(No Model.)

3 Sheets—Sheet 1.

E. M. LINDFORS.

ROTARY ENGINE.

No. 567,104. Patented Sept. 1, 1896.

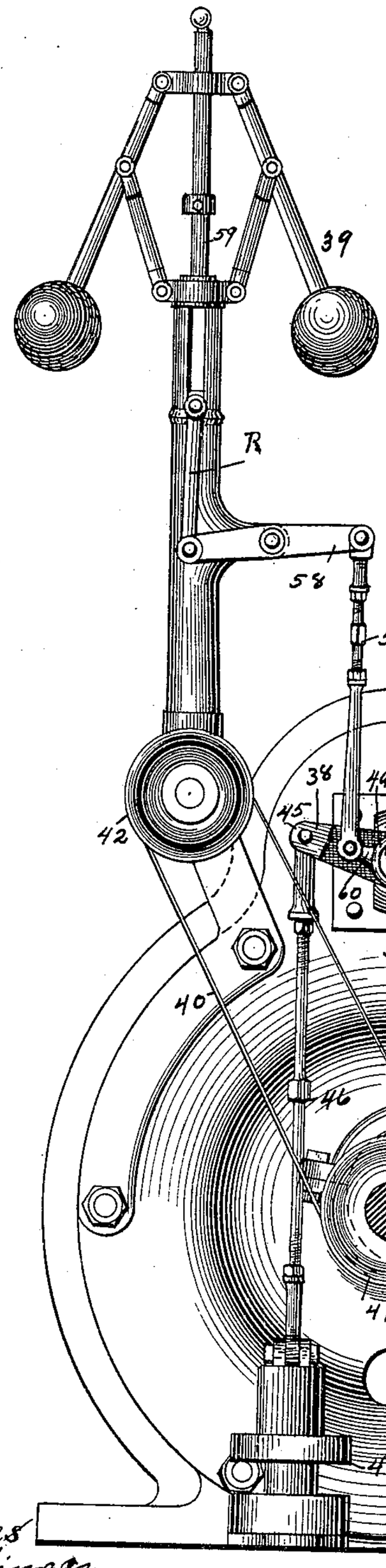

Fig. 1.

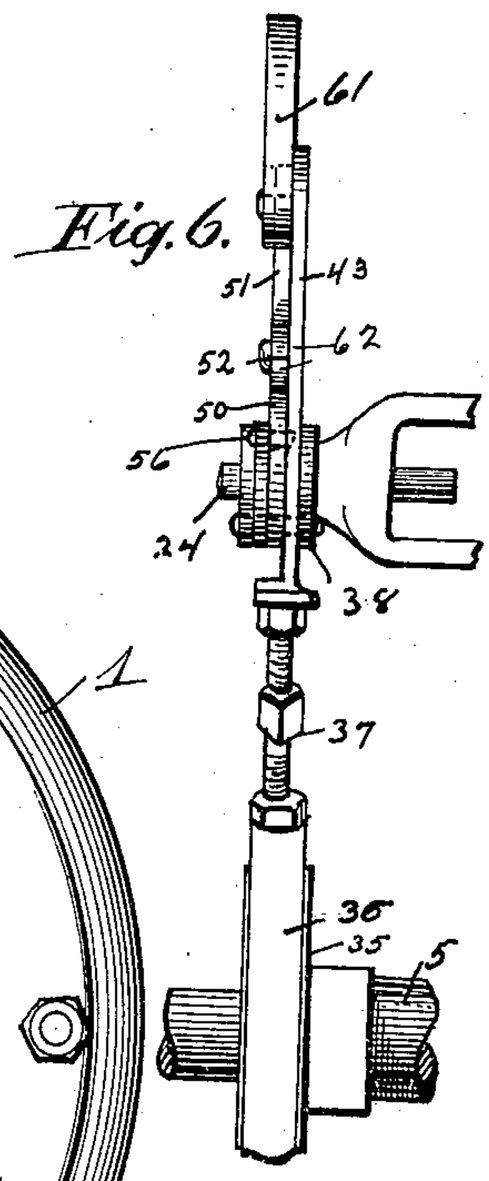

Fig. 6.

