(No Model.)

3 Sheets—Sheet 1.

E. S. SMITH.

STEAM ENGINE.

No. 457,927. Patented Aug. 18, 1891.

Fig. 2.

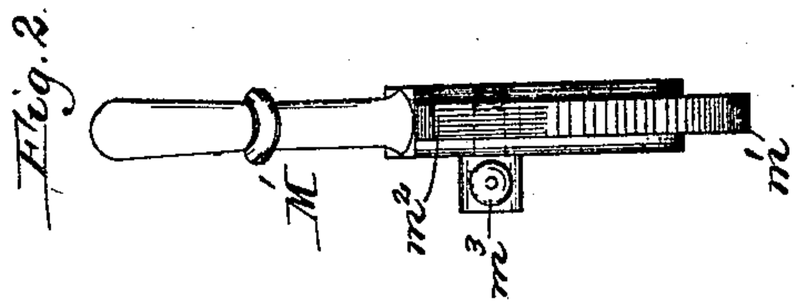
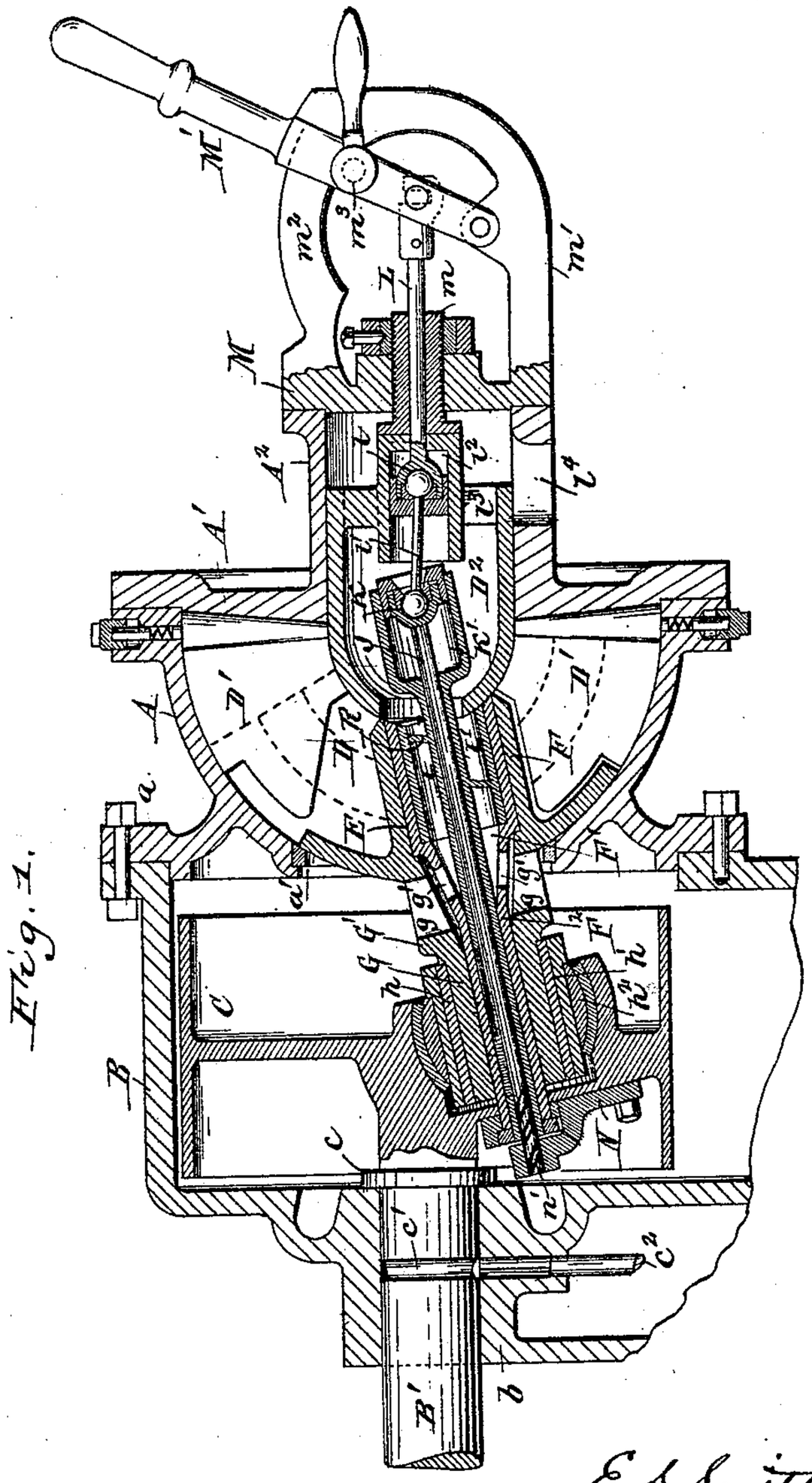


Fig. 1.



