No. 609,027. Patented Aug. 16, 1898.

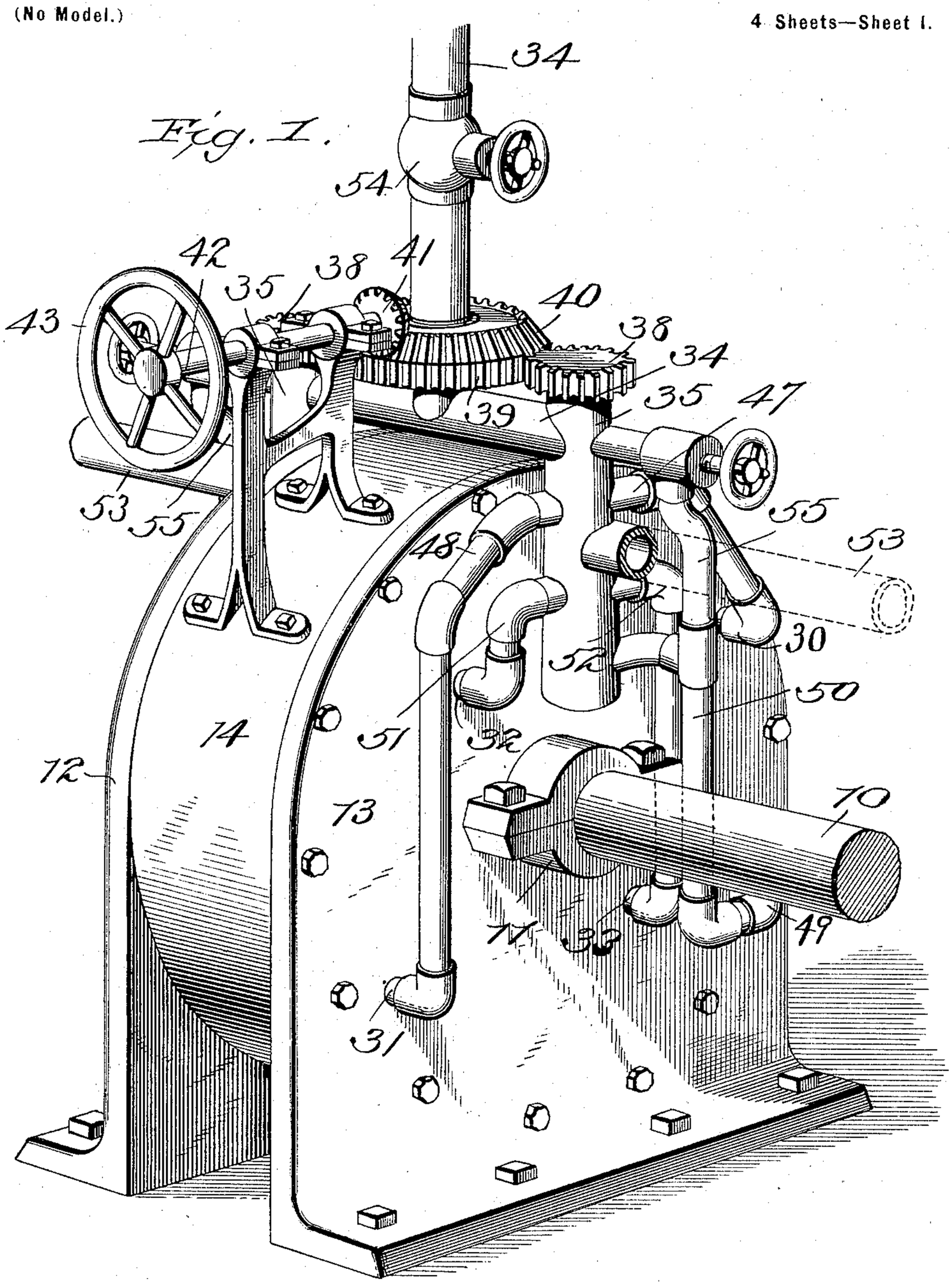
A. G. HILTON & J. H. WALLACE.

COMPOUND ROTARY ENGINE.

(Application filed May 24, 1897,)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



