(No Model.) 2 Sheets—Sheet 1.

# W. I. PHIFER.

## ROTARY ENGINE.

No. 422,829. Patented Mar. 4, 1890.

Fig. I.

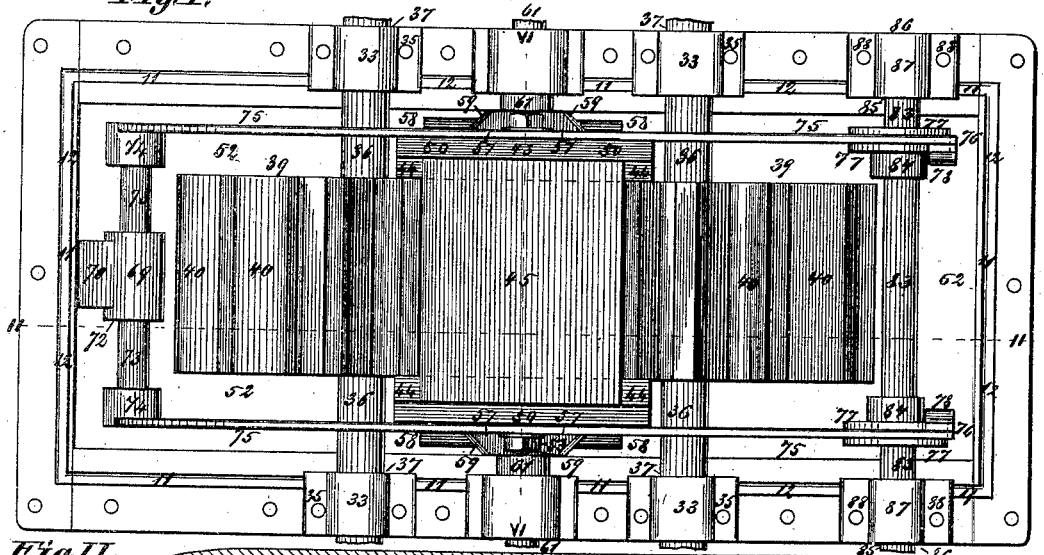


Fig. II.

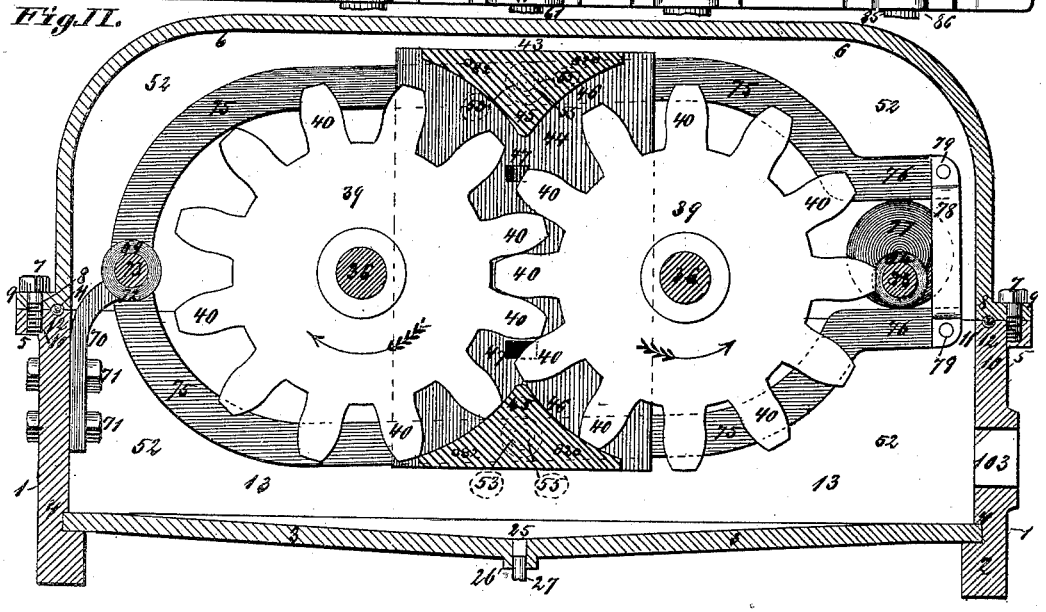


Fig. IV.

