(No Model.) 2 Sheets—Sheet 1.

A. D. BELLINGER.

ROTARY ENGINE.

No. 491,402. Patented Feb. 7, 1893.

Fig. 1.

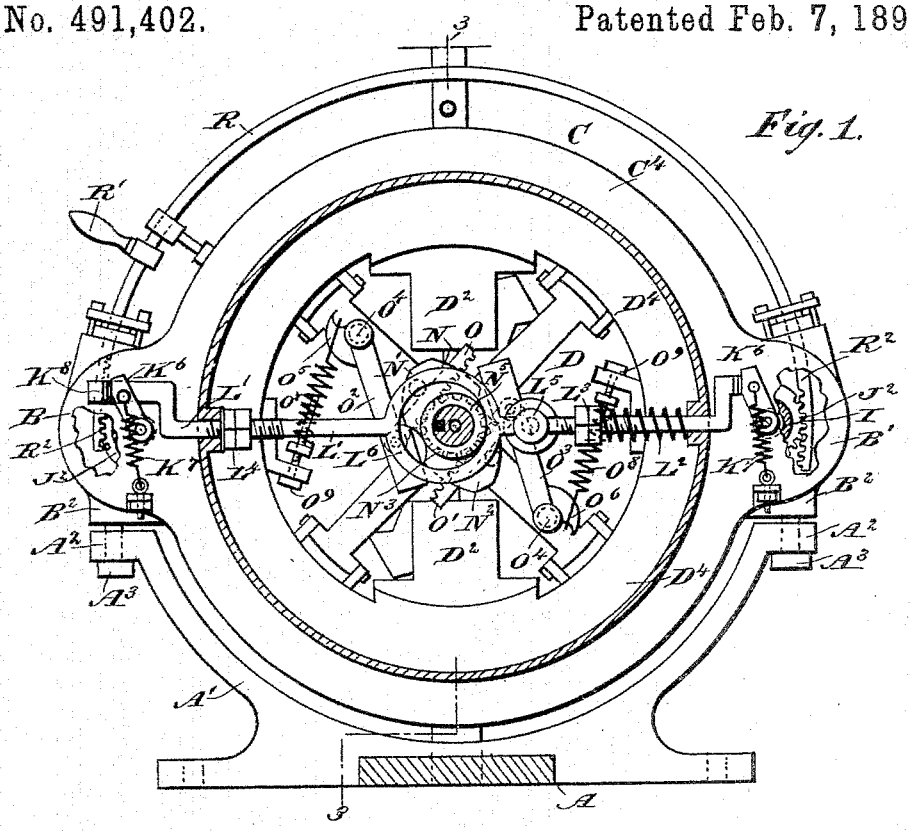

Fig. 6.

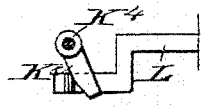

Fig. 2.

Fig. 5.

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Fig. 3.

