(No Model.)

3 Sheets—Sheet 1.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,558.

Patented Sept. 4, 1894.

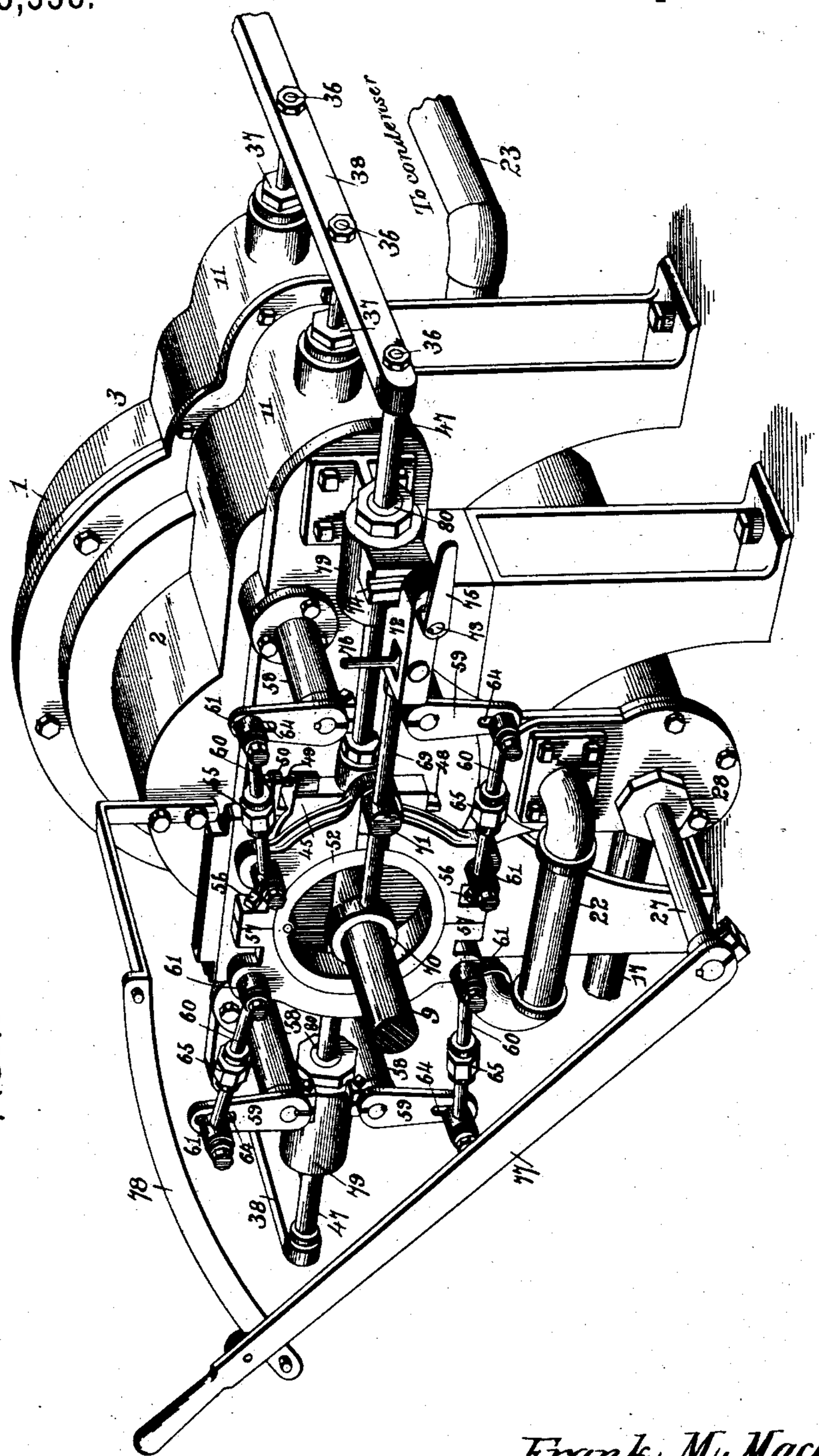


FIG. 1.

Witnesses

Jas. K. McCachran

Inventor

Frank M. Mackey

By his Attorneys.

Cachow & Co.

(No Model.) 3 Sheets—Sheet 2.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,558. Patented Sept. 4, 1894.

FIG. 2.

