I. T. PRICE.

OSCILLATING ENGINE.

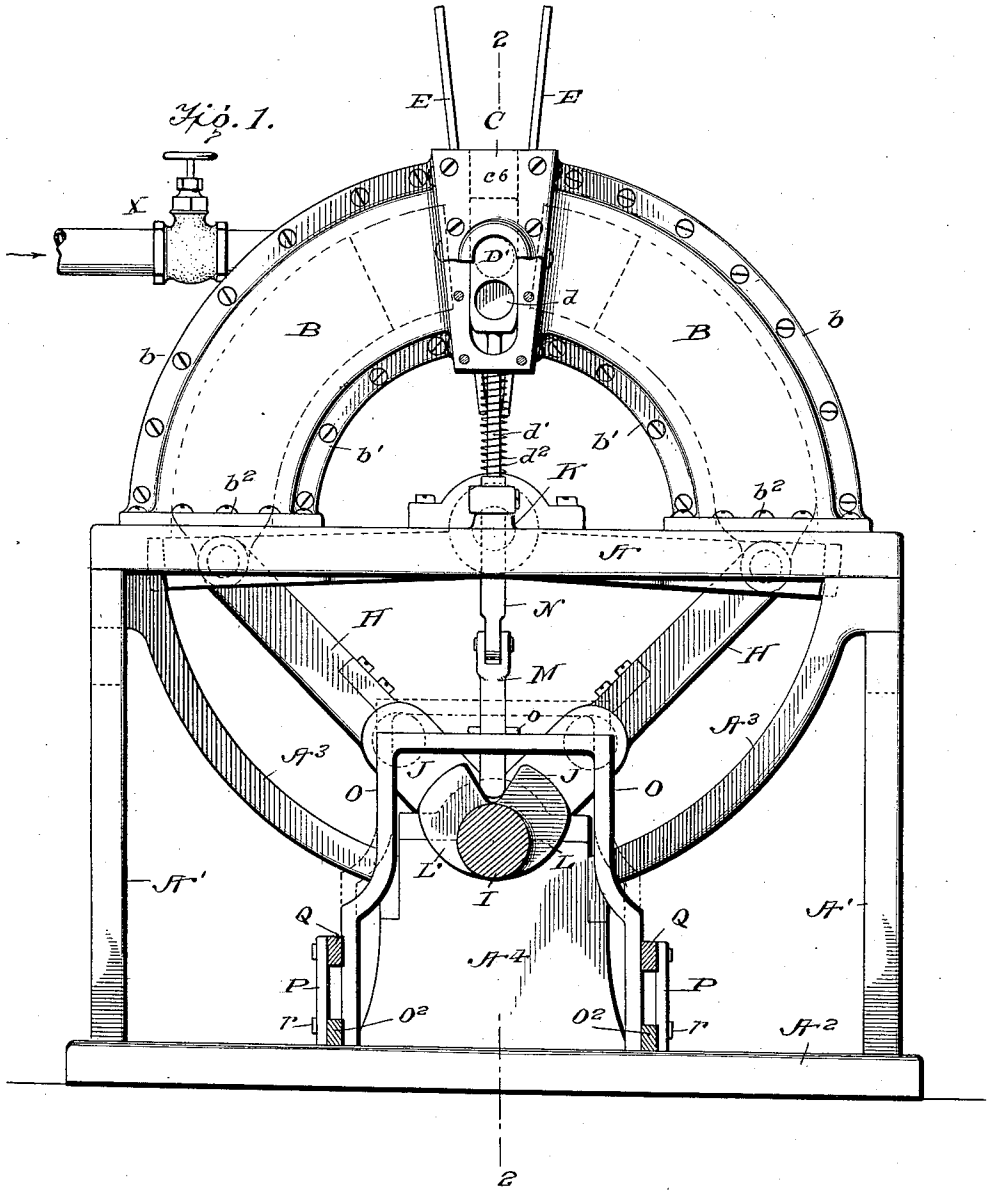
APPLICATION FILED FEB. 28, 1908.

1,024,098.

Patented Apr. 23, 1912.

5 SHEETS—SHEET 1.

Fig. 1.



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5 SHEETS—SHEET 2.

Fig. 2.