WITNESSES:

Theo. L. Popp.

Emil Neuhart.

E. S. Smith INVENTOR.

BY Wilhelm Bonner.

ATTORNEY.

(No Model.)

3 Sheets—Sheet 2.

E. S. SMITH.

STEAM ENGINE.

No. 457,927. Patented Aug. 18, 1891.

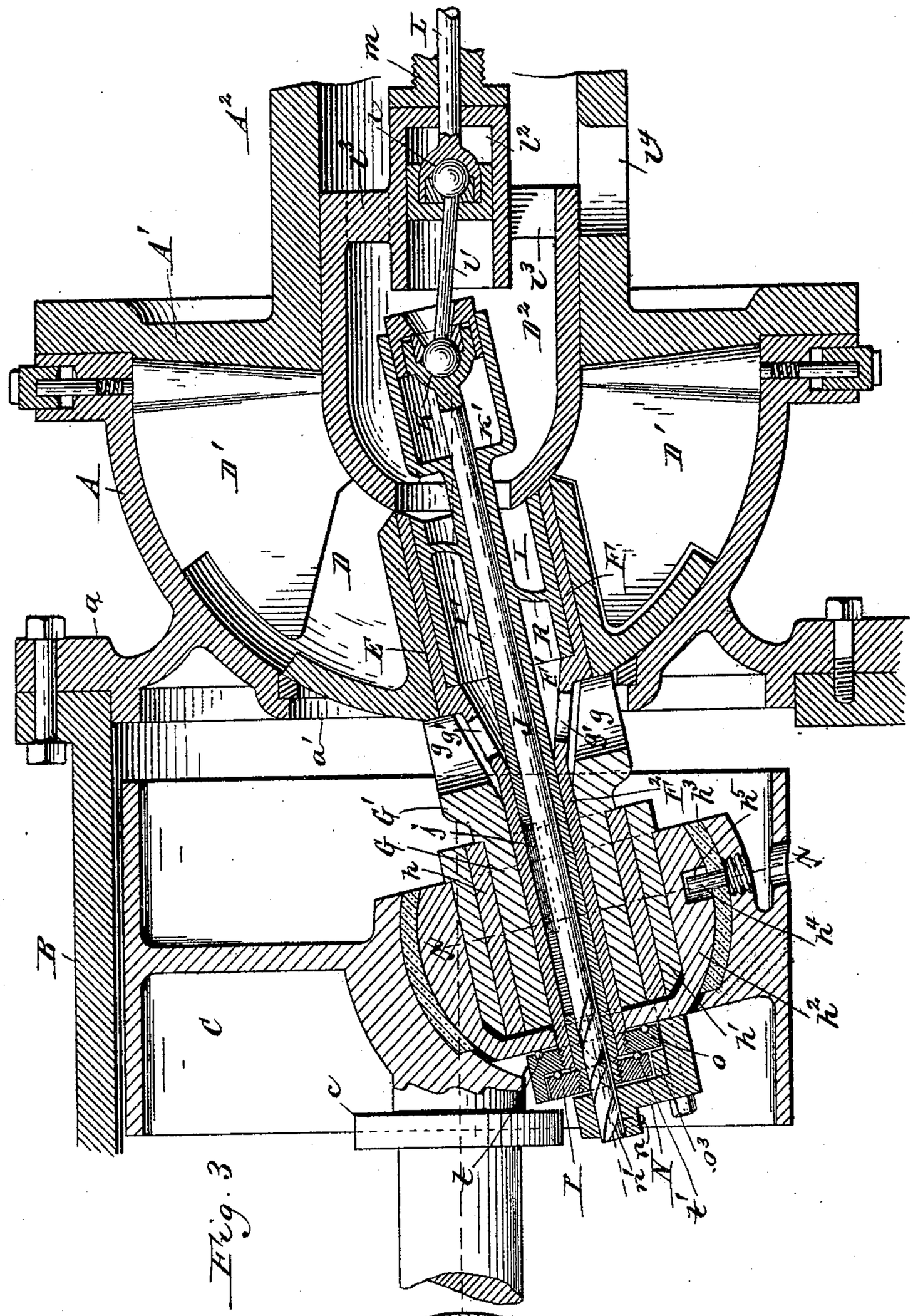


Fig. 3

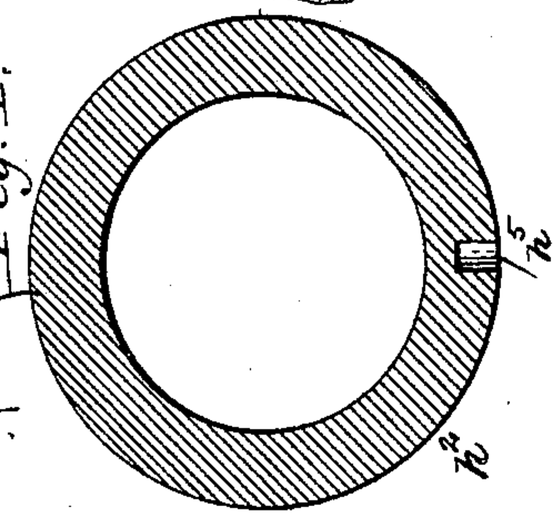


Fig. 4.