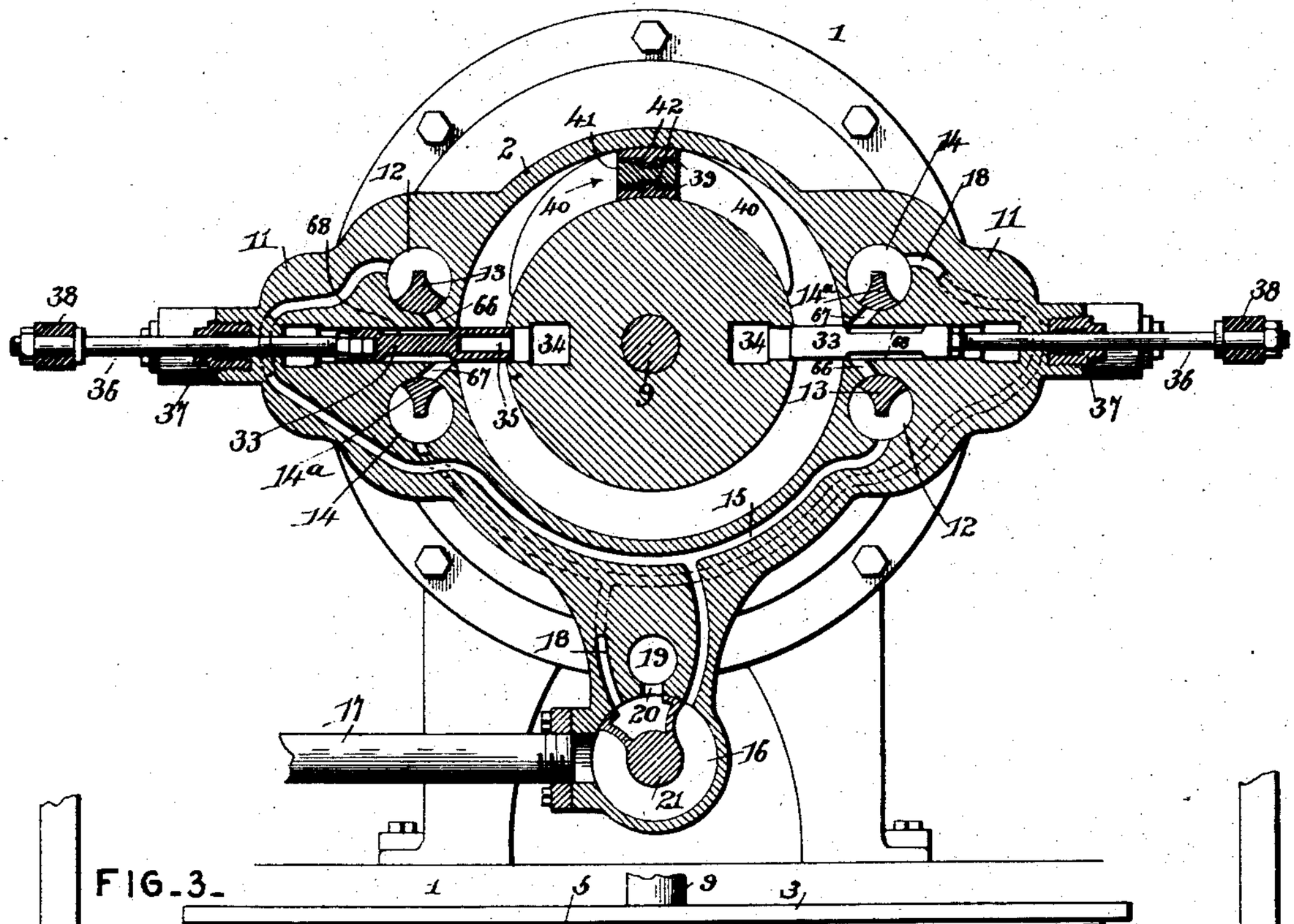
