(No Model.) 2 Sheets—Sheet 1.

D. F. ALLEN.

ROTARY ENGINE.

No. 530,874. Patented Dec. 11, 1894.

Fig. 2.

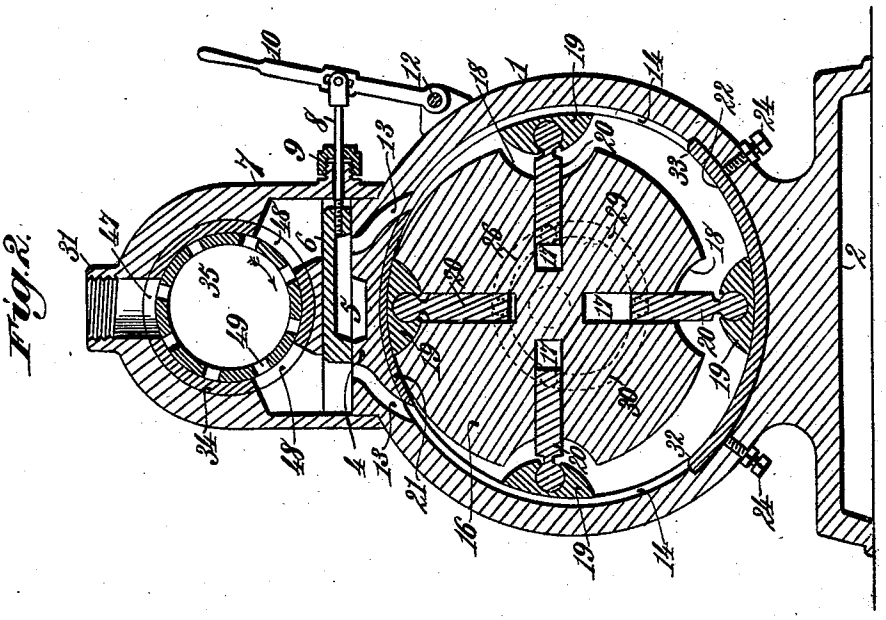
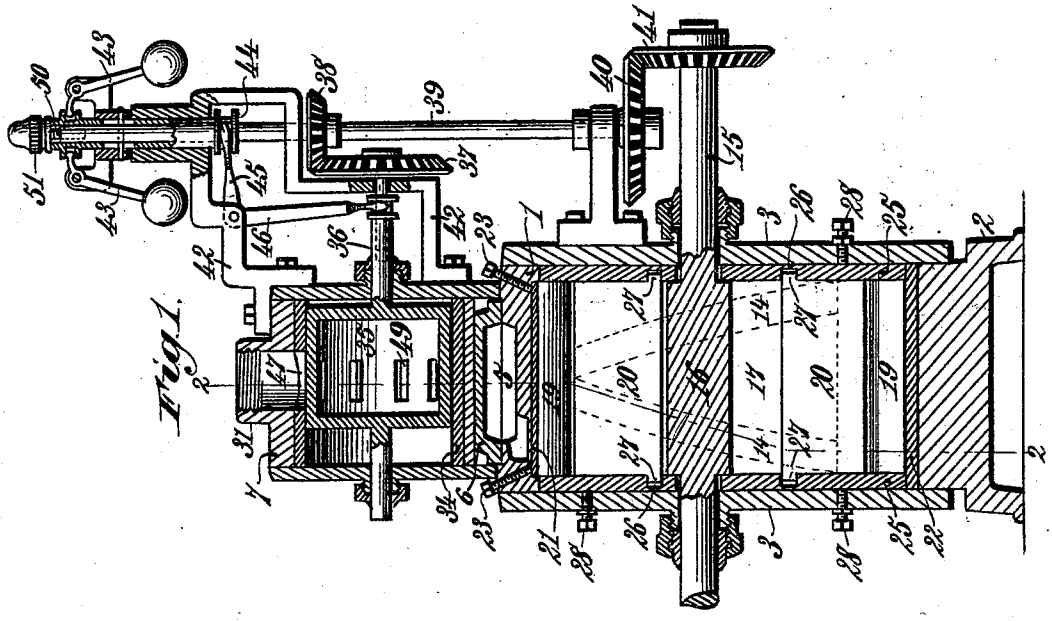


Fig. 1.