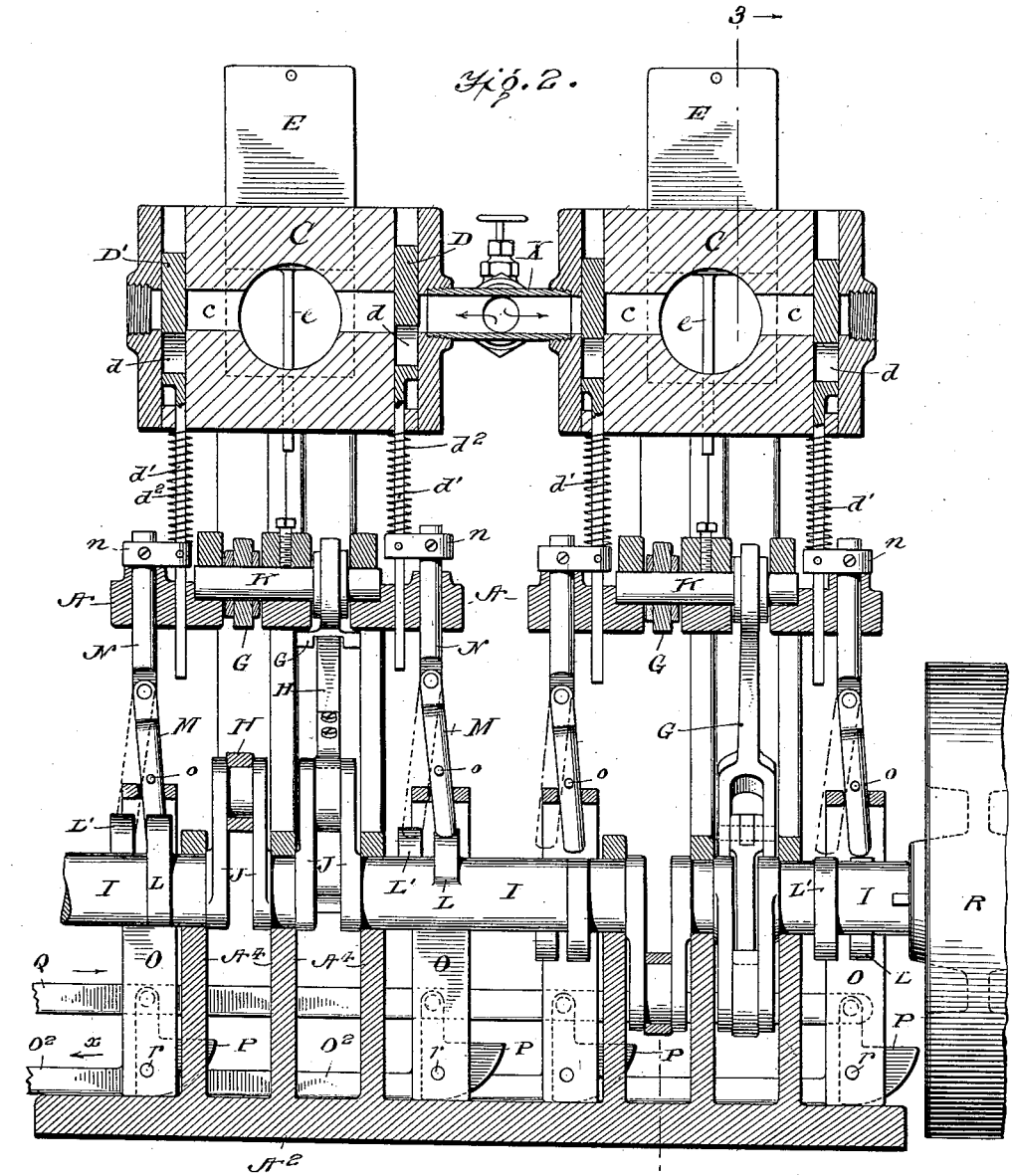
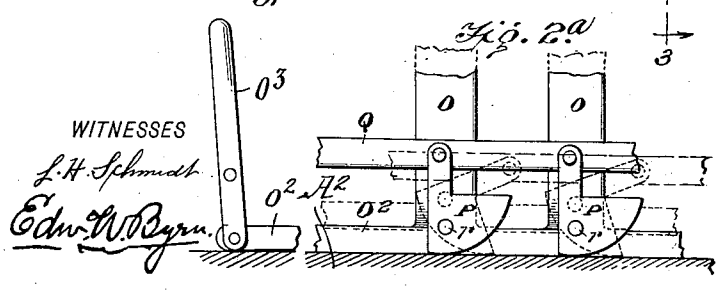


Fig. 2a.



