(No Model.) 3 Sheets—Sheet 1.

W. J. LANE.

STEAM ENGINE.

No. 315,516. Patented Apr. 14, 1885.

Fig. 1.

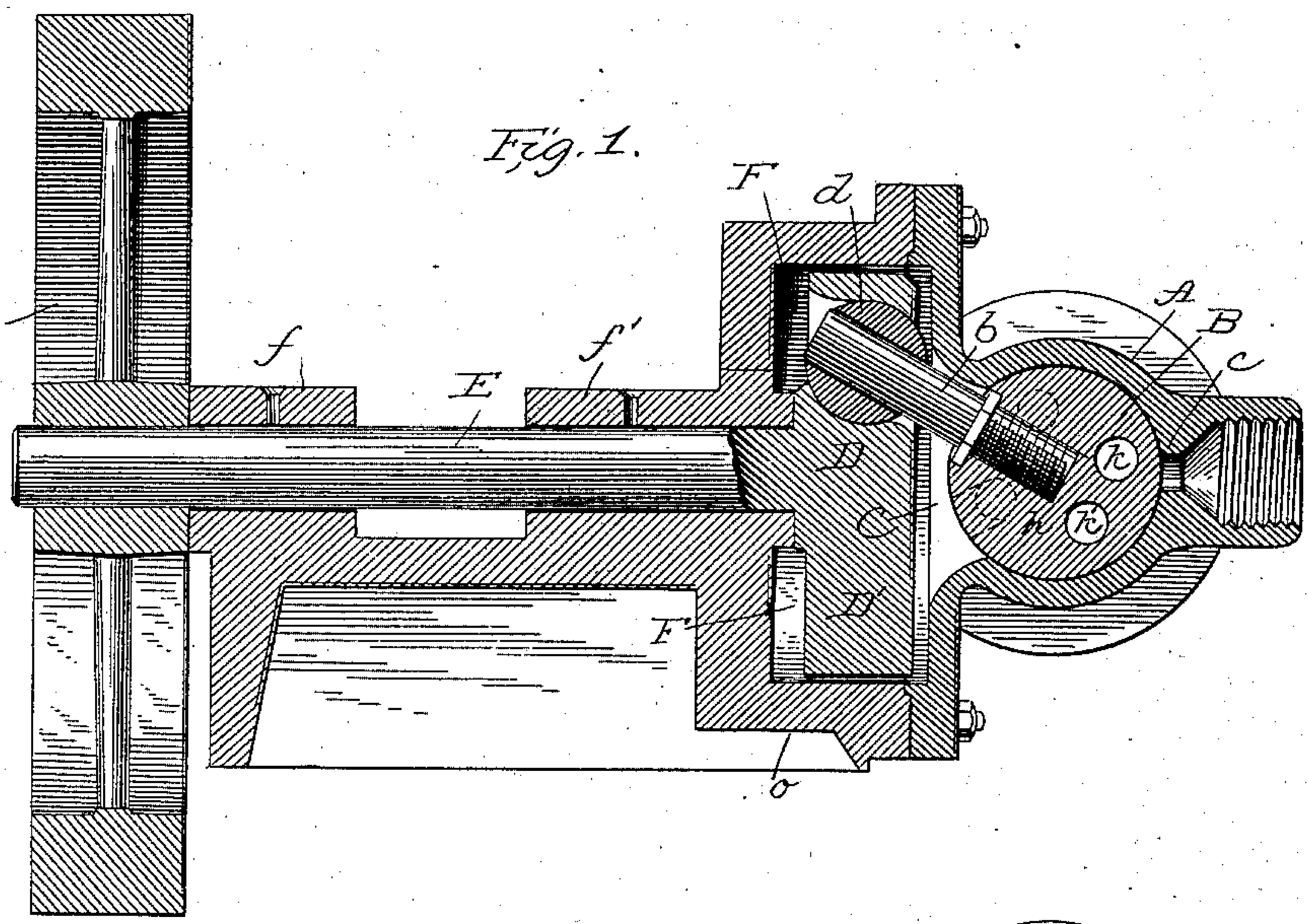
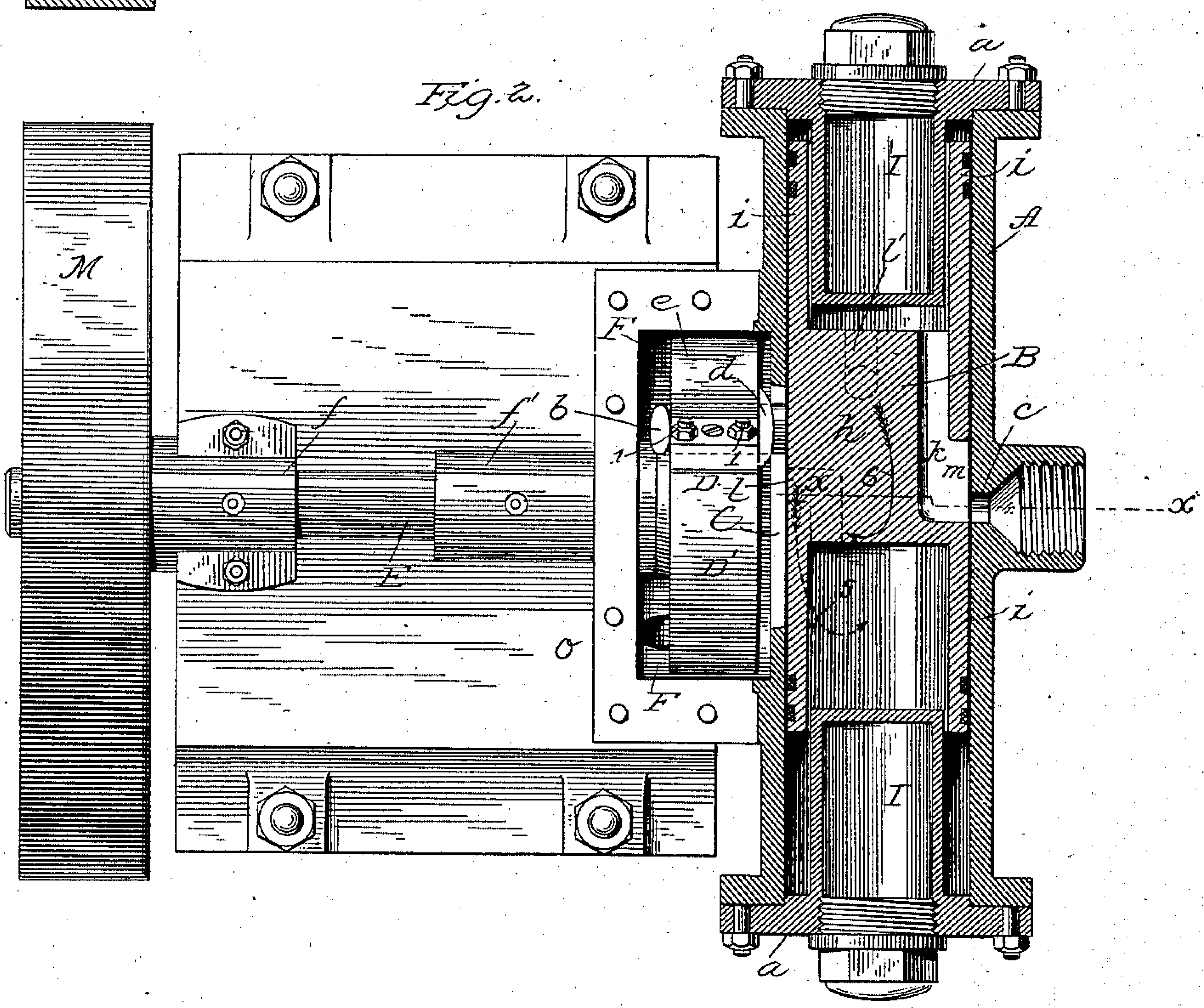


Fig. 2.



