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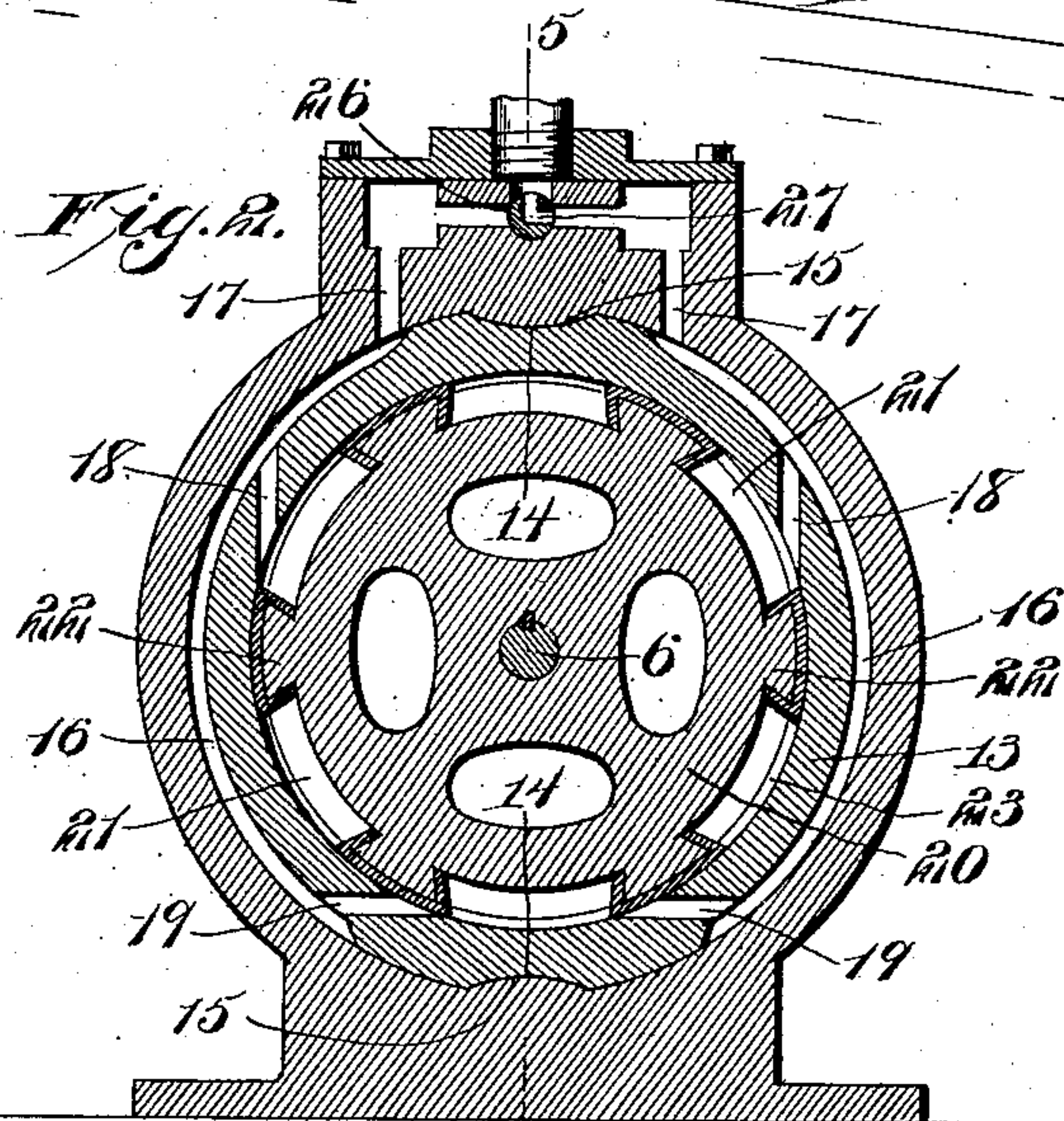