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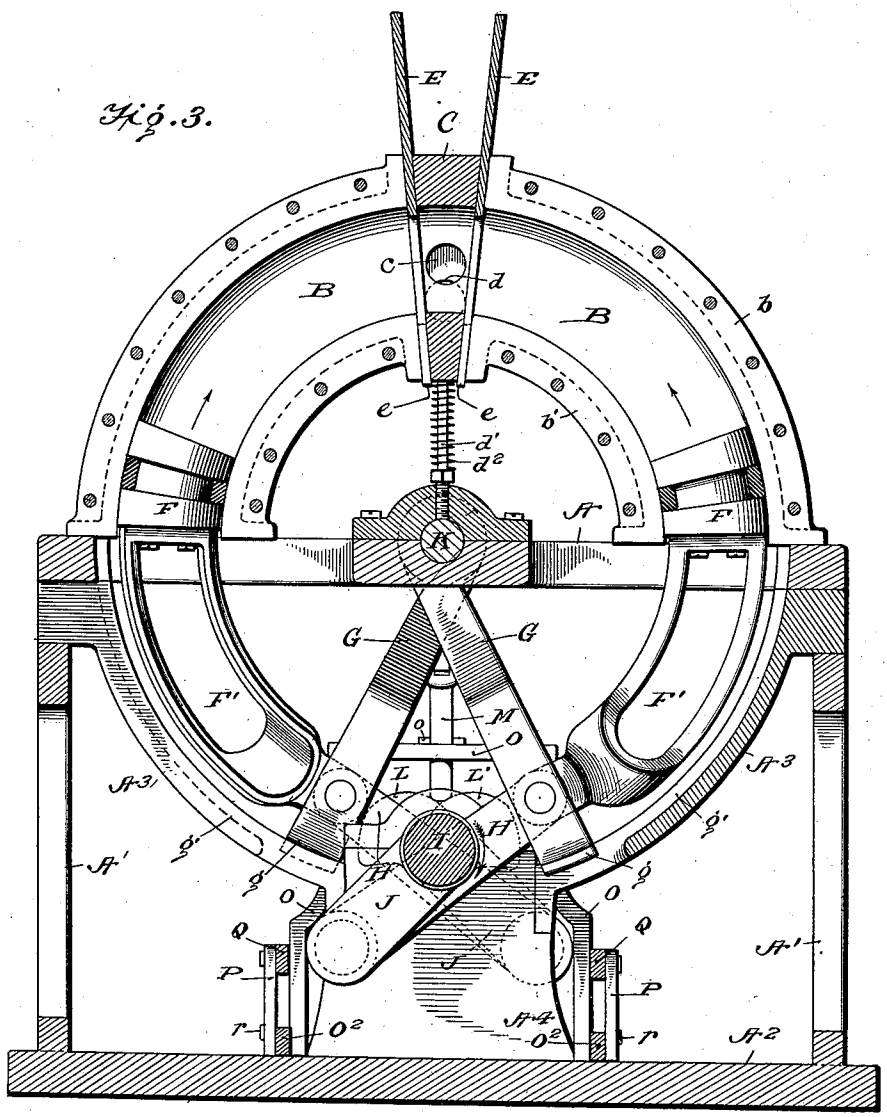
5 SHEETS—SHEET 3.

Fig. 3.



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5 SHEETS—SHEET 4.

Fig. 4.

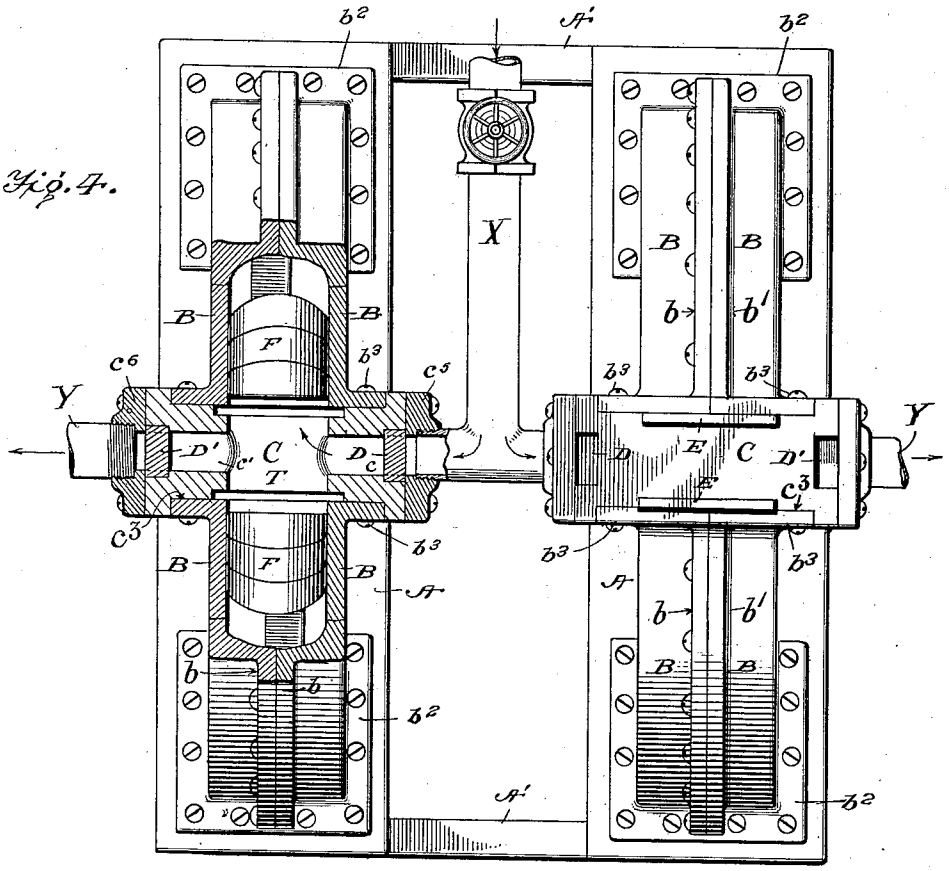
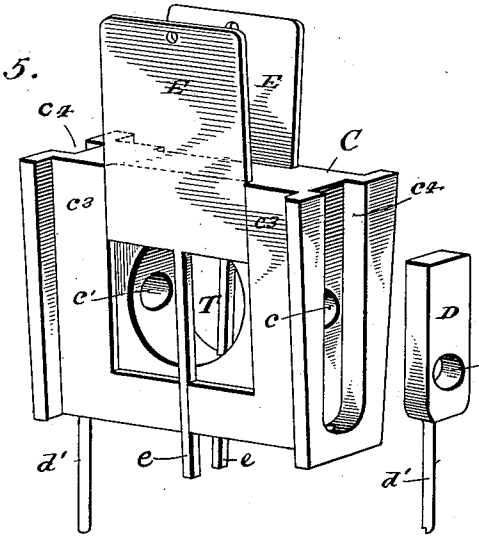


Fig. 5.