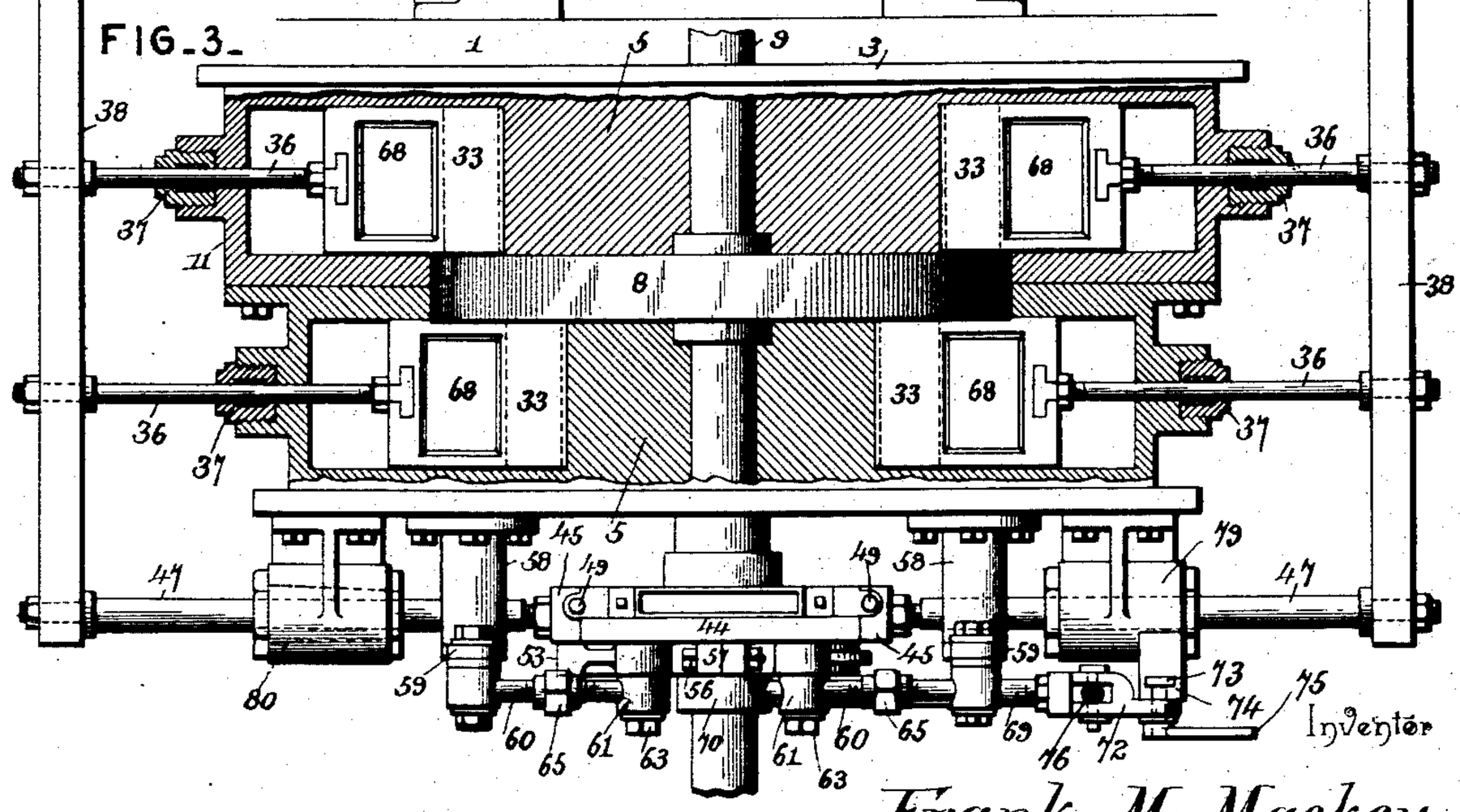


