No. 734,944. PATENTED JULY 28, 1903.

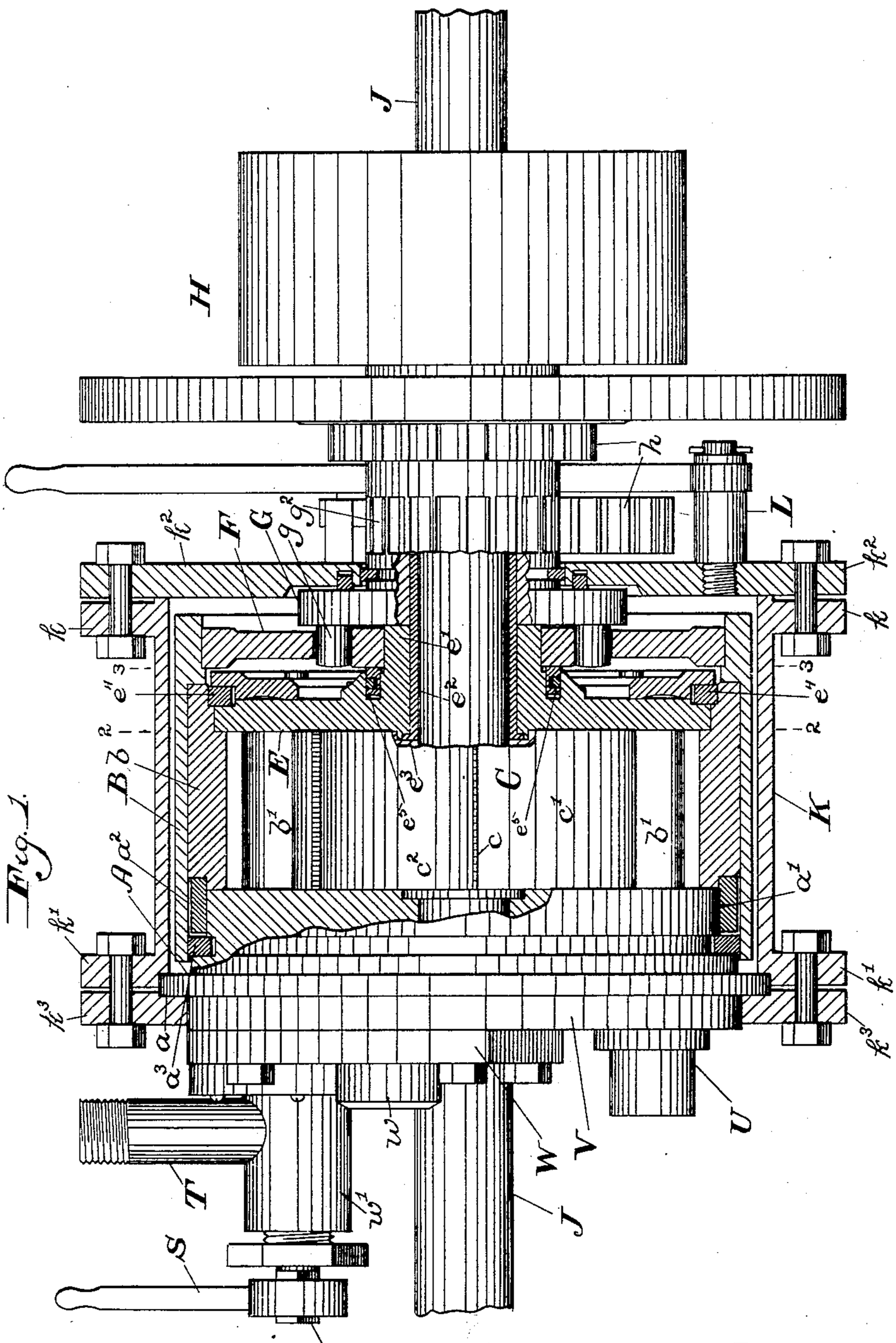
E. B. PORTER.

ROTARY ENGINE.

APPLICATION FILED DEC. 10, 1901. RENEWED JAN. 2, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



Witnesses.
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Inventor.
Elbert B. Porter
By Chas. B. Mann,
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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 6.

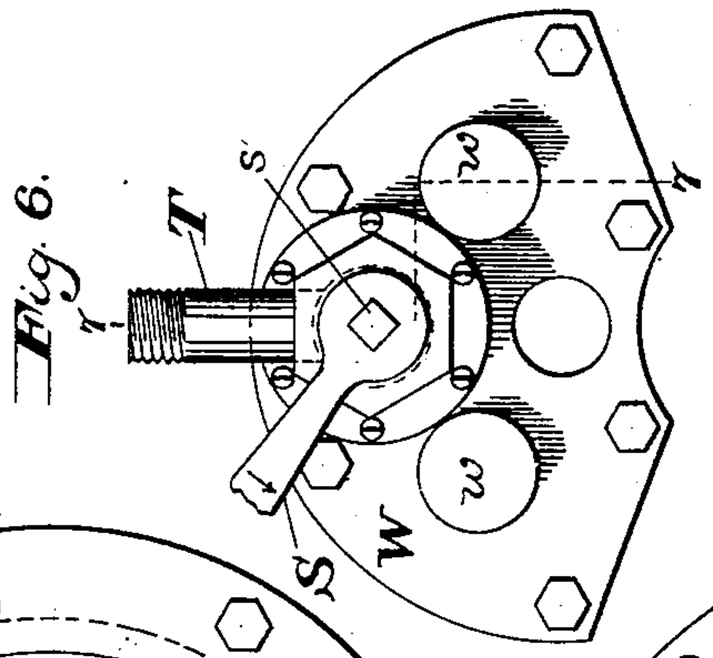


Fig. 7.

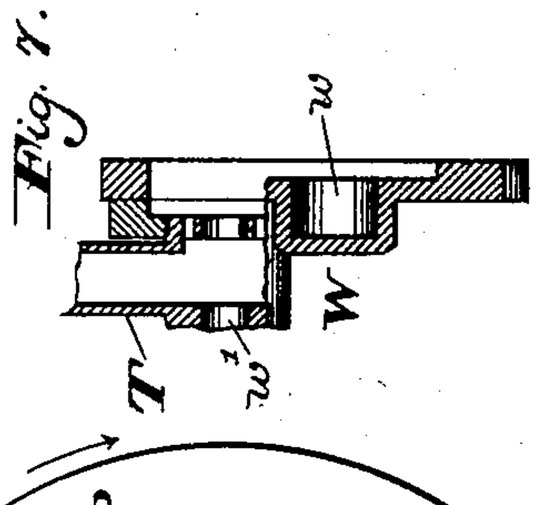


Fig. 4.

