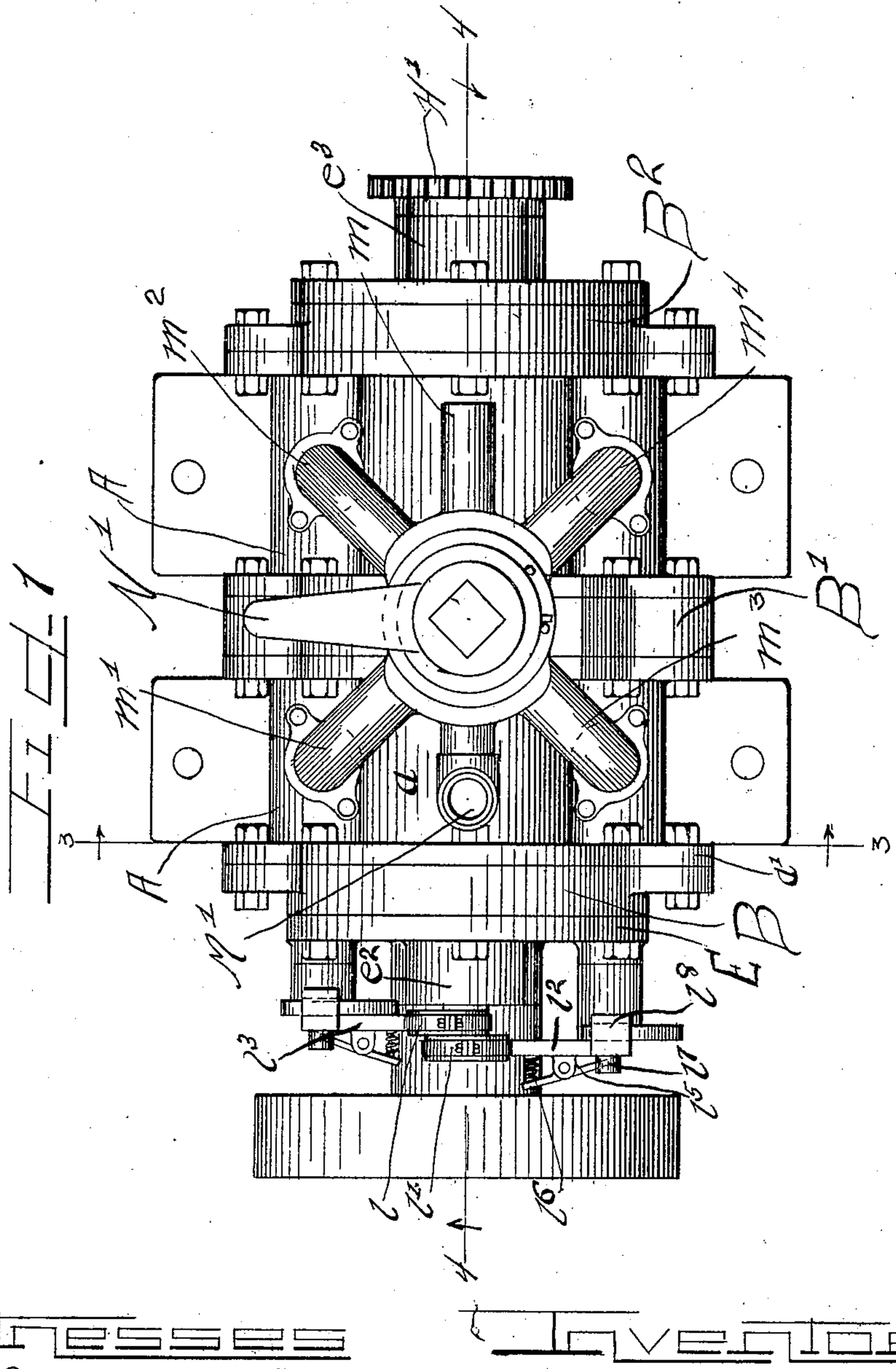
J. A. EATON.

COMPOUND ROTARY ENGINE.

APPLICATION FILED JUNE 15, 1908.

925,467. Patented June 22, 1909.

6 SHEETS—SHEET 1.



Witnesses

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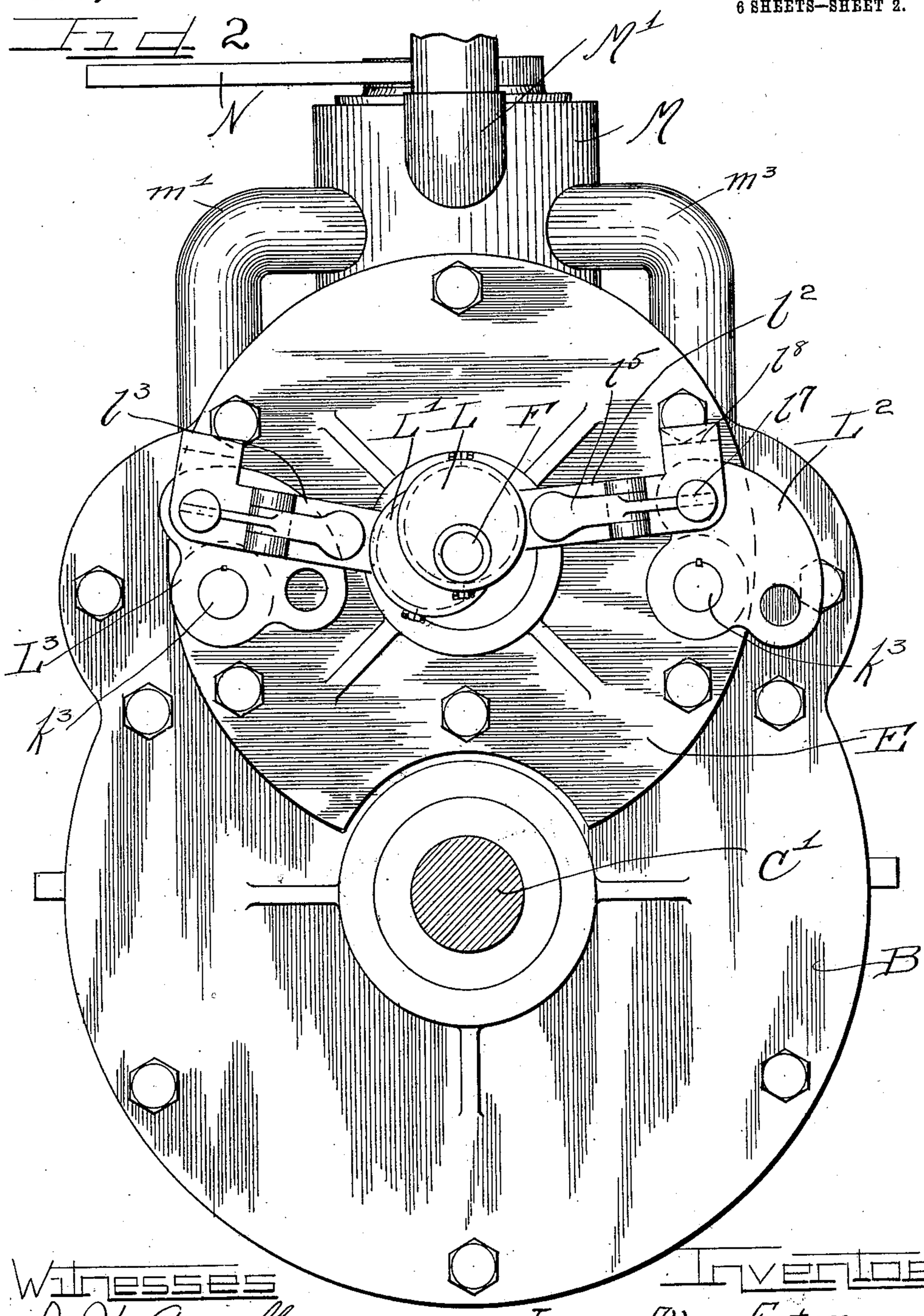
6 SHEETS—SHEET 2.