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(No Model.) 3 Sheets—Sheet 2.

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ROTARY ENGINE.

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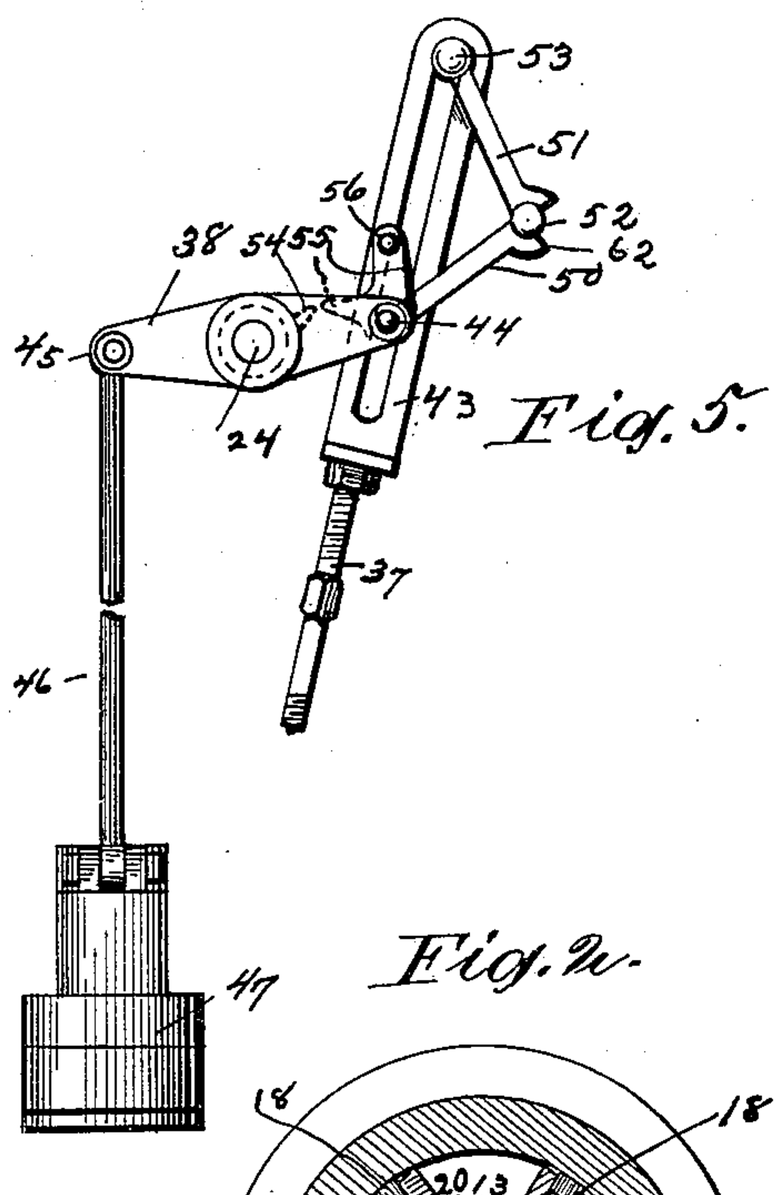
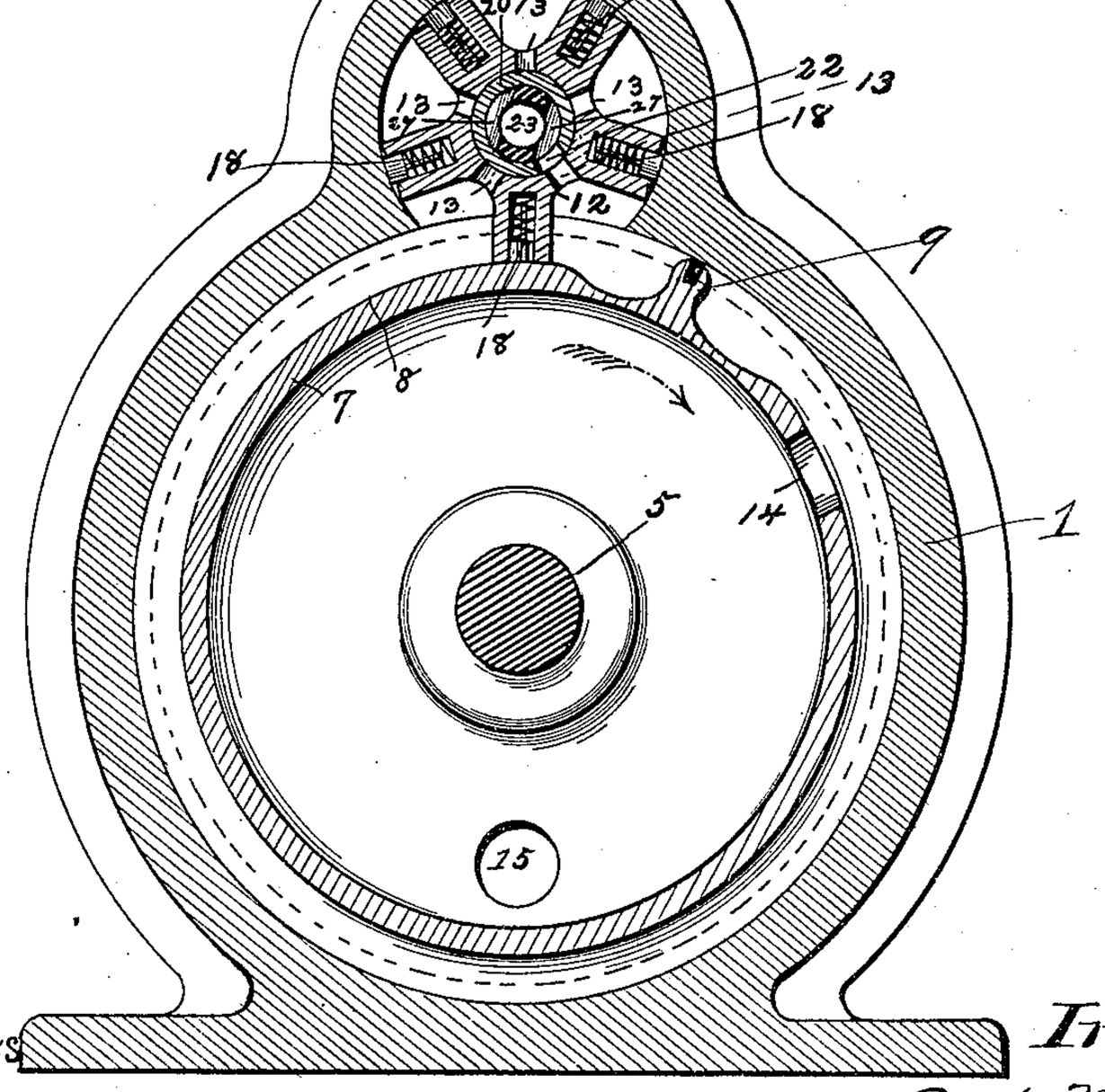


