No. 721,611. PATENTED FEB. 24, 1903.

C. C. SMITH.

ROTARY ENGINE.

APPLICATION FILED MAY 13, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

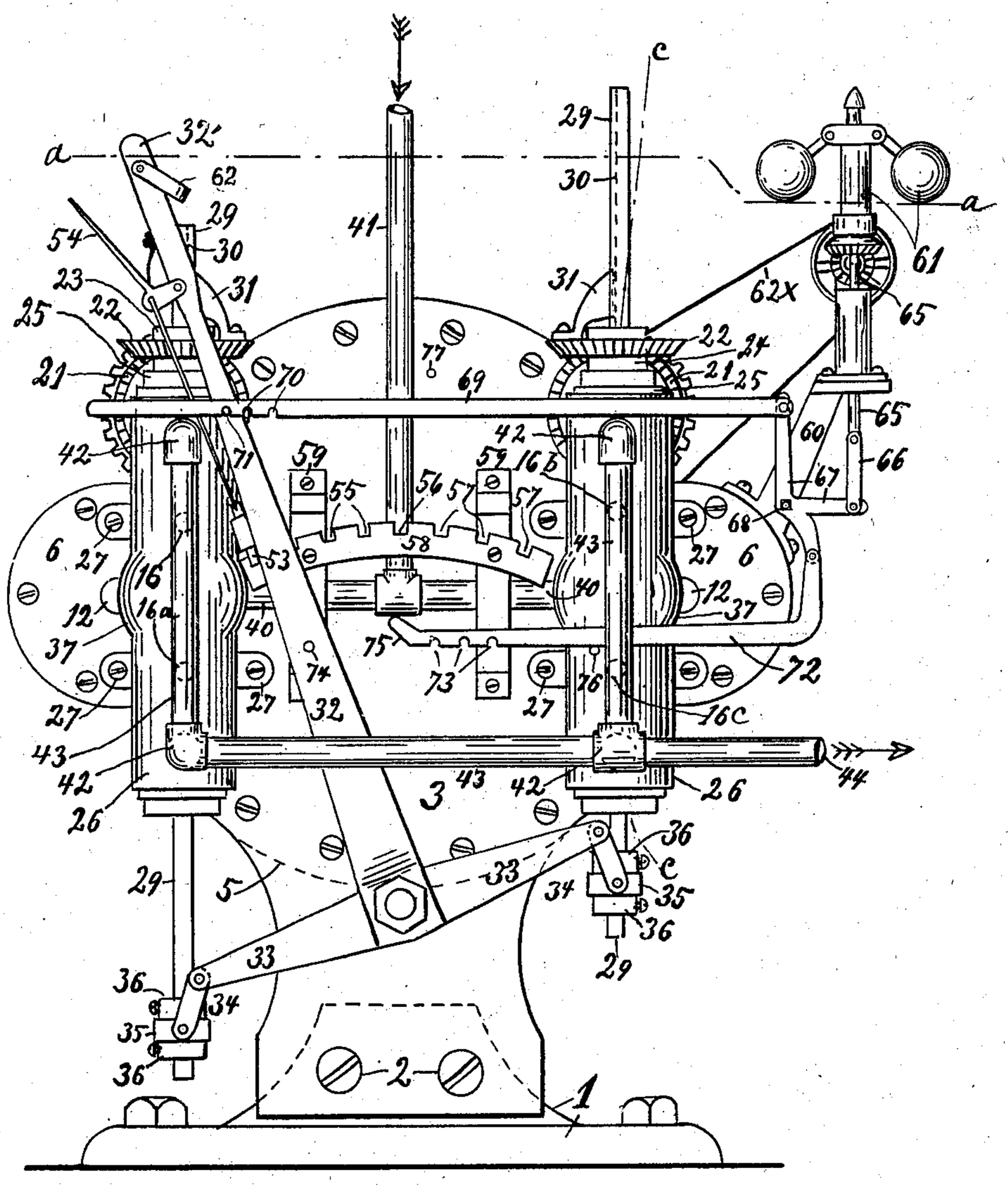

FIG. 1.

WITNESSES:

D. E. Carlsen.

A. E. Carlson.

INVENTOR:

Christopher C. Smith

BY his ATTORNEY:

A. M. Carlsen.

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NO MODEL. 4 SHEETS—SHEET 2.

