2 Sheets-Sheet 1.

J. B. Root,

Rotary Steam Engine.

No. 47,459. Patented Apr. 25, 1865.

Fig: 4.

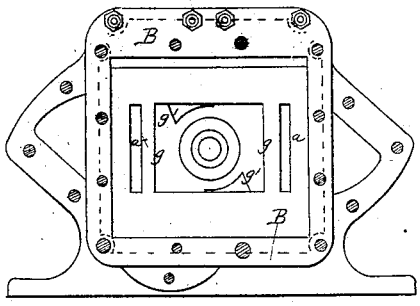


Fig: 1.

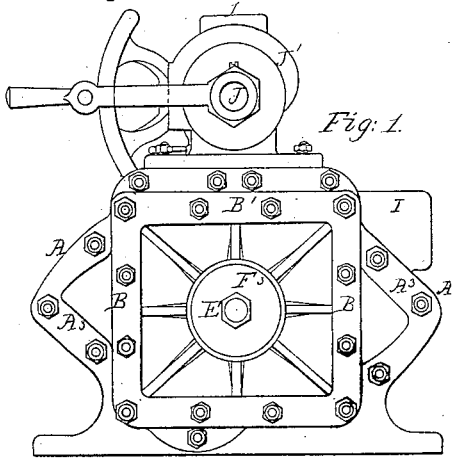


Fig: 4.

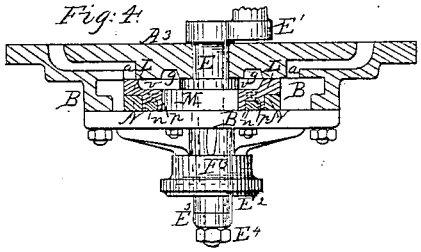


Fig: 3.

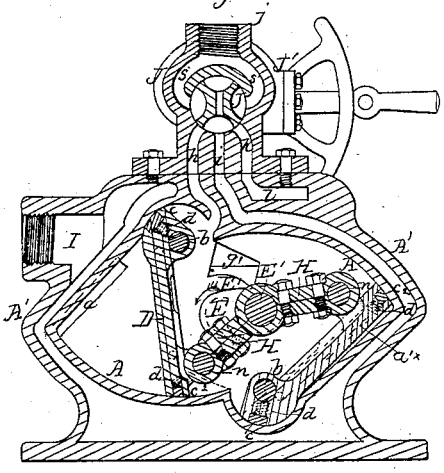
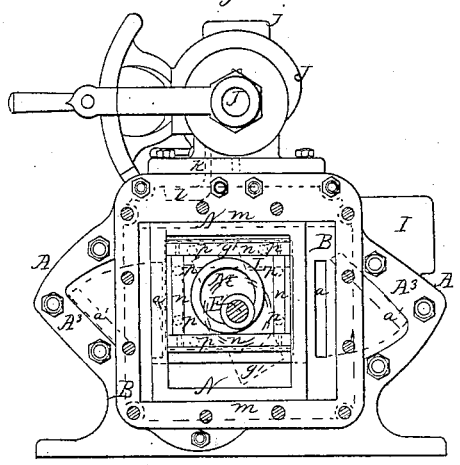


Fig: 2.



Witnesses.

Geo. W. Reed

Inventor.

John B. Root

per Brown, Coombs & Co.

Attorneys

2 Sheets-Sheet 2.

J. B. Root,

Rotary Steam Engine.

No. 47,459. Patented Apr. 25, 1865.

Fig: 8.

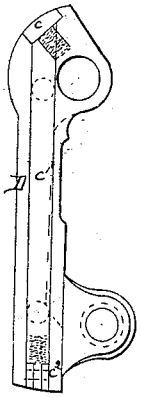


Fig: 7.

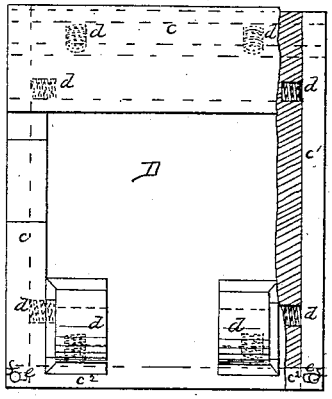


Fig: 6.