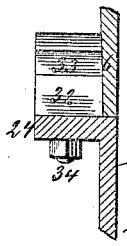
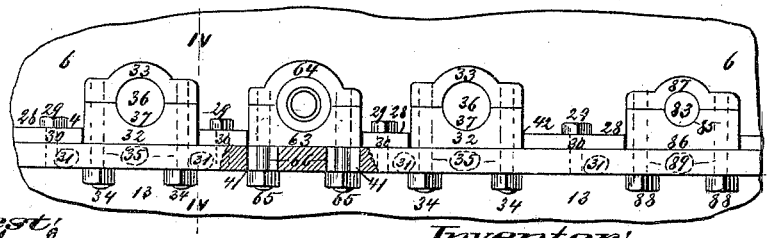


Fig. III.



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(No Model.) 2 Sheets—Sheet 2.

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## ROTARY ENGINE.

No. 422,829. Patented Mar. 4, 1890.

Fig. V.

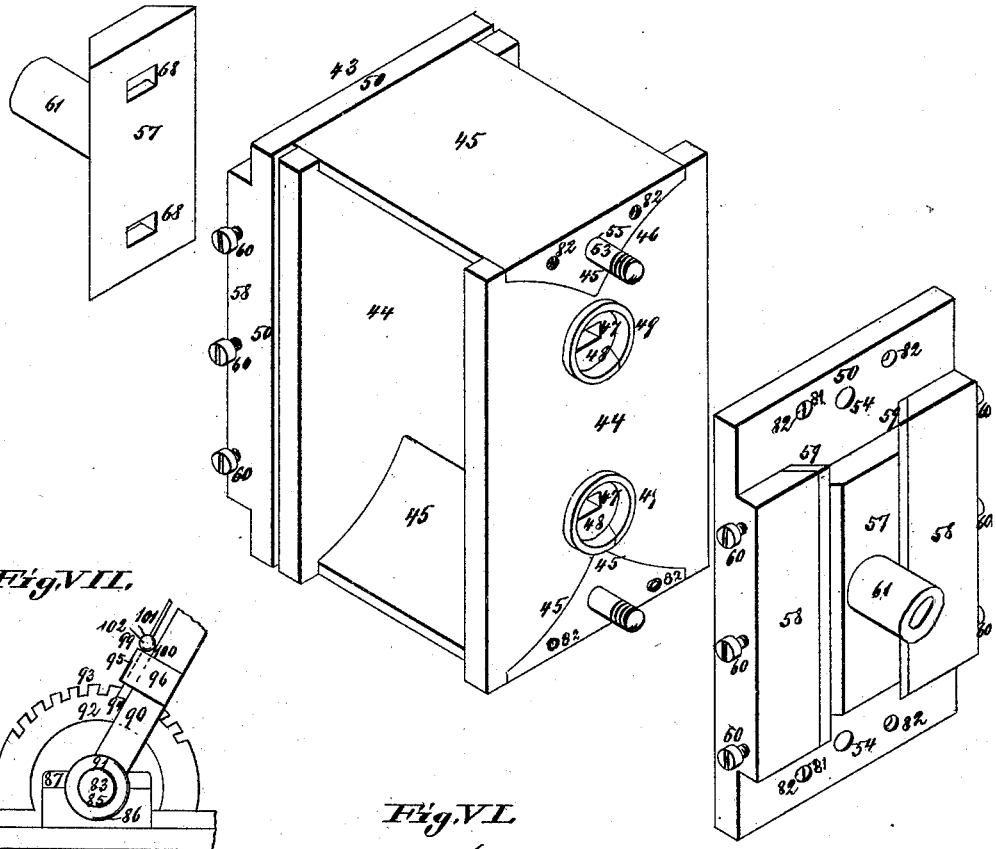
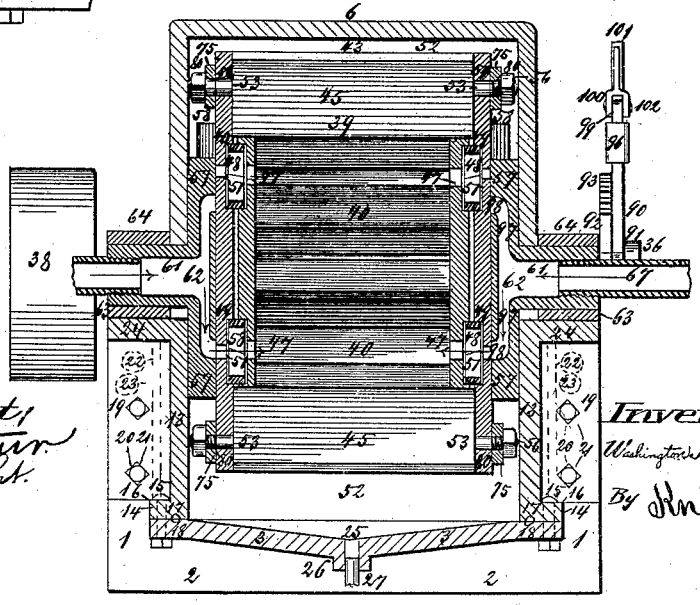