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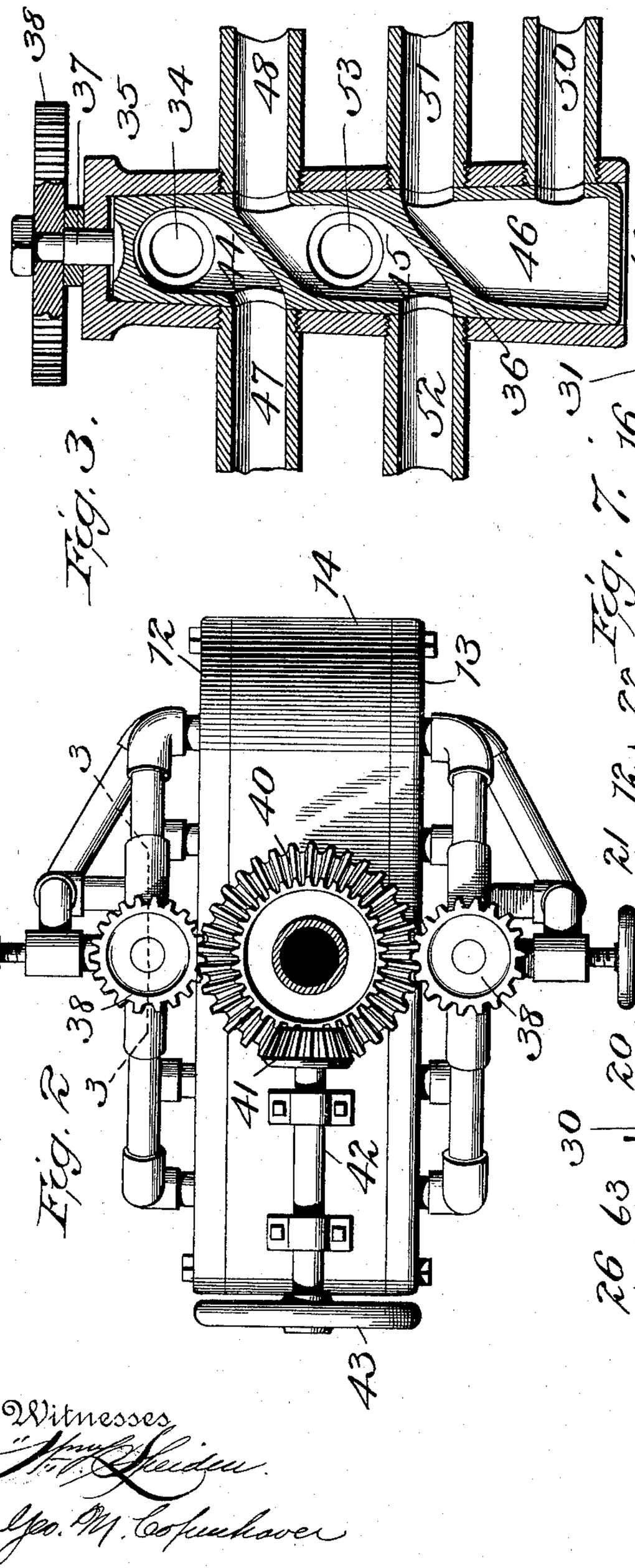

Fig. 3.

Fig. 2.

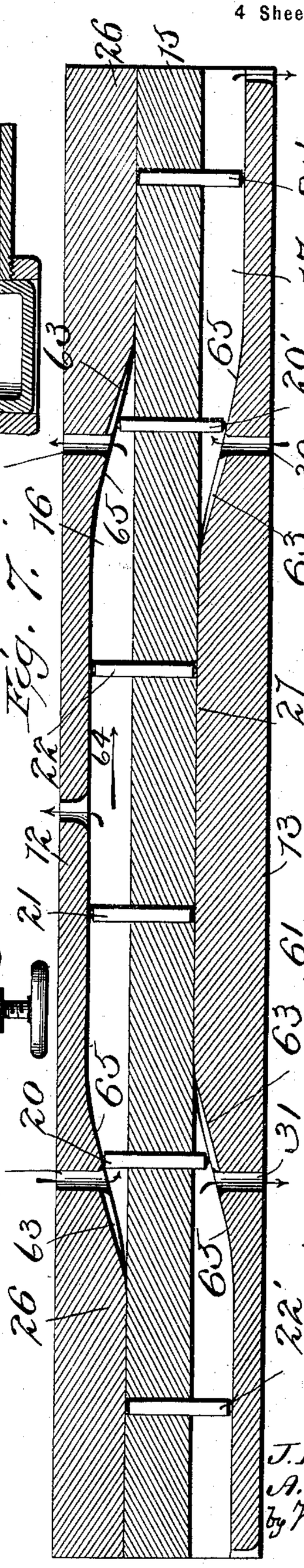

Fig. 7.

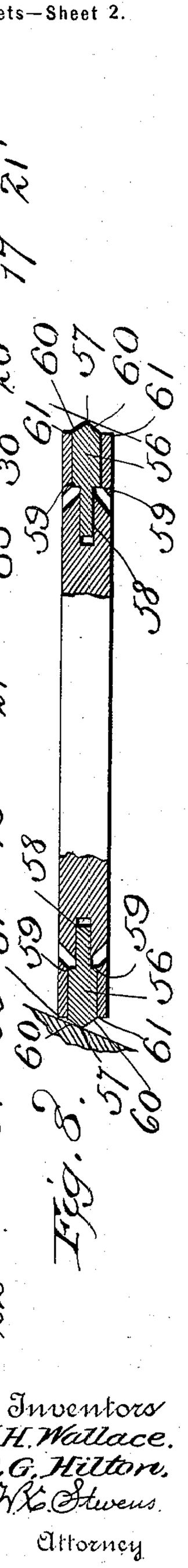

Fig. 6.