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5 SHEETS—SHEET 5.

Fig. 7.

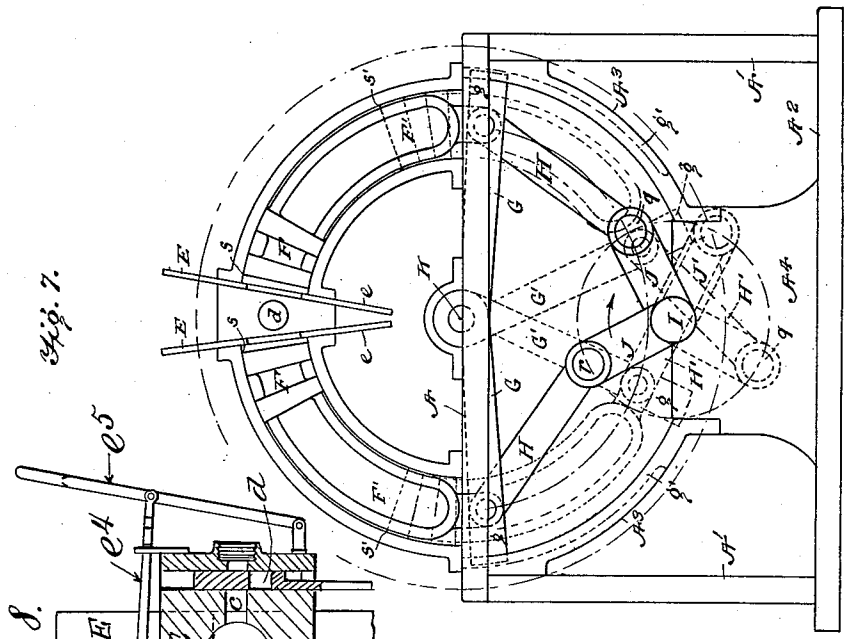
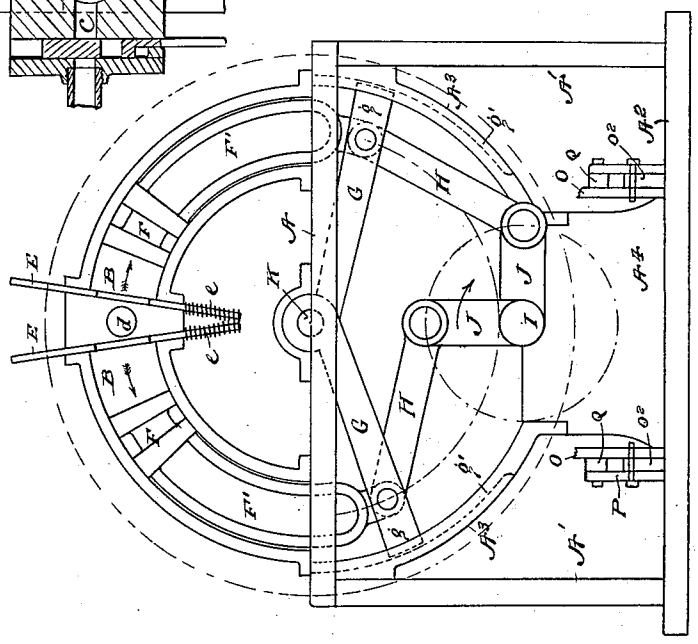


Fig. 8.

Fig. 6.



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OSCILLATING ENGINE.

1,024,098. Specification of Letters Patent. Patented Apr. 23, 1912.

Application filed February 28, 1908. Serial No. 418,246.

To all whom it may concern:

Be it known that I, ISAAC T. PRICE, a citizen of the United States, and a resident of Holton, in the county of Jackson and State of Kansas, have made certain new and useful Improvements in Oscillating Engines, of which the following is a specification.

The object of my invention is to provide an improved engine which shall be simple in construction, of high efficiency and compact form, which shall be capable of use with either steam, compressed air or explosive gases.