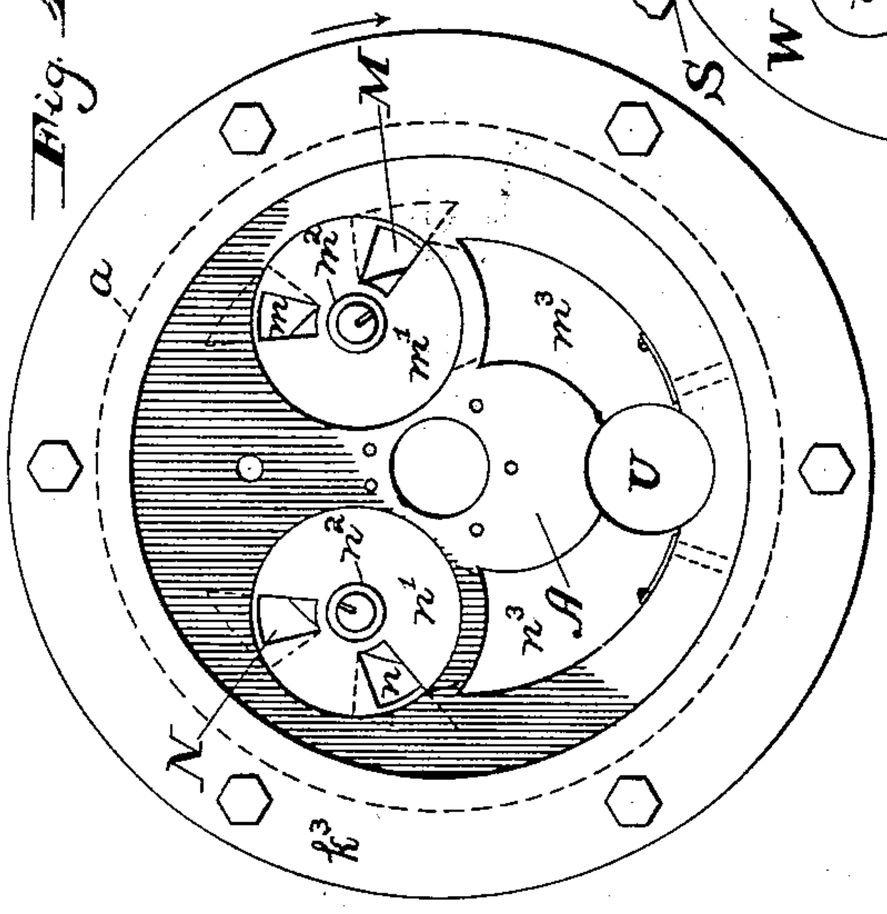


Fig. 5.

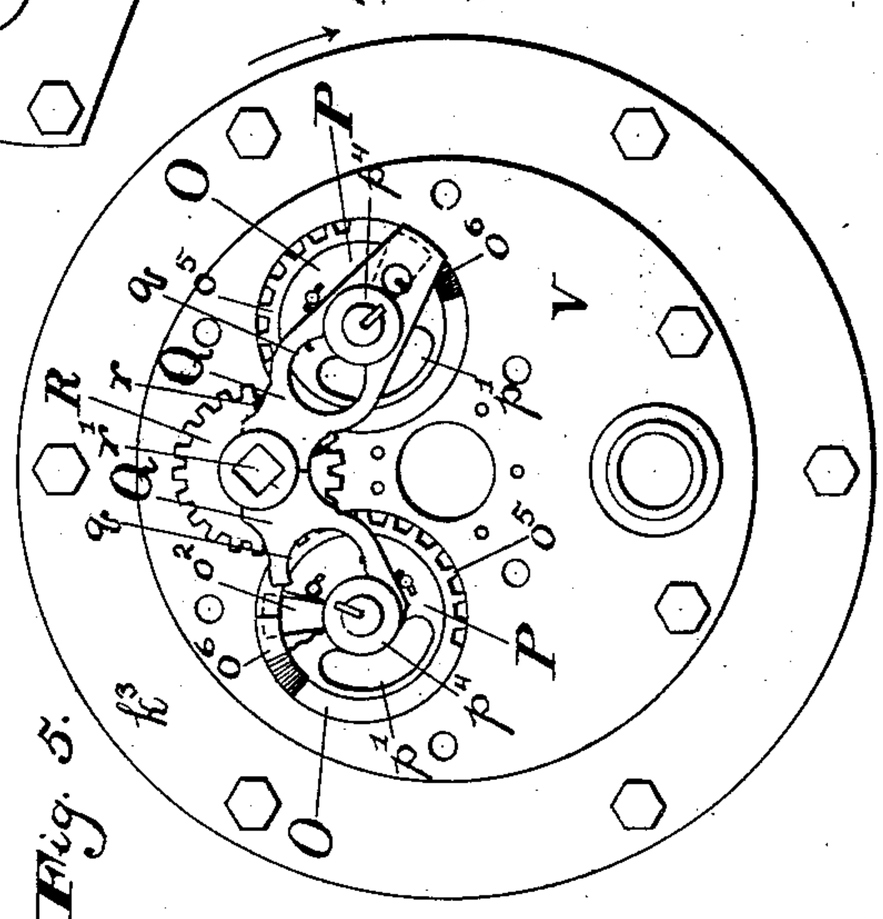


Fig. 2.

