(No Model.) 2 Sheets—Sheet 1.

E. S. SMITH.

STEAM ENGINE.

No. 380,825. Patented Apr. 10, 1888.

Fig. 1.

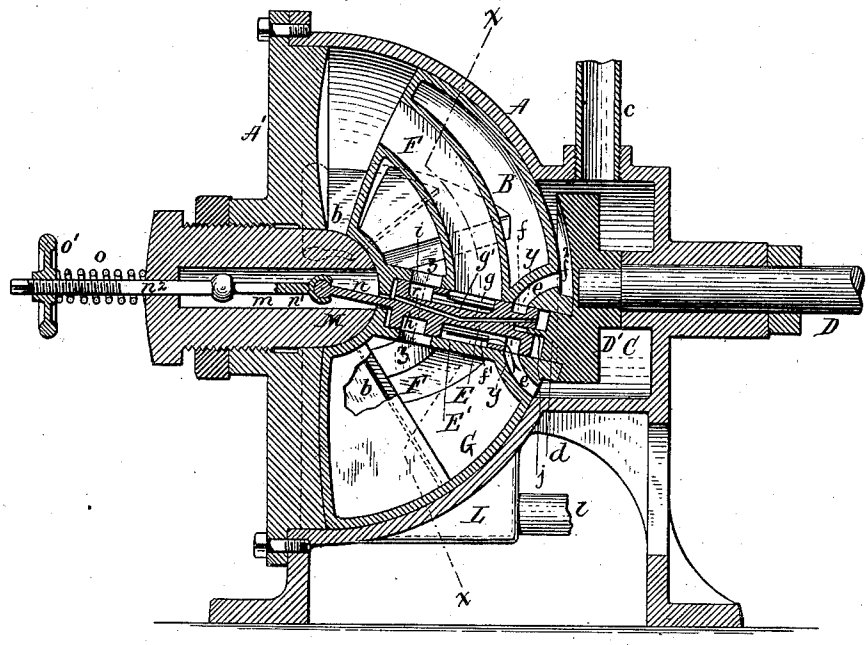
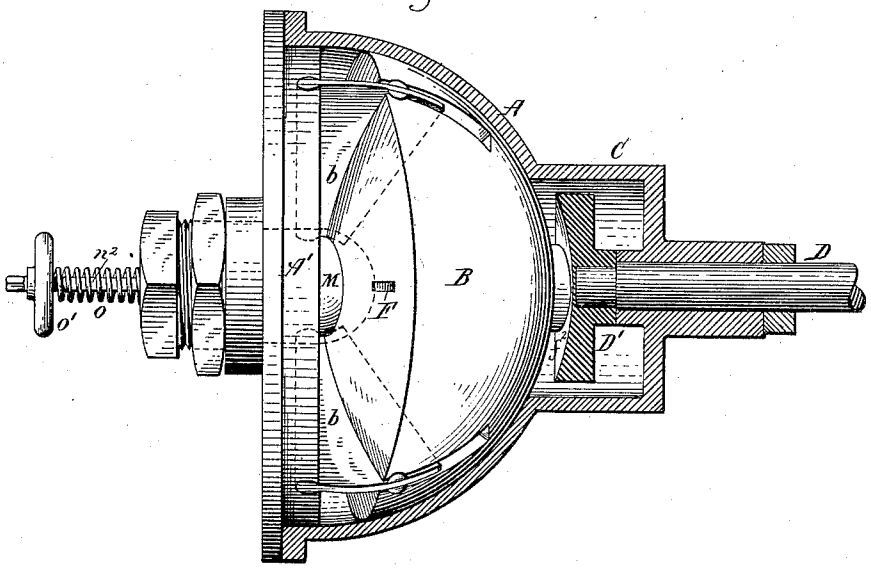


Fig. 2.