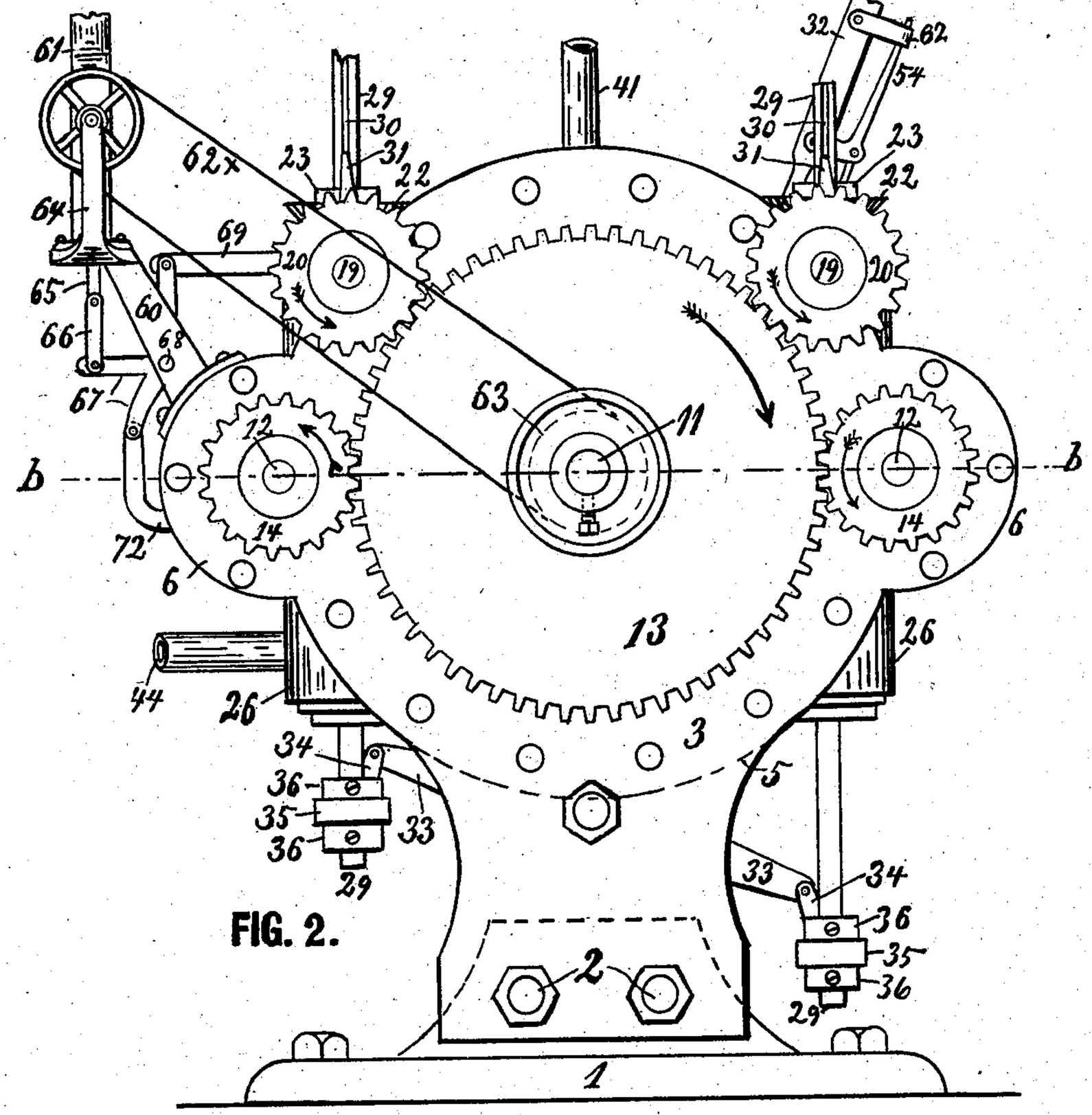

FIG. 2.

