No. 694,763. Patented Mar. 4, 1902.

H. LIETHEGENER & A. KLEMM.

ROTARY ENGINE.

(Application filed Dec. 19, 1900.)

(No Model.) 3 Sheets—Sheet 1.

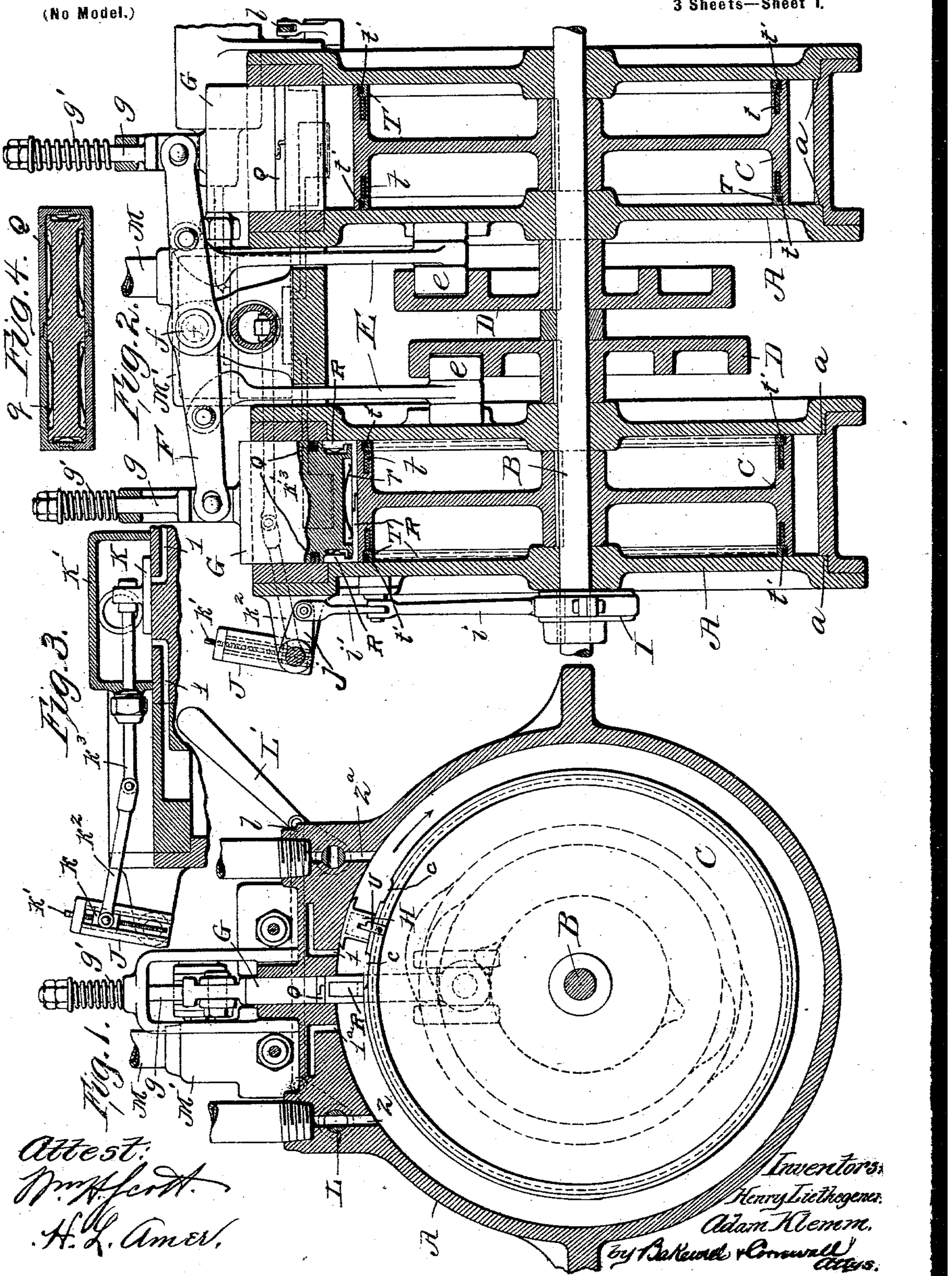

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Fig. 5.