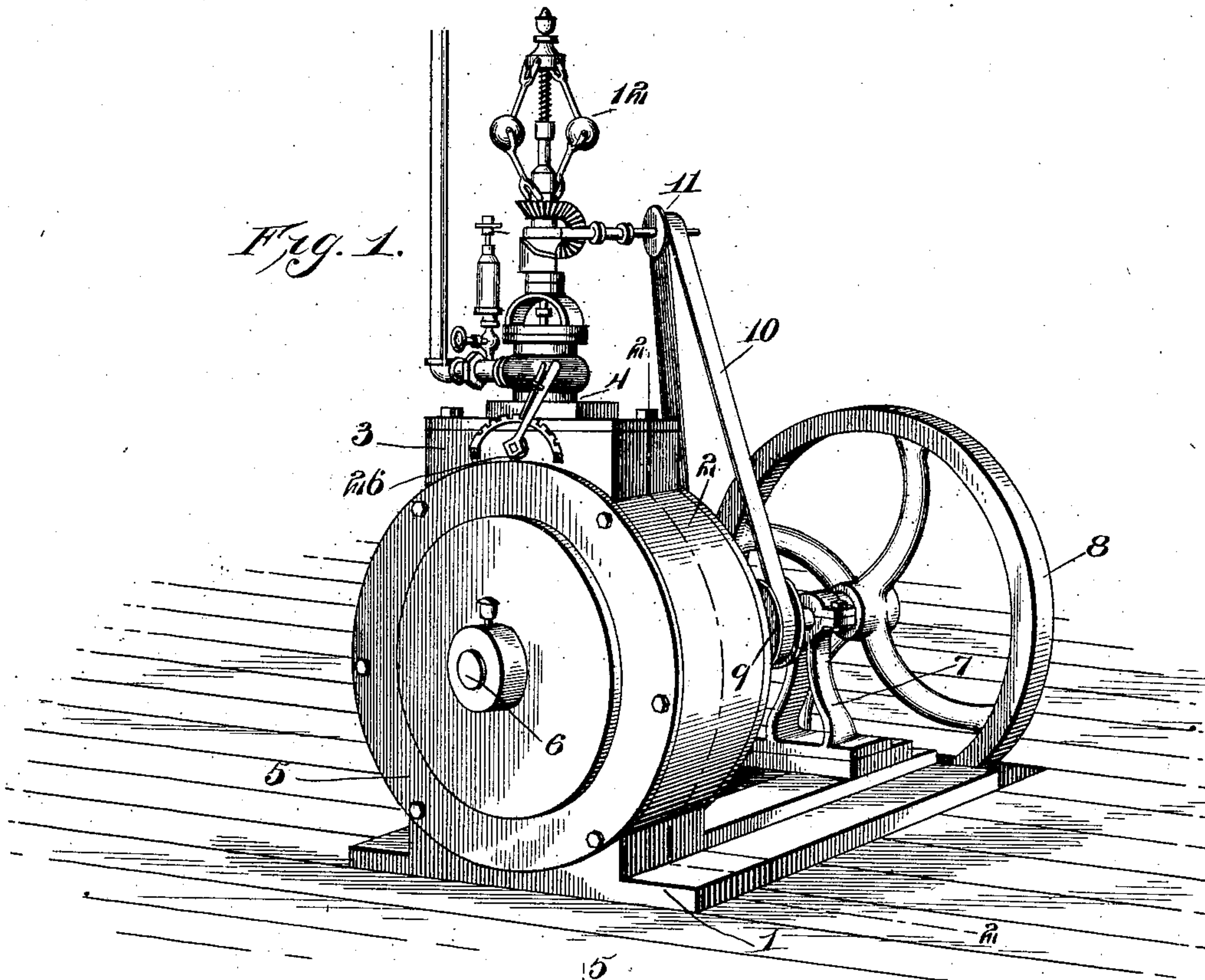
PATENTED NOV. 17, 1903.