FIG. 3.



Witnesses
Jas. K. McCutchan
D. L. Coyle

Inventor
Frank M. Mackey
By his Attorneys.
Cachow & Co.

(No Model.) 3 Sheets—Sheet 3.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,558. Patented Sept. 4, 1894.

FIG. 4.

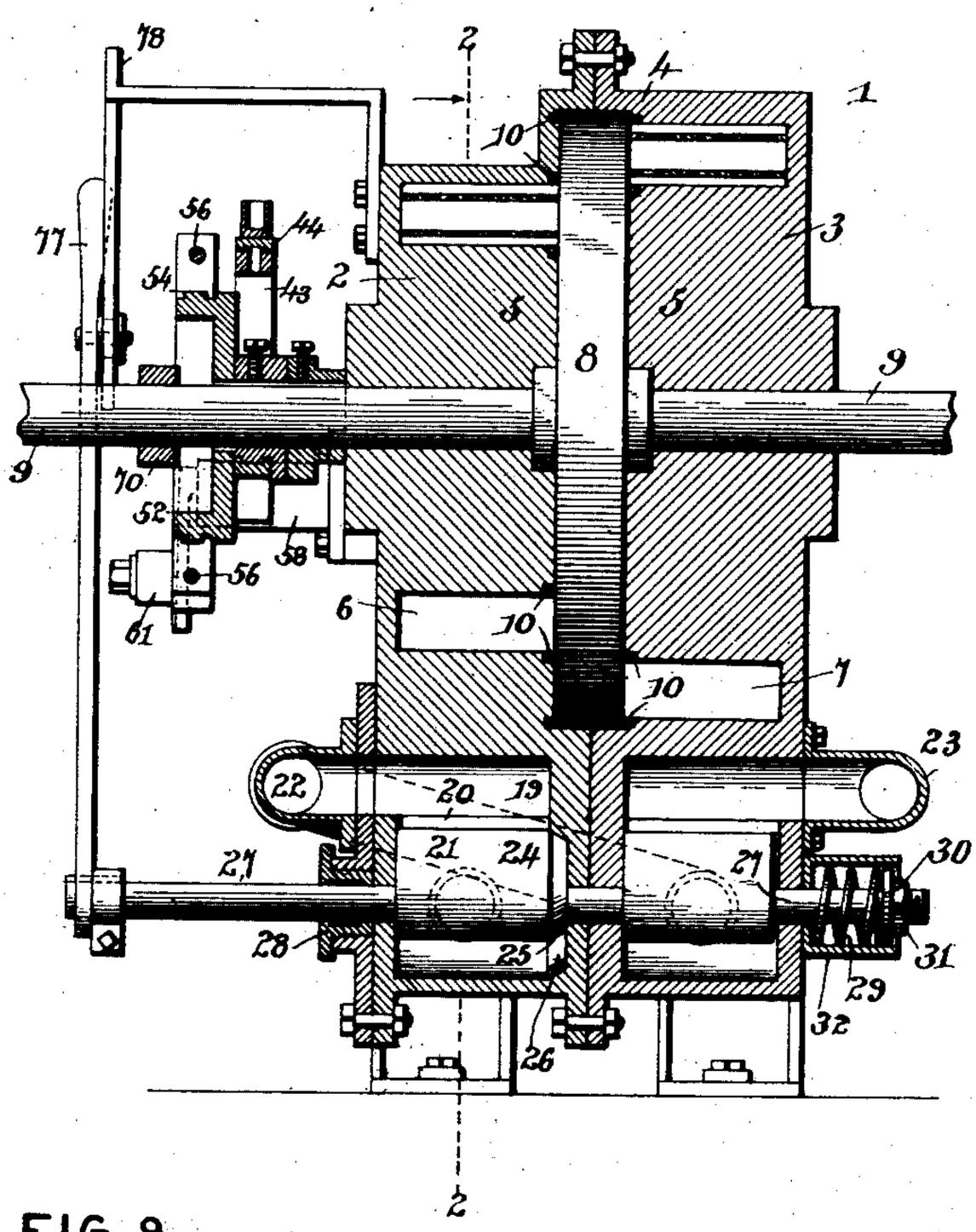


FIG. 6.

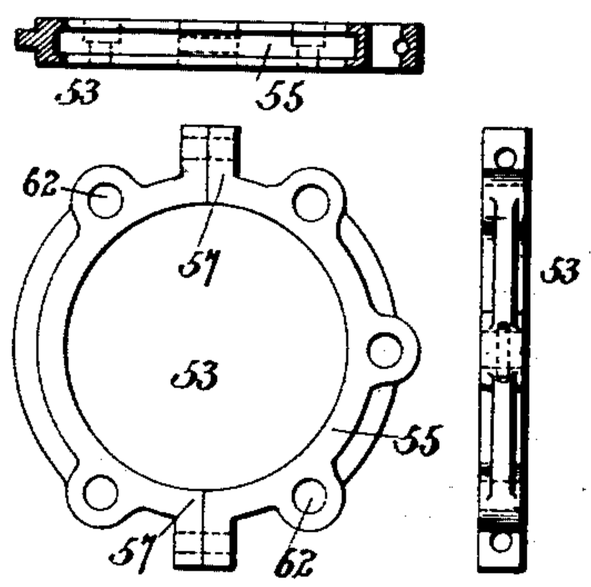


FIG. 7.

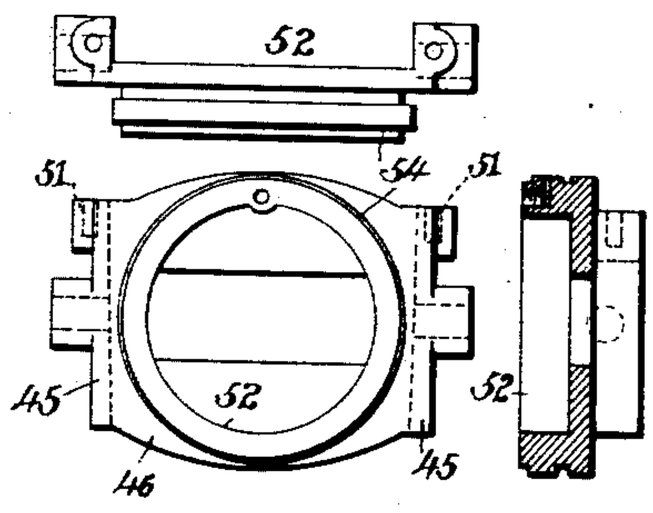


FIG. 8.