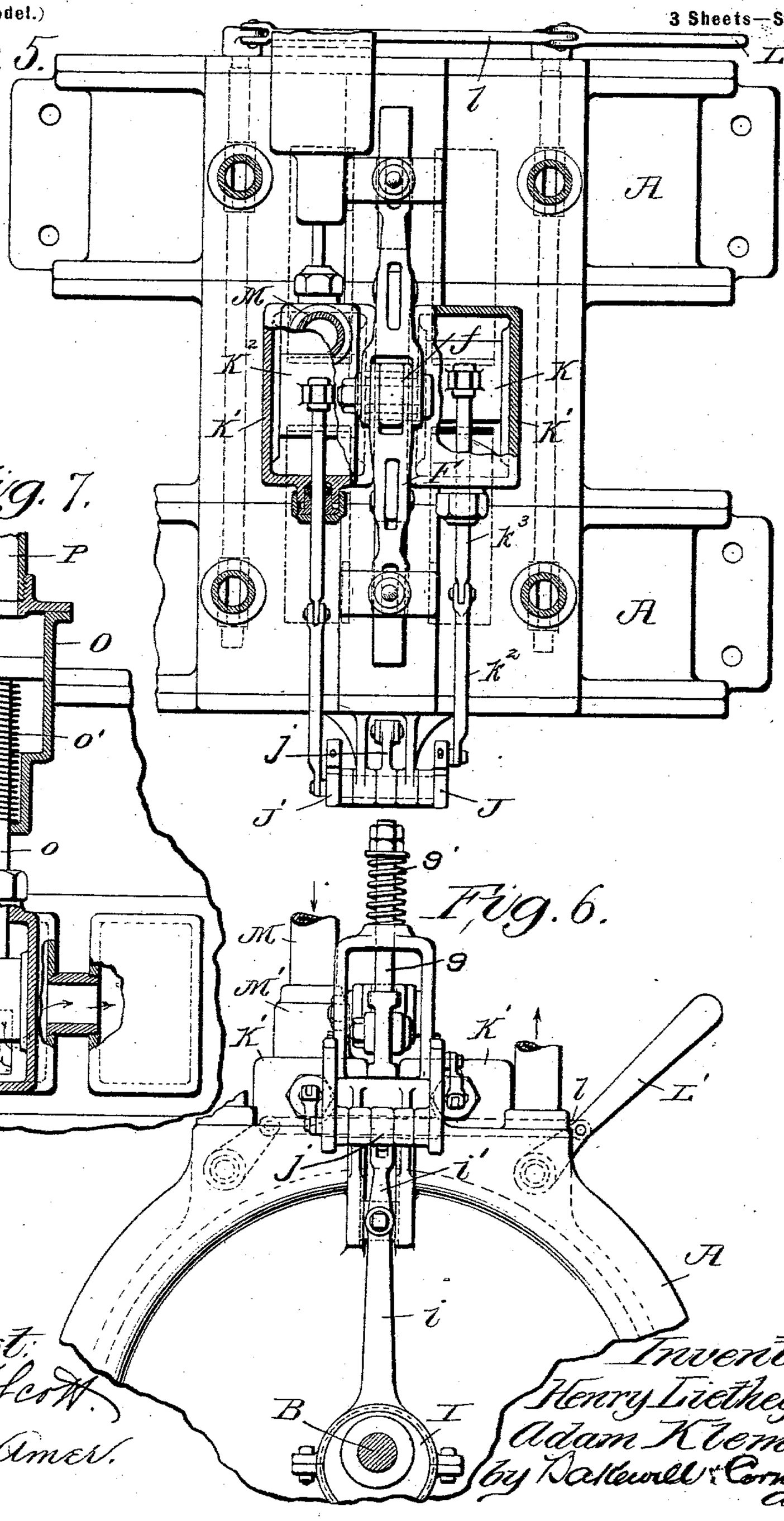

Fig. 7.

Fig. 6.