Witnesses:
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Theo. L. Popp

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

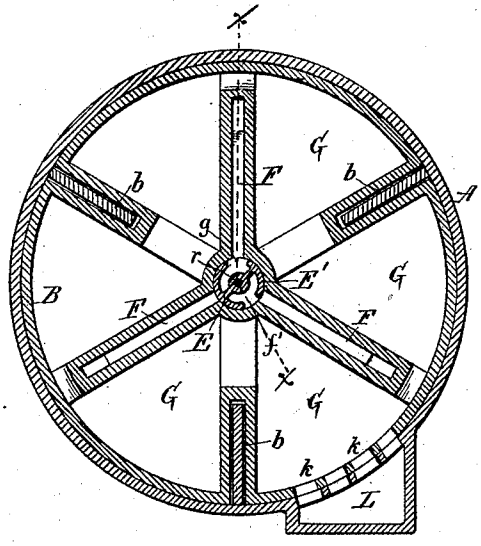


Fig. 5

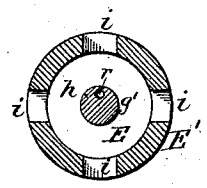


Fig. 4.

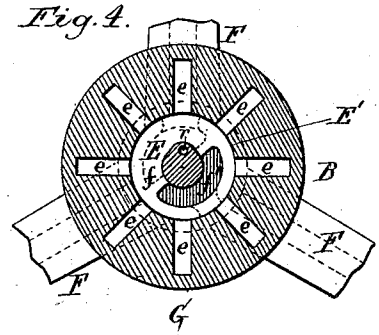


Fig. 6.

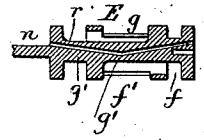


Fig. 7.

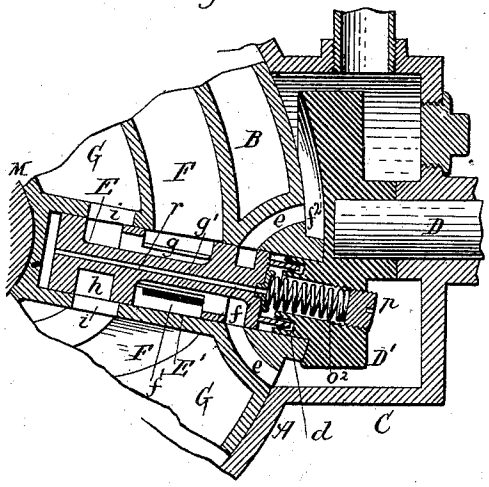
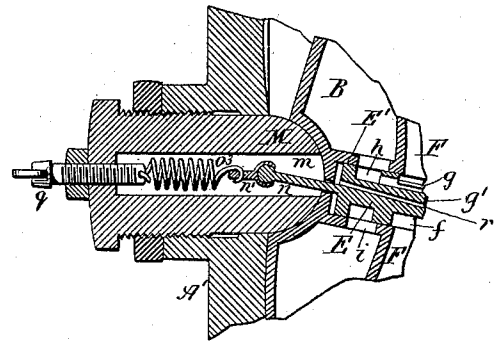


Fig. 8.



Witnesses:
Chas. J. Buchheit.
Theo. L. Popp.

E. S. Smith Inventor.
By Wilhelm & Bonner.
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UNITED STATES PATENT OFFICE.

ELMER S. SMITH, OF BUFFALO, NEW YORK, ASSIGNOR OF ONE-HALF TO RAY V. PIERCE, OF SAME PLACE.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 380,825, dated April 10, 1888.

Application filed August 4, 1887. Serial No. 246,109. (No model.)

To all whom it may concern:

Be it known that I, ELMER S. SMITH, a citizen of the United States, residing at the city of Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Steam-Engines, of which the following is a specification.

This invention relates to an engine which is provided with a disk or piston having a wabbling motion, partly oscillating and partly rotative, in a case or chamber which has the form of a spherical segment. An engine of this kind is described and shown in Letters Patent No. 366,894, granted to me July 19, 1887.

The object of this invention is to improve the exhaust devices of the engine and to provide the latter with an automatic governor of simple construction.