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F. L. Middleton

Inventor
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Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 3 Sheets—Sheet 2.

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## STEAM ENGINE.

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Fig. 3.

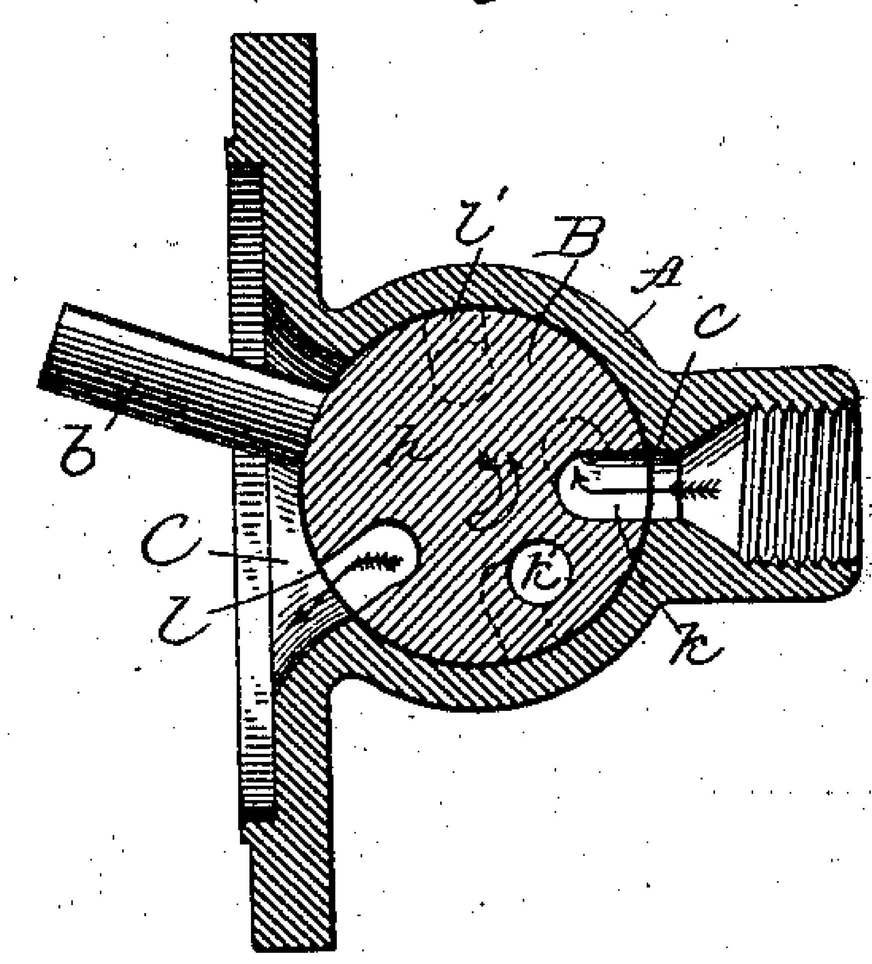


Fig. 4.

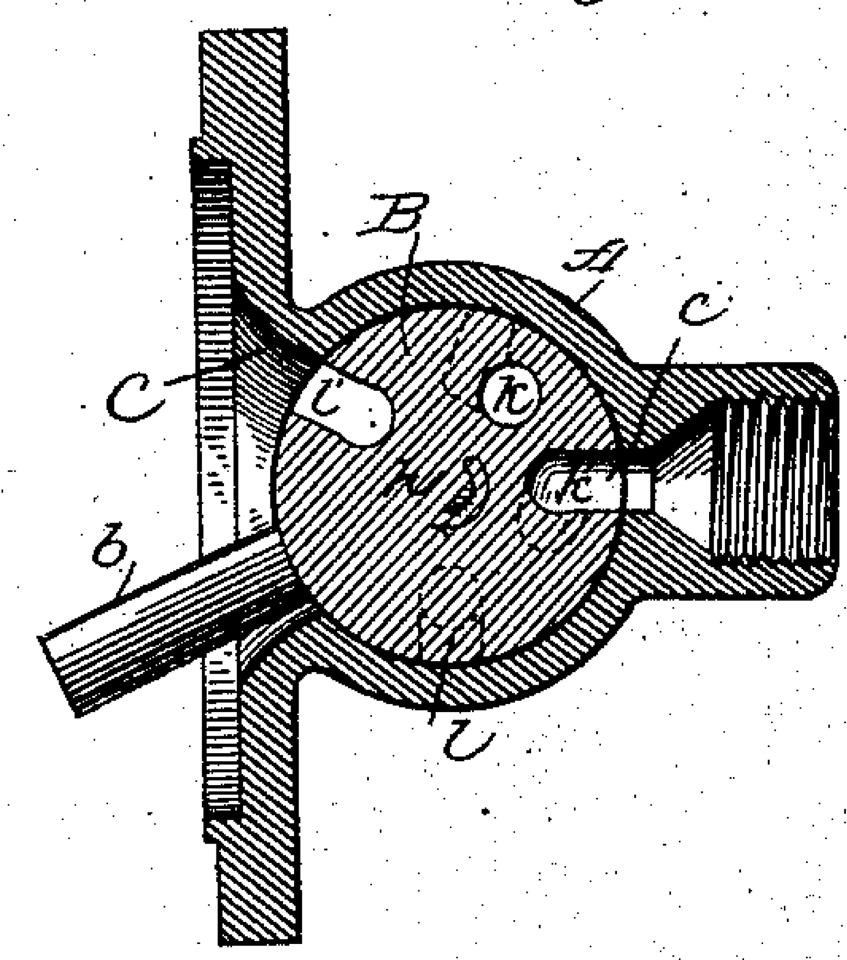


Fig. 5.