It consists of an oscillating engine in which two or more curved cylinders in pairs, provided with an equal number of pairs of pistons and piston rods, transmit power to a pair or pairs of cranks of a driven shaft, and it further consists in the novel construction and arrangement of the various parts of the engine, as will be hereinafter more fully described with reference to the drawings, in which:—

Figure 1 is a side elevation of the engine with parts in section; Fig. 2 is a vertical section taken on line 2—2 of Fig. 1; Fig. 2^a is a detail in side view of a part of the reversing devices; Fig. 3 is a transverse section taken on line 3—3 of Fig. 2; Fig. 4 is a top plan view with the steam chest and a portion of the cylinders on one side shown in horizontal section; Fig. 5 is a perspective view of the steam chest and its valves shown detached; Figs. 6 and 7 are diagrammatic side views of the engine, showing different positions of its parts; Fig. 8 is a sectional view of the valve casing showing the means for shifting the gates.

As will be seen in Figs. 2 and 4, I have shown my engine in duplex form, the parts shown on the right of these figures being exactly like the parts shown on the left; and it is intended that any desired plurality of these units may be employed in connection with the same driven shaft to increase the capacity of the engine at will. While I shall describe my invention in connection with steam as the motive power, it will be understood that I do not so limit myself, since it is equally useful, with modifications evident to one skilled in the art, in air or gas engines, as above stated.

Referring to Figs. 1, 3 and 4, A represents a horizontal table surface mounted on upright frame bars A′, A′, sustained upon a base A^2, on which base are supported pillow-blocks A^4, which carry the journals of the driven shaft I. Curved stationary guides A^3 extend from the upper corners of the frame down to the pillow-blocks A^4, and brace and strengthen the frame and also form guides for the outer ends of the swinging guide-arms, as hereinafter described. Upon the table surface A are erected any number of engine cylinders arranged in pairs, each pair being composed of two curved cylinders B, B, of quadrantal shape connected together at the top by means of the steam chest C. The term "quadrantal," as here employed, is descriptive, and not limiting, since the arc of the cylinder may be more or less than ninety degrees. These cylinders are of circular internal bore and are each formed in two halves provided with flanges b and b', which are bolted together, while the end portions thereof are provided with flanges b^2 bolted to the top of the table surface, and also flanges b^3 at their upper ends, which enter recesses c^3 (see Figs. 4 and 5) in the opposite sides of the steam chest C. Each quadrantal cylinder may be cast in one piece of a proper thickness and then milled out on the inside to form the internal bore for the reception of the piston; or by making each quadrantal cylinder section in two halves as thus described, it may be conveniently turned to form the internal bore for the reception of the piston. Arranged within the quadrantal cylinders are two pistons, F, F, which have a range of oscillation of approximately 90°, as shown in Fig. 3. These pistons are provided with curved piston-rod extensions F′, F′, whose lower ends are jointed to the connecting-rods H, H, and which, in turn, are connected to the cranks J, J, of the shaft I, which is preferably located substantially on the line of the circle about the center of the shaft K, which passes through the centers of the cylinders B, B, and in a vertical line below the center of the shaft K, at which point cranks equal in length to substantially one-half the radius of said circle may be turned a full revolution by a full stroke of the engine. This location is at the point where the most effective leverage in the shaft I may be had by

the continual changing of the angular relations of the connecting-rods H, H, to the shaft I throughout the stroke. It is not absolutely essential, however, to locate the shaft on this line, since the engine will work effectively even if the shaft is not located immediately on the circle.

At the joints between the piston rod extensions F′, F′, and the connecting rods H, H, are also pivoted the two swinging arms G, G. These arms are provided at their upper ends with collars which pivotally embrace a central shaft K, arranged in fixed position on the table surface A. These arms G, G, extend beyond their connections with the piston rods, as shown at g, and these ends enter curved slots g', g', formed in the curved guides and braces A^3, A^3, of the framework, as seen in Fig. 3.

As the two pistons F, F, oscillate about the center of the shaft K, the lower ends of their piston-rods swing in circularly-curved lines about the shaft K, by reason of their connection through the arms G, G, and the thrust of said piston-rods changes in its angular relation upon the shaft I through the different portions of the stroke. That is to say, when the pistons are in their uppermost positions, as shown in Fig. 1, and first commence to descend, they exercise a pressure in a more or less vertical direction; but when they have attained their lowermost position, as shown in Fig. 3, it will be seen that the pressure which they have exerted upon the cranks J, J, during the latter portion of their movement is approximately in a horizontal direction. It will be seen, therefore, that the joint of the piston-rods with their connecting-rods H, H, and arms G, G, in their movement follow a curved line about the shaft K, and consequently impart a more effective leverage to their cranks J, J, and upon the driven shaft I.

I will now describe the construction of the steam-chest and the action of the valves for giving continuous motion to the engine. As already stated, the steam-chest shown in Fig. 5 is securely fastened between the upper ends of the two quadrantal cylinders and is made a rigid part of the same. This steam-chest is preferably wedge-shaped, and is chambered interiorly with a steam space T, which opens into the opposite ports c and c', and also into the open ends of the two curved cylinders B, B. In the opposite ends of this steam-chest are formed the recesses c^4, c^4, (see Fig. 5) in the line of the induction and exhaust ports c, c', and in these recesses are arranged the slide-valves D and D′, seen in Figs. 1, 2, 4 and 5. These slide-valves are provided with openings d, d, arranged to open the ports c and c' in the steam-chest whenever the valves D and D′ are raised to secure registration between the openings d, d, and the said ports in the steam-chest. The slide-valves D, D′, are arranged to reciprocate in vertical directions and are retained in their recesses in the sides of the steam-chest by means of cover plates c^5 c^6, as seen in Fig. 4. Through one of these cover plates (c^5) is tapped a branch of the inlet steam-pipe X, and through the other of these cover plates (c^6) there is connected the exhaust pipe Y.