Fig. 5.

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(No Model.) 4 Sheets—Sheet 3.

Fig. 6.

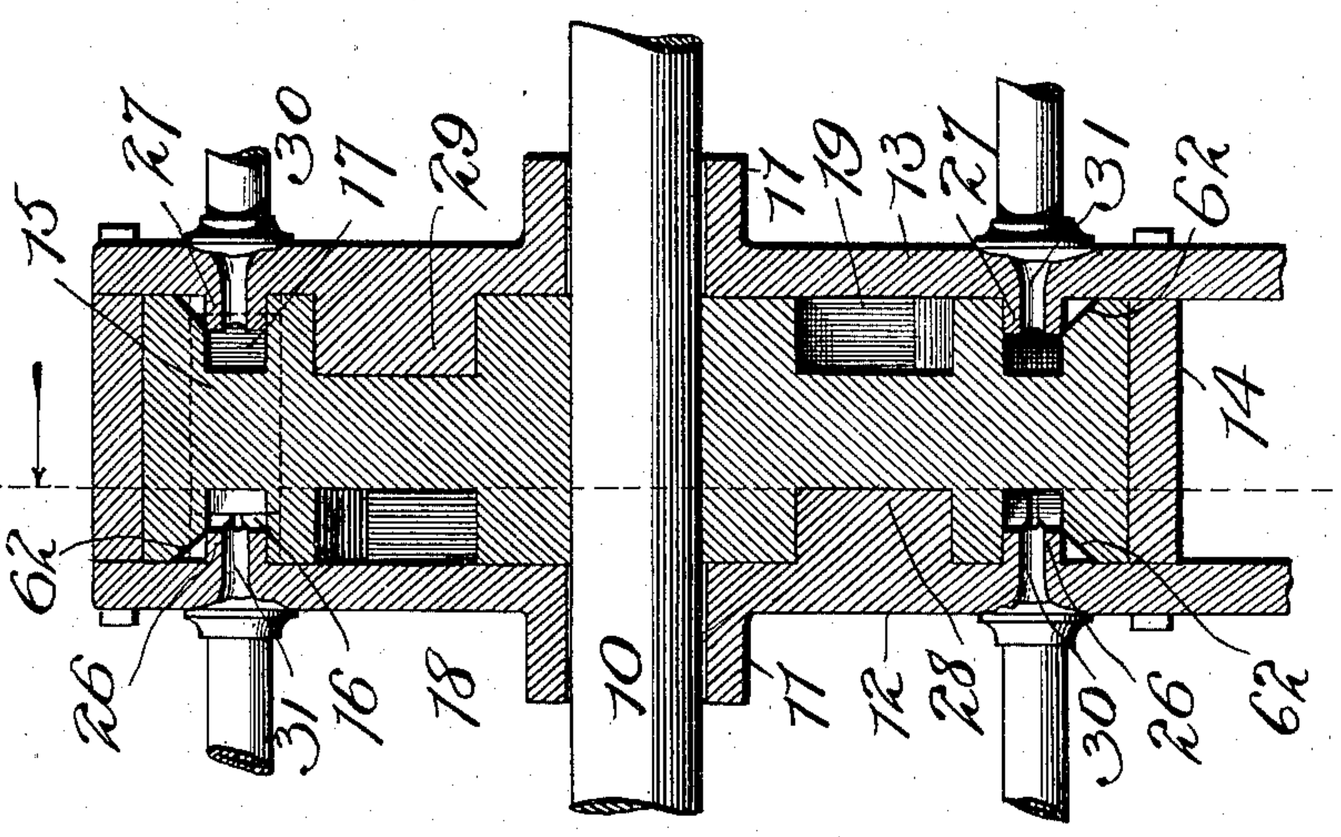


Fig. 5.