E. S. WARD.  
REVERSIBLE ROTARY ENGINE.

APPLICATION FILED JULY 29, 1903.

NO MODEL.

2 SHEETS—SHEET 1.



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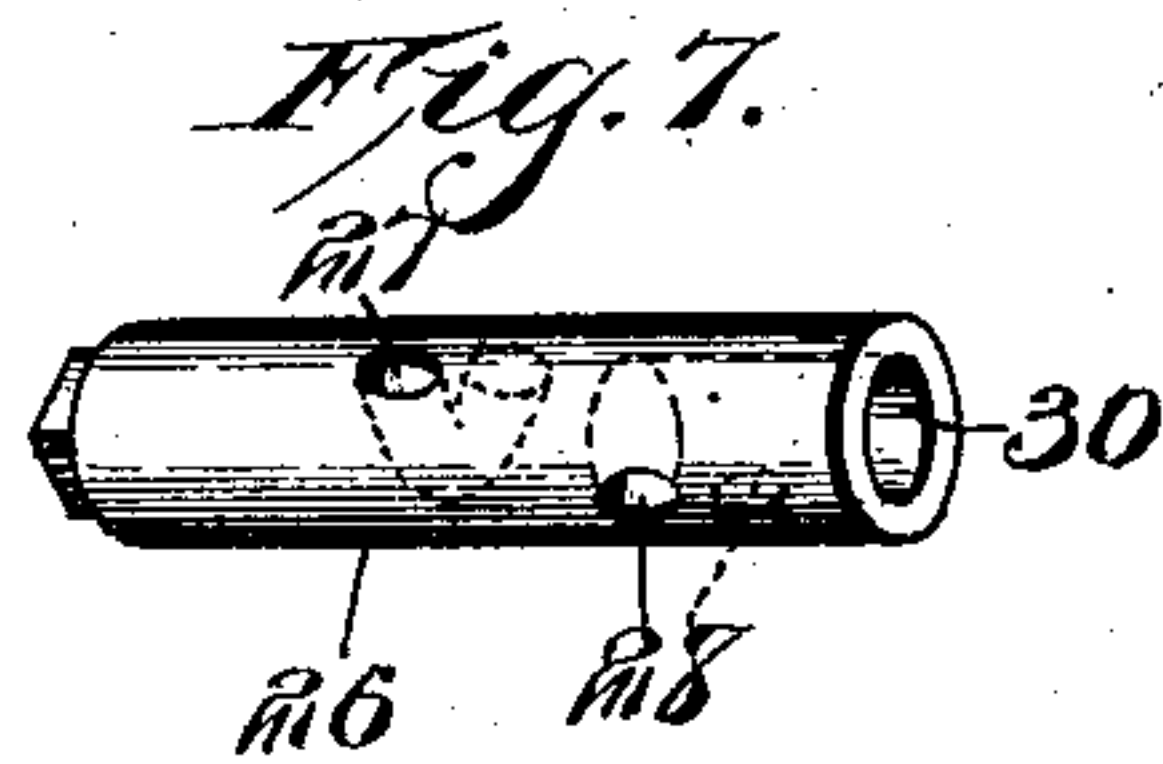
