No. 709,773.

Patented Sept. 23, 1902.

O. C. JONES.

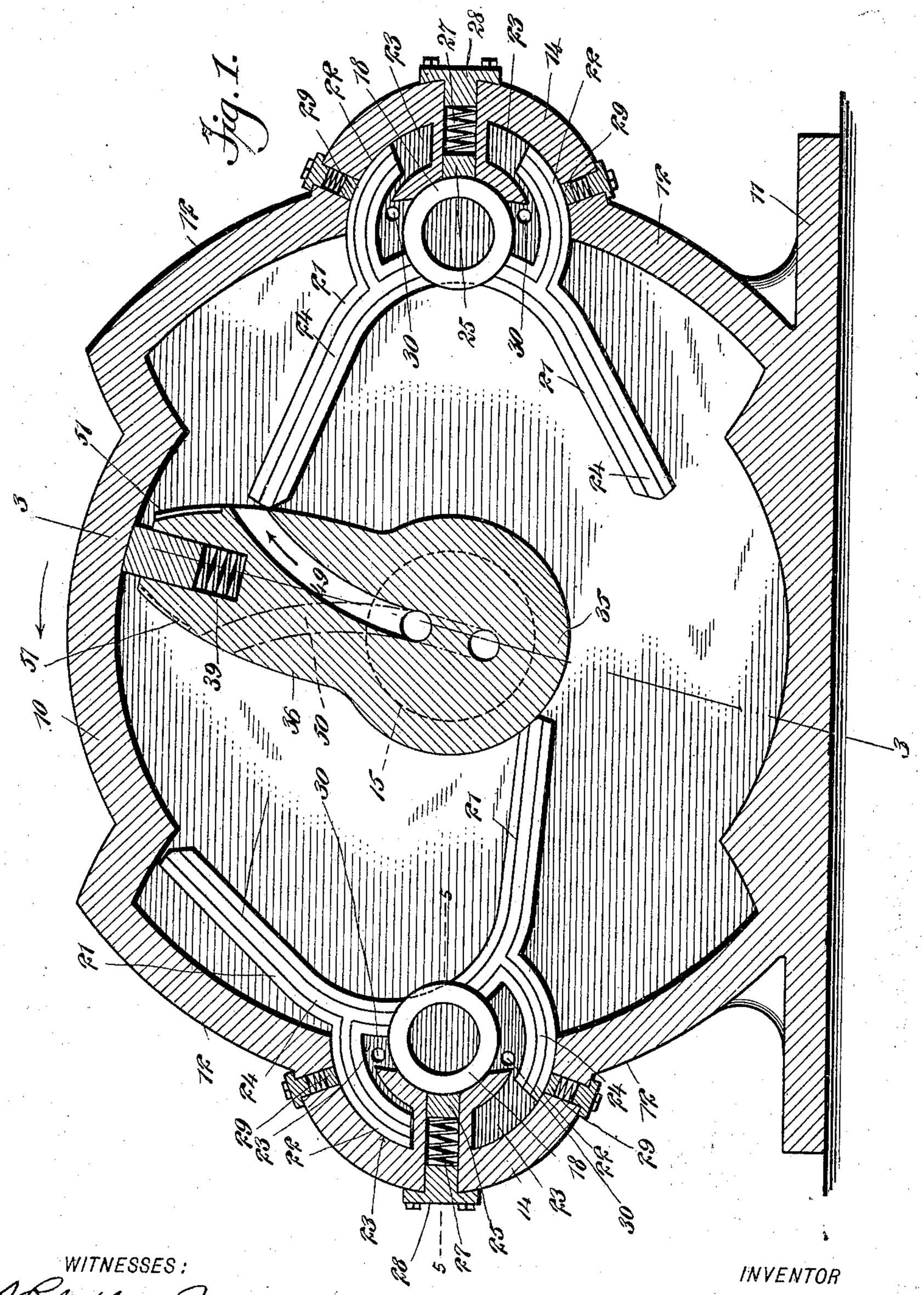
ROTARY ENGINE.

(Application filed Mar. 8, 1902.)

(No Model.)

5 Sheets—Sheet 1.

Fig. 1.



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(No Model.) 5 Sheets—Sheet 2.

Fig. 2.