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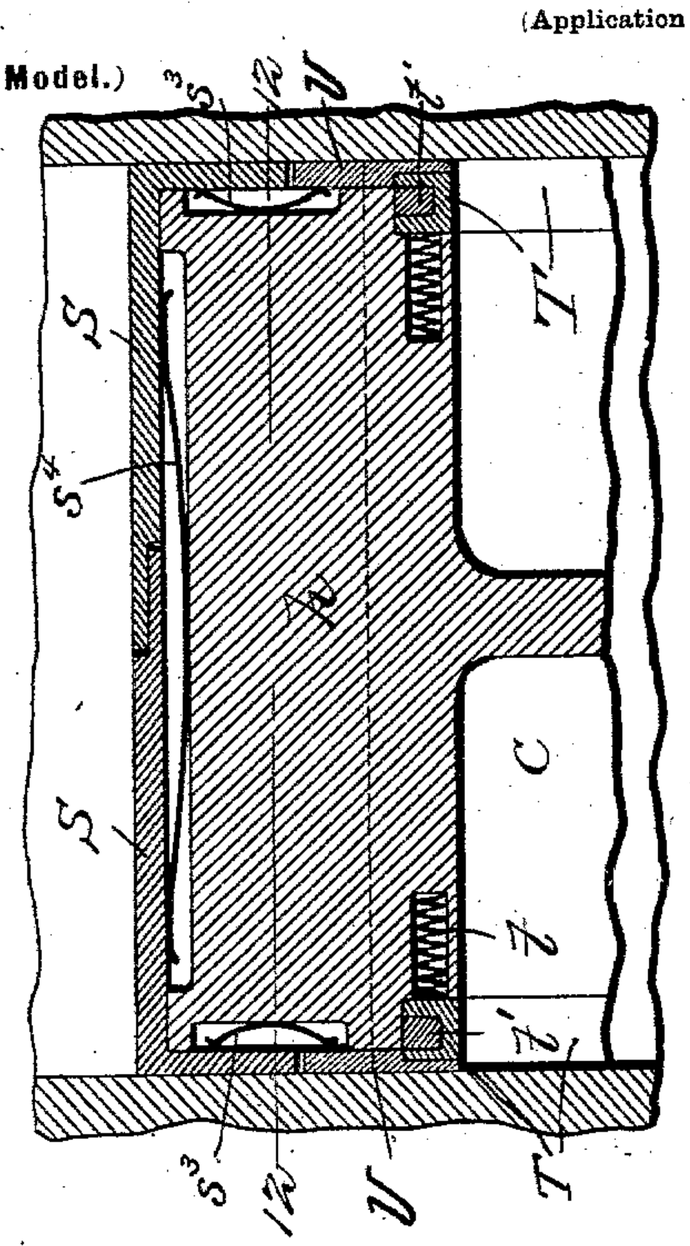

Fig. 10.

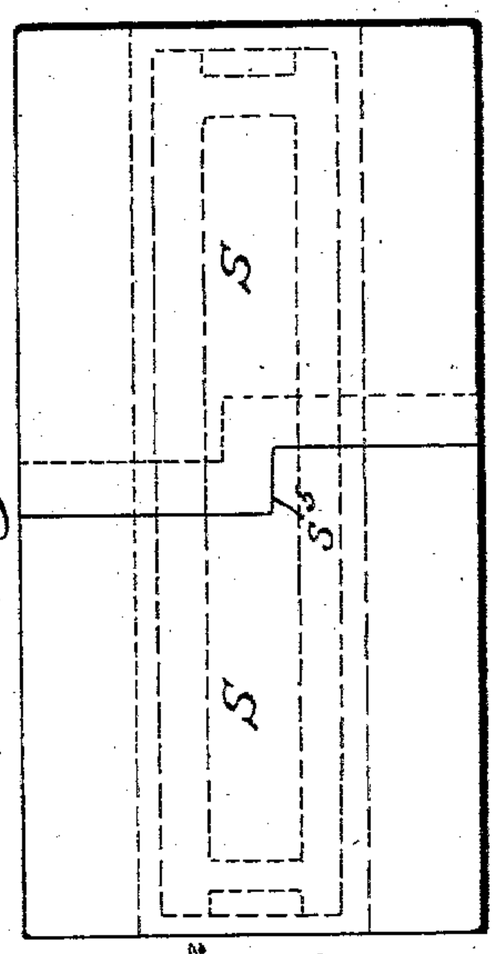

Fig. 11.

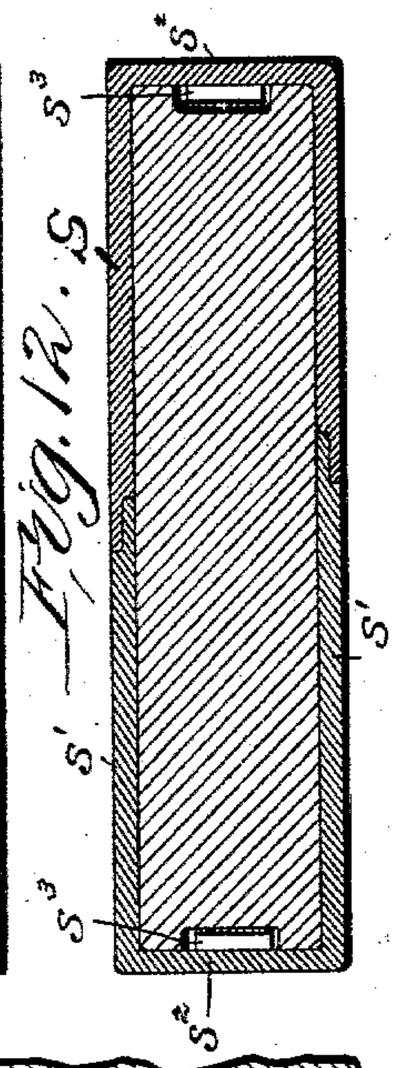

Fig. 12.