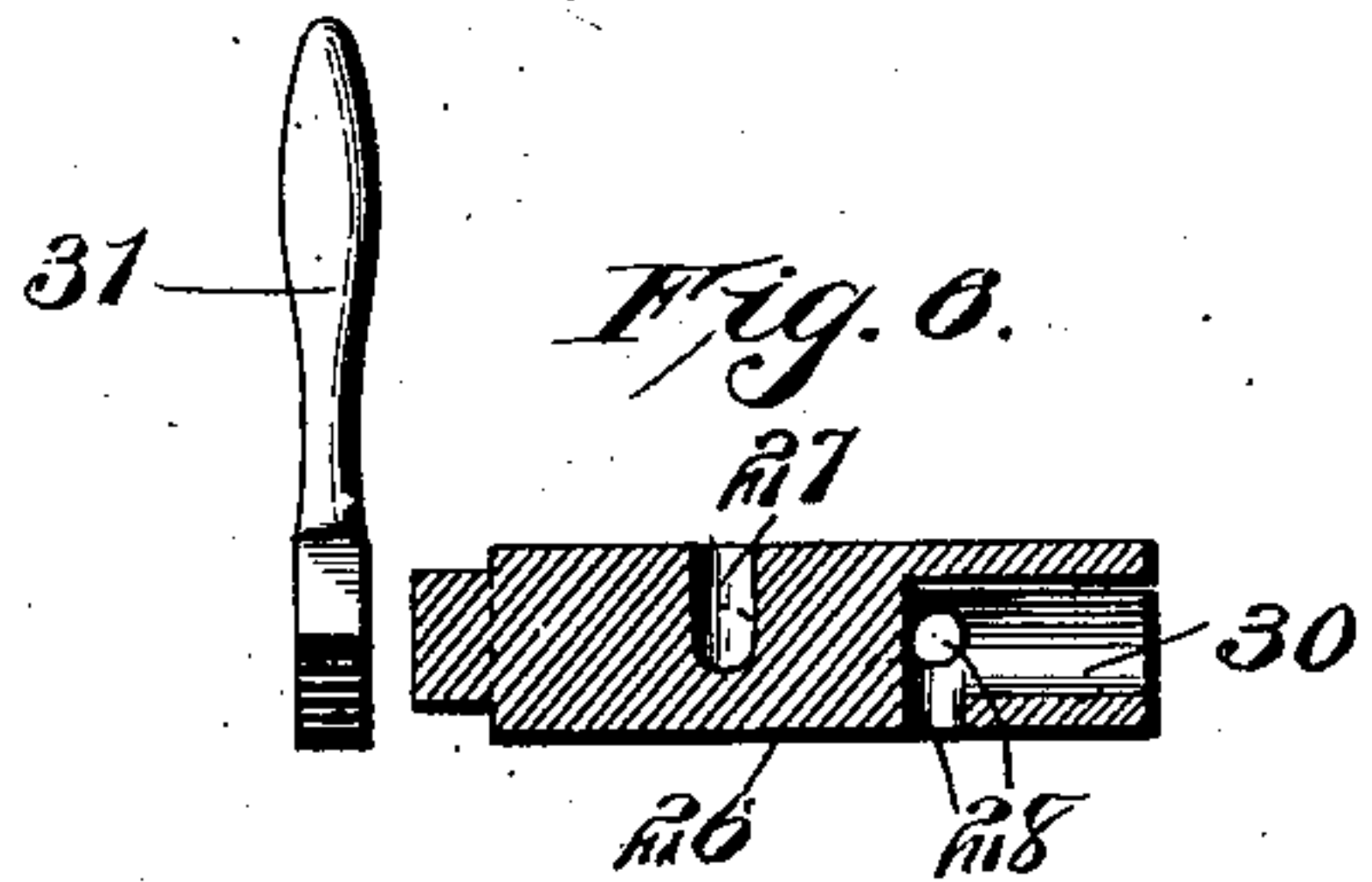
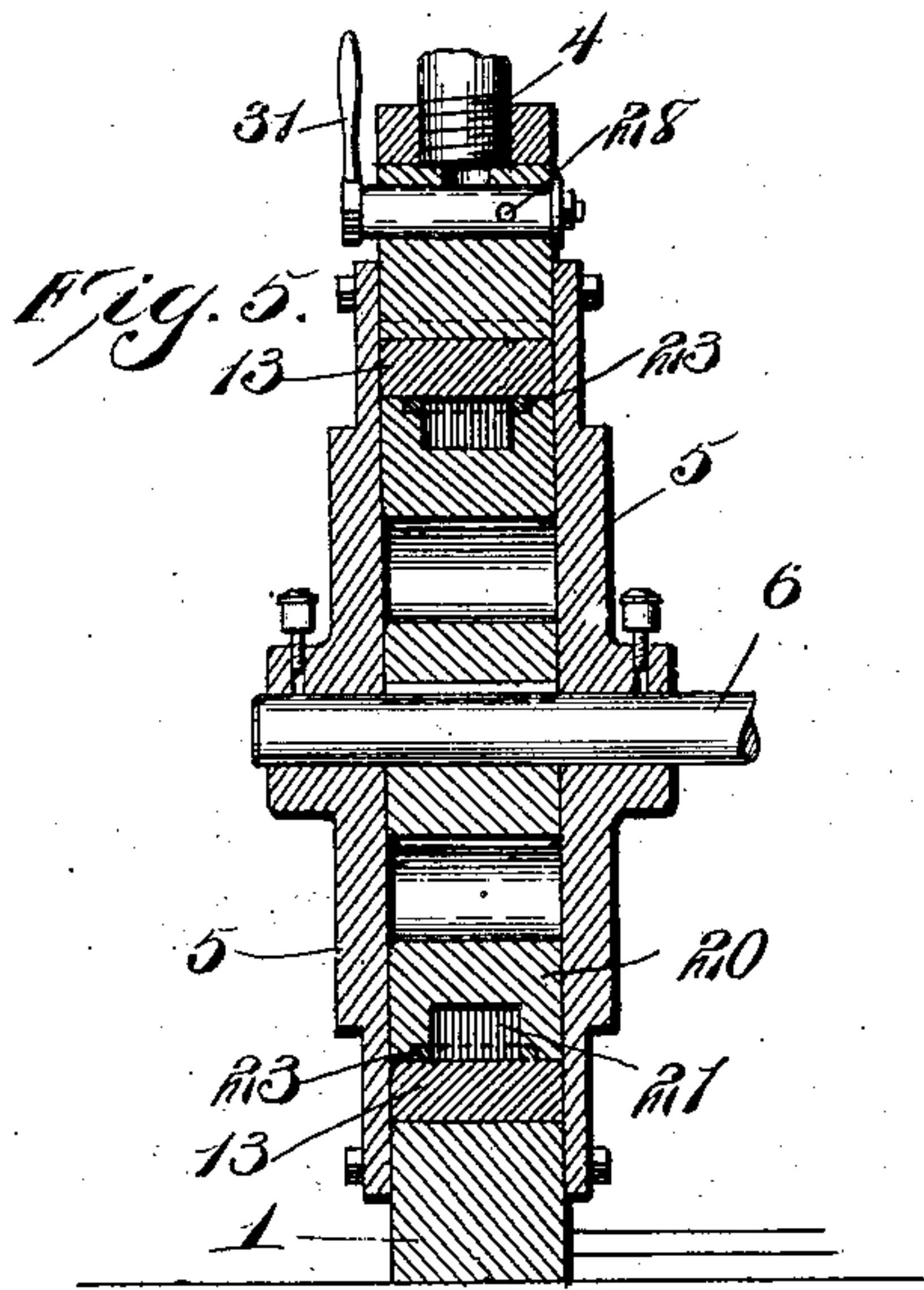
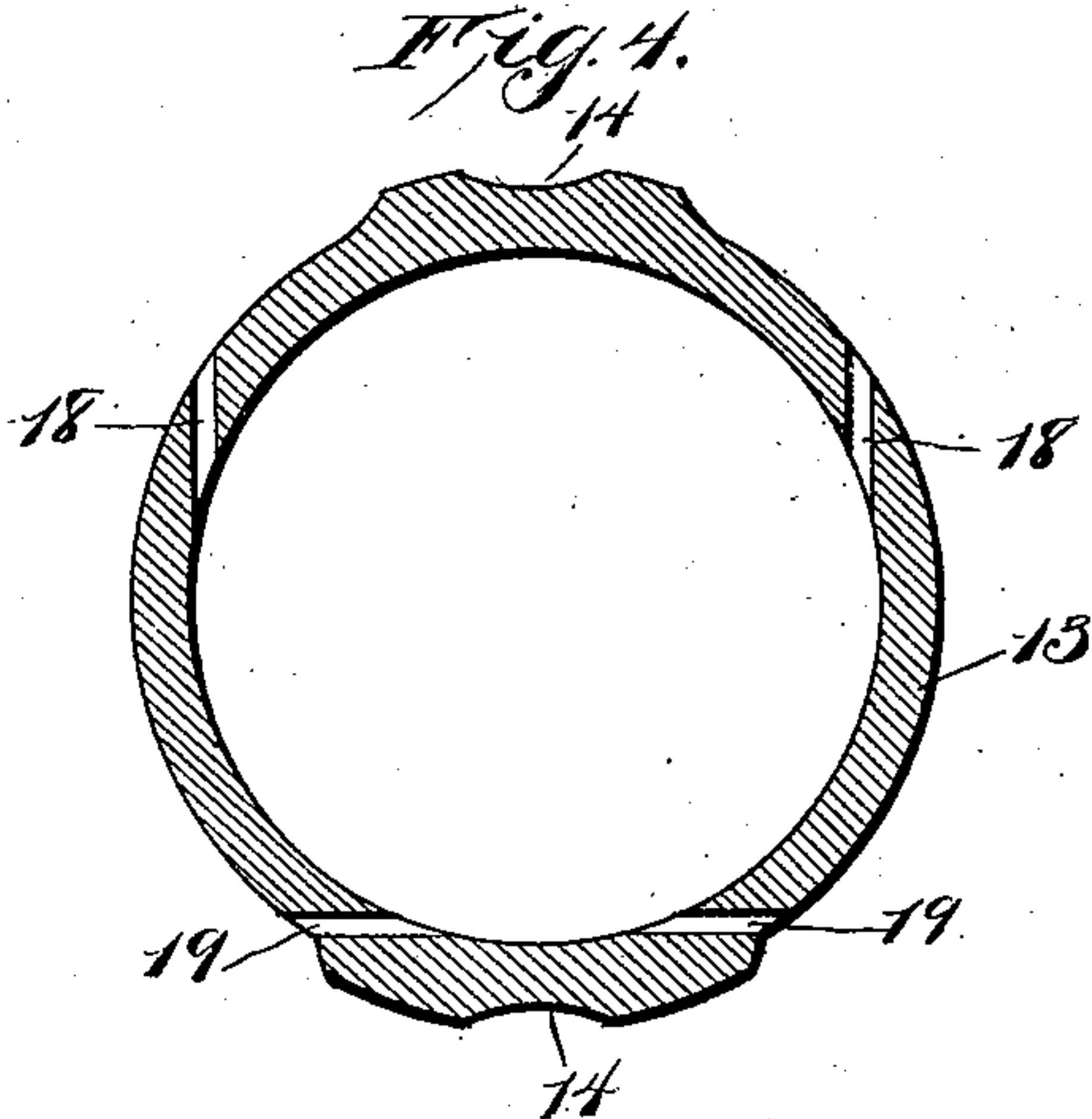