Fig. VII.



Fig. VI.



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# UNITED STATES PATENT OFFICE.

WASHINGTON I. PHIFER, OF CALIFORNIA, MISSOURI.

## ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 422,829, dated March 4, 1890.

Application filed August 30, 1889. Serial No. 322,422. (No model.)

*To all whom it may concern:*

Be it known that I, WASHINGTON I. PHIFER, of California, in the county of Moniteau and State of Missouri, have invented a certain new and useful Improvement in Rotary Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

This invention relates to a rotary engine with a dual system of corresponding cog-gear pistons, with means for adjusting the induction-ports respectively to forward and reverse the engine; and the invention consists in features of novelty hereinafter fully described, and pointed out in the claims.

Figure I is a top view of the engine with the cap of the steam-chamber removed. Fig. II is a vertical section taken on line II II, Fig. I, and shows the corresponding action of the rotary cog-gear pistons and the means for adjustment of the induction-ports respectively to forward and reverse the engine. Fig. III is a detail side view of the journal-box carrier angle-flange, with its surmounting journal-boxes secured thereto, with part broken away to show the means of adjustment of said journal-boxes. Fig. IV is a vertical detail section, taken on line IV IV, Fig. III, and shows one of the journal-boxes, with details of the angle-flange that supports it and of the cap of the cylinder. Fig. V is a perspective view of the steam-chest through which pass the induction-ports and the reversible closure-valves. Fig. VI is a vertical section taken on line VI VI, Fig. I, and shows the steam-chest and the induction-ports. It also shows the respective position of the ratchet-lever that operates the eccentric to reverse the engine; and Fig. VII is an enlarged detail side view of the ratchet-lever and the ratchet-arch that locks said lever's adjustment.

Referring to the drawings, 1 represents the end plates of the steam cylinder or chamber and base portions of said end plates, which form feet 2, projecting below the centrally-inclined bottom 3 of said steam-chamber, the ends of which bottom plate rest on the enlarged feet 2 and within the recessed slot 4 of said end plates, which end plates are also provided with outwardly-projecting angle-flanges 5 at top, to which the cap 6 of the steam-chamber is tightly secured by the screw-bolts 7, which bolts pass through registering perforations 8 in the end angle-flanges 9 of said cap, and are tight seated in the screw-perforations 10 in the top flanges 5 of the end plates. The said joint is made steam-tight by the packing 11, which is embedded in its conjoint channel-grooves 12 in the adjoining angle-flanges.