As will be seen in Figs. 2 and 4, when the inlet valve D is open and the exhaust valve D′ on the opposite side of the steam-chest is closed, steam will pass from the supply pipe X into the chambered interior of the valve-chest C, and exerting its pressure upon both of the pistons F, F, will cause them to descend, moving away from each other in opposite directions to the full range of their stroke, and imparting a rotary motion to the shaft I through the connections of the pair of pistons to the cranks J, J. After a sufficient movement of the pistons has been obtained, steam is cut off by the movement of the inlet valve D, and the steam allowed to act expansively upon the pistons; and at the proper time the exhaust valve D′ is opened to permit the escape of steam. The means whereby these valves are automatically operated are shown in Figs. 1 and 2. Referring to Fig. 2, the slide-valves are each provided with downwardly-extending rods d', d', around which are wound spiral springs d^2, d^2. A clamp coupling n connects each one of these valve rods with the upper end of a stem N, sliding vertically in guides in the table surface A. To the lower end of each of these stems N is attached a jointed member M, which normally rests above one of the two cams L and L′, rigidly fixed to the shaft I. As the shaft I rotates, the operative cam L acting upon the lower end of the member M, lifts the stem N and also the valve-stem d', lifting the engine valve, and when, by the rotation of the shaft, the cam L passes away from contact with the member M, the steam valve is again brought down by the tension of the spiral spring d^2 coiled about its stem.

The valve-operating cams L and L′ are arranged in pairs, one of each pair being employed when the engine is running in one direction, and the other of each pair being brought into action for rotating the engine shaft in the opposite direction. The lower ends of the members M of the lifting stems N are arranged to be shifted from cams L to cams L′, as shown in dotted lines in Fig. 2, whenever it is desired to reverse the engine. To accomplish this it is necessary to both raise the members M and swing them laterally; and to do this I have provided, as typical means, the devices shown at the bottom of Figs. 1, 2 and 2^a. Horizontal slide bars O^2 are arranged to move longitudinally on the base A^2 of the main frame. These

bars O^2 lie beside the pillow-blocks A^4 (see Fig. 1) and are rigidly connected to the lower portions of the yoke-shaped frames O, which, at their upper and horizontal portions are perforated to receive the lower ends of the lifting members M, which latter have cross-pins *o* lying above the perforations in the yokes O, so that when the yokes O are lifted, they will also lift the members M; and when the yokes O are moved horizontally, will swing the members M laterally, as indicated in dotted lines in Fig. 2. To give the required movements to the yokes O, there are pivoted to the connected bars O^2 and yokes O a plurality of cams P, these cams being pivotally connected at *r*, and having their upper ends connected to horizontal bars Q. The bars Q are moved longitudinally by means of a lever (not shown on the drawings), which is merely a pivoted lever capable of imparting longitudinal movement in both directions to said bars Q. When the bars Q are thrust longitudinally in the direction of the arrow in Fig. 2, the right hand and most eccentric portions of the cams P are turned about their centers *r*, and are made to bear against the bed A^2, thereby raising both the bars O^2 and the yokes O. It will therefore be seen that this action causes the proper elevation of the yokes O to lift the members M, so that the lower ends of the members M may be moved to engage with the other set of valve-operating cams (L′ in this case) to reverse the engine. The bars O^2 are now moved in the direction of the arrow *x* of Fig. 2 by a lever O^3 (see Fig. 2^a) which is pivoted medially to a lug on the bed A^2 and pivoted at its lower end to the bars O^2. This lever moves the bars O^2 and the yokes O attached to said bars to the left, bringing the lower ends of the members M over the cams L′. The bars Q are now moved in the reverse direction, returning the cams P to the position shown in full lines, and thus lowering the yokes O so that the lower ends of the members M come into operative relation with the valve-operating cams. This reverses the action of the valves in the valve-casing, producing reversal of the engine.

Referring now to Figs. 3, 5 and 8, it will be seen that in the normal action of my engine, the full force of the expansive action of the steam or any explosive when introduced into the chest, manifests itself in an equal pressure on each of the pistons, driving them with the full force of the steam or explosive used, simultaneously in opposite directions, the effect of which, through the connection of the pair of cranks on the driven shaft I, is to concentrate these oppositely-acting forces upon the shaft I. In some cases, however it will be desirable, when less power is required and it is desired to operate the engine at reduced or only half speed, to be able to run the engine from one piston alone. To accomplish this I arrange in the steam-chest on each side of the same within suitable recesses between the cylinders B, B, and the steam space T, cut-off gates E, E, provided with stems *e*, which serve to guide them in rectilinear movement. These gates are held open when both pistons are used by devices for operating the gates E, E, one of which is shown in Fig. 8. Pivoted to a lug e^2 on the steam-chest is a bell-crank lever e^3, one end of which is loosely pivoted to the gate E, and the other end of which is pivoted to a rod e^4. The rod e^4 is pivoted to a lever e^5 which, at its lower end, is pivoted to the side of the valve-casing. When the lever e^5 is thrust inwardly, it will cause the bell-crank lever to rotate on its pivot and lower the plate E, closing the opening between the steam space T and the respective cylinder. Reverse movement of the lever e^5 restores the cylinder to action.

