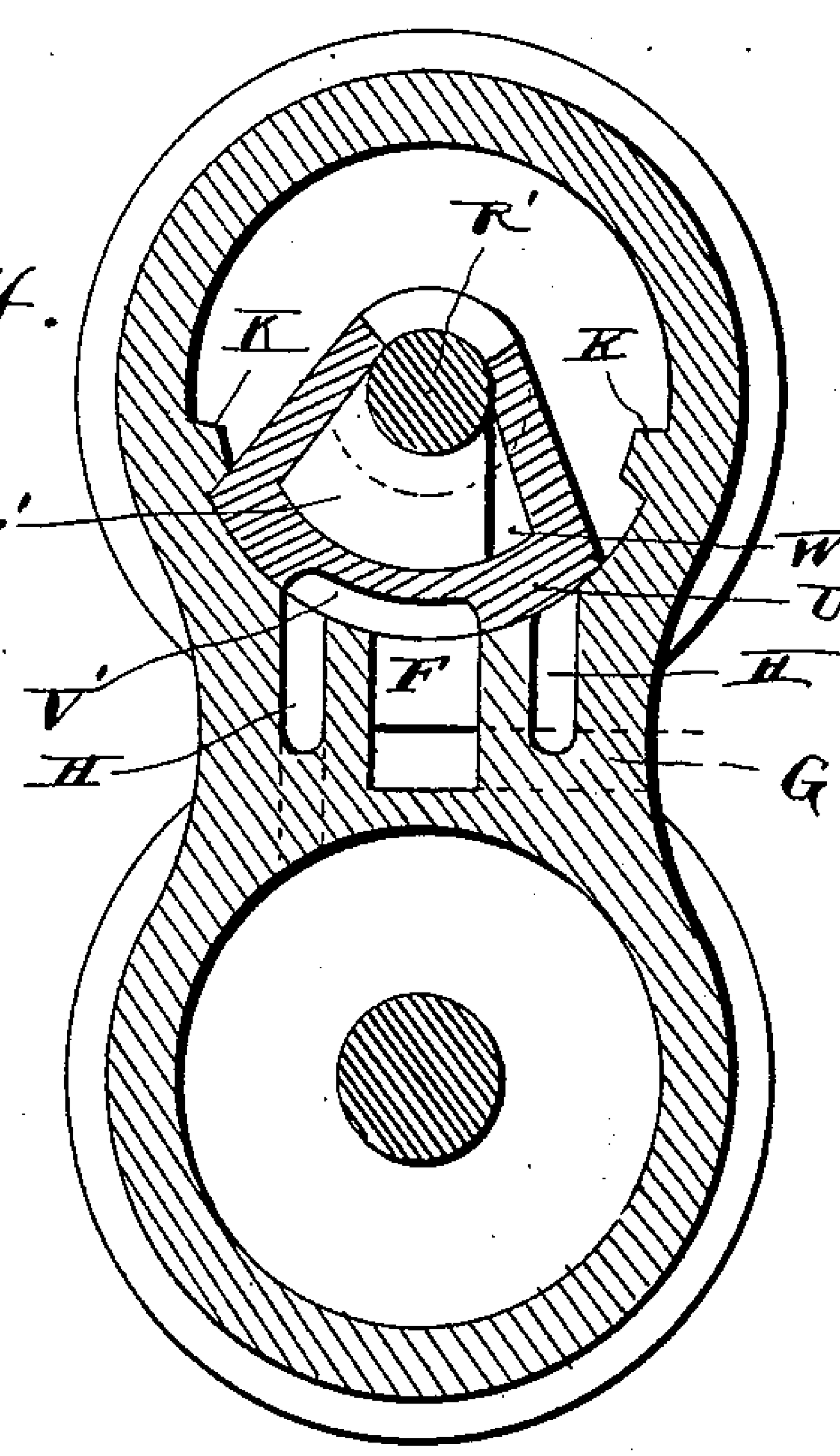