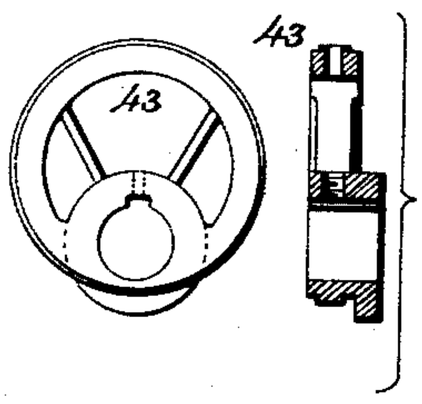


FIG. 9.

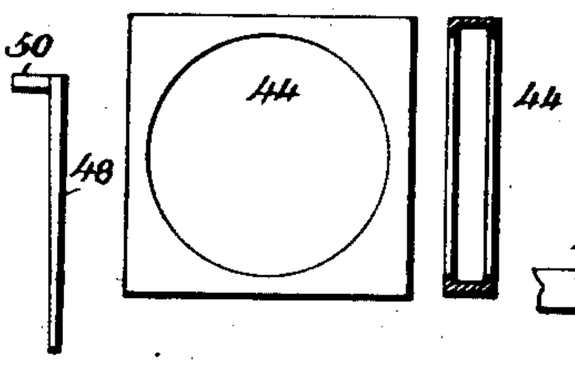
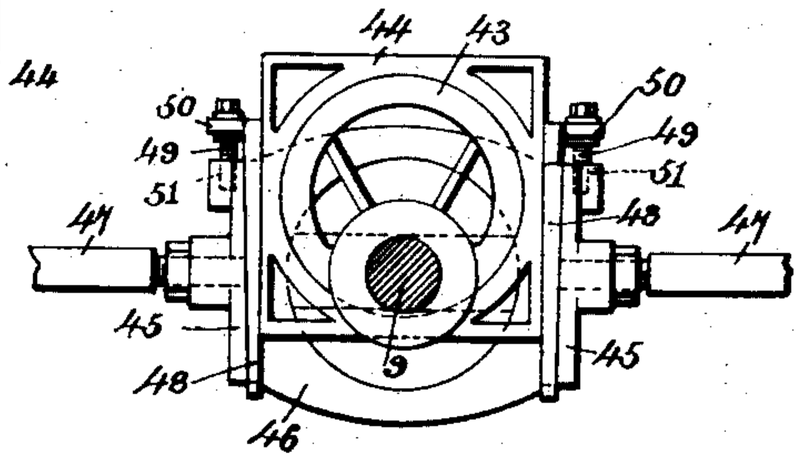


FIG. 5.



Witnesses

Jas. K. McCathran

Inventor

Frank M. Mackey

By his Attorneys.

C. A. Snow & Co.

UNITED STATES PATENT OFFICE.

FRANK M. MACKEY, OF PHILADELPHIA, ASSIGNOR OF FOUR-FIFTHS TO CHARLES C. GIBSON AND DANIEL F. RING, OF WILLIAMSPORT, PENNSYLVANIA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 525,558, dated September 4, 1894.

Application filed March 3, 1894. Serial No. 502,201. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. MACKEY, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Rotary Engine, of which the following is a specification.

My invention relates to rotary engines, particularly of the compound type, and it consists in an improvement upon the construction shown and described in my former application, Serial No. 509,275; and the objects in view are to provide an engine having high and low pressure cylinders of different areas and equal sections; to provide an arrangement of cored channels and ports whereby the different parts of the construction are interchangeable; to provide means for a continuous movement of the reciprocating valves; to provide variable cut-off mechanism for operation in conjunction with the reciprocating valves; to provide similar and direct means for exhausting from the high to the low pressure cylinder; to provide a construction whereby both cylinders may be employed as high pressure cylinders and whereby either cylinder may be used independently of the other; to provide means for cushioning the reciprocating valve; and to provide means for holding the operating valve snugly to its seat.

Further objects and advantages of the invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

Referring to the drawings:—Figure 1 is a perspective view of a rotary engine embodying my invention. Fig. 2 is a vertical section taken transversely through the main or drive-shaft through the high pressure cylinder upon the line 2—2 of Fig. 4. Fig. 3 is a horizontal section showing the valve operating mechanism in plan. Fig. 4 is a vertical section taken parallel with the axis of the drive-shaft. Fig. 5 is a rear view of the eccentric-operated yoke and attachments. Fig. 6 is a detail view showing the face, side, and a transverse section of the adjustable ring for the attachment to the yoke of the oscillating valve connecting-rods. Fig. 7 is a similar view showing the front, plan, and transverse section of the yoke. Fig. 8 is a similar view showing the front and a transverse section of the eccentric. Fig. 9 is a similar view showing the front and a transverse section of the eccentric strap or block and a front view of one of the adjustable keys.

Similar numerals of reference indicate corresponding parts in all the figures of the drawings.

