No. 730,661. PATENTED JUNE 9, 1903.

F. JACOB.

ROTARY ENGINE.

APPLICATION FILED JUNE 10, 1902.

NO MODEL. 6 SHEETS—SHEET 1.

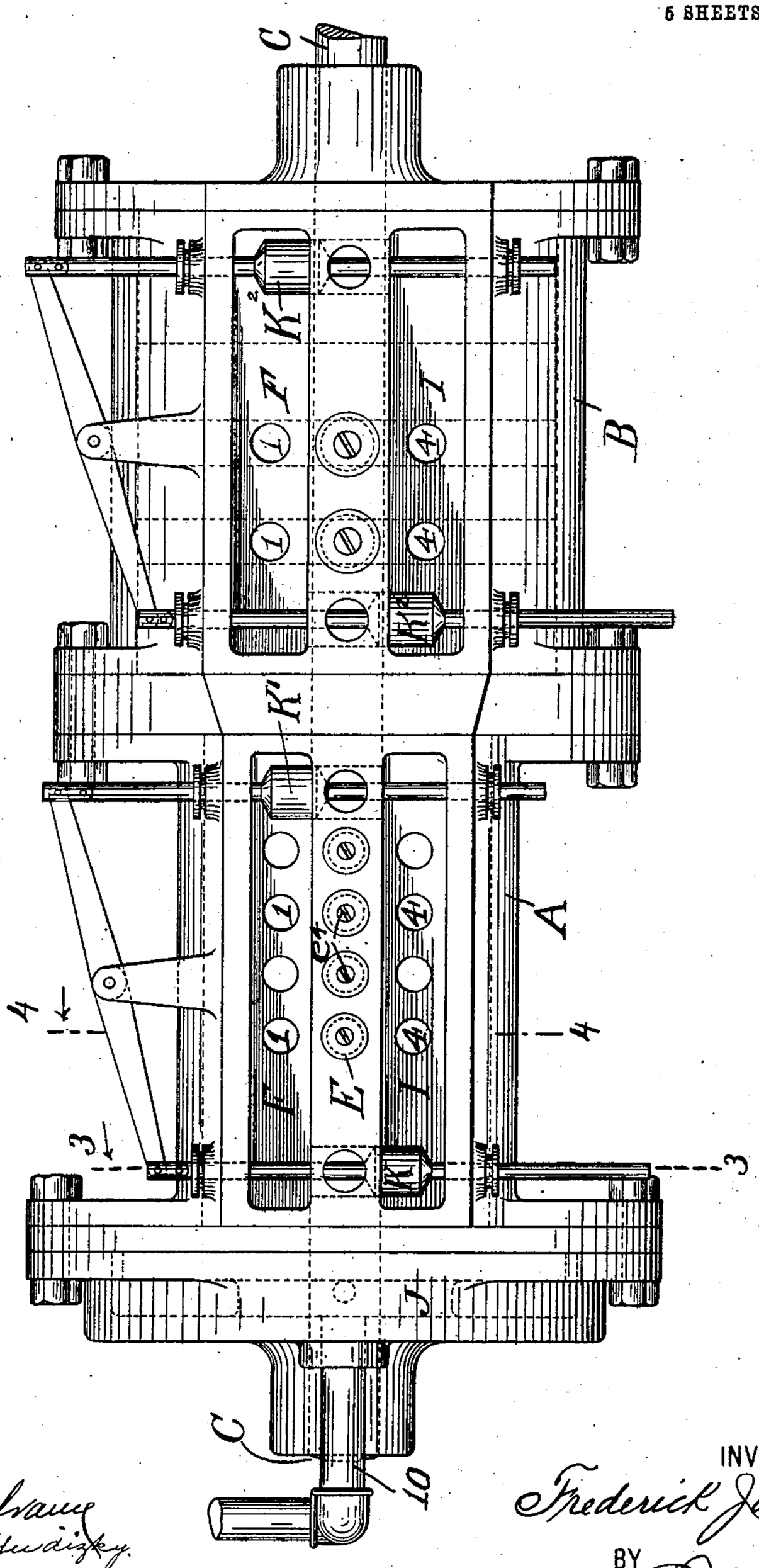

Fig. 1.

WITNESSES:

Geo. W. Eisenbrandt

Raena L. Yurdizky.

INVENTOR:

Frederick Jacob,

BY

Fisher & Bruninga

ATTORNEY.

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NO MODEL. 5 SHEETS—SHEET 2.