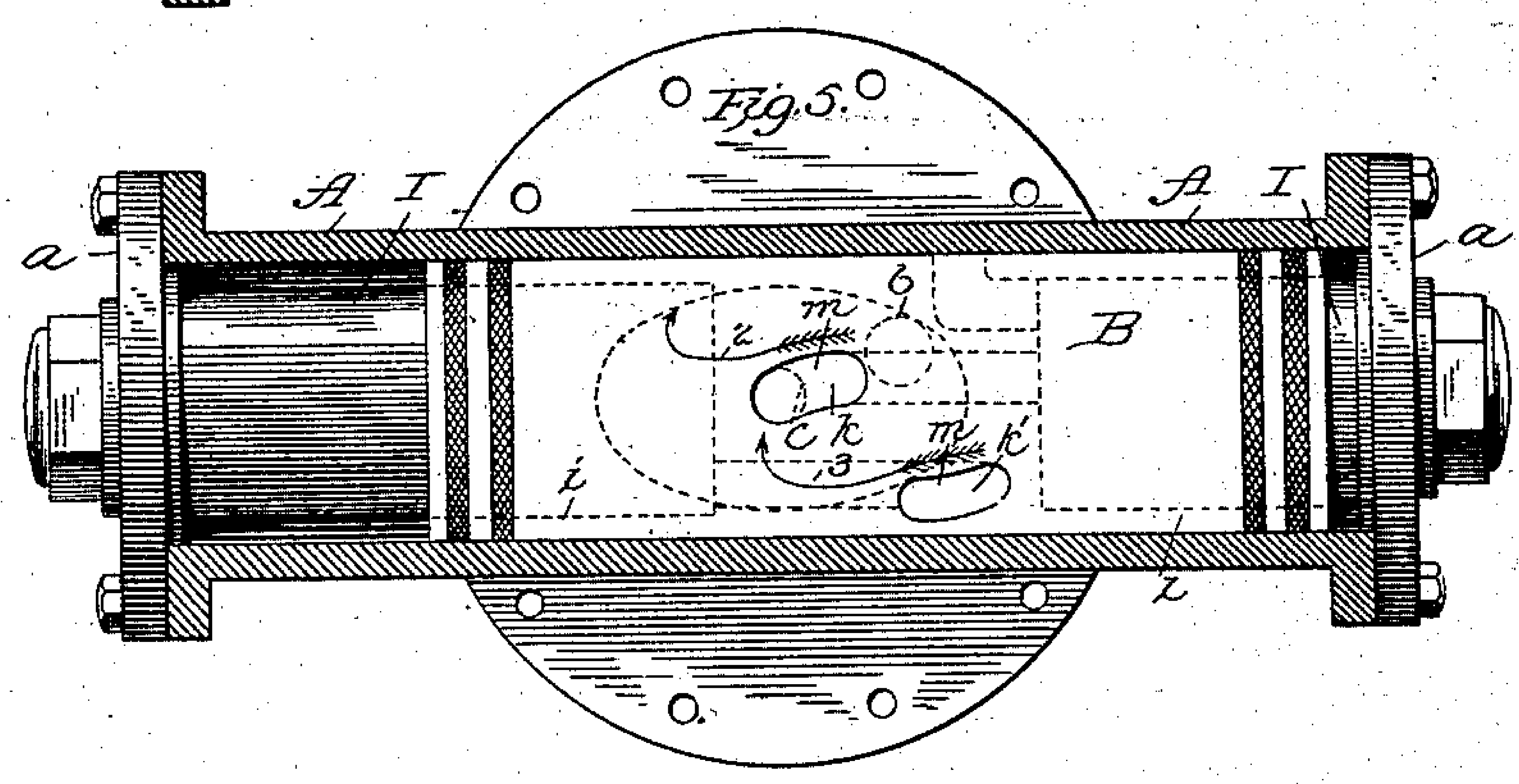


Fig. 6.

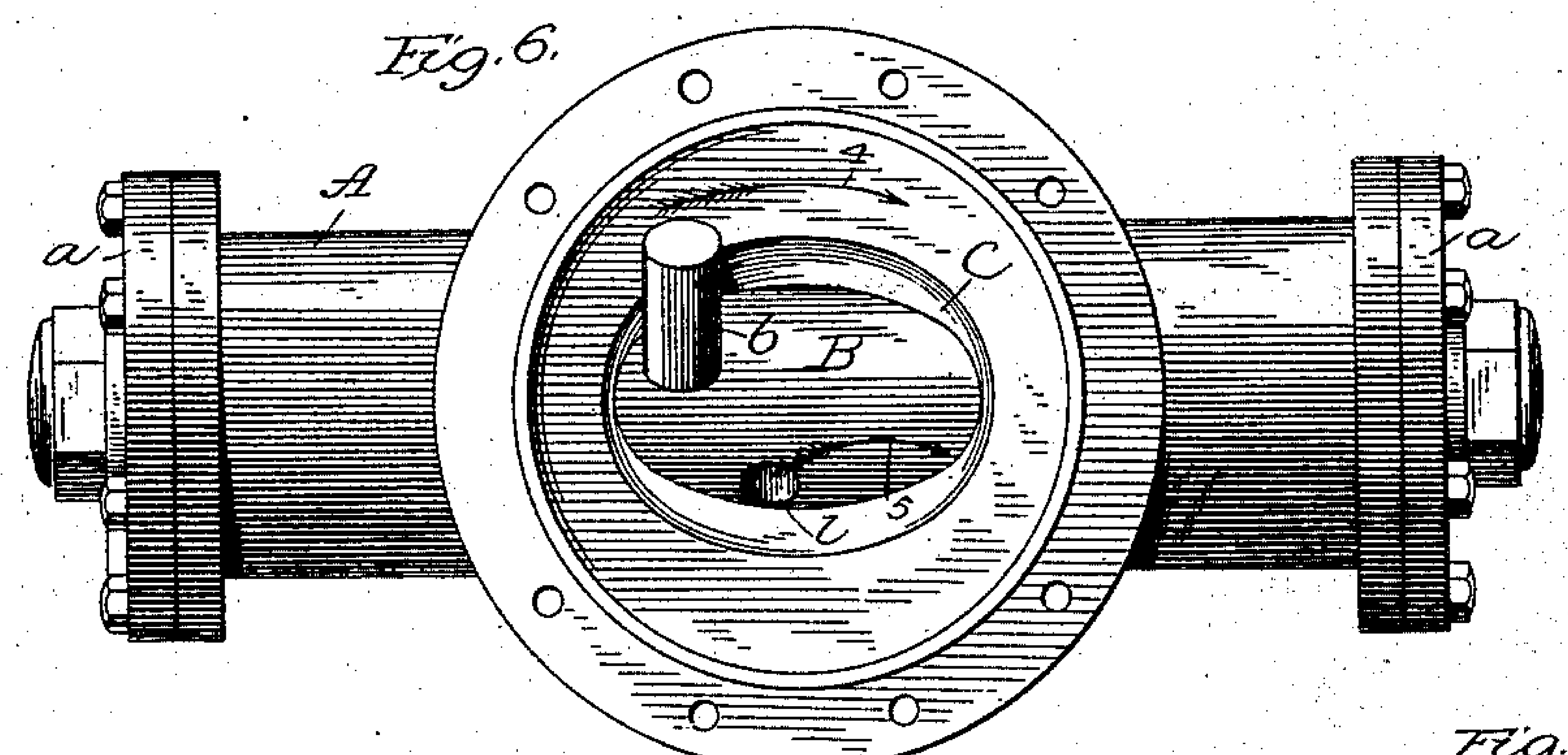


Fig. 8.

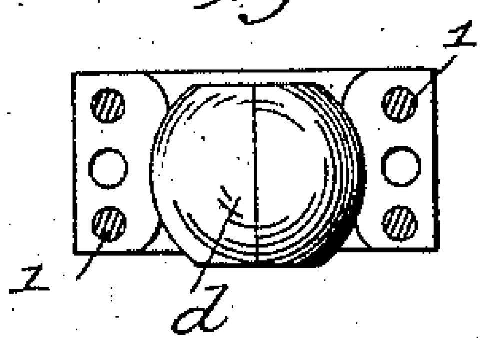


Fig. 7.

