(No Model.)

3 Sheets—Sheet 1.

J. HARRINGTON.

ROTARY ENGINE.

No. 310,053. Patented Dec. 30, 1884.

Fig. 1.

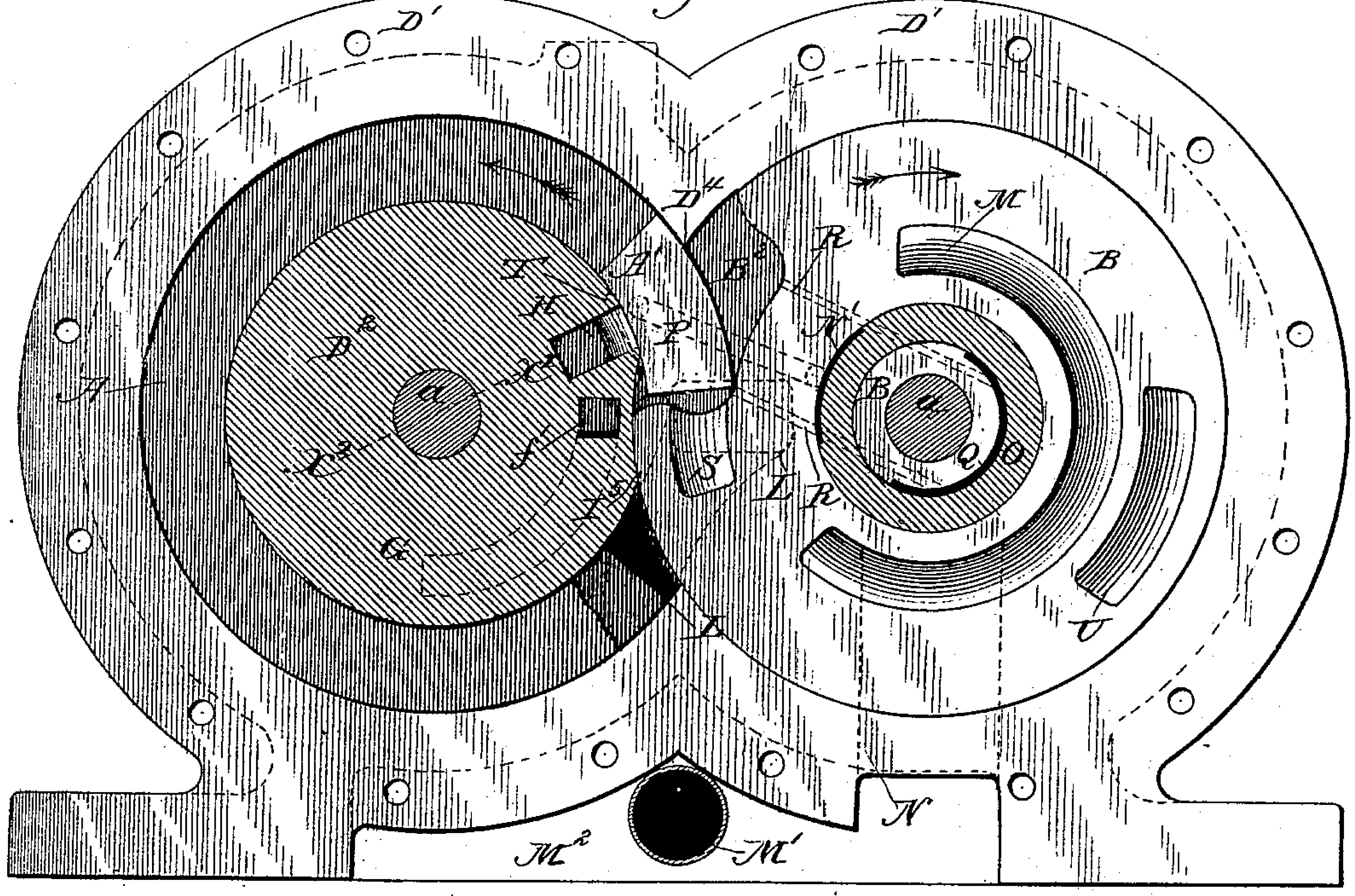
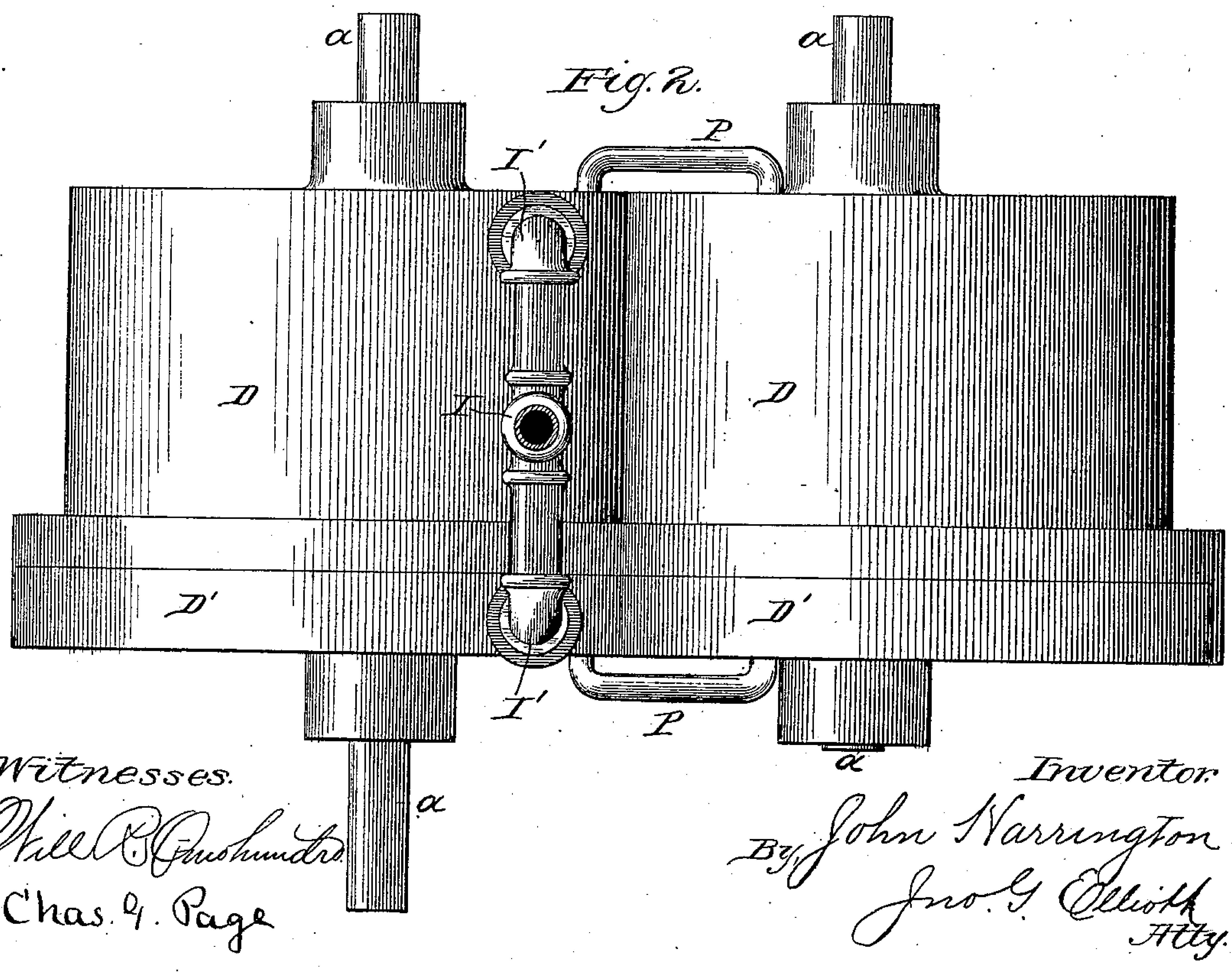