13 represents the side plates of said steam-chamber, whose bottom angle-flange 14 is secured to the bottom plate by screw-bolts 15, that are seated in perforations 16 in said angle-flange and bottom at their junction-joint, which joint is made steam-tight by the packing 17, that is embedded in the conjoint channel-groove 18. The end angle-flanges of the side pieces are securely jointed to the end plates 1 by the screw-bolts 20, that are seated in the perforations 21 in said angle-flanges and said end plates, and the joint is made steam-tight by the packing 22, which is seated in the channel-grooves 23, conjointly formed in said angle-flanges and end plates.

24 represents the surmounting angle-flanges of the side plates, which at each end rest on the end angle-flanges 19.

The bottom plate 3, which is secured, as stated, to the end and side plates, droops downward from said plates on all sides toward the center, (see Figs. II and VI,) at which center is a vent-port 25, which port is surrounded with a flange-collar 26 beneath the bottom plate, within which collar is seated the drain vent-pipe 27, in which may be affixed a draw-tap for drawing off the water of condensation that settles in the central dished bottom of said steam-chamber. If preferred, a simple vent-plug may take the place of the vent-pipe 27.

The angle-flanges 28 of the side bases of the cap 6 project outward between the journal-boxes, and are secured to the surmounting angle-flanges 24 of the side plates by screw-bolts 29, that pass through perforations 30 in the angle-flanges 28 of the cap, and are secured in their perforate screw-seats 31 in the angle-flanges 24 of the side plates, the channel-grooves 12 at the junction of the end angle-flange being continued round the side

flanges also, and the packing 11 thus also continued around said sides, constituting a steam-tight packing all around the base of the cap.

32 represents journal-boxes, which, with their caps 33, are secured to the surmounting angle-flange 24 of the side plates by screw-bolts 34, that are seated in the bolt-holes 35 in the said journal-boxes and angle-flanges.

36 represents the two rotary drive-shafts that have their bearings 37 in said journal-boxes, on one or both of which are mounted the drive pulley or pulleys 38, that transmit the power by means of their belt attachments.

39 represents the dual cog-gear rotary pistons fast mounted on the drive-shafts 36, the deep heavy cogs 40 of which pistons are milled to correspondingly fit each other perfectly, meshing together like cog-wheels or cog-rollers. The pistons are of uniform size and construction.

The attachment of the journal-boxes, both those that have been described and those yet to be described, are made adjustable, the bolt-holes in the angle-flanges 24, in which the attachment-bolts are seated, being elongated, as shown at 41 in the break-away in Fig. III, to disclose said parts. The sectional projected angle-flanges of the cap, which sectional projections are seated between said journal-boxes, are also foreshortened, as seen at 42 in same figure, so as to allow the adjustment of said journal-boxes as a take-up provision to overcome the shrinkage from wear.

43 represents the adjustable steam-chest, which is constructed of two vertical inner side plates 44, that are loosely coupled together at top and bottom by the curvilinear wedge-shaped blocks 45, that fit in the curvilinear recesses 46 in the ends of said side plates, but are not rigidly secured thereto, the said side plates fitting loosely to the end faces of the rotary cog-gear pistons. The said side plates at each end of the rotary pistons are provided with two steam-induction ports 47, one near the lower and the other near the upper end in the center of the countersunk circular packing-boxes 48, within which fit the elastic split packing-rings 49.