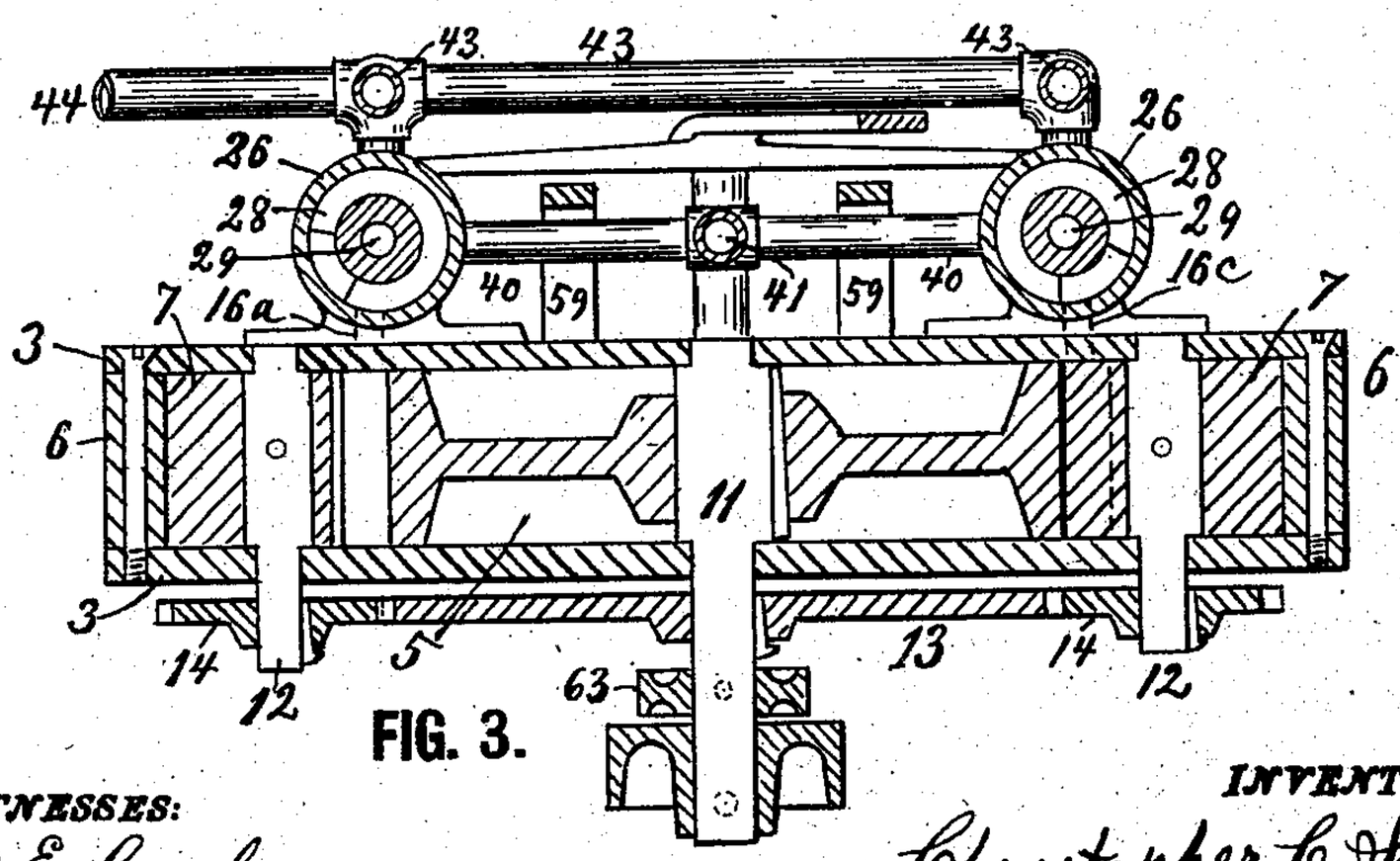

FIG. 3.

WITNESSES:
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NO MODEL. 4 SHEETS—SHEET 3.

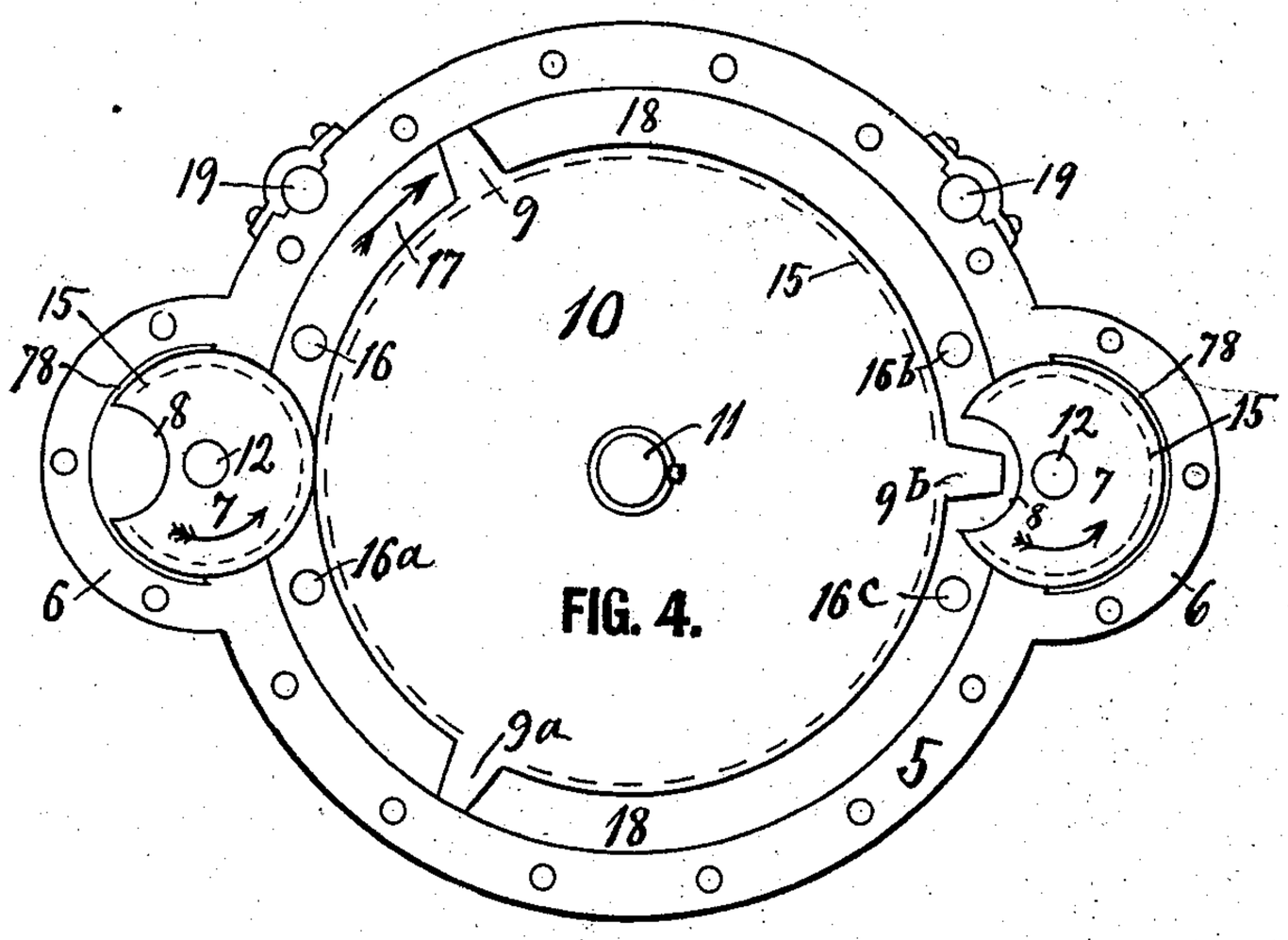

FIG. 4.