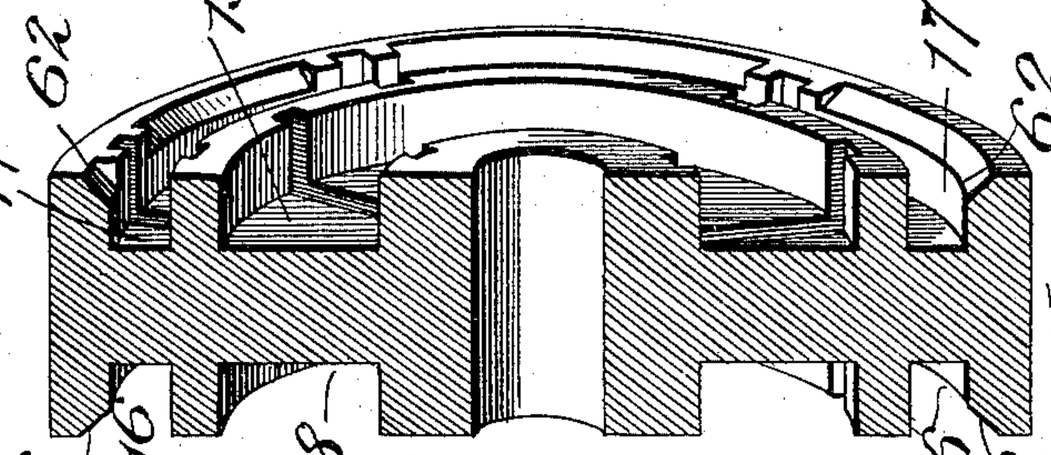
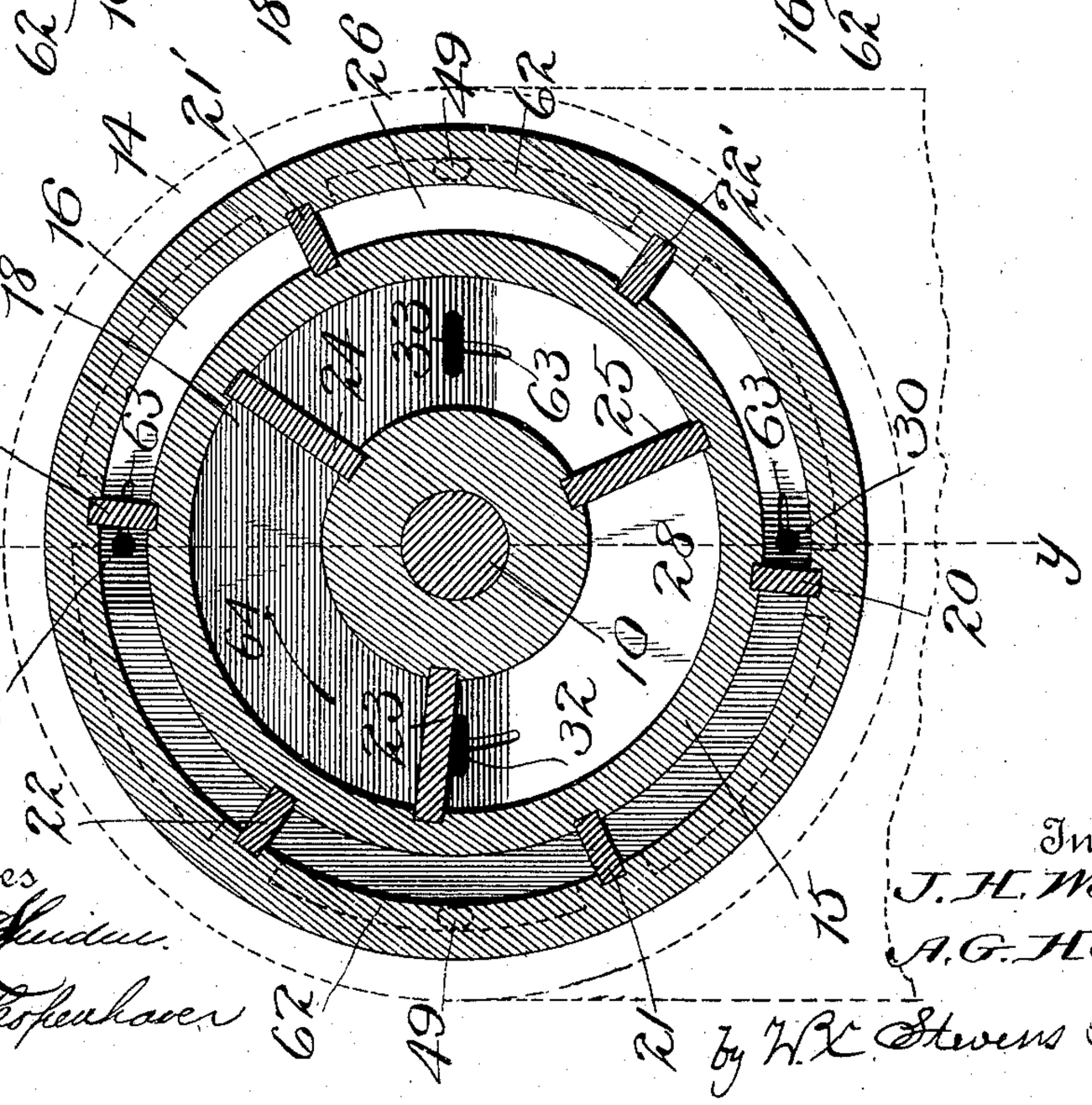


Fig. 4.