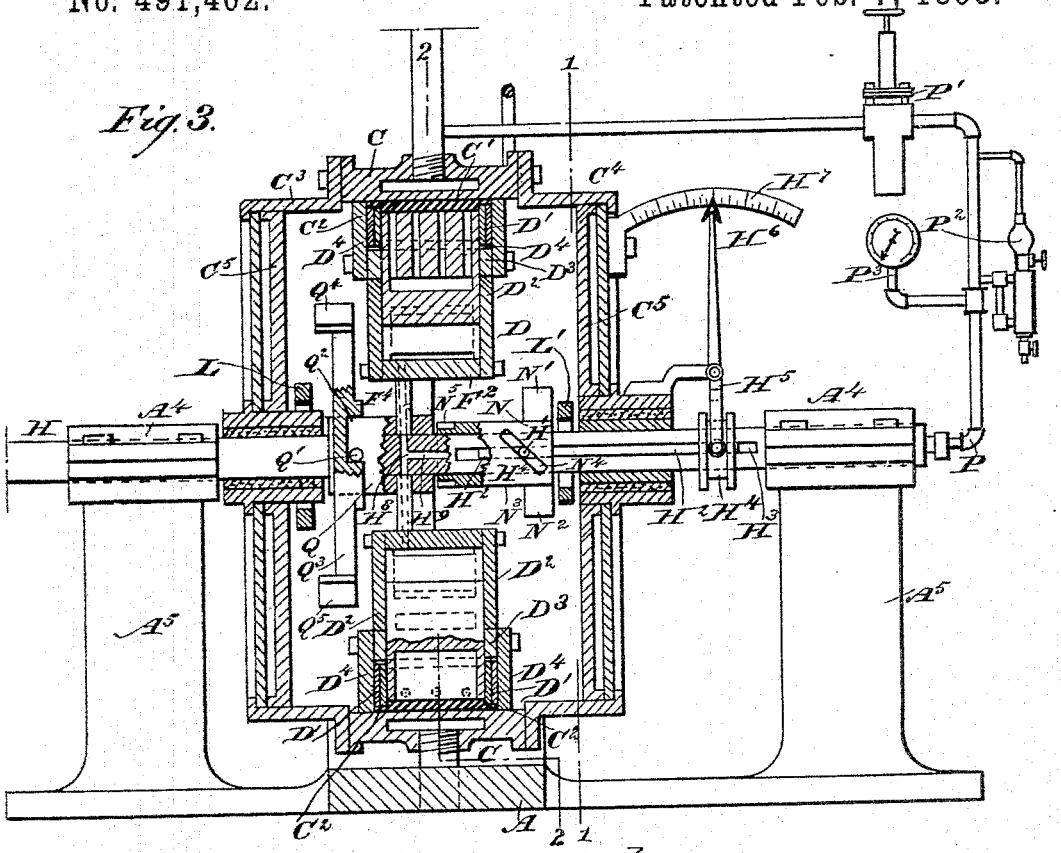
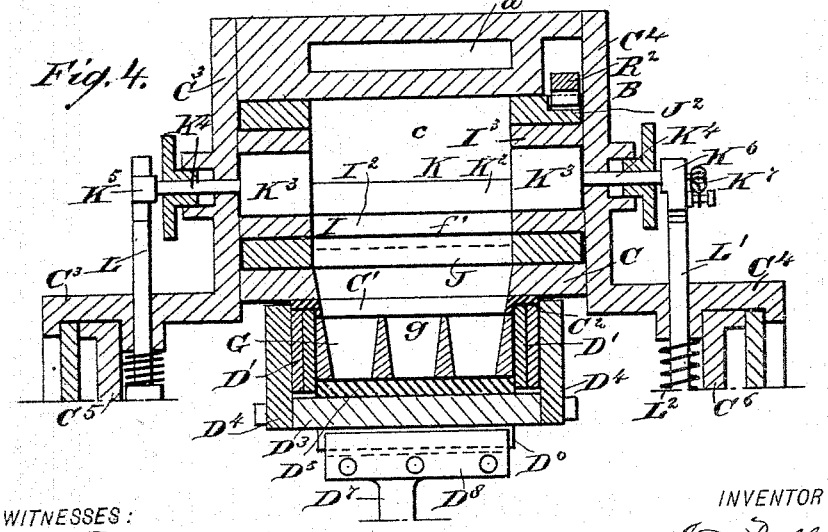


Fig. 4.



WITNESSES:

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UNITED STATES PATENT OFFICE.

ALBERT D. BELLINGER, OF BLACK RIVER FALLS, WISCONSIN, ASSIGNOR TO HIMSELF AND HENRI B. COLE, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 491,402, dated February 7, 1893.

Application filed December 8, 1891. Serial No. 414,360. (No model.)

To all whom it may concern:

Be it known that I, ALBERT D. BELLINGER, of Black River Falls, in the county of Jackson and State of Wisconsin, have invented a new and useful Improvement in Rotary Engines, of which the following is a full, clear, and exact description.

The object of the invention is to provide a new and improved rotary engine which is simple and durable in construction, very effective in operation, and arranged to utilize the motive agent to the fullest advantage, at the same time reducing friction to a minimum and compensating for any endwise thrust or movement of the shaft, so as not to disturb the relative position of the piston and cylinder.