Fig. 2.



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(No Model.)

3 Sheets—Sheet 2.

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ROTARY ENGINE.

No. 310,053. Patented Dec. 30, 1884.

Fig. 3.

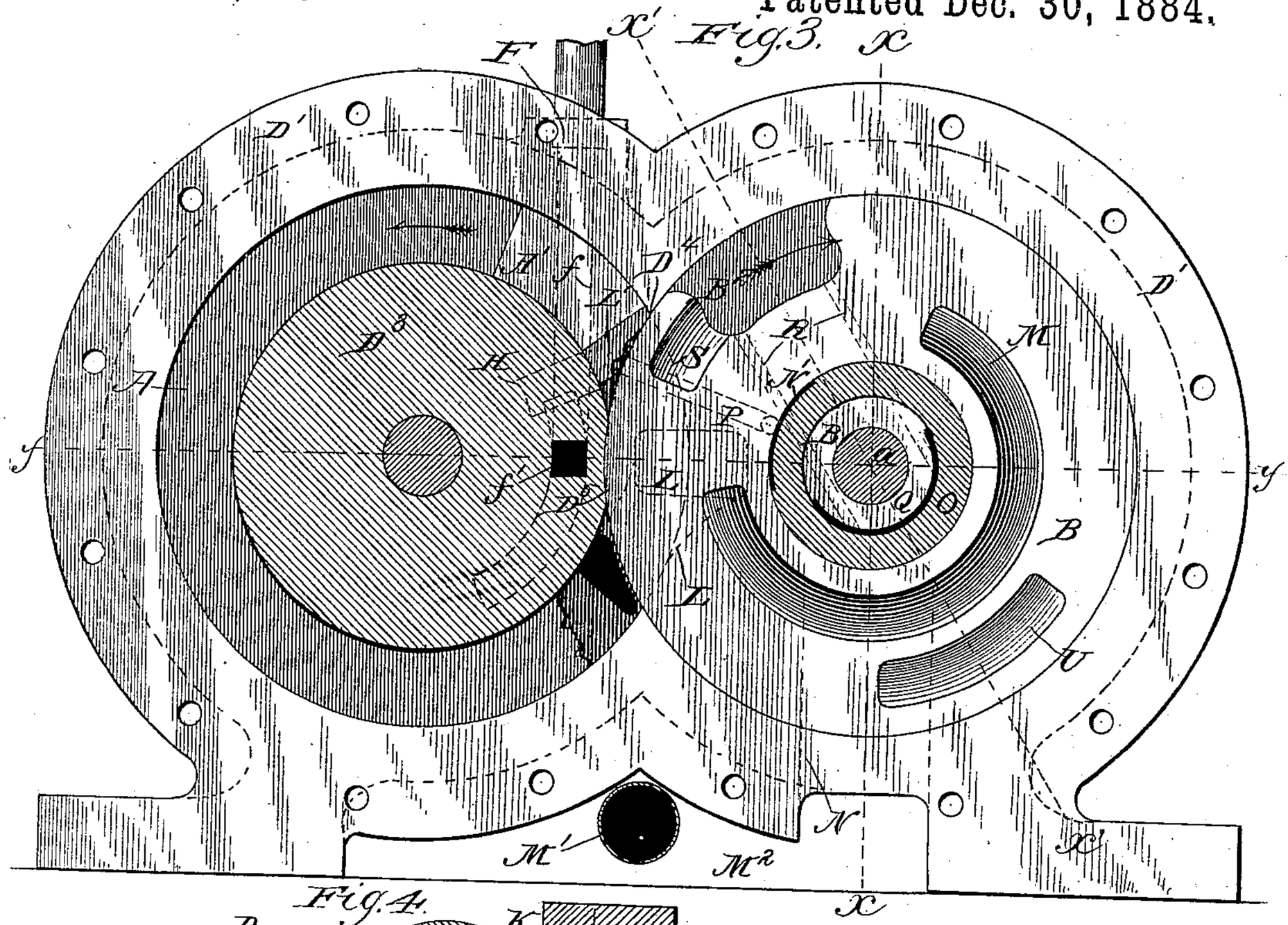


Fig. 4.