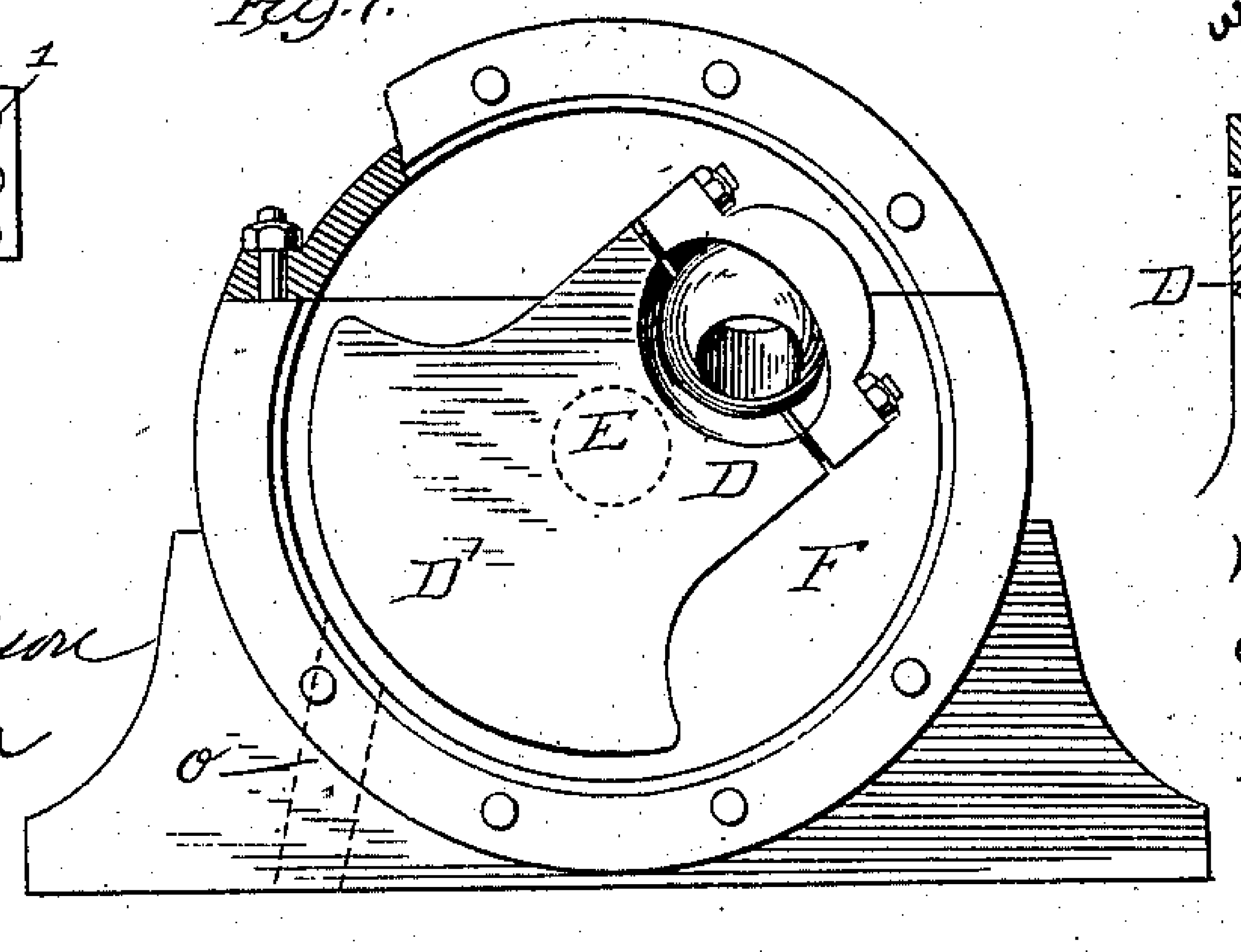
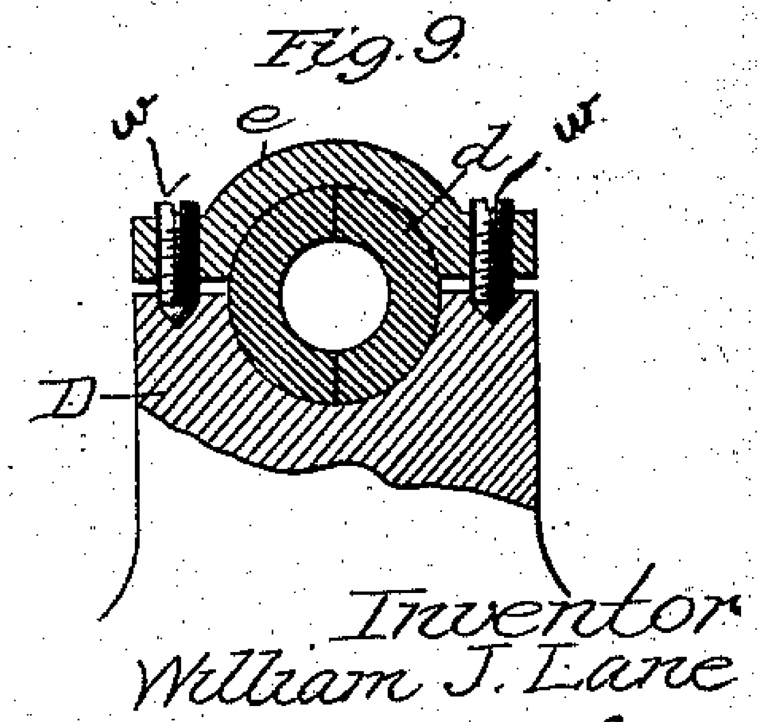


Fig. 9.



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(No Model.)