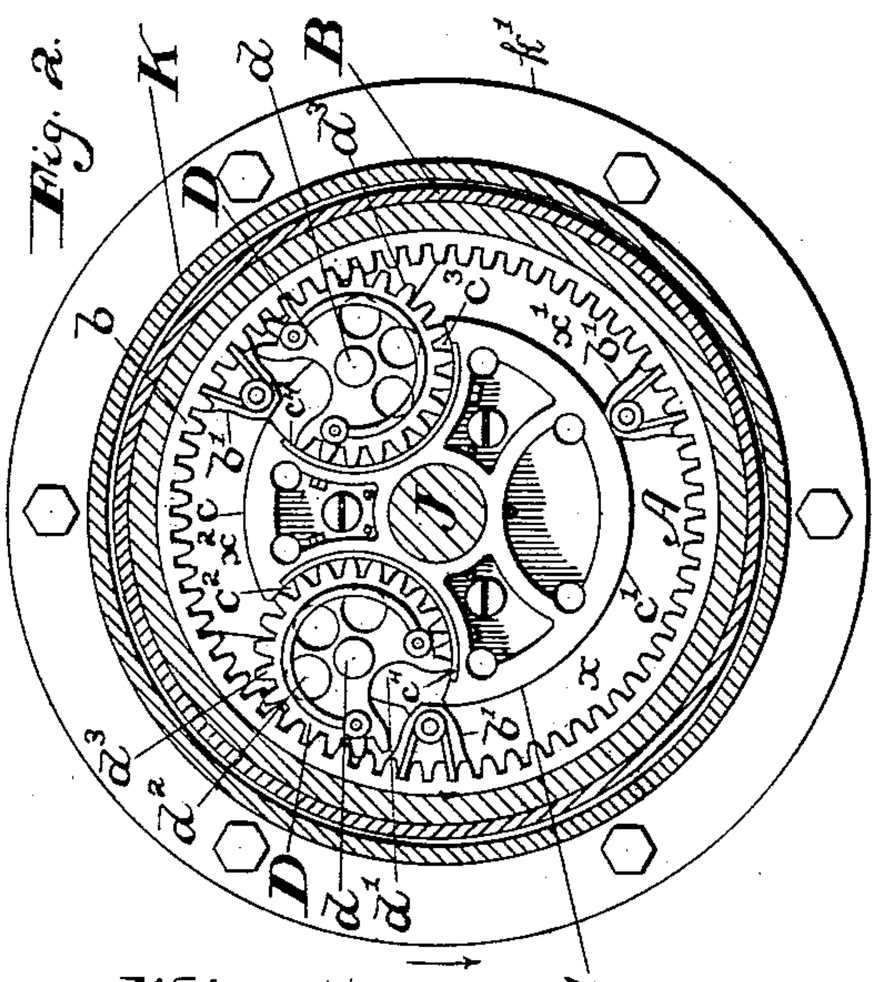
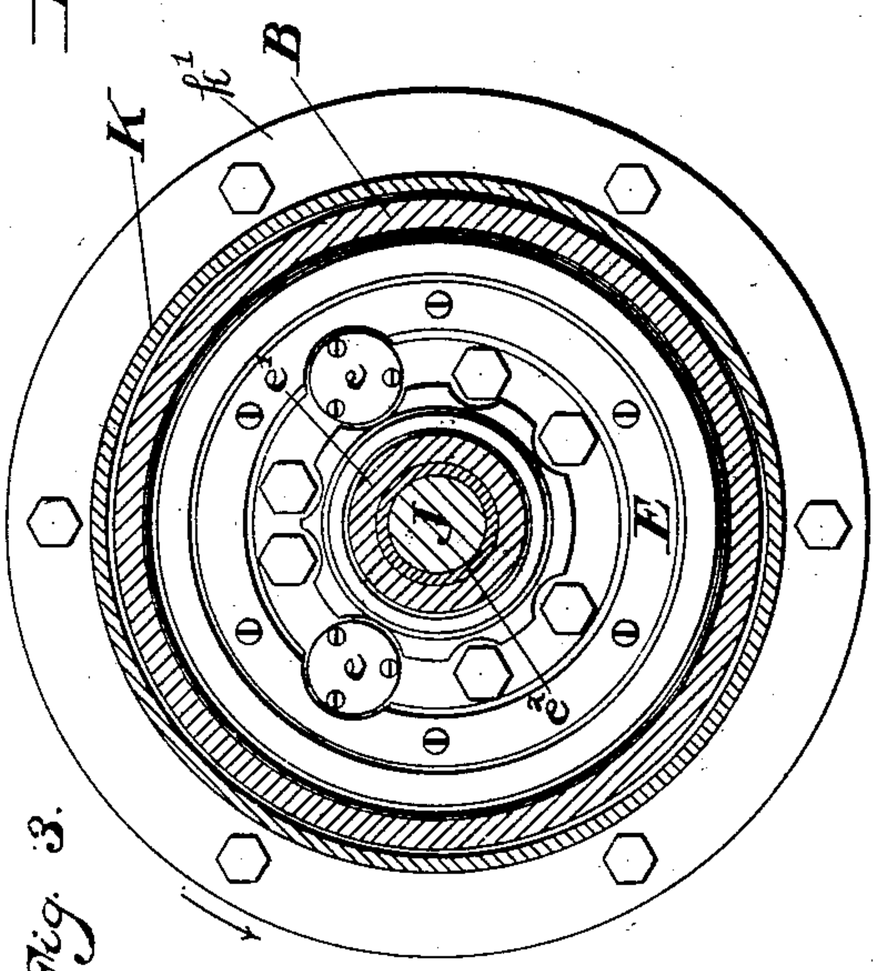


Fig. 3.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 13.

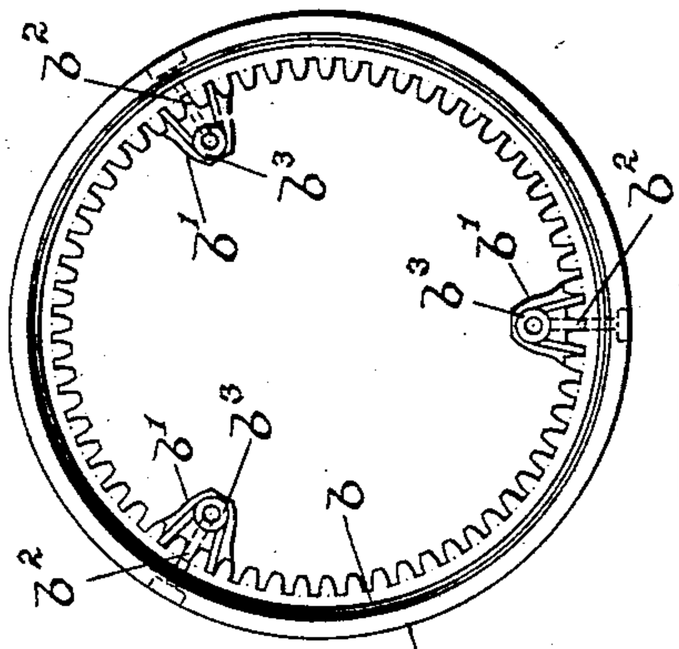


Fig. 14.

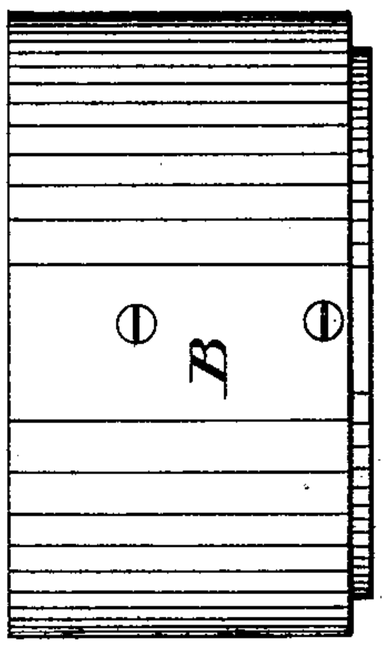


Fig. 16.

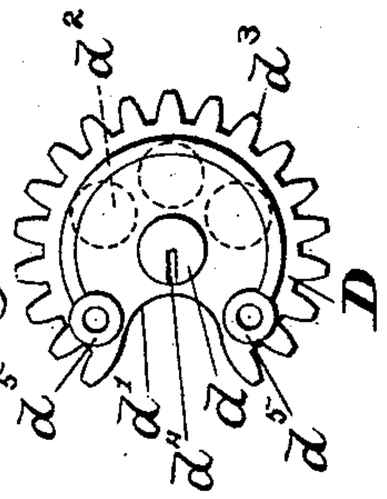


Fig. 10.

