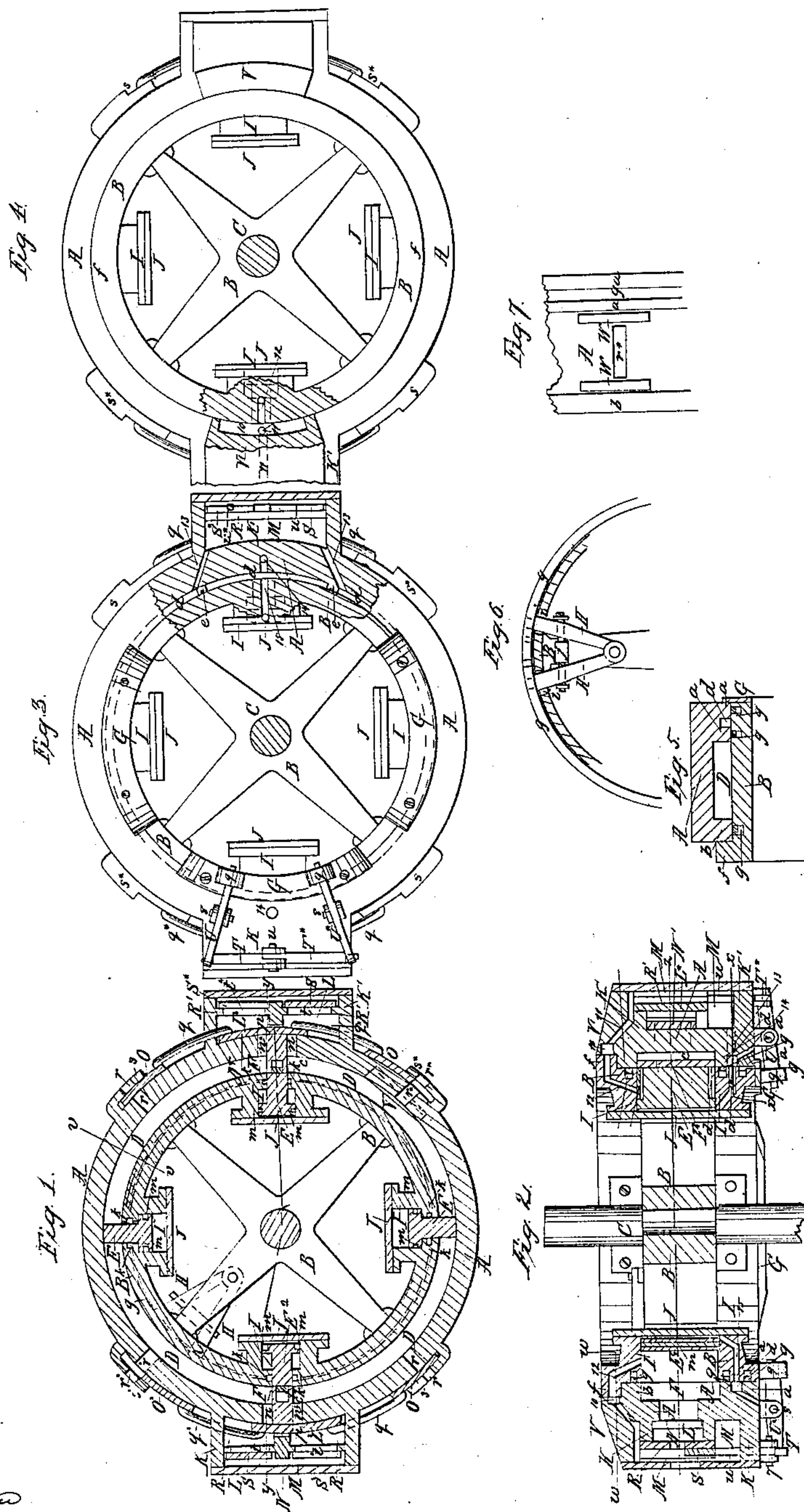


*S. T. Russell,*  
*Rotary Steam Engine.*

*No 29,408.*

*Patented July 31, 1860.*



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# UNITED STATES PATENT OFFICE.

SAMUEL T. RUSSELL, OF OTTAWA, ILLINOIS.

## ROTARY ENGINE.

Specification of Letters Patent No. 29,408, dated July 31, 1860.