50 represents the outer vertical side plates, which are of about uniform width and length with the inside ones, and are provided with duplicate corresponding induction-ports 51 and the duplicate parts of the countersunk packing-boxes 48, whose other parts, as described, are in the inner side plates, there being like elements on the inner plate, except that the parts of the countersunk packing-boxes are on the outer sides of the inner plates and on the inner sides of the outer plates, so that when the inner and outer side plates are fitted together the respective countersunk parts of the conjoint packing-boxes in the corresponding side plates register together and make complete packing-boxes, which the elastic split packing-rings 49 couple, and under the expansive pressure of the steam effect a steam-tight joint, the induction-ports in the centers of said packing-boxes in the corresponding inner and outer plates also registering in line with each other.

53 represents long screw-bolts that are seated in the bolt-holes 54 in respectively the upper and lower ends of the outer side plates 50, and in the bolt-holes 55, that extend longitudinally through the curvilinear wedge-blocks, and which, when the screw-nuts 56 are secured thereon, hold the outer side plates and curvilinear blocks rigidly in their respective position, while at the same time the inner side plates (which are not rigidly secured to any of the adjacent parts) are held by the curvilinear wedge-blocks at each end from longitudinal displacement, are also held from inward displacement by the pistons and from outside displacement by the outer side plate, while the split packing-rings also conjunctively and elastically couple said inner and outer side plates. The inner side plate while thus boxed in and held from displacement is loosely held within the above-described surrounding parts, and it will thus be seen that, while said side plates form an essential element in the closure of the steam-chest, they produce but a minimum of friction against the ends of said rotary pistons in consequence of the free means described above, by which they are elastically held to their seats. Screw-taps 81 engage in the screw-seats 82 in the outer side plates and bevel-blocks to reenforce the attachment of the parts.

57 represents bevel-edged sliding valves, which are seated between the overhung bevel-cleats 58, that are cast integral with the outside of the outer side plates on each side the steam-chest, between which cleats the said sliding valves play or are adjusted, or said parts are adjusted on them in the reversal of the rotary movement or circuit of the pistons. Adjustment-strips 59 of various thicknesses, to regulate the looseness of play of said valve and to serve as "take-ups" as the parts wear, are adjusted by the set-screws 60, that pass edgewise through said cleats and adjust the projection of said strips. I have shown and described two of said strips to each valve and two series of set-screws; but a single strip with the set-screws that command it to each valve may alone be used when desired.

61 represents the shoulder induction attachment-pipes that project from the open ports 62 of said slide-valves, and which attachment-pipes pass through cut-aways in the caps 6, and are seated in the boxings 63, which, with their caps 64, are secured to the angle-flange 24 of the side plates 13, that inclose the steam-chamber by screw-bolts 65, that pass through the bolt-holes 66 in said cap, boxing, and angle-flange, and are there secured by their screw-nuts. The said bolt-holes may be of elongated form through said angle-iron, so that, as is alike the case with the journal-boxes on the same angle-iron, the boxes may be ad-

justed on their seats when such change is required as a take-up provision or from any other cause.

67 represents the induction-pipes that furnish steam to the engine, and which have steam-tight screw-seats 68 within the shoulder attachment-pipes 61, that project from the sliding valves 57 and receive the steam from a boiler of any suitable description.

The open induction steam-ports 62 branch vertically within the sliding valves 57, so as to provide a double induction forked pipe 97 with steam-supply outlets 98, one of which outlets in each case respectively and alternately registers either with the forward steam-induction port 47 near the lower end of the steam-chest, as shown in Fig. VI, or with the reverse induction-port, also 47, near the upper end of the steam-chest, when it is required to reverse the engine.

I will now describe the mechanical device for effecting the change from the forward action to reverse action, and vice versa.