WITNESSES:

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(No Model.) 3 Sheets—Sheet 3.

E. S. SMITH.

STEAM ENGINE.

No. 457,927. Patented Aug. 18, 1891.

Fig. 15.

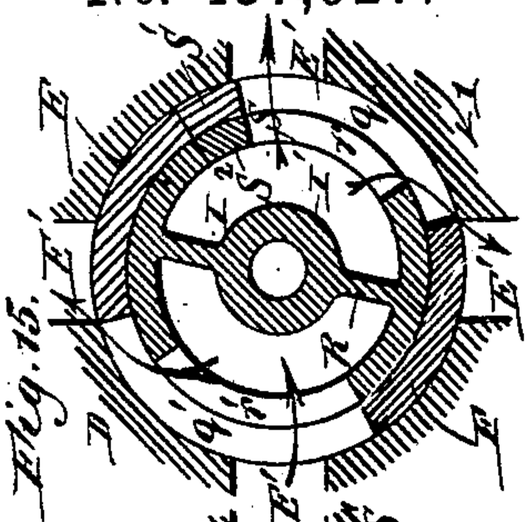


Fig. 10.

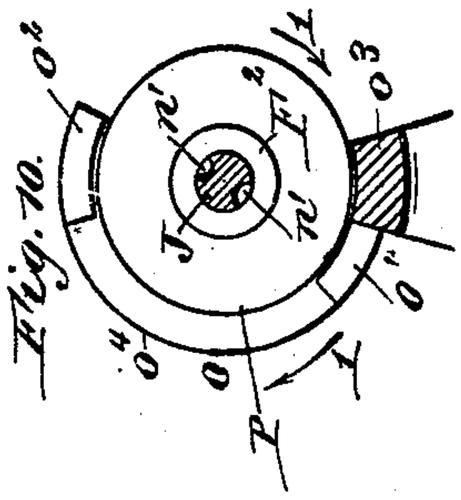


Fig. 7.

Fig. 16.

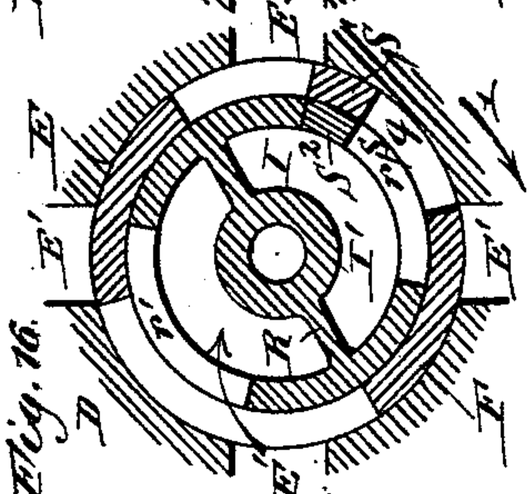


Fig. 17.

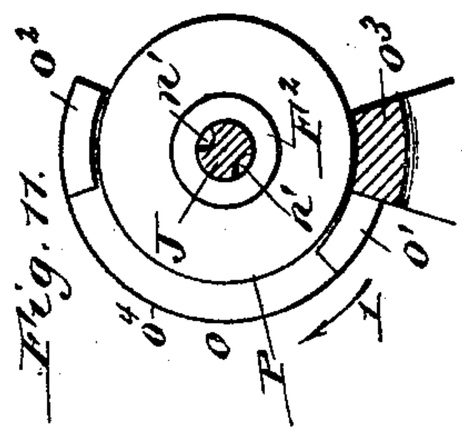


Fig. 6.

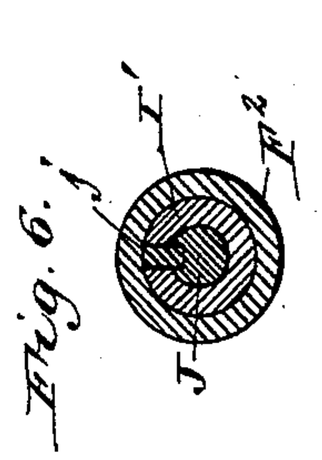


Fig. 17.