Referring now to Figs. 6 and 7, each of which represents the engine as running to the right, its pair of pistons F, F, receive the full propelling forces of the gases and move in opposite directions. The driven shaft having its axis nearly in the common circle of the pistons and at right angles to the plane of that circle, carrying the cranks J, J, arranged preferably at right angles to each other and connected to the pistons F, F, by the piston-rods F′, F′, and connecting rods H, H, receives the forces of the thrusts from the steam or gas in the cylinders substantially equally. This results in the direct application of the propelling forces—less the incident losses through friction, cooling and leakage common to all engines—to the driven shaft. Moreover, since the pistons and piston-rods move over arcs of a common circle, continually changing the positions of the pivotal connections between the piston-rods F′, F′, and connecting-rods H, H, the resultants of the effective forces at the crank-shaft are greater throughout the forward stroke than would be the case if pistons and piston-rods and joints between the connecting-rods H, H, and piston-rods F′, F′, traveled in a straight line toward the crank shaft. Thus the expansive energy of steam or gas exerts itself upon the crank-shaft with more advantageous leverage during the forward stroke, without compensating increase of speed of piston movement or length of piston stroke. The result is the conversion of an increased percentage of the expansive forces of the gases into energy in the form of motion in rotation of the driven shaft.

Having thus described my invention, I claim:

1. An oscillating engine comprising a pair of curved and communicating quadran-

tal cylinders, a steam chest bolted rigidly between said quadrantal cylinders and in common to both, a pair of curved pistons having curved piston rods extended and arranged to work in said curved quadrantal cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods having a connecting joint with said piston rods, a crank shaft having a pair of cranks at angles to each other and coupled to said connecting rods, a pair of independent swinging guide arms having loose connection with the joint between said piston rods and connecting rods, and an axis central to the pair of quadrantal cylinders, and upon which are loosely mounted the inner ends of said pair of swinging guide arms.

2. An oscillating engine comprising a pair of curved and communicating quadrantal cylinders, a steam chest bolted rigidly between said quadrantal cylinders and in common to both, a pair of curved pistons having curved piston rods extended and arranged to work in said curved quadrantal cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods, a loose joint securing said connecting rods to said piston rods, a crank shaft having a pair of cranks at angles to each other and coupled to said connecting rods, a pair of independent swinging guide arms having loose connection with the connecting joint between the said piston rods and connecting rods, an axis central to the pair of quadrantal cylinders loosely carrying the inner ends of the pair of swinging arms, and circular stationary guides in the frame-work which receive and guide the outer ends of the swinging arms.

3. An oscillating engine comprising a pair of curved and communicating quadrantal cylinders, a steam chest bolted rigidly between said quadrantal cylinders and in common to both, a pair of curved pistons having curved piston rods extended and arranged to work in said curved quadrantal cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods having connecting joints with said piston rod, a crank shaft having a pair of cranks at angles to each other and coupled to said connecting rods, a pair of independent swinging guide arms having connection with the connecting joint between said piston rods and connecting rods, an axis central to the pair of quadrantal cylinders loosely carrying the inner ends of the pair of swinging arms, circular stationary guides in the framework, which receive and guide the outer ends of the swinging arms, vertical slide valves for the inlet and exhaust ports of said steam chest, vertical rods for the same and cams arranged on said crank shafts to operate said valves.

4. An oscillating engine comprising a pair of curved and communicating quadrantal cylinders, a steam chest bolted rigidly between said quadrantal cylinders and in common to both, a pair of curved pistons having curved piston rods extended and arranged to work in said curved quadrantal cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods having connecting joints with said piston rods, a crank shaft having a pair of cranks at angles to each other and coupled to said connecting rods, a pair of swinging arms having connection with the connecting joint between said piston rods and connecting rods, an axis central to the pair of quadrantal cylinders carrying the inner ends of the pair of swinging arms, circular stationary guides which receive and guide the outer ends of the swinging arms, vertical slide valves for the inlet and exhaust ports of said steam chest, vertical rods for the same, cams arranged on said crank shaft to operate said valves, sliding gates between each of said quadrantal cylinders and the steam chest arranged to cut off the steam from both or either of said pistons and stems to guide the same.

5. An oscillating engine comprising a pair of curved communicating quadrantal cylinders with pistons, a steam chest bolted rigidly between said curved quadrantal cylinders and forming a common clearance, and having inlet and exhaust ports, valves for the same and cut-off gates arranged to wholly cut off either cylinder from the steam chest.