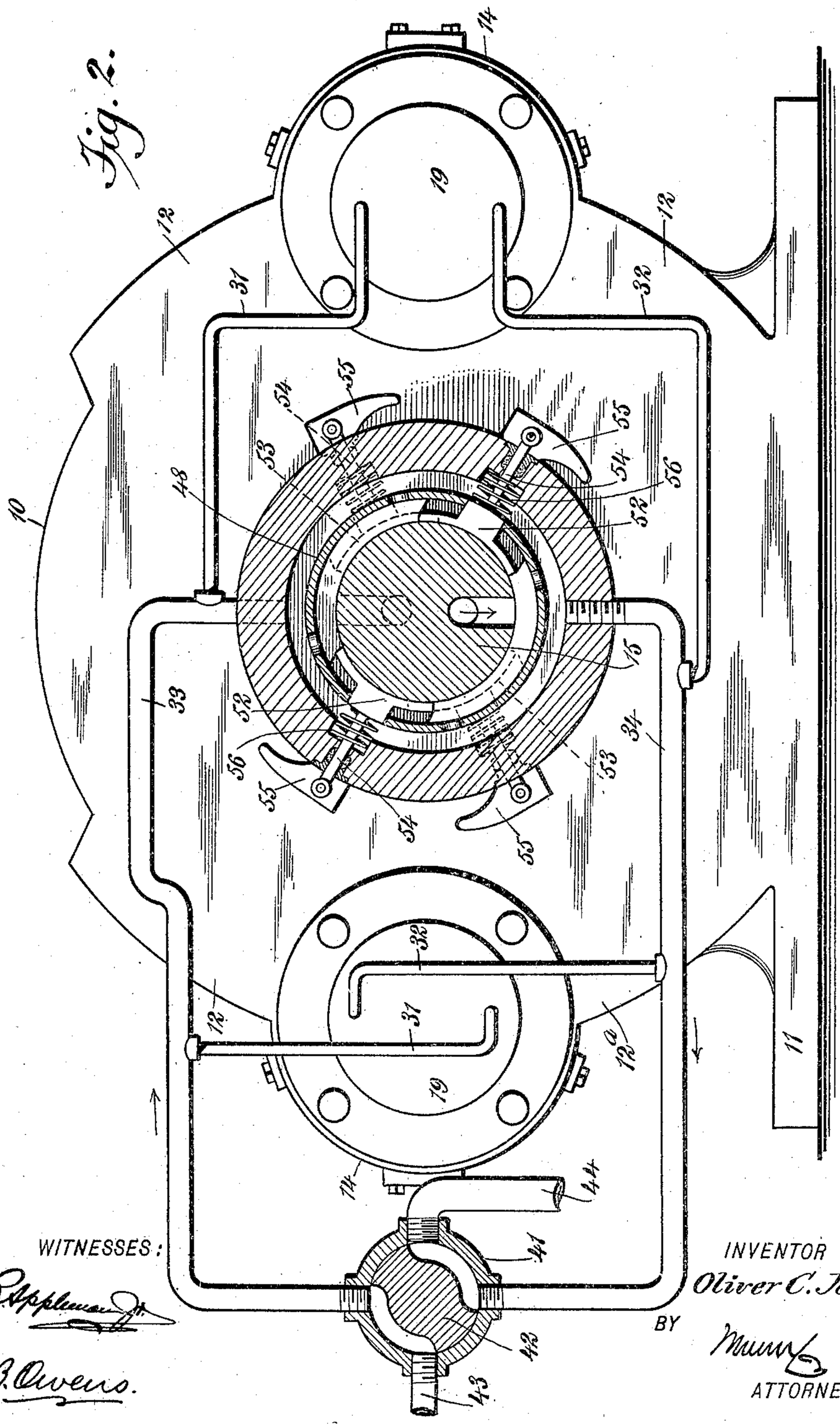

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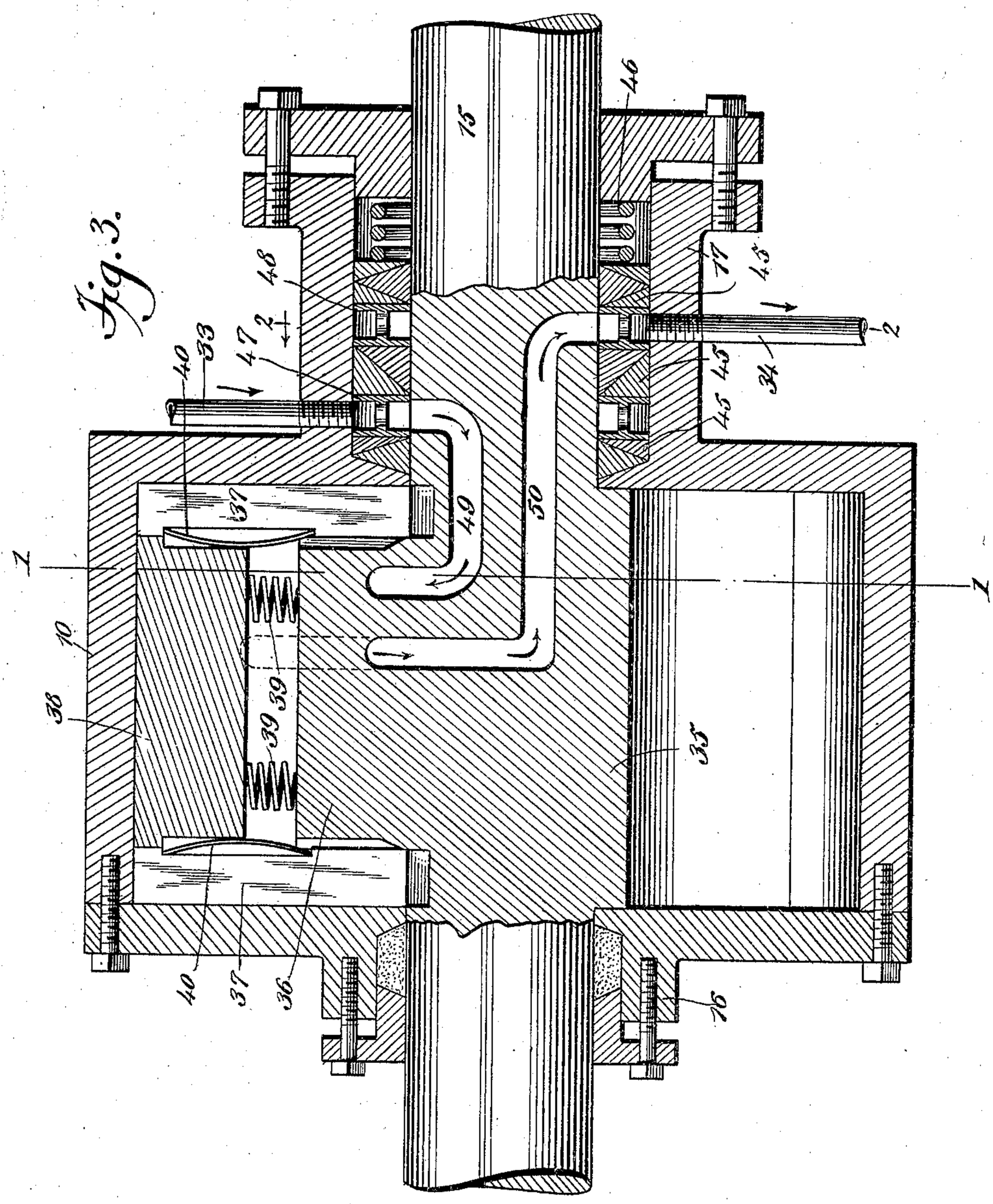
Fig. 3.



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No. 709,773.

Patented Sept. 23, 1902.