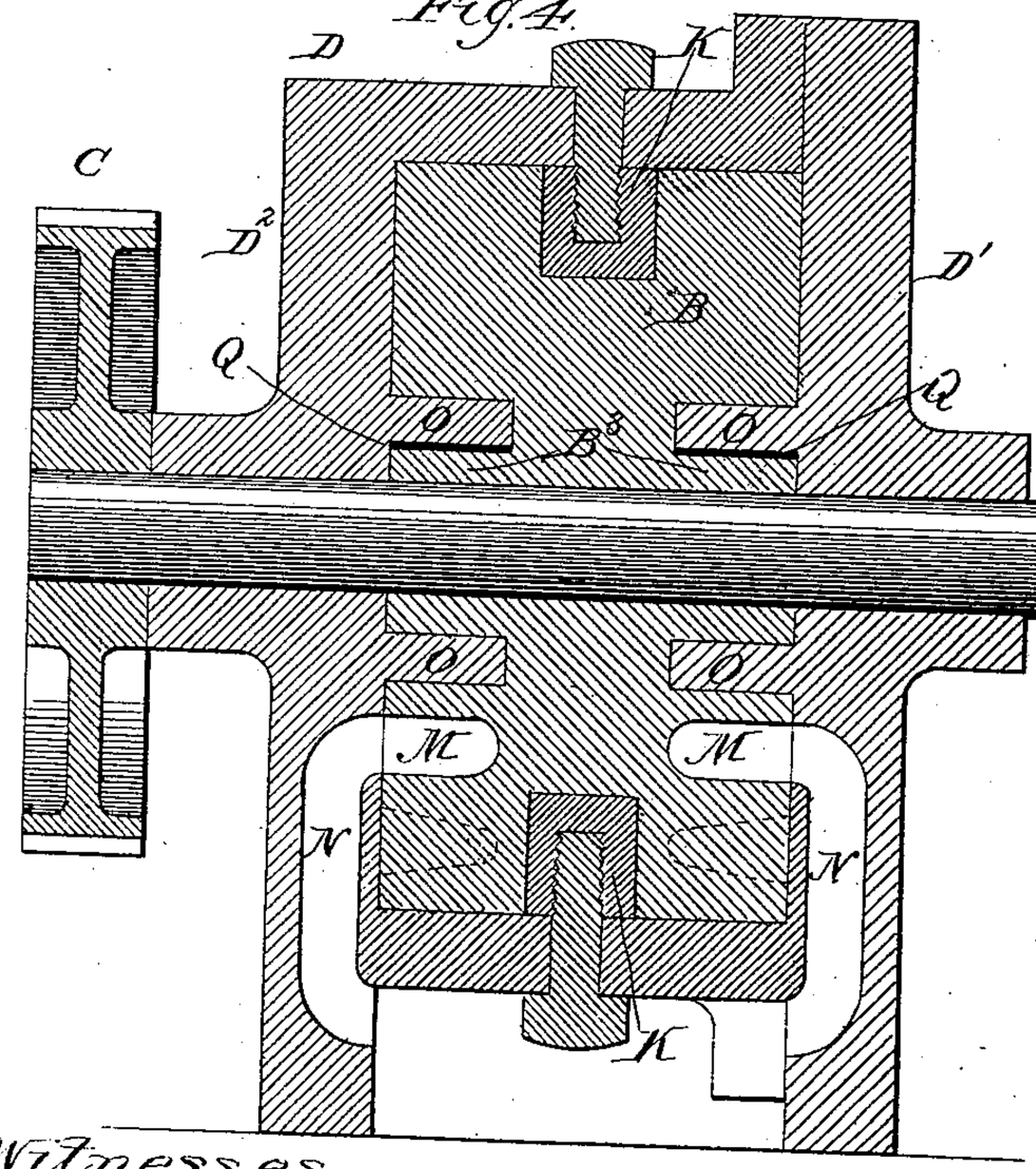
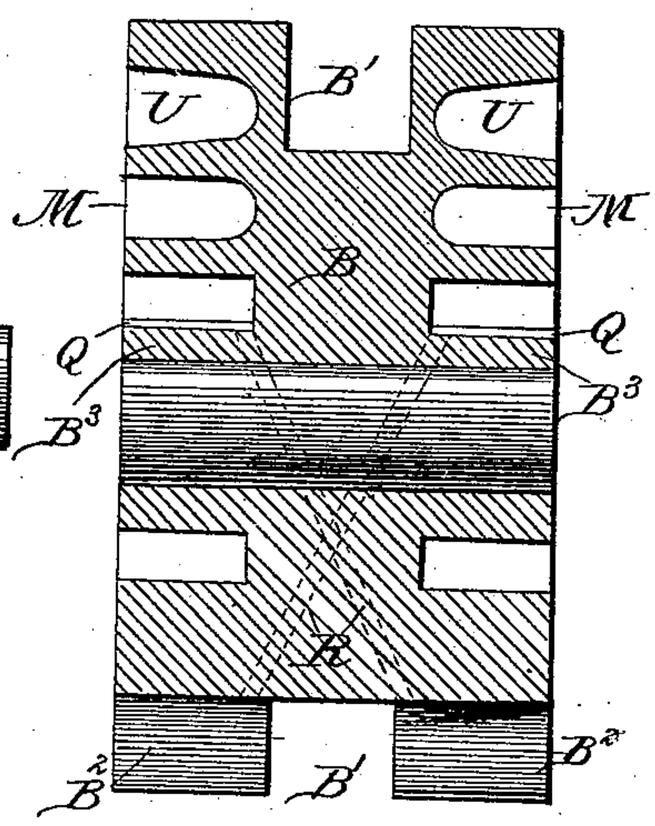


Fig. 5.



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(No Model.) 3 Sheets—Sheet 3.

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ROTARY ENGINE.

No. 310,053. Patented Dec. 30, 1884.