3 Sheets—Sheet 3.

# W. J. LANE.

## STEAM ENGINE.

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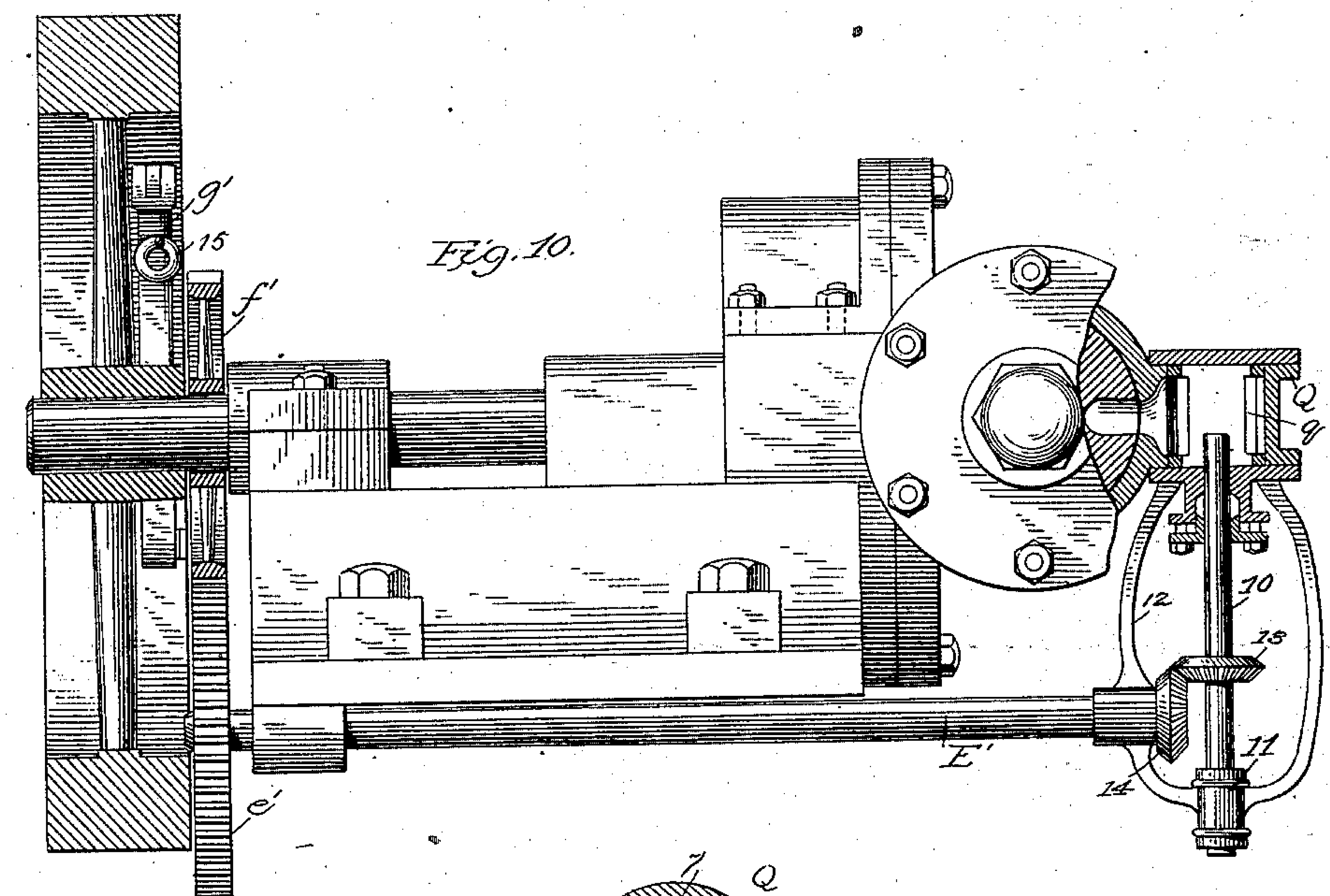



Fig. 10.

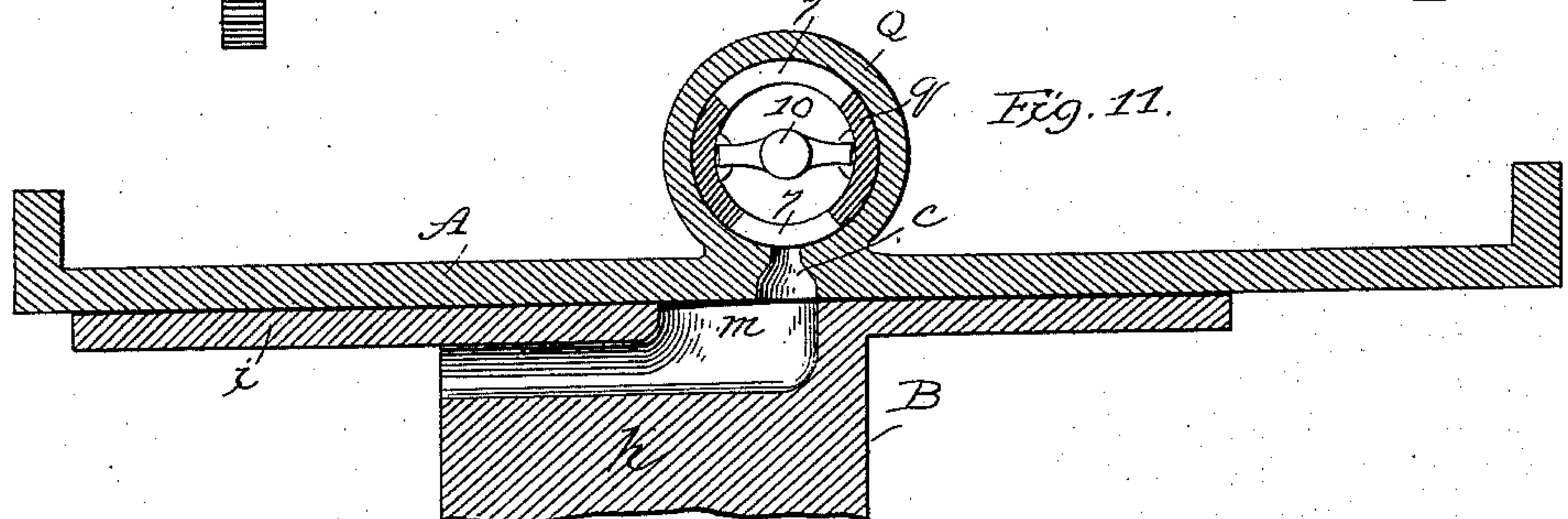
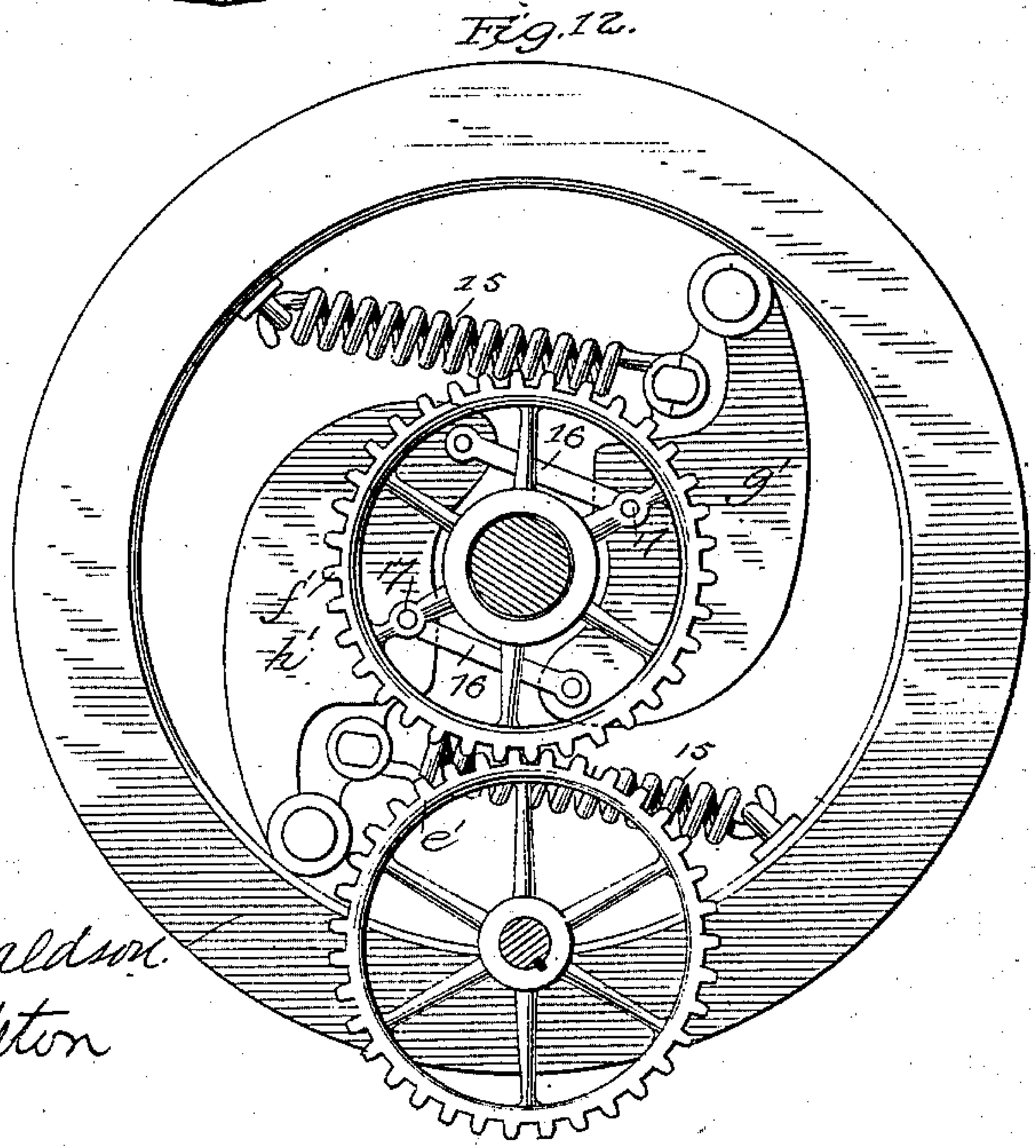