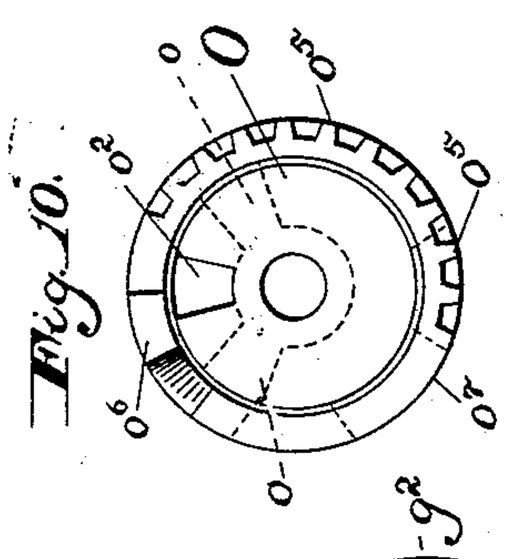


Fig. 11.

Fig. 12.

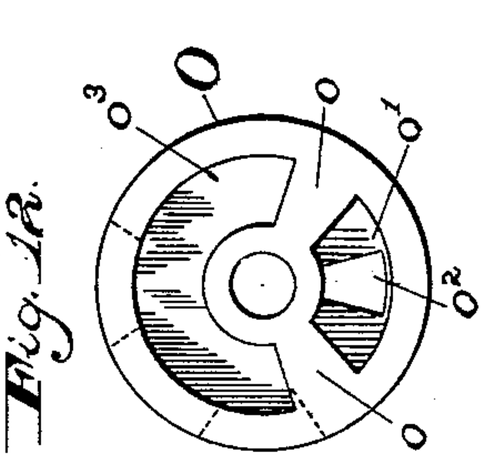


Fig. 15.

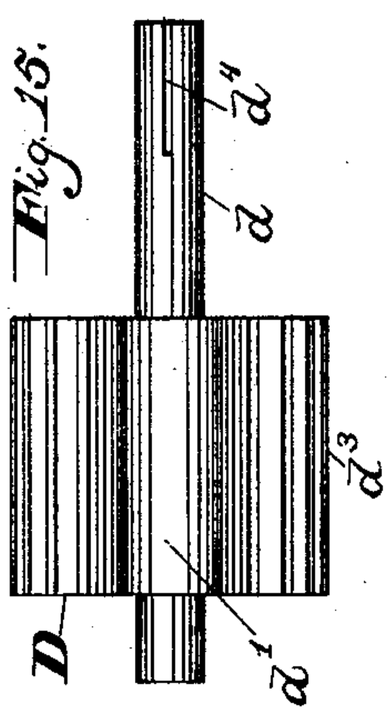


Fig. 9.

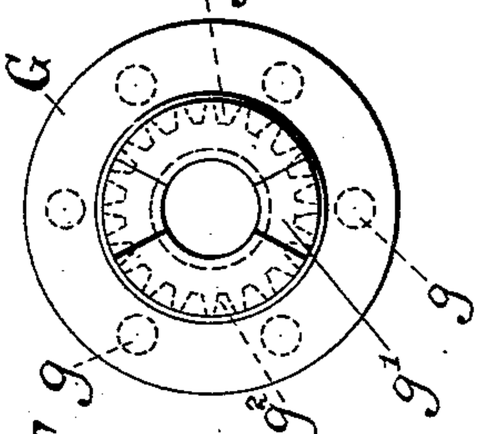


Fig. 8.

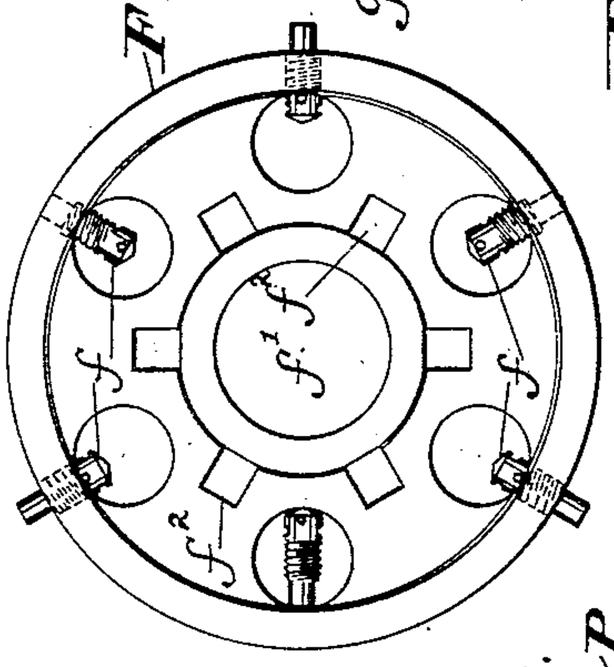


Fig. 17.

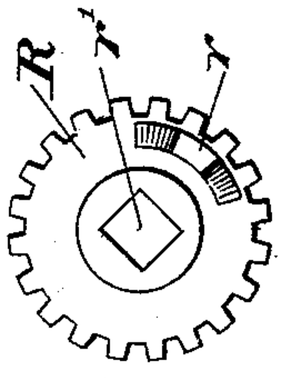


Fig. 18.

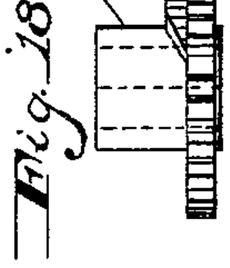


Fig. 23.

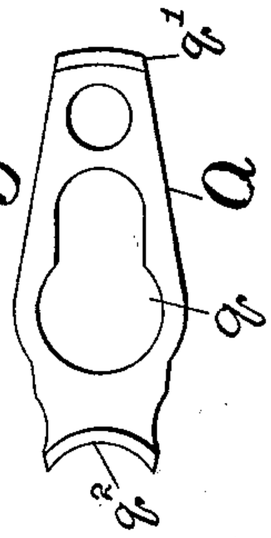


Fig. 20.

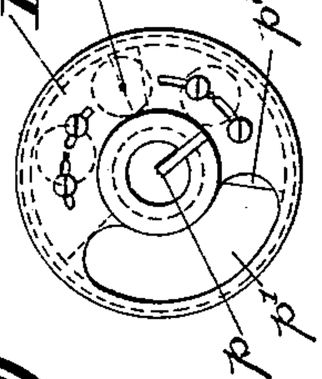


Fig. 21.

Fig. 22.

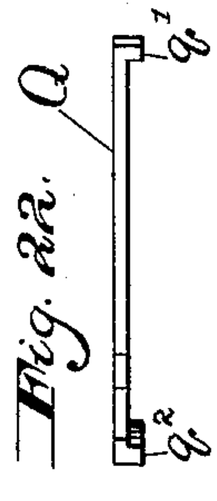
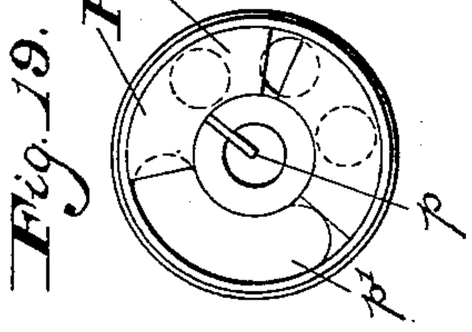


Fig. 19.