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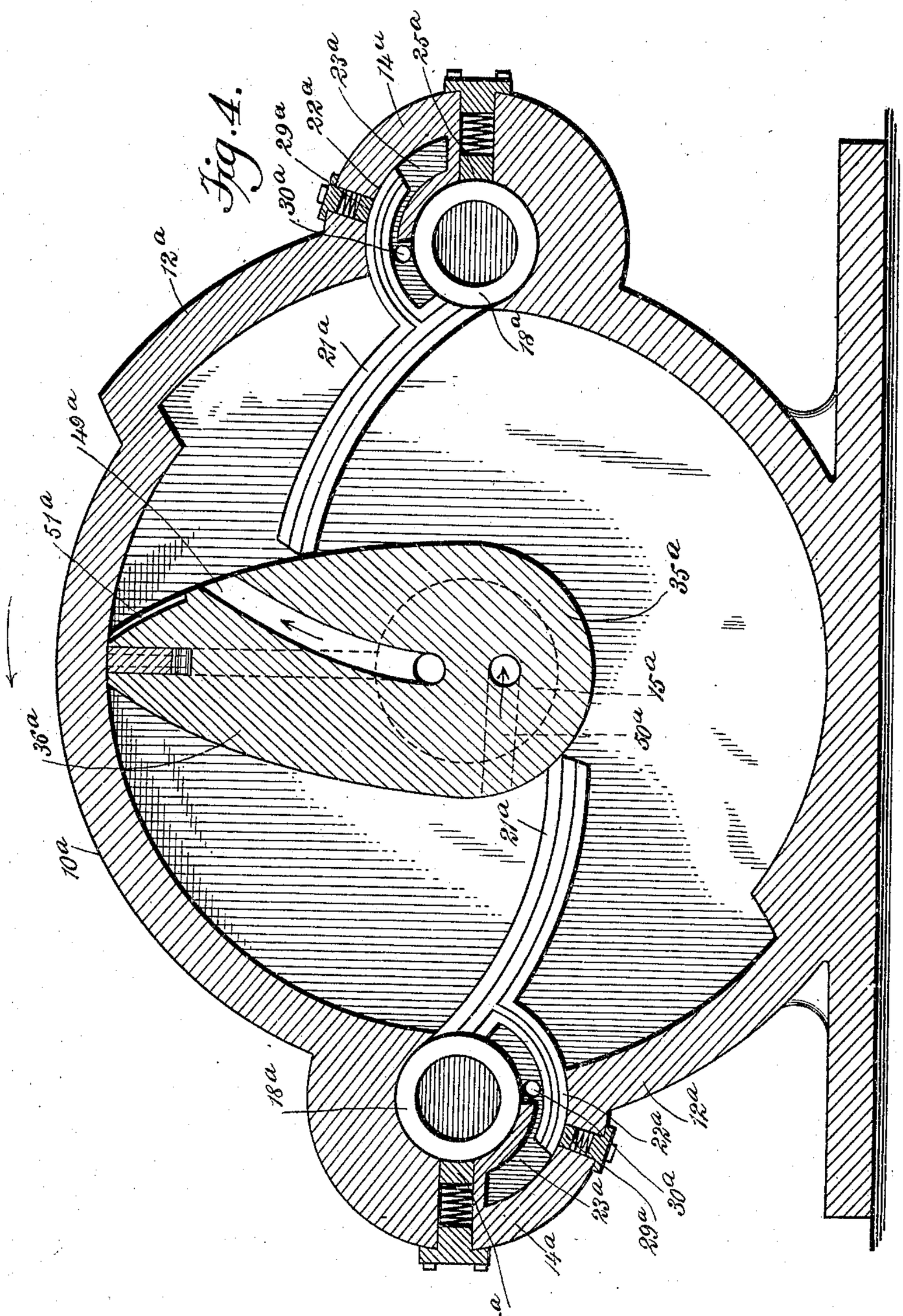
(No Model.)

5 Sheets—Sheet 4.

Fig. 4.



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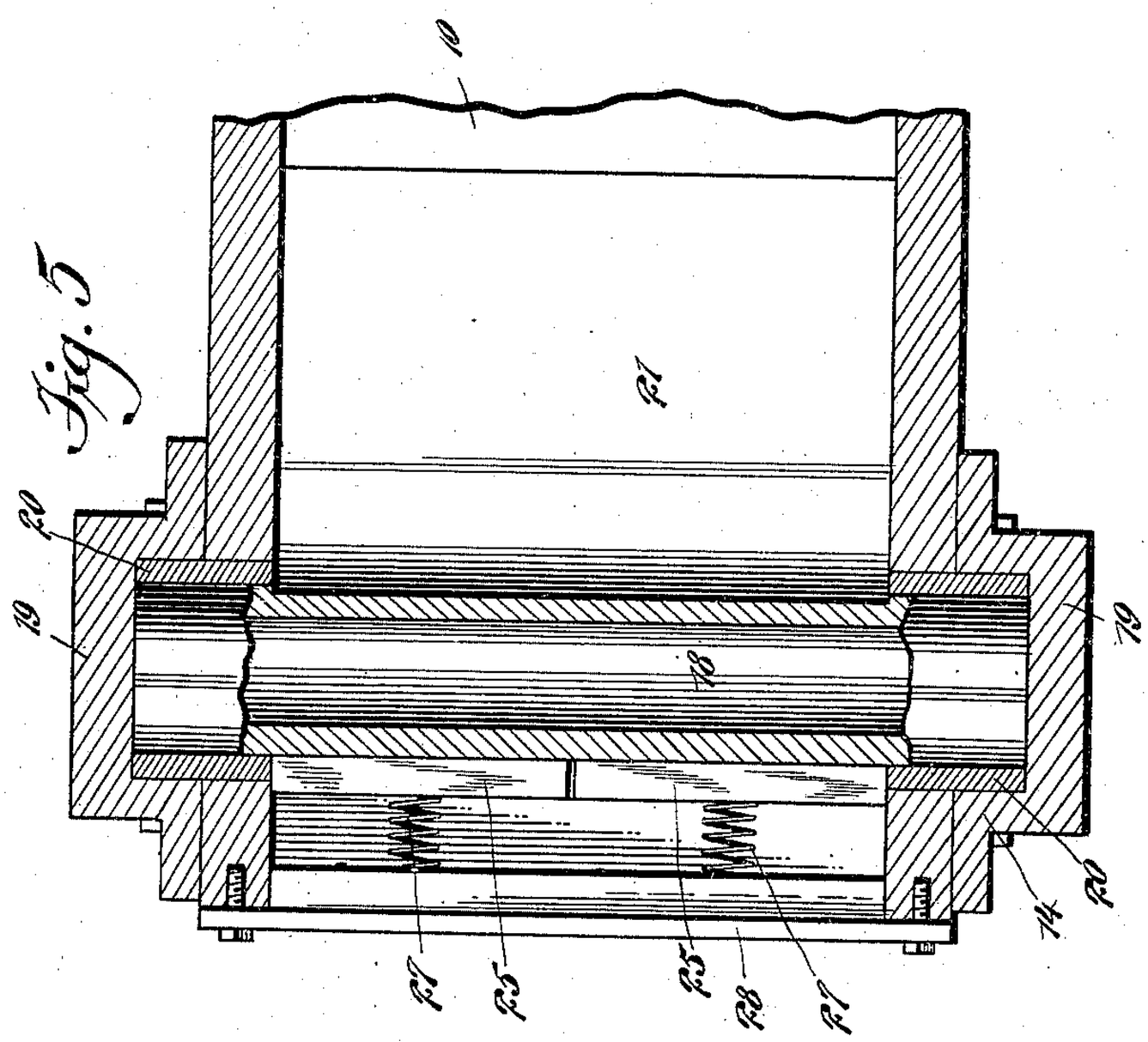