Fig. 11.

Fig. 12.

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# UNITED STATES PATENT OFFICE.

WILLIAM J. LANE, OF POUGHKEEPSIE, NEW YORK.

## STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 315,516, dated April 14, 1885.

Application filed December 31, 1884. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM J. LANE, of Poughkeepsie, in the county of Dutchess and State of New York, have invented a new and useful Improvement in Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention relates to steam-engines; and the objects sought to be accomplished by the invention are, first, to simplify the structure and reduce the number of parts; second, to render the engine more compact in form; and, third, to obtain efficiency and speed in working.

The invention is based upon that class of engines in which the piston, in addition to its longitudinal reciprocation, has also a rotary reciprocation, and is provided with ports which act, in connection with ports in the cylinder, as induction and eduction ports to admit and discharge the steam.

The invention consists, first, of a steam-engine having a cylinder provided with induction and eduction ports, a piston having corresponding ports, and a shaft arranged at right angles to the line of movement of the piston, with the crank of said shaft connected with the wrist-pin of the piston.

It consists, secondly, of a steam-engine cylinder provided with induction and eduction ports, a piston having corresponding ports, a shaft arranged at right angles to the line of movement of the piston, and a crank on said shaft connected to a wrist-pin fixed in the side of the piston.

It consists, thirdly, of a steam-engine cylinder having induction-ports, a piston having corresponding induction-ports and reciprocating in said cylinder longitudinally and laterally, a wrist-pin fixed in said piston, an opening in the cylinder adapted to permit the motion imparted to the wrist-pin by the rotary and longitudinal reciprocation of the piston, and exhaust-ports in the piston working in connection with the lateral opening in the cylinder, a crank on the shaft of the engine connected directly to the wrist-pin, and the exhaust-chamber inclosing the crank-shaft and the wrist-pin opening.

It consists, fourthly, of a piston having chambered or sleeved ends moving with rotary and longitudinal reciprocation in a cylinder having closed ends and lateral ports, ports in the piston, and a lateral wrist-pin connection between the said piston and the crank of the main shaft.

It consists, fifthly, of a special form of automatic cut-off adapted to be operated by a governor in connection with the valve mechanism of the engine.

Further, it consists of details of construction, all as hereinafter fully set forth, whereby the invention is embodied in a practical working machine of the form shown in the accompanying drawings.

Figure 1 is a central vertical section along the driving-shaft and through the piston and cylinder, the position of the parts being represented as on the half-stroke. Fig. 2 represents the machine in plan, the cylinder and piston being in section and the upper portion of the exhaust-chamber removed. The piston in this view is just beginning its stroke. Fig. 3 is a section on line *x x* of Fig. 2, showing the position of the piston and port when the piston is just beginning its stroke. Fig. 4 is a section on the same line with the piston moved to the opposite end of the cylinder and just beginning the return-stroke. The direction of rotary movement and of the currents of steam is shown by the arrows in said figures. Fig. 5 is a longitudinal section through the cylinder, showing the piston in side elevation, and also the induction-ports, the piston being in the same position as in Fig. 2. Fig. 6 is a view of the cylinder detached, showing the wrist-pin, the piston, and one of the eduction-ports in the same. Fig. 7 is a front view of the crank-arm. Figs. 8 and 9 are views of the ball-bearing for the wrist-pin. Fig. 10 is a side elevation of the machine, partly in section, showing the cut-off valve and mechanism for operating the same. Fig. 11 is a detail view of the valve and the cylinder. Fig. 12 shows a front elevation of the fly-wheel with the governor devices attached thereto.

In the drawings is represented an engine that takes steam on the center, cuts off at one-half stroke, and commences to exhaust nearly on the center, and closes the exhaust at a point to cushion up the exhaust to twenty-five pounds per square inch. The cylinder A is closed at both ends with heads *a a*. Within this cylinder is placed a piston, B, closely fitting and adapted to reciprocate both longitudinally and circumferentially. A wrist-pin, *b*, fixed to this piston at its mid-length, projects radially through an opening, C, in the side of the cylinder. This opening in size and shape is fitted to permit the required movement of the wrist-pin, as hereinafter fully explained. The projecting end of the wrist-pin is connected with the crank D of the engine-shaft E by a ball-and-socket joint, and causes the rotary reciprocation of the piston as it reciprocates longitudinally. The ball *d* is held in a socket in the crank, and has a central bearing for the wrist-pin *b*, which wrist-pin is fitted to slide and turn in the interior bearing of the ball. The ball is made of two parts, as shown in Figs. 8 and 9, with the line of separation parallel with the axial line of the wrist-pin. The upper half of the socket is shown in the same figure, and is marked *e*. It is held to the end of the crank by screw-studs 1 1, and when the machine is set up the half *e* fits upon the ball; but the ends of this half do not bear upon the ends of the crank directly, but through the conical-pointed adjusting-screws *w w* only, and as the parts wear, by means of adjusting-screws *w w* and studs 1 1 with these nuts, the upper half may be screwed down and held firmly in position to compensate for the wear, the advance of the upper half serving to take up the slack between the ball and the wrist-pin, and at the same time between the exterior bearing-surface of the ball and its socket. The crank D has a counter-weight, D′, and the shaft turns in bearings *f f′*. The crank and counter-weight turn in the exhaust-chest F. The opening C is elliptical in form, as shown in Fig. 6, to correspond with the movement of the wrist-pin as the piston reciprocates. It also serves as the eduction-port for both ends of the cylinder. An induction-port, *c*, is formed on the opposite side of the cylinder. The piston is made with a solid center, *h*, to which the wrist-pin is fixed. In order to secure lightness and an increased bearing-surface extended a sufficient distance each way from the wrist-pin, I prolong the ends of the piston in the form of sleeves, as represented at *i*. By this construction I obtain bearing-surface extended sufficiently to compensate for the lateral strain thrown upon the piston by the position and working of the wrist-pin. To compensate for the increased space left in the ends of the cylinder by this construction, and to reduce the clearance, I provide cylinder-heads *a a* on the ends of the cylinder, having the inwardly-projecting portions I I, nearly corresponding in form and size to the interior of the sleeves *i i*, but not fitting closely into the sleeves *i*, an annular space being left between the portion I of the cylinder-head *a* and the interior of the sleeve *i* sufficient to permit the free passage and action of steam upon that part of the piston formed by the ends of the sleeve *i*. The extent of this annular space-area of its cross-section may be left to the judgment of the skilled engine-builder; but I make it equal to the area of cross-section of induction-port *c*. These projections may be formed upon the cylinder-heads, as indicated in the drawings, Fig. 2, or may be fixed thereon in any convenient manner. As shown, the inwardly-projecting portions of the cylinder-heads are hollow, with the outer ends closed. Induction and eduction ports are formed in the solid central part of the piston, and lead from the interior of the sleeved ends to the sides of the solid part of the piston, where they communicate with the ports in the cylinder. The induction-ports in the piston are represented by *k k*, both open to the surface of the piston by lateral mouths, one communicating with the interior of the sleeve at one end, and the other with the interior of the sleeve at the other end, of the piston in the manner shown by the horizontal section in Fig. 2.