My invention consists of the improvements which will be hereinafter described, and pointed out in the claims.

In the accompanying drawings, consisting of two sheets, Figure 1 is a longitudinal section of my improved engine. Fig. 2 is a top plan view with part of the casing in section. Fig. 3 is a cross-section in line *x x*, Fig. 1. Fig. 4 is a cross-section through the valve-chamber in line *y y*, Fig. 1, on an enlarged scale. Fig. 5 is a cross-section through the exhaust end of the valve in line *z z*, Fig. 1, on an enlarged scale. Fig. 6 is a longitudinal section of the valve. Fig. 7 is a longitudinal section of a modified construction of the valve mechanism and adjacent parts on an enlarged scale, the section being taken through two steam-ports in line *x x*, Fig. 3. Fig. 8 is a similar view showing another modification of the valve mechanism.

Like letters of reference refer to like parts in the several figures.

My improved engine can be actuated by steam, compressed air, water, or any other fluid or liquid under pressure; but for the purpose of simplifying the description I will describe it as a steam-engine.

A represents the case having the form of a spherical segment; A′, the head which closes the large end of the case; B, the piston having the form of a spherical segment which fills the case A partially; *b*, the wings attached to the head A′ and projecting into pockets or depressions in the piston; C, the steam-chest formed at the convex end of the case A, and *c* the steam-supply pipe. All of these parts are constructed and arranged substantially as described in my aforesaid Letters Patent.

D represents the engine-shaft, arranged in line with the axis of the case A, and D′ represents the crank-disk secured to the shaft D within the steam-chest C.

d is the wrist-pin formed on or secured to the disk D′, and connected with the segmental piston B in the axial line of the latter.

E represents the cylindrical steam-valve arranged in a cylindrical seat or cavity, E′, formed axially in the piston B, the seat being somewhat longer than the valve, so that the latter can move lengthwise in the seat.

e represents steam-supply ports or passages radiating from the rear portion of the valve-seat E′, and opening with their rear ends on the convex back of the piston B within the steam-chest C, so as to conduct the steam from the latter to the valve-seat E′.

The valve E is provided near its rear end with an annular port, *f*, which registers with the supply-ports *e*, and communicates with the steam-port *f′* of the valve, the port *f′* extending inwardly or forwardly from the annular port *f*. The crank-disk D′ is made concave adjacent to the piston to form a passage, f^2, between the disk and the piston, through which passage the steam flows to some of the supply-ports *e*.

F represents the steam-ports, formed radially in the piston B, at equal distances apart circumferentially and between the wings *b*. The steam-ports extend from the valve-seat E′ to the face of the piston, so as to conduct the steam to and from the space between the face of the piston and the head A′.

The ports F are constructed in the form of flat tubes, and leave an exhaust-space, G, within the piston and around the tubes or ports F.

g represents the exhaust-port formed in the valve diametrically opposite the steam-port *f′*, these two ports being separated by a longitudinal partition, *g′*, extending through the valve.

h represents an annular port formed in the valve near the inner end thereof and communicating with the exhaust-port *g*.

i represents openings formed in the valve-seat E′ between the steam-ports F and the in-

ner face of the piston, and communicating with the exhaust-space G around the steam-ports. The annular port *h* of the valve registers with the openings *i*, so as to exhaust through these openings into the space G.

j represents a flat pin or an eccentrically-arranged pin connecting the wrist-pin *d* with the valve E, and compelling the latter to turn in the seat E′ with the pin, whereby the supply and exhaust of steam are controlled.

k represents one or more exhaust-openings formed in the convex back of the piston B, so as to form an outlet for the exhaust-space G.

L represents an exhaust-chamber formed in the case A and registering with the exhaust-openings *k*.

l represents the exhaust-pipe connecting with the exhaust-chamber L.

