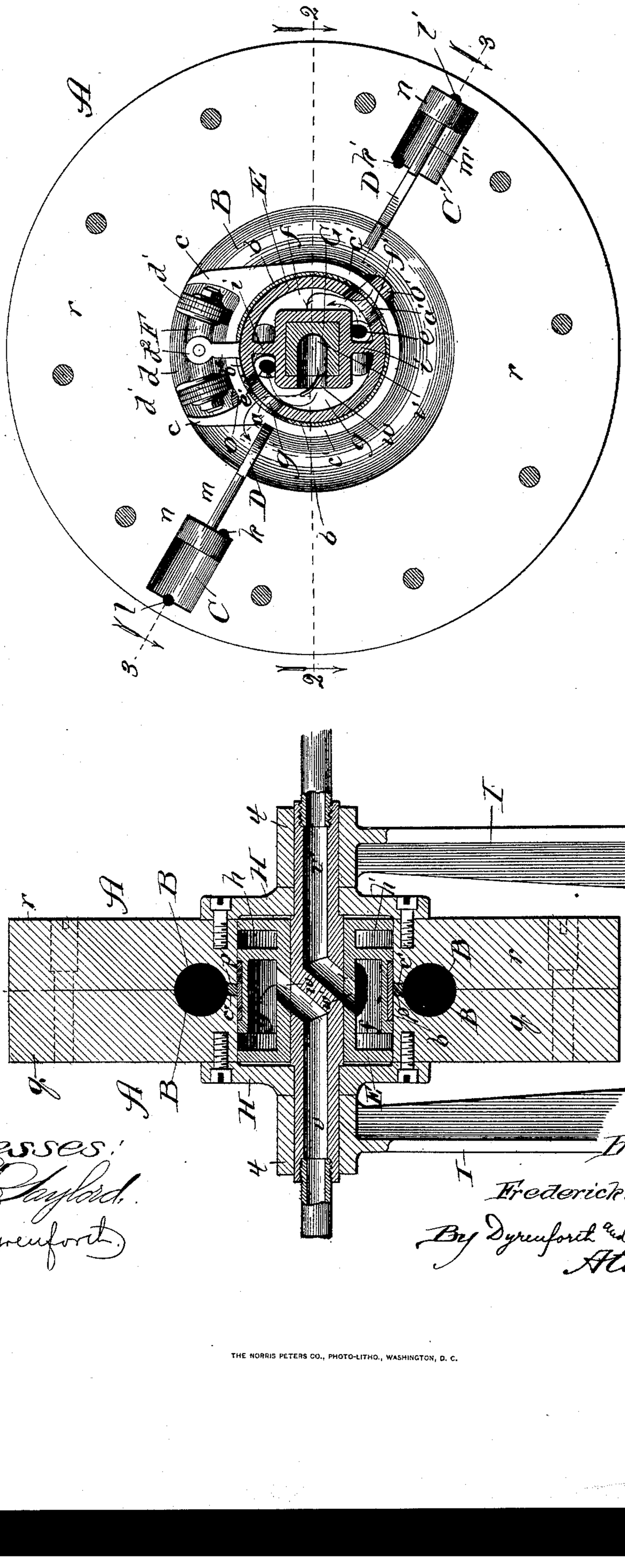
(No Model.) 2 Sheets—Sheet 1.

F. A. SMALL.

ROTARY STEAM ENGINE.

No. 483,726. Patented Oct. 4, 1892.



Witnesses:
Chas. E. Gaylord.
J. W. Dyrenforth.

Inventor:
Frederick A. Small.
By Dyrenforth and Dyrenforth
Atty's.

(No Model.) 2 Sheets—Sheet 2.

F. A. SMALL.

ROTARY STEAM ENGINE.

No. 483,726. Patented Oct. 4, 1892.

Fig. 10.