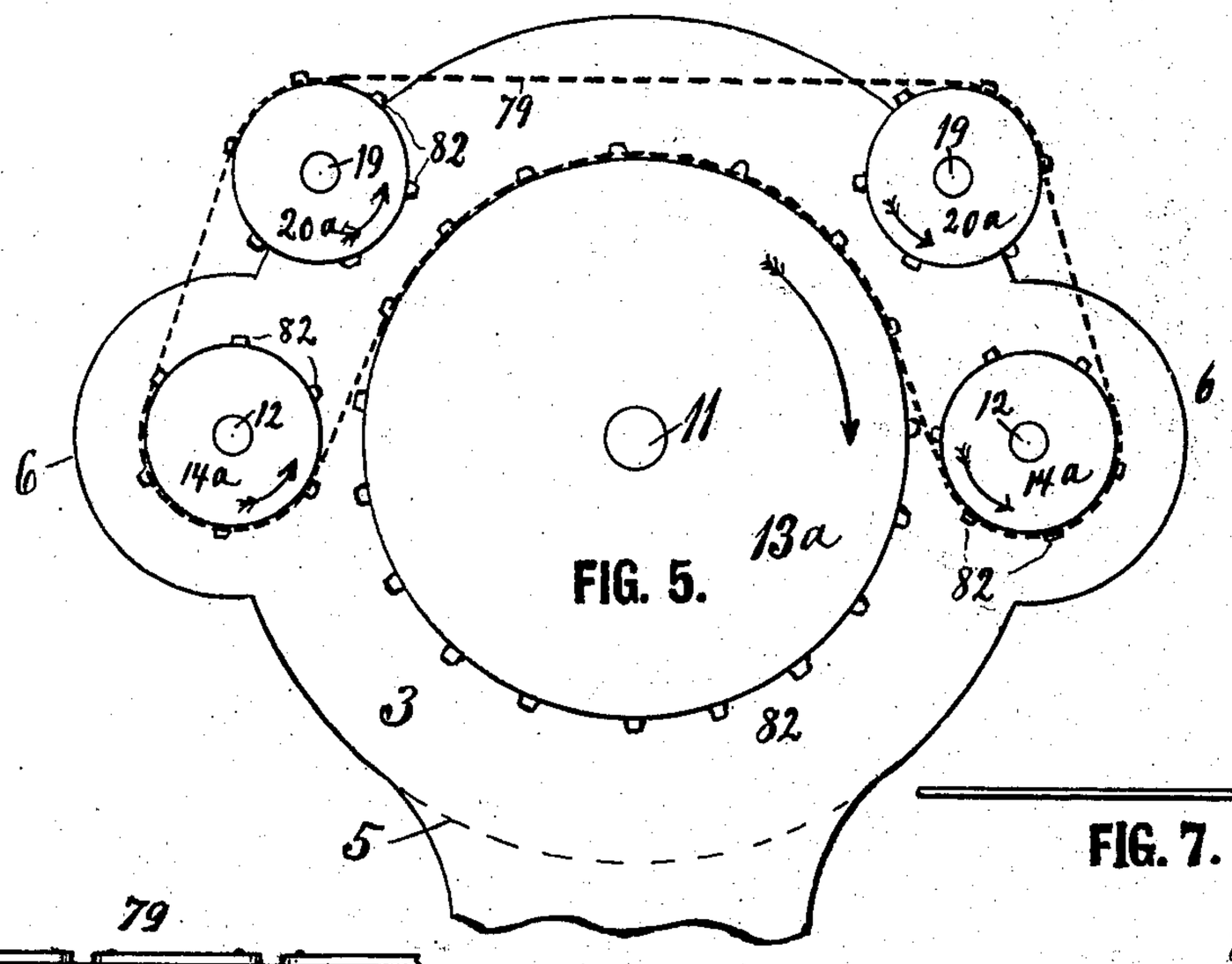

FIG. 5.

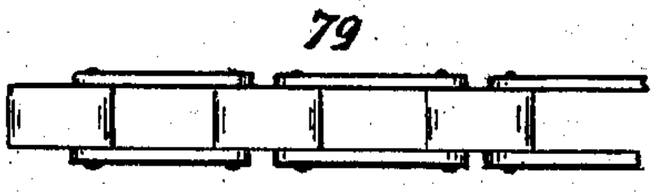

FIG. 6.

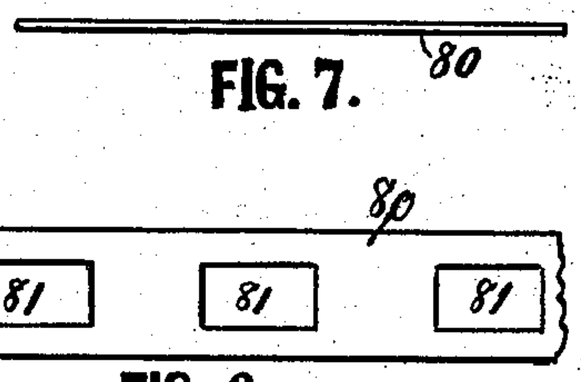

FIG. 8.

FIG. 7.