Fig. 2



Witnesses

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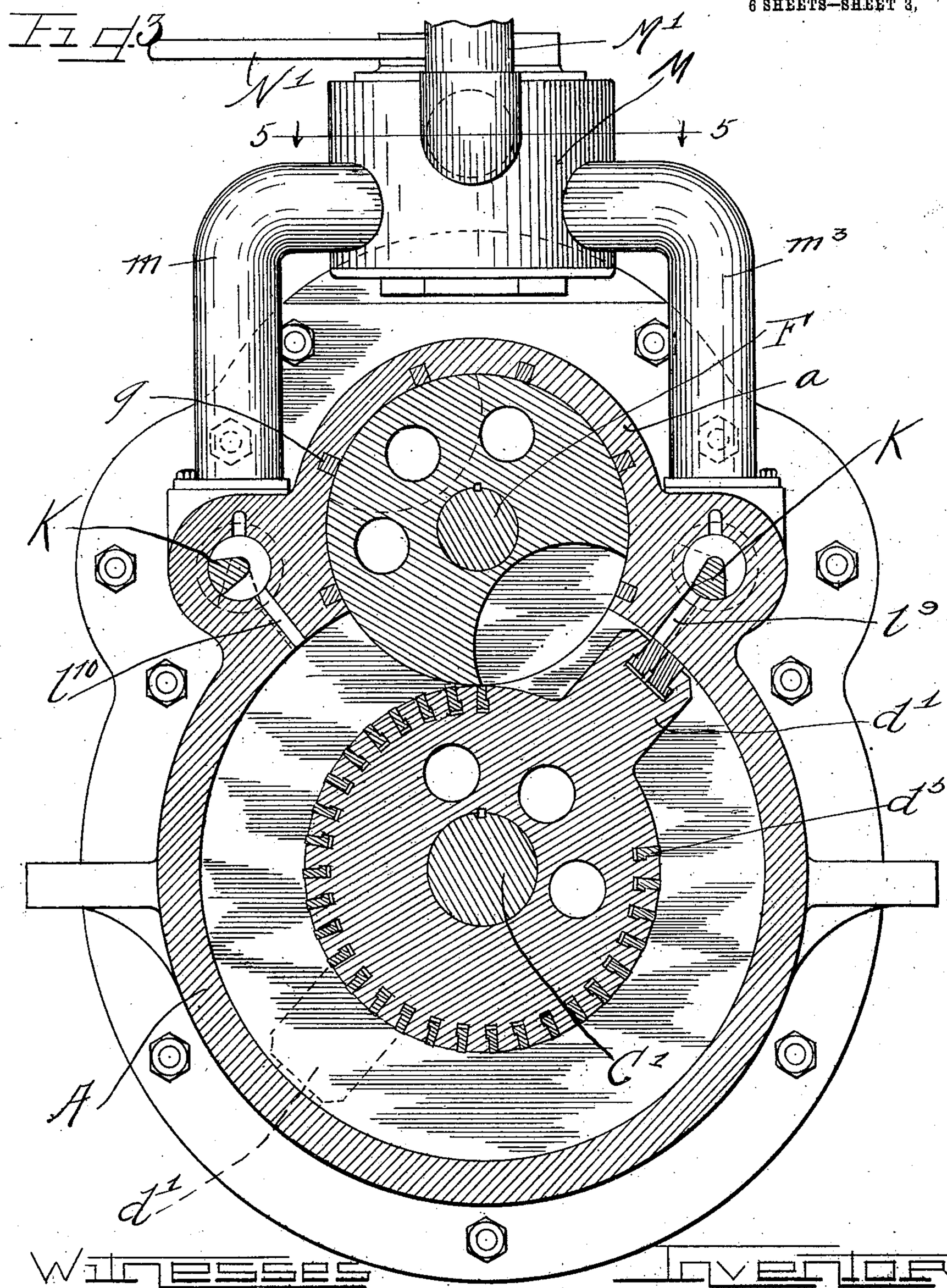
6 SHEETS—SHEET 3.

Fig. 3.