Fig. 6

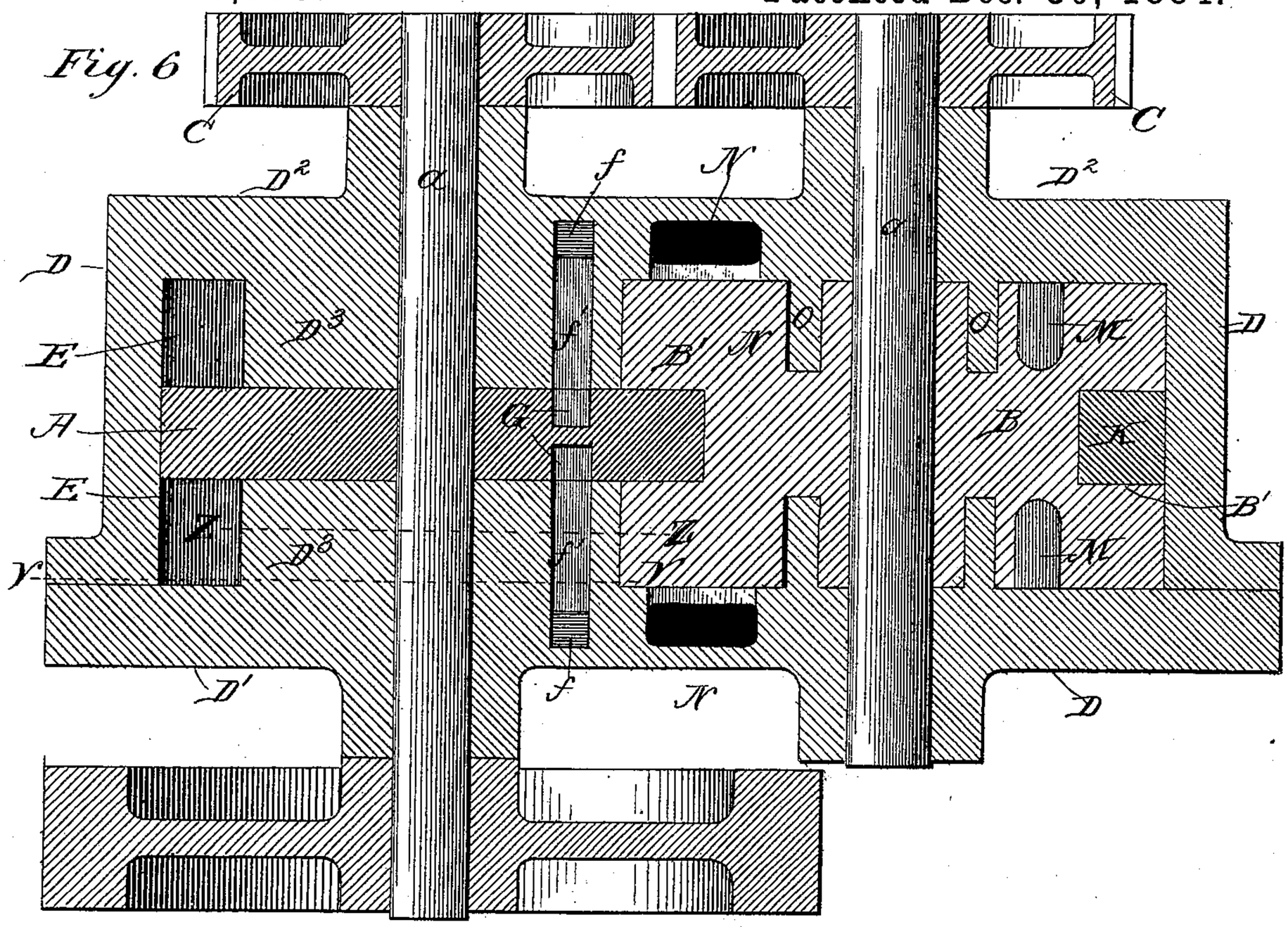


Fig. 7.

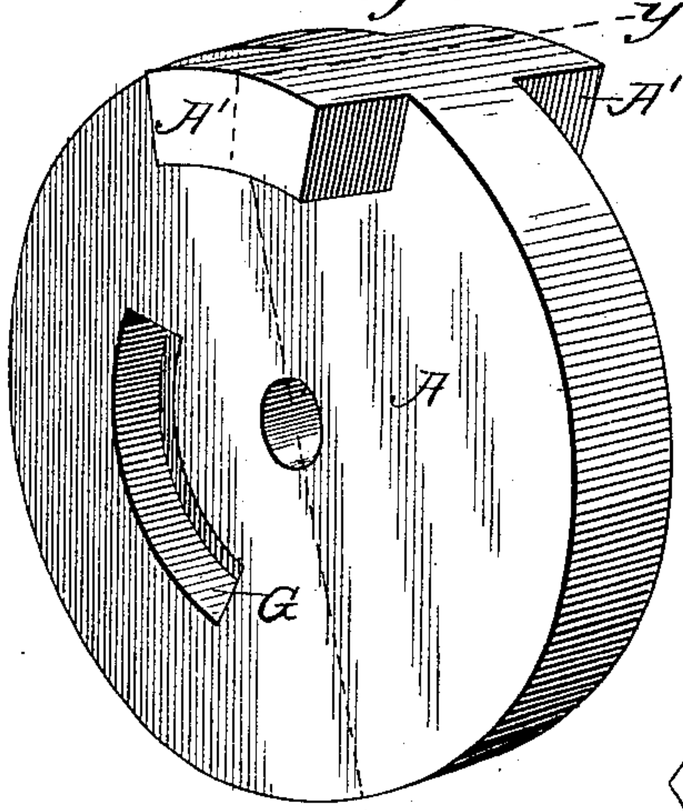


Fig. 8.

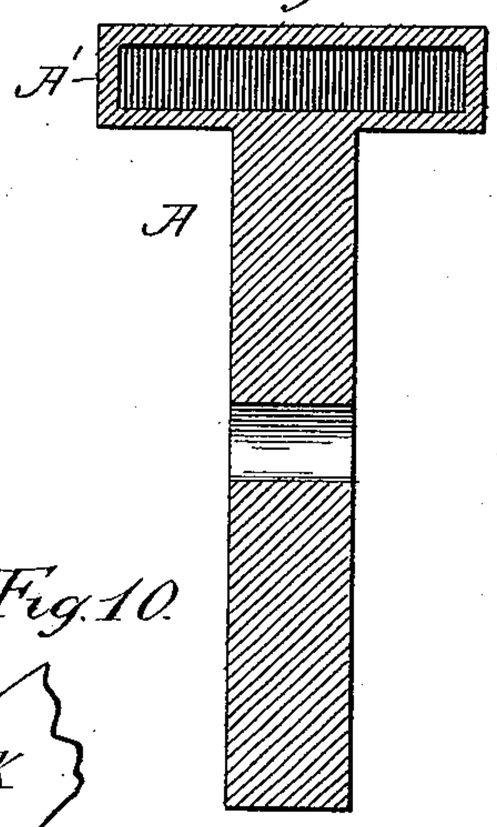


Fig. 9.