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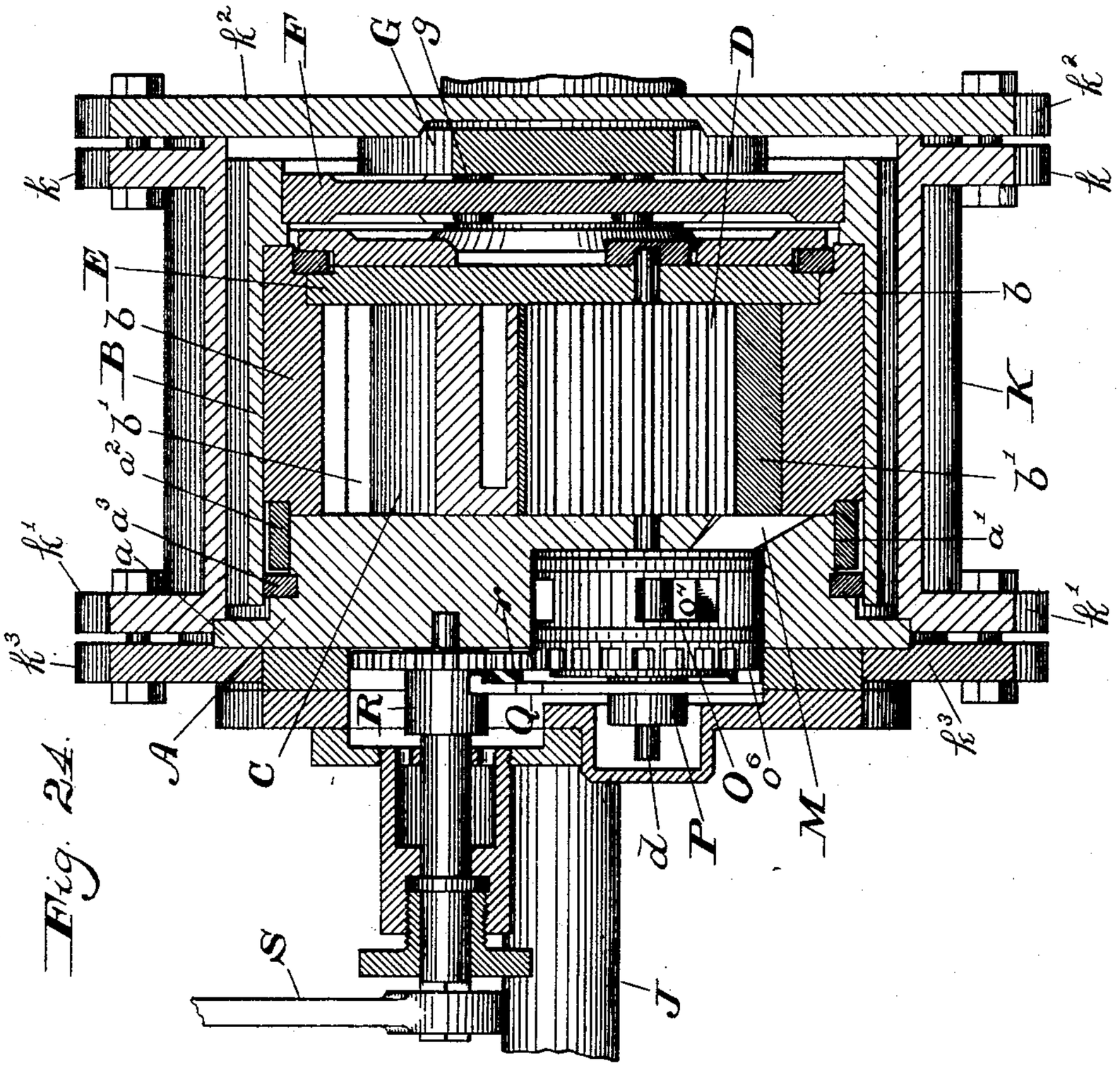

Fig. 24.

Witnesses.
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No. 734,944. Patented July 28, 1903.

UNITED STATES PATENT OFFICE.

ELBERT B. PORTER, OF PENN YAN, NEW YORK.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 734,944, dated July 28, 1903.

Application filed December 10, 1901. Renewed January 2, 1903. Serial No. 137,566. (No model.)

To all whom it may concern:

Be it known that I, ELBERT B. PORTER, a citizen of the United States, residing at Penn Yan, in the county of Yates and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to rotary engines; and one of its objects is to provide an improved construction of rotary engine in which the movable parts—such as pistons, abutments, and cut-offs—maintain a constant revoluble motion when the engine is in operation.

A further object of the invention is to provide improved means for readily starting the engine when the parts thereof are in the position commonly called the "dead-center;" and a further object is to provide an improved construction of rotary engine whereby a driving-shaft may be entirely dispensed with, if desired.

With these and other objects in view the invention consists in certain constructions, arrangements, and combinations of the parts hereinafter fully described and claimed, reference being had to the accompanying drawings, in which—

Figure 1 is a vertical transverse section, with parts in side elevation, of the improved rotary engine. Fig. 2 is a sectional view taken on the line 2 2 of Fig. 1 and on a smaller scale. Fig. 3 is a similar view taken on the line 3 3 of Fig. 1. Fig. 4 is an end elevation of the engine looking from the left-hand of Fig. 1 and with the two cover-plates or heads of the steam-chest removed. Fig. 5 is a similar view with one of said heads secured in place over the steam-exhaust passages. Fig. 6 is a detail outer face view of the other of said heads, which is intended to cover the two valves and cut-offs shown in Fig. 5 and to which is secured the feed-pipe and the starting and reversing lever for governing the valves. Fig. 7 is a detail sectional view of said last-named head, taken on the line 7 7 of Fig. 6. Fig. 8 is a detail face view of the coupling-head for connecting the part to be driven by the engine to the revoluble parts of the latter without the use of a main shaft. Fig. 9 is a detail view of the coupler adapted to be removably attached to said coupling-head. Figs. 10, 11, and 12 are respectively detail top plan, side, and bottom plan views of one of the valves. Fig. 13 is a detail edge view of the piston-ring. Fig. 14 is a peripheral or rim view thereof. Figs. 15 and 16 are side and end views, respectively, of the rotary abutments. Figs. 17 and 18 are respectively top plan and edge views of the valve-actuating gear-wheel. Figs. 19, 20, and 21 are detail bottom plan, top plan, and diametrical sectional views, respectively, of one of the cut-offs. Figs. 22 and 23 are respectively side, edge, and bottom plan views of one of the yoke-bars for lifting the cut-offs from their seats, whereby to admit steam to the valves irrespective of the position of the valves relative to the port in the cut-off. Fig. 24 is a transverse sectional view of the engine, taken through the axis of the valve-actuating gear-wheel and the axis of one of the rotary abutments.