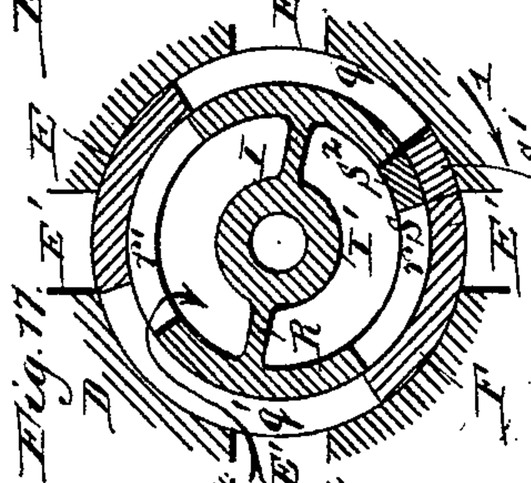


Fig. 12.

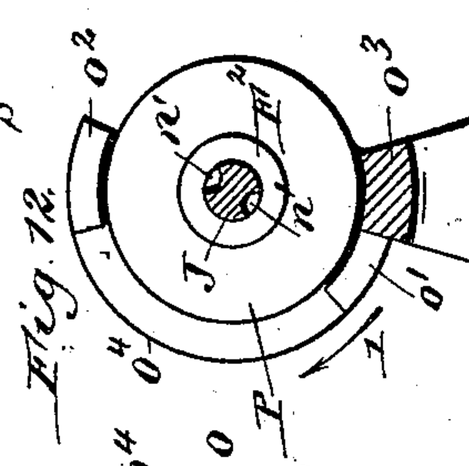


Fig. 9.

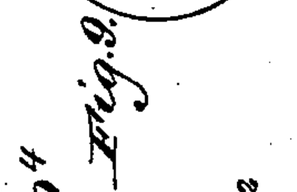


Fig. 18.

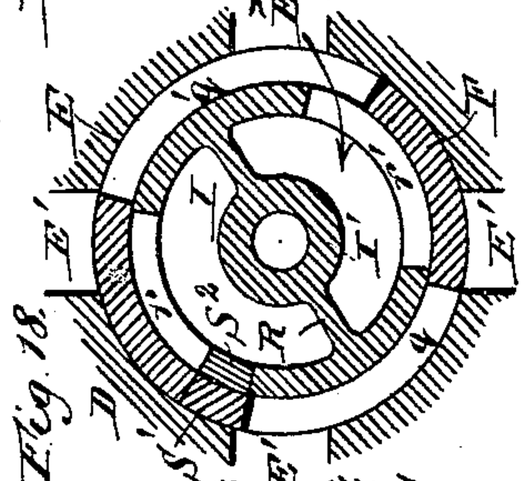


Fig. 13.

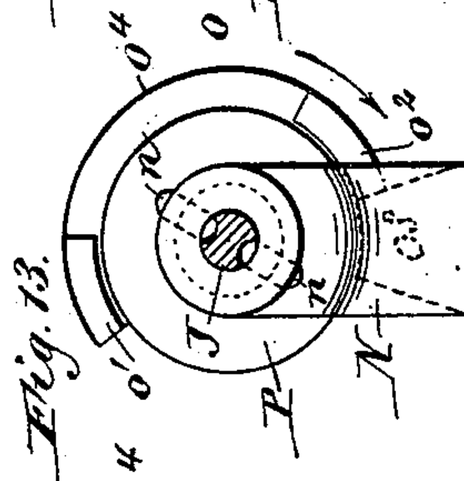


Fig. 5.

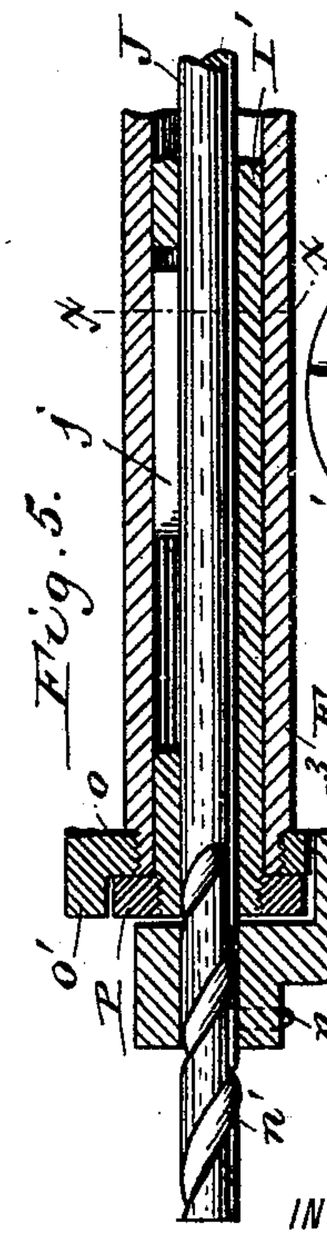


Fig. 8.