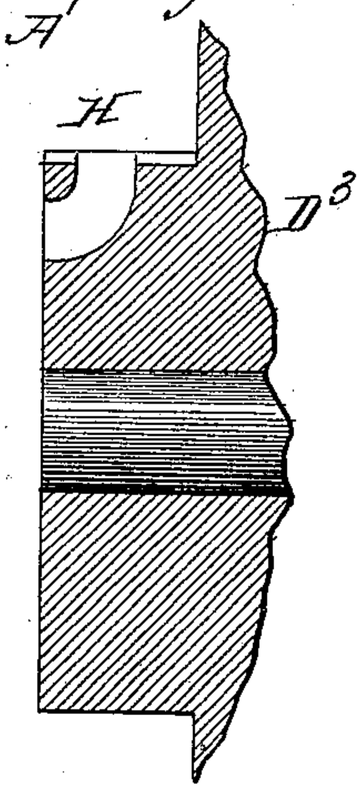
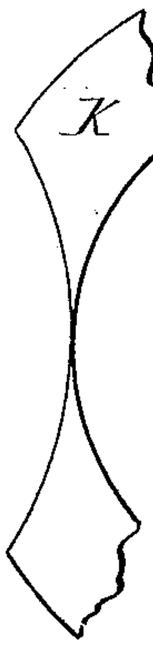


Fig. 10.



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UNITED STATES PATENT OFFICE.

JOHN HARRINGTON, OF CALDWELL, KANSAS.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 310,053, dated December 30, 1884.

Application filed February 6, 1884. (No model.)

To all whom it may concern:

Be it known that I, JOHN HARRINGTON, a citizen of the United States, and residing in Caldwell, county of Sumner, and State of Kansas, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

An object of this invention is to economize steam or other analogous agency employed in rotary engines; and to such end I propose at each stroke or revolution of the pistons, and at a moment prior to the exhaust and to the admission of live steam, to admit into the clearance-space—that is to say, the space occurring between the pistons and the abutments after the pistons have passed the latter and just prior to taking in live steam from the boiler—a portion of the expanded steam by which the pistons have been driven, whereby prior to taking in live steam there shall be within the clearance-space a steam-pressure equal to a portion of the pressure required to drive the piston, and capable, therefore, of relieving the otherwise required amount of live steam to an extent determined by the cut-off, in which way it will be evident a much less amount of live steam will be required than where the expanded steam back of the pistons is all exhausted at a point back of the abutment.

A further object is to utilize the full force of the steam-pressure against the pistons without allowing it to exert a side pressure either directly or indirectly in a direction radially or tangentially to the shaft with which the pistons revolve, and to such end I divide an annular piston-space having walls rigid with the casing by the rim portion of a revolving piston-disk provided with side pistons, which fill said space transversely.

A further object is to balance the revolving abutment-disk in a rotary engine both with reference to the steam-pressure exerted against the face of the abutment-disk and with reference to such portions of the disk from which material has been removed to form a piston-pocket; and to such end I provide steam-spaces between certain inner working-faces of the abutment-disk and bearings located at points between the face of the disk and the shaft upon which the disk is secured, and admit into such spaces steam capable of exerting a pressure that shall counterbalance the steam-pressures against the face of the disk, whereby there will be no undue friction occurring between the said shaft and its bearings. Also, I remove certain portions of the abutment-disk to an extent proportionate to the material removed to form the pocket, whereby the disk shall be mechanically balanced.

A further object is to provide certain improved details of construction in a rotary engine having its shell composed of a duplex cylinder—that is to say, a shell having its interior consisting of two equal segment-cylinders—all as hereinafter described and claimed, and illustrated in the annexed drawings, in which—

Figure 1 is an end elevation of a rotary engine embodying my invention and similar to Fig. 3, but partly in section on the line *z z*, Fig. 6, and showing the engine in position for filling the clearance-space with steam previous to exhausting the same before discharging through the final exhaust-ports. Fig. 2 is a top plan view of the engine with the gear-wheels removed, and showing the location of the bent steam-pipes which supply steam, and which form passages for steam balancing the steam-pressure on the abutment-disk. Fig. 3 is an end elevation, partly in section on the line *v v*, Fig. 6, with a part of the disk broken away to show the port, said figure showing the engine in a starting position. Fig. 4 is a vertical section taken on the line *x x* of Fig. 3, and shows the relative positions of the abutment-disk, dead-ring, and the cylinder-heads, and also the formation of the final exhaust-ports. Fig. 5 is a section taken on the line *x′ x′*, Fig. 3, but only through the abutment-disk. Fig. 6 is a horizontal section taken on the line *y y* of Fig. 3, and showing the relative positions of the piston, the abutment-disks, and their respective shafts connected at one end by twin gears outside of the cylinder, one of said shafts carrying a belt wheel or pulley. Fig. 7 is a perspective view of the piston-disk detached. Fig. 8 is a section of said disk on the line *y′ y′* of Fig. 7. Fig. 9 is a broken section of the inside hub of the cylinder-head, taken through the steam-port x^2 x^2

of Fig. 1; Fig. 10, a side elevation of the dead-ring, and showing so much of it as is concave to receive the piston-disk.

The essential operative members of this engine include a rotary disk, A, provided with pistons, and termed the "piston-disk," and a second rotary disk, B, subserving the functions of an abutment, and termed the "abutment-disk," in contradistinction to the piston-disk carrying the pistons. These two disks are arranged face to face within the shell, case, or cylinder of the engine, and are rigid upon their respective shafts, *a*, which latter are provided with twin gears C, meshing with each other, in order that a rotation of the piston-disk and its shaft shall cause a rotation on the part of the abutment-disk in a reverse direction.

The general arrangement of the case or shell D of the engine is that of a duplex cylinder—that is to say, its interior is in the nature of two cylinders intersecting each other so as to form segments of equal cylinders, whereby when the two disks are respectively arranged in said segments of cylinders, and each made with a diameter corresponding to the greatest internal diameter of the cylinder-segment in which it revolves, a portion of each disk shall project from one cylinder-segment into the other, and thereby admit of a portion of the piston-disk being received and working in an annular groove formed in and around the periphery of the abutment-disk. This duplex cylinder is closed at its ends by suitable heads, D′ and D², through which the shafts of the piston and abutment disks pass, and each head is provided upon its inner face at a point opposite the piston-disk with a centrally-located hub, D³, extending up to the said disk, and having its perimeter concentric with the interior of the cylinder-segment in which it is arranged, in order to form an annular steam-space, E, for the pistons on the piston-disk. The pistons A′ are located on opposite sides of the piston-disk, and are made to fit in the portions of the steam-space unoccupied by the disk, with the radius of curvature of their inner and outer sides, respectively, corresponding to the perimeter of the hub and the cylindrical interior of that portion of the shell in which the piston-disk is fitted to revolve.