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COMPOUND ROTARY ENGINE.

(Application filed May 24, 1897,)

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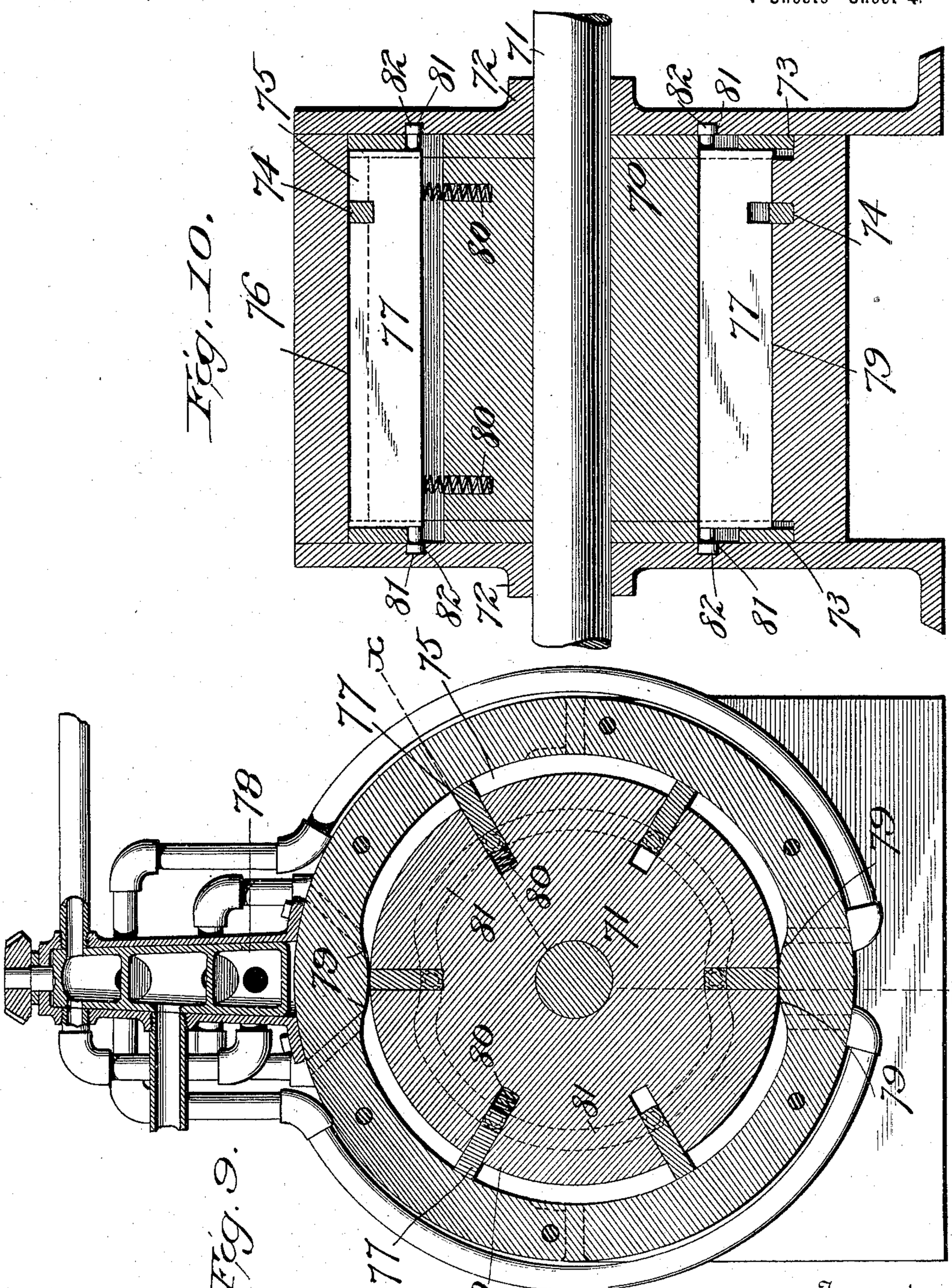

Fig. 10.

Fig. 9.

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UNITED STATES PATENT OFFICE.

ARTHUR G. HILTON AND JAMES H. WALLACE, OF FORT FAIRFIELD, MAINE.

COMPOUND ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 609,027, dated August 16, 1898.

Application filed May 24, 1897. Serial No. 637,936. (No model.)