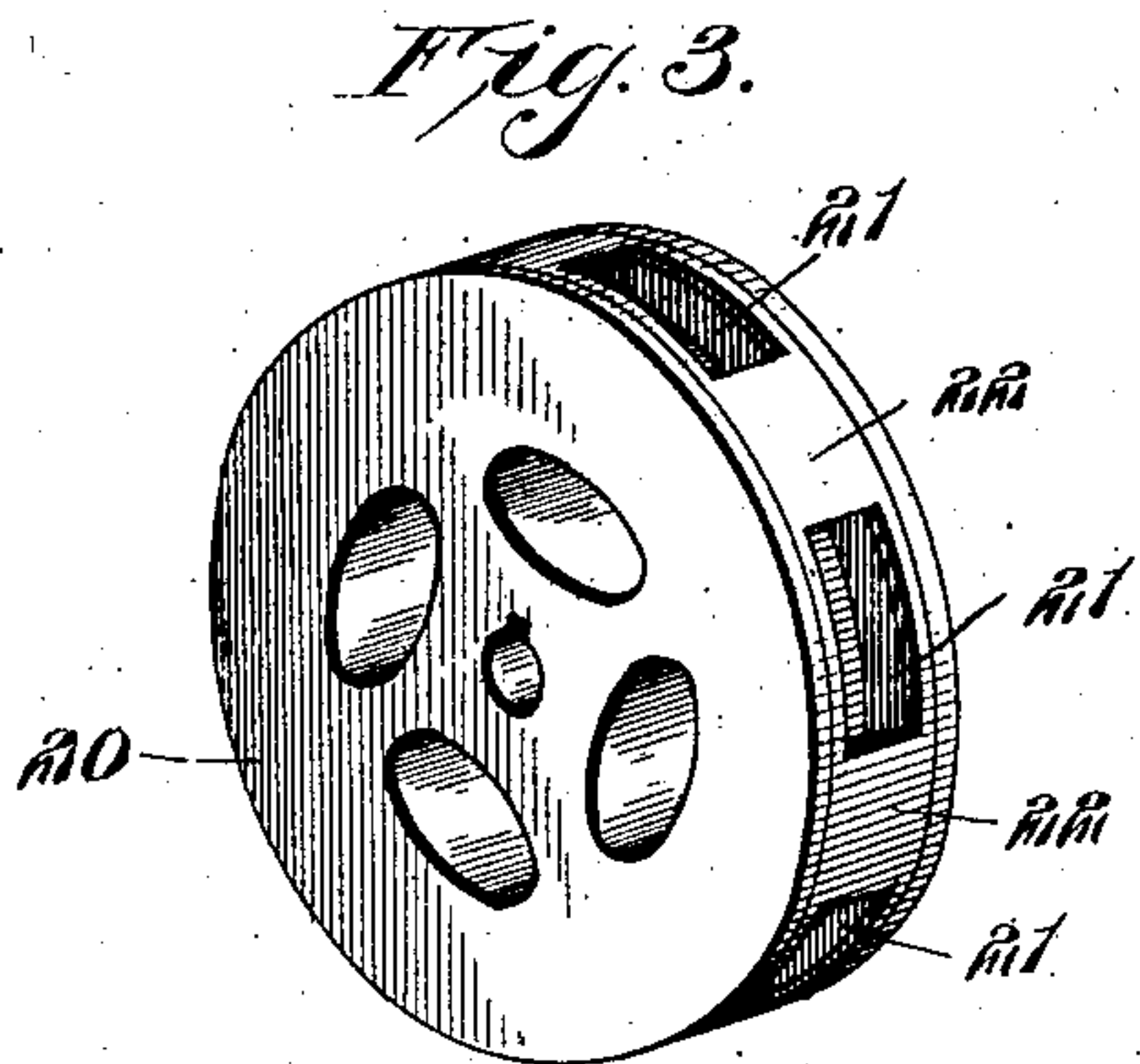
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2 SHEETS—SHEET 2.