Fig. 19.

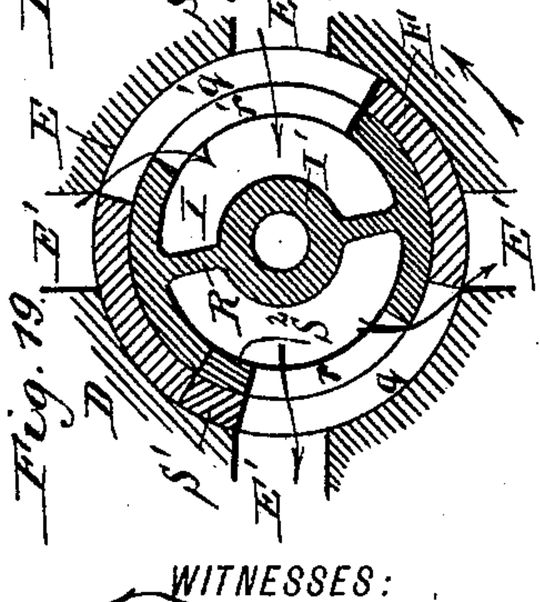
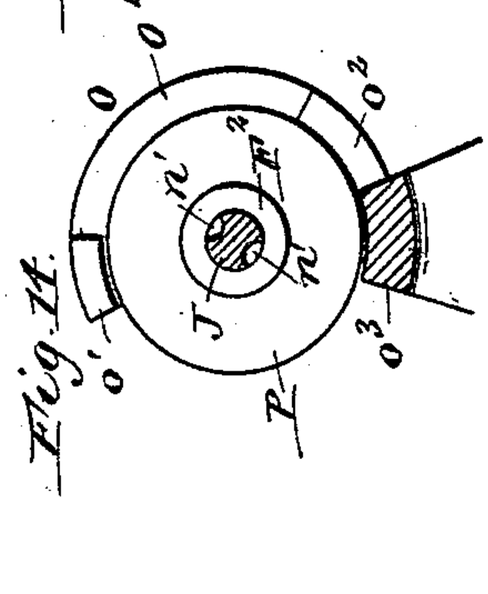


Fig. 14.



E. S. Smith

INVENTOR

WITNESSES:

Theo. L. Popp.

Emil Neuhart

BY Wilhelm & Bonner.

ATTORNEY.

UNITED STATES PATENT OFFICE.

ELMER S. SMITH, OF NEW YORK, ASSIGNOR TO THE AMERICAN ENGINE COMPANY, OF BUFFALO, NEW YORK.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 457,927, dated August 18, 1891.

Application filed April 27, 1891. Serial No. 390,552. (No model.)

To all whom it may concern:

Be it known that I, ELMER S. SMITH, a citizen of the United States, residing at New York, in the county 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, and which is arranged in a case or chamber having the form of a spherical segment. An engine of this character is described in Letters Patent No. 366,894, granted to me July 19, 1887.

The object of the present invention is to improve the cut-off and reversing mechanism of the engine and to improve the engine in various other respects.

In the accompanying drawings, consisting of three sheets, Figure 1 is a longitudinal sectional elevation of my improved engine. Fig. 2 is an end elevation of the reversing-lever and connecting parts. Fig. 3 is a fragmentary longitudinal section of the engine on an enlarged scale. Fig. 4 is a cross-section of the spherical cap surrounding the wrist-pin in line *x x*, Fig. 3. Fig. 5 is a longitudinal section of the rear portions of the valve-stems and connecting parts. Fig. 6 is a cross-section in line *x x*, Fig. 5. Fig. 7 is a longitudinal section through the cut-off segment arranged in the valves. Fig. 8 is a rear elevation of the carrier-plate attached to the stem of the main valve. Fig. 9 is a rear elevation of the collar attached to the stem of the cut-off valve. Figs. 10, 11, 12, 13, and 14 are rear elevations of the carrier-plate of the main valve in different positions of the valves. Figs. 15, 16, 17, 18, and 19 are cross-sections of the valves, showing the same in corresponding positions.

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

A represents the case in which the piston works, and which has the form of a spherical segment.

A′ represents the head, which is secured to the large end of the case and is provided with a cylindrical extension A^2, arranged axially with reference to the case.

a represents an annular flange which surrounds the central opening *a′*, formed in the crown of the spherical case, and by which the latter is secured to the steam-chest B, which receives the steam from a suitable supply-pipe. The steam-chest is preferably cast integral with the main bearing *b* of the engine-shaft B′.