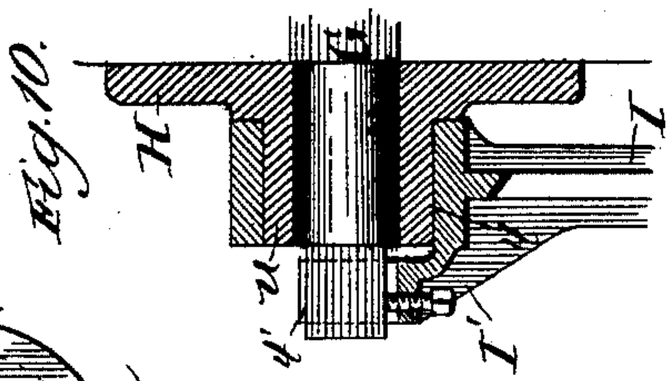


Fig. 4.

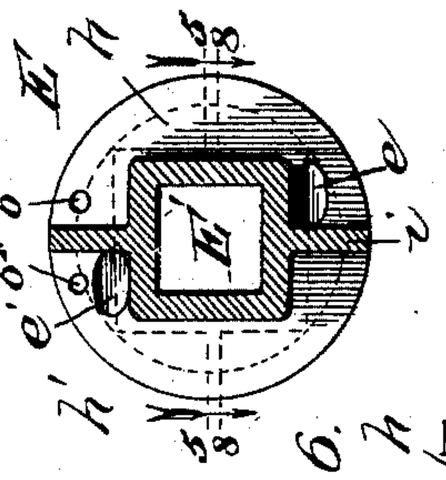


Fig. 9.

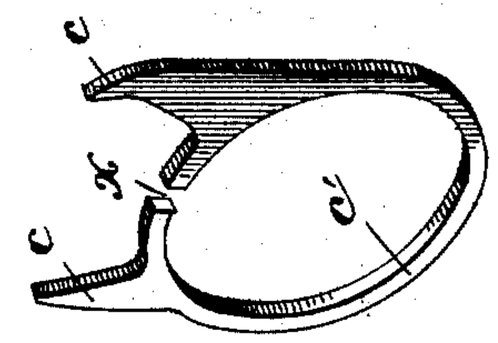


Fig. 6.

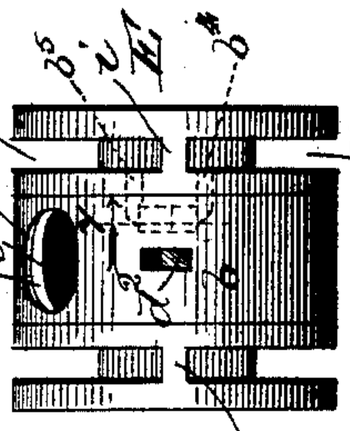


Fig. 5.

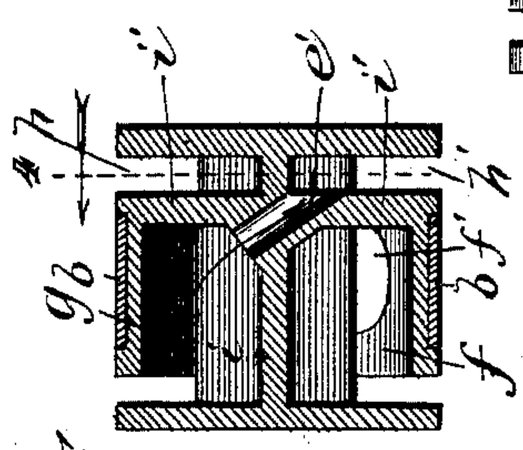


Fig. 7.

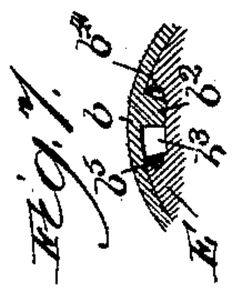


Fig. 8.