*To all whom it may concern:*

Be it known that I, SAMUEL T. RUSSELL, of Ottawa, in the county of Lasalle and State of Illinois, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a section of a rotary engine with my improvements taken in a plane perpendicular to the axis of the shaft such plane being indicated by the line *z, z*, in Fig. 2. Fig. 2 is a section of the same taken parallel with the axis as indicated by the line *y, y*, Fig. 1. Fig. 3 is a side view of the same having parts of the cylinder and piston wheel cut out as indicated by the line *x, x*, in Fig. 2. Fig. 4 is an opposite side view of the same having parts of the cylinder and piston wheel cut out as indicated by the line *w, w*, in Fig. 2. Fig. 5 is a section of parts of the cylinder and steam wheel in the plane indicated by the line *v, v*, in Fig. 1. Fig. 6, exhibits the method of setting out the packing rings of the piston wheel. Fig. 7 is a view of a portion of the interior of the cylinder which will be hereinafter explained.

Similar letters and numbers of reference indicate corresponding parts in the several figures.

My invention consists in an improved construction and mode of applying the sliding pistons of a rotary engine and an improved system of steam and exhaust passages for effecting the movements of the pistons toward and from the axis of rotation of the engine. It also consists in certain improved means of operating a system of cut-off valves for the purpose of using the steam expansively in a rotary engine. And it further consists in an improved system of reversing valves.

To enable others skilled in the art to make and use my invention I will proceed to describe its construction and operation.

A, represents the stationary cylinder of the engine which is intended to be bolted securely to a suitable framing or foundation, said cylinder consisting simply of a cylindrical band of cast iron or other metal having two internally projecting rims or flanges *a*, and *b*, one on each side, said flanges being of equal width, but *a*, being

thicker than *b*. To the inner peripheries of these flanges the outer cylindrical periphery of the rotating piston wheel B, is fitted and the said cylinder and wheel combine to form the annular steam way D, in which the steam acts upon the pistons E, E', E<sup>2</sup>, E<sup>3</sup>, which are carried by the rotating steam wheel, the form of the transverse section of such steam way being quadrangular as shown in Fig. 5. The cavity formed in the cylinder between its two flanges *a*, and *b*, is fitted at opposite points with the two stationary abutments F, F', the faces of which are fitted with packing *c, c*, to keep them steam tight with the outer periphery of the piston wheel. In the thicker flange *a*, of the cylinder there is a groove *d*, which extends all round with the exception of its having a transverse stop or partition *e*, at a short distance from each side of each abutment as shown in Fig. 3, said stops being packed to fit the piston wheel which covering the inside of the groove *d*, makes the latter constitute a steam way the object of which will be presently described.

The piston wheel which is secured to a central shaft C, which is to be arranged to rotate in fixed bearings has an outwardly projecting flange *f*, at one side, such flange fitting close up to the outer face of the thinner flange *b*, of the stationary cylinder. When the wheel is placed in the cylinder A, with its flange *f*, against the flange *b*, the other side of the wheel is flush with the corresponding side of the cylinder A, and the wheel is secured in the cylinder in this condition by four plates G, G, which are bolted to the side of the wheel and lap over the flange *a*, of the cylinder. The piston wheel B, has turned in its periphery three grooves to receive packing rings *g, g, g*, of brass or other metal, and rings *h, h, h*, of vulcanized india-rubber applied within the said rings *g, g, g*, to keep them out in contact with the cylinder and to prevent any steam passing behind them. One of the packing rings *g, g, g*, is applied opposite the flange *b*, and two others opposite the flange *a*, of the cylinder the two latter being one on each side of the groove *d*. I have shown in Fig. 1, and also in Fig. 6, applied to one of the packing rings *g, g*, a contrivance for setting it out against the cylinder consisting of two levers H, H, jointed together at one end of each, and having the other ends passing through slots



$i, i$ , see Fig. 6, in the rim of the wheel and connected with the ring  $g$ , at points near where it is cut in such a manner that the ends lap each other side by side. Between  
5 these levers  $H, H$ , there is a screw  $j$ , applied in such a manner as to force them apart and cause the ring to be expanded.

To the interior of the rim of the wheel  $B$ , there are cast at equal distances apart four  
10 piston boxes  $I, I', I^2, I^3$ , which receive the flanged inner ends of the four pistons  $E, E', E^2, E^3$ , which are fitted to work radially to the wheel through slots in the rim thereof,  
15 said slots being of a length equal to the width of the steam way  $D$ , and the said pistons being fitted to work in the said steam way. The sides of the slots are fitted with packing  $k, k$ , composed of strips of brass having strips of india-rubber applied  
20 behind them and the ends of the pistons are fitted with similar packing  $l, l$ , to keep the pistons steam tight in the slots. The flanged inner ends of the pistons are fitted all round with similar packing  $m, m$ , to  
25 keep them steam tight within the boxes  $I, I', I^2, I^3$ , which are of quadrangular form. The pistons are inserted in their places from the backs of the boxes which after the pistons have been inserted are closed by steam  
30 tight bonnets  $J, J, J, J$ .