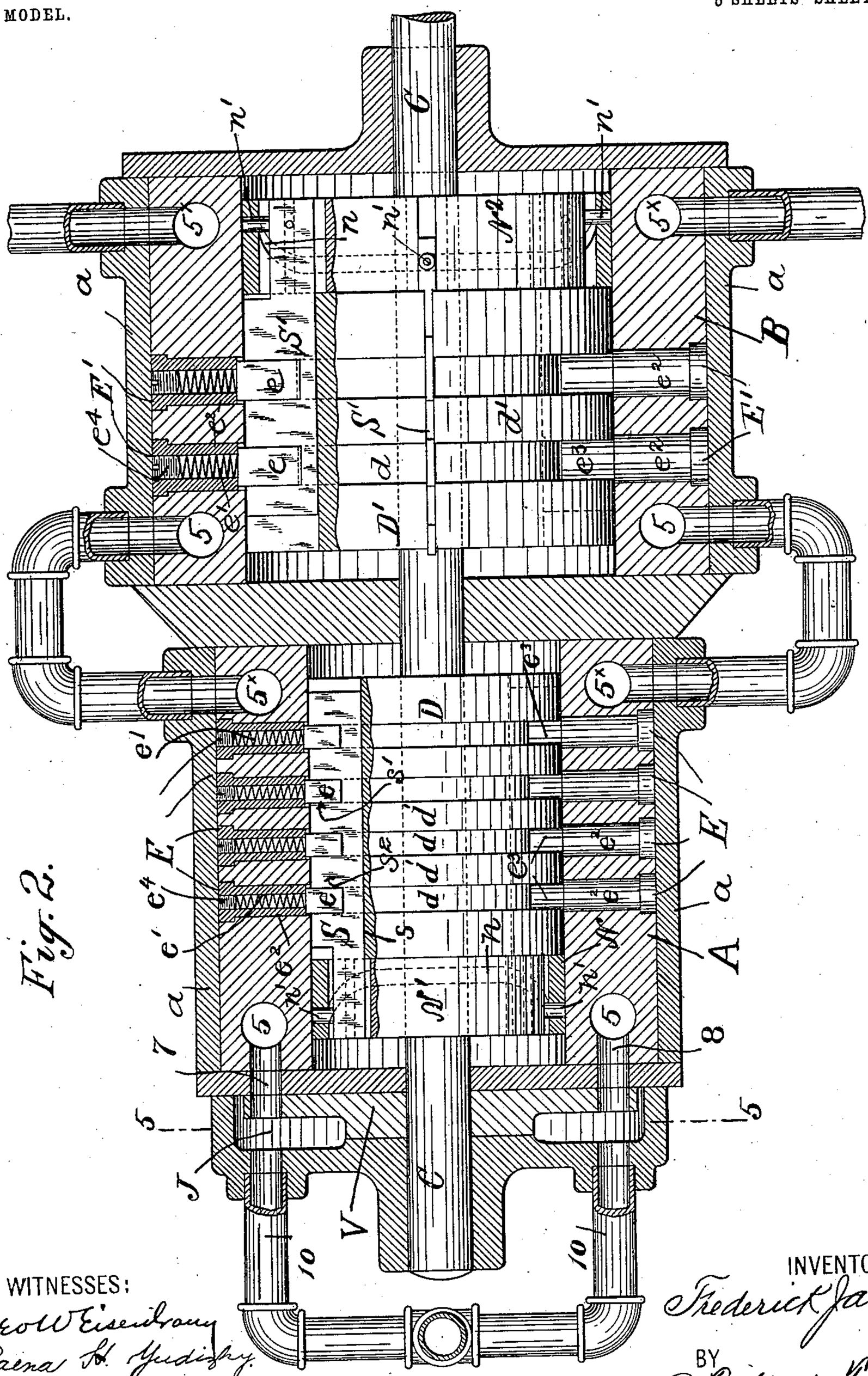

Fig. 2.

WITNESSES:
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Raina L. Yudisky.

INVENTOR:
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BY
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NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.

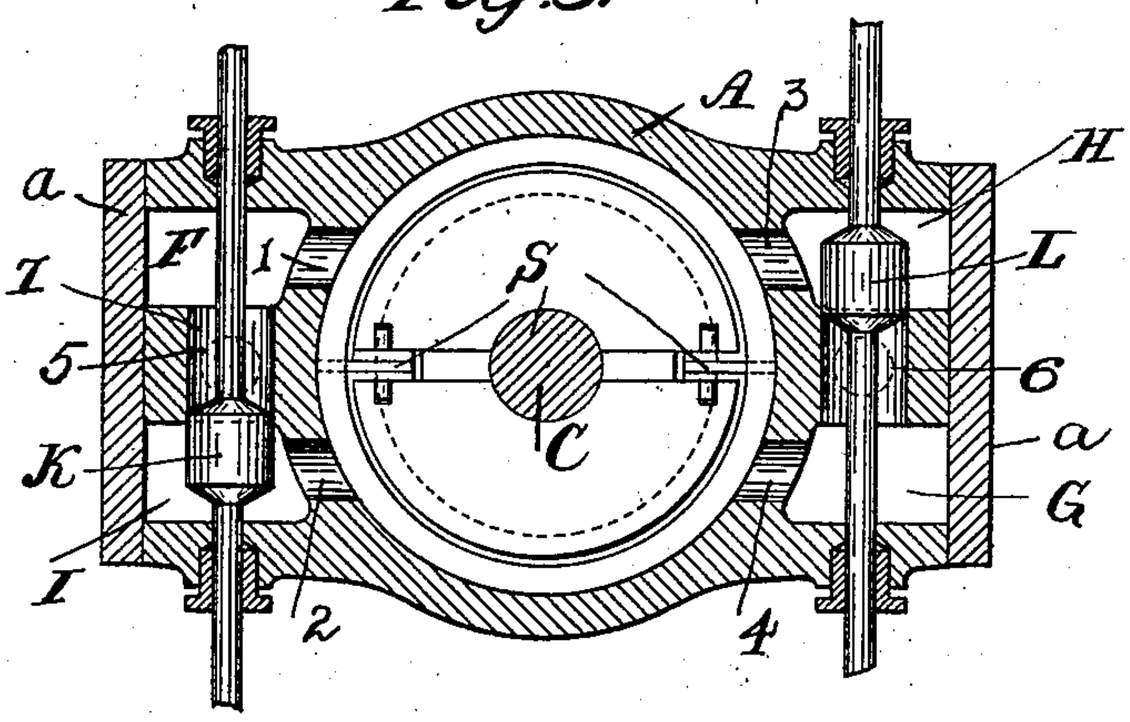


Fig. 4.