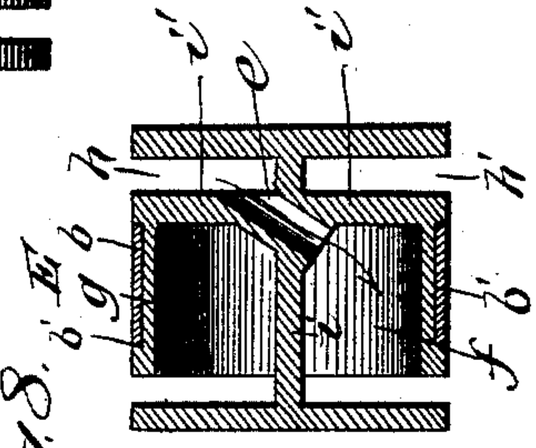
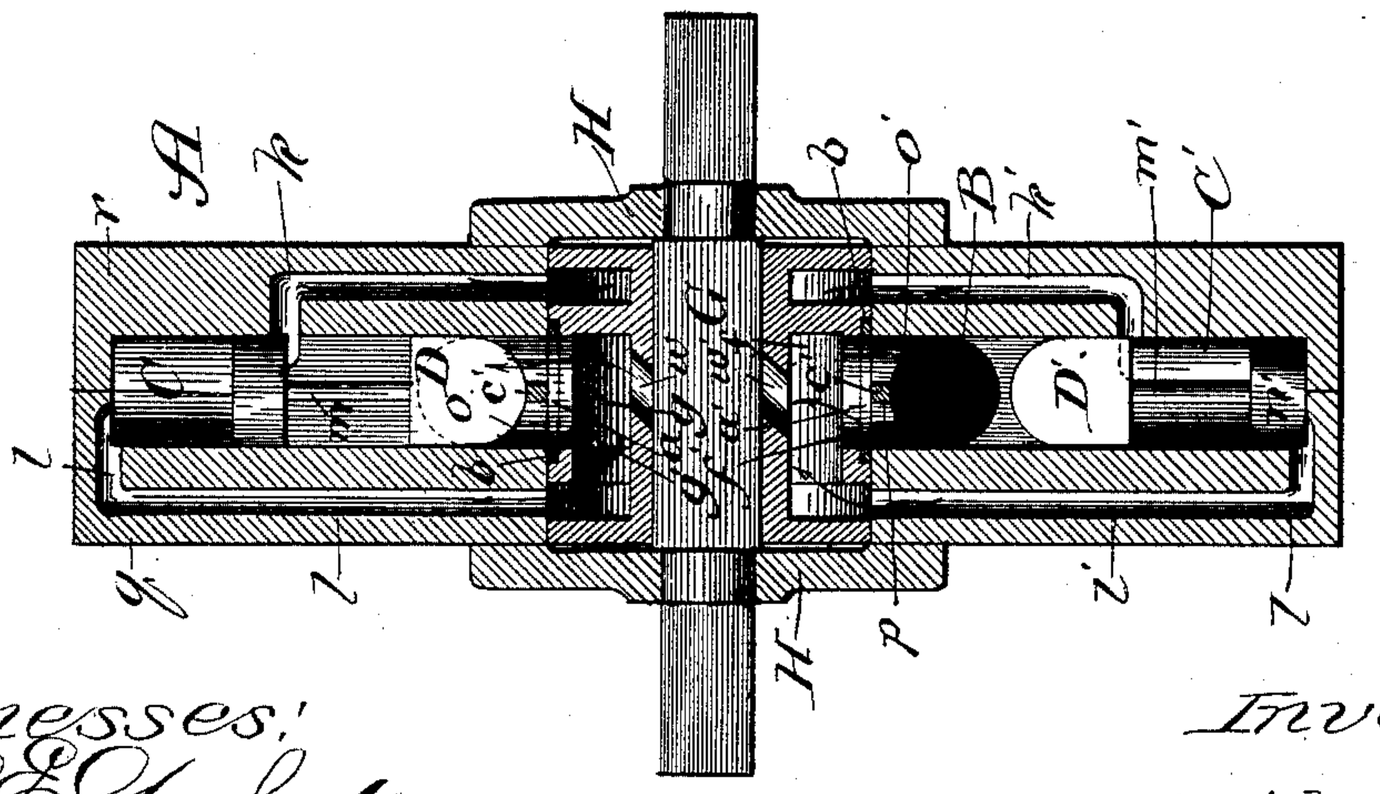


Fig. 3.