69 represents the journal-tube, which surmounts and is supported by the bow-necked bracket 70, which is secured inside the steam-exhaust chamber 52 to one of the end plates (that form part of the inclosure of said chamber) by the screw-bolts 71. The said journal-tube 69 forms bearings 72 for the axle-shaft 73, to whose swelled ends 74 is secured at each end the U-shaped adjustment-frame 75, the U-links of which approach each other in front and then run forward with parallel extension-arms 76 sufficiently wide apart for the movement between them of the eccentric cam-wheels 77, the said extension-arms being coupled together by the straps 78, which are secured to the arms at each end by the screw-bolts or rivets 79. About mid-length of the U-links of said adjustment-frame are provided bolt-holes 80, through which pass the long-bolts 53, that couple the outer side plates 50 to the curvilinear wedge-blocks 45. It will thus be seen that said U-frame is secured to the curvilinear wedge-blocks and side plates of the steam-chest and commands the same to produce, respectively, a forward or reverse action of the engine, as will be hereinafter explained, the sliding valves with their steam induction-pipes in their boxings 63 remaining unmoved.

83 represents the reversing-shaft, which passes through the cam-wheels near their periphery on one side thereof and through the boss-collars 84, and which shaft has its bearings 85 in the journal-boxes 86, which, with their caps 87, are secured to the surmounting angle-flange 24 of the side plates 13 by the screw-bolts 88, which pass through bolt-holes 89 in said boxings and caps and said angle-flange.

90 represents the reversing-lever, which is rigidly secured to the collar 91, that is shrunk, keyed, or otherwise rigidly attached to the reversing-shaft 83, which lever, by the movement of said shaft, the cam-wheel 77, and the U-frame, reverses the action of the engine.

92 represents an arc rack secured by bolts or otherwise to the angle-flange 24 of one of the side plates 13, which is surmounted by the cogs 93, in which engages the drop dog-pawl 94, that works within the projecting slideway 95 of the clip-bracket 96, which is secured to said lever. The boss-head 99 of said dog-pawl is secured to the bifurcated end 100 of the actuating-rod 101 by the pivot-pin or rivet 102, and said dog and the rod that governs it may be operated when releasing by the usual trigger at the upper end of the rod, which, as usual, is pivoted to the lever near the handle thereof. 103 is the exhaust-port, through which the exhaust-steam escapes from the exhaust-steam chamber 52.

The operation of the device is as follows: When the U-frame by the operation of the lever 90 has been raised to the positions shown in Figs. II and VI, it will be seen that the lower curvilinear wedge-block is brought into contact with such of the piston-cogs that are then immediately below the then open steam-induction port 47 near the lower end of the steam-chest, the said movement of the lever having also simultaneously with tightening the steam-joint of the said piston-cogs at the same time brought the steam-supply induction-port 98 to register with the lower induction-ports 51 and 47 and the lower packing-boxes 48, with and through which said induction-ports communicate and deliver the steam immediately above the piston-cogs of both pistons that are sweeping past in steam-tight contact with the arc tracks presented by the lower curvilinear wedge-block, thus running the engine in its forward action. When it is required to reverse the engine, the operator by a movement of the lever reverses the eccentric cam-wheel 77, which governs the U-frame, and thus lowers the forward end of said frame, and consequently lowers the lower curvilinear block from contact with the piston-cogs and brings the upper block in contact with the piston-cogs that are sweeping past it. Simultaneously, also, the lower induction-ports which have (while the engine was driven ahead) registered with the lower supply steam-induction port of the sliding valve are now by the same action of the lever put out of registry and the upper induction-ports are brought into registry, and the steam in consequence passes upward against the piston-cogs of both pistons that are thus made to sweep past the arc track of the upper curvilinear wedge-block, the rotary pistons in consequence working in the opposite direction to that previously described, so that the action of the engine is reversed. The point of the curvilinear wedge-block is preferably slightly reduced from the exact arc line or cut quicker, so that as the piston-cogs sweep into line with their steam-tight track they may gradually come in contact there-

with, and all danger of their striking the point or edge line of said wedge-block is avoided.

By the above description it will be seen that the frame is constructed with adjustable journal-boxes, so that the machine or engine by means of set-screws can be easily lined or trued up; also, as described, an external casing incloses nearly the whole of the mechanism, except the belt-pulley and the reversing-lever. At the same time it is seen that said casing is constructed of removable side, end, bottom, and top or cap sections, the individual parts of which are easily detached, so as to give free access to any part of the machinery for purposes of setting up, adjusting, or repairing.