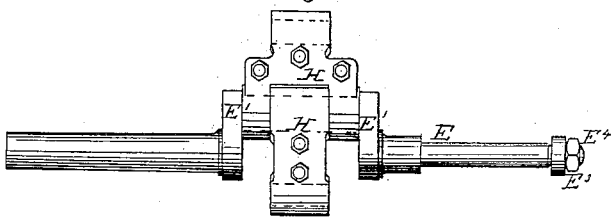
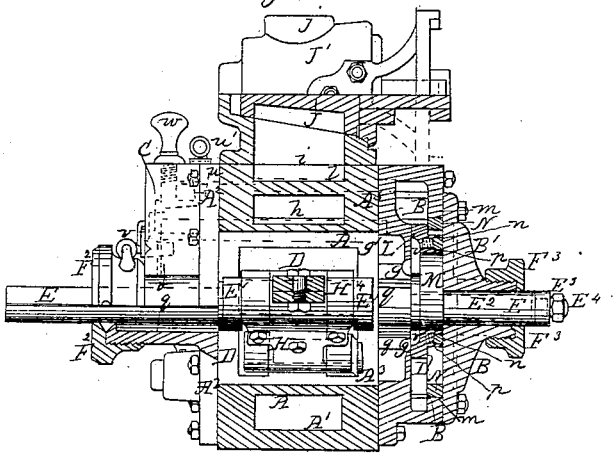


Fig: 5.



Witnesses.

H. Ohren

Geo. W. Reed

Inventor.

John B. Root

per Brown Combs & Co

Attys

UNITED STATES PATENT OFFICE.

JOHN B. ROOT, OF NEW YORK, N. Y.

IMPROVEMENT IN VIBRATING-PISTON ENGINES.

Specification forming part of Letters Patent No. **47,459**, dated April 25, 1865.

To all whom it may concern:

Be it known that I, JOHN B. ROOT, of the city, county, and State of New York, have invented a new and Improved Engine, to be used as a motor or for other purposes; 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 side view of the engine complete. Fig. 2 is a similar view with the cover of the valve-chest removed. Fig. 3 is a vertical section of the same, taken in a plane parallel with Figs. 1 and 2, but seen from the opposite side. Fig. 4 is a horizontal section of one of the cylinder-heads and its attached valve-chest, showing also a section of the valve, and exhibiting the valve-operating devices. Fig. 4* is an inside view of the valve-chest, the valve being removed to show the arrangement of ports. Fig. 5 is a central vertical section of the engine parallel with the axis of the crank-shaft. Fig. 6 is a plan view of the crank and the piston-connections. Fig. 7 is an inner face view of one of the pistons, on a larger scale than the before mentioned figures, a part near one edge being broken away to show the packing. Fig. 8 is an edge view of the same piston. Fig. 9 is a view, of similar character to Fig. 3, of a modification of the engine. Fig. 10 is a view, of similar character to Fig. 5, of the modification shown in Fig. 9. Fig. 11 is a back view, corresponding with Figs. 9 and 10. Fig. 12 is a diagram illustrating the relative movements of the pistons and crank.

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

This engine has a cylinder, the sectional form of which, taken in a plane parallel with the planes of motion of the pistons, resembles two united quadrants or sectors, arranged in reversed positions, and in this cylinder two oscillating pistons are employed, each working in one of the quadrant or sector shaped portions of the cylinder. These pistons are so connected with one crank on the main shaft of the engine that by a properly-regulated induction and eduction of steam or other fluid at a suitable pressure to and from opposite ends of the cylinder the steam may act on each piston during more than half a revolution of the crank-shaft, and so, although each piston is only single-acting, the two combined will act continuously upon the crank, without any dead-points. The main shaft may extend directly through the cylinder, and the crank be inside of the same and between the two pistons, and the pistons be connected directly with the crank by means of suitable rods or links; or the crank may be outside of the cylinder and connected with arms attached to rock-shafts on which the pistons are secured.