I shall first describe the details of construction of those parts of the engine which constantly revolve during the operation of the engine, then next describe in detail the valve mechanism for admitting live steam to said constantly-revoluble parts for automatically cutting off the supply of live steam, whereby to permit the same to act expansively and for permitting the steam after it has been effectively used to exhaust, and shall finally describe the movements of the engine, pointing out specifically the correlated operations of the various assembled parts.

The revoluble parts.—Referring now by reference-letters to the accompanying drawings, more especially Figs. 1, 2, and 4, A designates the foundation-plate, upon which practically all the other parts of the engine are built. Said plate is provided with a circular flange a and a circular tread a', around which is fitted to revolve a cylinder B, to whose interior is secured an interiorly-toothed piston-ring b, fitting accurately with one side edge against the adjacent face of the said foundation-plate. A guide-ring a^2 is slipped over the tread of the foundation-plate and is interposed between said tread and the adjacent end of the revoluble cylinder B, whereby to guide the latter and also serve as a packing, and a packing-ring a^3 is also fitted around the tread of said foundation-plate between said guide-ring and the flange of the

plate, whereby to serve, with the guide-ring, to make an effective steam-tight joint at that side of the piston-chamber of the engine. The piston-ring b is rabbeted to receive one edge of said guide-ring a^2, as best shown in Fig. 1. Solid pistons b' are rigidly secured to the inner toothed wall of the piston-ring b, and in the present instance said pistons are three in number and are located equidistant from each other. Each piston extends from one side of the piston-ring to the other and is provided along its outer side with teeth b^2, meshing with the teeth of said ring, and is secured to said ring by bolts, as shown in Figs. 13 and 14, so that whenever desired for the purpose of taking up wear or for any other purpose the said bolts may be temporarily loosened and the pistons set slightly inward by interposing thin metal strips between the intermeshing teeth of the pistons and piston-ring. The pistons are preferably wedge shape in cross-section, with slightly-bulged side walls and slightly-concave inner walls, whereby they may slide along the walls of peripheral recesses in rotary abutments, presently described, with a minimum degree of friction commensurate with a steam-tight contact with said walls, and packing-rings b^3 are secured to the pistons, as shown.

Rigidly secured to that face of the foundation-plate A, around which the pistons b' revolve, is a web center C, which is provided with two curved surfaces $c\,c'$, concentric with the piston-ring b, and one of said surfaces c' is in the present instance an arc of about one hundred and eighty degrees, while the other, c, is relatively smaller and is an arc of about sixty degrees, and said web center is also provided with two reversely-curved recesses $c^2\,c^3$, separating the said two surfaces $c\,c'$ and adapted to receive a portion of the two rotary abutments D, fixedly secured to spindles d, journaled to rotate in the foundation-plate A at about one hundred and twenty degrees apart and passing through said plate to and beyond the opposite face thereof. Said two abutments D, one of which is illustrated in detail in Figs. 15 and 16, are part cylindrical and each is provided with a peripheral recess d', orifices d^2 to balance or compensate for said recess, and a transversely-toothed periphery d^3, meshing with the toothed inner wall of the piston-ring b and also sliding along packing-segments c^4 in the recesses $c^2\,c^3$. As the piston-ring b revolves, the two abutments will, as is evident, rotate and will meet with their peripheral recesses the pistons b' and permit the latter to pass through said recesses. The abutments D are also provided with packing-rings d^5.

E designates a piston-head or cover, which abuts against the web center C and is securely fastened in place by bolts passing therethrough and through said web center into the foundation-plate A. Said piston-head E is provided with packing-rings $e^4\,e^5$ and with end bearings e for the ends of the two abutment-spindles d and forms, with the foundation-plate A and revoluble cylinder B, a circular track or piston-chamber steam-tight with the exception, of course, of the feed and exhaust ports hereinafter described. This piston-head E is also provided with a central tubular boss e', within which is fitted a sleeve e^2, Fig. 1, provided on its inner end with a flange e^3, by which it is securely held between said web center C and said piston-head E.

Within the revoluble cylinder B, at the right-hand extremity thereof, as shown in section in Fig. 1, is located a coupling-head F, detachably but rigidly secured to said cylinder by means of a series of outwardly-bearing radial screws f, (see Fig. 8,) and said coupling-head is provided with a central opening f', whose walls surround the central boss e' of the piston-head E. The coupling-head F is further provided with a series of sockets f^2, in which pins g, projecting from one end of a tubular coupling G, fit in order to detachably connect the latter with said coupling-head. On the opposite end from said pin said coupler G, which is shown in detail in Fig. 9, is provided with clutch-recesses g', so that it may serve as one member of a clutch, and it is also provided on said end with a pinion g^2, meshing with a pinion h, which is carried by a lever L, said lever also carrying another pinion (not shown) on the same axis as the pinion h and in gear with a spur-wheel h', mounted to turn with a driving-pulley H.

A cylindrical jacket K surrounds the revoluble cylinder B and is provided with end flanges $k\,k'$, to one of which is bolted a head k^2, supporting the said lever L, and to the other flange is bolted a ring k^3, between which latter and said flange the flange a of the foundation-plate A is securely held. The said jacket K incloses and protects the moving parts of the engine and retains the lubricant and also prevents condensation by keeping the steam-chambers warm.

A main shaft J passes through the piston-chamber; but said shaft is not necessary in the engine of this invention and may be entirely dispensed with, if desired, because the revoluble parts of the engine are supported by the foundation-plate A and transmit their motion to the parts to be driven through the instrumentality of the coupling-head F and coupler G with its pinion g^2 or clutch-recesses g'. The said shaft J may fit throughout its length or for a portion only of its length in the opening of the engine through which it passes, or it may pass freely therethrough without touching at any point. With my improved engine a central or main shaft is only used for convenience in communicating motion—as, for instance, to some remote point—and its use or non-use depends largely upon what service the engine is put, or the shaft may be used as a support for the engine to hold it in any position for any special

work, and it may also serve as a feed or advancing shaft when the engine is used to drive any special tool, such as boring or drilling tools.

Briefly setting forth the operation of the parts hereinbefore described, it is to be noted that the cylinder B, carrying the piston-ring b, with its piston b', revolves around the stationary foundation-plate A, its web center C, and piston-head E and when so revolving carries with it the coupling-head F and coupler G, thereby imparting a rotary motion to the driving-pulley H. It will thus be seen that the pistons and abutments do not have any oscillating, reciprocating, or vibrating motion whatever, but maintain a constant revoluble motion, thereby doing away with the loss of power incident to end thrusts and reverse motions.