It will be seen under such arrangement that the hubs around which the pistons revolve constitute portions of the shell or casing, and hence as the pistons move in an annular steam-space having its walls, which inclose the pistons, formed of the stationary casing of the engine, the expansive force of the steam exerted within said steam-space to drive the pistons will, while acting in the direction in which the pistons revolve, have no other effect upon the engine, and hence will be incapable of affecting in anywise the balance of the piston-disk.

The steam-induction ports F, one of which is indicated in dotted lines, Fig. 3, into which steam is admitted from some suitable connection with the boiler, are formed through the casing, and disposed so as to intersect concentric steam-grooves G, arranged in the sides of the piston-disk, and adapted, during the revolution of said disk, to connect these induction-ports with short ports or passages H, (see Fig. 1, and also dotted lines, Fig. 3,) that are formed through the hubs D³, and located so as to discharge the live steam at the proper moment into the steam-space back of the pistons.

In Fig. 2 I have illustrated convenient means for admitting steam to the steam-grooves in the piston-disk, the same consisting of an inverted-T pipe, I, connecting the ends of its two arms by bent pipes I′ with the induction-ports F, which latter consist each of a vertical passage, *f*, extending downward through a portion of the cylinder-head, and then running laterally toward the piston-disk, so as to form a horizontal passage, *f′*, which, during the revolution of the disk, will intersect one of the steam-grooves in the latter. These steam-grooves formed in the sides of the piston-disk, as shown in Fig. 7, are of such length as to cut off the steam at one-quarter of the working-stroke or revolution of the engine; but it will be obvious that the said grooves can be made in such manner as to take steam during the entire stroke of the piston.

The abutment-disk is provided in and around its periphery with an annular groove, B′, in which the rim portion of the piston-disk constantly projects, the width of said groove being such that the piston-disk, while accurately fitting in the groove, shall be free to revolve about its axis in a direction reverse to the revolution of the abutment-disk. The piston-disk projects into the grooved face of the abutment-disk to a degree dependent upon the extent to which the two cylinders intersect or run into each other; and hence the depth of the groove is made proportionate to the extent to which the piston-disk will project into the abutment-disk. Thus at all times some portion of the piston-disk will lie in the groove formed in the abutment-disk, and in order to fill up the remaining portion of the groove unoccupied by the piston-disk, so as to prevent the live steam admitted into the space back of the pistons from blowing through at the sharp corners indicated at D⁴, and formed at the intersections of the cylinders, the piston, and abutment disks, I provide a dead-ring, K, fitting within the groove in the abutment-disk, and secured by bolts or analogous means to or otherwise made rigid with the shell or segment-cylinder in which the abutment-disk is arranged. Of this ring a part proportionate to the extent of the piston-disk occupying the groove in the abutment-disk is broken away, and the said ring, while fitting in the groove, is made so as to in no manner interfere with

the free rotation of the abutment-disk. As these two disks intersect each other at the point where the cylinders in which they are respectively located intersect, a portion of the abutment-disk will project into the annular steam-space around the hub D^3, and in order to adapt the abutment-disk to constitute an efficient abutment within said steam-space it is arranged so that at all times some portion of its face at each side of the groove therein, and consequently at each side of the piston-disk working in said groove, shall extend into a concavity, D^5, formed in the perimeter of each one of the hubs D^3. In this way the annular steam-space traversed by the pistons is at a point on a right line between the axes of the two disks filled by a portion of the abutment-disks, and hence allows the pistons to pass the abutment-disk. This latter is provided in its periphery with a notch or pocket, B^2, arranged at such point in the disk that during each revolution of the two disks it shall meet the pistons, which latter will fit in the pocket when the pocket and the pistons are on a right line between the axes of the disks.

From the foregoing construction it will be understood that steam from the boiler enters the eduction ports or passages in the cylinder or casing, thence passes into the steam-grooves in the side of the piston-disks so long as these steam-grooves are intersected by the induction ports or passages, and from thence passes through the short ports or passages in the hubs, and enters the steam-space back of the pistons at points between the pistons and the face of the abutment-disk, where it acts directly against the pistons, so as to force the same around in the direction indicated by the arrow.

Prior to exhausting the steam through the exhaust-ports, which will be hereinafter described, I propose utilizing sufficient of the expanded steam by which the pistons have been driven to fill the clearance-space between the abutment-disk and the pistons at the moment occurring after the pistons in their forward revolution have cleared the abutment-disk, and just prior to the exhaust and before taking in live steam from the boiler for such purpose at each revolution of the engine. To such end I provide in each one of the heads of the shell or double cylinder a port or passage, L, partly shown in dotted lines, Figs. 1 and 3, which may be termed a "relief" or "expansion" port, and I arrange these said ports so that before the pistons have completed their forward stroke or revolution they shall pass said expansion-ports, into which latter the expanded steam back of the pistons shall enter as soon as the pistons pass the said ports, and, passing through these ports or passages, issue into the clearance-space prior to the admission of live steam therein. These relief or expansion ports L communicate at one of their ends with the annular steam-space at one side of the abutment which is at all times formed by some portion of the abutment-disk, and at their remaining ends communicate with the steam-space at the opposite side of the said abutment, the direction of one of these ports being shown in dotted lines, Figs. 1 and 3. The expanded steam, entering these relief or expansion ports after the pistons pass the latter, passes through said ports or passages while the pistons and the pockets are passing a right line between the axes of the two disks, and as the pistons are in the act of leaving the pockets the expanded steam enters the pocket from the discharge end of the expansion-ports, which are located so as to communicate with the pocket at the period of the operation of the engine. This pocket is made of a greater area than the combined size of the pistons, in order that the pistons shall not strike the walls of the pocket during operation, and also so that as the pistons leave the pocket a passage shall be afforded for expanded steam admitted into the pocket to pass into the clearance-space occurring between the pistons and the abutment-disk after the pistons have left the pocket and up to the point of exhaust and of the admission of live steam from the boiler. The clearance-space L′ will thus be filled with steam at a pressure corresponding with the expansive force of the expanded steam determined by the extent of cut off—that is to say, if, for example, the steam in the cylinder is cut off at eighty pounds pressure at one-half stroke, the pressure of the expanded steam in the clearance-space will represent a pressure of nearly forty pounds, which would be equivalent to relieving the required pressure of live steam one-half, and thereby require but one-half of the live steam, which, if alone employed, would be eighty pounds, assuming the steam to be cut off at eighty pounds pressure.