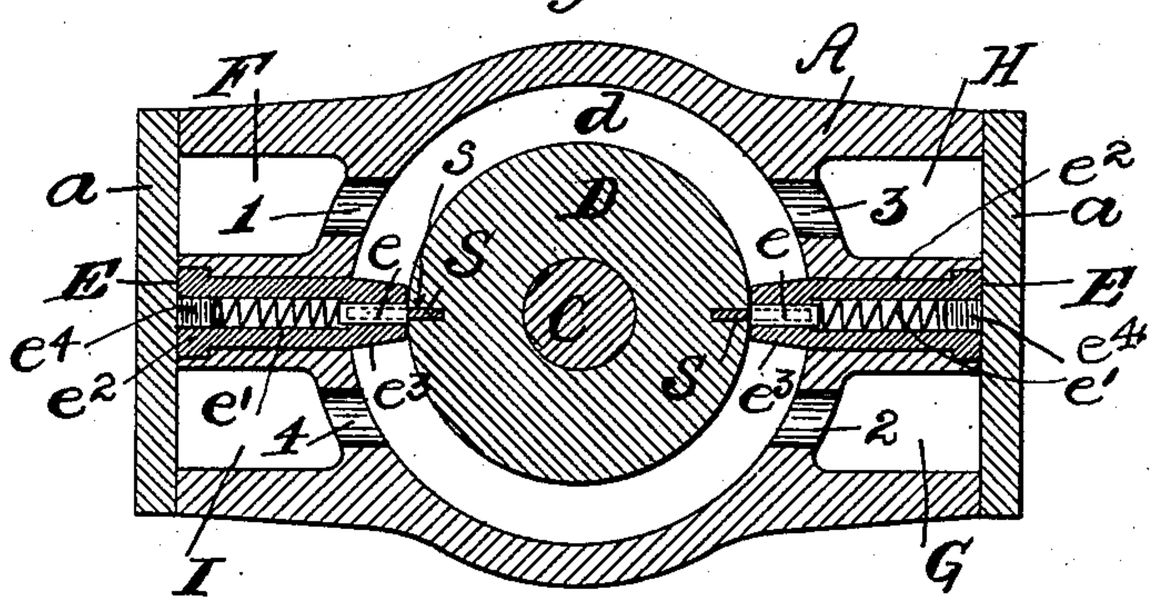
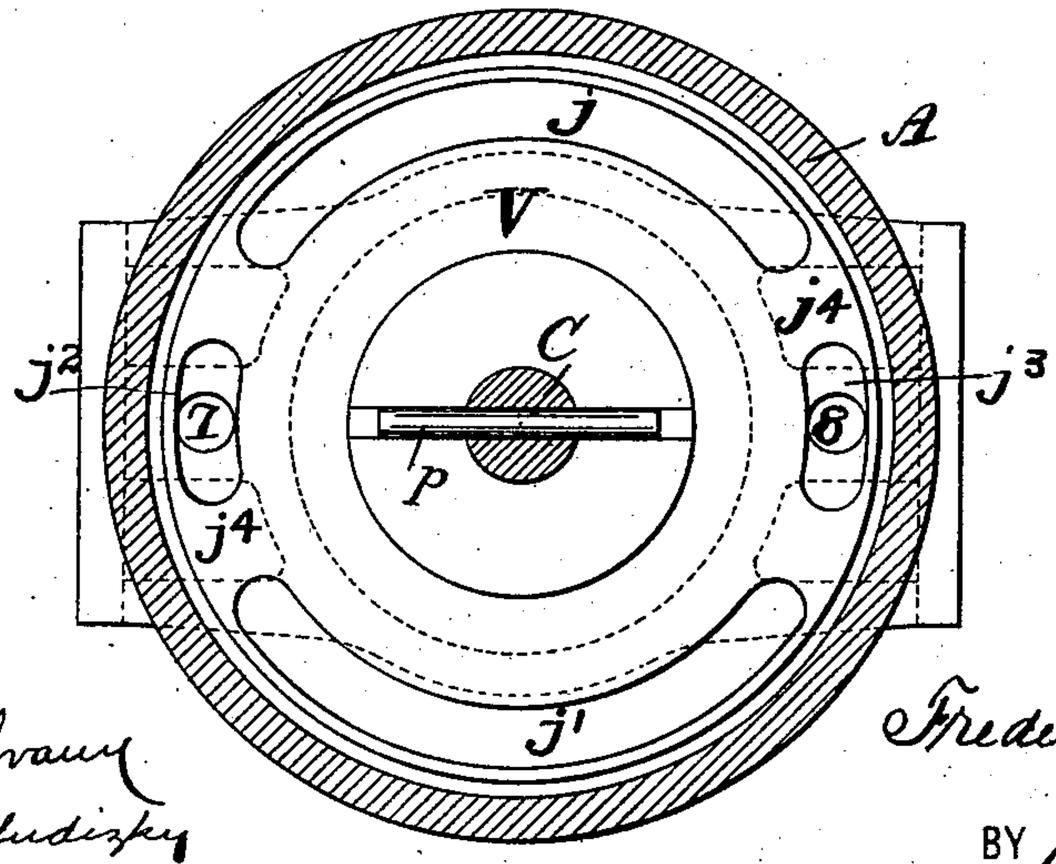


Fig. 5.



WITNESSES:

Geo. W. Eisenbrandt

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INVENTOR:

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No. 730,661. PATENTED JUNE 9, 1903.

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APPLICATION FILED JUNE 10, 1902.

NO MODEL. 5 SHEETS—SHEET 4

Fig. 6.