Witnesses.
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By James L. Norris.
Atty.

(No Model.)

2 Sheets—Sheet 2.

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Fig. 3.

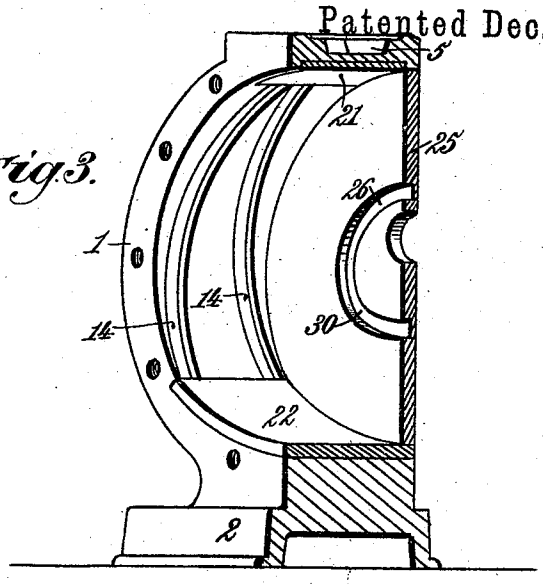


Fig. 4.

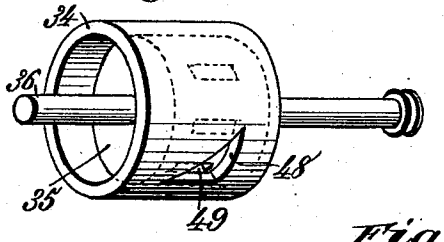


Fig. 5.

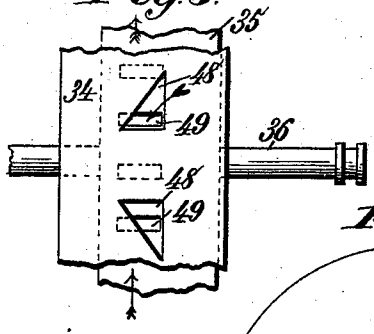


Fig. 6.

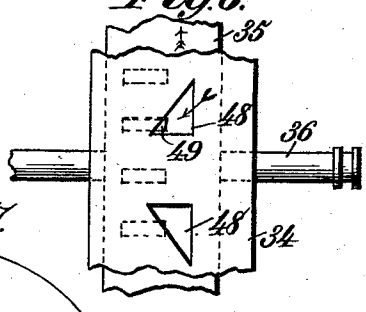
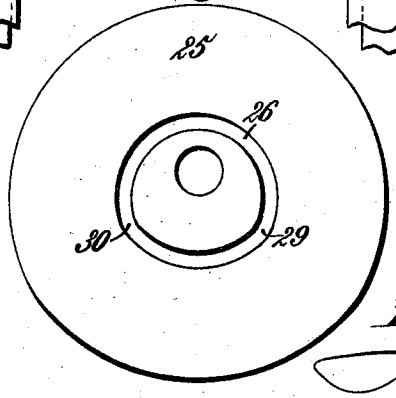


Fig. 7.



Witnesses.
Robert Emett,
A. F. Norris.

Inventor:
David F. Allen.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

DAVID F. ALLEN, OF RICHBURG, NEW YORK.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 530,874, dated December 11, 1894.

Application filed May 15, 1894. Serial No. 511,363. (No model.)