WITNESSES:

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No. 721,611. PATENTED FEB. 24, 1903.

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ROTARY ENGINE.

APPLICATION FILED MAY 13, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

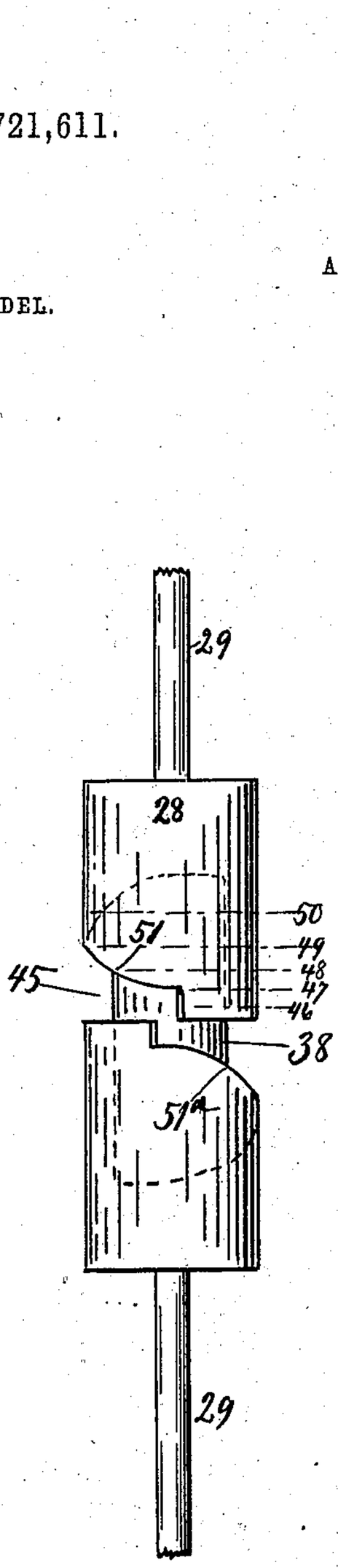

FIG. 10.

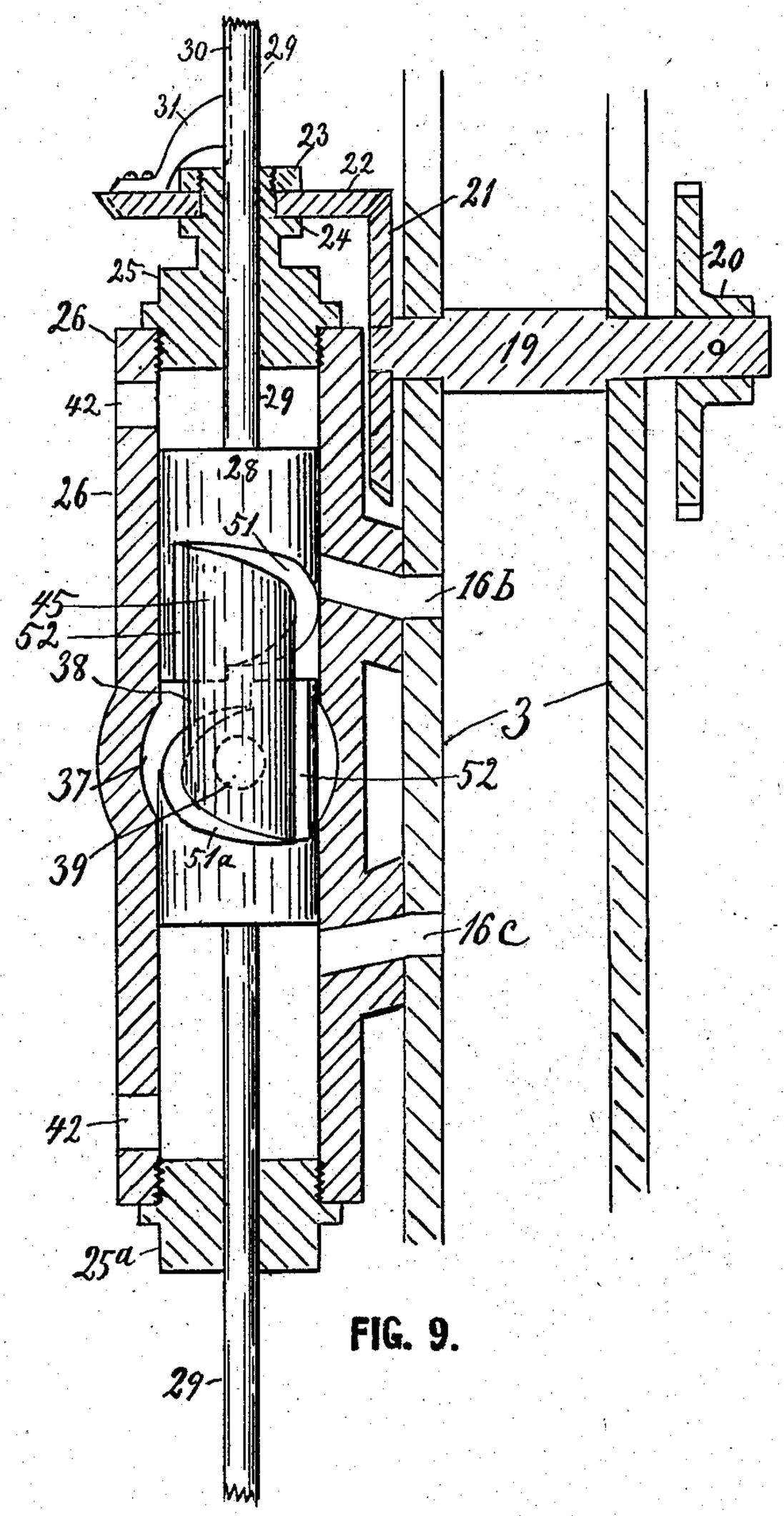

FIG. 9.