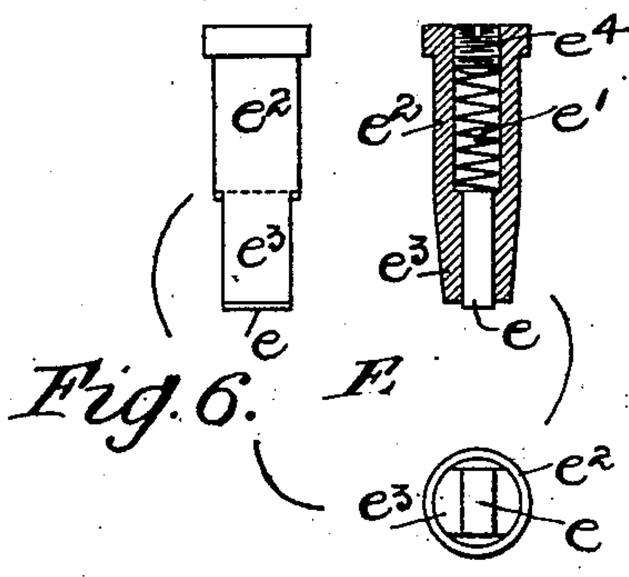


Fig. 1.

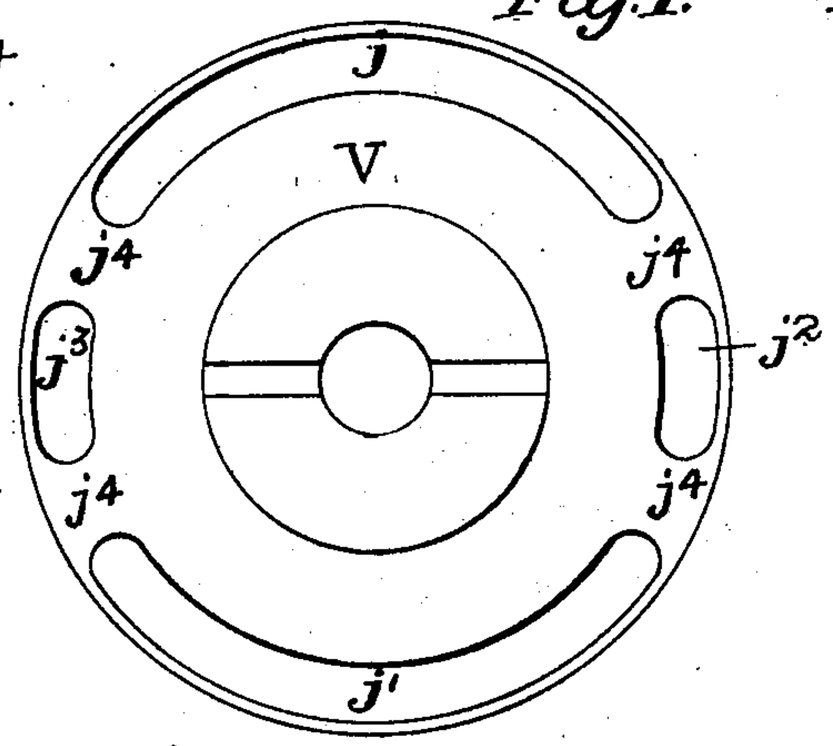


Fig. 8.

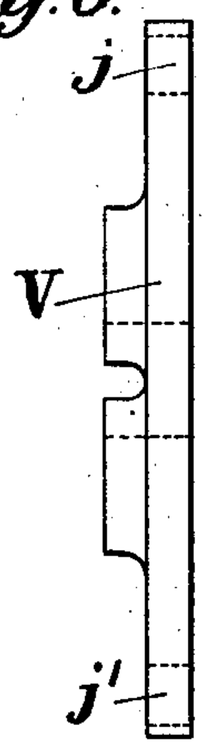


Fig. 9.

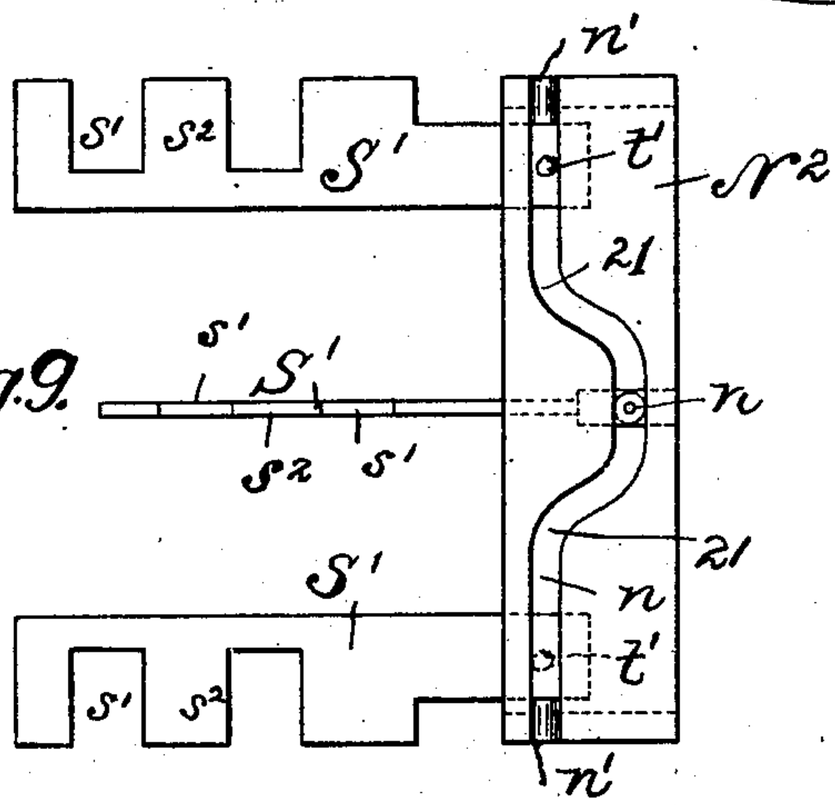


Fig. 10.