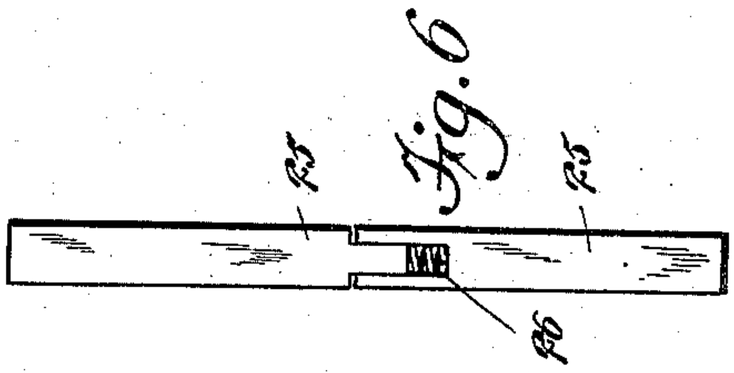

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UNITED STATES PATENT OFFICE.

OLIVER C. JONES, OF PHILADELPHIA, PENNSYLVANIA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 709,773, dated September 23, 1902.

Application filed March 8, 1902. Serial No. 97,251. (No model.)

To all whom it may concern:

Be it known that I, OLIVER CROMWELL JONES, of the United States Navy, a citizen of the United States, and a resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented new and useful Improvements in Rotary Engines, of which the following is a full, clear, and exact description.

This invention relates to an engine of the general type known as "rotary," and by means of the novel features of construction and arrangement incident to my invention I am enabled to drive the engine-shaft in either direction and to utilize the steam force under continuous impact or by certain cut-off devices to work the engine expansively for such period of its operation as may be desired, all of which will be fully brought out hereinafter.

This specification is an exact description of several examples of my invention, while the claims define the actual scope thereof.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a cross-section taken through the engine-cylinder on the line 1 1 of Fig. 3. Fig. 2 is a sectional elevation on the line 2 2 of Fig. 3. Fig. 3 is a section on the line 3 3 of Fig. 1. Fig. 4 is a view similar to Fig. 1, excepting that it shows a modified form of the invention. Fig. 5 is a section on the line 5 5 of Fig. 1, and Fig. 6 is a detail plan view of the packing which works against the trunnion-shaft of the rocking abutments.

Referring to Figs. 1 to 3, 10 indicates the cylinder, having a suitable base 11, whereon it is mounted. The cylinder is provided at each side with offset portions 12, each divided into upper and lower parts by a curved boxing 14, these boxings 14 lying in horizontal alinement, as Fig. 1 best shows. 15 indicates the engine-shaft, one end of which is mounted in a stuffing-box 16 on one cylinder-head and the other end of which is mounted in an elongated box 17, containing the steam-feed and cut-off devices and suitable packing, as will be hereinafter fully described. Mounted to rock in each boxing 14 is a horizontal trunnion-shaft 18, preferably hollow and having its ends covered by exterior caps 19 on the cylinder-heads. These caps contain bushings 20, in which the ends of the shafts 18 turn. The shafts 18 each carry two abutments 21, and these abutments are capable of swinging with the shafts from the position shown at the left-hand end of Fig. 1 downward, so as to throw the upper abutment into engagement with the engine-shaft and the lower abutment into the offset 12, provided therefor. Each abutment 21 has formed thereon a tailpiece 22, and these tailpieces work in cavities 23, formed in the boxings 14. The parts 21 and 22 fit with their edges steam-tight against the heads of the cylinders and are provided with suitable packing 24, making steam-tight connections between the parts, at the same time allowing the movements of the abutments during the operation of the engine. 25 indicates a packing-strip which bears longitudinally against the outer side of each trunnion-shaft 18, these packing-strips being formed in two sections, as shown in Figs. 5 and 6, with a spring 26 pressing them apart. Springs 27 press the packing-strips 25 laterally against the trunnion-shafts, and 28 indicates cap-pieces which set in longitudinal openings in the boxings 14 to hold the parts removably in place. The springs 26 and 27 serve to hold the sides of the packing-strip sections 25 against the trunnion-shafts and also to press the sections longitudinally, keeping their outer ends engaged with the adjacent walls of the boxings 14, thus making steam-tight connection at all necessary points. As shown in Fig. 1, packing-strips 29, with suitable springs or other devices behind them to hold them in position, are arranged to bear, respectively, against the tailpieces 28 of the abutments 21, thus effecting steam-tight connection between the tailpieces and the adjacent walls of the boxings 14. In Fig. 1, 30 indicates ports leading, respectively, into the chambers 23, and reference to Fig. 2 will show branch pipes 31 and 32 leading to these ports 30. There are two pipes 32 and two pipes 31. One pipe 32 and one pipe 31 lead to the ports 30 of one boxing 14, while the other two pipes 31 and 32 lead to the ports 30 of the other boxing 14. The pipes 31 pass from the steam-pipe 33, and the pipes 32 pass from the steam-pipe 34. By these means