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INVENTOR:

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A. M. Carlsen.

UNITED STATES PATENT OFFICE.

CHRISTOPHER C. SMITH, OF KINGSLEY, IOWA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 721,611, dated February 24, 1903.

Application filed May 13, 1902. Serial No. 107,197. (No model.)

To all whom it may concern:

Be it known that I, CHRISTOPHER C. SMITH, a citizen of the United States, residing at Kingsley, in the county of Plymouth and State of Iowa, have invented certain new and useful Improvements in Rotary Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in rotary engines; and the main objects of the invention are, first, to provide an improved rotary engine in which the expansion of the steam may be regulated by a governor or by changing a hand-lever into various positions or by both of said means; second, to provide a rotary engine in which the live steam is shut off while the wings of the piston pass points that are difficult to fit steam-tight. These and other advantages hereinbelow fully described and claimed I attain by the novel construction and arrangement of parts illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of my engine. Fig. 2 is a rear elevation of the engine, with some of its upper parts cut away, as on the line *a a* in Fig. 1. Fig. 3 is a horizontal sectional view about as on the line *b b* in Fig. 2 with all main parts shown. Fig. 4 is an end elevation of the cylinder with its cover removed and adjacent abutment-chambers, abutments, and piston in full view. Fig. 5 is a rear elevation of a portion of the engine, showing a modification in the gearing connecting the piston with the abutments and valves. Fig. 6 is an enlarged portion of the chain placed over the wheels in Fig. 5. Fig. 7 is an edge view, and Fig. 8 is a plan view, of a metallic belt which may be used in place of the chain Fig. 6. Fig. 9 is an enlarged vertical sectional view about as on the line *c c* in Fig. 1 looking from right to left, exposing the valve-plug in the intersected valve-shell and showing portions of the cylinder-covers 3 and the position of the valve-operating gear-wheels. Fig. 10 is the valve-plug in Fig. 9 viewed from its opposite side.

Referring to the drawings by reference-numerals, 1 designates a foot-piece, to which is secured by bolts 2 the covers 3 of the cylinder 5, which is formed with two oppositely-disposed abutment-chambers 6, in which are fitted revoluble abutments 7, each of which is provided with a side groove 8 to permit the three wings 9 of the piston 10 to pass the abutment, as shown to the right in Fig. 4, while to the left is shown how the abutment closes tightly against the periphery of the piston.

11 is the main shaft of the engine. It is secured in the center of the piston and projects beyond the rear cylinder-cover, where I secure upon it a gear-wheel 13, meshing with gear-wheels 14, secured on the shafts 12 of the abutments. The wheels 14 are each one-third the size of the wheel 13, when, as in the present case, three wings are used on the piston or piston-head and only one groove in the abutment; but it is obvious that the number or ratio of wings and grooves may be varied, and the diameters of the gear-wheels must then be varied accordingly.

The piston and abutments may have in their adjoining peripheries suitable packing-rings, as indicated in dotted lines 15 in Fig. 4; but I do not wish to confine such packing-rings to any specific construction.

In Fig. 4 the circles 16, 16^a, 16^b, and 16^c indicate the position of the four steam-ports in the removed cylinder-cover. If the piston rotates in the direction of the arrow 17 in the steam-space 18, the live steam enters the cylinder through the port 16 and acts on the wing 9, while the ports 16^a and 16^h serve as exhausts until the wing 9^b has passed the port 16^c and the abutment is closed behind it. Then live steam enters through port 16^b and drives said wing 9^b until the wing 9^a has got beyond the port 16 and is under full pressure from a new charge of steam from port 16. In other words, each wing is chased through the steam-space 18 in the upper and lower half of the cylinder by steam-using ports 16 and 16^a for inlet and ports 16^c and 16^b for outlets, and when the engine is to be reversed the steam is directed so as to enter the cylinder at the ports formerly used for exhausts and leave the cylinder through the ports formerly used as live-steam ports. Such reversing of the engine and the cutting off of the steam while the pis-

ton-wings pass the abutments and the controlling and regulating of the expansion are effected by the following-described mechanism.

Suitably journaled upon the cylinder are two shafts 19, on the rear ends of which are secured the wheels 20, (see Fig. 9,) driven by the three times larger wheel 13, so as to run exactly the same speed as the abutments. Upon the front end of each of the shafts 19 is secured a miter-gear 21, meshing with a miter-gear 22, journaled between a nut 23 and a collar 24 of the top plug or cover 25 of a valve-shell 26, secured by screws 27 or other means upon the front cover of the cylinder. In each valve-shell is a revoluble and slidable valve-plug 28, secured on a rod or stem 29, which is revolved by having its keyway 30 engaged by the key arm or tooth 31, secured on the miter-gear 22, and receive sliding motion from the hand-lever 32, having the arms 33, connected by links 34 to loose collars 35, held on the lower ends of the valve-stems between set-screwed collars 36.