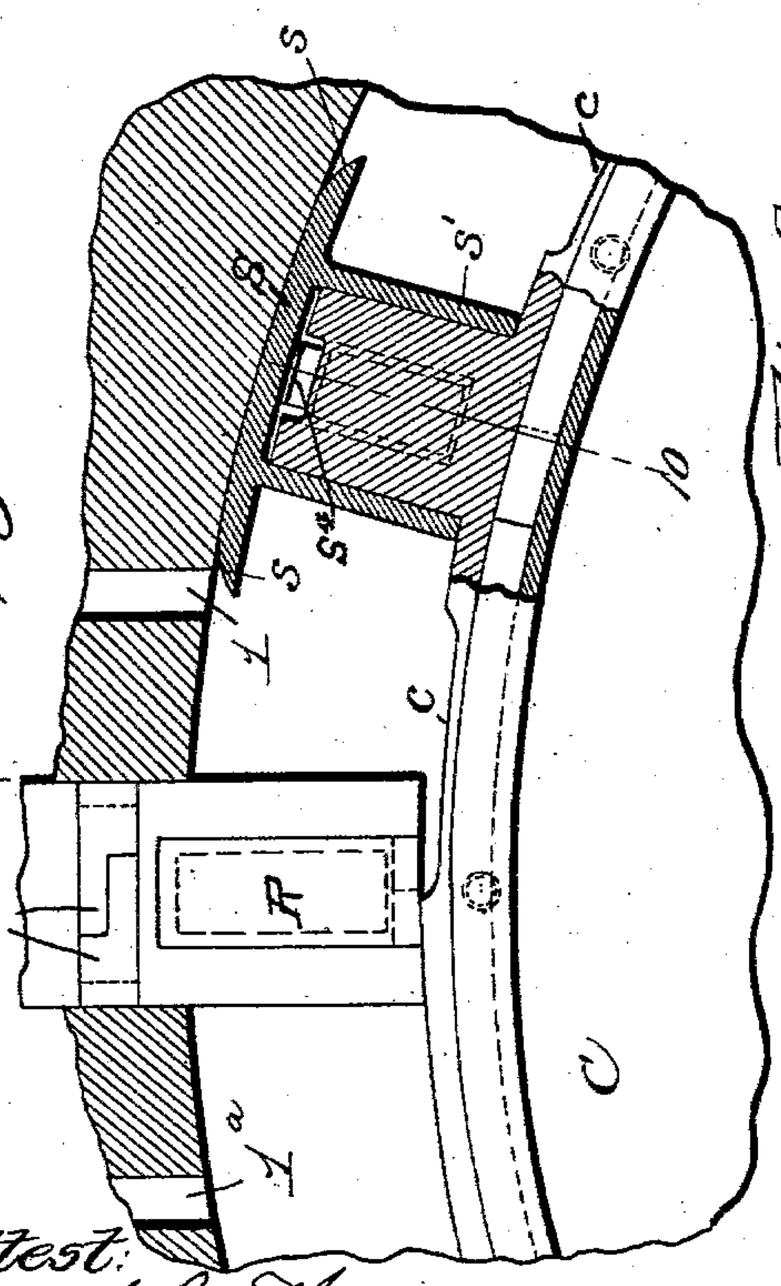

Fig. 8.