This mode of utilizing a portion of the expanded steam in place of simply exhausting the same at or before the time the pistons are passing and clearing the abutment will obviously effect a great saving in steam, and hence effect a like saving in the cost of fuel required to run the engine, and also in case of any condensation of steam tending to create a vacuum within the clearance-space the admission of the expanded steam into the latter will entirely avoid the occurrence of such objectionable features.

The induction of live steam from the boiler should commence as nearly as possible at the time of the exhaust, and in order to effect the latter I provide in each side of the abutment-disk a concentrically arranged steam-groove, M, which said grooves communicate with the exhaust-ports N, that are formed in the heads of the shell or double cylinder, and arranged to meet the concentric steam-groove in the abutment-disk. These exhaust-ports are shown in the sectional view, Fig. 6, and also in dotted lines in Figs. 1 and 3, and communicate in any suitable way with a pipe for carrying off the exhaust-steam—as, for example, the lower

ends of the exhaust ports or passages can open into a hollow base, M′, for the engine, from which said base a pipe, M², may lead to any suitable point.

The concentric steam-grooves M in the abutment-disk are arranged so that at or about the moment steam from the boiler is admitted into the steam-space back of the pistons said grooves shall be in communication with the discharge end of the relief or expansion port or passage, as illustrated in Fig. 3, in which the pistons are illustrated as having cleared the pocket in the abutment-disk and also one of the concentric steam-grooves in the steam-disk, (shown in dotted lines,) in position to establish communication between one of the induction-ports and one of the ports formed in the hub and opening into the steam-space between the piston and the abutment, it being understood at this moment in the operation of the engine communication is established between both of the induction-ports and the steam-space between the abutment and each piston in order to drive the piston. The steam-pressure in said steam space against the abutment is equal to the pressure exerted against the pistons, and as a result there will be an objectionable side pressure on the shaft carrying the abutment-disk, thereby causing undue friction between said shaft and its bearing, and consequently a loss of power, unless some means are provided to counterbalance such pressure; and to such end I provide means for counterbalancing this pressure exerted upon the abutment-disk by the steam in the steam or clearance space L′, which said means consist in a steam space or recess, N′, formed in the periphery of each one of the two ring-hubs, O, which are respectively provided upon the inner faces of the heads of the casing and received in annular recesses formed in opposite sides of the abutment-disks at points around and concentric to the shaft on which the said disk is mounted. These steam-spaces in the faces of the ring-hub, between said hub and the abutment-disk, revolving about the latter, are arranged diametrically opposite the portion of the annular steam-space into which steam is admitted from the boiler, and are connected with said steam-space by conveniently-arranged steam-passages—as, for example, by means of bent pipes P, (shown in full lines, Fig. 2, and dotted lines, Fig. 3)—leading from the annular steam-space to the steam-spaces between the abutment-disk and the hub. These latter steam-spaces are arranged between an interior portion of the abutment-disk and a stationary part of the casing at a point between the axis of the abutment disk shaft and that portion of the steam-space which is between the face of the abutment-disk and the piston, and in which steam is admitted to drive the latter, and hence the pressure exerted by the expansive force of the steam against the abutment-disk will obviously be counterbalanced by the steam-pressure exerted in the said spaces between the abutment-disk and the ring-hub. It will also be seen that whenever the steam-pressure is reduced by reason of expansion or otherwise in the annular piston-space it will be correspondingly reduced in the recesses, thereby balancing the abutment-disk so far as steam-pressure is concerned.

The cut-out or piston-pocket in the perimeter of the abutment-disk will, after the first revolution of the engine, be always charged with steam, which, in exerting a pressure against the interior of the casing and the side and bottom of the pocket, exerts a pressure against the abutment-disk in a direction lateral to the shaft on which the abutment-disk is secured, and hence has a tendency to cause undue friction between the disk and the hubs around which the disk revolves, and also between the shaft and its bearings. In order to therefore counterbalance such pressure, I provide steam-spaces Q in the face of each one of the hub portions B³ of the abutment-disk, and arrange steam-passages R, (shown in dotted lines, Figs. 1, 3, and 5,) leading from the piston-pocket to said steam-spaces Q, whereby steam from the pocket will pass into these spaces in the hubs of the disk. These steam-spaces Q revolve with the abutment-disk, and always occupy the same relative position to the pocket. The steam admitted from the pocket into said spaces will therefore at all times during the operation of the engine serve to counterbalance the pressure of the steam in the pocket against the abutment-disk.

In order to insure the admission of a suitable quantity of steam into the pocket, both for the purpose of supplying steam to the clearance-space between the pistons and the abutment-disk and to the space Q in the interior of said disk, I provide on each side of the disk a short steam-groove, S, opening at one end of the pocket and running back from the latter, as in Fig. 1, so that after the pocket has passed by the discharge end of the expansion port or passage steam from the latter will for a short period, or so long as may be necessary, continue to enter the pocket through the medium of the steam-grooves S in the side of the abutment-disk.

While the pistons are in the act of leaving the pocket, and expanded steam is entering the latter, there will necessarily be a pressure exerted against the outer sides of the pistons, and hence a tendency to cause undue friction between the inner sides of the pistons and the faces of the stationary hubs, around which the pistons travel. In order, therefore, to counterbalance such pressure, I cut away a portion of the face of each hub, so as to provide steam-spaces T (see dotted lines, Fig. 1) at a point which shall be under the pistons when the latter are leaving the pockets in the abutment-disk, steam being supplied to these spaces from the clearance-space.