The valve-shell is preferably enlarged some at 37, so as to afford more free passage of the live steam about the narrow middle portion 38 of the valve-plug. The steam enters the valve-shell through the middle port 39 from the horizontal arms 40 of the live-steam pipe 40 41, is admitted to and from the cylinder through the ports 16, and exhausted from the valve-shell through ports 42, which ports are therefore all connected together by the piping 43, terminating in a single exhaust-opening 44.

The operation of each valve-plug 28 will be best understood from Figs. 9 and 10, where it will be seen that the valve-shell is closed at both ends by covers 25 and 25^a, and between each cover and the valve-plug 28 is play enough to permit the plug to be lowered, so that the exhaust-steam passes across the end of the valve-plug and out at 42. In said Fig. 9 the plug is shown in the elevated potion, allowing the exhaust-steam from port 16^c of the cylinder to escape freely by the lower exhaust-port 42, while the live steam enters the cylinder by the port 16^b every time the spiral-shaped reduction 45 of the plug turns toward the said port, and the live steam is shut off from said port as long as the unreduced cylindrical portion of the plug covers the port, as it does in Fig. 9. During the period the port is thus closed the steam expands in the cylinder and commences to exhaust, while the wing in front of it passes one of the abutments. If it is desired to give the cylinder less steam, with more chance to expand, the valve-plug is simply lowered, so that the gradually-increased circumference of its unreduced portion travels across the port, and thus closes it for a longer and longer time, as indicated in Fig. 10, where it is obvious that the covering-surface of the plug increases as the lines 46, 47, 48, 49, and 50, while the reduction or steam space 45 below the spiral-shaped shoulder 51 is reduced accordingly, and if the valve-plug is raised the space 45 increases in circumference, and the engine uses more steam and can do more work. To reverse the engine, the plug is simply lowered, so that the lower half operates on the lower port 16^c in exactly the same way as already described about the upper port 16^b.

It will be understood that one of the longitudinal shoulders 52 of the valve-plug always opens the inlet of steam to the cylinder when the piston-wings are in the same proper position to receive steam; but the spiral shoulders vary the duration of the inlet.

The hand-lever 32 is provided with a latch 53, controlled by a finger-lever 54, so that the latch may be dropped into the various notches 55 56 57 of a segment 58, secured by brackets or braces 59 to the front cover of the cylinder. When the latch 53 is in the central notch 56, the valve-plugs will cover all inlets for steam to the cylinder, and the engine stands still, and if the lever be swung toward either end of the segment 58 the valve-plugs will move one up and the other down, and the engine will start in one direction or the other and with increased power the nearer the lever gets to the end of the segment. The hand-lever 32 may also be controlled by a governor when the engine performs work causing considerable variation in the resistance to the engine. This may be done in various ways, of which I have illustrated one quite convenient way. Upon the bracket 60 I mount a regular ball-governor 61, driven by a belt $62^\times$ from a small pulley 63 on the engine-shaft.

64 is a brace supporting the outer end of the pulley-shaft of the governor.

The usual central rod 65 of the governor is connected by a link 66 to the horizontal arm of a three-armed lever 67, pivoted at 68 to said bracket. To the upper arm of the lever 67 is pivoted a horizontal rod 69, having notches 70 to engage a pin 71 in the hand-lever when the latter is leaning to the left, as in Fig. 1. When the governor is to be used, the bail 62, pivoted near top of hand-lever, is thrown over the finger-lever 54, as in Fig. 2, so that the latch 53 is held clear above the segment 58. The increased speed of the governor will then pull on the rod 69 and draw the hand-lever more or less toward a vertical position, with the shutting-off results on the valve-plugs already described; but if the engine be reversed, by leaning the lever 32 to the opposite side of the vertical line the rod 69, if connected with the lever, would open the valves more and more with the increased speed of the governor. Hence I pivot to the lower arm of the lever 67 another rod 72, having notches 73 engaging the pin 74 of the hand-lever in various positions upon the right-side half of the segment and pushing the lever toward the vertical position as the speed of the governor increases. This rod 72 is formed at its free end with an incline 75, which the pin 74 glides in under and lifts the rod a sufficient distance above the peg

76, on which it normally rests when not in use, and when in use the upper rod 69 may either rest slidingly on the pin 71 or be thrown upon a fixed peg 77. Each of the horizontal rods may have only one notch; but a plurality of them enables the operator to set the hand-lever for more or less power and still make the same governor operate the lever as the speed increases or decreases.

The abutment-chamber may fit the body of the abutment; but it may also have some clearing 78 to avoid unnecessary friction and wear on the abutment, and, as shown to the right in Fig. 4, the wings or blades of my piston are not fitted tightly against the abutment, as there is no need of such fitting, with attending friction, wear, and noise, because at the time the wing passes the abutment the steam above the wing is exhausting at 16^b, and the port 16^c does not get live steam from the rotating valve before the wing has passed below said port and the abutment has closed against the piston-head. The steam then entering at 16^c helps the steam at 77 to rotate the piston; but with only two abutments and three wings there may not at all times be two wings under pressure of the steam, gas, or other pressure-producing agent which may be employed. The wings may, however, also be made to fit in the grooves 8 of the abutments.