Witnesses:
Chas. E. Gaylord.
J. W. Dyrenforth.

Inventor:
Frederick A. Small,
By Dyrenforth and Dyrenforth.
Attys.

UNITED STATES PATENT OFFICE.

FREDERICK A. SMALL, OF BLUE ISLAND, ILLINOIS.

ROTARY STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 483,726, dated October 4, 1892.

Application filed November 3, 1890. Renewed August 20, 1891. Again renewed March 5, 1892. Serial No. 423,844. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK A. SMALL, a citizen of the United States, residing at Blue Island, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Rotary Steam-Engines, of which the following is a specification.

The object of my invention is to provide a rotary steam-engine which shall be easily and reliably operative by the expansive force of steam without undue consumption of the steam for the amount of work done and which shall be reversible to adapt it to be worked in either direction of rotation.

My improvement is illustrated in the accompanying drawings, in which—

Figure 1 is a view in sectional side elevation of my improved rotary engine, the section being taken at the line 1 on Fig. 2 and viewed in the direction of the arrow. Figs. 2 and 3 are sections taken, respectively, on the lines 2 2 and 3 3 of Fig. 1 and viewed in the direction of the arrows. Fig. 4 is a cross-sectional view of the steam and exhaust chest, the section being taken on the line 4 of Fig. 5 and viewed in the direction of the arrow. Fig. 5 is a section taken on the irregulur line 5 5 of Fig. 4 and viewed in the direction of the arrows. Fig. 6 is a view in elevation of the steam-chest. Fig. 7 is a section taken on the line 7 of Fig. 6 and viewed in the direction of the arrow. Fig. 8 is a section taken on the irregular line 8 8 of Fig. 4 and viewed in the direction of the arrows. Fig. 9 is a perspective view of a detail. Fig. 10 is a broken sectional view showing a modification in a detail of construction.

A is an annular disk or wheel formed, preferably, in two sections *r* and *q*, fastened flatwise together. The disk A contains a steam-expansion chamber B, extending inward from near its inner periphery and encircling the latter and which is most readily formed by grooving out each section on its inner side near its inner periphery to form a recess of semicircular shape in cross-section, whereby when the two sections are adjusted together the semicircular grooves will coincide and form the circumferential chamber. The chamber B is provided circumferentially with a slot *p* in its base, (meaning the part bounding the inner periphery of the annular disk,) and this slot is widened to form ports *o* and *o'*, shown as two in number and diametrically opposite each other, though they may be differently disposed relatively and more than two in number.

C and C' are steam-chambers formed radially in the body of the disk A to correspond with the ports *o* and *o'*, thus being diametrically opposite each other. In the respective chambers are piston-heads *n* and *n'* on rods *m* and *m'*, extending toward the chamber B and carrying at their inner ends valves D and D', adapted by their form when brought to the inner ends of their play to fit the chamber B transversely, and thus effectually close and obstruct the passage through it. Steam-ducts *l* and *l'* lead through the disk A from (outside of) one side of the expansion-chamber B, respectively, into the outer ends of the chambers C and C', or into them at least beyond the outward limits of play of the piston-heads therein, and open at the inner periphery of the disk, and similar ducts *k* and *k'* lead from the opposite side of the chamber B, respectively, into the chambers C and C' at or near the inward limits of play of the piston-heads.