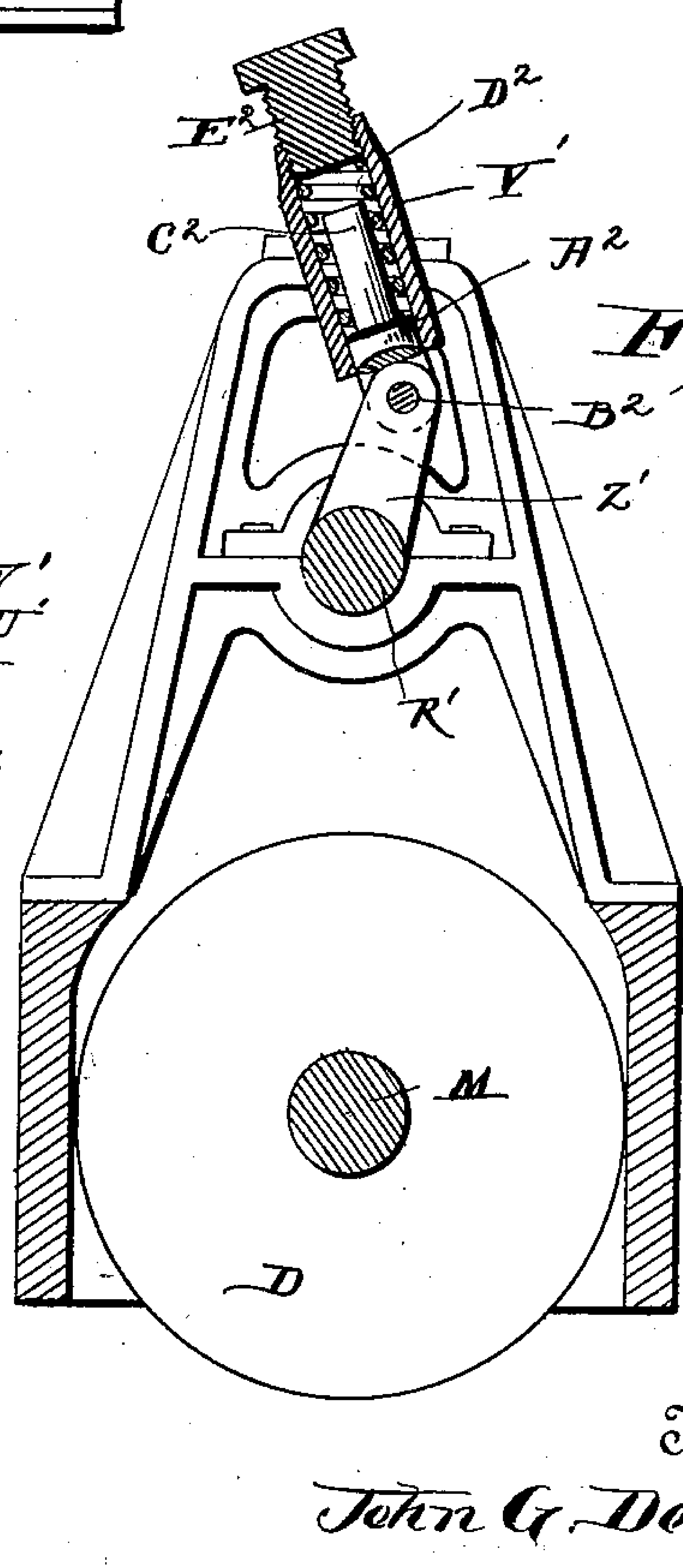


