(No Model.)

2 Sheets—Sheet 1.

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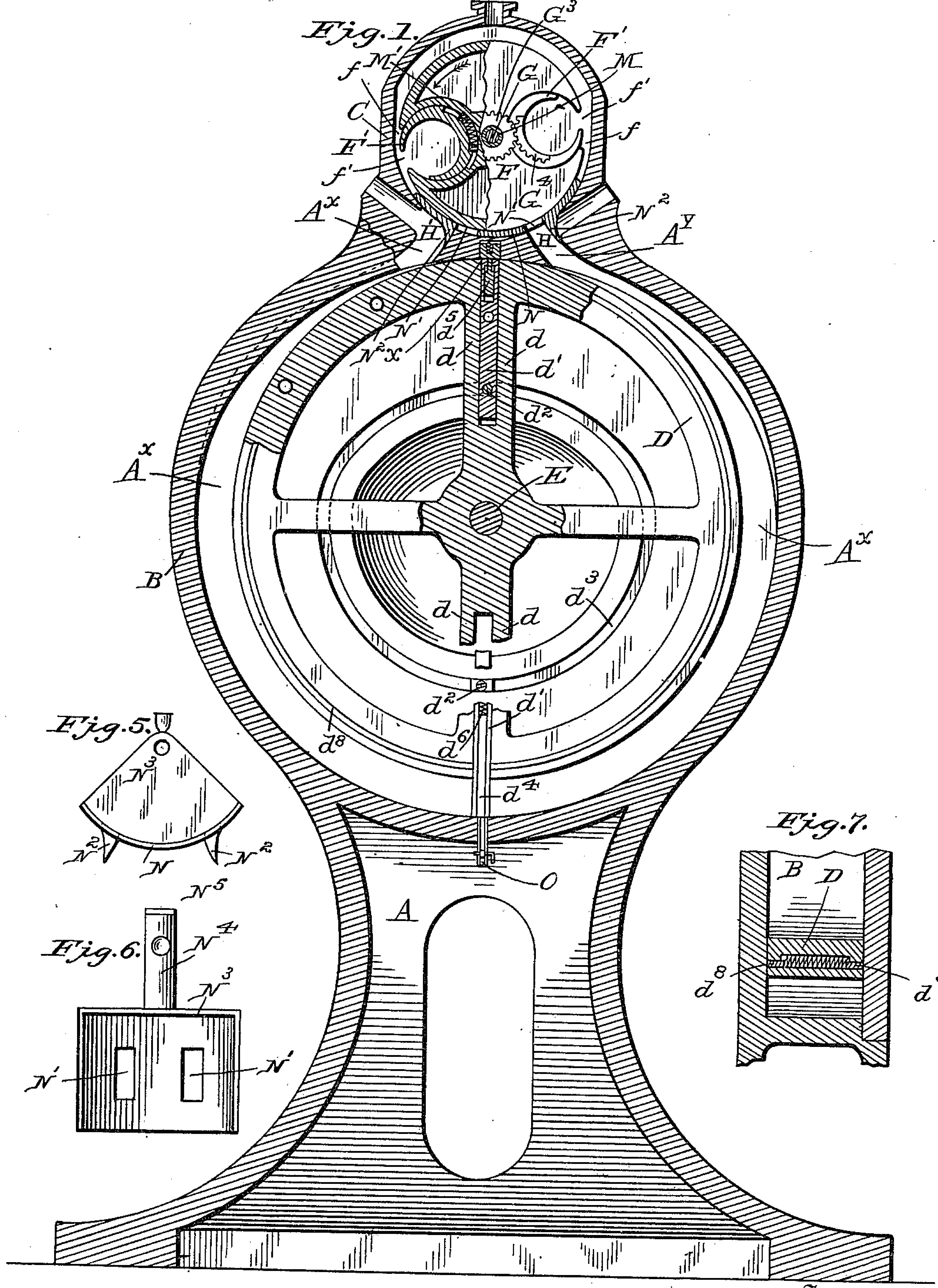
ROTARY ENGINE.

No. 566,303. Patented Aug. 25, 1896.



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(No Model.)