Fig. 5.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

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ROTARY ENGINE.

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Fig. 4.

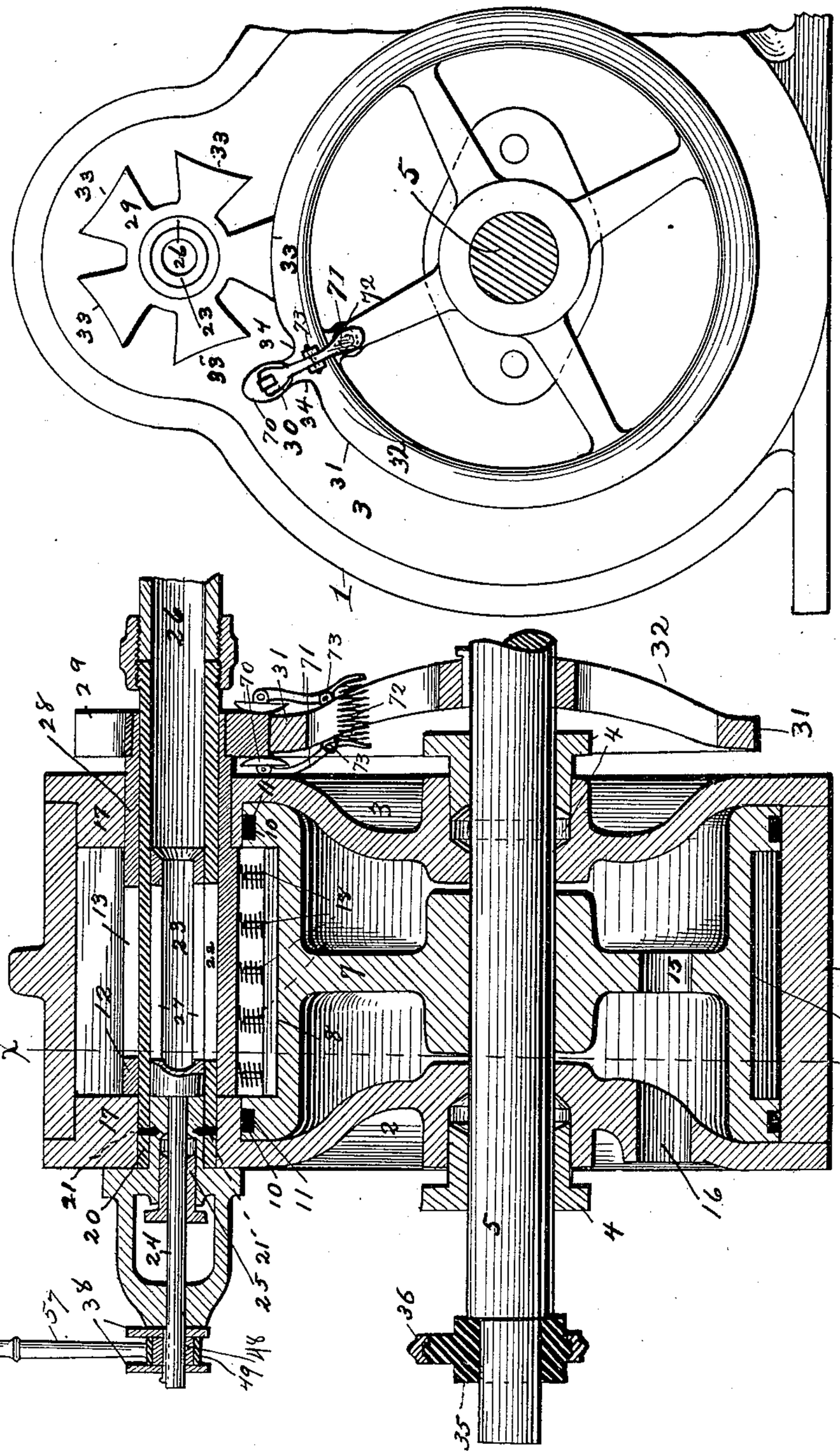

Fig. 3.

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UNITED STATES PATENT OFFICE.

ERICK M. LINDFORS, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-FOURTH TO LAURENCE W. JERNBERG, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 567,104, dated September 1, 1896.

Application filed April 6, 1896. Serial No. 586,282. (No model.)

To all whom it may concern:

Be it known that I, ERICK M. LINDFORS, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, State of Ohio, have invented certain new and useful Improvements in Rotary Engines, of which I hereby declare the following to be a full, clear, and exact description, such as will enable others skilled in the art to which my invention appertains to make and use the same.