steam-pressure is supplied to the desired cavity 23 of the rear boxing 14, thus holding the abutments yieldingly in normal position and automatically returning them to such position after the piston passes, all of which will be fully described hereinafter. The piston 36 is located in the cylinder, as shown best in Figs. 1 and 3, and its hub 35 is preferably formed integral with the engine-shaft 15. The piston is packed at its side edges against the heads of the cylinder and at its outer edge against the outer wall of the cylinder by means of side packing-strips 37 and an end packing-strip 38. 39 indicates springs pressing outward the packing-strip 38, and 40 indicates springs pressing sidewise the strips 37. The springs 39 should be of sufficient strength to overcome the steam-pressure in the chambers 23, for a purpose which will be hereinafter fully brought out. As the shaft and piston turn within the cylinder the piston (assuming that it is moving in the direction of the arrow shown at the top of Fig. 1) will move past the two pairs of abutments, rocking them as it passes, and the abutments afterward returning to their active position, as shown in said view, by the steam-pressure within the chambers 23. The action of the steam with respect to these parts will be hereinafter described. The steam-pipes 33 and 34 lead from a valve-casing 41, containing a four-way plug 42. 43 indicates the steam-feed pipe, and 44 the exhaust-pipe. By proper adjustment of this plug 42 the pipes 43 and 33 may be connected and the pipes 34 and 44 connected, or the pipe 34 may be connected with the pipe 43 and the pipe 33 with the pipe 44. As shown in Fig. 2, the steam-feed from the pipe 43 is led to the pipe 33 and the exhaust-pipe 44 is in connection with the pipe 34. The pipes 33 and 34 lead to the elongated box 17, and in this box is placed suitable metallic packing 45, pressed by a spring or other device 46. Between the groups of packing-rings 45 are placed steam-chamber rings 47 and 48, these chamber-rings being H-shaped in cross-section, and the web or horizontal portions being perforated at various points along their extent, as indicated in Fig. 2, and said chamber-rings form two annular steam-chambers between the box 17 and shaft 15. To these chambers the pipes 33 and 34 lead, respectively, the pipe 33 leading to the ring 47 and the pipe 34 to the ring 48. Formed in the engine-shaft are two ports 49 and 50, these ports communicating, respectively, with the chambers formed by the rings 47 and 48, and passing longitudinally through the engine-shaft, and thence laterally into the piston, after which they diverge toward the sides of the piston and open at the opposite face thereof. In each side or face of the piston, directly adjacent to the outer end thereof, are a number of by-pass grooves 51, which are adapted to permit the steam to pass from one side of one of the abutments to the other during the time that the end of said abutment lies over the grooves. This operation is essential to certain functions of the apparatus and will be fully described hereinafter. As shown by full and dotted lines in Fig. 2, each chamber formed by the chamber-rings 47 and 48 is provided with two cut-off shoes 52 in the chamber 48 and 53 in the chamber 47. These shoes according to the construction here shown are arranged diametrically opposite each other in each chamber, and they are movable radially therein, each shoe being provided with a stem 54, passing through the walls of the box 17 and connected with finger-cams 55, said finger-cams working on the outside of the box 17. Springs 56 press the cut-off shoes normally against the shaft 15. In Fig. 2 the cut-off shoes 52 and 53 are shown to be engaged with the shaft; but by throwing any one of the cams 55 the disengagement of the cut-off shoes may be effected. The cut-off shoes bear on the shaft 15, so that the ends of the ports 49 and 50 move, respectively, under the cut-off shoes 52 and 53, thus opening and closing the ports 49 and 50 as the shaft turns. According to the adjustment shown in the drawings the plug 42 is turned to allow the live steam to pass into the pipe 33 and chamber 47. This also feeds live steam to the pipes 31, causing live steam to enter the lower left-hand chamber 23 and the upper right-hand chamber 23. (See Fig. 1.) The pipe 34, being connected with the chamber 48, constitutes the exhaust-pipe, and therefore the branch pipes 32. have no live steam therein. The action of the live steam in the said lower left-hand chamber 23 and upper right-hand chamber 23 (see Fig. 1) causes the left-hand abutments 21 to lie normally upward and the right-hand abutments to lie normally downward. Now, therefore, the steam passing from the pipe 33 and through the port 49 enters the cylinder at the right-hand side of the piston, (see Fig. 1,) causing said piston to turn in the direction of the arrow. Without considering at the present the action of the cut-off shoes 52 and 53 the operation of the other parts will be as follows: The piston 36 in moving to the left as described will pass beyond the end of the upper left-hand abutment, and the live steam will pass by the end of said abutment and back of the same, this steam then pressing the abutment downward toward the piston. The piston will then engage the lower left-hand abutment 21 and aided by the steam-pressure above referred to will rock the abutments downward, thus allowing the piston to pass, after which the steam-pressure in the lower left-hand chamber 23 returns the left-hand abutment to the position shown in the drawings. As the piston turns into the downward position, or nearly opposite the position shown in Fig. 1, the lower left-hand abutment 21 in returning rides along the steam-feeding face of the piston—that is to say, the face into which the port 49 opens. As the said abutment moves over the grooves 51 in the said feeding-face of the piston said