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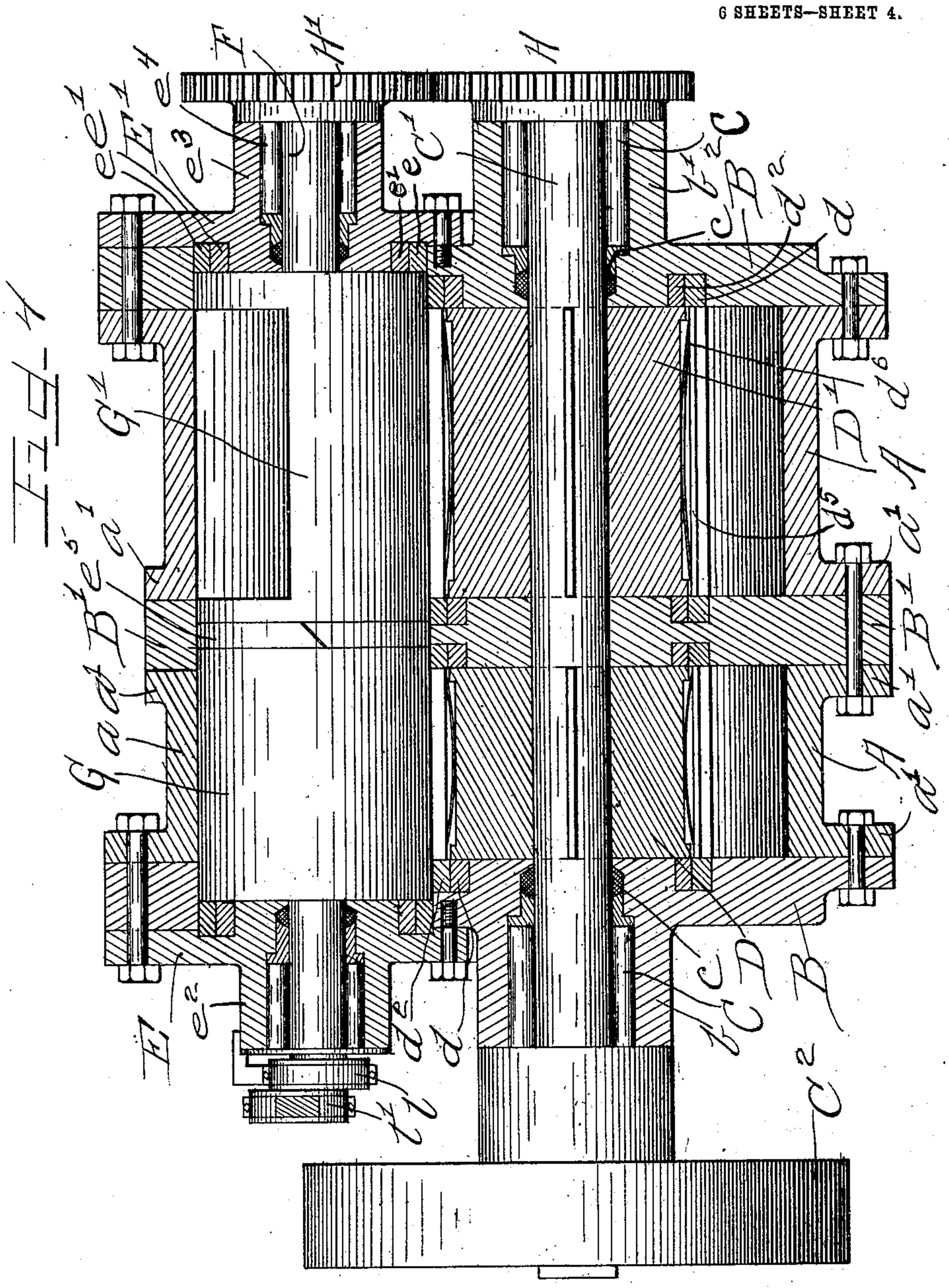

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6 SHEETS—SHEET 5.