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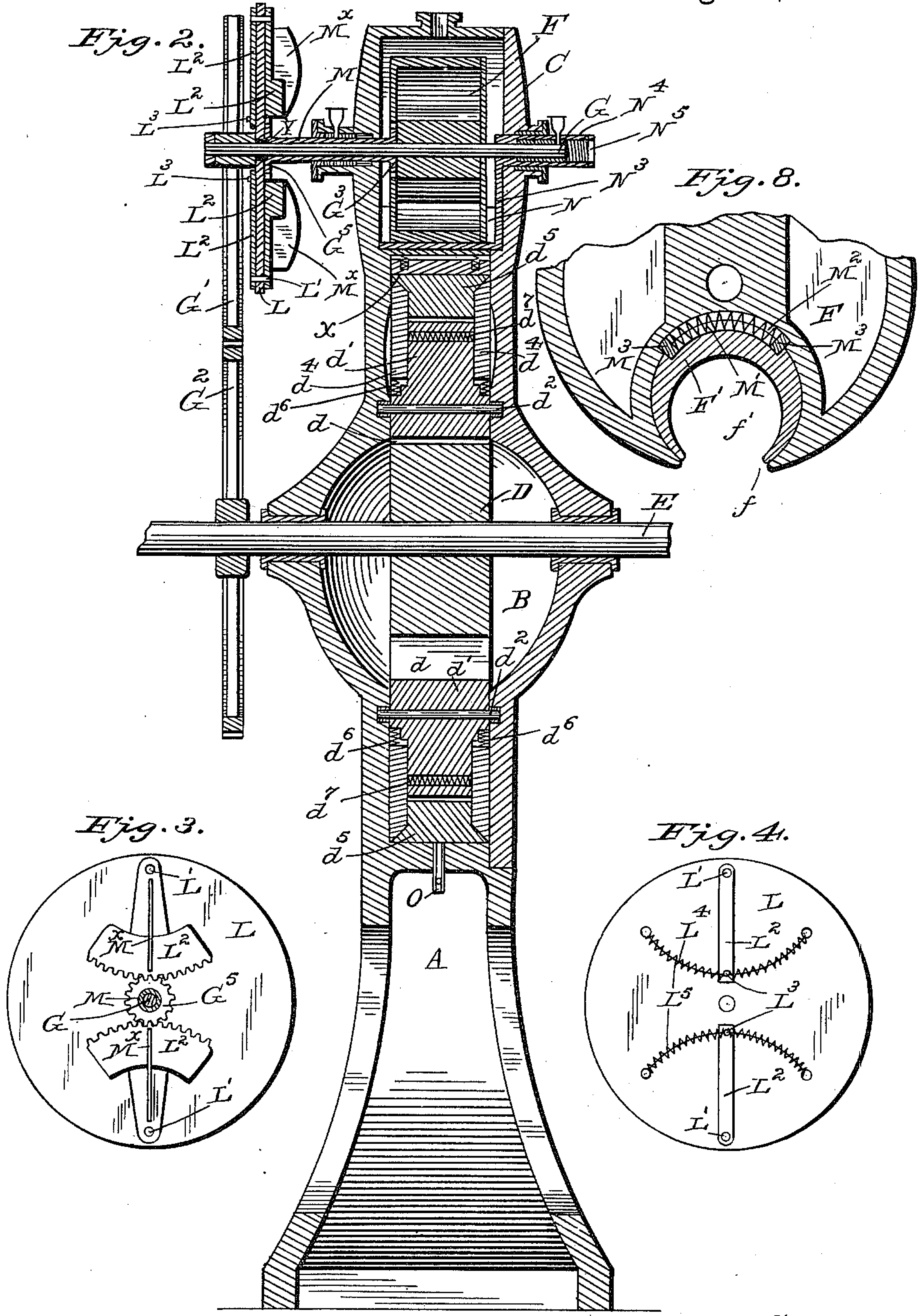
Fig. 2. Fig. 8. Fig. 3. Fig. 4.



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UNITED STATES PATENT OFFICE.

BRADLEY W. FISK AND WALTER M. CAMP, OF SEDRO, WASHINGTON.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 566,303, dated August 25, 1896.