The invention consists of certain parts and details, and combinations of the same as will be hereinafter fully described and then pointed out in the claims.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a sectional end elevation of the improvement on the line 1—1 of Fig. 3; Fig. 2 is a like view of the same on the line 2—2 of Fig. 3; Fig. 3 is a sectional side elevation of the same on the line 3—3 of Fig. 1; Fig. 4 is an enlarged sectional plan view of the steam chests and adjacent parts; Fig. 5 is an enlarged sectional side elevation of part of the same; and Fig. 6 is a side elevation of the device for returning the cut off valves.

The improved rotary engine is mounted on a base A, formed at or near its center with a transversely extending segmental arm A′, provided at its upper end with outwardly extending flanges A^2, supporting screws or bolts A^3, engaging lugs B^2, formed in the under side of the steam chests B and B′, arranged diametrically opposite each other on the cylinder C, and forming part of the same. The cylinder C is lined on its inside with a ring C′, formed with annular shoulders C^2, on its ends, the said shoulders being engaged by sets of packing rings D′, forming part of a wheel D, mounted to rotate within the stationary cylinder C.

The rings D′ are supported partly on plates D^2 and on the rim D^3, on which the former are bolted or otherwise secured at their inner ends. The faces of the two outermost rings of the sets of rings D′ abut against the inner surface of the rings D^4, bolted to the outer edges of the rim D^3 and the plates D^2, as plainly shown in Figs. 3 and 4.

The peripheries of the rings D^4 extend closely to the inner surface of the cylinder C, and the inner sides of the said rings also abut against the edges of the lining C, thus holding the rings D′, which are packing rings, in place on the shoulders C^2 of the lining C′. The periphery of the rim D^3 is lined by a sectional ring D^5, which latter forms with the lining C′ and the packing rings D′, a steam space E, into which passes and acts, the motive agent for driving the machine. The motive agent introduced into the steam space E acts on the pistons F and F′, fitted to slide in casings F^2 and F^3, respectively extending to the rim D^3 of the wheel D. The outer ends of the said pistons pass through the rim D^3 and lining D^5 and are adapted to travel on the inner surface of the lining C′ of the cylinder C and also come in contact with the abutments G and G′, located diametrically opposite each other next to the steam chests B and B′ respectively, as plainly illustrated in Fig. 2.

The rim D^3 of the wheel D is provided with inwardly projecting and longitudinally extending lugs D^6, engaged at opposite sides by plates D^8, bolted or otherwise secured to the arms of a spider D^7, secured by suitable means on the main driving shaft H, passing centrally through the cylinder C and journaled in suitable bearings A^4, formed or attached to standards A^5, supported on the base A of the main frame. Thus the shaft H is journaled in bearings independent of the support for the cylinder C. The outer surfaces of the arms of the spider D^7 abut on the inner surfaces of the lugs D^6, but the ends of the said arms are unrestricted so that a lengthwise shifting of the shaft H and the spider D^7 does not disturb the position of the rim D^3, as the said spider arms D^7 are free to slide longitudinally on the lugs D^6. When the shaft H, however, is turned, the spider arms by their plates D^8 engaging the lugs D^6 at opposite sides carry the rim D^3 along, thus revolving

the entire wheel D within the casing C. The lining D^5 abuts at its outer edges on the innermost rings of the sets of rings D′ so as to hold the same in proper position on the rim D^3, the said rings thus forming with the lining C′, and the lining D^5, a tight joint to prevent all leakage of the motive agent from the steam space E.

In the rim of the cylinder C are formed the channels *a* and *b*, of which the channel *a* is connected with a suitable source of motive agent supply, while the channel *b* is connected with an exhaust pipe. The channels *a* and *b* extend each through nearly one-half of the rim of the cylinder C, as plainly shown in Fig. 2, so as to steam-jacket the cylinder C. The ends of the channels *a* open into the cylindrical spaces *c* and *c′*, formed in the steam chests B and B′ respectively, and the ends of the channel *b* terminate in circular channels *d* and *d′*, also formed in the steam chests B and B′, respectively, and surrounding the central spaces *c* and *c′*. In the latter are secured the valve seats I and I′, containing the cut-off valves K and K′, respectively, each of the said valve seats being formed with a cross bar I^2, attached to the cylindrical parts I^3, fastened to the head plates C^3 and C^4, of the cylinder C, as plainly illustrated in Fig. 4.