My invention consists in the cylinder and system of pistons and connections above described, and in a novel system of packing the pistons.

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 cylinder, the vertical section of which, in one direction, is of a form resembling that of two united sectors arranged in reversed positions, as shown in Figs. 3 and 9, and that in a perpendicular direction is of the form of a parallelogram, as shown in Figs. 5 and 10. This cylinder is made with a steam-jacket, A', and has two detachable heads, A^2 and A^3. The head A^3 has cast with it the valve-chest B, and the head A^2 has cast with it a grease-chamber, C, Fig. 5, to contain the grease for lubricating the cylinder and pistons, the crank-shaft bearings, and the crank and its connections also, when the latter are within the cylinder.

D D* are the pistons, fitted one to each sector-shaped half of the cylinder. In the engine represented in Figs. 1 to 8, inclusive, in which the crank and its connections are inside of the cylinder, these pistons are arranged to oscillate each upon one of two fixed shafts, *b b**, which extend through the cylinder and are supported in the two heads A^2 and A^3, the said axles being concentric with their respective sector-shaped portions of the cylinder, the reversed positions of which cause one of said shafts to be near the bottom and the other near the top of the cylinder, as shown in Fig. 3. These pistons, which occupy reversed positions, have their edges grooved and fitted with straight metal packing-strips *c c' c²*, which are pressed out against the top, bottom, and heads of the cylinder, respectively, by means of spiral springs *d d*, placed within cav-

ities provided in the backs of the grooves, as shown in Figs. 3 and 7. The side strips, c', are fitted to the end strip, c^2, with mortise-and-tenon joints, and the mortises and tenons are connected by transverse pins f, inserted tightly into holes in the tenons and entering slots e in the sides of the mortises, as shown in Fig. 7, so that while the side strips are free to be pressed outward by their springs independently of the end strips, to compensate for their own wear and that of the interiors of the cylinder-heads, the said end strips, in being forced outward against the arcs of the cylinder, will draw the side strips longitudinally along with them, and so preserve tight joints between the piston and cylinder at their corners.

E is the main shaft of the engine, extending right through the cylinder, with its axis in the imaginary plane which divides the two sector-shaped portions thereof and equidistant from the two shafts b b^*. This shaft works in bearings q q in the cylinder-heads A^2 A^3. The bearing q of the head A^2 is capped outside with a stuffing-box, F^2, fitting to the shaft, to prevent leakage of steam. On the other side of the cylinder the shaft extends through the valve-chest B, and is surrounded by a stuffing-box, F^3, which is provided on or in the bonnet-plate B′ of the valve chest.

In Figs. 3 and 5 the crank E′ is represented in the cylinder, and connected with the two pistons D D* by means of rods H H*, the rod H being forked, as shown in Figs. 5 and 6, in order that it may connect with the wrist of the crank on opposite sides of H. The rods H H* are connected with the pistons by means of pin-joints n n^*. The valve L, employed in the chest B to effect the induction and eduction of steam to and from the cylinder, is substantially like an ordinary three port slide-valve, and works over three ports, a a^* g. The arrangement of these ports is best shown in Fig. 4*. The steam-ports a a^* communicate by passages a' and a'^* with opposite ends of the cylinder, and the exhaust-port g communicates by passages g' g' with the central portion of the cylinder between the two pistons D D*. The outlet from this portion of the cylinder is by a passage, h, Fig. 3, which leads to a second passage, i, communicating with the steam-jacket A′, which is in constant communication with the exhaust-pipe I. On the top of the cylinder is a four-way valve, J, Fig. 3, with the casing of which the steam-pipe is connected at j. This valve is of a kind commonly used as a reversing and stop valve, for oscillating, rotary, and other engines. The steam passes through the said valve to the valve-chest B by passages k l, Figs. 2, 3, 5, and by the movement of the slide-valve L is admited from the valve-chest to the ends of the cylinder through the ports a a^* and passages a' a'^*, and exhausted therefrom through the said passages and ports, and under the valve. This valve L might be worked like an ordinary slide-valve, by any suitable mechanical contrivance; but the simplest mode of operating it is by an eccentric, M, so arranged upon the shaft E as to work in a circular hole in the valve itself. This eccentric gives the valve a circular, though not a rotary, movement, its revolution being prevented by its being fitted to a quadrangular yoke, N, which is fitted between guides m m, at the top and bottom of the steam-chest. This yoke is only permitted by the guides to move in the direction in which the valve is required to move for covering and uncovering the ports—viz., horizontal—and the valve, while it moves with the yoke, at the same time moves vertically therein, every portion of it describing a circle the radius of which is equal to the throw of the eccentric. This mode of working the slide-valve is the subject-matter of Letters Patent No. 42,878, dated May 24, 1864.