My invention relates to improvements in rotary engines; and the objects of the invention are to provide means for automatically cutting off the steam-inlet at fractional parts of the piston-stroke and for using the steam expansively, and thereby less wastefully than has heretofore been accomplished in engines of this class. To accomplish this purpose I employ the balanced admission-valve and governing device, with the means for affording suitable back pressure for the expanding steam and for regulating the exhaust, as hereinafter described, shown in the accompanying drawings, and more specifically pointed out in the claims.

In the accompanying drawings, Figure 1 shows a front elevation of the engine and governor. Fig. 2 is a transverse section taken on line X X, Fig. 3. Fig. 3 is a longitudinal vertical section taken centrally through the machine. Fig. 4 is a rear elevation of the machine. Figs. 5 and 6 are detail views of releasing-joint and slotted eccentric-stem.

In the views, 1 is the cylinder, provided with heads 2 and 3, through stuffing-boxes 4 in which passes the driving-shaft 5, upon which is fixed the rotary piston 7. This piston is provided with annular recess 8 on its periphery for steam transmission and expansion, and the ridge 9, which closely fits the cylinder as it revolves. Packing-rings 10 in grooves 11 serve to retain the steam within the recess 8. The steam striking this ridge rotates the piston and expands between the ridge and the rotatable abutment 12, entering through passages 13. The exhaust-openings 14 and 15, at one side of the ridge and through the center of the piston, permit the steam to escape into the cylinder, which is provided with the exhaust-pipe 16.

The rotary abutment is in section in the form of a five-pointed star, and each of the rays is inwardly curved upon the apex to conform to the periphery of the recess in the piston across which it extends, the cylinder-heads filling the remaining space at 17. Spring-packing 18 also assists in making the abutment steam-tight. Live-steam ports 13 are placed between the rays.

The steam-admission valve is rotary, and the construction thereof, with the manner of supporting the rotary abutment and the arrangement of steam-passage, is seen in Figs. 2 and 3, where 20 is a sleeve secured to one cylinder-head at 21, and provided with steam-port 22, adapted to register with one of the ports 13 in the abutment when the abutment is stationary, as seen in Fig. 2.

23 is the valve, which is tubular and provided with the stem 24, which passes through the stuffing-box 25 on the front cylinder-head. This tubular valve is adapted to rotate closely within the sleeve 20, which extends through the rear cylinder-head and is connected with the live-steam pipe at 26. The valve 23 is provided with deeply-cut steam-ports 27, oppositely arranged so as to afford steam-pressure on both sides of the inclosing sleeve and so balance the valve. The star abutment is provided with tubular stem 28, which sheaths the sleeve 20 and extends to the rear of the cylinder-head, where the star washer 29 is secured thereto and is engaged by the arm 30 upon the rim 31 of the wheel 32, secured upon the driving-shaft, whereby the star washer and abutment are rotated simultaneously with the movement of the piston.

The apices of the star-rays are inwardly curved at 33 to correspond to the periphery of the wheel-rim, which is recessed at 34 on either side of the arm 30 to permit its passage as it strikes each ray in turn. At other times the engaging ray and rim will be locked securely from movement.

The driving mechanism described is seen distinctly in Figs. 3 and 4. The valve 23 is operated by means of the eccentric 35, provided with strap 36 and adjustable stem 37, and the rock-arm 38. This mechanism, however, would give an unvarying opening and closing movement to the valve, and in order to regulate the port-opening to the alterations in

steam-pressure required to maintain a uniform rate of speed under varying loads, and also to use the steam expansively, the controlling mechanism is employed shown in Figs. 1, 3, 5, and 6, where 39 is a fly-ball governor of the usual type, rotated by means of the belt 40, connecting the pulleys 41 and 42 upon the governor and main shafts, respectively.