The cross bars I^2 of the valve seats I and I′ engage the back of the reversing valves J and J′ respectively, mounted to turn in the spaces *c* and *c′*, the shifting of the reversing valves being accomplished by hand whenever it is desired to reverse the engine, as hereinafter more fully described.

In the cross bars I^2 of the fixed valve seats I and I′ are formed the inlet ports *e* and *e′*, respectively, opening at all times into larger ports *f* and *f′*, formed in the reversing valves J and J′ respectively. The ports *f* and *f′* in the reversing valves J and J′, connect with the ports *g* and *g′*, extending through the cylinder C, and lining C′ and the abutments G and G′, to open into the steam space E below and above a horizontal plane extending diametrically through the shaft H and the centers of the steam chests B and B′. When the reversing valves J and J′ are turned in order to reverse the engine, the ports *f* and *f′* connect with the ports *h* and *h′*, respectively, also extending through the cylinder C, its lining C′ and the abutments G, G′ respectively, to open into the steam space E at opposite sides, that is above and below the ports *g* and *g′*, as plainly illustrated in said Fig. 2.

In the abutment G between the inner ends of the ports *g* and *h* is arranged a packing bar G^2, pressing on the outer surface of the ring lining D^5, the pressure on the bar G^2 being exerted by the motive agent passing through the port *f* and a small port f^2, to the back of the said bar, as plainly shown in Fig. 2. A similar packing bar G^3, is arranged in the abutment G′ and is located between the inner ends of the two ports *g′* and *h′*. The motive agent from the port *f′* passes through a port f^3, to the back of the packing bar G^3 so as to press the latter in contact with the outer surface of the ring lining D^5. In the periphery of the reversing valve J and above and below the port *f* are formed cavities *i i′*, and similar cavities i^2 and i^3, are formed on the reversing valve J′ above and below the port *f′*. The cavity *i* is adapted to connect the port *h* with the channel *d* so that the exhaust motive agent from the space E can pass through the port *h*, cavity *i*, into the channel *d* and from the latter to the exhaust channel *b* to finally pass to the outer air. The other cavity *i′* is adapted to connect the port *g* with the channel *d* when the reversing valve J has been changed to reverse the engine, as above described. In a like manner the cavity i^2 is adapted to connect the port *g′* with the channel *d′* at the time the position of the reversing valve J′ has been changed to reverse the engine. The other cavity i^3 is adapted to connect the port *h′* with the channel *d′* when the engine is run in the direction of the arrow *a′*, the exhaust steam passing through the port *h′*, cavity i^3, into the channel *d′* and from the latter to the channel *b* to finally pass to the outer air.

When the several parts are in the position illustrated in Fig. 2, and steam is admitted to the channel *a* then it passes into the spaces *c*, *c′* and from the latter through the ports *e*, *e′* and ports *f*, *f′* respectively, into the ports *g*, *g′*, respectively, and then into the space E below and above the abutments G, G′, respectively, so that the motive agent acts on the two pistons F and F′ to turn the wheel D in the direction of the arrow *a′*. The exhaust steam in front of the pistons F, F′ passes through the ports *h*, *h′*, cavities *i*, i^3 into the channels *d*, *d′* and from the latter through the channel *b* to the outer air. When the positions of the reversing valves J and J′ are changed, then the ports *h h′* become the inlet ports for the motive agent, and the ports *g*, *g′* the exhaust ports, to conduct the exhaust into the channel *b* by means of the cavities *i′*, i^2 and the channels *d*, *d′*. Each of the channels *d* and *d′* is connected by a channel *k*, with a port *l*, connecting the inlet channel *a* with the interior of the cylinder, that is the space E, as plainly illustrated in Fig. 5. In this port *l* is arranged to slide a block or valve *n*, held normally closed, as shown in the said figure, by the pressure of the motive agent in the channel *a*. In case of the increase of pressure (back pressure) in the space E, the valve *n* is forced outwardly so that the channel *k* is opened and connection is established between the space E and the channel *d* or *d′* to permit the excess of pressure to pass into the exhaust channel *b*. The amount of motive agent passing from the respective space *c*, *c′* through the ports *e e′* respectively in the valve seat I or I′ respectively, is controlled by the respective cut-off valve K or K′ each of which is provided with a cross bar