The steam-balanced loose-seated inner side plates form an important medium to reduce the friction of the moving parts to a minimum.

The machine or engine may be fed from both sides, as shown and described, or especially when but a small power is required it may be fed from one side only; also, the rotary pistons may be made of various lengths and diameter, the curvilinear wedge-blocks being also of corresponding length, the length being largely governed by the number of horse-power required and the consequent amount of steam provided.

In a small machine or engine now constructed in accordance with the details of this invention, the piston cog-wheels are three inches across the face and twelve inches in diameter, and are fed from one side only through a half-inch steam-induction pipe. With fifty pounds steam it develops about two and a half horse-power and runs six hundred revolutions a minute.

Larger wheels may be advantageously used, reducing the speed and wear at the same time that they increase the leverage and power.

I have shown the cog-wheel rotary pistons of solid construction from the drive-shafts on which they are mounted to their peripheries, but I do not confine myself to said solid construction, for when the engine is intended for light work the said cog-wheel pistons may then be constructed with hub-centers, spokes, and cogged rims, in which case the peripheral rims would then preferably be the only parts that would contact with the side plates, the sides of the cogs being slightly reduced to prevent friction on said side plates. When said rotary cog-pistons are made solid, as shown, the ends may be dished in between the rims and center bearing, and the cogs also be reduced on their sides to reduce friction of the piston against the side plates to a minimum.

I claim as my invention—

1. In a rotary engine, the combination of the rotary cog-gear pistons, the curvilinear wedge-blocks, and the adjustable steam-chest 43, substantially as and for the purpose set forth.

2. In a rotary engine, the combination of the rotary cog-gear pistons, the curvilinear wedge-blocks, against which the cogs of said pistons work, the outer side plates 50, and the bolt 53, that secures said side plates to said wedge-blocks, substantially as and for the purpose set forth.

3. In a rotary engine, the combination of the rotary cog-gear pistons, the steam-chest 43, having side plates 50, and curvilinear wedge-blocks 45, and the inner steam-balanced inside plates 44, substantially as and for the purpose set forth.

4. In a rotary engine, the combination of the rotary cog-gear pistons, the steam-chest 43, having side plates 50, curvilinear top and bottom wedge-blocks, said side plates and wedge-blocks secured together by the screw-bolts 53, the steam-balanced inside plates 44, and the U-shaped adjusting pivoted frame 75, by which the engine is respectively thrown into forward and reverse action, substantially as and for the purpose set forth.

5. In a rotary engine, the combination of the rotary cog-gear pistons, the adjustable steam-chest 43, having top and bottom curvilinear wedge-blocks with which the cogs of said pistons engage, the casing that incloses the exhaust-steam chamber, the bow-necked bracket 70 inside said casing and secured thereto, the journal-tube 69, that surmounts said bracket, the shaft 73, that works in said journal-tube, and the U-shaped frame 75, mounted on said shaft and secured to the curvilinear wedge-blocks of the steam-chest, the said frame being arranged to adjustably carry said steam-chest, substantially as and for the purpose set forth.

6. In a rotary engine, the combination of the rotary cog-gear pistons, the casing that incloses the steam-exhaust chamber, the adjustable and adjusting U-shaped frame pivotally journaled within said casing, the steam-chest that said frame carries and adjusts, the reversing-shaft 83, the eccentric cam-wheel 77, and the lever 90, that operates said eccentric and U-frame to adjust the engine respectively to a forward or reverse action, substantially as and for the purpose set forth.

7. In a rotary engine, the combination of the rotary cog-gear pistons, the steam-chest 43, having top and bottom curvilinear wedge-blocks that with the other parts of said steam-chest are adjustable, respectively, to bring the lower curvilinear block into steam-tight engagement with the piston-cogs to effect the forward action of the engine and to bring the upper curvilinear block into steam-tight engagement with the piston-cogs to effect reverse action of the engine, substantially as and for the purpose set forth.