Fig. 5

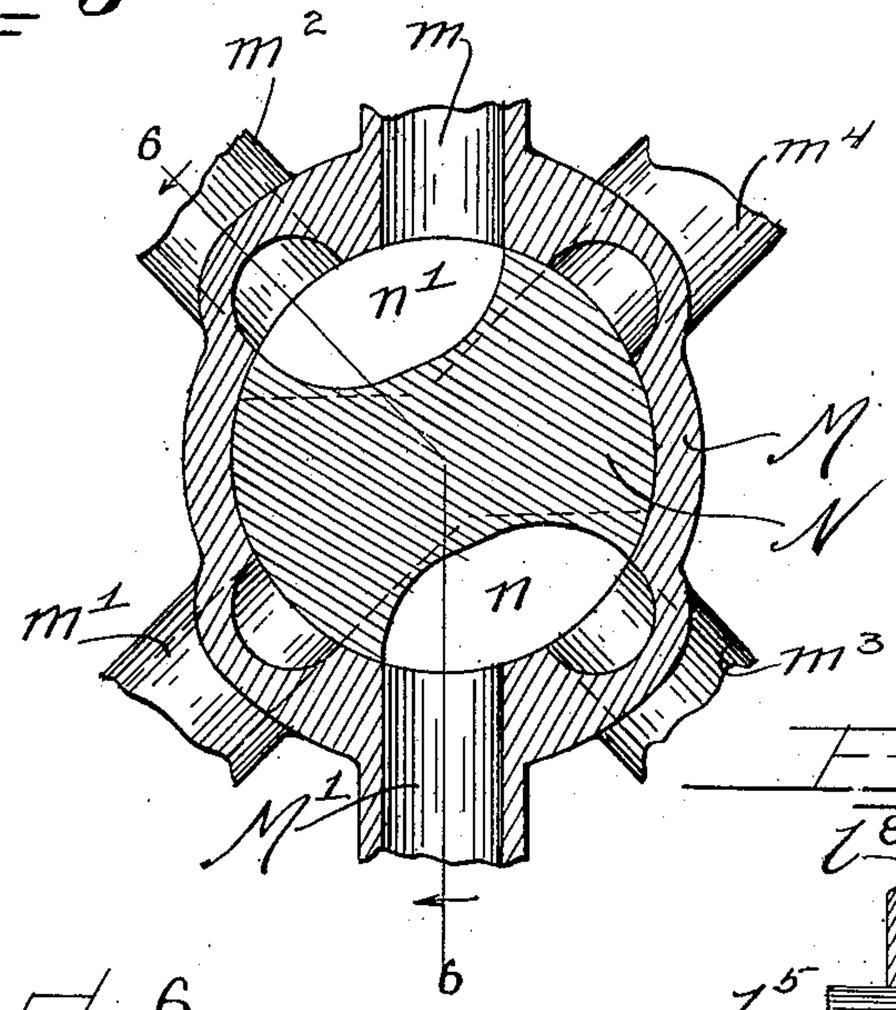


Fig. 7

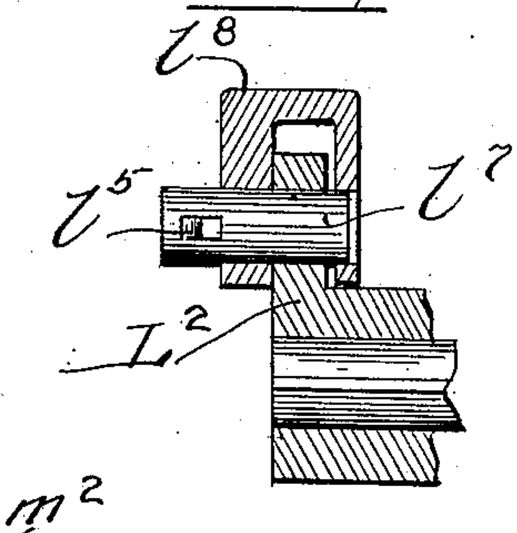


Fig. 6

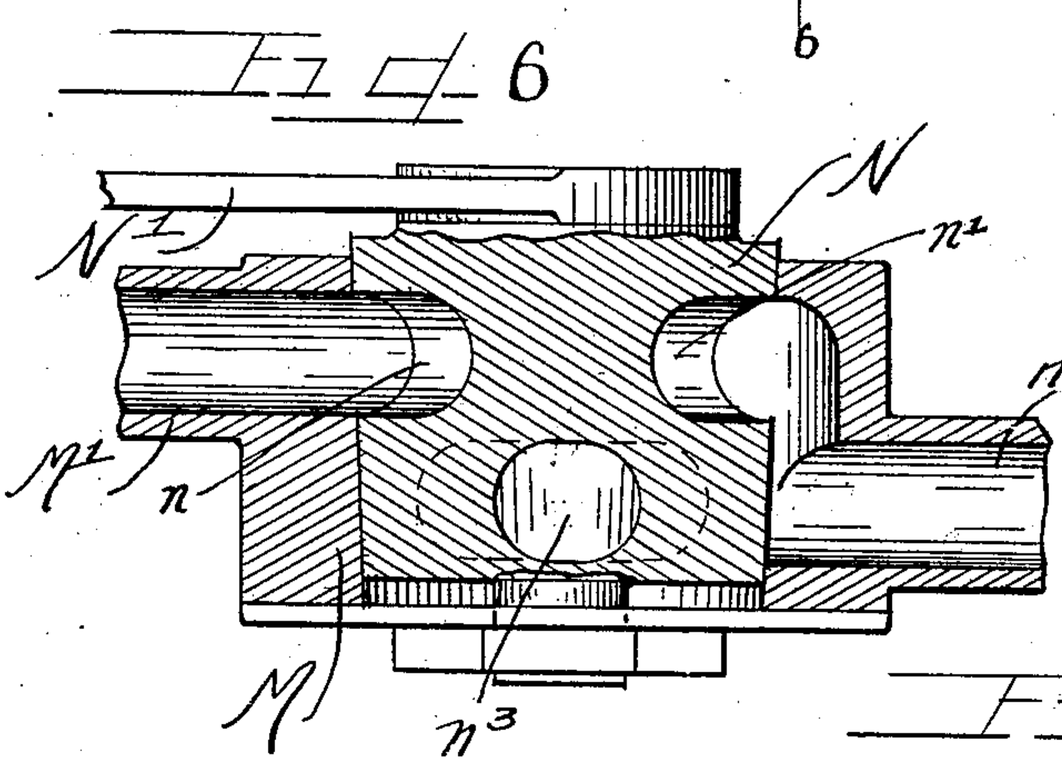
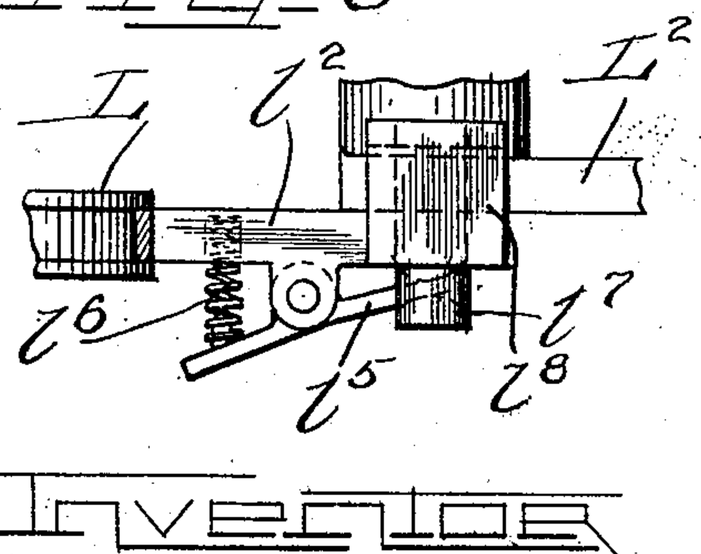


Fig. 8



Witnesses

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[illegible]

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6 SHEETS—SHEET 6.