C is the crank-disk formed on the engine-shaft and arranged within the steam-chest, and *c* is a collar also formed on the shaft within the steam-chest and bearing against the adjacent end of the main bearing to prevent as much as possible steam from leaking into the main bearing.

c′ is an annular groove formed in the shaft within the main bearing, and c^2 is the drain-pipe communicating with the groove. Steam which leaks along the shaft into the main bearing enters this groove and is carried off by the pipe c^2. It is obvious that the annular groove may be formed in the bearing instead of the shaft.

D represents the piston having the form of a spherical segment and fitting with its spherical back in the spherical case, while its face is made convex, so that the piston, which is arranged obliquely in the case, fills the latter only partially and leaves a steam-space between the receding portion of its face and the head of the case.

D′ represents the division plates or abutments, which are pivotally attached to the head of the case and project across the steam-space and into pockets formed in the piston.

D^2 represents the hollow follower pin or knuckle, which is arranged in the cylindrical extension A^2 of the head A′ and projects with its semi-spheral end into the case and enters a correspondingly-shaped recess in the face of the piston.

E represents the cylindrical valve-seat for the main valve arranged axially in the piston, and E′ represents the steam-ports, which extend from the sides of the valve-seat to the face of the piston between the pockets for the division-plates.

F represents the cylindrical main valve arranged in the seat E and made open toward the face of the piston, while its opposite end is provided with a tapering neck F′, which connects with a hollow stem F^2.

G represents the hollow wrist-pin, which projects rearwardly from the middle of the piston and is connected with the latter by a hollow collar G′, which surrounds the tapering neck of the main valve. This collar is provided with openings *g*, through which the steam passes from the steam-chest into the cavity of the collar, which cavity surrounds the tapering neck of the valve-stem and from which the steam passes through openings *g′* in the neck into the cavity of the valve. The piston is arranged obliquely in the case, and the wrist-pin, through which the valve-stems pass, is seated in an oblique socket formed eccentrically in the crank-disk. As shown in the drawings, the wrist-pin is surrounded by two cylindrical wear-rings *h h′* and an outer cap h^2, which has a spherical external face. This spherical cap is seated in a spherical socket formed in the crank-disk by pouring Babbitt or other soft metal h^3 into the socket in the crank-disk around the spherical cap. The outer portion of the latter extends inwardly to the hollow stem of the main valve. The spherical cap is prevented from turning about the valve-stem by a pin h^4, which is secured to the crank-disk and projects into a groove h^5 in the spherical cap. This groove is made long enough to permit the cap to rock in its seat lengthwise of the engine in adjusting itself to the angle of the valve-stem.

I represents the cylindrical cut-off valve, which is arranged within the cylindrical main valve and fits snugly in the bore thereof. This cut-off valve is provided with a hollow stem I′, which extends forwardly beyond the valves and rearwardly beyond the end of the hollow stem of the main valve.

J represents the reversing-rod, which is arranged in the bore of the hollow stem of the cut-off valve and extends rearwardly beyond said hollow stem. This rod is provided with a longitudinal feather *j*, which enters a groove in the stem of the cut-off valve and compels the latter to turn with the rod, the groove being longer than the feather to permit the rod to move lengthwise, while the cut-off valve is incapable of lengthwise movement. This reversing-rod is provided at its front end with a spherical socket K, which is guided in a cylindrical enlargement K′, formed at the front end of the stem of the cut-off valve and arranged within the hollow follower-pin.

L represents the shifting-rod, which is arranged axially in the cylindrical extension of the head of the case and provided at its inner end with a spherical socket *l*. This socket is connected with the socket K at the front end of the reversing-rod by a link *l′*, having spherical knuckles or heads at its ends, so that the longitudinal movement of the shifting-rod is transmitted by the link to the reversing-rod, while the link follows the rotative motion of the socket K, which rotates about the center line of the case. The socket *l* of the shifting-rod is guided in a cylinder l^2, which is arranged centrally in the hollow follower-pin and connected by radial arms l^3 with the front end thereof, the spaces between the arms permitting the exhaust-steam to pass from the cavity of the pin into the extension A^2, from which it escapes through the exhaust-pipe l^4.

m is a screw-sleeve which is arranged in the head M of the extension A^2 and bears against the outer end of the guide-cylinder l^2, so that the follower-pin can be adjusted inwardly by adjusting the screw-sleeve, while the follower-pin is free to turn in the extension A^2 in adjusting itself to the position of least resistance.

M′ is the reversing-lever which is pivoted to the lower part of a frame *m′*, formed on the head M and provided with a quadrant or segment m^2, on which the lever can be secured in position by a clamping-screw m^3. The outer end of the shifting-rod is connected with the reversing-lever, so that the reversing-rod is moved lengthwise in the valves by shifting the lever.