Additional mechanism is employed as follows: 43 is a longitudinally-slotted extension from the eccentric-stem 37, through which passes the pin 44 of the rock-arm. Bars 50 and 51, jointed at 52 and pivoted at one extremity 53 to the outer end of the slotted extension 43 and at the other to the rock-arm pin, serve normally to prevent the movement of the pin in the slotted extension, but when bent from alinement permit the pin to pass freely, as the eccentric plays, without affecting the rock-arm and valve. To the other extremity of the rock-arm, at 45, is provided the adjustable stem 46, which connects the rock-arm with the dash-pot 47, which therefore moves in unison therewith. The rock-arm is keyed to the valve-stem 24, which moves therewith, and also to the narrow sleeve 48, placed between divisions of the rock-arm. Upon this sleeve is placed the loose sleeve 49, provided with the radial lug 54, adapted to engage one arm of the bell-crank 55 upon the rock-arm pin 44. The other arm of this bell-crank is provided with the pin 56, which abuts against the lower bar 50 and will break the alinement of the pointed bars if thrown backward. Link mechanism connects the governor with the loose sleeve 49, as shown in Fig. 1, where R and 57 are link-rods connecting the rock-arm 58 with the vertical governor-stem 59 and the short arm 60 upon the loose sleeve.

From the drawings the operation of the governing device will be apparent. When steam admission is too free and the piston rotates too rapidly, the governor-balls will fly up and raise the vertical stem 59, and through the connecting-links will rotate the loose sleeve 49, and the lug 54 will tip up the ball-crank 55, press the pin 56 against the lower one of the jointed bars 50, and force them out of alinement. This will occur at any portion of the stroke desired, and can be regulated by setting the eccentric on the shaft to cut off at one-quarter or one-half or any other fraction of stroke desired. As soon as the rigidity of the joint is broken the rock-arm pin will be free to move in the slotted extension, and the dash-pot will at once fall and turn the rock-arm to close the valve. Afterward the eccentric will have no influence upon the rock-arm until it completes its stroke and the jointed bars are rigidly extended again, into which position they are assisted by the spring 61. Enlarged meeting surfaces at 62 also serve to maintain rigid alinement in the bars until the joint is again broken. This action will be constantly repeated as often as the speed raises the governor-balls to the requisite height. At 70 are seen friction-pads mounted upon lever 71, spring-compressed at 72, and pivoted at 73 to the rim 32. These pads are adapted to embrace the rays of the star washer 29 and prevent any noise from the concussion of the parts.

I claim—

1. In a rotary engine, the combination with a cylinder, a rotary piston provided with a steam-recess and ridge in the recess, of a star abutment, adapted to move with each revolution of the piston, a fixed sleeve and rotary cut-off valve within the abutment, live-steam passages through the valve sleeve and abutment, and exhaust-steam passages through the piston and cylinder-head, with means for rotating the abutment in unison with the movement of the piston, consisting of the disk 32 upon the piston-shaft exterior to the cylinder and provided with the ridge 30 and star washer 29, upon an extension of the abutment, substantially as described.

2. In a rotary engine, a cylinder in combination with a rotary piston, a star abutment adapted to engage a ridge upon said piston, and move within an annular recess in said piston, a fixed sleeve in the abutment, a rotary cut-off valve within the sleeve, and means for controlling the movements of the valve to maintain a uniform steam-pressure, consisting of an eccentric on the piston-shaft, a dash-pot, a rock-arm connecting the valve-stem with the dash-pot and eccentric-stems, a ball-governor driven by the piston-shaft, and releasing mechanism for the valve-stem and dash-pot actuated by the governor, whereby the valve is closed at a predetermined rate of piston-speed, substantially as described.

3. In a rotary engine, provided with rotary abutment and rotary cut-off valve, means for closing the valve at a predetermined piston-speed consisting in an eccentric upon the piston-shaft, a dash-pot, a rock-arm upon the valve-stem, an adjustable stem connecting one end of the rock-arm and dash-pot, and an adjustable stem connecting the other extremity of the arm and eccentric-strap, and provided with an elongated slot in which the rock-arm pin is adapted to travel, jointed rigid bars adapted normally to secure the pin in said slot, and means for breaking the rigidity of the joint in said bars, consisting of a fly-ball governor, and intermediate mechanism adapted to throw back the bars when the balls fly up, substantially as described.

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