Fig 9

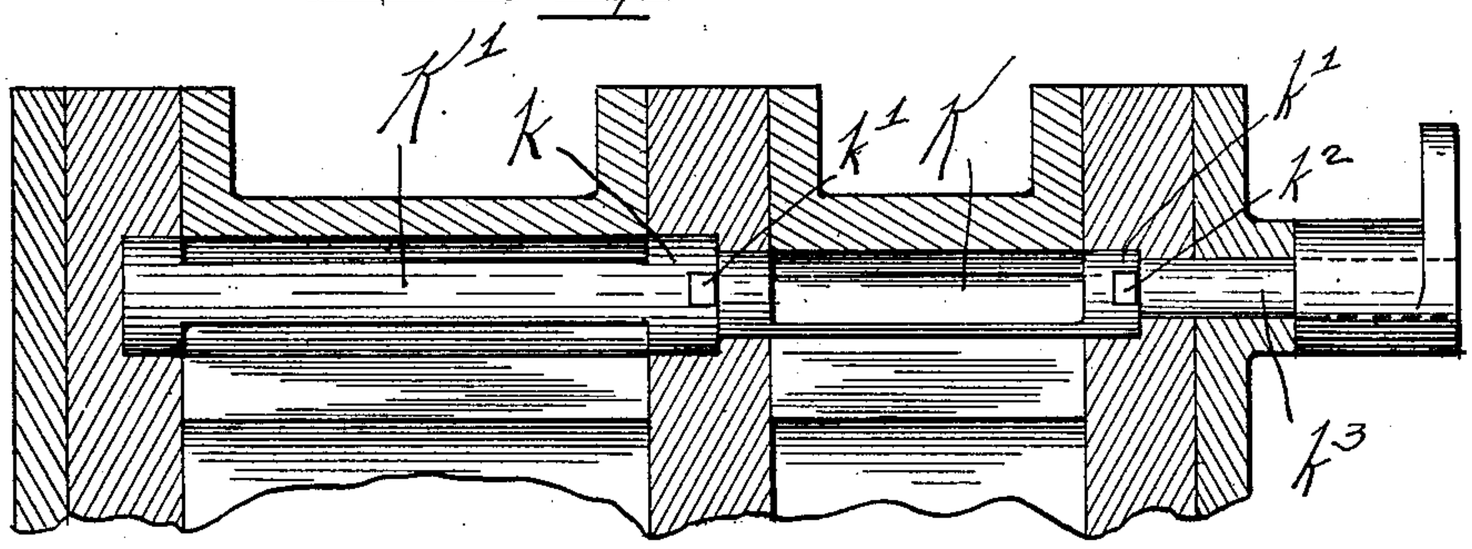


Fig 11

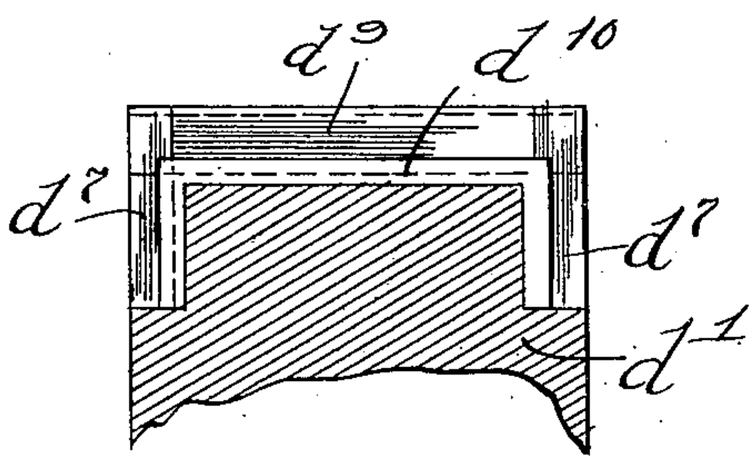


Fig 10

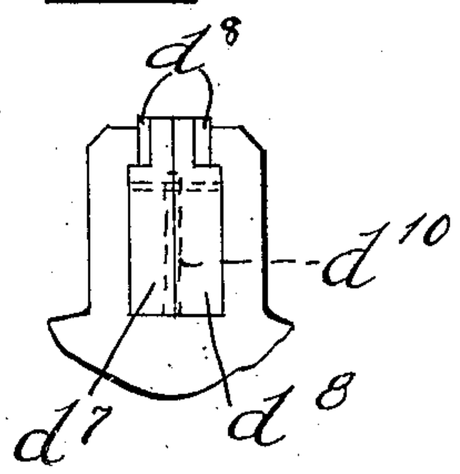


Fig 12

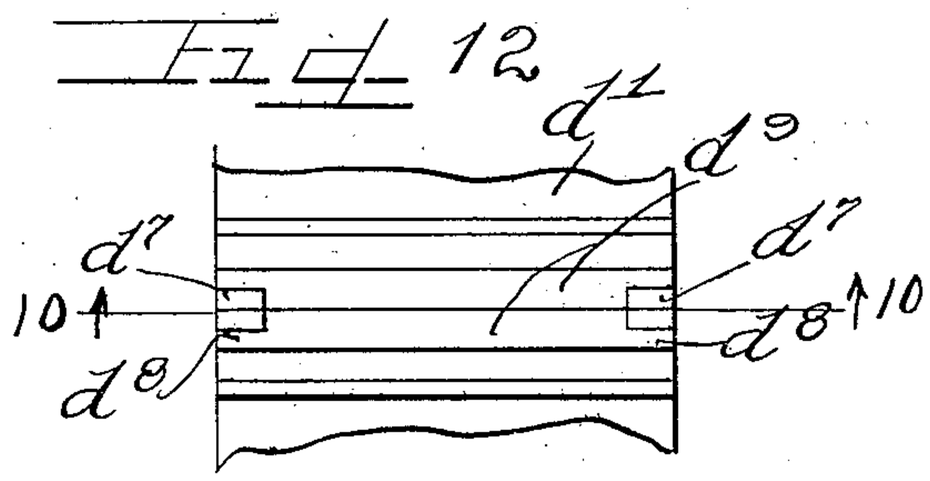
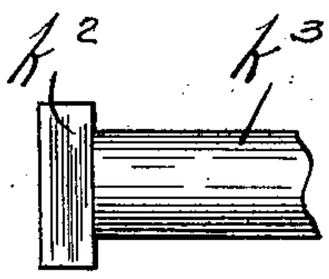


Fig 13



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UNITED STATES PATENT OFFICE.

JAMES ALLEN EATON, OF CHICAGO, ILLINOIS.

COMPOUND ROTARY ENGINE.

No. 925,467. Specification of Letters Patent. Patented June 22, 1909.

Application filed June 15, 1908. Serial No. 438,466.

To all whom it may concern:

Be it known that I, JAMES ALLEN EATON, a citizen of the United States, and a resident of the city of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Compound Rotary Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in rotary engines of that class set forth in my prior patent issued to me on the 24th day of March, 1908, No. 882,750.

The object of the present invention is to compound the engine and also to afford in connection therewith a novel valve mechanism enabling the engine to be reversed at will and to operate equally well when driven in either direction.

It is also an important object of the invention to afford means for packing the various parts of the engine to render the same steam tight and to afford an exceedingly cheap, novel and durable construction for the purpose specified by the use of which economy in steam consumption may be secured.

The invention consists in the many novel features hereinafter described and more fully pointed out and defined in the appended claims.

In the drawings: Figure 1 is a top plan view of an engine embodying my invention. Fig. 2 is an enlarged end elevation thereof. Fig. 3 is a section on line 3—3 of Fig. 1. Fig. 4 is a central longitudinal section with the throttle valve omitted. Fig. 5 is a horizontal section of the throttle valve taken on line 5—5. Fig. 6 is a section taken on line 6—6 of Fig. 5. Fig. 7 is a fragmentary enlarged section illustrating the construction of the detent for the eccentrics. Fig. 8 is a side elevation of the same. Fig. 9 is an enlarged, fragmentary longitudinal section illustrating the construction of the inlet valves. Fig. 10 is a fragmentary end elevation of the abutment or head on the revolving piston. Fig. 11 is a slightly enlarged section on line 11—11 of Fig. 12. Fig. 12 is a fragmentary top plan view of the piston and abutment head. Fig. 13 is a fragmentary view in elevation of the valve stem and illustrates its connection with the inlet valve.