The casing 1, as in the construction shown in my former application above referred to, is formed in two separable parts, respectively designated as 2 and 3, which combine to form the shell 4 and the concentric core 5. Between the core and the shell are the annular high and low pressure cylinders 6 and 7, which are separated by a rotatable disk 8 fixed to the drive shaft 9 which is mounted in suitable registering bearings in the parts of the core 5 and projects beyond the faces of the casing. In the construction illustrated in the drawings the high and low pressure cylinders 6 and 7 are made of corresponding cross-sections, but the diameter of the low pressure cylinder is greater than that of the high pressure cylinder, thereby providing greater area in the former to permit of greater expansion of the steam which is exhausted thereinto from the latter. The disk 8 is arranged between the planes of the inner sides of the core sections and slightly exceeds in diameter that of the low pressure cylinder in order to form, in connection with the packing-rings 10, a steam-tight joint with the casing and prevent direct communication between the high and low pressure cylinders.

The casing is extended laterally at opposite sides of the cylinders, as shown clearly at 11 in Fig. 2, and in these enlargements are formed the horizontal oscillating valve chambers 12 containing the oscillating valves 13, which may be of the ordinary or any preferred construction, and corresponding exhaust chambers 14. The inlet valve-chambers 12, as shown in the drawings, are located respectively below and above the horizontal plane of the drive shaft at opposite sides of the cylinders and communicate by means of the cored channels 15 with the operating valve chamber 16, which is preferably located below the cas-

ing instead of above as in the construction illustrated in my former application. The steam-inlet or supply pipe 17 communicates with the operating valve chamber, preferably at the side as illustrated. The exhaust chambers 14, which are fitted with the outlet valves 14^a, communicate by means of the cored channels 18 with the operating valve chamber, and the main exhaust chamber 19 communicates by means of a port 20 with said operating valve chamber, whereby when the operating valve 21 is in the position shown in Fig. 2, the cored exhaust channels 18 communicate through the operating valve chamber with the main exhaust chamber 19. The construction and relative disposition of the inlet and exhaust chambers and the communicating channels correspond upon the high and low pressure sides of the casing, and therefore the above description is sufficient for both, but the main exhaust 19 of the high pressure cylinder is connected by means of a suitable conducting pipe 22, with the operating valve casing of the low pressure cylinder, whereby the exhaust steam from the high pressure cylinder after passing into the main exhaust 19 of the high pressure cylinder is conveyed to the operating valve casing or main inlet of the low pressure cylinder, whereas, the exhaust steam from the low pressure cylinder after leaving said low pressure cylinder and passing to the main exhaust chamber thereof is conveyed by means of a suitable conductor 23 to the atmosphere or to a condenser (not shown).

The operating valve is formed in two sections, as clearly shown in Fig. 4, of which the section 24 arranged in the operating valve casing of the high pressure cylinder is provided with a conical terminal 25 arranged in a correspondingly shaped seat 26 in the inner end of the valve casing and the operating valve stem 27, which is journaled in the walls of the valve casing and passes at the high pressure side of the cylinder through a stuffing-box 28, projects at the other end, namely, the low pressure side of the engine, beyond the face of the casing, and is fitted with a coiled tension spring 29, which bears against the face of the casing at one end and against an adjustable collar 30 at the opposite end, such collar being held in place by a tension nut 31, which is threaded upon the extremity of the valve stem. This tension device comprising the spring 29, collar 30, and adjusting nut 31 is arranged in a cup 32, which is secured to the end of the operating valve casing. The function of this tension device is to hold the conical end of the high pressure operating valve section snugly in contact with its seat to prevent the excess of pressure in the high pressure cylinder from being communicated to the low pressure cylinder.

The reciprocating valves 33, which are preferably arranged in a horizontal position at opposite sides of the cylinders and between the planes of the oscillating valve chambers, are adapted to extend across the sections of the cylinders and fit at their inner ends into seats 34, which are formed in diametrically opposite sides of the cross-sections, said inner ends of the valves being provided with cavities 35, whereby the valves are cushioned by the confined steam in the seats 34 at the limit of their inward or forward movements. The reciprocating valve stems 36 pass through stuffing boxes 37 and are secured at their outer ends to the cross bars 38, whereby the reciprocating valves of the high and low pressure cylinders operate simultaneously.

The disk 8 is provided at its opposite sides at the proper distances from its axis with piston-head seats 39 formed in crescent-shaped webs 40, and the piston-heads 41, which are arranged in said seats 39, may be of any preferred construction and may be provided with any suitable means for maintaining an even steam-tight contact with the inner and outer walls of the cylinders. In the drawings the piston-heads are constructed of parts separated by interposed expansible packing 42.