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN G. DOWNIE, OF BEAVER FALLS, PENNSYLVANIA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 407,338, dated July 23, 1889.

Application filed February 28, 1889. Serial No. 301,459. (No model.)

To all whom it may concern:

Be it known that I, JOHN G. DOWNIE, a citizen of the United States, residing at Beaver Falls, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Steam-Engines, of which the following is a specification.

My invention relates to an improvement in steam-engines for operating pumps; and it consists in the peculiar construction and combination of devices, that will be more fully set forth hereinafter and particularly pointed out in the claims. This engine is particularly designed for operating a pump such as fully described in my pending application for Letters Patent of the United States, Serial No. 266,498, filed March 8, 1888.

In the accompanying drawings, Figure 1 is a front elevation of my improved engine, showing the same connected to a pump. Fig. 2 is a vertical transverse sectional view of the same. Fig. 3 is a vertical transverse sectional view of the steam-chest, the valve having been removed from the same. Fig. 4 is a transverse sectional view taken on the line *x x* of Fig. 1. Fig. 5 is a similar view taken on the line *y y* of Fig. 1.

A represents a suitable frame, which serves as a guide for the yoke or cross-head of the pump.

To the upper end of the frame is secured the steam-cylinder D. On one side of the said cylinder, and either secured thereto or formed integral therewith, is a cylindrical steam-chest E, which is also arranged in a vertical position. On the inner side of the steam-chest, at the center of the same, is an exhaust-recess F, which communicates with an exhaust-channel G, and on opposite sides of said recess F are steam-ports H, which communicate with opposite ends of cylinder D through channels I.

K represents a pair of stops, which are arranged on the inner side of the steam-chest, and are at equal distances from the center of the recess F.

L represents the piston, of the usual construction, which is arranged in the cylinder D, and from the same depends the usual piston-rod M, which passes through the packing-box in the lower head of the steam-cylinder, and has its lower end connected to the yoke or cross-head N of the pump, whereby the same is adapted to be operated.

R′ represents a rock-shaft, the upper end of which enters the cylindrical steam-chest and remains in the center of the same, and the lower end of which is swiveled in a bearing at the outer end of a bracket S′, that projects horizontally from the front side of frame A.

T′ represents a segmental arm, which projects radially from one side of the rock-shaft near the upper end of the same, and U′ represents a segmental oscillating slide-valve, which is seated in the concave side of the cylindrical steam-chest adjacent to the steam-cylinder, and is provided on its face with a recess or channel V′, adapted to alternately establish communication between the steam-ports and the exhaust-recess F. The said valve is adapted to play between the offsets or shoulders K of the steam-chest, the said offsets or shoulders forming stops to limit the movement of said valve, and the latter is hollow, as shown, or provided with a segmental recess W′, in which the radial segmental arm T′ extends. The said recess is slightly wider than the said arm, so that the latter has a slight lost motion or play in the recess of the valve, as will be readily understood.

X′ represents a pair of horizontal brackets, which project from the front side of the frame A near the upper end thereof, and these brackets are provided at a suitable distance from their outer ends with bearings through which the rock-shaft R′ extends. In the extreme outer ends of the said brackets is a pair of bearings, which are in line with each other, and in which are journaled the projecting trunnions of a cylindrical hollow rocking arm Y′.

Z′ represents a rock-arm, which is rigidly secured to and projects from one side of the rock-shaft R′. In the cylindrical rocking arm Y′ is a piston A^2, the inner end of which is pivoted to the outer end of the rock-arm Z′ by means of a pin or bolt B^2, a toggle-joint being thereby formed between the said piston and the said arm. The outer portion of the piston is reduced for a suitable length to form a stem C^2.

D^2 represents a coiled extensile spring, which is fitted in the cylindrical arm Y′, en-

circles the stem C^2, and bears at its inner end against the head of the piston.

E^2 represents a plug, which is screwed into the outer end of the hollow arm Y′, and bears against the outer end of the spring, the function of the said plug being to regulate the tension of the spring and cause the latter to bear against the piston with the requisite degree of force.

From the lower end of the piston-rod M projects an arm F^2, which is arranged at right angles to the piston-rod, and has a spindle G^2 formed near its outer end. On the said spindle is journaled a cam-roller H^2, which forms the frustum of a cone, and from the center of the spindle at the outer end thereof projects an extension or arm I^2, having an opening through which the rock-shaft R′ extends, the said rock-shaft thereby forming a guide for the arm F^2.