N represents a carrier which is secured to the rear side of the crank-disk, as shown in Fig. 1, or to the rear side of the spherical cap, as shown in Fig. 3, so as to rotate with the crank-disk. When the carrier is secured to the spherical cap, it takes part in the adjustment of the latter in the spherical socket, whereby binding is prevented. This carrier is provided with a bearing, in which the rear end of the reversing-rod is guided and which is provided with one or more radial pins or feathers *n*, each of which projects into a spiral groove *n′*, formed in the reversing-rod. Two pins and two grooves, arranged on diametrically-opposite sides, as shown, are preferably employed to equalize the strain; but one pin and one groove may be used. Upon moving the reversing-rod lengthwise by means of the reversing-lever the rod is turned by the engagement of the spiral grooves with the pins. The turning of the rod causes the turning of the cut-off valve by the feather of the rod engaging in the groove of the cut-off valve.

O represents a carrier-plate secured to the rear end of the stem of the main valve and provided with two rearwardly-projecting lugs O′ O^2, which are arranged nearly diametrically opposite each other, as represented in Fig. 8.

O^3 represents a lug or tooth formed on the base-plate of the carrier N and adapted to engage against the front or outer face of either of the lugs O′ O^2. The outer faces of the lugs O′ O^2 may be cut down to the circular hub of the carrier-plate, while the rear or inner faces of these lugs may be connected by a segmental web O^4. The tooth of the carrier-plate resting against one of these lugs causes the main valve to rotate in a certain direction

and the piston to be actuated in the corresponding direction. By turning the main valve so as bring the other lug against the tooth of the carrier-plate the main valve is reversed and the direction of movement of the piston is reversed.

P represents a collar which is secured to the rear end of the stem of the cut-off valve and bears against the rear side of the carrier-plate O of the main valve, so as to receive the inward thrust of the steam-pressure on the cut-off valve.

q is a steam-induction port, and *q'* the exhaust-port, formed in opposite sides of the main valve. *r* is the steam-induction port, and *r'* the exhaust-port, of the cut-off valve, arranged to register with the corresponding parts of the main valve.

R is the diagonal diaphragm formed lengthwise in the cut-off valve around the stem thereof and separating the induction-ports of both valves from the exhaust-ports of both valves, the induction cavity and ports communicating with the hollow neck of the main valve, and the exhaust-ports and cavity with the open end of the main valve, from which the exhaust-steam passes into the hollow follower-pin.

S is a movable cut-off segment which is arranged in the induction-ports of both valves, and which rests against the rear or trailing edge of the induction-port of the cut-off valve, or of both valves, in either direction in which the engine may run. This cut-off segment is composed of two plates, an outer plate S', having beveled sides and fitting between the beveled sides of the induction-port of the main valve, and an inner plate S^2 somewhat longer than the narrowest portion of the outer plate and arranged in the induction-port of the cut-off valve. Both plates are secured together, so as to form a segment having dovetail sides, by which the segment is attached to the valves, but permitted to be shifted circumferentially in the induction-port of the main valve.

In the position of the parts represented in Figs. 10 and 15 the crank-disk and the valves rotate in the direction of the arrows 1. The tooth O^3 of the carrier rests against the front or outer side of the lug O' of the main valve and causes the latter to rotate with the crank-disk. The pins of the carrier-plate N, engaging in the grooves of the reversing-rod, cause the latter to rotate with the main valve, and the feather *j* on the reversing-rod causes the cut-off valve to rotate with the reversing-rod. In this position of the cut-off valve the induction-ports *q r* of both valves are wide open and the movable cut-off segment S rests against the rear edges of the induction-ports of both valves. In this position of the valves the reversing-rod is nearly in its rearmost position. By moving the reversing-rod forwardly the cut-off valve is turned to the right in Fig. 15 in the direction in which it closes the induction-port of the main valve. In Fig. 16 the induction-port is shown partly closed by the cut-off valve, which has carried the movable cut-off segment with it toward the front edge of the induction-port. By continuing the forward motion of the reversing-rod the cut-off valve and the segment finally close the induction-port of the main valve, as represented in Fig. 17, thereby shutting off the steam and stopping the engine. The cut-off segment now rests against the front edge of the induction-port. By continuing the forward movement of the reversing-rod still farther the cut-off segment now bearing against the main valve causes the cut-off valve to carry the main valve around with it until the lug O^2 strikes against the tooth O^3 of the carrier, as represented in Fig. 13, in which position the main valve is reversed, as represented in Fig. 18, and the engine is prepared to move in the opposite direction. The cut-off valve and segment still close the induction-port of the main valve, and the reversing-rod is in its foremost position. The cut-off valve is now reversed and the induction-port opened wide by a partial backward movement of the reversing-rod, which is continued until the opposite edge of the steam-port of the cut-off valve rests against the cut-off segment, as represented in Fig. 19. If it is now desired to cut off, the reversing-lever is farther moved in the same direction, so as to shift the cut-off valve and the cut-off segment and close the induction-port of the main valve to a greater or less extent. In order to reverse the engine, therefore, the main valve is reversed by placing the reversing-lever in its opposite extreme position. The cut-off valve is next reversed, and the induction-port of the main valve is opened wide by a short return movement of the reversing-lever, and the cut-off valve is shifted to partially close the induction-port, if it is desired to cut off, by a further short return movement of the reversing-lever.