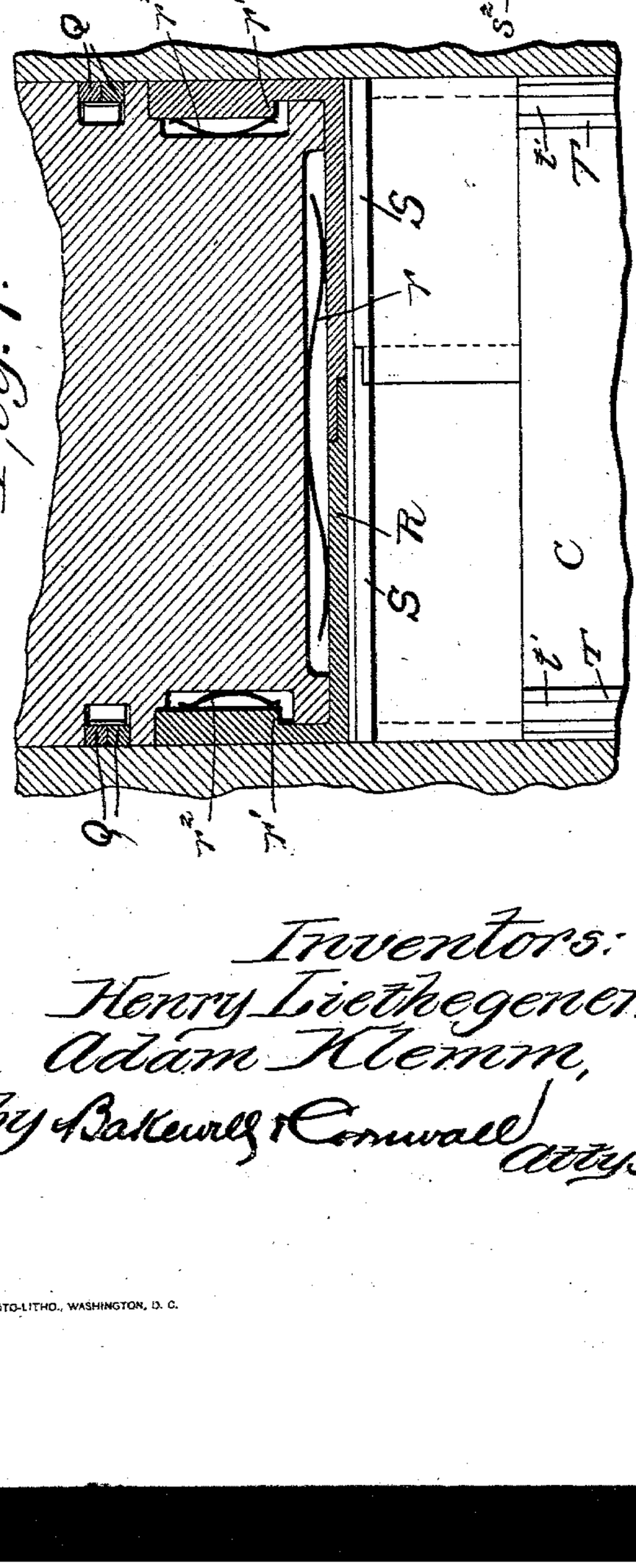

Fig. 9.

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UNITED STATES PATENT OFFICE.

HENRY LIETHEGENER AND ADAM KLEMM, OF ST. LOUIS, MISSOURI; SAID KLEMM ASSIGNOR TO SAID LIETHEGENER.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 694,763, dated March 4, 1902.

Application filed December 19, 1900. Serial No. 40,361. (No model.)

To all whom it may concern:

Be it known that we, HENRY LIETHEGENER and ADAM KLEMM, citizens of the United States, residing at the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Rotary Engines, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a vertical cross-sectional view through our improved rotary engine. Fig. 2 is a longitudinal vertical sectional view through the same. Fig. 3 is a detailed sectional view through one of the steam-chests and its valve mechanism. Fig. 4 is a horizontal sectional view through the plunger, showing the manner of arranging the packing thereon. Fig. 5 is a top plan view, partly in section, of our improved engine. Fig. 6 is a front elevational view of the upper portion of the engine. Fig. 7 is a horizontal sectional view showing the arrangement of the pressure-regulating cylinder. Fig. 8 is an enlarged detailed view showing the piston-head in section. Fig. 9 is an enlarged cross-sectional view of the plunger. Fig. 10 is an enlarged cross-sectional view on line 10 10, Fig. 8. Fig. 11 is a top plan view of the piston-head; and Fig. 12 is a sectional view on line 12 12, Fig. 10.

This invention relates to a new and useful improvement in rotary engines, an object being to simplify the construction of devices of the character described.

Another object is to so construct the engine that the steam is utilized to such an extent that its pressure is wholly taken advantage of, the exhaust coming from the engine being at approximately atmospheric pressure.

Another object is to provide means to automatically control the inlet-port of the engine to regulate the available area of said inlet-port with relation to boiler-pressure.

With these objects in view the invention consists in the construction, arrangement, and combination of the several parts, all as will hereinafter be described, and afterward pointed out in the claims.

In the drawings we have shown two cylinders A, mounted side by side, through which passes a shaft B, this shaft having mounted upon it rotary pistons C. These pistons are preferably lightened, and appropriate packing is arranged at the side edges of the periphery thereof for purposes well understood. Each of these cylinders is thickened somewhat at the top for affording a suitable mount for the steam-chest and movable parts for controlling the admission and exhaust to and from the engine, in addition to which said thickened portions are preferably cored or provided in some suitable manner with ducts or passages leading to and from the respective cylinders.

In describing the valve mechanism we will refer to such mechanism as used in connection with a single cylinder, it being understood that such mechanism is duplicated with respect to the other cylinder.