To all whom it may concern:

Be it known that I, DAVID F. ALLEN, a citizen of the United States, residing at Richburg, in the county of Allegany and State of New York, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to that type of steam engines wherein a piston-cylinder, having radially slidable pistons, rotates eccentrically in a stationary casing, and the pistons engage cam-races, so that they are moved outward and inward as the piston-cylinder rotates.

The present invention has for its objects to provide a new and improved engine of the character alluded to, which is simple in construction and economical in the use of steam or other working fluid; to provide such a construction that friction is materially reduced and the rotary-piston-cylinder is more evenly balanced and operates easily and more efficiently; to provide an accurate and perfect fit between the pistons and the internal surface of the stationary casing during the entire rotation of the piston-cylinder, whereby the pistons move free and easy as they rise and pass over and around the engine-shaft; to provide novel means whereby the radially movable pistons are held rigid on the piston-cylinder and run under steam pressure in a true circle below the axis of the engine-shaft; to provide a new and improved expansion cut-off valve which economically delivers the steam or other working fluid in jets or puffs to the piston, in such manner that as the pistons come into the path of the steam or working fluid, they are uniformly acted on, and the usual binding action is avoided, thereby largely reducing friction and securing a more easy and perfect working engine; and to provide novel means for automatically regulating the speed of the engine and adapting it to the conditions required or the work to be performed. These objects are accomplished in the manner and by the means hereinafter described and claimed, reference being made to the accompanying drawings, in which—

Figure 1 is a vertical central sectional view of my improved rotary engine. Fig. 2 is a similar view, taken on the line 2—2, Fig. 1. Fig. 3 is a detail broken perspective view, looking at the interior of the stationary casing. Fig. 4 is a detail perspective view of the cut-off-valve. Figs. 5 and 6 are diagrams, showing the rotatable valve-cylinder in two different positions; and Fig. 7 is a detail view of one of the plates or disks having the cam-races.

In order to enable those skilled in the art to make and use my invention, I will now describe the same in detail, referring to the drawings, wherein—

The numeral 1 indicates a stationary casing mounted upon or rising from a suitable bed-plate 2, and having a smooth internal cylindrical surface struck from two different centers, as will hereinafter appear.

The casing or cylinder is preferably made as a casting with open sides, to which the heads 3 are bolted or otherwise secured, and in the upper portion is inserted an abutment or backing 4 having an exhaust-port 5, and a flat valve face on which moves a starting, stopping, and reversing slide-valve 6, adapted to be shifted back and forth in the dome-shaped casing 7 which surmounts the stationary casing. The slide-valve is operated through the medium of suitable contrivances, such as a valve-rod 8 passing through a stuffing-box 9, and connected to a swinging hand-lever 10 pivotally mounted, as at 12, on the casing. The abutment or backing 4 is arranged within the casing to provide steam-ports 13, which, according to the position of the slide-valve, serve as an inlet and an outlet.

The smooth internal surface of the casing is provided with downwardly extending channels or passages 14, two of which lead from each port 13 and terminate at their lower end portions considerably below the axis of the engine-shaft 15 which carries the rotatable-piston-cylinder 16, the periphery of which is constructed with radial recesses 17 terminating at their outer end portions in concavities 18, which serve as seats for the piston-heads 19, pivotally mounted on the outer ends of the radially movable pistons 20. The pivotal connection between each piston-head and piston is in the form of a cylindrical portion on the outer end of the piston engaging a cylindrical groove in the piston-head, so that the latter accurately fits and accommodates

itself to the internal surface of the casing during the entire revolution of the piston cylinder.

The abutment or backing 4 is provided with an adjustable wear-plate 21, and the lower portion of the internal surface of the casing is provided with a similar wear-plate 22. These wear-plates can be slightly moved inward through the medium of set-screws 23 and 24 to compensate for wear, and preserve an accurate fit between the wear-plates and the jointed piston-heads if occasion demands.