M represents the knuckle secured centrally in the head A′, and entering with its semi-spherical inner end a central socket in the face of the piston B. As shown in Fig. 1, the knuckle M is provided with a longitudinal bore or cavity, *m*.

n represents a stem formed on or secured to the inner end of the valve E and projecting into the bore of the knuckle M.

n′ represents a link, which is arranged in the bore *m*, and connects the stem *n* with a screw-rod, n^2. The latter extends through the outer end of the knuckle, and is provided outside of the knuckle with a spring, *o*, and screw-nut, *o′*. The joints of the link with the screw-rod and valve-stem are ball-and-socket joints, in order to permit the stem to move freely as the valve rotates. The centrifugal force created by the rotative motion of the piston causes the valve E to move toward the convex back of the piston. The spring *o* resists this tendency of the valve to move backwardly, and by adjusting the screw-nut *o′* the resistance of the spring can be increased or reduced as may be desired. When the valve E is in its normal position, the annular inlet-port *f* registers squarely with the supply-ports *e*, and permits of an unrestricted supply of steam to the valve. As the speed increases and the valve E moves backwardly in the seat by the action of centrifugal force, the annular port *f* of the valve moves partly past the supply-ports *e*, thereby throttling the steam-supply and reducing the speed correspondingly. When the speed has fallen sufficiently to permit the spring *o* to overcome the centrifugal force, the valve is drawn forwardly by the spring *o*, and the supply-ports are again fully opened. In this manner the valve cuts off the steam-supply automatically and maintains a uniform rate of speed of the engine. By adjusting the tension of the spring the rate of speed can be increased or reduced at desire.

In the construction represented in Fig. 7 the tension-spring o^2 is arranged in a cavity formed in the wrist-pin so as to bear against the outer or rear end of the valve, and is adjusted by a screw, *p*, secured in the crank-disk.

In the construction represented in Fig. 8 the tension-spring o^3 is arranged in the bore of the knuckle M and attached to an adjusting-screw, *q*, which works in the outer portion of the knuckle.

r is an equalizing-passage extending through the valve from end to end thereof for the purpose of equalizing the pressure against both ends of the valve, thereby enabling the valve to move freely in its seat.

My present improvements provide an extremely simple governor for regulating the speed of the engine and dispense with the exhaust-passage formerly formed in the knuckle, whereby the bearing-surfaces of the knuckle and piston can be increased and the parts are more easily fitted to work steam-tight.

I claim as my invention—

1. The combination, with the segmental case, of a segmental piston provided with an internal valve-seat and inlet and exhaust passages, and a valve capable of movement in said seat in one direction by centrifugal force and in the opposite direction by a tension device, whereby the valve is adjusted automatically and the supply of the actuating-fluid is increased or reduced inversely with the speed, substantially as set forth.

2. The combination, with the segmental case and the segmental piston provided with an internal valve-seat and inlet and exhaust passages, of a valve capable of longitudinal movement in said seat, and a spring which resists the outward movement of the valve in its seat, substantially as set forth.

3. The combination, with the segmental case, of a knuckle, M, secured to said case, a segmental piston provided with an internal valve-seat and inlet and exhaust passages, a valve capable of longitudinal movement in said seat, and a resisting-spring attached to said knuckle and connected with the valve, substantially as set forth.

4. The combination, with the segmental case A A′ and segmental piston B, provided with supply-ports *e*, main ports F, and exhaust-space G, of the valve capable of longitudinal movement in the seat, and with inlet-ports *f f′* and exhaust-ports *g h*, substantially as set forth.

5. The combination, with the segmental case A A′ and segmental piston B, provided with an internal valve-seat, E′, of the valve E, provided with an equalizing-passage, *r*, extending from end to end of the valve, substantially as set forth.

6. The combination, with the segmental case A A′, provided with an external chamber, L, of the segmental piston B, provided with ports F, an exhaust-space, G, around said ports, and openings whereby said exhaust-space communicates with the exhaust-chamber L, substantially as set forth.

Witness my hand this 29th day of July, 1887.

ELMER S. SMITH.

Witnesses:

JNO. J. BONNER,

CHESTER D. HOWE.