as the latter approaches or recedes from the cylinder B. The packing-strips a^3 b^3 of the abutments are restrained from being forced out of place by the springs d^3 d^4, when the abutments are working in or out, by means of stops or pins e^3, the heads of which fit in the slot in reduced right-angled extensions of the strip a^3, on which the strips b^3 rest, and are connected with by pins and slots, all substantially as shown in Fig. 3 of the drawing.

I claim—

1. The steam-chest E, provided with passages c c^1 d and cocks or valves G G′, in combination with the hollow engine-shaft D, having inlet and outlet passages b f, the pipe or passage F, and the apertures g and g' and h and h' in the revolving piston-hub, substantially as specified, for reversing the engine.

2. The hollow revolving cylinder B, having the duplicate ports g g' and h h' arranged on nearly opposite sides of the cylinder, near its rim, in combination with the piston C, movable abutments J J′, and cylinder A, all constructed to operate substantially in the manner herein shown and described.

3. The hollow revolving cylinder or hub B of the piston, having end cavities i i', in combination with the ports h or h' and aperture k, whereby the piston is counterbalanced in an endwise direction, substantially as specified.

4. The combination, with the abutments J J′, of the eccentric M, the crank N, the rocking shaft O, the cams P P′, having curved portions m, also straight or abrupt sides n n, the arms r r, the slides Q Q′, and the arms S, formed with inclines t and curved recesses or portions y, corresponding with the curvatures of the cams, for operation of the abutments, substantially as specified.

5. The combination of the overlapping packing-rings K K′, adjustably connected together, as described, with the packing l', cylinder A, and revolving cylinder B, substantially as set forth, for the purpose specified.

6. The abutments J, provided with the sectional strips a^3 b^3, springs d^4 d^3, and locking-pins or stops e^3, substantially as described, for the purpose specified.

ALPHEUS C. GALLAHUE.

Witnesses:

MICHAEL RYAN,

FRED. HAYNES.

2 Sheets--Sheet 2.

A. C. GALLAHUE.

Rotary-Engines.

No. 150,019. Patented April 21, 1874.

Fig. 9.