D indicates a cam mounted upon the shaft B, in the groove of which is arranged a roller *e* on a pitman E, said pitman being guided in its movement by suitable guideways arranged upon the head of the cylinder. The upper end of this pitman is connected to a lever F, pivoted at *f*, the outer or free end of said lever being connected to a plunger G, which plunger in the operation of the engine is reciprocated and when in operative position closes the space between the cylinder and piston, thus affording an abutment. In order to relieve the cam-operated pitman from lifting the entire weight of plunger G, we prefer to provide an upwardly-extending stem *g* on the plunger, which passes through the guiding-yoke thereof, a spring *g'* being employed above the yoke and under a nut on the upper end of the stem, the tension of which spring is constantly exerted to lift the plunger, this tendency serving to balance the plunger, rendering its operation comparatively easy. The cam-groove in the cam D is practically concentric throughout its length, with the exception of one point, at which point it forces the pitman E to raise the plunger G at a time when the piston-head H is passing under the plunger.

I indicates an eccentric whose rod *i* is connected to a cross-head and by means of a suit-

able pitman i' to a rock-arm j, arranged upon a rock-shaft, upon which shaft is mounted an oscillating slotted frame J. This frame J carries a block k adjustable longitudinally the frame through the medium of a threaded rod k'. Block k has a link k^2 pivotally mounted thereon, which link connects with a rod k^3, said rod operating a slide-valve K, mounted in the steam-chest K'. This valve K controls the inlet-ports 1 leading to both cylinders, the operation of said slide-valve being such as to alternately open and close said inlet-ports. Each inlet-port 1 opens into its respective cylinder near the plunger G, and when steam is admitted therethrough when the parts are in the position shown in Fig. 1 the steam will force the piston-head H around in the direction of the arrow, the admission of steam behind the piston-head being controlled by the length of time that the valve K permits the particular inlet-port in question to remain open. The throw of the eccentric I, and consequently the rocking or oscillation of the frame J, is fixed, and when the engine is in operation the movement of these parts occurs at a predetermined time and to a fixed limit. To adjust the movement of valve K from the certain movement of the rocking frame J, a wrench (preferably a socket-wrench) is applied to the threaded rod k' and said rod rotated, so as to adjust the pivotal point of the link k^2 nearer to or farther from the rock-shaft upon which the frame J is mounted. Of course it is understood that the farther away the pivotal point of link k^2 is from the axis of rotation of the frame J the greater the movement imparted to valve K, while, on the other hand, the nearer the pivotal point of link or pitman K^2 approaches the axis of movement of the frame J the less movement will be imparted to the valve K until the pivotal point of the pitman k^2 is coincident with or in axial alinement with the axis of movement of the rocking frame J, when no movement will be imparted to the valve K, said valve now remaining stationary, notwithstanding the rocking of frame J, and when stationary it will occupy a "lap" position—that is, closing the inlet-ports which it controls of both cylinders.

When steam is being admitted through the inlet-port 1, a rotary valve L is thrown into position to open the exhaust-port 2, which exhaust-port when the engine is running in the direction of the arrow shown in Fig. 1 is constantly open. In the operation of the engine above described it is intended that the valve K, which may be termed a "cut-off" valve, will admit a limited amount of steam, imparting an initial impulse to the piston-head, forcing said piston-head around under the direct action of the steam until the cut-off closes the port 1, the operation of the valve K in closing this port being controlled by the position of the pivotal point of the link k^2 relative to the axis of movement of the frame J. The piston-head is now forced around by the expansion of the steam, and as the steam expands its pressure is reduced, so that by the time the piston-head passes the exhaust-port 2 the pressure of the steam has been reduced to approximately atmospheric pressure, the momentum of the piston carrying the head past plunger G, the plunger being raised to permit of this, and when the piston passes the inlet-port another impulse of steam is admitted therebehind and the operation above described is repeated. Where there are two cylinders coupled together, the piston-heads being relatively at diametrically opposite points, it follows that when one piston-head is traveling on momentum the other is being impelled by the expansion of steam, so that at no time is momentum entirely relied upon to carry the engine past the position of dead-center.

Referring now to Fig. 5, it will be observed that the rock-shaft actuated by the eccentric I carries a slotted frame J', corresponding in construction and movement to the frame J. This frame J' controls a valve K^2, corresponding to valve K, but controlling ports 1^a, leading into the cylinders near the plunger, but entering at the other side thereof with respect to the inlet-ports 1. When valve K is being operated, valve K^2 is stationary by adjusting the pivotal point of its operating-pitman to a position to coincide with the axis of movement of the frame J', as before described. Valve K^2 of course laps ports 1^a and no steam is admitted to the cylinders through these ports. When, however, it is desired to reverse the engine, the pivotal point of the operating-pitman of the valve K is adjusted to a position to coincide with the axis of movement of the frame J, so that valve K will occupy a lap position to prevent the admission of steam through the ports 1. The pivotal point of the operating-pitman of valve K^2 is now adjusted so that the relation between the frame J' and said pitman will be that necessary to vibrate the valve K^2 and alternately admit and cut off steam through the inlet-ports 1^a. When the frame J' is thus actively related to the attached pitman and the piston is being rotated in a direction reverse to that indicated by the arrow, it follows that the exhaust-ports 2 must be closed and the exhaust-ports 2^a open. The desired control of the valves of these exhaust-ports is effected through the medium of a handle L' and a link l, connecting the valves which control the exhaust-ports, so that when said handle L' is operated to open the exhaust-port 2^a the exhaust-port 2 will be closed, and vice versa.