grooves serve as by-passes for the steam from the port 49, the steam passing downward through the grooves around the ends of the lower left-hand abutment and into the space behind said abutment, such space being formed by the adjacent offset 12. This steam thus entered into said space presses upward on the lower left-hand end abutment and accelerates its return. The piston continuing its movement disengages the left-hand abutments and permits them to return to their normal position, as shown in Fig. 1, the piston continuing its movement under the action of the steam. As the piston moved from the position shown in Fig. 1 the right-hand abutments 21, acting under the pressure of the steam in the upper right-hand chamber 23, were thrown downward, so that the upper right-hand abutment 21 will bear against the hub 35 of the piston. Then after the piston has performed the movement above described—that is to say, having cleared the left-hand abutments—it moves against the right-hand abutments in the same manner, causing them to swing and allowing the piston to pass exactly as described with respect to the left-hand abutments. It will be observed that the by-pass grooves 51 are arranged in each face of the piston, so that the grooves at one side work with one pair of abutments and the grooves at the other side work with the other pair of abutments. During this action of the piston the exhaust-steam is taken in continuously through the port 50 and passed out into the chamber 48 and thence by way of the pipe 34 to the pipe 44. To reverse the engine, it is only necessary to throw the plug 42 so as to connect the pipe 43 with the pipe 34 and the pipe 33 with the pipe 44. The steam-feed then passes into the port 50 and the piston is turned to the right in Fig. 1. Simultaneously steam-pressure from the branch pipes 31 is relieved and transferred to the branch pipes 42. This causes the steam-pressure to act in the upper left-hand chamber 23 and the lower right-hand chamber 23, and the abutments are held yieldingly in exactly opposite positions to those before described. The operation under this reversal is the same as that before described, except as concerns the directions taken by the moving parts.

The above operation takes no account of utilizing the expansive force of the steam; but by means of the cut-off shoes 52 and 53 the steam may be made to work expansively for any desired period of the operation of the engine. Assuming the adjustment shown in Figs. 1 and 2, the cut-off shoes 52 being located in the exhaust-chamber 48 are inert elements and may, if desired, be raised from the active position shown through the medium of the hand-cams 55, before described. The shoes 53 in the chamber 47 should, however, be allowed to bear on the shaft, and as the shaft turns these shoes will alternately cover and uncover the feed-ports 49. During the time that the feed-port 49 is uncovered the steam is allowed to be fed into the cylinder and to act directly on the piston, and during the time that the feed-port 49 is covered by one of the shoes 53 the steam-feed is cut off and the steam is allowed to act expansively. Either one or both of the cut-off shoes 52 or 53 may be used, according to the period or periods of expansion desired, and these cut-off shoes may be made of any size or they may be made of adjustable sections, so as to vary their size, thus varying the time at which the cut-off is effected and the time during which it is maintained. Should the engine be reversed, as has been described above, the cut-off shoes 53 may be thrown out of action and the shoes 52 be allowed to operate the same, as described above with respect to the shoes 53. From the foregoing description it will be seen that the form of engine above described may be worked in either direction, and the steam may be made to act directly or expansively, as desired.

Fig. 4 illustrates a modified form of the engine, in which but one abutment is provided at each side of the cylinder instead of a pair at each side. In this form of the engine the cylinder 10^a has at each side one offset portion 12^a and one boxing 14^a. In each boxing 14^a steam-chambers 23^a are formed, the chamber 23^a of the left-hand boxing being at the lower side and the chamber 23^a of the right-hand boxing being at the upper side. 21^a indicates the two abutments arranged one at each side of the cylinder and carried on the rocking trunnion-shafts 18^a. Each abutment 21^a has a tailpiece 22^a working, respectively, in the chambers 23^a, these parts 21^a and 22^a being suitably packed, as before described. The chambers 23^a have ports 30^a communicating therewith, which supply steam-pressure to said chambers, thus holding the abutments yieldingly in active position, as before described. Packing-strips 25^a and 29^a are provided, as will be understood from the previous description. The engine-shaft 15^a has a piston 36^a formed thereon or fastened thereto, and this piston is suitably packed at its sides and outer end, as the drawings indicate. This form of the engine is non-reversible, the piston being intended to turn continuously in the direction of the arrow shown, and for this purpose it is provided with a feed-port 49^a and an exhaust-port 50^a, said ports leading from the center of the engine-shaft and opening at opposite sides of the piston. The feed-port 49^a is the same as the port 49 in Figs. 1 to 6; but the exhaust-port 50^a instead of extending toward the ends of the piston extends laterally outward at the hub 35^a of the piston. As the steam passes into the cylinder at the right-hand side of the piston it causes the piston to turn, and as the exhaust-port 50^a passes below the right-hand abutment 21^a such steam as may lie in the lower part of the cylinder between the abutments will be exhausted, and thus no resistance will be of-

fered to the downward movement of the lower abutment, excepting the pressure of the steam in the chamber 23^a, which pressure may be readily effected by the superior force of the pressure in the piston. As the piston moves downward it throws back and passes the left-hand abutment 21^a, and then the by-pass groove 51^a in the end portion of the piston at its steam-feed side passes under the end of the abutment as the abutment is returning. This allows the steam to enter below the left-hand abutment and to act thereon to accelerate its returning movement. The piston then goes on to the right-hand abutment, when the same operation is performed, thus causing a continuous rotary movement of the piston. I have not illustrated the steam-feed and exhaust connections with the ports 49^a and 50^a nor the steam-pressure connections with the ports 30^a. These may be of any approved sort. For example, they may be and preferably are those shown in Figs. 1 and 6. Also cut-off devices may be employed to cause the steam to work expansively.

Various changes in the form and details of my invention may be resorted to at will without departing from the spirit of my invention. Hence I consider myself entitled to all forms of the invention as may lie within the intent of my claims. Among these changes it may be noted (referring to Fig. 1) that either one of the two pairs of abutments 21 and its appurtenant parts may be dispensed with and the engine made to operate with one pair of abutments, in which case the steam will act throughout the whole of the cylinder at all times. The engine thus modified will be reversible, and it may be used with the same cut-off as above described or, indeed, with any cut-off to make it work expansively. The same is true of the construction shown in Fig. 4—that is to say, either one of the two abutments therein shown may be dispensed with, if so desired. According to the construction here shown the abutments are thrown back to allow the passage of the piston by direct contact of the piston with the abutments. If preferred, a suitable cam or other gear may be employed positively to drive the abutments—that is, to drive them backward at the proper periods to allow the passage of the pistons; but it is preferable at all times to return the pistons to active position by the steam-pressures within the chambers 23 and 23^a, as explained hereinbefore. If desired, the engine shown in Fig. 4 may be modified by placing the two abutments so that both will extend upward or both downward, as contradistinguished from one extending upward and one downward, and combining these parts with devices for holding one or the other of the abutments in inactive position. This will render the engine with its two abutments reversible, the same as in the construction shown in Figs. 1 to 6, such operation being effected by using only one abutment at a time and when the engine is to be reversed by throwing back the previously-active abutment and throwing into action the previously-inactive abutment.