E is the steam and exhaust chest, which is stationary, and forms with its support, hereinafter described, the axis about which the disk A is rotated. As shown, it has the form of a short hollow cylinder, thus conforming to the annular opening in the disk A, which it fits. The cylinder E is formed with a preferably-angular central chamber E', Fig. 4, extending longitudinally through it from one end to the other in a vertical partition *i*, divided longitudinally by the chamber E', and near one end of the chamber E' is a transverse diaphragm *i'*, forming a separate compartment at one end thereof, divided by the partition *i* into two chambers *h h'*. The ends of the cylinder are closed, as represented, around the longitudinal angular chamber E', which, as will be seen, with the partition *i* divides the cylinder E longitudinally into two separate chambers *g* and *f*, either of which may be for steam and the other for exhaust, the first-named being provided in its periphery with a port *g'* and the other with a port *f'*, both of which are so disposed that in the rotation of the disk A they will be passed

over by the ports *o* and *o'*, leading to the expansion-chamber B. The end chamber *h* communicates with the chamber *f* through a diagonally-disposed duct *e*, Fig. 8, and the end chamber *h'* communicates with the chamber *g* by a similarly-disposed duct *e'*, Fig. 5, the ducts being formed through the diaphragm *i'* near its center.

F is an abutment in the expansion-chamber B. As shown, it involves the construction I prefer for it of a head *d*, pivotally supported between its ends on a rigid bracket d^2, extending into the chamber B from the periphery of the cylinder E, and at each end of the head *d* I fasten between washers, as represented in Fig. 1, a metal expansion-ring *d'*, (or more than one such ring,) involving the usual construction of a diagonally-split ring and which is adapted to maintain its desired snug fit in the chamber B, even with increase in its diameter by wear. To prevent the valves D and D' from striking against the abutment F, say particularly when the disk A is being turned around by hand to bring parts of the machine into desired juxtaposition or at any time when there is no steam on for operating the valves in the manner hereinafter described, and generally as a precautionary means for protecting the valves against striking the abutment, I provide the cam-guides *c* at opposite ends of the abutment, employing as a means for their application a narrow ring *c'*, filling the slot *p*, and from the periphery of which the cams project, as shown, into the chamber B, the ring surrounding the cylinder E, and being severed, as shown at *x* in Fig. 9, to abut at its severed ends against opposite sides of the bracket d^2.

In the exterior surface of the cylinder E, I form circumferentially thereof a recess *b'* to receive a band *b*, (which the ring *c'* immediately surrounds,) having openings *a* and *a'* in it to coincide, respectively, with the ports *g'* and *f'* in the cylinder E, the said openings being so arranged relatively that when one completely covers one of said ports the other extends only part way over the other port, thereby to afford the full dimensions of the exhausting-port for the exhaust and to reduce the ingress-port for the steam to afford a comparatively-small area for the supply-opening. The band *b* is applied to the steam and exhaust chest to adapt it to be shifted to regulate automatically the ports for the purpose described by providing to that end an abutment b^2, (see Fig. 7,) which enters a countersink or chamber b^3, wider or longer than the said abutment and which is flanked by the ports of ducts *b* and b^5, communicating, respectively, with the chambers *h* and *h'* in the cylinder E. To permit the shifting of the band *b*, the opening b^6 in it, at which it surrounds the bracket d^2, is made accordingly large, as indicated in Fig. 1. The ring *c'* fits closely the circumferential slot *p* in the base of the steam-expansion chamber B to preclude entrance of steam into the chamber at points other than the steam-inlet port.

G is the stationary supporting-shaft for the cylinder E. It is angular, as shown, where it is contained in the cylinder within the angular chamber E', circular where it passes through the heads H H, which are secured to opposite sides of the wheel A to revolve with it, and to that end may, as represented in Fig. 2, support the disk on the rounded portions of the shaft G, and again angular toward its opposite ends, where it is supported in angular bearings *t* on standards I. Thus, as will be seen, the axis of the disk A, and which includes the cylinder E, is stationary, and it may also support the disk to be revolved around its said axis. It is deemed preferable, however, not to support the disk on the shaft G, but to provide a separate support for it, which may be afforded by the construction illustrated in Fig. 10, wherein only one end of the machine is shown, because the other end is intended to involve the same construction and need not, therefore, be represented. In that figure the bearing *t* on the upper end of the standard I is circular to receive the externally-circular hub *u* of the head H, the hub closely fitting its bearing and having the opening through it of larger diameter than the portion of the shaft G which passes through it, and the square end of the shaft is supported in a bearing *t'* in a branch I', extending from the standard I. The shaft G also contains the ducts *v* and *v'*, leading into it from opposite ends toward its longitudinal center, whence they are directed, respectively, to openings *w* and *w'* in opposite sides of the angular chamber E', and which lead, respectively, into the chambers *g* and *f*.