As shown in the drawings: the engine is compounded to afford a high and a low pressure side and for this purpose is divided longitudinally into a relatively small high pressure cylinder and a larger low pressure cylinder adapted to receive the exhaust from the high pressure cylinder and to use the steam expansively. As shown, said cylinders each comprise annular walls A, constructed in one piece with walls *a*, for the upper cut-off valve chamber, which is also cylindric, the centers of said cylinders and the radius of the cylinders being such that the chambers so formed intersect. Each of said cylinder walls and the walls for the cut-off valve chamber are provided with flanges *a'*, and on the outer faces ground to afford a steam tight joint, with the cylinder head B, on the outer end and the intermediate head B', which separates the high from the low pressure cylinder. The flanges *a'*, of the cylinder wall A', are bolted through said intermediate head around the periphery of the cylinder, as shown, but not around the cut-off valve chamber or abutment. At the opposite end of the low pressure cylinder, is rigidly bolted the head B^2, corresponding with the head B, at the opposite end of the engine. Each of the cylinder heads B and B^2, concentric with the cylinder, are provided with outwardly directed bosses or hubs *b*—*b'*, bored to receive a roller bearing indicated by C, and in which is journaled the main shaft C', of the engine. As shown also, a gland *c*, is provided on said shaft at the inner end of each of said roller bearings to render the joints steam tight. Said shaft, as shown, extends through and is journaled in the intermediate head B', which fits comparatively closely thereto. Keyed on said shaft in each of the cylinders is the piston D—D', provided with an integral abutment head *d'*, provided with suitable packing hereinafter described, and which fits closely to the walls of the steam cylinder. Each of said cylinder heads, as shown, is provided with an annular channel concentric with the shaft coinciding approximately with the periphery of the piston and in each of which is seated expansion rings *d*—d^2, which serve to render the joint between the end of the piston and cylinder steam tight. Each of the cylinder heads B—B'—B^2 is provided with a circular aperture therethrough of equal diameter with the abutment or cut off valve casing to permit the insertion of the rotative cut-off valve therethrough, and bolted on

said cylinder head to close said openings are abutment heads E—E′, each of which, as shown, is recessed to afford an annular groove coinciding with the periphery of the rotative cut-off valve closure, and in which are provided expansion rings *e*—*e*′, corresponding with the expansion rings *d*—*d*² before described. Each of said heads E—E′, is also provided with a central hub or boss *e*²—*e*³, and these are bored out as before described to receive anti-friction rollers *e*⁴ between which the valve shaft F, is journaled, as shown in Fig. 4.

As shown, a rotative abutment G—G′, is rigidly keyed on the shaft F, in the cylindric chamber above the steam cylinders. For this purpose, as shown, a cylindric body of cast metal is turned up to fit said cylindric chamber and to bear at its ends against the expansion rings *e*—*e*′, in the respective heads, and is provided with one or more expansion rings *e*⁵, seated in a suitable groove in said rotative abutment and located to bear on the expansion rings in the intermediate head for the respective high and low pressure pistons and affords a steam tight joint at said intermediate head, thus affording an abutment for the high and for the low pressure cylinder. As shown in Fig. 3, the respective abutments are provided with notches extending inwardly nearly to the shaft F, to receive the abutment head *d*′, on the rotative piston therein and inasmuch as the abutment heads on the respective pistons are arranged diametrically opposite each other, it follows that the notches in the rotative abutments must in consequence be arranged diametrically opposite each other, as shown in Fig. 3.

As shown, packing strips *g*, are provided longitudinally of the cylindric abutment chamber at suitable distances apart and bear upon the periphery of the cylindric rotative abutments to afford a steam tight joint, and as shown, longitudinal packing strips *d*⁵, are secured at short intervals apart in each of the rotative pistons, and are provided with springs beneath the same, and as shown, the seats for said packing strips are milled out at a greater width at the bottom than at the top and said strips are shaped accordingly to hold each in place. A spring *d*⁶, is provided beneath each of said strips, which serves to hold the same outwardly at all times, and these bearing against the periphery of the rotative abutment afford at all times a steam tight joint thereat. The top of the abutment heads *d*′, on the rotative pistons are milled out, as shown in Figs. 3, 10, 11 and 12, and seated in each of the same are packing strips comprising end strips *d*⁷, which fit closely in said milled channel and at the upper ends are cut away or halved on the outer side to receive the similarly shaped, or cut ends *d*⁸, of the packing strips *d*⁹, which fit closely together between said end packing strips *d*⁷, and fit closely in the milled channel, each serving to interlock the other in place, and, as shown, between the end strips *d*⁷, longitudinal packing strips *d*¹⁰ are provided beneath the packing strip *d*⁹. This is seated in a channel arranged on the inner side of each of the packing strips and affords an intermediate packing, as shown in Figs. 10 and 11.

On the outer end of the shaft C′, is provided a belt pulley C², to permit the drive of the engine to be transmitted to the machinery to be driven, and on the opposite end of the shafts C′—F are spur gears H—H′, which intermesh whereby the pistons are driven oppositely from, and at uniform rate with the rotative abutments.

Valves are provided, one on each side of the rotative abutment, either of which may serve as the inlet valve and the other as the exhaust valve, thus permitting the engine to be reversed at will by the adjustment of the valves. Said valves, as shown, each are seated in cylindric bores, extending longitudinally of the steam cylinder, the valve K, for the high pressure cylinder being, of course, relatively short and having the web thereof directed approximately at an angle of 45°, with the valve K′, for the low pressure cylinder. The valve closures in each case, as shown in Figs. 3 and 9, are provided with cylindric ends, which are journaled in the respective heads of the cylinders and intermediate the cylinders are cut away to afford a relatively narrow segment shaped portion adapted to bear at all times against the periphery of the valve chamber and which serves at the proper position to cut off the steam while the abutment *d*′, on the piston is passing through the notch in the corresponding rotary abutment. As shown inasmuch as the pistons and the abutments are arranged oppositely in the respective cylinders, the inlet valves of necessity are arranged substantially in the same manner, so that the low pressure cylinder may receive the exhaust steam from the high pressure at the moment the high pressure begins to exhaust, and obviously the arrangement of the valves for said cylinders with respect to each other will depend upon the point at which the high pressure cylinder begins to exhaust, and the degree of the valve closure may thus vary more or less. As shown the low pressure valve closure K′, is provided in its head *k*, with a transverse slot, adapted to receive a transverse web or key *k*′, on the end of the high pressure closure K. As shown, the head *k*′, of the high pressure cylinder, is provided with a somewhat transverse slot adapted to receive a key *k*², the valve stem *k*³, of which projects through the abutment head E.

The end of the shaft F, protrudes beyond

the bearing or hub e^2, and is provided on its outer end with two eccentrics L—L′, each provided with an eccentric yoke l—l', engaged thereon, the arm or rod l^2—l^3, of which extends outwardly therefrom and is provided with means for detachably engaging a segment shaped rocker arm L^2—L^3, each of which is segment shaped and is rigidly secured on the valve stems k^3, and is provided at equal distances from the stems and approximately 90° apart with apertures, as shown in Fig. 2, to receive the plunger l^7. A spring detent l^5, is pivotally supported on the eccentric rod provided with a spring l^6, which presses the inner end outwardly and at the outer end said lever l^5 extends through an aperture in the rod or plunger l^7, which extends through a suitable clip l^8, on the end of the eccentric rod and which straddles the rocker arm and locks the rocker arm thereto.