6. An oscillating engine comprising a pair of curved communicating quadrantal cylinders, a steam chest bolted rigidly between the said quadrantal cylinders and in common to both, a pair of curved pistons having curved piston rods extended and arranged to work in said curved quadrantal cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods having connecting joints with said piston rods, a crank shaft having a pair of cranks at angles to each other and coupled to said connecting rods, a pair of independent swinging guide arms having connection with the connecting joint between said piston rods and connecting rods, an axis central to the pair of quadrantal cylinders carrying the inner ends of the pair of swinging arms, circular stationary guides in the framework, which receive and guide the outer ends of the swinging arms, vertical slide valves for the inlet and exhaust ports of said steam chest, vertical rods for the same, cams arranged on said crank shaft to

operate said valves, slide gates between each of said quadrantal cylinders and steam chest, arranged to cut off the steam from both or either of said pistons, gate rods to guide the same, said steam chest having induction and exhaust valves arranged on opposite sides to slide radially in relation to the cylinders, and a base frame all constructed and arranged substantially as herein shown and described.

7. An oscillating engine comprising a pair of curved and communicating quadrantal cylinders, a steam chest mounted rigidly between said cylinders and forming a common clearance, a pair of curved pistons having curved piston rods extended and arranged to work in said cylinders, the pistons on opposite sides of said steam chest being arranged to move in opposite directions, a pair of connecting rods having a connecting joint with said piston rods and a crank shaft having a pair of cranks approximately at right angles to each other and coupled to said connecting rods.

8. An oscillating engine comprising a pair of curved and concentric cylinders, pistons for said cylinders oppositely actuated, a chamber for supplying gas under pressure to said cylinders forming a common clearance, inlet and exhaust ports and valves, a crank shaft and connections for imparting movement in rotation to said shaft.

9. An oscillating engine comprising a pair of curved and concentric cylinders, pistons for said cylinders oppositely actuated, a chamber for supplying gas under pressure to said cylinders forming a common clearance, inlet and exhaust ports and valves, a crank shaft, curved and concentric piston rods, cranks mounted on said shaft, and connecting rods pivoted to said piston rods and said cranks.

10. An oscillating engine comprising a pair of curved and concentric cylinders, pistons for said cylinders oppositely actuated, a chamber for supplying gas under pressure to said cylinders forming a common clearance, inlet and exhaust ports and valves, a crank shaft, curved and concentric piston rods, cranks mounted on said shaft, connecting rods pivoted to said piston rods and said cranks, a central pivot, and arms mounted thereon and pivoted to said connecting rods.

11. An oscillating engine comprising a pair of curved and concentric cylinders, pistons for said cylinders oppositely actuated, a chamber for supplying gas under pressure to said cylinders forming a common clearance, inlet and exhaust ports and valves, a crank-shaft, curved and concentric piston rods, cranks mounted on said shafts, connecting rods pivoted to said piston rods and said cranks, and guides for said piston rods.

12. An oscillating engine comprising two quadrantal cylinders concentrically placed, means for supplying gas under pressure to said cylinders, an interposed chamber forming a common clearance, oppositely acting pistons in said cylinders, curved piston rods, a crank shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, and connecting rods pivoted to said cranks and said piston rods, whereby motion in rotation is imparted to said shaft.

13. An oscillating engine comprising two quadrantal cylinders concentrically placed, an interposed chamber common to both cylinders forming a common clearance for supplying gas under pressure, oppositely acting pistons in said cylinders, curved piston rods, a crank shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, and connecting rods pivoted to said cranks and said piston rods, whereby motion in rotation is imparted to said shaft.

14. An oscillating engine comprising two quadrantal cylinders concentrically placed, means for supplying gas under pressure to said cylinders, an interposed chamber forming a common clearance, oppositely acting pistons in said cylinders, curved piston rods, a crank shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, connecting rods pivoted to said cranks and said piston rods, and guides for said piston rods to control their movement upon said common curved axis.

15. An oscillating engine comprising two quadrantal cylinders concentrically placed, means for supplying gas under pressure to said cylinders, oppositely-acting pistons in said cylinders, curved piston-rods, a crank-shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, and connecting-rods pivoted to said cranks and said piston-rods, whereby motion in rotation is imparted to said shaft.

16. An oscillating engine comprising two quadrantal cylinders concentrically placed, a chamber, oppositely-acting pistons in said cylinders, curved piston-rods, a crank-shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, and connecting-rods pivoted to said cranks and said piston-rods, whereby motion in rotation is imparted to said shaft.

17. An oscillating engine comprising two quadrantal cylinders concentrically placed, means for supplying gas under pressure to said cylinders, oppositely-acting pistons in

said cylinders, curved piston-rods, a crank-shaft having its axis substantially in the common circle of said pistons and at right angles to the plane thereof, cranks on said shaft angularly positioned, connecting-rods pivoted to said cranks and said piston-rods, and guides for said piston-rods to control their movement upon said common curved axis.

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