Fixed to the drive shaft, preferably adjacent to one head of the cylinder-casing, is an eccentric 43, which operates revolubly in an eccentric-strap or block 44 fitting slidably for vertical movement between the parallel side flanges 45 of the horizontally movable yoke 46, this yoke being connected by means of the rods 47 to the extremities of the transverse bars 38 to which are connected the reciprocating valve stems. Between the side edges of the vertically slidable eccentric-strap or block 44, and the contiguous side flanges of the yoke 46 are arranged the adjustably tapered keys 48 having parallel inner surfaces and inclined outer surfaces to agree with the correspondingly inclined inner surfaces of the flanges 45 and these keys are capable of adjustment to take up wear by means of the adjusting screws 49, which are swiveled in ears 50 of the keys and engage threaded sockets 51 in the upper ends of the flanges 45. The yoke is provided upon its outer or front side with a ring 52, upon which is revolubly mounted the adjustable ring 53, the connection being by means of a feather 54 formed upon the periphery of the rim and fitting in a corresponding groove 55 in the inner surface of the ring, the latter being formed in separable sections which are secured together when applied to the rim by means of bolts 56 engaging perforations in the terminal ears 57 of said ring sections. The oscillating valve stems 58 terminate in rock-arms 59, the extremities of which are connected by means of rods 60 to wrist-pins 61, which are fitted in perforations 62, formed in the ring, the crank-pins 63 at the outer extremities of said rock-arms and upon which the connecting rods 60 are swiveled being fitted adjustably in longitudinal slots 64 in

the rock-arms, whereby the throw of the rock-arms may be varied by the point of attachment of the rod 60. The connecting rods 60 are sectional in construction and the parts thereof are connected by means of right and left threaded adjusting nuts 65, by which the lengths of the connecting rods may be adjusted to secure the proper opening and closing of the valves.

From the above description it will be understood that the horizontal reciprocation of the yoke by means of the eccentric above described causes an oscillation of the valves 13 and 14ª, whereby the ports 66 and 67 which connect the oscillating valve-chambers with the cylinder are alternately opened and closed to admit steam at one side of the reciprocating valves 33 and exhaust at the opposite side through recesses 68 which are formed respectively in the upper and lower surfaces of said reciprocating valves. In order to vary the period of cut-off to avoid the use of an unnecessary quantity of steam I have provided means for adjusting the relative points of attachment of the connecting rods 60 with the yoke, and such means comprise the ring 53, which is held at any desired adjustment, by means of the adjusting-lever 69 fulcrumed by means of the ring 70 upon the drive shaft and pivotally connected at 71 to the ring. The outer end of this lever 69 is provided with a head 72 provided with a key 73, which fits slidably in a segmental guide 74 fixed in any suitable manner to the casing. The handle 75 is threaded upon the outer end of the key 73, whereby adjusting-lever 69 may be locked at any desired adjustment. When desired a governor of any suitable construction may be attached to this adjusting lever, and in the drawings I have shown the lower end of a connecting rod 76, whereby the lever may be connected to the governor device.

The operating valve stem 27 projects beyond the front end of the operating valve casing and is fitted with an operating lever 77 arranged to swing in contact with a segmental guide 78. The connecting rods 47 which are attached at their inner ends to the sides of the yoke and at their outer ends to the terminals of the transverse bars 38, extend at intermediate points through horizontal guides 79 having adjustable bushings 80 to compensate for wear.

From the above description in connection with that included in my former application above referred to, the operation of the mechanism will be clearly and briefly stated as follows:—The steam which is admitted to the operating valve casing passes through the cored-channels in the casing into the inlet oscillating valve casings from which it proceeds through the ports 66 into the cylinder when the reciprocating valves are extended across the cylinder sufficiently to open communication between the recesses 68 in the surfaces of the reciprocating valves and the cylinder. Such communication is not established until the inner ends of the reciprocating valves have entered the seats 34 in the opposite sides of the core section and have formed a steam-tight joint at that point. Referring to Fig. 2, it will be seen that the reciprocating valves are at the center of their movement, at which time the inner ends thereof have entered the seats in the core-section, but communication has not been established between the cylinder and the recesses 68. With the parts in these positions the piston-head is located between the reciprocating valves or at the top of the cylinder, as shown in Fig. 2, and any further movement of the piston in the direction indicated by the arrow in said figure will be accompanied by an outward or retracting movement of the right hand reciprocating valve and an inward or forward movement of the left hand reciprocating valve, and at the same time by an opening of the left hand inlet oscillating valve and the corresponding or left hand outlet oscillating valve. The movements of the reciprocating valves are continuous by reason of the regular movement of the yoke, which is actuated by the eccentric, and therefore when the piston head reaches the plane of the reciprocating valves the adjacent valve will be in its retracted position while the opposite or remote valve will be in its extended position, and when the piston head reaches its lowermost position, or the position opposite to that indicated in Fig. 2, the reciprocating valve will have assumed the same position as shown in said figure, but the right hand valve will be advancing while the left hand valve will be retreating to allow the piston head to pass. Thus it will be understood that steam is admitted and exhausted at the same side of the cylinder at one time through the recesses which are provided in the upper and lower surfaces of the reciprocating valves, and inasmuch as both reciprocating valves are in the position shown in Fig. 2 when the piston-head is at the quarters of its revolutions, it is obvious that the steam contained in one-fourth of the cylinder is confined by the forward movement of the reciprocating valve just passed by the piston, whereby when steam is again admitted by way of the reciprocating valve just passed, this confined steam will assist in the operation of the piston.