To all whom it may concern:

Be it known that we, ARTHUR G. HILTON and JAMES H. WALLACE, citizens of the United States, residing at Fort Fairfield, in the county of Aroostook and State of Maine, have invented a new and useful Improvement in Compound Rotary Engines; and we do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, in which—

Figure I is a perspective view of a rotary engine according to our invention. Fig. II is a top view of the same. Fig. III is a vertical section of one of the two-way stop-cocks for reversing the direction of steam entrance to and exit from this engine in order to reverse the engine. Fig. IV is a transverse section of the engine-piston at the inner face of the segmental abutment of the further cylinder-head and looking toward that head. Fig. V is a longitudinal section, partly in perspective, of the piston-head of the engine without the wing-grooves. Fig. VI is a longitudinal section of the engine at the line $x\ y$ of Fig. IV. Fig. VII is an edgewise view of the circumference of the engine with the circumferential casing removed as the circumference would appear if rolled out flat upon the paper, that portion of the casing which projects radially beyond the piston-head being section-lined. Fig. VIII is a longitudinal section of a wing of the piston. Fig. IX is a transverse vertical section of a modification of our rotary engine, and Fig. X is a longitudinal section of the same on the angular lines $x\ x$ of Fig. IX.

This invention relates to that class of rotary engines which are designed to be operated by some expansive agent, such as steam, gas, compressed air, or the like; and its object is to adapt two cylinders to operate around one shaft as a single expansion-engine, the first cylinder to utilize a portion of the force of the motive agent under full pressure and the second cylinder to utilize a further and much greater amount of that force from the expansion of the motive agent as it is discharged from the first cyclinder. To this end our invention consists in the construction and combination of parts forming an expansion rotary engine, hereinafter more fully described, and particularly pointed out in the claims. In this specification steam is considered to be the motive agent.

10 represents a shaft fitted to revolve in bearings 11, which for convenience of illustration we have shown as integral with the stationary ends or heads 12 and 13 of the engine-cylinders, of which 14 represents the drum or outer surrounding casing.

15 is the piston-head, which is secured rigidly to the shaft 10 to revolve the same. This piston-head is circumferentially cylindrical to revolve within the casing 14, and it has a pair of annular channels 16 17, one in each end, which channels serve as the high-pressure-steam-acting chambers or the first cylinder. The piston-head 15 has also another and much larger pair of annular channels 18 19 in its ends and surrounded by the first cylinder to serve as expansion steam-chambers called the "second" cylinder. All these annular channels 16 17 18 19 would be complete circles concentric with the shaft 10, but they are about half filled by segments 26, 27, 28, and 29, respectively.

20, 21, and 22 and 20′, 21′, and 22′, respectively, represent the piston-wings for the two high-pressure-steam channels or the first cylinder, and 23, 24, and 25 represent the piston-wings in the second cylinder or expansion-chambers 18 and 19. All of the wings are fitted to slide longitudinally through the piston-head 15, and they are provided with suitable packing along all the joints of sliding contact to make them steam-tight. The inner face of each end 12 13 of the cylinder has a semi-annular segment entirely filling a semicircle of each adjacent channel, the segment 26 on the end 12 being located in the channel 16, opposite to the open chamber of the mate channel 17, and the segment 27 on the end 13 being located in the channel 17, opposite to the open chamber of the said channel 16. The two heads 12 13 have also semi-annular segments 28 and 29, projecting in a similar manner into the channels 18 19, respectively, of the second cylinder; but these segments are preferably located quartering with the segments 26 27, the middles of the first set of segments 26 27 being circumferentially oppo-

site to the ends of the second segments 28 29. The distance from the face of any segment to the adjacent face of the opposite head is at all points just equal to the length of the piston-wings which are to travel in that pair of channels. The ends 65 of the segments serve as abutments against which the steam takes its base in pushing against the piston-wings to work the engine, and each abutment is slanted to form an easy incline, up and down which the wings may slide with the least practicable friction as they are rotated with the piston 15.

Each of the ports 30, 31, 32, or 33 is midway of an incline, and one port (30, for example) in each pair is the entry-port, while its mate, 31, would be the exit-port for steam operating in the channels 16 17 of the first cylinder to rotate the piston forward, the direction of the steam being indicated by arrows, and 32 would be the port of entry, and 33 the port of exit, of steam for the channels 18 19 of the second cylinder at the same time; but when the engine is to be rotated backward the above order will be reversed, so that 31 and 33 are the entry-ports, while 30 and 32 are the exit-ports. To accomplish such a reversal, a two-way stop-cock 35 is used, in which 36 is the turn-plug, having a stem 37. Fixed upon this stem is a pinion-gear 38, which is engaged by a spur-gear 39, having upon one face a beveled gear 40, which is engaged by a beveled pinion 41, that is fixed to the shaft 42 of a hand-wheel 43. All of this gearing is journaled in bearings which are mounted upon the stationary cylinder-casing 12 13 14. There are two cocks 35, one at each end of the cylinder, and their two gears 38 are both operated by the same spur-wheel 39 and hand-wheel 43. Each turn-plug is provided with three chambers 44 45 46, and the construction and operation of the two cocks are alike. The chamber 44, receiving live steam from the pipe 34, may deliver it to the pipe 47, which conducts it to port 30 to rotate the piston forward, as indicated by arrows 64; or, if the plug 36 be reversed by hand-wheel 43, the chamber 44 will communicate with pipe 48, which will conduct the steam to port 31 and rotate the piston backward.