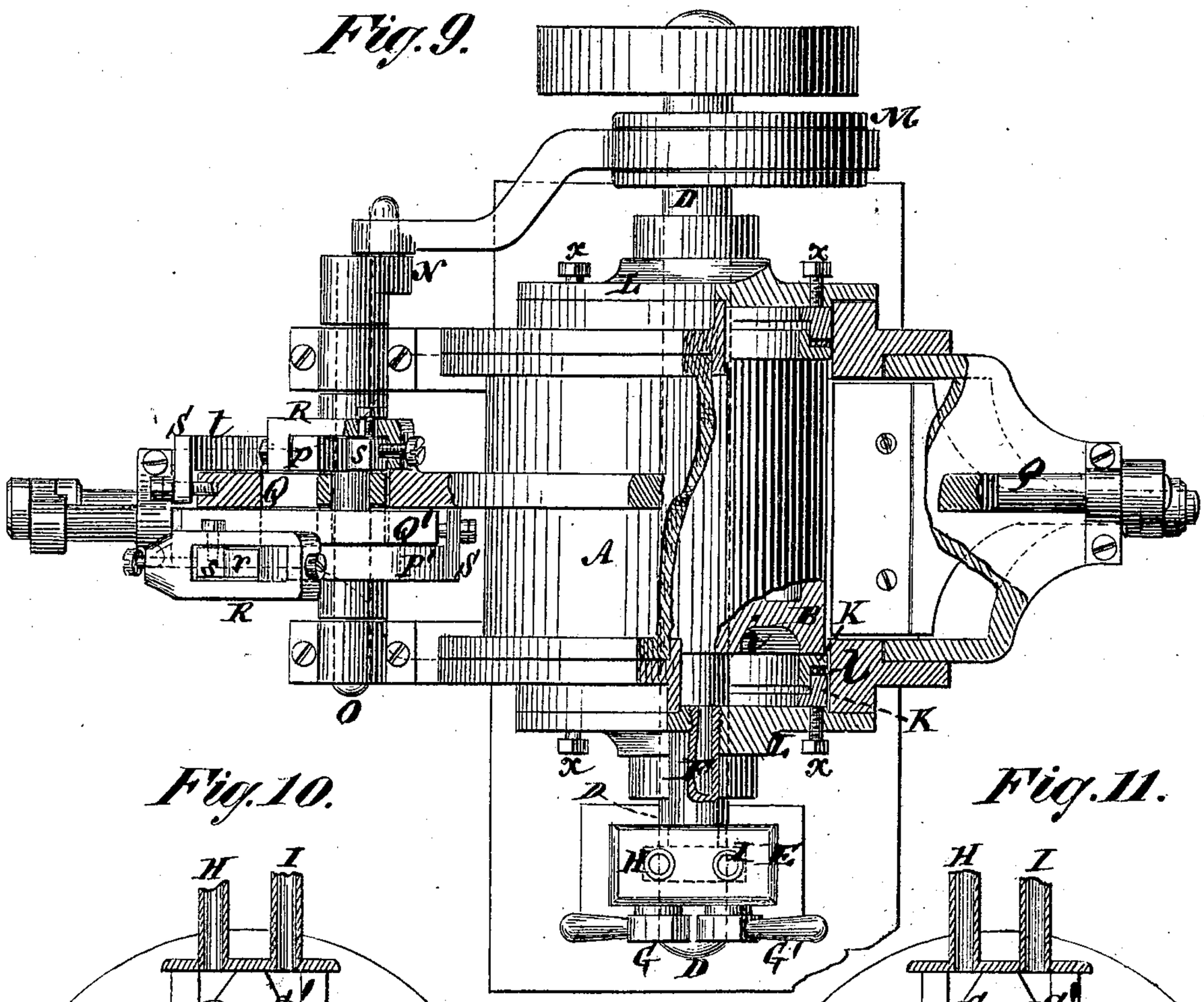

Fig. 10.

Fig. 11.

Fig. 12.

Witnesses.

John Becker

Fred. Haynes

A. C. Gallahue

by his Attorneys

Brown & Allen

UNITED STATES PATENT OFFICE.

ALPHEUS C. GALLAHUE, OF MORRISANIA, NEW YORK.

IMPROVEMENT IN ROTARY ENGINES.

Specification forming part of Letters Patent No. **150,019**, dated April 21, 1874; application filed December 9, 1873.

To all whom it may concern:

Be it known that I, ALPHEUS C. GALLAHUE, of Morrisania, in the county of Westchester and State of New York, have invented certain Improvements in Rotary Engines, of which the following is a specification:

This invention mainly relates to that description of rotary engines in which a radial piston connected with an inner revolving cylinder or hub is used in concert with radially-sliding abutments within an outer stationary cylinder. The invention consists, partly, in a novel combination of ports and passages and cocks or valves, for introducing steam to the piston, and for reversing the motion of the latter; also, in a certain arrangement of duplicate ports, whereby provision is made for keeping up a constant action and equalizing the pressure on opposite sides of the sliding abutments while in motion, to relieve the latter of lateral pressure. The invention also consists in a novel means and mode of operating the abutments; likewise, in a hole or passage in the hollow revolving cylinder, for equalizing the pressure on opposite ends of the said cylinder.

Figure 1 represents a sectional elevation of the engine in a transverse direction to its axis; Fig. 2, a similar view, but with the working parts in a different position. Fig. 3 is a face view, with the covering-plate removed, of one of the radially-sliding abutments; Fig. 4, a partly-broken outer-end view thereof, and Fig. 5 a side or edge view of the same. Fig. 6 is a partly-broken outside longitudinal view of the revolving piston and its cylinder; Fig. 7, a partly-broken end view thereof, and Fig. 8 a longitudinal section of the same. Fig. 9 is a partly-broken plan of the engine; Figs. 10 and 11, sectional end views through the steam-chest and valves in different directions, in illustration of the reversing action of engine; and Fig. 12, a sectional view, in a longitudinal direction with the axis of the piston, of that portion of the engine through and from which the steam is admitted and exhausted.