The eccentric M is not secured directly upon the shaft E, but upon a sleeve, E^2, which is fitted tightly to the said shaft and secured firmly thereon by a collar, E^3, and a nut, E^4. This allows the eccentric to be easily and conveniently "set."

The back of the slide valve is fitted with metallic packing-strips n n, which are pressed outward against the inner face of the bonnet B′ of the valve-chest B, by means of suitable spiral springs, p p, applied within the valve inside of the said strips, and which are thereby caused to protect the greater portion of the back of the valve from the pressure of steam, and prevent the steam from blowing through the valve around the eccentric.

Fig. 3 represents the valve J in position to shut off the steam from the engine. By turning it far enough in the proper direction to admit steam from the upper passage, S′, in the casing J′ to the passage k the steam is allowed to pass freely to the valve-chest B, and thence through the ports a a^*, through which it enters the cylinder A at opposite ends, to act upon the outer faces of the pistons D D* and produce the oscillation of the said pistons, by which they are made to give a rotary motion to the crank E′ and shaft E, in the direction of the arrows shown in Figs. 2 and 3, the eccentric producing the necessary movements of the valve L to effect the induction and eduction of steam to and from the ports a a^* at the proper stages of the said movements of the pistons.

The engine represented in Figs. 9, 10, and 11 differs from that represented in Figs. 1 to 8 in no essential point but in having the crank E′ and its connections with the pistons outside of the cylinder. In order to effect this system of connection, the pistons must be secured firmly to the shafts b b^*, which must be rock-shafts, and which must be extended a suitable distance through stuffing-boxes in one of the cylinder-heads to enable them to have secured to them two arms, P P*, which are connected with the crank E by rods H H*, substantially like those hereinbefore described for connecting the pistons directly with the crank. Out-

side bearings are in this case provided for the shaft E and rock-shafts *b b** in a standard, Q. The connections of the pistons or of their rock-shafts with the cranks E′ are in both cases so arranged and their length so proportioned that each piston may be acted upon by the steam, and transmit its effect to the crank during more than half a revolution of the latter. This is illustrated by the diagram, Fig. 12, which represents the crank and connections in five different positions, in which the lines representing the pistons or their arms P P* are marked, respectively, D′ D^2 D^3 D^4 D^5 and D′* D^{2*} D^{3*} D^{4*} D^{5*}, and the dot representing the crank-wrist is marked 1 2 3 4 5, the numbers corresponding with those on the piston-lines.