The piston-cylinder may be formed integral with or otherwise mounted on the engine-shaft, and the latter is eccentrically journaled in the casing, so that when the piston cylinder rotates it is necessary for the piston to move inward and outward. To accomplish this, the heads 3 of the casing are provided at their inner sides with adjustable disks or circular plates 25, each of which is provided with a cam-recess 26 to receive projecting lugs 27 on the ends of the radially movable pistons. The disks or plates 25 can be slightly moved toward each other to compensate for wear through the medium of set-screws 28. The internal surface of the stationary casing, which includes the surface of the wear-plates 21 and 22, is struck from two centers, the upper portion from the center of the upper portion of the cam-recesses 26, and the lower portion from the center of the engine-shaft 15. The cam-races are each struck from two centers, so that the upper portion from 29 to 30 is concentric with the internal surface of the casing above the engine-shaft and around the same to the extremities of the wear-plate 22, while the lower portion of the cam-races are concentric with the center of the engine-shaft and with the internal surface of the wear-plate 22 as well as with the periphery of the piston-cylinder.

The diverging channels or passages 14 cause the steam to act uniformly along the convex or curved faces of the jointed piston-heads in moving from the upper to the lower ends of the channels or passages, for the purpose of causing the faces of the piston-heads to wear uniformly, and avoiding the formation of channels in or the cutting of the faces of the piston-heads, as would occur if a single steam-channel or passage ran straight from each port 13 in the internal surface of the casing. The two diverging channels or passages at the live steam side enable the steam to flow past the pistons, and to act on the piston below the center of the shaft, thus preventing the steam from acting solely on the upper side of one piston, which would interfere with its outward movement by binding it tight and creating great friction. By this operation each upper piston is relieved from steam pressure as the steam enters, and therefore friction is reduced since each piston works free and easy as it descends toward one end of the wear-plate 22. The live steam entering through one of the ports 13 passes down the diverging channels or passages 14 and acts upon the radially movable pistons. The cams constructed and arranged as described operate to gradually move the pistons outward and keep the piston-heads close against the smooth internal surface of the casing, and, during a portion of the revolution, while the pistons move from 32 to 33, or from one end of the wear-plate 22 to the opposite end, the pistons are held as rigid fixtures of the rotating piston-cylinder, and do not move radially, because the outer faces of the piston-heads are traveling concentric with the center of the engine-shaft, and with the center of the lower portion of the cam-recesses, and the steam or working fluid tends to support the cylinder and balance the same, whereby friction is reduced when the steam is expanded and the cylinder more easily rotates.

The piston-heads 19 are adapted to fit into the concavities or seats 18 in the rotatable piston-cylinder, and when the pistons commence to move outward, they do not require to overcome the full resistance of the fluid pressure, because the fluid can pass into the spaces behind the piston-heads, formed by the concavities 18, thus relieving the pistons of pressure in front of the faces of the jointed piston-heads, so that the pistons move easily in an outward direction, and the piston-cylinder more readily rotates.

The speed of the engine and its adaptation to the work to be performed is controlled or regulated by an automatic expansion cut-off valve composed of a hollow valve-cylinder 34 fixed stationary in the upper portion of the valve-casing 7, and a hollow valve-cylinder 35 rotatable within the stationary valve-cylinder, and fixed to a lengthwise movable shaft 36 arranged parallel with the engine-shaft, and having at one end a bevel-gear 37 engaging a smaller bevel-gear 38 on an upright shaft 39 which is geared at its lower end to the engine-shaft through the medium of miter or other gears 40 and 41.

The upright-shaft is journaled in a suitable bracket 42, and at its upper end is provided with a ball governor 43, the vertically movable sleeve 44 of which engages one arm 45 of a bell-crank lever pivoted to the bracket 42, and having its other arm 46 engaged with the shaft 36 of the rotary valve-cylinder 35, whereby the action of the governor serves to move the shaft 36 and valve-cylinder 35 lengthwise in one or the other direction.