Application filed November 14, 1895. Serial No. 568,944. (No model.)

To all whom it may concern:

Be it known that we, BRADLEY W. FISK and WALTER M. CAMP, citizens of the United States, residing at Sedro, in the county of Skagit and State of Washington, have invented certain new and useful Improvements in Rotary Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates generally to steam-engines, particularly to rotary engines, and more specifically stated belongs to the rotary concentric piston type.

The objects of the invention are to provide a simple and efficient form of engine of this class, and one employing a rotary valve in connection with the rotary piston.

Another object is to provide a novel construction of cut-off mechanism and governor, and a still further object is to provide a novel form of piston-operating devices.

Another object is to construct a peculiarly-shaped cylinder; and with all these objects in view our invention consists in the peculiar construction of the various parts and their novel combination or arrangement, all of which will be fully described and then pointed out in the claims.

In the drawings forming a part of this specification, Figure 1 is a vertical longitudinal section of our improved engine. Fig. 2 is a transverse section. Fig. 3 is a detail view of the governor. Fig. 4. is a detail view of the opposite side. Fig. 5 shows the reversing slide in detail. Fig. 6 is a plan view of the same. Fig. 7 is a sectional view showing the packing-rings. Fig. 8 is an enlarged detail view of the valve.

In carrying out our invention we provide a suitable support A, upon which is mounted the cylinder B, and above this the steam-chest C.

The support, cylinder, and chest can be made a composite structure or entirely separate, as desired, as this forms no feature of our invention.

Within the cylinder B rotates the piston D, mounted upon the shaft E, and within the chest C rotates the valve F, mounted upon a shaft G, as presently explained. The cylinder B has the piston mounted at its center, and this cylinder is of peculiar construction, the lower half being formed upon one radius only, the object being to have no movement or sliding of the wing inward or outward while the pressure of the steam is being exerted upon it, and hence tend to minimize the wear of such wing and the slot in which it works. The wing herein referred to is to be described presently. The upper half is constructed upon two or more different radii, or the top part can be a portion of an ellipse, the construction of each half of the cylinder being such with reference to the piston that said piston touches the cylinder only at one point, namely, at x, and at that point we provide a packing-piece held down by spring or direct steam pressure. The steam-space between piston and cylinder can be rectangular or partly curved in cross-section, which steam-space extends entirely around the cylinder except at point x.

The piston is cylindrical in shape and is constructed with arms or spokes d, in which slide wings d', said wings having pins d^2, which work with sliding blocks in suitable grooves d^3, formed in the two sides of the cylinder, which grooves constrain the wings to press to the outside or against the outside or case at all times except when said wings pass under or by the packing-piece x, at which point and for a short distance approaching it from either direction the grooves are at such a distance therefrom as to pull in the wings and constrain them to pass by the said piece x at a safe clearing distance. The piece x must therefore be of a greater thickness than the sliding wing, so that it cannot get into the slot while the wing is pulled in. The wings d' are provided with side packing-strips d^4 and an end strip d^5, the springs d^6 and d^7, respectively, pressing said strips outward against the side of cylinder or case, and said piston is also provided with adjustable packing-rings d^8, pressed outward by a spring between the two at intervals. Thus it will be seen that the sliding wings fit the cylinder tightly and as they are moved around are pushed in and out through the medium of the grooves.

The end packing-strip d^5 is limited in its

movement outward by a shoulder, as shown. Hence nothing can catch the packing-piece *x* while passing it. Steam is admitted through inlet-port H and exhausted through port H′. These ports are or may be both alike, extending around each way to points of admission and exhaust, respectively, the lower part of each being a groove or channel in the outside or case of the cylinder of less width than the steam-chamber and opening into it all along, so as to allow room for the steam while the wing is passing through it just before admission. The rotary valve F consists of a cylindrical shell having within it two smaller cylindrical shells F′ F′. (Shown in Fig. 1.)

In the circumference of the outer shell are two openings *f*, which allow the steam to escape to port H, the object of the shell F being to revolve continuously and cover and uncover alternately these openings *f*, and thus control the cut off of steam. It will be noted here that steam is admitted while opening *f* is passing or is uncovered by the port H. The shell F′ has an opening *f*′ to correspond with each opening *f*, but when each shell F′ is revolved it closes or partly closes the opening *f*.