The valve mechanism.—Referring now particularly to Figs. 1, 4, 5, and 6, the foundation-plate A is provided with two pairs of ports, designated, respectively M m N n and extending transversely through said plate in a direction oblique to the radii of the latter at points in the path of the piston b' and on the inner face of said plate of such shape and location with respect to said pistons that they can never be entirely covered by the latter. Each pair of ports is located contiguous to one of the rotary abutments D, and one port of each pair is a feed-port and the other an exhaust-port, the said functions of the ports alternating according as the engine rotates in one direction or the other.

On the outer face of the foundation-plate A each pair of ports opens into a circular recess m' n', which recesses form one side of valve-chambers concentric to the projecting spindles d of the two abutments D and provided with bosses m^2 n^2, surrounding said spindle, and each valve-chamber opens at one side into an exhaust-passage m^3 n^3, which lead to a common discharge U for the exhaust-steam, as illustrated in Figs. 4 and 5. A circular plate V, as shown in Fig. 5, covers the two exhaust-passages m^3 n^3 and surrounds the two valve-chambers m' n'. Each spindle d is provided, as shown best in Figs. 15 and 16, with a feather-groove d^4. A circular partially-rotatable valve O is mounted so that it can be turned when necessary on said bosses m^2 n^2, and rotary cut-offs P are each provided with a central feathered socket p, taking over the end of said spindles and into said grooves d^4, whereby the cut-offs will rotate with the abutments.

Each valve O, one of which is shown in detail in Figs. 10, 11, and 12, is in the form of a short hollow cylinder closed at one end with the exception of the feed-port and divided by webs o into two chambers—namely, first a feed-chamber o', provided at its top with a feed-port o^2, and, secondly, a relatively larger exhaust-chamber o^3, provided in its sides with two exhaust-ports o^4—and each valve is provided on its outer side edge or top with a series of teeth o^5 and a cam-surface o^6. The said teeth and cam-surface are in this instance formed on a ring o^7, which is set in a rabbet in the valve and is adjusted on the latter, so that the said teeth and cam-surface will have the proper position relative to the ports in the valve. Each valve is provided with two packing-rings, one on each side of the exhaust-ports, as best shown in Fig. 11.

Each of the cut-offs P, which fit over said valves, is provided with a segmental port p', whose size may be regulated at either end by adjustable plates p^2, and is also provided with small orifices p^3, which lead to circular shallow steam-chambers on the inner side of the cut-off, through which orifices a very slight amount of steam may issue sufficient to prevent the cut-off from being packed down against the respective valve by the steam-pressure. Each cut-off is provided with an exteriorly-grooved hub or boss p^4, having a feather p adapted to take in the groove d^4 of the abutment-spindle d, and a yoke-bar Q, of which there are two, is provided with a keyhole-shaped slot q, by which it takes in the groove of said boss p^4, and is also provided with segmental end flanges q' q^2, of which the outer end flange q' is adapted to ride up on the cam-surface o^6 of the valve O. The other end flange q^2 is adapted to ride up on the double cam-surface r, rising from the adjacent face of a valve-actuating gear-wheel R, which, as shown in Fig. 5, is mounted on the foundation-plate A above and between said valves and meshing with both of said valves, so that as it turns it will move both valves in the same direction and will also, if it turns far enough, raise the yoke-bar Q on that side of the engine in the direction of which the engine is intended to run and cause the latter to lift the said cut-off away from the respective valve.

A part-circular head W (shown in Fig. 6) is bolted over the exhaust-passage cover V, as illustrated in Fig. 1. Said head is provided with sockets w for the adjacent end of the abutment-spindles and is also provided with a tubular boss w', through which the square stem s of the starting and reversing lever S is inserted into engagement with the square socket r' of the throttle-wheel R, and a steam-feed pipe T is secured to the boss w', as illustrated in Figs. 1, 6, and 7, the steam passing from said feed-pipe through the openings in the boss around said stem and thence to the valves.

The operation of the engine is as follows: When the engine is at rest, the starting and reversing lever S points in a vertical direction, the feed-port of each valve is out of registry with its respective feed-port of the valve-chamber, and the webs in the open ends of the valves cover the ports in the valve-chambers. To start the engine in the direction indicated by the darts in Figs. 2, 3, 4, and 5, the said lever is swung in the opposite direction, (indicated by the dart in Fig. 6.) This movement of said lever, through the

instrumentality of the gear-wheel R, causes the two valves to turn, so that their feed-chambers will communicate with the feed-ports M N by means of the ports in the top of the valves, and thereby admit live steam to the piston-chamber. The said live steam acts with an impact behind either one or two of the pistons *b*, according to the positions of the same. When the pistons are in the position shown in Fig. 2, the steam will act behind the two pistons that are adjacent said rotary abutments and will also act against the peripheral recesses of the rotary abutments in a direction to rotate the latter, and thereby assist the piston-ring in its revolution. This is an important part of this invention. The abutments get puffs of live steam every time the pistons begin to pass out of the abutment-recesses and uncover the feed-ports of the piston-chamber, and said steam filling the peripheral recesses of the abutments serves to turn the latter until they turn far enough to begin to receive the succeeding piston, at which time said puffs of live steam in the said recesses exhaust through the exhaust-ports. The steam acting against the disengaged teeth of the abutments also serves to turn the latter. As the pistons revolve around the two curved surfaces *c c'* of the web center C that feed-port which is adjacent the shorter surface will be cut off (in the present instance) until the time the piston reaches the far end of said surface. Hence the steam behind said piston will act expansively. The other feed-port is cut off at the same time unless it is prevented from so doing by means hereinafter described for starting the engine under certain conditions. The time of the "cut-off" may be regulated by adjusting the plates of the cut-off. In the position of the parts shown in Fig. 2 live steam is entering the feed-ports M and N behind the two adjacent pistons and between said pistons and the walls of the recesses in the abutments, the space *x* between two of the pistons is of course filled with dead steam, and the spaces x' x^2 between the advance ends of two of the pistons and the two exhaust-ports *m n* contain exhaust-steam. If the engine should be stopped in a position that two of the pistons point radially inward in the abutment-recesses and the cut-offs at the same time cover the feed-chambers of the two valves, the engine is in the condition commonly called the "dead-center," and it is to be especially noted that my invention provides means for readily starting the engine under such conditions, said means comprising the peculiar construction and arrangement of the cut-offs P, yoke-bars Q, and valve-actuating gear-wheel R. To start the engine under the conditions just described, the lever S is swung over in one direction until one of the surfaces of the cam of said gear-wheel and the cam-surface of the valve which is the forward valve relative to the direction in which it is desired the engine shall be run both enter under the respective yoke-bar and raise said bar, which latter thereby raises the corresponding cut-off from the valve and permits live steam to pass under the cut-off and into the feed-chamber of the valve and thence into the piston-chamber behind the adjacent piston and against the teeth of the abutment, whereby to start the engine. The steam can pass through the feed-ports to act on the pistons, because, as before described, said ports are of such area on the inner face of the foundation-plate A that they can never be entirely covered by the pistons. The cut-off of the other valve is of course not raised in this operation, because if it were the position of the cut-off is such on the valve that the steam would be merely wasted through the exhaust-port of that valve. After the engine has thus been started from a dead-center, the lever S is moved still farther in the same direction or a reverse direction, according to the speed at which it is desired the engine shall be run.