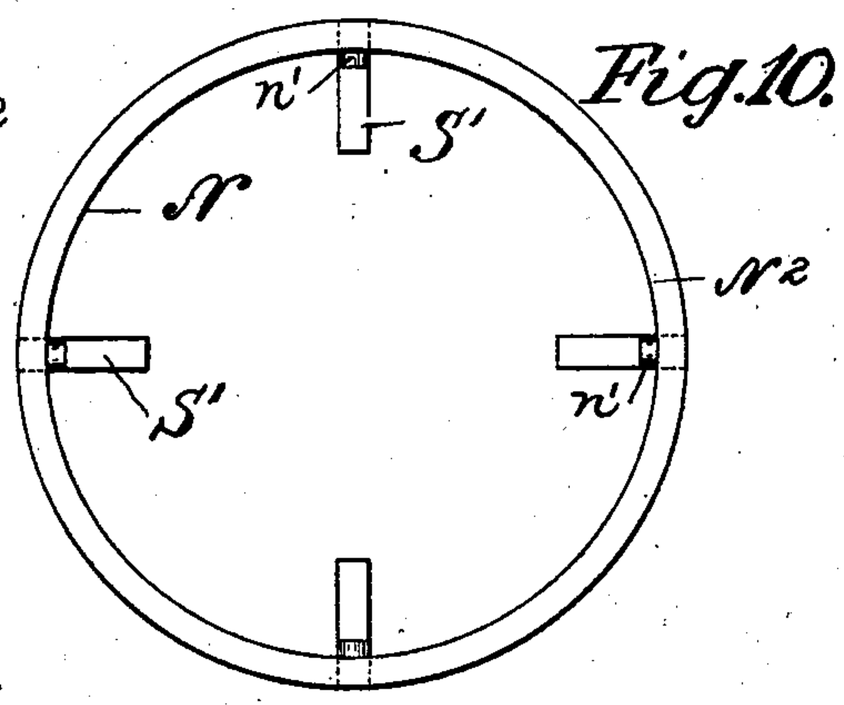


Fig. 11.

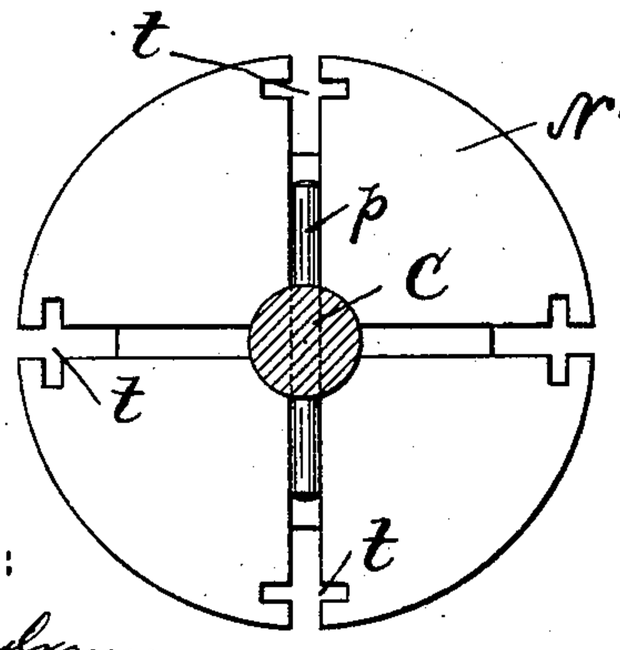
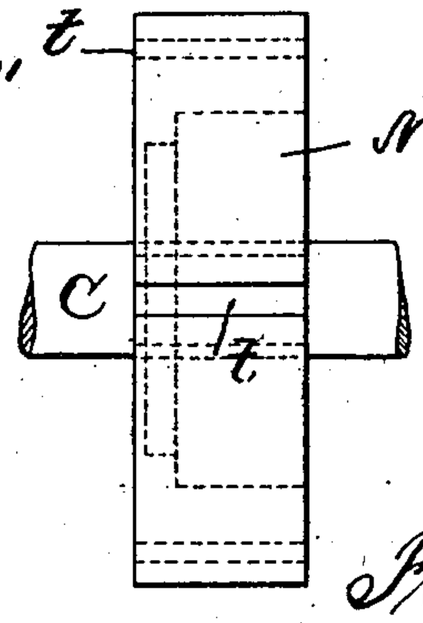


Fig. 12.



WITNESSES:

Geo. W. Eisenbrandt

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No. 730,661. PATENTED JUNE 9, 1903.

F. JACOB.

ROTARY ENGINE.

APPLICATION FILED JUNE 10, 1902.

NO MODEL. 5 SHEETS—SHEET 5.

Fig. 14.