Witnesses  
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# UNITED STATES PATENT OFFICE.

EDWARD S. WARD, OF SAN JOSE, CALIFORNIA.

## REVERSIBLE ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 744,447, dated November 17, 1903.

Application filed July 29, 1903. Serial No. 167,464. (No model.)

*To all whom it may concern:*

Be it known that I, EDWARD S. WARD, a citizen of the United States, residing at San Jose, in the county of Santa Clara and State of California, have invented a new and useful Reversible Rotary Engine, of which the following is a specification.

This invention relates to certain improvements in rotary engines, and has for its principal object to provide an engine of the impact type wherein a number of pockets are successively presented in alinements with steam-entrance ports for the purpose of subjecting the revoluble piston to a number of impacts during each revolution.

A further object of the invention is to provide an engine in which the piston and its pockets are so arranged as to permit of the ready reversal of the direction of rotative movement.

A still further object of the invention is to provide an engine of this type in which the revoluble piston member is provided with removable wear-plates for contact with the inner circular wall of the cylinder, these plates being expansible under the heat due to direct contact with the steam and the friction offered by the extensive surface of the cylinder.

With these and other objects in view, as will more fully hereinafter appear, the invention consists in the novel construction and arrangement of parts hereinafter described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the form, proportions, and minor details of construction may be made without departing from the spirit or sacrificing any of the advantages of the invention.

In the accompanying drawings, Figure 1 is a perspective view of a rotary engine constructed in accordance with the invention. Fig. 2 is a transverse sectional elevation of the same on a line 2 2 of Fig. 1. Fig. 3 is a detailed perspective view of the piston member proper. Fig. 4 is a detailed sectional view of the inner ring that forms the cylinder. Fig. 5 is a longitudinal sectional elevation of the engine on the line 5 5 of Fig. 2.

Figs. 6 and 7 are detailed views of the reversing-valve.

Similar numerals of reference are employed to indicate corresponding parts throughout the several figures of the drawings.

The main frame of the engine comprises a bed-plate 1, that preferably is formed integral with an annular cylinder-casing 2, that is extended vertically to form a steam-chest 3, to which steam is admitted through a main inlet-pipe 4.

The cylinder-casing is provided with a pair of removable heads 5, each of which has a central opening forming a bearing for a horizontally-disposed main shaft 6, that is extended out through one of the heads and finds a bearing in a standard 7, carried by the bed-plate. On the outer end of the shaft is a balance or belt wheel 8, and said shaft also carries a belt-wheel 9, over which passes a belt 10 to a governor-pulley 11, the latter actuating an ordinary form of centrifugal governor 12, that controls the throttle-valve of the engine.

Within the cylinder-casing is the cylinder member proper, this being formed of a ring 13, that is held in proper circumferential position by the formation of recesses 14 on the periphery of the cylinder and corresponding interfitting projections 15, projecting inward from the cylinder-casing. Between the cylinder and its casing are formed two curved steam-passages 16, that terminate near the bottom of the cylinder member, and the upper ends of said passages are in communication with the steam-chest 3 through suitable ports 17, either of which may act as the inlet, while the other serves as the exhaust. From the steam-passages lead ports 18 and 19, disposed in tangential lines in order that the steam passing therethrough may the better exert its impact and pressure on the piston, and each pair of ports is so disposed with relation to the impact-pockets of the piston that when one is in communication with a pocket the other will be closed.

The piston 20 is secured to the main shaft 6 and is circular in form, being preferably cut away in order to form a number of radi-



ally-disposed spokes for the sake of lightness. In the periphery of the piston are formed a number of equal distantly spaced pockets 21, the end walls of which are disposed on lines at a tangent to the peripheral surface of the piston or, in other words, undercut, so that the steam issuing from the ports may act to better advantage, and as the opposite end walls of the pockets are of similar shape they will be effective for operation in either direction of rotative movement. In the present instance six of these pockets have been shown, and the piston-sections between said pockets are so proportioned to the length of the pockets that when one pocket is in alinement with the port 18 the other port 19 will be opposite an intermediate wing or abutment 22, that fills the space between the pockets, and when the pocket has passed the port 18 another pocket will be brought into alinement with the port 19 and will be acted upon by the steam passing therethrough.