Similar letters of reference indicate corresponding parts.

A is the outside and stationary cylinder of the engine, and B its internal and concentrically arranged revolving inner cylinder, forming a hollow hub to the radial piston C, and having a hollow, or partly-hollow, shaft, D, which constitutes the main or driving shaft of the engine. This shaft works at its one or hollow end through the steam-chest E of the engine, and is in communication therewith by one or more radial openings, *b*. Said steam-chest consists of passages *c* c^1, terminating below in a space surrounding the portion of the shaft D in which are the openings *b;* also, of an intermediate passage, *d*, in communication with a pipe, F, which is parallel with the engine-shaft. These passages *c*, c^1, and *d* are controlled by cocks or valves G G′, which serve, accordingly as they are turned, as represented in Figs. 10 and 11, to pass steam from the steam-inlet H to the shaft D, and to exhaust from the pipe F through the outlet I, or to admit steam from the inlet H to the pipe F, and to exhaust from the shaft D through the outlet I, according to the direction in which it is required to run the engine. J J′ are the radially-sliding abutments, arranged opposite one another, and working in and out of the cylinder A, within outwardly-projecting chambers *e* $e,^1$ which may be provided with stuffing-boxes at their outer ends for the rod-like extensions of the abutments to work freely but closely through.

To run the engine in the direction of the arrow shown in Figs. 1 and 2, the valves G G′ are adjusted as represented in Fig. 10, which causes the steam to enter the shaft D, and to pass, by one or more outlets, *f*, into the interior of the cylinder B, from whence it passes, by ports *g g′* in the central or body portion of the rim of the cylinder B, into the cylinder A, to act upon the piston C, subject to control by the abutments. After such steam has performed its duty in the engine, it escapes, by duplicate ports *h h′*, through the rim of the cylinder, near its one end, into a cavity, *i*, in such end of the cylinder B, and from thence, through the pipe F, to the exhaust-outlet I. The action of the abutments J J′ regulates the timely admission and exhaustion of the steam to and from the cylinder A, to keep up a constant pressure on the piston C to keep it revolving.

When it is desired to run the engine in the reverse direction to that indicated by the ar-

rows in Figs. 1 and 2, the valves G G′ are adjusted as represented in Fig. 11. This causes the steam to enter the pipe F, and to pass from thence, through the ports *h h′*, into the cylinder A, and, after such steam has performed its duty in said cylinder, to escape, through the ports *g g′*, into the body of the revolving cylinder B, and from thence, by the hollow shaft D, through the openings *b* and passage C′, into and out through the general exhaust-outlet I. Inasmuch, however, as, when the steam is thus admitted to the engine, it enters and fills the cavity *i* in the one end of the revolving cylinder B, and so causes an end thrust, which, unless counterbalanced, would produce much friction, the opposite end of the cylinder B is provided with a similar cavity, *i′*, to which steam from the cylinder A passes by one or more apertures, *k*, (see Fig. 6,) and produces an opposite or counterbalancing end thrust or pressure.