K^2, connecting the cylindrical ends K^3, with each other. The cylindrical ends K^3 are mounted to turn in the valve seats I, I′ respectively, as plainly shown in Fig. 4. Each valve stem K^4, of the two cut-off valves K and K′ carries on its outer ends arms K^5 and K^6, of which the latter are each connected with a spring K^7, attached on the casing C and serving to hold the arm K^6 and its valve in either of the two positions into which it is moved, as hereinafter more fully described. The arms K^5 stand diametrically opposite the arms K^6 as plainly shown in Figs. 1, 4 and 6.

The arms K^5 and K^6 of the valve K are adapted to be engaged by the left ends of the bars L and L′, respectively mounted to slide in suitable bearings in the cylinder heads C^3 and C^4 respectively. The other or right hand ends of the bars L and L′ abut against and are adapted to impart a swinging motion to the arms K^5 and K^6 of the valve K′.

The bar L′ serves to move the valves K and K′, to cut off on the ports *e* and *e′* respectively, the valves being held in this cut off position by the action of the spring K^7 until the other bar L moves the valves in an opposite direction to reopen the ports *e* and *e′* to admit the motive agent.

Both bars L and L′ are actuated from the main driving shaft H, the bar L by means of a cam and the other bar L′ by a cam controlled by a centrifugal governor to regulate the amount of cut off according to the speed of the engine. Each of the bars L or L′ is pressed on by a spring L^2, resting with one end against the head C^4 and with its other end presses against a nut L^3, held adjustably on the respective bar L or L′. A jam nut abutting against the nut L^3 locks the latter in place. The sliding motion of the bar L′ is limited in one direction by adjustable nuts L^4, held on the bar L′ and abutting against the head C^4, as shown in Fig. 1. In the middle of each of the bars L or L′ is formed a ring L^6, through which passes loosely the main driving shaft H. On one side of the ring on the bar L′ is arranged a friction roller L^5, adapted to be alternately engaged by the ends N′ and N^2 of a cam N, provided with a sleeve N^3, fitted on the main driving shaft H. In the sleeve N^3 is formed a diagonal slot N^4, engaged by a pin H′, projecting from a key H^2, mounted to slide in a longitudinal groove or key-way H^3, formed in the main driving shaft H. On the outer end of the key H^2 is secured a grooved collar H^4, engaged by the forked end of a lever H^5, pivoted on a bracket supported from the casing C. The free end of the lever H^5 is provided with a pointer H^6, indicating on a graduated segment H^7, as illustated in Fig. 3.