As shown in Fig. 7, the steam-chests containing the valves K and K^2 are connected or communicate with each other, steam being admitted to said communicating chests through a pipe M. This pipe M enters a casing M', in which is located a slide-valve N. From the casing M' the steam passes through an opening m into the connected chests containing the cut-off valves. The valve N controls the

opening *m*, said valve being automatically actuated by mechanism to regulate the opening *m* according to the boiler-pressure of the steam entering the engine. The stem of valve N is in the form of a piston-rod connected to a piston *o* in a cylinder O, and in front of the piston-head or plunger is arranged a spring *o'*. Behind this plunger is a pipe P, connected directly with the source of steam-supply, the pressure thus admitted behind the plunger acting against the resistance of the spring *o'*. As this pressure increases it follows that the plunger will be moved inwardly, forcing the valve N to reduce the available area of opening *m* for the admission of such high-pressure steam to the engine. Should the boiler-pressure decrease, the spring *o'* will force the valve N rearwardly, so as to increase the size of opening *m*, and thus admit a greater amount of such low-pressure steam to the engine. This automatic control of the volume of steam admitted to the engine is highly desirable in that as the boiler-pressure is not always the same the speed of the engine would be less susceptible to any changes therein. In the event of a wide variation in the boiler-pressure the throw of the cut-off valves K or K^2 should be adjusted to meet new conditions; but the automatic control of the volume of steam admitted to the engine will cause the engine to run at a more uniform speed, and thus dispense with constant attention in the way of manual adjustment of these cut-offs.

On account of the number of moving parts in a rotary engine and the great area of surfaces having contact with each other, which contacting surfaces are to be made steam-tight, it is highly desirable that a packing be employed which will not only wear a long time, but which will accommodate itself under varying conditions, and yet make a steam-tight contact.

Referring now to Figs. 2, 4, 8, and 9, it will be observed that the plunger G passes through an opening in the top of the cylinder, the ends of said plunger engaging the cylinder-heads, while the inner face of the plunger contacts with the periphery of the piston. In order to make a steam-tight packing to prevent the steam in the cylinder passing beyond the plunger and out through the opening containing the plunger, we arrange a sectional frame Q in a channel formed in said plunger, behind which sectional frame is a set of springs, preferably leaf-springs *q*, which exert a pressure against the frame to force the same outwardly in all directions. By reference to Fig. 4 it will be seen that the meeting edges of the sections of this frame, which meeting edges are located midway between the ends and sides, are rabbeted, so that in filling the opening through the top of the casing this sectional frame may expand without leaving a pathway or exposed crack for the escape of steam therearound. In addition to rabbeting the vertical faces of the ends of the frame-sections we also overlap said end sections, as shown in Fig. 8, by forming shoulders therein, which shoulders, while permitting the expansion of the frame in a horizontal direction, interrupt the vertical cracks or openings resulting from such horizontal expansion, and in this way prevent the steam from escaping into the exterior. The inner end and face of the plunger are also packed by a U-shaped frame R divided midway its length, the meeting ends of the sections being rabbeted or overlapped to prevent steam passing therebeyond when pressure is against the piston. A spring, preferably a leaf-spring *r*, is arranged above the horizontal portion of this packing, the ends of said spring bearing against the two sections composing the packing, so as to force them uniformly against the periphery of the piston. The vertical end sections of the packing are shouldered, as at *r'*, so as to engage a projection on the body portion of the plunger, so that when said plunger is raised it will carry the packing with it, and thus prevent the displacement thereof. These end sections are also forced outwardly against the sides of the cylinder-heads by means of leaf-springs r^2. (See Fig. 9.) The piston-head H, heretofore described, is of novel construction in that instead of carrying its packing in grooves it is packed by means of an expansible shoe, which practically forms an inclosing shell for the piston-head. The body of the piston-head proper is indicated at *h* in Fig. 10, where the inclosing shell or wearing-shoe is designated by the reference-letter S. This shoe is made up of two sections, each of said sections having an outer wearing-face *s* of some considerable extent, the front and back edges of which are rounded, so as to permit said wearing-face to easily pass over interruptions in the periphery of the cylinder. This wearing-face is also of such length as to practically bridge the opening in which the plunger is located when in its reseated position. Each section of the wearing-shoe has front and back walls *s'*, connected at the end of the piston-head by an end wall s^2. A spring s^3 forces the end walls laterally against the cylinder-heads to make close contact therewith, while a spring s^4 bears under the wearing-faces to force the same in close contact with the circumferential inner wall of the cylinder. The sections of this wearing-shoe at their meeting edges are rabbeted or reduced, so as to overlap each other, the overlapped portions lying in different planes, so as to form a shoulder s^5, as shown in Fig. 11. The packing of the piston is shown more clearly in Figs. 2 and 10, it consisting of a U-shaped ring T, forced laterally against the cylinder-heads by a set of coil-springs *t*, located at convenient points around the ring. The channel in the ring T opens outwardly and contains an expansible ring *t'*, which has a tendency to crowd the overhanging periphery of the piston. By this construction ring