As for modifications, it is obvious that instead of the valves I have shown slide-valves may be employed and operated by eccentrics on any shaft which will give the required motion, and for the cog-wheels 13, 14, and 20 may be substituted sprocket-wheels of any suitable size and class, as indicated by the wheels 13^a, 14^a, and 20^a in Fig. 5, and a suitable chain 79 taken over the wheels in the manner indicated, so that the shafts 11 12 19 are rotated in unison and in the same directions as with the cog-wheels. For fast-running engines the chain or belt is especially desirable, as the cog-wheels are apt to make some noise when run at a high speed. The chain 79 may be on the belt chain or link principle, (indicated in Fig. 6,) or for small engines it may consist of a sheet-metal or leather belt, like 80 in Figs. 7 and 8, having holes 81 for the sprockets 82 of the wheels to engage in. These and other modifications I consider can be made without diverging from the spirit and vital features of my invention.

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

1. A rotary engine comprising in combination, a cylinder, a shaft journaled centrally therein, a cylindrical piston secured centrally on the shaft and being smaller in diameter than the cylinder but having fixed wings traversing the concentric space between the piston and the cylinder, abutment-chambers in the sides of the cylinder, revoluble abutments in said chambers; said abutments being cylindrical and provided with side grooves to permit the wings of the piston to pass, and means connecting the piston and the abutments so that they revolve in unison at the proper relative speed to cause the wings of the piston to meet the grooves in the abutments; and valves geared to the engine-shaft and adapted to regulate the inlet and outlet of steam to and from the cylinder when the piston-wings are in the desired position, said valves being rotary and arranged with their sides against one end cover of the cylinder, so as to circulate the steam to and from the cylinder through the cover.

2. A rotary engine comprising in combination, a cylinder, a shaft journaled centrally therein, a cylindrical piston secured centrally on the shaft and being smaller in diameter than the cylinder, but having fixed wings traversing the concentric space between the piston and the cylinder, abutment-chambers in the sides of the cylinder, revoluble abutments in said chambers; said abutments being cylindrical and provided with side grooves to permit the wings of the piston to pass and means connecting the piston and the abutments so that they revolve in unison at the proper relative speed to cause the wings of the piston to meet the grooves in the abutments; valves having rotary and slidable valve-plugs geared to the engine-shaft and adapted to regulate the inlet and outlet of the steam to and from the cylinder when the piston-wing abutments are in the desired position, and an adjustable hand-lever adapted to control said valves by sliding their plugs longitudinally in the shells.

3. A rotary engine comprising in combination a cylinder, a shaft journaled centrally therein, a cylindrical piston secured centrally on the shaft and being smaller in diameter than the cylinder but having fixed wings traversing the concentric space between the piston and the cylinder, abutment-chambers in the sides of the cylinder, revoluble abutments in said chambers; said abutments being cylindrical and provided with side grooves to permit the wings of the piston to pass, and means connecting the piston and the abutments so that they revolve in unison at the proper relative speed to cause the wings of the piston to meet the grooves in the abutments; and valves geared to the engine-shaft and adapted to regulate the inlet and outlet of the steam to and from the cylinder when the piston-wings are in the desired position, and an adjustable hand-lever adapted to control said valves, and a speed-governor detachably connected with the hand-lever controlling the valves.

4. The combination with the shaft and cylinder of an engine, of a rotary valve geared to rotate in unison with the shaft, said valve comprising a cylindrical shell 26 having closed ends and two steam-ducts communicating with the cylinder, an exhaust-port near each end of the shell and an inlet for live steam intermediate the ends of the shell, the cylin-

drical valve-plug 28 having the longitudinal shoulders 52 and the spiral shoulders 51 with adjacent central recess about the plug.

5. The combination with the shaft and cylinder of an engine, of a rotary valve geared to rotate in unison with the shaft, said valve comprising a cylindrical shell 26 having closed ends, and two steam-ducts communicating with the cylinder, an exhaust-port near each end of the shell and an inlet for live steam intermediate the ends of the shell, the cylindrical valve-plug 28 having the longitudinal shoulders 52 and the spiral shoulders 51 with adjacent central recess about the plug; said shell or casing having the enlargement 37 to permit the live steam to circulate more freely about the plug.

6. The combination with the shaft and cylinder of an engine, of a rotary valve geared to rotate in unison with the shaft, said valve comprising a cylindrical shell 26 having closed ends, and two steam-ducts communicating with the cylinder, an exhaust-port near each end of the shell and an inlet for live steam intermediate the ends of the shell, the cylindrical valve-plug 28 having the longitudinal shoulders 52 and the spiral shoulders 51 with adjacent central recess about the plug, a hand-lever connected with said valve-stem to slide it, a fixed notched segment and a latch on the lever engaging therewith for holding the lever in various positions, a speed-governor, and means for connecting the lever quickly to the speed-governor and for holding it disconnected from the segment when connected with the governor.

7. The combination with the cylinder and piston of a steam-engine, of a valve having a slidable revoluble plug embraced by a cylindrical casing and having a portion of its body cut away intermediate the ends of the plug, such cut-away and the cylindrical portions of the plug being adapted to regulate the circulation of steam through ports or ducts in the shell, some of which extend into the cylinder.

In testimony whereof I affix my signature in presence of two witnesses.

CHRISTOPHER C. SMITH.

Witnesses:

F. D. CATHCART,

J. E. CATHCART.