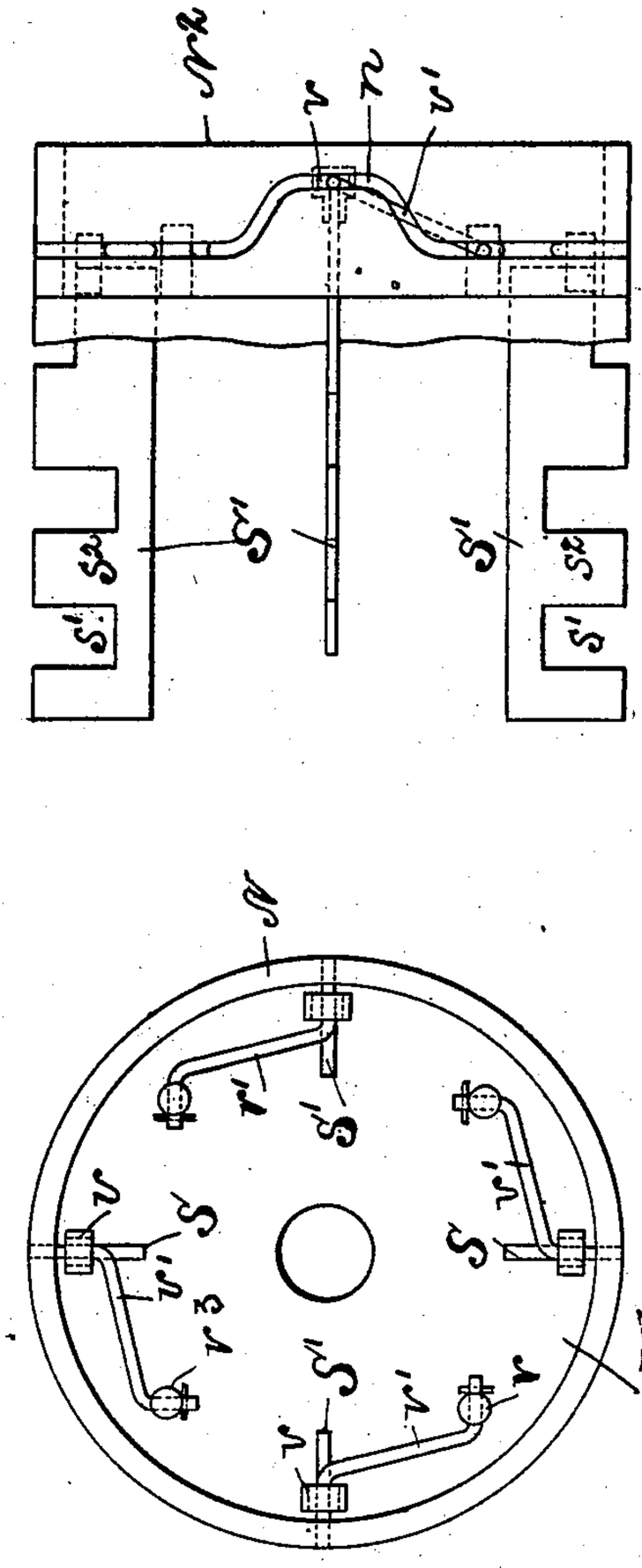

Fig. 15.

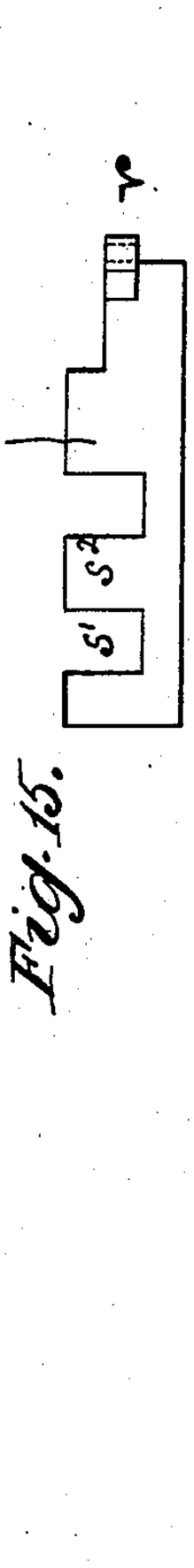

Fig. 13.

WITNESSES:

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ATTORNEY.

No. 730,661. Patented June 9, 1903.

UNITED STATES PATENT OFFICE.

FREDERICK JACOB, OF NEWARK, NEW JERSEY.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 730,661, dated June 9, 1903.

Application filed June 10, 1902. Serial No. 111,056. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK JACOB, a citizen of the United States of America, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention has reference to improvements in rotary engines of that class having rotary pistons, stationary abutments, and vanes reciprocated for the purpose of clearing the abutments during the revolution of the piston, and has for its objects, first, to reduce the friction incident to such constructions to a minimum; secondly, to obtain substantially tight connections without the use of packing; thirdly, to obtain an increased efficiency by compounding; fourthly, to provide perfect means for reciprocating the vanes; fifthly, to insure a perfect balancing of the piston, and, sixthly, to render the engine reversible in a simple and effective manner.

The nature of my invention will best be understood when described in connection with the accompanying drawings, in which—

Figure 1 represents a side elevation of a compound reversible rotary engine embodying my invention, the steam-chest covers being removed. Fig. 2 is a sectional plan view. Fig. 3 is a vertical section on the line 3 3, Fig. 1. Fig. 4 is a similar section on the line 4 4, Fig. 1. Fig. 5 is a similar section on the line 5 5, Fig. 2. Fig. 6 shows detail views of the abutments. Fig. 7 is a face view of the cut-off admission-disk. Fig. 8 is a side view thereof. Fig. 9 is a detail plan illustrating the construction of the sliding vanes and the operating-cam therefor. Fig. 10 is an end view thereof. Fig. 11 is a face view of the cam. Fig. 12 is a side view of the same. Fig. 13 is a face view illustrating a modified form for the means for operating the sliding vanes. Fig. 14 is a plan view thereof. Fig. 15 illustrates details of the vanes.

Similar letters and numerals of reference designate corresponding parts throughout the several views of the drawings.

In the example illustrated in the present drawings a reversible compound engine is shown; but of course it is to be understood that I do not wish to restrict myself to such construction and will therefore describe the simple engine or cylinder first without regard to the compounding or reversibility.