On the inner end of the sleeve N^3 of the cam N is formed or secured a gear wheel N^5, engaged at opposite sides by racks O and O′, pivotally-connected with weighted governor arms O^2 and O^3, respectively pivoted at O^4 on arms of the spider D^7, the two pivot points being located diametrically opposite each other, as indicated in Fig. 1. Each of the arms O^2 and O^3 is formed near its pivot end with a lug O^5 and O^6, connected with springs O^7 and O^8, respectively, attached on adjustable bolts O^9, held on the wheel D. The pressure of the springs O^7 and O^8 holds the weighted ends of the governor arms O^2 and O^3 in an innermost position, but when the speed of the engine increases above a normal rate then the said arms O^2 and O^3 swing outwardly against the tension of the springs O^7 and O^8 respectively. The swinging movement of the arms O^2 and O^3 causes the racks O and O′ to turn the gear wheel N^5 so that the sleeve N^3 of the cam N is turned, and the position of the cam ends N′ and N^2 of the cam N is changed. At the same time the slot N^4 of the sleeve N^3, engaging the pin H′ imparts a sliding motion to the latter and consequently to the key H^2 so that the collar H^4 imparts a swinging motion to the lever H^5, the point H^6 of which then indicates the amount or cut-off on the segment H^7. The cam ends N′ and N^2 in revolving with the shaft H alternately engage the friction roller L^5 so that the bar L′ is shifted to the right against the tension of the spring L^2. The latter returns the bar to the normal position shown in Fig. 1, as soon as the cam ends have left the friction roller L^5. The shifting of the bar L to the right causes a swinging of the arms K^6 so that the cut-off valves K and K′ are turned and the cross bars K^2 of the said valves cut off sooner or later on the ports *e* and *e′*, thus admitting more or less steam to the space E. It is understood that the bar L is returned to its former position after passing the arrow-shaped ends Q^4, Q^5 of the lever Q^3 by its spring L^2. At this point the admission valve is open, effected by the movement of the bar L′ by pushing arms K^6 over the center, the spring K^7 finishing the movement. The length of this movement is checked by the arms K^5 striking ends of bar L. It is further understood that the two arms K^5 and K^6 play outside the ends of bars L and L′ and the two arms on the opposite or left side play between the turned-up or right angle ends of bars L and L′. This arrangement allows the four arms to have a free movement and to play to and from their respective abutting points.

It will be seen that when the speed of the engine increases above a normal rate the position of the cam N is changed so that the cam ends N′ and N^2 act sooner on the friction roller L^5, thus changing the position of the valves K and K′ to cut off the motive agent sooner at the ports *e* and *e′*.

On the shaft H is secured a sleeve Q, provided with a pin Q′, extending into a notch Q^2, formed in a lever Q^3, mounted to turn loosely on the said sleeve Q and having its outer ends Q^4 and Q^5, arrow-shaped as plainly illustrated in Figs. 2 and 3. The outer ends Q^4 and Q^5 are adapted to alternately engage a friction roller L^7 held on the bar L, to shift

the latter so as to turn the valves K and K′ to reopen the ports *e* and *e′* as before described. It will be seen that on reversing the motion of the engine the shaft H turns in an opposite direction for a distance before the pin Q′ of sleeve Q strikes the other end of notch Q^2 and carries lever Q^3 along, so that the latter does not act on friction roller L^7 until piston F or F′ has passed the respective live steam port in the abutment G or G′. It is understood that when the arms K^5 and K^6 are pushed or pulled past a central position by the action of the bars L and L′, as above described, the springs K^7 finish the opening or closing motion of the valves K and K′. A pad or other device is arranged in casing C^4 for the rod L′, to deaden the noise on the return of rod L′ and its nuts L^4. The cut-off cam N can follow the cam lever Q^3 so closely that the motive agent can be cut off at less than one-tenth of full stroke and owing to the free exhaust ports uncontrolled by valves and open at all times into the channel *b*, the cut-off can be prolonged ninety-nine one-hundredths of the full stroke and the governor will likewise work automatically within the range of one-tenth to ninety-nine one-hundredths.

The pistons F and F′ are mounted to slide in casings F^2 and F^3 respectively attached to the inside of the rim D^3 of the wheel D, the plates D^2 covering the sides of the said casings. The inner ends of the casings F^2 and F^3 are connected by pipes F^4 with a diametrical opening H^8, formed in the main driving shaft H connected with a central opening H^9, arranged longitudinally in the said shaft and extending to one end thereof. The outer end of the shaft is connected at the central opening H^9 with a pipe P, connected with the inlet pipe of the motive agent, as plainly shown in Fig. 3. On the pipe P is arranged a reducing valve P′, a lubricant-feeding device P^2, and a pressure gage P^3, all of approved constructions. The reducing valve P′ serves to maintain a constant pressure in cylinder in case of varying boiler pressure. Now a part of the motive agent can pass through the pipe P into the openings H^9 and H^8 to pass through the pipes F^4 into the inner ends of the casings F^2 and F^3, so that the motive agent presses against the inner ends of the pistons F and F′ to hold the same with their outer ends in contact with the lining C′ and the inner surfaces or sides of the abutments G and G′. The inner sides of the abutments extend vertically and tangentially to the ring lining D^5 as shown in Fig. 2.