The throttle valve is provided to admit of the transference of the exhaust from the high pressure cylinder to the intake for the low pressure and permits of reversing the engine when the connection of the eccentric rods with the rocker arms L^2— L^3 is shifted. Said valve, as shown, comprises a casing M, mounted centrally on the engine and provided with an intake connection M′, and an exhaust pipe m. Said casing is also connected at right angles with each other with pipes m'—m^2—m^3—m^4, each of which opens to the respective inlet valves for each of said cylinders, as shown in Figs. 1 and 3. Rotatably engaged within the casing M, before described, is a rotative plug N, provided with a lever N′, for rotating the same. This plug, as shown, is provided on opposite sides with passages n—n', as shown in Figs. 5 and 6, and positioned relatively high in the plug, and adapted for adjustment either to connect the supply pipe M′, with the inlet pipe m^3 for the high pressure cylinder, while the exhaust pipe m, is connected on the opposite side of the plug with the exhaust pipe m^2, from the low pressure cylinder and cored through said plug below the passages before described, is a transverse passage n^3 shown in dotted lines in Fig. 5, and more fully shown in Fig. 6, through which the pipes m'—m^4, communicate to afford a by-pass from the exhaust side of the high pressure to the intake side of the low pressure cylinder, or, in reversing, a quarter turn approximately of the plug adjusts the passage n, to connect the supply pipe M′ with the intake pipe m', and the passage n' to connect the pipe m^4 with the exhaust, pipe m, while the by-pass passage through the plug connects the pipes m^3—m^2, thus causing the engine to receive the intake on the opposite side of the cylinder as before described.

The operation is as follows: With the eccentrics connected as shown in Figs. 1 and 2, and the valve adjusted as indicated in Figs. 1, 5 and 6, the steam flows into the right side of the high pressure cylinder through the supply pipe M′, the passage n, in the throttle valve, and the intake pipe m^3, in the position shown in Fig. 3, the valve K, is just about to open the bore into the steam chamber, as the abutment head is just clearing the port, and as the rotary abutment is turned to a position to close down upon the cylinder, as shown in Fig. 3. In this position the exhaust port l^{10}, on the opposite side of the cylinder, is open and any steam remaining on the front side of the abutment, of course, is driven out over to the low pressure side of the engine. The steam, however, flowing inwardly through the port l^9, filling behind the abutment head on the piston, forces the piston around and the piston during the initial portion of its travel, acting under direct steam pressure. The eccentric connections, however, after the abutment d', has completed approximately one fourth of a revolution around the steam cylinder, shifts the rocker arm l^2, to close the inlet valve and in the high pressure cylinder the steam thereafter acts in part expansively to continue the rotation of the piston until the abutment head d', passes the exhaust port l^{10}, and is about to enter the notch in the rotative abutment, which, as said abutment rotates isochronously with the piston is then positioned to receive the piston abutment. The steam passing through the pipe on the exhaust side of the high pressure cylinder, passes through the by-pass discharge n^3, in the throttle valve, and through the pipe m^4, to the inlet side of the low pressure cylinder, the inlet valve of which, (shown in dotted lines in Fig. 3) is then in position to admit the steam expansively back of the abutment head d', on said low pressure piston. Said low pressure abutment head then, having assumed the position corresponding with the position of the high pressure abutment shown in Fig. 3. In consequence, the expansive action of the steam materially assists in driving the engine and at the completion of one half a revolution the high pressure abutment again, of course, receives steam and the low pressure cylinder exhausts, in this case through the pipe m^2, passage n' in the rotative plug N, of the throttle valve, and through the exhaust pipe m. To reverse the engine, it is only necessary to manually release the detents on the respective eccentric rods and to engage the same each in the other aperture in the rocker arm engaged on its valve stem k^3, a corresponding change being effected in each connection of the eccentric with the valve stem. This results merely in the reversal of the engine, inasmuch as the intake is then of necessity on the opposite side of each of the cylinders from that before described, each cylinder receiving the intake from the pipes m'—m^2 and exhaust from the

pipes m^3—m^4 to the by-pass exhaust pipe respectively.

Owing to the simple construction and the fact that anti-friction bearings are used on the main shafts, and the fact also that although the engine is steam tight in every particular, there are no parts which, under action of centrifugal force tend to bear with any great pressure upon the cylinder walls, it is obvious that very little resistance to rotation can be afforded by the parts of the engine mutually engaging to cause excessive friction. Furthermore owing to the compounding of the engine as before described, a very large portion of the heat value of the steam is effectively used and converted into mechanical energy.

Of course, I am well aware that there may be numerous variations in the construction and arrangement of the packing of the various parts desired to be steam tight and, of course, the throttle valve may be materially varied as may also other valves embodied in the invention, and I am also aware that instead of using two cylinders, a greater number may be employed, if preferred, all the pistons in which are rigidly secured upon the same shaft and thus enabling the fullest possible value of the steam to be attained. I therefore do not purpose limiting this application for patent otherwise than necessitated by the prior art.

I claim as my invention:

1. In a compound rotary engine axially alined cylinders, a piston in each cylinder, a head on each piston, a rotary abutment valve for each piston provided with a notch and adapted to contact the periphery of the piston except at the notch, a reversible rock valve on each side of each rotary abutment valve, and a reversible rotary throttle valve for admitting the motive fluid through one of said valves and exhausting the motive fluid through the other valve.

2. A reversible compound rotary engine comprising a casing having a plurality of piston chambers and a plurality of valve chambers communicating therewith, a rotary piston in each piston chamber, a rotary notched valve in each valve chamber adapted to contact the periphery of the piston, an abutment head rigidly secured to each piston adapted to fit in the notch in each rotary valve, means for discharging the exhaust from one piston chamber to the other, admission and outlet valves for the piston chamber, eccentric mechanism operated by rotation of the pistons and mechanism connecting the eccentric mechanism and the admission and outlet valves adapted for adjustment to reverse the engine.

3. A multiple expansion rotary engine embracing different sized chambers, pistons in said chambers, a valve shaft, rotary valves thereon contacting the periphery of the pistons, means for supplying steam to one of the chambers, for exhausting from said chamber into the next and for exhausting from the last named chamber, rock valves controlling the inlet and outlet ports of the cylinders, an apertured segment arm connected with each rock valve, an eccentric mechanism operated by the valve shaft, and a releasable plunger connected with each eccentric mechanism adapted to engage in any aperture in its corresponding segment for controlling the operation of the rock valves.