It will be understood that for the admission of steam at the proper moment the external opening of the induction-ports in the piston should be in a position to commence registering with the induction-port *c* in the cylinder when the piston is at or near the end of its stroke. At this period of the revolution of the crank, when the engine is at or nearly on the center, the longitudinal movement of the piston is at its minimum, while at the same time the rotary movement of the piston is at its maximum. By reason of this the port opens with great rapidity. The eduction-ports in the piston exhaust through the large opening C, in which the wrist-pin moves. Their location and movement are indicated hereinafter. The precise relative size and location of the openings in the piston with respect to the port *c* for the purpose of admitting and cutting off steam relatively to its stroke may be left to the discretion of the skilled workman. The positions are sufficiently indicated by the letters *k k* in Figs. 1, 2, 3, and 4, and a description sufficient for the skilled workman is given hereinafter. To aid the workman, however, in constructing the first engine it may be proper to state that the positions of the ports may be conveniently determined by constructing the engine as shown in Figs. 1 to 9, inclusive, but without the ports in the piston. After the engine is set up the shaft is turned so as to place the piston successively at the points determined upon for taking steam and cutting off, and when the piston is thus placed at the proper points the workman can make marks on the piston through the port *c*, and thus he can indicate the position, size, and shape of the ports *k k*. Similarly the piston can be placed successively in position to commence exhausting and to stop exhausting to cause the proper cushioning at each stroke, and while at each position indicated a mark can be made along the margin of the elliptical opening C of the piston, and these lines will cross each other and indicate in each case the position of the exhaust-port just above the point of crossing of the two lines. The direction of the movement of the wrist-pin is shown by the upper arrow in Fig. 6. The piston is therefore moving from left to right, as represented by Fig. 6. The upper induction-port, *k*, shown in Fig. 2, is then open and the lower eduction-port, *l*, of the other end of the piston (shown in Figs. 3 and 6 and in dotted lines Fig. 2) is also open, moving along the margin of the elliptical opening C on an elliptical path curved reversely to that of the nearest margin of the ellipse C. At this time the induction-port *k'*, leading to the right-hand end of the piston, is closed, the port of the piston no longer registering with that of the cylinder. The eduction-port *l'* of the left-hand end of Fig. 6 (upper part of Fig. 2) is closed by reason of the eduction-piston port moving outside of the elliptical opening C. As the piston approaches the right-hand end of the cylinder the piston is rocked in reverse direction, and the lower induction-port, *k'*, Fig. 1, is brought up and forward into line with the port *c* of the cylinder, thus making steam connection with that end of the cylinder. The form of the induction-ports of the piston and their movement in relation to the port *c* of the cylinder is illustrated in Fig. 5. The form of the mouth of the induction-ports on the surface of the piston is shown at *m*, a section of the same being shown in Fig. 2. It will be borne in mind that Fig. 5 is a view from the opposite side of Fig. 6, with the cylinder in longitudinal section, and showing the side of the piston opposite to that which carries the wrist-pin. The mouth of the port *c* in the cylinder is round, but the induction-ports *k k* in the piston are somewhat elongated to give the engine steam the required distance on the stroke. The same result may be attained by increasing the diameter of port *c* and making the ports *k k* round and of equal diameter with port *c*. Thus, in the drawings, if port *c* were made fifty per cent. larger in diameter, and ports *k k* of equal size with it and in proper position, steam would be taken and carried same as with ports shown. In Fig. 5 the lower port, *k'*, has passed the port *c* and is closed. The upper induction-port has been carried by direct and rotary movement over and downward, as shown by the feathered end of the arrow 2, till the end of the elongated port is opened. Further movement of the piston causes the mouth of the port *k* to pass over the port *c*, thus causing the engine to take steam during a portion of the stroke proportioned to the length of said mouth and the width or diameter of the port *c*. As the rear end of the mouth of port *k* passes the port *c* it moves upward and over by path indicated by point of arrow 2 by reason of the downward movement of the wrist-pin *b* on the other side of the piston. The path of the closed port *k* is indicated by the arrow 3, this port being open when the leading end of the elongated mouth is brought to the port *c*. These mouths of the ports *k* in the piston have the proper curve to correspond to their line of movement. As before intimated, I do not here undertake to indicate the precise relative length of the mouths of the ports or at precisely what point in the stroke the steam is cut off, leaving this to the skill of the workman. I have not indicated in Fig. 5 the position of the eduction-ports, but they are shown sufficiently in the Figs. 1, 2, and 6, and their movements indicated by the arrows. Arrow 4 in Fig. 6 shows the path and direction of the wrist-pin, arrow 5 the direction of movement of the eduction-port. The ports are in the same position in Fig. 2, and arrow 5 there indicates the direction of movement of the port, while arrow 6 illustrates the direction in which the other eduction-port moves. The eduction-ports of the piston are shown as round, and the length of time during which they are open depends upon their position, the shape of opening C, and the path on which they move across the opening. The chamber F, inclosing the crank and wrist-pin, is provided with a port, *o*, through which the exhaust-steam passes. The port *o* is located a little above the lowest part of a circle described by the crank or parts connected therewith. In order to provide perfect lubrication for all parts of the engine in contact with steam, I introduce a suitable lubricant by means of an ordinary automatic feeder attached to the steam-supply pipe. In order to retain this lubricant as long as possible in the exhaust-chamber F, I place the opening for exhaust-pipe above the bottom of the chamber, in order that the water resulting from condensation due to radiation, expansion of steam, and conversion of heat into work may collect therein, and with the oil previously referred to may be dashed and sprayed by the revolution of the crank and caused to keep all bearings in connection with this chamber thoroughly lubricated, as well as to prevent their becoming hot, the water acting as a vehicle for the more perfect conveyance of the oil, and also to prevent the possibility of temperature of said bearings rising sensibly above that due to the exhaust-steam, or about 212°.