The valve F is turned by a shaft G, geared by spur-gears G′ and G^2, turned by the main shaft E. The shells F′ F′ are moved by a spur-gear G^3, which meshes with gear G^4, mounted upon their ends. This spur-gear G^3 is attached to a collar M, which fits over the shaft G and passes out through a stuffing-box. This collar also carries another gear G^5, which is actuated by the governor.

The governor or speed-regulator is described as follows: Upon the shaft G is keyed a circular plate L. This plate L has two pins L′ near its outer edge, to which swing two weights L^2, hanging by arms keyed to the pins L′, to which also are keyed arms L^2 on the back side of the plate. These arms on the back side of the plate carry at their ends the pins L^3, which are bored and slide along the curved rods L^4, and around these curved rods are coiled springs L^5, which press against the pins L^3 and hold the arms to the center. When the engine is at rest, the weights L^2 are then hanging directly toward each other and toward the center of the plate L. At the outer edges of these weights are gear-teeth engaged with the spur gear-wheel G^5. This spur gear-wheel G^5 is allowed to turn a small distance either way before it moves the collar M, thus allowing the weights to swing a small distance off the center before operating the collar. A small packing Y between the plate L, the shaft G, and the collar M makes a steam-tight fitting. It will be found that the weights L^2 will swing always in a direction opposite to the movement of the pins L′. To aid this initial movement vanes $M^\times$ are attached to the arm and weight so as to catch air. The springs L^5 may be adjusted to such stiffness as to hold the weights at a balance until such speed as is desired will swing them from the center. This governor thus will act for a rotation of the engine in either direction. As the weights swing out they turn the gear G^5 until it moves the collar M, which turns the shells F′ by means of the spur-gears G^3 and G^4, thus controlling the cut off. The shells F′ are held to their central position by springs M′, held in chambers at the outer ends of the shells, as shown at M^2. Each chamber is cut half out of the shell and half out of the casing around it, and at the ends of this chamber are blocks M^3 for the springs M′ to act against. It will thus be seen that whichever way the shells are revolved the blocks are pushed toward each other and compress the spring. The springs thus have a tendency to push the shells to their central position no matter which way they have been turned from it, and the springs L^5 push the governor-weights L^2 to their central position. The governor in all its details is thus fitted to control the cut-off no matter which way the engine is running without making any change or giving any attention whatever at the time of reversal.

The reversing-slide N is made in one piece, and is the same width as the steam-chest, and has two slots or openings N′ cut therein to correspond to the cross-section of the port H. The slide is curved in form to fit the valve-seat, and it rests directly underneath the continuously-revolving valve F. The lugs N^2 are integral therewith and are for the purpose of closing the exhaust-port, being of the same width as the exhaust-port. Thus while the inlet-port H is open the exhaust-port H′ adjacent to it on the same side is closed, and the inlet-port on the opposite side is closed while the exhaust-port adjacent to it on the same side is open. The reversing-slide N is cast with an arm N^3. This arm has a cylindrical collar or shaft which passes out through a stuffing-box to the outside, where it may be moved by a lever or other contrivance. (Not shown.) This cylindrical collar or shaft may be cast integral with the arm N^3, and the reversing-slide N, the arm N^3, and it be all one piece.

The collar or shaft is denoted by N^4. It is bored out so that the shaft G may turn within it and have room for steam-packing within it and bearings also for the shaft G. A cap N^5 is screwed to the end. The steam-tight stuffing-boxes for the shafting of the steam-chest and also the main shaft E need not be described, as they are things of common occurrence. Thus the shaft G, to which the continuously-revolving valve F is keyed and with which it turns, passes at both ends through or into collars M and N^4, respectively. The collar M, as heretofore described, turns with the shaft G and moves relatively to it only when actuated by the governor to change the cut off; but the collar or hollow shaft N^4, being part of the reversing-slide, is stationary, except when being thrown to reverse the engine, and the shaft G turns with-

in it and has to be lubricated in its bearings therein by an oil-cup or other device.