49 represents in dotted lines the location of an exit-port which is in each end casing 12 and 13 circumferentially midway of the adjacent chamber 16 or 17 of the first cylinder and connected by a pipe 50 with the lower chamber 46 of the turn-plug 36, and thence a pipe 51 communicates with the entry-port 32 of the expansion-chamber 18 of the second cylinder.

52 is a pipe communicating between the exit-port 33 of the expansion-chamber and chamber 45 of the turn-plug, from which a pipe 53 exhausts into the open air or into a condenser.

54 represents a throttle-valve by means of which the steam coming from a boiler through pipe 34 may be wholly stopped or be admitted in any quantity required to stop the engine or to run it at the speed desired. As any style of governor may be used, we do not show one.

55 is a pipe communicating between the live-steam chamber 44 and the pipe 50, by means of which live steam may be admitted directly into the expansion-chamber or second cylinder of the engine. The full force of the steam being thus applied in the large chambers increases the power of the engine many fold in case of any emergency, such as starting a heavy load, climbing a hill, &c. The packings 56 in the wings have each a narrow surface 57 along its outer end to slide against the cylinder, and a corresponding portion of the inner end not quite so narrow is made into a shank 58, leaving shoulders at 59 a little wider than the exposed region 60 of the packing for steam to act upon, so as to press the packing lightly outward against the adjacent sliding surface and insure a tight joint with little friction in service.

61 represents a shoulder at the end of each wing, which shoulder becomes exposed to the pressure of the acting steam when the wing ascends an incline, whereby the wing is impelled toward the opposite and descending incline, overcoming the friction usually consequent to ascending an incline. The inner edge 62 of the outer ring of the piston is chamfered between wings, and opposite this chamfer the exit-port 49 is located, so that the ends of the wings are not required to slide across these ports; but there is a space at each wing not chamfered long enough to cover the port 49, while the wing is passing the port to prevent the escape of steam under the edge of a wing through the port to the front side of the wing. Each port which is in the incline of an abutment has a branch groove 63, tapering to the top of that incline, whereby steam will begin to enter in a very small stream the instant a wing comes over the abutment, and as the wing progresses the groove 63 enlarges until the port is reached and passed, when the full head of steam is in action on that wing, and, on the other hand, these grooves 63 permit the last bit of steam to escape that would otherwise have been locked in ahead of the wing and beyond the port against the remaining abutment. If steam were so locked in, it would greatly retard the engine and cause a continual thumping while at work.

The operation is as follows: The hand-wheel 43 is to be turned to set the cock-plug 36 so as to rotate the engine in the direction desired. Then the throttle-valve 54 is to be opened. Let us suppose the engine is to go forward, as indicated by the arrows 64. Steam coming into plug 36 by pipe 34 will be directed by pipe 47 to port 30, and acting first between wing 20 and the abutment 65 of segment 26 in the first cylinder it pushes that wing forward and with it carries the piston 15, thereby starting the engine to work. When wing 20 reaches the position now shown by

21, another wing 22′ will be taking steam where wing 20 now is, and when this wing 22′ has passed the port 30 there is no inlet nor outlet for the steam between the wings 20 and 22′; but when wing 20 reaches the exit-port 49 that steam is permitted to escape through pipe 50 (see Fig. I) to chamber 46 of the plug, and by pipe 51 and port 32 into the expansion-chamber 18 of the second cylinder, where its first action is against wing 23. Here the steam may continue to expand, acting against the abutment 65 of the segment 28 until another wing 25 comes past the port 32, when the steam thus expanded and exhausted finds free exit through port 33, pipe 52, plug-chamber 45, and pipe 53 into the open air or into a condenser. The ratio of the expansion-chambers to the live-steam chambers and the ratio of the wing-surfaces in the first and second cylinders may be thirteen to one, more or less, as shall be found economical under different conditions. There cannot be back pressure in either cylinder, because there is no abutment ahead of a wing in any part of its path where live steam can find a base without there being an outlet for the steam to escape forward of that wing, and there is no back pressure in the first cylinder from the steam held for expansion in the second cylinder, because the steam when escaping into the second cylinder acts alike forward and backward in the first cylinder on the wings before and behind it. Neither can live steam escape into the expansion-chamber from the first cylinder while under pressure, because the distance between the wings in the first chamber is less than the distance between the entry and exit ports of that chamber, so that the second wing cuts off steam before the first permits exit. The little steam that remains between the wings 22 and 20 20′ after wing 22 passes the expansion exit-port 49 will be permitted to escape ahead of wing 22 through port 31, pipe 48, turn-plug chamber 45, and exhaust-pipe 53. The arrangement of the two ends of the piston-head is alike, and the arrangement of all parts of the two ends of the cylinder is alike, and every port is circumferentially midway of an abutment-incline or midway of the chamber between two abutments, so that whether the steam be let in to run the engine backward or forward the order of the ports is duplicated and their action both ways is exactly alike. The inner ends of the cylinder are plane parallel faces, excepting at the short inclines of the abutments, so that the principal movement of the piston is upon plane surfaces which are subject to little wear. The outer or hot-steam chambers surrounding the inner or expansion chambers serve as a jacket therefor, whereby the heat is retained and great economy of steam is secured. Any style of steam pipe and cylinder jacketing may be used around these parts. The ratio of the live-steam wing-surfaces to the expansion wing-surfaces and of their respective chambers may be varied as experiment and experience shall dictate, and it is believed that steam may be worked with great economy in this engine.