The stationary valve-cylinder 34 is provided with an opening 47, communicating with the steam-inlet pipe connection 31, and the side of the stationary valve-cylinder, opposite the opening 47, is provided with two triangular ports 48.

The hollow rotatable valve-cylinder is provided with a plurality of rectangular ports 49, which, as the valve-cylinder rotates, successively communicate with one of the trian-

gular ports 48, through which live steam is delivered to the piston-cylinder for rotating the latter.

The engine-shaft, through the medium of the gearing above described, imparts rotary motion to the hollow-valve-cylinder 35, and the governor operates to move this valve-cylinder longitudinally, or in the direction of the length of the shaft 36 on which the valve-cylinder is mounted, so that when the rotary-valve-cylinder is moved lengthwise, more or less area of each port 49 is placed in communication with the triangular ports 48. By this means an automatic variable expansion cut-off is provided which is very simple, economical and efficient in operation. The rapid rotation of the governor balls serve to depress the sleeve 44, and thus operate the bell crank-lever 45, 46 to shift the shaft 36 and valve-cylinder 35 longitudinally. The extent of this movement can be varied by adjusting the sleeve 44 on the shaft 39, and to accomplish this I provide the upper end of the shaft 39 with a set-screw 50 having a head 51 which bears against the upper end of the sleeve 44, in such manner that by tightening the set-screw 50, the sleeve 44 will be lowered on the shaft 39, and loosening the set-screw the sleeve 44 will be permitted to rise, by which means it is possible to regulate the working power of the engine by varying the throw of the hollow rotatable valve-cylinder, and causing more or less steam to be supplied through the ports 49 and 48 to the piston-cylinder. The steam expands in the hollow valve-cylinder, and therefore the latter acts as a steam-chest, whereby an ample steam supply is constantly maintained to be directed in jets or puffs on the piston.

By admitting the steam in jets or puffs in the manner explained, and causing the steam to take the course specified I secure all the advantages of the expansive power of the steam; and, furthermore, by the construction of the cut-off valve and operating mechanism described and shown, as the velocity increases the cut-off valve is gradually closed until the steam is checked sufficiently to maintain the required speed.

The mechanism above described for varying the lengthwise throw of the rotatable valve-cylinder and its shaft will be found suitable for the purposes in hand, but I do not wish to be understood as confining myself to the exact construction described and shown, as other contrivances for varying the throw or adjusting the rotatable valve-cylinder can be employed without altering the spirit of my invention.

In the present example of my invention the piston-cylinder is provided with four radially movable pistons, and the cut-off valve-cylinder makes one revolution to two revolutions of the piston-cylinder, for which reason I provide the rotating valve-cylinder 35 with eight rectangular steam-ports 49, whereby one jet or puff of steam is delivered upon each piston. It will be obvious that the number of ports in the rotatable valve-cylinder can be varied to meet the conditions required, if the number of pistons on the piston-cylinder is varied. The live steam passing into the rotating and lengthwise reciprocating valve-cylinder enters one of the ports 13, and thence flows down the diverging channels or passages 14, so that the steam acts upon the upper side of each piston and passes to the opposite side thereof by way of the channels or passages 14, thereby relieving the piston of excessive downward pressure, and enabling it to easily and freely move outward. The concavities or recesses 18 contribute to this result, in that the steam can pass into the spaces formed by these concavities or recesses, and thus relieve the pistons from the necessity of overcoming the entire pressure of steam in front of the faces of the jointed piston-heads, which would be necessary were the concavities or recesses 18 not provided.

The construction and arrangement of the ports 49 and 48 are such that when the engine is at rest one of the ports 49 will deliver steam through a triangular port 48, and therefore the dead center is entirely avoided and the engine can be easily started at any time by simply operating the valve 6.