As pocket 21 is in direct communication with port 18, the wing or abutment will pass directly over port 19, alternately closing and opening ports 18 and 19, thus causing the steam to expand and to rush with greater force in the following pocket; hence the increase of power and the saving of steam.

In engines of this type there is considerable friction between the periphery of the piston and the inner circular wall of the cylinder, resulting in considerable wear and in many cases necessitating the renewal of either the cylinder or the piston, or both, after comparatively short period of use. In the present instance this difficulty is overcome by placing on the wearing-surface of the piston a removable annulus formed of any suitable metal and so arranged as to be readily renewed in case of wear. The wear-ring 23 is seated in a shallow angular groove formed in the periphery of the piston and of a width somewhat greater than that of the pockets. This ring is cut away to form openings at the edge of each pocket, and the edges are turned downward and inward to follow the tangential lines of the end walls of the pockets, and as the metal is bent at an acute angle it will be confined in place at both ends of each of the pockets and cannot be removed under ordinary usage nor can it slip and have free circumferential movement independent of the piston. When this ring is worn away by continued contact with the inner circular wall of the cylinder, it is a comparatively easy matter to remove it and place a new one in position, the added ring being preferably a trifle thicker in order to compensate for the wear which has necessarily ensued on the inner walls of the cylinder.

During the operation of the engine steam will pass from the chest through one of the

ports 17 and thence through the steam-passage and cylinder-ports leading to the piston, while on the opposite side the similar ports serve to exhaust the dead steam from the pockets.

In order to govern the direction of the flow of the steam, and consequently the direction of the travel of the piston, a cylindrical reversing-valve 26 is placed in the steam-chest at a point in vertical alinement with the main steam-inlet pipe 4. This valve 26 is provided with a steam-port 27, having two radially-disposed communicating passages that extend at a right angle to each other and are so disposed that the steam entering through inlet-pipe 4 can be directed to either side of the engine. The valve is also provided with exhaust-ports 28, also formed of a pair of radially-disposed passages disposed at a right angle to each other and in communication with a main exhaust 30, leading to the outer end of the valve. The inlet and exhaust pipes are so arranged as to be spaced at an angle of ninety degrees from each other, and in reversing it is merely necessary to give the valve a quarter-turn by means of its operating-handle 31.

Having thus described the invention, what is claimed is—

1. In a rotary engine, a cylinder having steam-passages, a steam-chest having ported communication with said passages, a pair of tangentially-disposed ports leading from each passage to the interior of the cylinder, and a piston having a plurality of spaced pockets so disposed with relation to the ports as to be successively acted upon by the steam passing through the tangential ports, the distance between the two ports of each pair being greater than the length of any one of the pockets.

2. In a rotary engine, a cylinder having curved steam-passages, a steam-chest having ported communication with said passages, a pair of tangentially-disposed ports leading from each passage to the interior of the cylinder, and a piston having a plurality of spaced pockets so spaced and disposed with relation to the pair of ports that while one pocket is subjected to the action of the steam through one port the second port will be closed by the peripheral surface of the piston.

3. In a rotary steam-engine, a cylinder having ports, a piston having a plurality of pockets, and a wear-ring having openings in alinement with the pockets, portions of the rings being bent inward against the end walls of said pockets.

4. In a rotary engine, a cylinder having ports, a piston having pockets, the end walls of which are arranged on lines tangential to the peripheral line of the piston, and a wear-ring having openings formed in alinement with the pockets, portions of said ring, at the

edges of the openings being bent inward to embrace the tangential end walls of said pockets.

5 5. In a rotary engine, a bed-plate, a cylinder-casing formed integral therewith and provided with inwardly-extending projections, a cylinder-ring having recesses for the reception of said projections, curved steam-passages formed between the periphery of the  
10 ring and the inner wall of the cylinder, tan-

gential ports leading from the passages to the interior of the cylinder-ring, and a revoluble piston having peripheral impact-pockets.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in 15 the presence of two witnesses.

EDWARD S. WARD.

Witnesses:

W. H. FINCH,

W. H. FERGUSON.