The operation is as follows: Steam from the supply (not shown) is admitted into the duct *v* or the duct *v'* to cause it to enter the chamber *g* or the chamber *f*, depending on the direction desired for the rotation of the wheel A. When it is admitted into one of the chambers *g* or *f*, the other forms the exhaust-chamber. For the purpose of the following explanation of the operation of my improved engine the rotation of the disk A may be regarded as being in the direction in which it would be driven by steam admitted to the chamber *g*. Then by such admission the initial work of the steam will be to enter through the duct *l* the chamber C and force the piston *n* inward, thereby causing the valve D to enter and close the passage through the expansion-chamber B, and it will also be to enter the end chamber *h'* through the diagonal duct *e'*, and thence gain access through the duct *k'* to the chamber C' at the inner side of the piston *n'* therein, thereby forcing that piston to and holding it at its outer position, whereby the valve D' is withheld from obstructing the chamber B. In the initial operation the relative positions of parts are such as to cause the ports *o* and *g'* and *o'* and *f'* to coincide,

respectively. A further effect of the aforesaid steam admission is to cause it to enter the duct b^4 (see Fig. 7) and operate against the abutment b^2 or piston on the band b to shift the latter in the direction to bring and hold the opening a part way over the port g' and the opening a' entirely coincident with the port f'. The steam also enters through the ports g' and o the disk-chamber B, wherein it expands against the abutment F and valve D, and through the medium of the latter causes rotary movement of the disk A, which in rotating moves its port o past the port g', thereby shutting off the supply of steam to the chamber B. The expansive force of the steam turns the disk A around until its port o reaches the port f' in the exhaust-chamber f of the cylinder E, into which the expanded steam exhausts, and it also brings the duct l' to the steam-supply chamber g, the duct k' to the end chamber h', into which steam is admitted, as aforesaid, through the diagonal duct e', thereby forcing the piston n' inward and the piston n outward, the movement having, furthermore, permitted the steam at the outer side of the piston n and that at the inner side of the piston n' to exhaust by bringing the duct l to the exhaust-chamber f and the duct k' to the end chamber h, which communicates with the said exhaust-chamber through the diagonal duct e. Such rotation of the disk A likewise brings its port o' into coincidence with the steam-inlet port g' in the chamber g of the cylinder E, thereby again admitting steam into the expansion-chamber B to expand against the valve D', then obstructing the passage, and through the medium of the last-named valve continuing the rotation. It will thus be seen that the continued rotation of the disk is produced in the manner already described—namely, by admitting steam to the chamber B successively through the ports o and o' as they are brought in succession to the steam-inlet port to cause the steam to expand in that order against the valves D and D', which are simultaneously reciprocated in the directions necessary to cause one to close the expansion-chamber while the other opens it, and by exhausting the steam from behind one valve while fresh steam is being admitted behind the other. By using the chamber f as the steam-chamber and the chamber g for exhaust the direction of rotation of the wheel A will be reversed.

While I have described and hereinafter claim my improved engine as operated by steam, I intend its use with any other fluid as the motive power, as gas, to be included within the spirit of my invention.

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

1. A rotary steam-engine comprising, in combination, a non-rotary cylinder divided internally into at least four chambers having ports, one of each pair of said chambers forming a steam-chamber and the other an exhaust-chamber, the steam-chambers being respectively on different sides in the hollow axis and intercommunicating and the exhaust-chambers being similarly disposed and intercommunicating, a rotary wheel supported independently of the said cylinder to surround it and containing an inner peripheral steam-expansion chamber provided with ports to communicate with a pair of the said steam and exhaust chambers in the cylinder, valves supported to work in chambers on the wheel containing pistons and communicating from opposite sides of the pistons, respectively, with the members of the said other pair of steam and exhaust chambers in the hollow axis, and a stationary abutment in the said expansion-chamber supported from the cylinder, substantially as described.