4. A rotary engine comprising a high pressure cylinder, a low pressure cylinder, inlet and outlet valves for said cylinders, a reversible eccentric mechanism for operating the valves, a piston in each cylinder and a throttle valve for admitting the motive fluid into the high pressure cylinder and delivering the exhaust from the high pressure cylinder to the low pressure cylinder.

5. A rotary engine comprising a high pressure cylinders, a low pressure cylinder, inlet and outlet valves for said cylinders, eccentric mechanism, releasable mechanism carried by the eccentric mechanism and adjustably connected with the valves to reverse the same, a piston in each cylinder, a throttle valve for admitting the motive fluid into the high pressure cylinder and delivering the exhaust from the high pressure cylinder to the low pressure cylinder and eccentric mechanisms for operating the inlet and outlet valves of the high and low pressure cylinders.

6. A rotary engine comprising a high pressure cylinder, a low pressure cylinder, inlet and outlet valves for said cylinders, a piston in each cylinder, a throttle valve for admitting the motive fluid into the high pressure cylinder and delivering the exhaust from the high pressure cylinder to the low pressure cylinder, eccentric mechanisms for operating the inlet and outlet valves of the high and low pressure cylinders, means for reversing the eccentric mechanisms and means for actuating the throttle valve to reverse the delivery of motive fluid.

7. An engine embracing a casing containing cylindric piston chambers and cylindric valve chambers, one intersecting each piston chamber with parallel axis but each beyond the periphery of the other, a piston in each piston chamber, a rotary valve in each valve chamber contacting the periphery of the respective piston, a piston head secured to each piston and adapted to fit in a notch in the respective rotary valve, means for admitting the motive fluid under pressure into one of the cylinders and delivering the exhaust from said cylinder into the other cylinder, means for actuating the aforesaid means to reverse the delivery of motive fluid and the exhaust thereby reversing the engine, spring pressed packing members arranged longitudinally

around the periphery of the pistons, packing members at the ends of the pistons and packing members between the pistons.

8. In an engine a casing provided with heads, a partition dividing said casings into a high and a low pressure chamber, a shaft journaled in the heads, roller bearings for said shaft, pistons on said shaft, one in each chamber, expansible packing rings fitted in grooves in the heads and partitions, packing rings secured in the periphery of each piston, a head rigidly secured to each piston extending outwardly into close proximity with the wall of the respective chamber and packing strips secured to the head and bearing against the respective walls of the cylinders.

9. In an engine a casing, heads secured thereto, a partition dividing the casing into chambers, packing rings in grooves in the heads and in the partition, pistons bearing at their ends against the packing rings, a piston head secured to each piston, spring pressed packing members arranged peripherally around the pistons, rotary valves, one for each piston adapted to contact the periphery of the respective piston, roller bearings for the valve shaft and a packing member between the valves and contacting the top of the partition.

10. An engine comprising a casing, providing a valve chamber and a piston chamber, a head on each end thereof, a partition dividing the piston chamber into a high and low pressure chamber, a piston in each chamber having a piston head, a rotary valve having its ends journaled in recesses in the heads, and said valve oppositely notched to receive the appropriate piston head, means for rotating the pistons and rotary valve isochronously, a single valve connected with a source of steam, with the high and low pressure cylinder and with the exhaust for admitting fluid under pressure into the high pressure chamber and admitting the exhaust from the high pressure chamber into the low pressure chamber and exhausting from the low pressure cylinder into the atmosphere, means for reversing the delivery of the motive fluid into each chamber and packing members for the sides of the casing, the walls of the valve chamber and the pistons.

11. A rotary engine embracing high and low cylindric pressure chambers, a shaft extending axially through both, high and low pressure abutment chambers, a shaft extending axially through both, parallel the main shaft, a piston on the main shaft in each cylinder, a rigid abutment head on each, a rotative abutment valve in each abutment chamber and notched to receive the piston abutment head therein, rock valves affording the inlet and the exhaust valves for each cylinder, a throttle valve adjusted and connected to supply steam under pressure to the high pressure chamber to deliver the exhaust from the high pressure chamber to the inlet of the low pressure chamber and to exhaust from the low pressure chamber to the atmosphere.

12. A rotary engine embracing high and low cylindric pressure chambers, a shaft extending axially through both, high and low pressure abutment chambers, a shaft extending through both, parallel the main shaft, a piston on the main shaft in each cylinder, a rigid abutment thereon, a rotative abutment in the abutment chamber and notched to receive the piston abutment therein, rock valves affording the inlet and the exhaust valves for each cylinder, a throttle valve adjusted and connected to supply steam under pressure to the high pressure cylinder, the exhaust from the high pressure to the inlet of the low and to exhaust from the low to the atmosphere, means for reversing the valves to reverse the engine, rock arms on the valves and eccentrics on one of the shafts adapted to actuate the rock arms to afford the cut-off.

13. A rotary engine embracing high and low cylindric pressure chambers, high and low pressure abutment valve chambers, a piston in each pressure chamber, a rigid abutment head on each piston, a rotative abutment valve in each abutment chamber and notched to receive the respective piston abutment head therein, valves controlling the inlet and the exhaust for each pressure chamber, means for operating the same, and a single valve connected to supply steam under pressure to the high pressure cylinder, to deliver the exhaust from the high pressure chamber to the inlet of the low pressure chamber and to exhaust from the low pressure chamber to the atmosphere.

14. A rotary engine embracing high and low cylindric pressure chambers, a piston in each chamber, a rigid abutment head on each, valves controlling the inlet and the exhaust passages for each cylinder, means for actuating said valves, means for adjusting the actuating means to operate the valves on reversing the engine, means for delivering the exhaust from the high to the low pressure cylinder and means for reversing the delivery of the exhaust.

15. A rotary engine embracing high and low cylindric pressure chambers, expansible packing members fitted in grooves in the wall of the chambers, a shaft extending axially through both, high and low pressure abutment valve chambers, expansible packing members fitted in the end walls of the abutment valve chamber, a shaft extending through both piston chambers, a piston on the main shaft in each cylinder, a rigid abutment head thereon, packing bars secured to the pistons, packing members secured to the heads, a rotative abutment valve in each abutment valve chamber and notched to receive the respective piston abutment head

therein, valves affording the inlet and the exhaust valves for each cylinder and a throttle valve connected to supply steam under pressure to the high pressure cylinder and to exhaust from the high pressure cylinder to the inlet of the low pressure cylinder.

In testimony whereof I have hereunto subscribed my name in the presence of two subscribing witnesses.

JAMES ALLEN EATON.

Witnesses:
C. W. HIERS,
K. E. HANNAH.