K^2 represents a pair of curved tappet-arms, which have collars L^2 at their outer ends, the said collars being slipped on the rock-shaft R′ and secured rigidly thereto by means of set-screws M^2. The said arms K^2 have their inner ends curved, as shown, and adapted to be engaged alternately by the cam-roller as the latter moves up and down, so as to partly rotate the shaft R′ first in one direction and then in the contrary direction, as will be readily understood. Engines of this class are run comparatively slowly. An objection hitherto existing to steam-pump engines is that when the pressure of steam is very low it frequently happens that the piston is not moved quite far enough in the cylinder to actuate the valve and cause the same to cut off the steam from one port and open the steam-port for the reverse stroke of the piston, and as a consequence the valve lodges after closing one steam-port and before it opens the other, thereby causing the operation of the piston to cease. One of the objects of my invention is to obviate this difficulty by means of the peculiar valve and mechanism for operating the same, hereinbefore described, so that the valve will be always caused to complete its motion and thereby be prevented from closing one port without opening the other.

The operation of my invention is as follows: On the downstroke of the piston the cam-roller slips past and out of contact with the upper curved arm K^2 and engages the lower curved arm, and thereby moves said arm laterally in a circular direction, and consequently partly rotates the shaft R′ and causes the arm T′ to move through a portion of a circle and to reverse the position of the valve U′. The first part of the partial rotation of the rock-shaft is accomplished against the tension of the spring D^2, as the arm Z′ forces the piston A^2 inward in the cylindrical arm Y′; but as soon as the rock-shaft carries the bolt or pin B^2 past the dead-center, which it does at only a partial stroke of the piston in the steam-cylinder, the resilience of the spring, as the latter tends to reassume its normal expanded position, forces the plunger A^2 outward in the cylindrical arm Y′, and exerts so considerable pressure against the toggle-jointed end of the arm Z′ as to cause the latter to act as a lever and complete the partial rotation of the rock-shaft, so as to carry the valve to the extreme limit of its movement, and thereby cut off one of the steam-ports and place the same in communication with the exhaust-port and at the same instant open the other steam-port and establish communication between the live steam in the steam-chest and one end of the cylinder, so as to reverse the stroke of the piston. On the next ensuing upstroke of the piston the movement of the valve is reversed, the spring and its connections serving to carry the valve to the extreme limit of the stroke as soon as the rock-shaft has carried the arm Z′ past the dead-center. The arm T′ being somewat narrower than the recess in the valve the said arm is given a slight lost motion in the said valve, which allows the live steam to enter the port about to be closed until the rock-shaft is carried past the dead-center, at which point the resilience of the spring, without further assistance from the piston-rod, completes the closing of one port and opens the other.

A steam-pump thus constructed is adapted to successfully operate the pump-plungers when only a sufficient pressure of steam is obtained to move the piston in the steam-cylinder and to move the plungers when loaded.

Having thus described my invention, I claim—

1. The combination, in a steam-pump engine, of the rock-shaft carrying the oscillating cut-off valve, the arm Z′, projecting from the rock-shaft, the oscillating arm Y′, and the spring-pressed plunger guided by the said oscillating arm and flexibly jointed thereto, substantially as described.

2. The combination, in a steam-pump engine, of the rock-shaft carrying the cut-off valve, the arm Z′, projecting from said rock-shaft, the oscillating cylindrical arm Y′, the plunger arranged in the said oscillating arm and pivotally connected to arm Z′, the spring bearing on said plunger, and means, substantially as set forth, to regulate the tension of the spring, substantially as described.

3. The combination, in a steam-pump engine, of the rock-shaft R′, having the arm Z′ and the segment-arm T′, the oscillating cut-off valve having the recess with which arm T′ engages, said recess exceeding the width of the said arm to give the latter lost motion, the oscillating arm Y′, the spring-pressed plunger guided in said arm and connected to arm Z′, and stops to limit the play of the valve, substantially as described.

4. The combination, with an oscillating steam-valve, of mechanism for completing the stroke of such valve independently of the motion communicated to it from the piston-rod

of the engine, and stops arranged interiorly in the steam-chest to limit the motion of the valve, substantially as set forth.

5. The combination of a cylinder or steam-chest, an oscillating valve arranged within the latter, curved arms attached to the valve-stem and adapted to be engaged by a roller journaled to the piston-rod, and an arm extending radially from the valve-stem and connected pivotally with a spring-pressed slide arranged within an oscillating casing, substantially as set forth.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in presence of two witnesses.

JOHN G. DOWNIE.

Witnesses:
J. F. MERRIMAN,
WILLIAM C. GALTON.