Some of the advantages of this invention may be obtained by locating the first and second cylinders side by side around the same shaft. We show one such form of engine in Figs. IX and X, in which the piston 70 is fixed upon the shaft 71, which is journaled to rotate in the heads 72. The piston has two end flanges 73 and a partition-flange 74, which separates the annular space around the body of the piston into two cylinders, of which 75 is the first or live-steam cylinder and 76 is the second or expansion cylinder. In this instance the wings 77 reciprocate radially to pass over the abutments 79, and the wings may be impelled outward by springs 80 or by means of cam-shaped grooves 81 in the heads 72, in which antifriction-rollers 82 of the wings project, and the same wing-pieces may extend the whole length of the piston to serve in both cylinders, each wing being slotted to pass at both sides of the partition 74. The abutments 79 may be merely two inclines, as shown, in order to permit two sets of wings, one in each half of the circle, to work at once, instead of having semicircular segments to fill a half-circle each of the cylinder-space, as described in the first instance. The ports are midway of the inclines and the connections between the two cylinders 75 and 76, and the piping leading to all the ports is connected with a two-way stop-cock 78, the operation being similar to that hereinbefore described. One of the flanges—74, for example—is chamfered between wings to permit periodical outflow of steam at the exit-ports on its way to the second cylinder. The connections and action of the two stop-cocks, one at each end of the cylinder, being similar, it is evident that the similar or mated pipes might be connected by a branch T and all the pipes be thus operated by one stop-cock. It is to be understood that the chamfer at the edges 62 may be of any depth and have any formed bottom or recess desired.

Having thus fully described our invention, what we believe to be new, and desire to secure by Letters Patent, is the following:

1. In rotary engines, a piston mounted to rotate on a shaft and having two concentric grooves in each end, the walls of each groove constituting the outer and inner sides and one end of a steam-cylinder; a cylinder-head fitting against each end of the piston, the piston being in rotary contact with the said cylinder-heads; the said heads each provided with abutments projecting into the cylinder-grooves; and independent wings for the inner pair of cylinders and for the outer pair of cylinders, fitted to reciprocate longitudinally from one cylinder of a pair to the other, substantially as described.

2. In rotary engines, a live-steam cylinder, and an expansion-cylinder mounted to rotate

on one shaft, steam entrance, exit and exhaust ports for the first cylinder; steam entrance and exhaust ports for the second cylinder; piston-wings for both cylinders; a three-chambered reversible stop-cock, and pipe connections, substantially as described.

3. In rotary engines, a cylindrical piston mounted to rotate on a shaft and having annular concentric channels mated in its ends; cylinder-heads at the ends of the piston, segmental abutments projecting into the said channels, and wings fitted to reciprocate longitudinally through the piston, substantially as described.

4. In rotary engines, two cylinders upon a shaft; a piston to rotate with wings extending into the cylinders; abutments in pairs in the cylinders, leaving a steam-channel between each pair of abutments; an entry-port near one end, an exhaust-port near the other end, and an exit-port midway of the first cylinder-channel; an entry and an exhaust port for the second cylinder; communication between the exit-port of the first cylinder and the entry-port of the second cylinder, and the wings of the first cylinder being located in the piston at a less distance apart than the distance between either an entry or exhaust port and the midway exit-port, substantially as described, whereby back pressure from the second cylinder to the first cylinder is balanced in the first cylinder.

5. In rotary engines, a live-steam chamber, and an expansion-chamber, each having entrance and exhaust ports at their ends, and the live-steam chamber having an exit-port midway, connected with the entrance-port of the expansion-chamber, and piston-wings fitted to rotate through the chambers, the wings in the live-steam chamber being nearer together than one-half the length of the said chamber, substantially as described.

6. In rotary engines, a piston having flanges which constitute sides of the steam-cylinder; wings fitted in the piston across the cylinder-space between flanges; the inner edge of a flange being chamfered nearly to the wings; a cylinder-casing inclosing the space between flanges, and ports in the casing in the circle of the said chamfered edge, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

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JAMES H. WALLACE.

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