While the accompanying drawings and description disclose one form in which the generic principles of my invention are embodied, yet it is to be understood that changes may be made in the arrangement, design, and construction of the parts without departing from the scope of the invention as defined in the appended claims.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a rotary engine, the combination of a foundation-plate provided with inlet and exhaust ports; an internally-toothed piston-ring revoluble around said foundation-plate at one side thereof and provided with pistons; rotary toothed abutments gearing with said piston-ring and mounted on spindles journaled in said foundation-plate contiguous to said ports and said spindles projecting through said plate to the opposite side thereof; valves surrounding the projecting ends of said spindles and adapted to govern said ports; and cut-offs mounted on said spindles to turn therewith.

2. In a rotary engine, the combination of a foundation-plate provided with ports; a piston-ring revoluble around said foundation-plate at one side thereof and carrying pistons; rotary abutments adapted to be rotated by said piston-ring and mounted on spindles projecting through said plate to the opposite side thereof; valves mounted to turn on the projecting ends of said spindles and adapted to govern said ports; and cut-offs also mounted on said spindles and arranged to turn therewith.

3. In a rotary engine, the combination of a piston-chamber provided with a circular piston-track divided or separated into two different-length curved surfaces; two rotary abutments in said piston-chamber in the spaces between said two curved surfaces; equidistant pistons revoluble around said

piston-track; and a valve mechanism provided with ports contiguous to said abutments and also provided with cut-offs governed by said abutments.

4. In a rotary engine, the combination of a revoluble interiorly-toothed piston-ring; three equidistant pistons rigidly secured to said ring; two rotary abutments mounted with their axes one hundred and twenty degrees apart, and provided with toothed peripheries meshing with said piston-ring and also provided with peripheral recesses through which the pistons successively pass; and a valve mechanism provided with two pairs of ports each pair of which is contiguous to one of said abutments, and also provided with two cut-offs governed by said abutments.

5. A rotary engine, provided with a piston-chamber; revoluble pistons and rotary abutments in said piston-chamber; and a valve mechanism having inlet and exhaust ports opening into said piston-chamber contiguous to said abutments and of such shape adjacent said piston-chamber that they can never be completely covered by the pistons and said mechanism also having cut-offs arranged to be moved away from said valves to let steam under the cut-offs.

6. In a rotary engine, the combination of revoluble pistons; valves governing the admission to and exhaust of steam from said pistons; cut-offs for said valves; and means for moving said cut-offs from said valves whereby to throw the cut-offs out of operation.

7. In a rotary engine, the combination with the piston-chamber, pistons and abutments, of valves for admitting steam to and permitting it to exhaust from said piston-chamber; automatic cut-offs for said valves; and means for moving said cut-offs out of operative relation with either of said valves.

8. In a rotary engine, the combination with the piston-chamber, pistons, and abutments, of valves for admitting steam to and permitting it to exhaust from said piston-chamber; cut-offs covering said valves; and means whereby when the valves are moved to admit steam either of said cut-offs may be raised off said valve to uncover the same, as set forth.

9. In a rotary engine, the combination of a foundation-plate provided with inlet and exhaust ports; a piston-ring revoluble around said foundation-plate at one side thereof; pistons secured to said piston-ring; rotary abutments for said pistons, said abutments being mounted on spindles journaled in said foundation-plate contiguous to said ports and said spindles projecting through said plate to the opposite side thereof; partially-rotatable valves surrounding the projecting ends of said spindles and adapted to govern said ports; cut-offs mounted on said spindles to turn therewith, and adapted to cover said valves; and yoke-bars secured to said cut-offs and adapted to hold the cut-offs away from said valves, as set forth.

10. In a rotary engine, the combination of a foundation-plate provided with inlet and exhaust ports; a piston-ring revoluble around said foundation-plate at one side thereof; pistons secured to said ring; rotary abutments for said pistons, said abutments being mounted on spindles journaled in said foundation-plate contiguous to said ports and said spindles projecting through said plate to the opposite side thereof; partially-rotatable valves surrounding the projecting ends of said spindles and adapted to govern said ports, said valves being provided with cam-surfaces; cut-offs mounted on said spindles to turn therewith and adapted to cover said valves and provided with grooved bosses; and yoke-bars taking around said grooved bosses and adapted to ride on the cam-surfaces of the valves whereby to hold the cut-offs away from the latter, as set forth.

11. In a rotary engine, the combination of a foundation-plate provided with inlet and exhaust ports; a piston-ring revoluble around said foundation-plate at one side thereof; pistons secured to said piston-ring; rotary abutments for said pistons, said abutments being mounted on spindles journaled in said foundation-plate contiguous to said ports, and said spindles projecting through said plate to the opposite side thereof; partially-rotatable valves surrounding the projecting ends of said spindles, and adapted to govern said ports, said valves being provided with cam-surfaces; cut-offs mounted on said spindles to turn therewith and adapted to cover said valves and provided with grooved bosses; a throttle-wheel engaging said valves to turn the latter and provided with a double cam-surface; and yoke-bars taking around the grooved bosses of said cut-offs and adapted to ride on the cam-surfaces of said valves and throttle-wheel, as set forth.

12. In a rotary engine, the combination of a stationary foundation-plate; a cylinder revoluble around said foundation-plate; means for revolving said cylinder; a coupling-head, F, provided with outwardly-bearing radial screws by which it is secured in said cylinder; and a coupler, G, arranged for detachable connection to said coupling-head and adapted to be connected to a part to be driven, as set forth.

13. In a rotary engine, the combination of a stationary foundation-plate; a web center, C, rigidly secured thereto; a piston-head, E, rigidly secured to said web center; a cylinder revoluble around said aforenamed parts and forming with the same a piston-chamber; pistons in said chamber and revoluble around the said web center; a coupling-head, F, secured to said cylinder; and a coupler, G, in engagement with said coupling-head, as and for the purpose set forth.

14. In a rotary engine, the combination of a stationary foundation-plate; a web center, C, rigidly secured thereto; a piston head or cover, E, rigidly secured to said web center;

a cylinder revoluble around said aforenamed parts and forming with the same a piston-chamber; pistons in said chamber and revoluble around the said web center; a coupling-head, F, provided with outwardly-bearing radial screws by which it is secured in said cylinder, and also provided with sockets, f^2; and a tubular coupler provided with pins entering said sockets whereby to detachably connect said coupler with said coupling-head, as set forth.

In testimony whereof I affix my signature in the presence of two witnesses.

ELBERT B. PORTER.

Witnesses:
FREDERICK S. STITT,
CHARLES B. MANN, Jr.