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

1. A rotary engine, comprising the combination with the cylinder and piston, of an abutment mounted in the cylinder and a tailpiece attached to the abutment and moving therewith, the tailpiece lying in a chamber in the cylinder, means for supplying steam-pressure to said chamber, and a packing device carried in the walls of the cylinder and acting against the tailpiece, to keep the chamber steam-tight.

2. A rotary engine, comprising the combination with the cylinder and piston, the former having a chamber therein, of means leading steam-pressure to said chamber, and an abutment mounted to rock in the cylinder, said abutment being directly opposite the chamber and having a rigid and curved part projecting from its pivoted end and extending into said chamber, for the purpose specified.

3. A rotary engine, comprising the combination with the cylinder and piston, the former having a chamber therein, of means leading steam-pressure to said chamber, an abutment mounted to move in the cylinder, said abutment being directly opposite the chamber and having a part extended thereinto, for the purpose specified, and a packing carried in the walls of the cylinder and bearing against said extended part of the abutment.

4. In a rotary engine, the combination with the cylinder and piston, the former having a chamber therein, of an abutment mounted to swing, the pivoted end of the abutment being adjacent to and opposite to said chamber, a tailpiece rigidly secured to the abutment and curved around the center of the swinging movement thereof, said tailpiece projecting into the chamber, and means for supplying steam-pressure to the chamber.

5. In a rotary engine, the combination with the cylinder and piston, the former having a chamber therein, of an abutment mounted to swing, the pivoted end of the abutment being adjacent to and opposite to said chamber, a tailpiece carried by the abutment and curved around the center of the swinging movement thereof, said tailpiece projecting into the chamber, means for supplying steam-pressure to the chamber, and a packing carried in the walls of the cylinder and bearing against the convex side of the tailpiece.

6. In a rotary engine, the combination with the cylinder and piston, the former having a boxing therein and a chamber in the boxing, of a rockable shaft mounted transversely in the boxing, an abutment carried thereby opposite the chamber, a tailpiece attached to the abutment and projecting into the chamber, means for supplying steam-pressure to the steam-chamber, and packing devices bearing

respectively against the shaft and against the outer side of the tailpiece to keep the said chamber steam-tight.

7. In a rotary engine, the combination with the cylinder and piston, the former having a chamber therein, of an abutment mounted to swing in the cylinder and lying opposite the open end of the chamber, a curved tailpiece rigidly secured to the pivoted end of the abutment and projecting into the chamber to form a moving wall thereof, and means for supplying steam-pressure to said chamber.

8. In a rotary engine, the combination with the cylinder and piston, of an abutment arranged to swing therein, and steam feed and exhaust devices, the piston having a by-pass groove arranged to permit the passage of the steam past the abutment during the time that the end of the abutment lies over said groove, for the purpose specified.

9. A rotary engine, comprising the combination with the piston and cylinder, of a rockable shaft mounted therein, an abutment carried on the shaft, a packing working against the shaft, the packing comprising two strip-sections, a spring pressing said sections longitudinally from each other, and additional springs pressing the strip-sections sidewise against the shaft.

10. In a rotary engine, the combination with the cylinder and piston, the former having a boxing therein with an interior chamber opening into the cylinder, of an abutment mounted to rock at the mouth of the chamber, a tailpiece rigidly secured to the pivoted end of the abutment and projecting against the side walls of the chamber to keep the chamber closed irrespective of the movements of the abutment, and means for supplying steam-pressure to the chamber.

11. In a rotary engine, the combination with the cylinder and piston, the former having a boxing therein with an interior chamber opening into the cylinder, of an abutment mounted to rock at the mouth of the chamber, a tailpiece rigidly secured to the abutment and projecting against the side walls of the chamber to keep the chamber closed irrespective of the movements of the abutment, and means for supplying steam-pressure to the chamber, the said tailpiece being curved around the center of the swinging movement of the abutment and the adjacent walls of the chamber being correspondingly shaped.

12. In a rotary engine, the combination with the cylinder and piston, the former having a boxing therein with an interior chamber opening into the cylinder, of an abutment mounted to rock at the mouth of the chamber, a tailpiece carried by the abutment and projecting against the side walls of the chamber to keep the chamber closed irrespective of the movements of the abutment, means for supplying steam-pressure to the chamber, the said tailpiece being curved around the center of the swinging movement of the abutment and the adjacent walls of the chamber being correspondingly shaped, and a packing device carried by the cylinder and working against the convex or outer walls of the tailpiece.

13. In a rotary engine, the combination with the cylinder and piston, the former having a boxing therein with an interior chamber opening into the cylinder, of an abutment mounted to rock at the mouth of the chamber, a tailpiece carried by the abutment and projecting against the side walls of the chamber to keep the chamber closed irrespective of the movements of the abutment, means for supplying steam-pressure to the chamber, a rocking shaft mounted in the cylinder and carrying the abutment, and packing devices working with the shaft and with the tailpiece to keep the said chamber steam-tight.

14. In a rotary engine, the combination of a cylinder, a piston arranged to turn therein, and an abutment mounted to swing in the cylinder, for the purpose specified, the said piston having a port leading through the side thereof and a by-pass groove in said side at the outer end thereof, said groove permitting the steam to pass the abutment when the abutment lies over the groove.

15. A rotary engine, comprising a cylinder, a piston arranged to turn therein and having a by-pass groove, an abutment working with the piston, and means for applying steam-pressure continuously to the abutment to return it to normal position, the by-pass groove permitting the passage of steam past the abutment as it lies over the groove, whereby to accelerate the return movement of the abutment.