The pistons F and F′ are moved inward when passing onto the respective abutment G or G′ and are finally pressed into an innermost position when passing the respective packing bar G^2 or G^3. The pistons are then again forced outward while passing over the other half of the respective abutment by the action of the motive agent in the casings F^2 and F^3 pressing on the inner ends of the said pistons. When the pistons pass onto the abutments G and G′, then the said pistons in passing over the exhaust ports exhaust the motive agent in the casings F^2 and F^3, to permit the pistons to readily slide inward while traveling over the remainder of the abutments. For this purpose each of the abutments is provided with a channel *o*, adapted to connect with a port *p* formed in one side of the exhaust casing F^2, so that the motive agent from the casing can pass through the port *p* into the channel *o* and from the latter into the respective exhaust port at the time the piston passes over the latter. The shifting of the reversing valves J and J′ is accomplished by hand and for this purpose the following device is employed.

A segmental rod R is mounted to slide in suitable bearings attached to the casing C and is provided with a handle R′ for conveniently shifting the said rod R, the ends of the latter passing through suitable stuffing boxes into the steam chests B and B′, and each inner end is formed with segmental gear teeth R^2 in mesh with gear teeth J^2 formed on the respective reversing valves J or J′, as plainly illustrated in Figs 1 and 2. By moving the handle R′ in one direction, the two valves J and J′ are turned so that their positions are changed to reverse the engine, as above described. It is understood that the reversing valves J and J′ turn in the steam chests in the space *c* on the cylindrical ends I^3 of the fixed valve seats I and I′ respectively, as above described.

It will be seen that by this machine full provision is made for all endwise thrust of the shaft H, as the longitudinal shifting of the latter does not affect the relative positions of the wheel D and the cylinder C. It will further be seen that the cylinder is steam-jacketed by forming the inlet channel *a* and the exhaust channel *b* semi-circular, as above described and shown in the drawings.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent,—

1. In a rotary engine, a wheel provided with a rim having projections, a spider abutting with its arms on the said projections, and plates attached to the spider arms and abutting on the sides of the said projections, substantially as shown and described.

2. A rotary engine, provided with a wheel comprising a spider, a rim formed with inwardly-extending projections abutting on the arms on the spider, plates secured on the spider arms and engaging opposite sides of the said projections, a lining held on the outer surface of the said rim, and packing rings supported on the said rim and abutting against the said lining, substantially as shown and described.

3. A rotary engine, provided with a wheel comprising a spider, a rim formed with inwardly-extending projections abutting on the arms of the spider, plates secured on the

spider arms and engaging opposite sides of the said projections, a lining held on the outer surface of the said rim, packing rings supported on the said rim and abutting against the said lining, and outer rings abutting against the said packing rings and secured on the said rim, substantially as shown and described.

4. In a rotary engine, the combination with a cylinder provided with a lining in the form of a ring having annular shoulders, of a wheel mounted to turn within the said cylinder and comprising a ring, a spider carrying the said rim, a lining held on the said rim, and packing plates extending from the said rim and its lining to the shoulders on the lining of the said cylinder, and rings secured to the outer edges of the said rim to hold the packing rings in place, substantially as shown and described.

5. In a rotary engine, the combination with a cylinder provided with a lining in the form of a ring having annular shoulders, of a wheel mounted to turn within the said cylinder and comprising a rim, a spider carrying the said rim, a lining held on the said rim, and packing plates extending from the said rim and its lining to the shoulders on the lining of said cylinder, rings secured to the outer edges of the said rim to hold the packing rings in place, projections extending inwardly from the said ring, and plates attached to the spider arms and engaging the sides of the said projections, substantially as shown and described.

6. In a rotary engine, the combination with a wheel provided with sliding pistons, of a cylinder forming a steam space with the said wheel and provided with an inlet channel and an exhaust channel, a channel leading from the said inlet channel to the said steam space, and an auxiliary channel leading from the last mentioned channel to the exhaust channel, and a valve fitted to slide in the channel connecting the steam space with the inlet channel, substantially as shown and described.

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