8. In a rotary engine, the combination of the rotary cog-pistons, the steam-chest with its top and bottom curvilinear wedge-blocks with which the cogs of said rotary pistons engage, the loosely-held steam-balanced inner side plates 44, provided with induction-ports,

the side plates 50 of the steam-chest being also provided with registering induction-ports, and said side plates 44 and 50 conjointly provided with packing-boxes 48, and the elastic split packing-rings that make a steam-tight joint around the periphery of said packing-boxes bridging over the joint between the adjacent side plates, substantially as for the purpose set forth.

9. In a rotary engine, the combination of the rotary cog-pistons, the curvilinear-faced wedge-blocks 45, the side plates 50, secured to said blocks, and the loosely-held steam-balanced side plates 44, having cut aways at their ends in which the curvilinear points of said blocks fit in loose contact, substantially as and for the purpose set forth.

10. In a rotary engine, the combination of the rotary cog-pistons, the adjustable steam-chest having adjustable inwardly-faced curvilinear wedge-blocks, the adjustable steam-induction ports, and the pivoted adjusting U-frame 75, eccentric wheels 77, and operating-lever 90, the said adjusting U-frame and said eccentric-actuating devices being arranged to adjust the said steam-chest, its curvilinear-faced blocks, and interchangeable steam-induction ports to effect the respective forward and reverse action of the engine, substantially as and for the purpose set forth.

11. In a rotary engine, the combination of the rotary cog-pistons, the curvilinear-faced wedge-blocks that form top and bottom plates to the adjustable steam-chest, the outer side plates rigidly attached to said blocks, the inner loosely-seated steam-balanced side plates being curvilinearly recessed at the ends to fit said wedge-blocks, the outer side plates having integral bevel-faced brackets 58 on their outside faces, and the bevel-edged sliding valves 57, that work between said brackets when the steam-chest is adjusted, substantially as and for the purpose set forth.

12. In a rotary engine, the combination of the rotary cog-pistons, the curvilinear-faced wedge-blocks with the curved inner surfaces of which the piston-cogs engage, the outer side plates 50, fast to said blocks, the inner loosely-seated steam-balanced side plates 44, the sliding valves 57, that work between the bevel-cleats on the outside of plates 50, the take-up adjustment strip or strips 59, seated between said valves and cleats, and the set-screws 60, that adjust the looseness of said valves in their seats, substantially as and for the purpose set forth.

13. In a rotary engine, the combination of the rotary cog-pistons, the adjustable steam-chest with its curvilinear wedge-blocks, the steam-balanced loosely-seated inner side plates, the sliding valves, and the steam-induction pipes 67, attached to said valves, the said valves provided with forked steam-induction ports, the inner and outer side plates being provided with lower and upper steam-induction ports and packing-boxes, which alternately are brought into coincident registration with the lower or upper induction-ports, as the case may be, to effect the forward movement in one case and the reverse movement in the other of the engine, substantially as and for the purpose set forth.

14. In a rotary engine, the combination of the rotary cog-pistons, the adjustable steam-chest 43, with its curvilinear-faced wedge-blocks 45, the knockdown casing that incloses the adjustable rotary piston mechanism, the packing that provides a steam-joint between said knockdown parts, the centrally downwardly-inclined bottom plate that gathers the waste water of condensation, the drain vent-pipe through which said water is drawn, and the adjustable journal-boxes by which the bearings of the axle-shafts are adjusted as a take-up to counterbalance the wear of said mechanism, the said exhaust-steam chamber being provided with the exhaust-port 103, substantially as and for the purpose set forth.

WASHINGTON I. PHIFER.

In presence of—
SIMON B. PHIFER,
EDWARD B. CRANE.