Opposite to the two abutments, there are on the exterior of the cylinder two steam chests  $K, K'$ , which are cast with the cylinder said steam chests containing each two  
35 inner chambers  $L, L^*$ , and an outer chamber  $M$ , to the latter of which the steam pipe is connected. From each inner chamber a steam port  $n$ , or  $n^*$ , leads to the cylinder, one close to one side of the abutment and one  
40 close to the other side thereof, one for admitting steam to the cylinder to drive the pistons in one direction and the other for admitting steam thereto to drive them in the opposite direction, said ports terminating in  
45 a valve seat which is continued through both chambers and which is fitted with a slide valve  $N$ , or  $N'$ , which works through an opening in the portion  $o$ , which separates the two chambers  $L, L^*$ , said valve having a  
50 single port  $p$ , of a size and form corresponding with the ports  $n, n^*$ . The said valve seat and valve are of arc form concentric with the cylinder, and by sliding the valve on the seat the port  $p$  may be brought into  
55 either of the two chambers and opposite to the port  $n$ , or  $n^*$ , to admit steam to the cylinder on one or other side of the abutment, or may be brought to a position between the two ports so as to shut off the steam from  
60 the cylinder altogether. The valves  $N, N'$ , are each connected by two rods  $q, q^*$ , passing through stuffing boxes in the top and bottom of the steam chest with two valves  
65  $O, O^*$ , of similar arc form fitted to seats provided for them on the exterior of the

cylinder at some distance from their respective abutments each of said seats containing one of two exhaust ports  $r, r^*$ , one for exhausting the steam from the cylinder one  
70 from one side and one from the other side of the abutment, the said valves sliding into boxes  $s, s^*$ , cast on the outside of the cylinder the said boxes having ports  $r, r^*$ , corresponding with and opposite to those  $r, r^*$ , of  
75 the cylinder. The faces of these valves may be grooved and fitted with packing strips of metal having strips of india rubber behind them to keep them steam tight. The ports  $r, r^*$ , and valves  $O, O^*$ , are so arranged that  
80 when the port  $p$ , of the valve  $N$ , or  $N'$ , is midway between its respective ports  $n, n^*$ , the valves  $O, O^*$ , leave both ports  $r, r^*$ , partly uncovered but that when the port  $p$ , is opposite to the port  $n$ , the port  $r$ , is entirely uncovered and  $r^*$ , entirely covered,  
85 and that when the port  $p$ , is opposite to the port  $n^*$ , the port  $r^*$ , is entirely uncovered, and  $r$ , entirely covered as shown in Fig. 1. The only duty of the valves  $N, N', O, O^*$ , is to effect the reversal of the engine and for this purpose their rods  $q, q^*$ ,  
90 may be connected by a suitable system of levers so that all may be operated properly together.

In the plates  $R, R'$ , which cover the valve  
95 chambers  $L, L^*$ , of the two steam chests  $K, K'$ , there are ports  $t, t^*$ , one forming a communication between each of the inner chambers  $L, L^*$ , and its respective chamber  $M$ , and each port  $t$ , is furnished with a slide  
100 valve  $S$ , and each port  $t^*$ , with a slide valve  $S^*$ , said valves being fitted to flat slats on the plates  $R, R'$ , within the outer chambers  $M, M$ . These valves are furnished with stems  $u, u^*$ , which pass through stuffing  
105 boxes on one side of the steam chest. The steam acting on a portion of the opposite end of the valve equal to the area of the transverse section of the stem always exerts a tendency to move the said valves in a di-  
110 rection to push their stems  $u, u^*$ , outward and open the ports  $t, t^*$ . The outer ends of the stems  $u, u^*$ , bear against levers  $T, T^*$ , of which the two belonging to the same steam chest work on a single fulcrum  $7$ , secured to  
115 the side of the chest as shown in Fig. 3. The two levers  $T, T^*$ , belonging to each steam chest are each connected with one end of one of two levers  $U, U^*$ , which work on separate fulcra  $8, 8$ , attached to the side of  
120 the steam chest. These levers  $U, U^*$ , are furnished at their other ends with anti-friction rollers  $9, 9$ , upon which the rounded or beveled cam like ends of the plates  $G, G$ , before described as attached to the piston  
125 wheel  $B$ , act in such a manner as to press them outward from the cylinder and so cause the first named ends of the said levers to move the levers  $T, T^*$ , toward the side of the steam chest and force in the valve stems 133



and so move the valves over the ports; the arrangement of the ends of the plates and the rollers being such that the plates act upon the rollers at the proper intervals of time to cut off the steam according to the degree of expansion it is desired to use and that the plates pass the rollers and allow the steam to open the valves at the proper intervals to effect the induction of steam to the steam way D, between the abutments and the pistons.