2. In a rotary steam-engine having a wheel and a non-rotary cylinder about which the wheel is supported to rotate and through which the steam for driving the wheel is directed to expand against it, a steam-expansion chamber surrounding the inner periphery of the wheel and having a circumferential slot-opening, a stationary abutment inside the said expansion-chamber, and a ring-section surrounding the cylinder and extending into the said slot-opening, substantially as and for the purpose set forth.

3. In a rotary steam-engine, the combination of a non-rotary cylinder divided internally into chambers having ports, ducts leading to the said chambers, an annular wheel supported to surround and be rotated about the cylinder and containing a steam-expansion chamber surrounding its inner periphery and having ports, valves for the expansion-chamber, a stationary abutment supported from the cylinder in the expansion-chamber, and means, substantially as described, for closing the said expansion-chamber to a steam-supply port immediately after its port has passed the latter, thereby utilizing the expansive force of the steam in driving the wheel, substantially as set forth.

4. In a rotary steam-engine, the combination of a non-rotary cylinder E, divided internally into chambers g and f, having ports g' and f', a diaphragm i', forming end chambers h and h' in the cylinder, communicating, respectively, with the chambers f and g, ducts v and v', an annular wheel A, supported to surround and be rotated about the cylinder and containing a steam-expansion chamber B, surrounding its inner periphery and having ports o and o', chambers C and C', formed radially in the wheel and containing piston-heads n and n', having valves D and D' connected with them, ducts k and k', leading into the said piston-chambers near the inner ends of the play of the piston-heads from the plane of the chambers h and h', and a stationary abutment F, supported from the cylinder in the expansion-chamber, substantially as described.

5. In a rotary steam-engine, the combination of a non-rotary cylinder E, divided in-

ternally into chambers g and f, having ports g' and f', a diaphragm i', forming end chambers h and h' in the cylinder, communicating through the diagonal ducts e and e', respectively, with the chambers f and g, ducts v and v', leading to the chambers g and f, an annular wheel A, supported to surround and be rotated about the cylinder and containing a steam-expansion chamber B, surrounding its inner periphery and having ports o and o', chambers C and C', formed radially in the wheel and containing piston-heads n and n', having valves D and D' connected with them, ducts l and l', leading into the said piston-chamber near the outer end of the play of the piston-head and communicating with the cylinder near one end, ducts k and k', leading into the piston-chambers near the inner ends of the play of the piston-heads from the plane of the chambers h and h', and a stationary abutment F, supported from the cylinder in the expansion-chamber, substantially as described.

6. In a rotary steam-engine, the combination of a non-rotary cylinder divided internally into chambers and having ports g' and f', ducts v and v', leading to the chambers, a shifting band b, having openings and surrounding the cylinder and provided with an abutment b^2, extending into a chamber b^5 in the outer side of the cylinder, ducts b^3 and b^4, leading into the chamber b^5 at opposite sides of the said abutment and communicating with the chambers in the cylinder and an annular wheel A, supported to surround and be rotated about the cylinder, a steam-expansion chamber B in the wheel, surrounding the inner periphery thereof and having ports o and o', valves D and D' for the expansion-chamber, and a stationary abutment F, supported from the cylinder in the expansion-chamber, substantially as described.

7. In a rotary steam-engine, the combination, with the non-rotary cylinder E, wheel A, supported to surround and be rotated about the cylinder and provided with the steam-expanison chamber B, of the reciprocating valves D and D' in the wheel, a stationary abutment F, supported in the expansion-chamber from the cylinder, a ring c', loosely surrounding the cylinder E and forming the closure for the expansion-chamber B, and cam-guides c on the ring at opposite ends of the abutment, substantially as and for the purpose set forth.

FREDERICK A. SMALL.

In presence of—
J. W. DYRENFORTH,
M. J. FROST.