My invention provides a novel, simple, efficient, and economical rotary-engine which works easily and perfectly, and avoids, to a large extent, the friction incident to rotary engines of ordinary construction, while the improved automatic expansion cut-off secures excellent results and places the engine under perfect control as regards its speed and its adaptation to the work to be performed, or the conditions required.

Having thus described my invention, what I claim is—

1. The combination with a stationary casing having the adjustable wear-plate 22 and steam ports 13, exhaust 5 and channels or passages 14 diverging from the steam ports to the opposite ends of the wear-plate, of an engine shaft 15, a rotatable piston-cylinder 16 carried by said shaft and having radially slidable pistons 20 provided with lugs 27 and jointed piston-heads 19, cam-races engaging the lugs of the piston and having their upper portions concentric with the internal surface of the casing above and around the engine-shaft and their lower portions concentric with the said wear-plate, a reversing valve 6 governing the steam-ports and exhaust, and an expansion cut-off valve arranged above the reversing valve, substantially as and for the purposes described.

2. The combination with a stationary casing having steam ports, and a rotatable piston-cylinder having radially slidable pistons, of an automatic expansion cut-off-valve composed of a horizontal hollow valve-cylinder having approximately triangular ports and a horizontal interior hollow valve cylinder having a series of ports, means for rotating and

horizontally moving one of said hollow cylinders by the rotation of the piston-cylinder, devices for varying the horizontal throw of the rotating cylinder, and a reversing valve interposed between the automatic expansion cut-off-valve and the piston-cylinder, substantially as described.

3. The combination with a stationary casing having steam ports, and a rotatable piston-cylinder having radially slidable pistons, of an automatic expansion cut-off-valve composed of a horizontal valve cylinder having suitable ports and a horizontally rotating and reciprocating hollow valve cylinder having a series of ports, a governor-shaft geared to the shaft of the piston-cylinder and to the rotating and reciprocating cylinder, a governor mounted on the governor-shaft and connected with the rotating and reciprocating valve-cylinder for reciprocating the latter horizontally, and a reversing valve governing the ports of the stationary casing, substantially as described.

4. The combination with a stationary casing having steam ports, and a rotatable piston-cylinder having radially slidable pistons, of an automatic expansion cut-off-valve composed of a horizontal hollow valve-cylinder having suitable ports and a horizontally rotating and reciprocating hollow valve-cylinder having a series of ports, a governor-shaft geared to the shaft of the piston-cylinder and to the rotating and reciprocating valve-cylinder, a governor mounted on the governor-shaft and having a vertically movable sleeve, connections between the said sleeve and the rotating and reciprocating valve-cylinder for moving the latter horizontally by the action of the governor, and a reversing valve governing the ports of the stationary casing, substantially as described.

5. The combination with a stationary casing having steam-ports, and a rotatable piston-cylinder, having radially slidable pistons, of an expansion cut-off valve composed of a stationary hollow valve-cylinder provided with approximately triangular ports, and a rotating and lengthwise reciprocating hollow-valve-cylinder provided with a series of ports, the area of which is more or less placed in communication with the triangular ports by shifting the valve cylinder lengthwise, gearing between the engine-shaft and the rotatable valve-cylinder, a governor, and connections between the governor and the rotatable valve-cylinder for automatically shifting the latter lengthwise, substantially as described.

6. The combination with a stationary casing having steam-ports, and a rotatable piston-cylinder having radially slidable pistons, of an expansion cut-off valve composed of a stationary hollow valve-cylinder having approximately triangular ports, and a rotating and lengthwise moving hollow valve cylinder having a series of ports, the area of which is more or less placed in communication with the triangular ports by the lengthwise movements of the rotating valve cylinder, gearing between the engine-shaft and the rotating valve-cylinder, a governor, connections between the governor and the rotating and lengthwise moving valve-cylinder, and devices for varying the lengthwise throw of the rotating hollow cylinder, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

D. F. ALLEN.

Witnesses:
ALBERT H. NORRIS,
G. W. REA.