From the above description it will be understood that the engine is reversible by means of the operating valve, in which case the exhaust valves 14ª become the inlet valves.

Furthermore, angular adjustment of the lever 69 in either direction causes the oscillating valves to open and close at relatively different moments, whereby as the speed of the piston increases the oscillating valves may be caused to admit steam and exhaust sooner than when the piston is moving more slowly, to avoid back pressure.

It will be understood, furthermore, that the difference of areas between the high and low

pressure cylinders may be attained, as shown and described in my former application, by increasing the section of the low-pressure cylinder, but by the arrangement herein described consisting in increasing the diameter instead of the section of the cylinder, I am enabled to employ interchangeable valves for the high and low pressure cylinders, and I find in addition thereto, that the sections of the casing may be bored with greater facility.

In the accompanying drawings the valve operating mechanism upon the high pressure side of the casing only is illustrated, but it will be understood that when the cylinders are of different diameters, as shown, this mechanism is duplicated upon the opposite or low pressure side of the casing.

Various changes in the form, proportion, and the minor details of construction may be resorted to without departing from the principle of this invention or sacrificing any of the advantages thereof.

Having described my invention, what I claim is—

1. In a rotary engine, the combination of contiguous annular high and low pressure cylinders of equal sectional areas and different diameters, pistons operating in the cylinders, valves, and operating connections, substantially as specified.

2. A rotary engine having an annular cylinder, and a concentric core provided with seats equal in depth to a cross section of one side of said cylinder, reciprocating valves adapted to span the cylinder and fit in said seats when extended, means for imparting a continuous reciprocating movement to said valves, cut-offs, and operating connections, substantially as specified.

3. A rotary engine having an annular cylinder, and a concentric core provided with seats, reciprocating valves adapted to span the cylinder and fit in said seats when extended, said valves being provided with terminal cavities to cushion the steam in said seats, cut offs, and operating connections, substantially as specified.

4. A rotary engine having an annular cylinder, a piston, reciprocating valves, cut-offs located adjacent to said valves and provided with rock-arms, an eccentric-operated yoke provided with a rim, a ring fitted upon said rim, connections between the ring and the rock-arms of the cut-offs, and means for adjusting the ring, substantially as specified.

5. A rotary engine having an annular cylinder, a piston, reciprocating valves, cut-offs arranged adjacent to said valves, a yoke connected to the stems of the valves and to the rock-arms on the stems of the cut-offs, an eccentric carried by the shaft of the piston, an eccentric-strap or block fitting upon the eccentric and connected slidably to the yoke, and adjustable keys located between the sides of the strap or block and the contiguous portions of the yoke, substantially as specified.

6. A rotary engine having an annular cylinder, a piston, reciprocating valves, adjacent cut-offs, an eccentric-operated yoke provided with a rim and connected to said reciprocating valves, a ring revolubly mounted upon said rim and connected to the rock-arms of the cut-offs, and a lever fulcrumed concentric with the piston and loosely connected to the ring, substantially as specified.

7. A rotary engine having annular high and low pressure cylinders, pistons mounted in said cylinders, opposite recessed reciprocating valves, cut-offs arranged adjacent to said valves, and operating connections between the piston-valves and cut-offs, in combination with main exhaust chambers communicating with the chambers of the cut-offs, an operating valve having its casing in communication with said main exhaust, and a conductor connecting the main exhaust of the high pressure cylinder with the casing of the operating valve in communication with the low pressure cylinder cut-offs, substantially as specified.

8. A rotary engine having a casing formed in separable sections, each section being provided with a core and an eccentric shell to form an intermediate annular cylinder, the cylinder in one of the sections being of greater diameter than that in the other, a rotary disk arranged between the core sections and seated at its periphery in the inner surfaces of the sections of the shell and covering the joint between the sections of the casing, piston-heads arranged upon and carried by the disk and disposed at different distances from the axis thereof to operate independently in the annular cylinders, valves, and operating connections, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

FRANK M. MACKEY.

Witnesses:
H. C. PRICE,
J. HARRY BROOKE.