On that side of the cylinder A, against which the flange *f*, of the steam wheel fits there are cast two hollow projections V, V', (see Figs. 2 and 4) which extend from the side of the steam chest far enough over the cylinder to fit to the outer periphery of the said flange. The cavities 10, 10, in these projections are open on the side next the flange *f*, as shown in the above mentioned figures and each is kept constantly filled with steam from the outer chamber M, of the adjacent steam chest by a small passage 11, communicating with said chamber which is always full of steam when the engine is in operation. Suitable packing should be applied around the mouths of the cavities 10, 10, to keep them steam tight with the flange *f*. In the outer periphery of the flange *f*, there are at equal distances apart four small openings 12, 12, each leading into one of the piston boxes and entering it close to the rim of the piston wheel B. These openings when in the mouth of one of the cavities 10, 10, admit steam to the piston boxes to act upon the flanges of the pistons to force the pistons within the periphery of the cylinder, and when the said openings are not opposite the projections V, V', form communication between the piston boxes and the atmosphere.

From the outer chamber M, of each steam chest, two passages 13, 13, shown in section in Fig. 3, and in dotted outline in Fig. 2, lead to the groove *d*, of the cylinder entering the said groove just beyond the stops *e*, *e*, and keeping the whole of the said groove except the portion, nearest each steam chest, embraced between the stops *e*, *e*, always full of live steam. The above mentioned portion between the stops *e*, *e*, are always in communication with the atmosphere by means of the two openings 14, 14, in the side of the cylinder. In that part of the periphery of the piston wheel which rotates opposite to the groove *d*, there are at equal distances apart, four openings 15, 15, see Figs. 2, and 3, which communicate with the piston boxes close to their bonnets J, J, for the purpose of admitting steam thereinto to act upon the broad surface of the flanged ends of the pistons for the purpose of forcing them out against the inner periphery of the cylinder and holding them close in contact therewith while the steam

is also acting upon them within the channel D, to produce the revolution of the wheel and shaft, steam being admitted to the said openings 15, 15, except during the time they pass between the two stops *e*, *e*, near either abutment, when the said openings are in communication with the atmosphere.

A short distance below the abutment F', there is shown in Fig. 1, a piece of brass or composition metal W, which is fitted into a mortise in the interior of the cylinder, with a piece of vulcanized india rubber 16, at the back of it to force it toward the center of the cylinder. Fig. 7 shows two of such pieces W, W, applied side by side. I propose to apply two such pieces of metal backed with vulcanized india rubber, at a short distance above and below each abutment, the india rubber being so applied that when nothing presses upon the pieces W, W, the latter will project slightly into the cylinder but that they will yield to the pressure of the pistons and allow the latter to pass them in their revolution. The said pieces W, W, are intended to serve as cushions to break the concussion of the pistons and prevent injury to the cylinder when the pistons after passing the abutments are forced out against the cylinder by the action of the steam admitted to the piston boxes through the openings 15, 15.

The construction of the several parts of the engine having now been described I will proceed to describe its operation. I will first suppose the valves N', N', O, O, O\*, O\*, to be severally brought to such positions that the ports *n*, *n*, *n*\*, *n*\*, of the two steam chests K, K', are all shut and the ports *r*, *r*, *r*\*, *r*\*, all partly open, and suppose the wheel to be in such a position that two of the pistons E, E<sup>2</sup>, are opposite to the abutments as shown in Fig. 1, steam will then pass from the outer or as they may be called the reception chambers M, M, of both steam chests through the passages 11, and cavities 10, of the cylinder and through the passages 13, 13, of the piston boxes I, I<sup>2</sup>, to act upon the flanges of the pistons E, E<sup>2</sup>, to force and hold the latter within the periphery of the wheel B, and at the same time steam will pass from the chambers M, M, through the passages 13, 13, into the groove *d*, of the cylinder and through the passages 15, 15, of the piston boxes I', I<sup>3</sup>, to act upon the inner ends of the pistons to force and hold the latter out in contact with the inner periphery of the cylinder. The valves N, N', and O, O, O\*, O\*, may then be shifted in either direction according to the direction in which the engine is desired to rotate but I will suppose them to be brought to a position to open the ports *n*\*, *n*\*, and *r*\*, *r*\*, when the steam will be admitted between the abutments and the pistons E', E<sup>3</sup>, and act upon those pistons to drive the wheel B,