Referring at present particularly to Figs. 1 to 5 of the drawings, the letter A designates the high-pressure cylinder of the engine, which is placed in communication with the low-pressure or expansion cylinder B in a manner subsequently to be described. The shaft C passes through the cylinder and carries rigidly secured thereto a piston D, provided with a series of circumferential grooves *d*, equally spaced and having intermediate hubs *d'* of greater width than the width of the grooves, as best seen in Fig. 2. The cylinder A is provided with diametrically opposite series of bores adapted for the reception of the abutments E. In the present example two parallel series are shown, although more or less can be used, as desired. The abutments E are arranged in line with the circumferential grooves *d* in the piston and are provided with movable slightly-projecting blades *e*, fitted to the said grooves and adapted to be held against the periphery of the piston D at the grooves *d* by suitable springs *e'*, inclosed in sleeves e^2, terminating in bifurcated portions e^3, adapted to guide and hold the blades. The tension of the springs *e'* may be regulated by suitable adjusting-screws e^4, screwed into the tops of the abutments. The construction of the abutments E is best seen in Figs. 2, 4, and 6, and it will be readily understood that said abutments divide each of the circumferential grooves *d* into two steam-chambers of equal dimensions separated from each other substantially steam-tight without the use of packing.

On opposite sides of the cylinder A are formed longitudinal steam-channels F and G and exhaust-channels H and I, closed by suitable covers *a* and communicating with the chambers formed by the circumferential grooves *d* and the abutments E through ports 1 2 and 3 4, the ports 1 2 forming the admission-ports and 3 4 the exhaust-ports. Steam or other actuating fluid can be supplied to the steam-channels from a steam-chest J, located at one head of the cylinder and communicating with common passages 5 and 6, connecting the several channels F and G and H and I through ports 7 and 8. The ports 7 and 8 are controlled by a suitable disk valve V,

hereinafter to be described. The passages 5 and 6 are controlled by suitable valves, as K and L, preferably plunger-valves, suitably guided and having their rods passing through stuffing-boxes. It is evident that by throwing the valves from one extreme position to the other the admission of steam will be switched and the engine caused to be reversed—that is to say, the admission-ports will be changed to exhaust, and vice versa. The valves are connected by suitable means so as to be operated simultaneously. The piston D is also provided with longitudinal or radial seats s, one to each abutment and extending throughout its entire length. Into these seats are neatly fitted vanes S, adapted to slide in the same and provided with alternating recesses s' and blades s^2. (See Figs. 2, 4, and 9.) The recesses s' in the vanes are of the same width as that of the circumferential grooves d, while the blades s^2 are slightly wider, so that when the vane is in position to cross the grooves the blades overlap the same, thus effecting a substantially tight closure between vane and piston.

To impart a reciprocating motion to the vanes S in the direction of the length of the cylinder, I make use of a cam N, secured in the cylinder against rotation and provided with a closed cam-groove n, in which pins n', attached to the vanes S, play. The cam-groove is of the configuration shown in Fig. 9 and serves to throw the vanes S back and forth at certain intervals. When but two sets of abutments E are used, the vanes are shifted twice during each revolution, so as to bring the recesses s' in the vanes in line with the circumferential grooves d, so that they may pass the abutments, after which the vanes are reversed, so as to bring the blades s across the said circumferential grooves. This movement of the vane in both directions is effected during a short portion of the revolution of the piston, as indicated by the reëntrant portion of the cam-groove, Fig. 9. The end of the piston within the cam N is turned down or a smaller hub N′ preferably affixed thereto, and this hub contains therein longitudinal T-slots t, through which the vanes pass, the latter being provided with projecting lateral lugs t', entering the transverse portions of said slots. This construction is for the purpose of truly guiding the vanes.

The valve V in the steam-chest J (see Figs. 2, 5, and 7) is provided with two segmental ports j and j', adapted to permit entrance of steam to the ports 7 and 8 during a predetermined portion of the stroke of the engine, the length of the ports determining the period of admission, and consequently the cut-off, although the cut-off may be dispensed with under certain conditions of compounding. Between said segmental ports are arranged two short segmental ports j^2 and j^3, leaving between the several ports intermediate spaces j^4, adapted to cover the ports 7 and 8 in the rotation of the valve. The position of the cam N is such that the portions 21 come into action after the supply of steam is closed off and expansion is taking place, thus relieving to a great extent the pressure on the vanes S and consequent friction due to the movement of the vanes. When this movement is completed, steam is admitted for a very short interval through the ports j^2 and j^3, this taking place when the blades of the vanes enter the respective seats in the hubs d'.

Live steam is supplied to the chest J through a suitable pipe or pipes 10 in the usual manner, from which it is distributed by the valve V, as hereinbefore described. By employing two or more series of abutments E arranged diametrically opposite each other and placing the admission-ports close beside the same in separated channels and on opposite sides of the abutments the piston is at all times perfectly balanced and the engine runs evenly without shock or noise.

In the present example I have shown a compound engine in which A is the high-pressure cylinder and B the low-pressure or expansion cylinder, the latter being of larger diameter than the former, but quite similar in construction, with the exception that the number of vanes S′ is increased and the cut-off valve V is omitted. The admission of steam to the expansion-cylinder in one direction or the other is controlled by the exhaust and admission plunger-valves K′ and L′ of the high-pressure cylinder controlling the ports $5^{\times}$. The exhaust is controlled by the position of plunger-valves K^2 and L^2 in the expansion-cylinder, as in the high-pressure cylinder.

In the modification shown in Figs. 13 and 14 a construction is illustrated for effecting the movement of the vanes S with the least possible friction. In this example the vanes instead of being provided with pins directly engaging the cam-groove in the cam N are each provided with a tubular head v, into which is journaled the end of a bent arm v', preferably passing through a movable box v^2 and entering the cam-groove. The other end of the arm v' is passed through a stud v^3, secured to the piston or other rotating part.

It is evident that in the movement of the piston a substantially frictionless action between the cam and the pins is obtained.

Instead of keying the piston to the shaft in a usual manner I prefer to groove the hub N diametrically, as shown in Fig. 11, and to drive a pin p through the shaft within said groove, thus obtaining a firm connection with no danger of working loose.