The revolving hub or cylinder B of the piston is packed at each of its ends by means of duplicate rings K K, (see Figs. 9 and 12,) made to fit closely but freely within a circular and concentric opening in either end cover of the stationary cylinder, between the ends of the cylinder B and an outer end plate or cover, L, to the opening in the main covers of the stationary cylinder. Said rings K K are constructed the one to overlap or fit within the other, and to hold a packing, *l*, in between them, whereby the rings are not only packed peripherically, but forced apart with an elastic pressure to make a close joint with the contiguous end of the revolving cylinder B, without, however, producing an undue friction. Screws *x x* serve to adjust these rings and packing from the outside, as required. The duplicate ports *g g′* and *h h′* are arranged at such distances from the piston C, and the one of either pair at such distance in advance of the other, that the stoppage of the advance one of such pair of ports by the abutment in contact with the revolving cylinder as said port passes the abutment does not interrupt the communication into the interior of the revolving cylinder, or into its end cavity *i*, inasmuch as the other port in said pair is sufficiently in the wake to keep open said communication till the advance one has passed the abutment. Likewise, provision is made by such arrangement of duplicate ports in pairs for exhausting from opposite sides of either one abutment, and admitting steam to opposite sides of the other abutment while said abutments J J′ are in motion, that the latter are relieved from one-sided or lateral pressure, thus enabling them to move freely; yet the position of the two pairs of ports *g g′* and *h h′* relatively to each other, and their distances from the piston C, are such that the advance one of either of such pair of ports does not complete its passage beyond the one abutment till the rear one of the other pair of ports is under cover of the other abutment, so that steam issuing through the one pair of such ports cannot escape directly through the other pair thereof, but is compelled to first do its duty in the engine. To this end the ports *g g′* and *h h′* are all situated on one side of a line intersecting the cylinder B transversely, while the abutments J J′ are disposed opposite one another. The abutments J J′ are operated by peculiar mechanism, and in a peculiar manner. Thus they have an intermittent motion in and out given them in suitable relation with each other, as required, by a single eccentric, M, on the main shaft, caused to vibrate or rock a crank, N, and shaft O. This shaft has fast on it a pair of cams, P P′, which, or for a portion at least of their peripheries, are of a curve, *m*, struck from the center of the shaft O, and have radial or abrupt terminations *n n′*, so that each cam P P′ may be of an approximate shape, as shown. These cams are set reversely on the shaft O—that is, the one on the one side of the axis of the shaft, and the other cam on the opposite side of the said axis—for the purpose of operating independent slides Q Q′ arranged to straddle in a free or sliding manner, by means of slots in them, the shaft O, and which slides are connected, respectively, with the abutments J J′. The attachments to said slides, against which the cams P P′ act, are similar, only differing in being arranged on opposite sides of the shaft O. Thus each slide Q or Q′ has an arm, *r*, against which the straight portion *n* of the cam P or P′ acts to force outward at its proper time the abutment J or J′ for the piston C to pass. The upper portion of this arm *r* enters a slotted projection, R, from the cam, and is supported at its back by an adjustable rest, *s*. In the reverse movement of the same cam its straight or terminal portion *n′* first acts against an incline, *t*, of an arm, S, attached to either slide Q or Q′, to move inward the abutment, J or J′, connected with said slide, and afterward the curved portion *m* of the cam works within a correspondingly-curved recess, *y*, in the arm S, to hold the abutment J or J′ in place against the revolving cylinder B for the requisite length of time during the travel of the piston. The packing of the piston C is composed of a longitudinal strip, a^2, and rectangular end pieces b^2, which latter are in pin-and-slot connection with the strip a^2, and are acted upon by S-shaped springs c^2, while the packing-strip a^2 is forced outward by a bow-spring, d^2, which is adjustable by a screw, e^2. The packing of the abutments J J′ is mainly of similar construction, being composed of a longitudinal packing-strip, a^3, and rectangular end pieces b^3, in pin-and-slot connection with the strip a^3; but in such packing semi-elliptic springs are substituted for the S-shaped springs, and the packing is controlled radially in a general way by a bow-spring, d^3, through or subject to, in case of unusual compression, the action of an interposed stronger and flatter bow-spring, d^4, (see Fig. 3,) which serves to meet various opposing contingencies, but which is more especially designed to resist the pressure of the steam on the end of the abutment

as the latter approaches or recedes from the cylinder B. The packing-strips a^3 b^3 of the abutments are restrained from being forced out of place by the springs d^3 d^4, when the abutments are working in or out, by means of stops or pins e^3, the heads of which fit in the slot in reduced right-angled extensions of the strip a^3, on which the strips b^3 rest, and are connected with by pins and slots, all substantially as shown in Fig. 3 of the drawing.

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