The carrier-plate O of the main valve is provided on its front side with an annular groove, in which are arranged balls *t*, which bear against the spherical cap of the wrist-pin and reduce the friction between these parts. The collar P of the cut-off valve is provided on its front side with a groove and a row of balls *t'*, by which it bears against the carrier-plate of the main valve. These balls receive the end-thrust caused by the steam pressure against the valves and materially reduce the friction between the parts.

My improved engine can be actuated by steam, compressed air, or any other fluid under pressure.

I do not wish to claim in this application the ball-bearing which is interposed between the stem of the cut-off valve and that of the main valve, because this subject-matter is claimed in an application filed by me March 2, 1891, Serial No. 383,400.

I claim as my invention—

1. The combination, with the case having the form of a spherical segment and the simi-

larly-shaped piston filling the case partially, of a reversible main valve arranged in the piston and moving therewith, and a reversible cut-off valve arranged in the main valve, substantially as set forth.

2. The combination, with the case having the form of a spherical segment and the similarly-shaped piston filling the case partially, of a reversible main valve arranged in the piston and moving therewith, a reversible cut-off valve arranged in the main valve, and a reversing-rod arranged in the cut-off valve, substantially as set forth.

3. The combination, with the case having the form of a spherical segment and the similarly-shaped piston filling the case partially, of a reversing-rod capable of rotative movement, a reversible cut-off valve which is rotated by said rod, and a reversible main valve which is arranged in said piston and shifted by the cut-off valve, substantially as set forth.

4. The combination, with the case, the piston, and the crank-disk, of a valve arranged in the piston and capable of rotary movement, but held against longitudinal movement, a reversing-rod capable of longitudinal movement in said valve and rotary movement with said valve and provided with a spiral groove, and a carrier attached to the crank-disk and provided with a projection which enters said groove, substantially as set forth.

5. The combination, with a spherical case and piston, of a main valve arranged in the piston, a cut-off valve arranged in the main valve and provided with a hollow stem having a guide at its front end, a reversing-rod arranged in said hollow stem and provided at its front end with a spherical socket which moves in said guide, a shifting-rod provided with a spherical socket, and a link having spherical knuckles and connecting said sockets, substantially as set forth.

6. The combination, with the spherical case and piston, of a cylindrical extension arranged on the head of said case, a hollow follower-pin arranged in said extension and provided with a cylindrical guide, a spherical socket arranged in said guide and connected with a shifting-rod, a reversible valve arranged in the piston, a reversing-rod arranged in said valve and provided with a spherical socket, and a link having spherical knuckles and connecting said sockets, substantially as set forth.

7. The combination, with the spherical case, the piston, and the crank-disk, of a carrier revolving with the disk and provided with a projection, and a reversible main valve arranged in the piston and provided with two projections, either of which can be brought in contact with the carrier, substantially as set forth.

8. The combination, with the spherical case, the piston, and the crank-disk, of a carrier attached to the disk and provided with a projection, a reversible main valve provided with two projections, either of which can be brought in contact with the projection of the carrier, and a reversible cut-off valve provided with a movable segment, whereby the main valve is moved, substantially as set forth.

9. The combination, with the main valve and the cut-off valve, both provided with induction-ports, of a detached cut-off segment arranged in the induction-ports, substantially as set forth.

10. The combination, with the spherical case, the spherical piston provided with a wrist-pin, and the crank-disk provided with a socket for the wrist-pin, of a sleeve surrounding the wrist-pin and arranged in the socket of the crank-disk to rotate therewith, a carrier secured to the sleeve, and a valve arranged in the piston and rotated by said carrier, substantially as set forth.

11. The combination, with the case having the form of a spherical segment, the similarly-shaped piston filling the case partially and provided with a wrist-pin, and the crank-disk provided with a seat for the wrist-pin, of a main valve arranged in the piston and having a stem which extends through the wrist-pin, and a ball-bearing which is interposed between said valve-stem and its support in the crank-disk and whereby the inward thrust of the main valve is taken up, substantially as set forth.

Witness my hand this 24th day of February, 1891.

ELMER S. SMITH.

Witnesses:
EDWARD WILHELM,
JNO. J. BONNER.