While in the example illustrated in the accompanying drawings I have shown but one low-pressure cylinder from which the exhaust is conducted either to the atmosphere or to a condenser, it is evident that any practical number of low-pressure cylinders could be placed in connection with each other, thus forming triple, quadruple, or other expansion engines.

What I claim as new is—

1. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, and means for supplying and exhausting an actuating fluid, substantially as described.

2. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments provided with blades entering the circumferential grooves, and having springs acting on said blades, and means for supplying and exhausting an actuating fluid, substantially as described.

3. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves; said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, abutments entering the circumferential grooves and fitted to the same, a stationary cam, connections between the vanes and the cam for reciprocating the former, and means for supplying and exhausting an actuating fluid, substantially as described.

4. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats; a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments provided with blades entering the circumferential grooves, and having springs acting on said blades, a stationary cam, connections between the vanes and the cam reciprocating the former, and means for supplying and exhausting an actuating fluid, substantially as described.

5. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves; said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, and a cut-off valve controlling the admission of actuating fluid, and means for supplying and exhausting said fluid, substantially as described.

6. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves; said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, and a cut-off valve provided with ports for the entrance of actuating fluid and intermediate spaces for closing off the supply of actuating fluid during part of the reciprocating movements of the vanes, and means for supplying and exhausting the actuating fluid, substantially as described.

7. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, an admission-channel and an exhaust-channel extending in the direction of the length of the cylinder on opposite sides of the piston, and ports communicating with the circumferential grooves and channels, substantially as described.

8. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves from opposite sides of the cylinder, two sets of admission and exhaust channels extending in the direction of the length of the cylinder on opposite sides of the same, and connected respectively by transverse passages, valves controlling said passages for the purpose of reversing the engine, and means for supplying and exhausting an actuating fluid, substantially as described.

9. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats and crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, a hub at one end of the piston provided with slots, projections on the vanes entering said slots for the guidance of the vanes, and a cam engaging with said vanes for reciprocating the latter, substantially as described.

10. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a

series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, a hub at one end of the piston provided with slots, projections on the vanes entering said slots for the guidance of the vanes, an annular cam surrounding said hub and held stationary, and provided with a cam-groove, and projections on the vanes engaging with said cam-groove, substantially as described.

11. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, abutments entering the circumferential grooves, heads formed on the vanes, arms journaled to the piston and extending through the heads on the vanes, and a stationary cam engaging with the projecting ends of the arms for reciprocating the vanes, substantially as described.

12. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, means for supplying and exhausting an actuating fluid, and a cut-off valve for closing off the supply of actuating fluid during a portion of or during the entire longitudinal stroke of the vanes and for supplying the actuating fluid for a short interval at the end of each stroke of said vanes, substantially as described.

13. In a rotary engine, an abutment comprising a sleeve terminating in a bifurcated portion at its inner end and containing in said bifurcated portion a blade fitted thereto, and adapted to project slightly beyond the inner end, a spring within said sleeve, and an adjusting-screw acting on said spring, substantially as described.

14. In a rotary engine, an abutment comprising a sleeve terminating in a bifurcated portion at its inner end and containing in said bifurcated portion a blade fitted thereto, and adapted to project slightly beyond the inner end and a spring within said sleeve, substantially as described.

15. In a rotary engine, the combination of a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves, a stationary cam engaging with said vanes and moving with the piston, and a cut-off valve timed with said cam to cut off the supply of steam during a portion of the stroke of the vanes, substantially as and for the purpose set forth.

16. In a compound rotary engine, a plurality of cylinders of different area arranged in line, and receiving the actuating fluid one from the other, pistons located in the respective cylinders and attached to a common shaft and each provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves; said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means in each cylinder for reciprocating the vanes, abutments entering the several circumferential grooves, means for supplying the actuating fluid to the first cylinder, and connections between the several cylinders for supplying the exhaust from one to the other in progression, substantially as described.

17. In a compound rotary engine, a plurality of cylinders of different area arranged in line, and receiving the actuating fluid one from the other, pistons located in the respective cylinders and attached to a common shaft and each provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves; said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means in each cylinder for reciprocating the vanes, abutments entering the several circumferential grooves, means for supplying the actuating fluid to the first cylinder, connections between the several cylinders for supplying the exhaust from one to the other in progression, and means for reversing the several pistons, substantially as described.

18. The vane herein described for rotary engines consisting of a slidable bar or body provided with alternating recesses and blades, and said blades being of greater width than the recesses, substantially as and for the purpose specified.

19. A rotary engine comprising a cylinder, a piston within said cylinder provided with a series of circumferential grooves and with a series of longitudinal seats, a series of vanes in said seats crossing said grooves, said vanes being provided with alternating blades and recesses corresponding to the circumferential grooves, means for reciprocating the vanes, abutments entering the circumferential grooves from opposite sides of the cylinder, admission and exhaust channels located on opposite sides of the abutments and extending in the direction of the length of the cylinder, and a series of ports communicating with the circumferential grooves and channels, the admission-ports and exhaust-ports

being located diagonally opposite for the purpose of balancing the piston, substantially as described.

20. In a compound rotary engine, a plurality of cylinders of different volume arranged in line and receiving the actuating fluid one from the other, pistons located in the respective cylinders and attached to a common shaft and each provided with a series of circumferential grooves of increasing cross-section of area, abutments for each cylinder entering the respective circumferential grooves, blades on said pistons adapted to clear said abutments, and means for supplying an actuating fluid to the first cylinder, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

FREDERICK JACOB.

Witnesses:
A. FABER DU FAUR, Jr.,
JOHN F. W. SEIDEL.