16. A rotary engine, comprising the combination of a cylinder having a boxing with two chambers therein, a rocking trunnion-shaft mounted in the boxing between the chambers, two abutments carried to rock with the shaft and lying opposite the chambers, tailpieces carried respectively by the abutments and projecting into the chambers for the purpose specified, and means for supplying steam-pressure to either one of said chambers, and a piston working in the cylinder and coacting with the abutments.

17. A rotary engine, comprising the combination of a cylinder having a boxing with two chambers therein, a rocking trunnion-shaft mounted in the boxing between the chambers, two abutments carried to rock with the shaft and lying opposite the chambers, tailpieces carried respectively by the abutments and projecting into the chambers, for the purpose specified, means for supplying steam-pressure to either one of said chambers, a piston working in the cylinder and coacting with the abutments, packing devices lying against the trunnion-shaft to keep the said chambers steam-tight from each other, and additional packing devices lying against the tailpieces to keep the respective chambers steam-tight.

18. In a rotary engine, the combination with the cylinder having an offset therein divided

by a horizontally-located boxing, said boxing having two chambers formed therein and opening into the cylinder, of a rocking trunnion-shaft mounted in the boxing intermediately said chambers, abutments carried on the trunnion-shaft and movable therewith to swing into the respective offsets of the cylinder, tailpieces carried respectively by the abutments and projecting into the chambers, for the purpose specified, means for supplying steam-pressure to either one of the chambers as desired, and a piston working in the cylinder and coacting with the abutments.

19. In a rotary engine, the combination with the cylinder having an offset therein divided by a horizontally-located boxing, said boxing having two chambers formed therein and opening into the cylinder, of a rocking trunnion-shaft mounted in the boxing intermediately said chambers, abutments carried on the trunnion-shaft and movable therewith to swing into the respective offsets of the cylinder, tailpieces carried respectively by the abutments and projecting into the chambers, for the purpose specified, means for supplying steam-pressure to either one of the chambers as desired, a piston working in the cylinder and coacting with the abutments, a packing-strip carried transversely at the end of the piston, and a spring pressing said packing-strip outward, whereby to effect steam-tight connection with the cylinder and abutments.

20. In a rotary engine, the combination of a cylinder, an abutment mounted to swing therein, a shaft mounted to turn in the cylinder, and a piston carried by the shaft within the cylinder and coacting with the abutment, said shaft having longitudinal passages formed therein and the steam-passages turning laterally into the piston and opening at opposite sides thereof, the said abutment being in two parts standing at an angle to each other and mounted at the middle to work in the manner specified.

21. In a rotary engine, the combination of a cylinder, an abutment mounted to swing therein, a shaft mounted to turn in the cylinder, a piston carried by the shaft within the cylinder and coacting with the abutment, said shaft having longitudinal passages formed therein and the steam-passages turning laterally into the piston and opening at opposite sides thereof, and cut-off devices working over the shaft to command the steam-passages.

22. In a rotary engine, the combination of a cylinder, an abutment mounted to swing therein, a shaft mounted to turn in the cylinder, a piston carried by the shaft within the cylinder and coacting with the abutment, said shaft having longitudinal passages formed therein and the steam-passages turning laterally into the piston and opening at opposite sides thereof, and cut-off devices working over the shaft to command the steam-passages, said cut-off devices comprising shoes loosely engaged with the shaft to open and close the steam-passages as the shaft turns.

23. A rotary engine having steam-passages formed in the piston-shaft, and radially-movable cut-off shoes loosely engaged with the shaft to open and close the steam-passages as the shaft turns.

24. A rotary engine having steam-passages formed in the piston-shaft, cut-off shoes loosely engaged with the shaft to open and close the steam-passages as the shaft turns, and means for mounting the cut-off shoes to allow their independent engagement with and disengagement from the shaft.

25. A rotary engine having steam-passages formed in the piston-shaft, cut-off shoes loosely engaged with the shaft to open and close the steam-passages as the shaft turns, and means for mounting the cut-off shoes to allow their independent engagement with and disengagement from the shaft, said means comprising hand-cams attached to the shanks of the shoes and working with a relatively stationary support.

26. In a rotary engine, the combination of the engine-shaft having a steam-passage therein, a gland in which the shaft turns, a chamber-ring located around the shaft and within the gland and communicating with the steam-feed and with the steam-passage in the shaft, and a radially-movable cut-off shoe located in the chamber-ring and engaged with the shaft in the manner specified.

27. In a rotary engine, the combination of the engine-shaft having a steam-passage therein, a gland in which the shaft turns, a chamber-ring located around the shaft and within the gland and communicating with the steam-feed and with the steam-passage in the shaft, a cut-off shoe located in the chamber-ring and engaged with the shaft in the manner specified, and means for removably holding the cut-off shoe in engagement with the shaft.

28. In a rotary engine, the combination of the engine-shaft having a steam-passage therein, a gland in which the shaft turns, a chamber-ring located around the shaft and within the gland and communicating with the steam-feed and with the steam-passage in the shaft, a cut-off shoe located in the chamber-ring and engaged with the shaft in the manner specified, and means for removably holding the cut-off shoe in engagement with the shaft, said means comprising a hand-cam connected with the shank of the cut-off shoe and working against the outer face of the gland.

29. In a rotary engine, the combination of the engine-shaft having a steam-passage therein, a gland in which the shaft turns, a chamber-ring located around the shaft and within the gland and communicating with the steam-feed and with the steam-passage in the shaft, and a cut-off shoe located in the chamber-ring and engaged with the shaft in the manner specified, the chamber-ring being H-

shaped in cross-section and having its web perforated to permit the passage of steam.

30. A rotary engine having a cylinder provided with chambers, abutments at the mouths of the chambers and each provided with a curved tailpiece rigid therewith and extending into the chambers, a piston, a piston-shaft having two steam-passages, steam-pipes communicating with the said passages, and branch pipes leading from the steam-pipes to the said chambers.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

OLIVER C. JONES.

Witnesses:
I. B. OWENS,
JNO. M. RITTER.