As a portion of the abutment-disk is neces-

sarily removed in forming the piston-pocket therein, I mechanically balance the said disk by removing portions of the material thereof from the sides at points on opposite sides of the shaft—as, for example, by forming grooves U, so that the material taken out to form such grooves shall compensate for that taken out to form the pocket and the grooves running into the same.

I have in the foregoing illustrated my improvements as embodied in an engine of the simplest construction; but it will be obvious that various changes could be made without departing from the spirit of my invention—as, for example, the admission of steam from the boiler to the annular steam-space could be attained by the employment of an outside valve operated by an eccentric or in any other suitable way; also, if desired, the engine herein illustrated could be made double, and so arranged on the shafts that there shall be no dead-point in its operation; and, further, with any ordinary mechanical skill the engine can readily be made reversible.

While I have described steam as a means for propelling the pistons, it will be evident that gas or compressed air could be utilized as an operating agent, or that the engine could be used as a water-motor.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination, in a rotary engine, of the revolving pistons and an abutment with a passage for conveying expanded steam from a point in the piston-space at one side of the abutment to the clearance-space at the opposite side of the abutment at a moment prior to the admission of live steam from the boiler, substantially as described.

2. The combination, in a rotary engine, of the revolving piston-disk carrying the pistons with the revolving abutment-disk adapted to constitute an abutment in the annular steam-space provided for the pistons, and a passage, substantially as described, for admitting expanded steam from one side of said abutment into the clearance-space at the opposite side of the abutment prior to the admission of live steam from the boiler, substantially as and for the purpose described.

3. The combination, substantially as described, in a rotary engine, of the revolving piston-disk having side pistons with the revolving abutment-disk and the expansion-port opening at its ends into the annular space for the pistons at points located at opposite sides of the abutment, which is formed of the abutment-disk, substantially as and for the purpose described.

4. The combination, substantially as described, in a rotary engine, of the revolving pistons traveling in an annular steam-space with an abutment and ports connecting the steam-space at opposite sides of the abutment, and having their inlet ends located in the path of the pistons, whereby after the latter passes said ends of the ports the expanded steam back of the piston shall enter the ports and pass to the other side of the abutment after the pistons have passed the abutment, substantially as described.

5. In a rotary engine, the pistons fitted and arranged to work in an annular steam-space formed by four fixed annular walls, of which two are in planes concentric with the axis about which the pistons revolve, and the other two in planes at right angles to the said axis, whereby the expansive force of the steam within said steam-space shall not exert a side pressure, either directly or indirectly, against the rotary shaft with which the pistons revolve, substantially as described.

6. In a rotary engine, the revolving disk having its rim portion dividing the annular steam-space formed by four annular stationary walls, substantially as described, and provided with side pistons which transversely fill the portions of the divided annular steam-space at opposite sides of the piston-disk, for the purpose specified.

7. In a rotary engine, a rotary disk provided with side pistons, and having an annular peripheral portion inclosed in an annular steam-space, which is in cross-section entirely filled by the piston and the disk at the points where the pistons occur in the disk, said parts being arranged so that the expansive force of the steam in the annular steam-space shall be incapable of exerting a pressure on the periphery of the disk, substantially as described.

8. In a rotary engine, the combination, with a pair of fixed hubs located centrally within the piston-cylinder, and having their faces concentric with the interior thereof, of the piston-disk revolving between the inner opposing ends of the hubs, and extending beyond the circumference of the hubs to the inner wall of the surrounding annular casing, and provided with side pistons which work in the space between said hubs and the inner side of the piston-cylinder, substantially as described.

9. The combination, in a rotary engine having duplex segmental cylinders, substantially as described, of the rotary abutment-disk having a piston-pocket in its periphery, with a rotary piston-disk intersecting the abutment-disk, and provided with side pistons which work in an annular steam-space formed in one of the segment-cylinders, and centrally divided by the said disk, substantially as and for the purpose set forth.

10. The combination of the duplex segmental cylinder with the revolving piston-disk provided with side pistons, a revolving abutment-disk adapted to constitute an abutment, substantially as described, and the hubs D^3, located within one of the cylinders for the purpose set forth, and provided in their faces with concavities, into which the rim portion of the abutment-disk extends, substantially as described.

11. The combination, substantially as de-

scribed, in a rotary engine, of the revolving piston-disks carrying the pistons with a revolving abutment-disk having a peripheral annular groove on which the rim portion of the piston-disk is secured, and a piston-pocket formed in its perimeter to allow the pistons to pass said abutment, substantially as and for the purpose described.

12. The combination, in a rotary engine, of the revolving abutment-disk with a steam-space located at a fixed point between said disk and a bearing, which is in turn arranged between said disk and the revolving shaft on which the disk is secured, and means for admitting steam into said space to counterbalance steam-pressure against the face of the disk, substantially as described.

13. In a rotary engine, the revolving abutment-disk, in combination with the stationary hubs received in recesses formed in the disk between the shaft on which the disk is secured and the face of the disk, the steam-spaces formed in the faces of the hubs, and passages connecting these steam-spaces with the annular steam-space at or near the point where live steam is admitted into the latter, substantially as described.

14. In a rotary engine, the revolving abutment-disk having in its periphery a piston-pocket, and provided with an internal steam-space communicating with the pocket, and located between a stationary hub, through which the disk-shaft passes, and an inner face portion of the disk working upon said hub, whereby pressure in the pocket shall be counterbalanced by pressure in the internal space in the disk, substantially as described.

15. In a rotary engine, the revolving abutment-disk provided with a piston-pocket in its periphery, and mechanically balanced by grooves cut in its sides, substantially as described.

16. The combination, in a rotary engine, of the duplex segment-cylinder with the revolving abutment-disk, the revolving piston-disk provided with side pistons and with steam-grooves in its sides, the eduction-ports arranged to intersect said steam-grooves, and ports adapted to connect said grooves with the annular piston-space, substantially as described.

17. In a rotary engine in which the piston-disk is provided with side pistons working in an annular steam-space, a steam-cavity formed in the bottom wall of the steam-space at a point opposite the clearance-space, and arranged to communicate with the latter when the pistons are passing said cavity in order to resist pressure against the outer sides of the pistons, substantially as described.

JOHN HARRINGTON.

Witnesses:
W. W. ELLIOTT,
CHAS. G. PAGE.