When the left-hand piston, D*, has arrived at the outer end of its stroke, as shown by the unbroken black lines numbered D′* in Fig. 12, the right-hand piston, upon which the steam is acting, and which is moving inward toward the crank-shaft, has arrived in the position of the similar line marked D′. The steam now commences to act upon the left-hand piston, D*, and acts upon both pistons until the right hand one, D, has arrived at the inner end of its stroke, as indicated by the dotted black line D^2, and the steam ceases to act upon it, the left-hand piston D* having in the meantime arrived in the position of the dotted black line D^{2*}. The steam now acts only upon the left-hand piston, D*, while the right-hand piston makes the whole of its outward stroke, and until it arrives in the position indicated by the unbroken red line D^3, the left-hand piston in the meantime moving only to the position indicated by the unbroken red line D^{3*}. The steam now commences to act upon the right-hand piston, D, and acts upon both until the left one, D*, has completed its inward stroke and arrived in the position indicated by red dotted outline, the right-hand one in the meantime moving to the position indicated by the red dotted line D^4. The steam now acts only upon the right-hand piston, D, while the left-hand piston, D*, makes the whole of its outward stroke, and arrives in the position indicated by the unbroken black line D′*, the right-hand piston in the meantime arriving in the position indicated by the unbroken black line D′. The pistons have now arrived in the first-described positions, and the crank has made a complete revolution. The crank moves in the direction of the arrow shown in Fig. 12; and it will be understood by reference to the positions 1 2 3 4 of the crank in the diagram that while the steam acts upon the left-hand piston, D*, the crank moves from the position 1 to the position 4, and while the steam acts upon the right-hand piston, D, the crank moves from the position 3 to the position 2, thus making about three-fourths of a revolution while the steam is in operation upon either piston, and that while the crank moves from the position marked 1 to the position marked 2, and from the position marked 3 to that marked 4, the steam is acting upon both pistons, each piston, though only single-acting, being thus acted upon by the steam during three quarters of a revolution of the crank, and the two pistons being acted upon during two quarters of the revolution. The position of the parts shown in blue color in the diagram is when the two connections H H* of the crank and pistons are in line with each other, both pistons being then in action upon the crank.

This engine may be reversed by simply turning the valve J, Fig. 3, to a position to bring the passages *s* and *h* into direct communication. This also brings *i* and *k* into communication. The steam passing the valve J then enters directly into and fills the space between the two pistons, and passes through the passages *g′ g′* and ports *g* to the cavity *v* in the face of the slide-valve, whence it is admitted by the movements of the slide-valve L into the ports *a a**, and thence through the passages *a′ a′** into the ends of the cylinder. The exhaust takes place outside of the slide-valve and through the valve-chest B and passages *l* and *k* to the valve J, which conducts it to the passages *i*, whence it escapes through the jacket to the pipe I.

In order to provide for the lubrication of the cylinder and pistons and shaft-bearings, and that of the crank and connections also, when the latter are within the steam-cylinder, the grease-chamber C, Fig. 5, hereinbefore mentioned, which is cast with the cylinder-head A, has its upper part connected by a passage, *t*, (shown in dotted outline in Fig. 5,) with the steam-passage *l*, and in this passage there is a stop-cock, *t′*. The lower part of the said chamber is connected by a passage, *u*, with the bearing *q* in the cylinder-head A^2, and this passage is fitted with a stop-cock, *w′*. The said chamber is fitted with a steam-tight stopper, *w*, which is only removed for filling it.

When it is desired to lubricate the engine, the stop-cocks *w′* and *v′* are opened, and steam being admitted from the passage *l* through the passage *u* to the upper part of the chamber forces the grease downward through the passage *v* into the bearing *q*, and thence along the surfaces of the shaft, crank, connections, pistons, and cylinder, and into the bearing of the opposite cylinder-head, thereby effecting a perfect lubrication of the whole interior of the engine. When sufficient grease has thus been introduced, the stop-cocks are both closed.

It will be understood by experts that this engine, by certain modifications which will readily suggest themselves, and which it is not necessary here to mention, can be converted into a pump for raising or forcing water or other liquid.

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

1. The combination of a cylinder, A, of a form substantially as herein specified, and two vibrating-pistons, D D*, occupying reversed positions within the said cylinder, and both

connected with the same crank-shaft, to operate substantially as herein set forth.

2. So arranging the connections between the said vibrating pistons and the crank that each piston, though being only single-acting, may act upon the crank during more than half of each revolution of the latter, substantially as herein described.

3. The crank E′, arranged directly between the vibrating pistons, and within the cylinder of an engine, substantially such as is herein described, with a separate and independent connection with each piston, substantially as herein set forth.

4. The connection of the side packing-strips, c', and end packing-strips, c^2, of the pistons by means of pins f and slots e, in combination with mortise-and tenon joints, substantially as and for the purpose herein specified.

JOHN B. ROOT.

Witnesses:
HENRY T. BROWN,
J. W. COOMBS.