In the figures particularly described above no governor is represented, and I contemplate the use of any suitable governor of the ordinary throttling type in connection with this engine. I have shown, however, (10, 11, and 12,) an improved form of automatic cut-off adapted to this engine, but not limited strictly thereto in its use. On the hollow stem of the steam-port *c* is set, at right angles to the passage-way in said stem, a small closed cylinder, Q. Within it is a tight-fitting rotary valve, *q*. Steam is admitted to the port *c* only through the cylinder Q and valve *q*. The valve has two openings, 7 7, adapted as the valve turns to register with the port *c*. The valve $q$ makes the same number of revolutions as the main shaft, and so long as the ports 7 of the valve $q$ register with the port $c$ at the same time that the ports $k'$ do so the valve $q$ will remain of no effect; but if the valve $q$ be moved forward in its revolution with reference to the main shaft E to the extent (in the case of the engine shown in these drawings) one-fourth revolution or less in advance of the revolution of the main shaft E, it will close the port $c$ and cut off steam at a point anywhere between the commencement of the stroke of the piston and its half-stroke, and, as the piston B keeps the port $c$ closed after the half-stroke, it follows that steam will be admitted to the cylinder at boiler-pressure practically, and may be cut off sharply at such point as may be necessary to do the work. It is manifest, however, that the same result may be reached by using a smaller valve, $q$, or one of same size, if preferred, and having one port only cut through it, and geared to revolve twice to each revolution of the main shaft. The valve is geared to the driving mechanism, as hereinafter described, so that it revolves once with each revolution of the engine. When the engine is running under a full load, or up to the limit of its capacity, the movement of the ports in the valve coincide with those in the piston, both opening and closing communication with the port $c$ at the same time. The valve $q$ is therefore under such conditions without effect. The proper advance of valve $q$ is caused by the mechanism shown in Figs. 10, 11, and 12. As therein shown, the cut-off valve is connected by suitable intermediate mechanism to governor-weights pivoted within the inner periphery of the fly-wheel, said weights being capable of a movement toward and from the center of the wheel, and being held in that part of their path nearest the center of the wheel when the engine is running below an ordinary rate of speed by means of springs. The connecting mechanism is arranged, as before stated, so that while the engine is running below proper rate of speed, and the weights are in the position mentioned, the valve will be turned once with every revolution of the shaft E; but as the engine attains its proper speed the centrifugal force of the weights will overcome the tension of the springs and the weights will move outward, thereby giving the connecting mechanism a movement additional to and in advance of the regular movement imparted by the fly-wheel, which will advance the valve, cut off steam sharply earlier in the stroke, and keep the engine at a uniform rate of speed. This mechanism is now to be particularly described. The valve-stem 10 passes through a stuffing-box, as shown, and has a bearing at 11 in the bracket 12 depending from the head of the valve-chamber. A miter-gear, 13, upon this stem meshes with a similar gear on the end of the countershaft E', which has a bearing at one end in the bracket and at the other at 14, as shown. At the end of this shaft is keyed a gear-wheel, $e'$, which meshes with a gear-wheel, $f'$, loose on the main driving-shaft E.

On the inner periphery of a wheel, which may be the band-wheel, fly-wheel, or an independent wheel for this purpose, and in the same diameter thereof, are pivoted governor-weights $g'$ $h'$, (either one or two, two being shown,) the free ends of which have a limited movement between the hub of the fly-wheel and the inner periphery thereof. Springs 15 15, attached to the weights and to the fly-wheel, are adjusted in regard to tension to keep the weight inward when the engine is overloaded and not running up to the ordinary rate of speed. At the free ends of the weights are secured links 16 16, which form the connection between the driving and governor devices of the valve and the intermediate mechanism to the same, said links being secured to the loose gear at 17 17.

Supposing the engine running under a full load, or below a proper rate of speed, the weights will then be inward, as shown in full lines of Fig. 12, being so held by the springs 15 15. The regular movement of the fly-wheel will then be imparted to the loose pinion through the links 16 16, and thence through the gear $e'$, shaft E', and miter-gear to the valve, making the movement of the parts of the said valve coincide with that of the parts of the piston. With a proper load upon the engine, however, and a sufficient pressure of steam, the weights will move outward by reason of their centrifugal force overcoming the tension of the springs. This outward movement of the weights will draw upon the links 16 16, and give the loose gear an additional movement in advance of its regular rotary movement, which will have the effect through the intermediate mechanism of advancing the valve, cutting off the steam sharply earlier in the stroke, and maintaining practically the uniform speed of the engine.

The springs are secured to eyebolts in the wheel, by means of which any desired amount of tension may be given them. Should any change of load or steam-pressure occur, the weights $g'$ $h'$ instantly adjust themselves, by reason of the slight change of speed, to the altered condition, and the cut-off takes place at the proper point to maintain the desired speed. This cut-off mechanism does not in any way affect the opening and closing of the exhaust-ports of the engine, which are not variable, but open and close at the same point in the stroke and to the same extent under all changes of load or cut-off, thus permitting a perfectly free exhaust and fixed amount of cushioning unaffected by variations of speed, load, or point of cut-off of steam supply.

I claim as my invention—

1. A steam-engine consisting of a cylinder provided with induction and eduction ports, a piston working therein having corresponding ports, a crank-shaft set in bearings at

right angles to the piston, with the crank connected to a wrist-pin fixed in the piston, substantially as described.

2. In a steam-engine, a cylinder having induction and eduction ports, a piston working therein, and having corresponding ports opened and closed by the longitudinal and rotary reciprocation of the piston, and a wrist-pin fixed in the piston and connected directly to the crank, substantially as described.

3. In a steam-engine, a cylinder having an induction-port and a substantially elliptical side opening, a piston having induction and eduction ports arranged to take steam by the lateral and longitudinal reciprocation of the piston, and by the same movements to exhaust through said elliptical opening, and a wrist-pin fixed to the piston and moving in the elliptical opening, said wrist being connected to the crank-shaft, substantially as described.

4. In a steam-engine, a cylinder having an induction-port and a substantially elliptical side opening, a piston having induction and eduction ports arranged to take steam by the lateral and longitudinal reciprocation of the piston, and by the same movements to exhaust through said elliptical opening, a wrist-pin fixed to the piston and moving in the elliptical opening, said wrist-pin being connected directly to the crank, and an exhaust-chamber covering the elliptical opening and inclosing the crank, all substantially as described.

5. In a steam-engine, a piston having chambered ends and a solid center carrying a wrist-pin, and having also ports with corresponding ports and a wrist-pin aperture in the cylinder, substantially as described.

6. In a steam-engine, a piston having chambered ends and a solid center carrying a wrist-pin, and having also ports with corresponding ports and a wrist-pin aperture in the cylinder, and inwardly-projecting cylinder-heads to reduce clearance, substantially as described.

7. In a steam-engine, a cylinder having an induction-port, *c*, and an aperture, C, a piston having a wrist-pin set therein and projecting through the aperture C, induction-ports *k k'*, having elongated mouths, and eduction-ports *l l'*, arranged to move across the aperture C as the piston reciprocates.

8. In a steam-engine, an automatic cut-off consisting of a rotary cylindrical valve having ports on its opposite sides, said valve being located in a cylinder in the steam-supply passage, and connections between said valve, and a governor arranged to cause the valve to rotate in unison with the movement of the induction-valve at a prescribed rate of speed of the engine, and to move in advance of the induction-valve when the speed of the engine exceeds the prescribed limit, substantially as described.

9. In combination with the induction-port *c* and piston and its cylinder-ports, the cylinder, and rotary valve *q*, having ports 7 7, the governor, and the connections between the governor and the valve *q*, all substantially as described.

10. In combination with the cylinder and piston and the wrist-pin set in the side of the piston, a crank connected to said piston, and an exhaust-chamber inclosing the crank, having a port for discharging steam therefrom situated above the lowest part of the circle described by the path of the crank, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM J. LANE.

Witnesses:
F. W. DAVIS,
JAS. W. RUST.