and its shaft in the direction of the arrow shown upon the wheel in Fig. 1. Soon after the pistons E, E<sup>2</sup>, pass the abutments the passages 12, 12, in the wheel will pass the projections V, V', and come into communication with the atmosphere, and immediately afterward the passages 15, 15, of the same piston boxes will pass the stops e, e, of the groove d, and receive steam from the said groove to act upon the said pistons to force them out against the cylinder and the steam in the steam way D, will then commence to act upon these pistons. By the time these pistons commence to be acted upon, the pistons E', E<sup>3</sup>, will pass the open exhaust ports r\*, r\*, and soon afterward the passages 15, 15, of the piston boxes I', I<sup>3</sup>, will pass the stops e, e, of the groove d, and be brought into communication with the atmosphere by means of the passages 14, 14, and the passages 12, 12, of the said boxes will arrive opposite to the cavities 10, 10, and admit steam into the boxes outside of the flanges of the pistons E', E<sup>3</sup>, to force the said pistons into the wheel to allow them to pass the abutments. In this way the steam acts always upon two opposite pistons and the two pair of opposite pistons are alternately forced out from their boxes to be operated upon by the steam to produce the revolution of the wheel and drawn in again to enable them to pass the abutments.

To reverse the engine it is only necessary to shift the valves N, N', O, O, O\*, O\*, to bring the ports p, p, opposite to those n, n, and to open the ports O, O, and close O\*, O\*.

I have not yet described the cut off. This is as follows: At the same time that two of the pistons arrive in contact with the inner periphery of the cylinder. The cam like ends of two of the plates G, G, commence to leave the rollers g, g, of the levers U, or U\*, according to the direction in which the engine is rotating and to permit the cut off valve S, S, or S\*, S\*, to be opened by the steam to admit steam to those chambers L, L, or L\*, L\*, which have their ports open to the ports p, p, of the valves N, N'. The cut-off valves remain open till the cam like ends of the other two plates G, G, come into operation on the rollers g, g, and close them and they remain closed while the plates are passing. Both sets of cut off valves are operated upon by the plates G, G, but only those belonging to the two induction chambers which are opened to the cylinder produce any effect; and the several sets of valve levers are so arranged that the valves are respectively operated at the proper time according to the direction of revolution of the piston wheel. The time of cutting off is varied by altering the lengths of the plates G, G, and changing the positions of the le-

vers U, U, or U\*, U\*; being made to take place sooner after the admission, to give more expansion, by shortening the plates and bringing the levers nearer to each other, and vice versa.

When the engine is only desired to run one way, the ports n, n, and r, r, or n\*, n\*, and r\*, r\* on one side of the abutments and the valves N, N, O, O, and O\*, O\*, may be dispensed with, and only a single cut off valve in each steam chest will be required thus dispensing with the necessity of one set of levers T, T, U, U, or T\*, T\*, U\*, U\*.

In an engine intended to run at a very high velocity, there might be some danger with four pistons and two abutments, of the pistons striking the abutments. I therefore propose whenever it may be desirable to construct the engine with only two pistons and a single abutment in which case only one steam chest will be necessary. In an engine thus constructed more room will be allowed for the inward and outward movements of the pistons.

I have described throughout this specification the use of steam as the motive agent of the engine, but it may be driven by any gaseous or fluid body and I consider with especial advantage by water. When used as a water pressure engine of course no cut off will be necessary.

I do not claim effecting the movements of the sliding pistons into and from the cylinder or from and toward the axis of rotation of a rotary engine by the action of the steam. But

What I claim as my invention and desire to secure by Letters Patent is—

1. The combination of the flanged pistons the piston boxes the cavities 10, and d, in the cylinder and the passages 11, 12, 13, 14, 15, in the cylinder and wheel the whole operating substantially as and for the purpose herein specified.

2. The plates G, G, constructed and applied to the steam wheel substantially as herein described and serving the double purpose of securing the same in the cylinder and of cams to operate the cut off valves.

3. The system of levers T, U, T\*, U\*, applied in combination with the plates G, G, and with the cut off valves substantially as herein described to effect the operation of the said valves.

4. In connection with the two sets of induction and eduction ports in the cylinder I claim the connected reversing valves N, N', O, O, O\*, O\*, constructed applied and operating as herein described.

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