T prevents the passage of steam from the chamber to the interior of the piston-cylinder chamber, while the ring *t'* prevents said steam from passing under the overhanging portion beyond said ring and into the interior of the piston.

As the shoe of the piston-head will move outwardly when worn, and thus leave a space at the periphery of the piston, we introduce a packing-strip U, (shown in Figs. 1 and 10,) which strip U is preferably secured to the ring T and is received in a groove in the outer face of the end wall of the shell of the piston-head. By this construction steam is prevented from passing beyond the piston-head when the shoe wears by contact with the periphery of the cylinder.

Referring now to Fig. 2, it will be seen that the cylindrical cylinder-casing is provided with shoulders *a*, against which fit cylinder-heads, so that a steam-tight joint is made at this point between the said parts. The shoulder *a* is intended to obviate the use of gaskets; but it is obvious that gaskets can be employed between the shoulder *a* and the inner face of the cylinder-head or between the flange of the cylindrical casing and the flange of the cylinder-head, or at both places, if desired.

As shown in Fig. 1, the periphery of the piston C is recessed, as at *c*, on each side of the piston-head, so that when the plunger is forced into the cylinder it will not deliver an impacting blow upon the periphery of the piston, but will be arrested in its movement by the lever F, the recess affording a clearance and preventing actual contact of the plunger with the periphery of the piston until the piston has made a partial revolution.

We are aware that many minor changes in the construction, arrangement, and combination of the several parts of our engine may be made and substituted for those herein shown and described without in the least departing from the nature and principle of our invention.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a rotary engine, the combination with the cylinder and its piston and piston-head, of a shaft upon which said piston is mounted, a cam on said shaft, a lever operated by said cam, a plunger to which said lever is connected, and a spring coöperating with said plunger to counterbalance the weight thereof, substantially as described.

2. In a rotary engine or the like, the combination with a cylinder, a piston carrying a piston-head and mounted upon a suitable shaft, a plunger, and means for operating said plunger, there being inlet-ports leading to different sides of said plunger, of means for reversing said engine, said means including rocking frames, means for rocking said frames, valves respectively controlling the said inlet-ports, and connections between said valves and said rocking frames, whereby the throw of said valves can be adjusted and either valve brought to a stationary position while its operating mechanism continues to move; substantially as described.

3. In a rotary engine, the combination with a plurality of cylinders, a shaft passing therethrough, pistons mounted on said shaft and carrying piston-heads, plungers, and means for operating said plungers, and means for reversing said engine, said means including rocking frames, means for rocking said frames, cut-off valves respectively controlling inlet-ports leading to different sides of the plungers, and connections between said cut-off valves and said rocking frames, whereby the throw of said valves may be adjusted and either valve brought to a stationary position while its operating mechanism continues to move, substantially as described.

4. In a rotary engine, the combination with the cylinder and its piston, of a piston-head arranged thereon, an inclosing shell or casing for said piston-head, which shell is composed of sections, springs coöperating with said sections and tending to force them in different directions, a packing-ring upon said piston and a packing-strip U secured to said ring and having its free end seated in a groove in the outer faces of the end walls of said sections, substantially as described.

5. In a rotary engine, the combination with the cylinder and piston, of a U-shaped packing-ring T, a spring for forcing said ring against the cylinder-heads, and an expansible ring *t'* seated in the channel of the ring T and bearing against the overhanging edge of the piston, substantially as described.

6. In a rotary engine, the combination with the cylinder and its piston carrying a piston-head, of a plunger, and means for operating said plunger, said piston having a recess in its periphery for receiving the plunger upon its introduction into the cylinder, substantially as described.

7. In a rotary engine, the combination with the cylinder, of a piston having a recess *c* and carrying a piston-head, a plunger, and means for operating said plunger, substantially as described.

In testimony whereof we hereunto affix our signatures, in the presence of two witnesses, this 15th day of December, 1900.

HENRY LIETHEGENER.
ADAM KLEMM.

Witnesses:
WM. H. SCOTT,
A. S. GRAY.