This engine, as described herein, may answer a great variety of purposes. All the parts described would not be necessary in every case. For instance, if the engine were to be single-acting only the reversing-slide could be dispensed with and only one port-hole would be necessary in the valve-seat, and only one exhaust-port, which could be placed anywhere between $A^{\times}$ and $A^{\times'}$; but if the engine were to be used as on a driver-axle of a locomotive or on the shaft of a steamer it would necessarily have to be double-acting, as shown in the drawings. In this case the governor could be dispensed with and the cut-off controlled in the same manner as above by moving the shells F′ by a lever after the same manner as locomotives are handled generally. The lever could be made to act upon the collar M. In a locomotive or other engine requiring at times live steam for the whole stroke the slide N would have to be longer, that is to say, reach farther around the valve-seat, the reason for which will be explained presently. There would be no special difficulty in making the engine take live steam the whole distance from $A^{\times}$ to $A^{\times}$ or the whole stroke or cut off anywhere between these two points.

The valve F is surrounded by steam, and is therefore balanced, except where it covers the port-holes. There may be a drip-cock O placed in the bottom or lowest point of the steam-chamber. The engine can be run with the main shaft vertical or horizontal.

Some provision must be made for starting the engine in case it stopped with the valve covering the inlet-port H. After the engine has turned a portion of a stroke the steam is admitted in the usual way, and it can be so arranged that as more steam is turned on by the throttle the further movement of the lever or wheel controlling the throttle may also be made to close the pipe or passage through which the steam was admitted in starting.

Our engine can also be made double or compound by arranging the two pistons and two cylinders upon the same shaft, the two cylinders having one cover or side between them in common, so as to be close to each other. One purpose of this double arrangement is to equalize the strain placed upon the shaft E caused by the pressure of the steam acting upon only one quadrant of the piston at the time of admitting steam, and it will be understood that for this purpose, when making the engine double, the steam-chests and admission-ports of the two cylinders will be arranged at diametrically opposite points, so that by having both ports to open at the same time the two pressures act on their respective pistons toward each other, and thus hold the said shaft E in balance between forces acting at all times from diametrically opposite directions. Otherwise, as in the case of the single engine, there would necessarily be an unequal bearing of the shaft toward one side of its housing or bearing.

The engine can also be made triple expansion by arranging three cylinders side by side, each having pistons on the same shaft, the admission-ports to said cylinders being arranged one hundred and two degrees apart with respect to the main shaft of the engine, or the admission-port to the middle cylinder one hundred and eighty degrees, or diametrically opposite the admission-ports of the other two cylinders.

Having thus described our invention, what we claim as new is—

1. In a rotary engine, the combination with a case and piston, of a continuously-rotating valve, having rotary shells, adapted to regulate the passage of steam and a reversing-valve carrying lugs to close the exhaust-port, substantially as shown and described.

2. In a rotary engine, the combination with a case and piston, of the continuously-revolving valve having rotary shells and the reversing slide and valves carrying lugs to close the exhaust-port, all arranged substantially as shown and described.

3. In a rotary engine, the combination with the case and piston, of the rotary valve, the reversing-valve carrying lugs to close the exhaust-port and the governor mechanism, all arranged substantially as shown and described.

4. In a rotary engine, the combination with a case and piston, of the rotary valve, carrying rotary shells and reversing-valves carrying lugs adapted to close the exhaust-port, the governor operated by weights hanging toward the center and controlled by springs, all arranged substantially as shown and described.

5. In a rotary engine, the combination with a case and piston, of the rotary valve, and the reversing slide and valves carrying lugs to close the exhaust-port, having integral lugs to close the exhaust-ports, the continuously-rotating valve carrying the rotary shells, all arranged substantially as shown and described.

6. In a rotary engine, the combination with the case, of the rotary piston carrying sliding wings provided with packing-strips, the pins, sliding blocks and grooves therefor, the reversing-valve carrying lugs to close the exhaust-port, the continuously-rotating valve carrying rotary shells, the valve-revolving mechanism and governor devices, all arranged substantially as shown and described.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

BRADLEY W. FISK.
WALTER M. CAMP.

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