No. 678,338. Patented July 9, 1901.

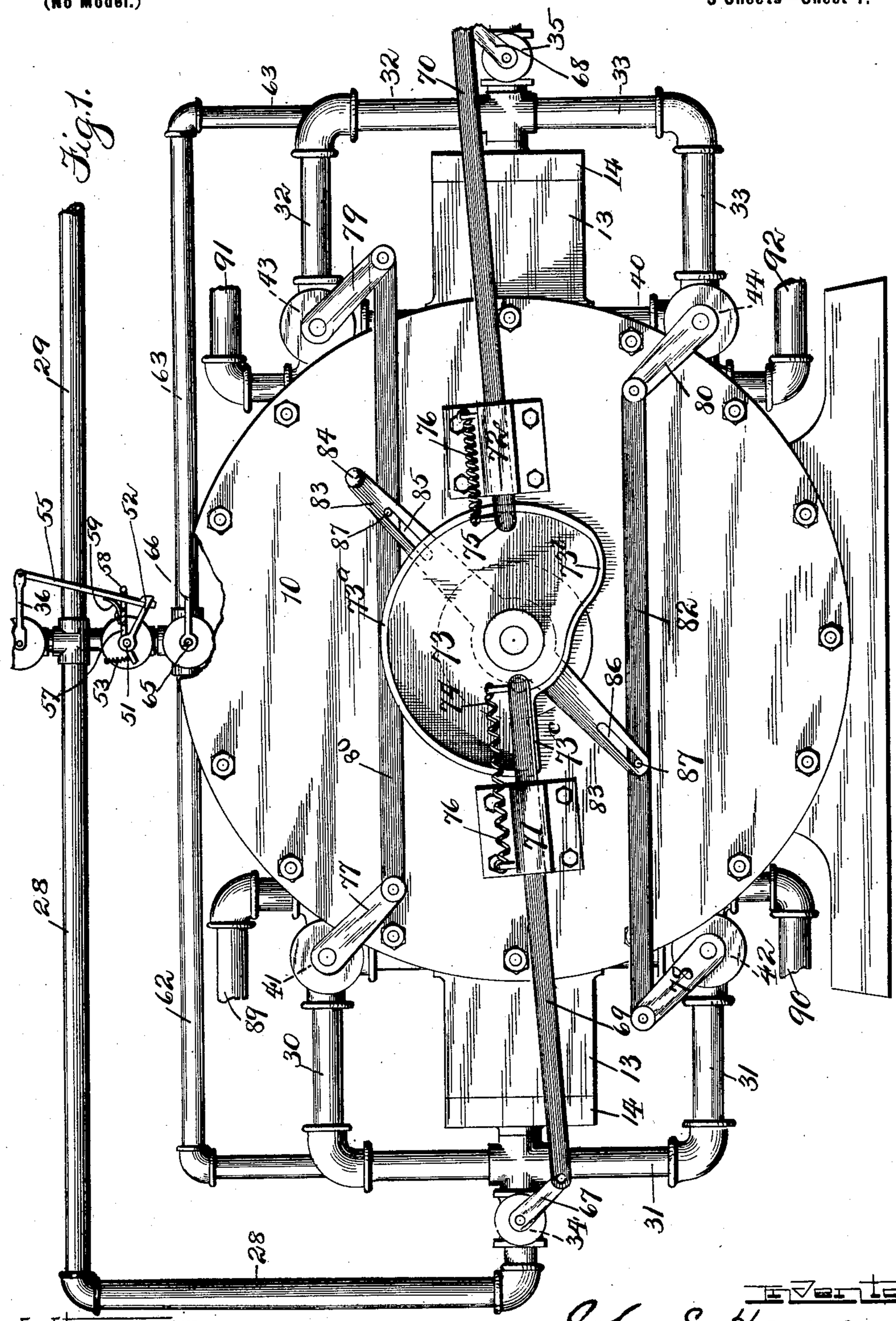
J. S. HARGER.

ROTARY ENGINE.

(Application filed July 27, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



Witnesses
W. B. Keir
Chas. D. Lowry

Inventor
John S. Harger
by Bond, Adams, Pickard & Jackson
Att'ys

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J. S. HARGER.

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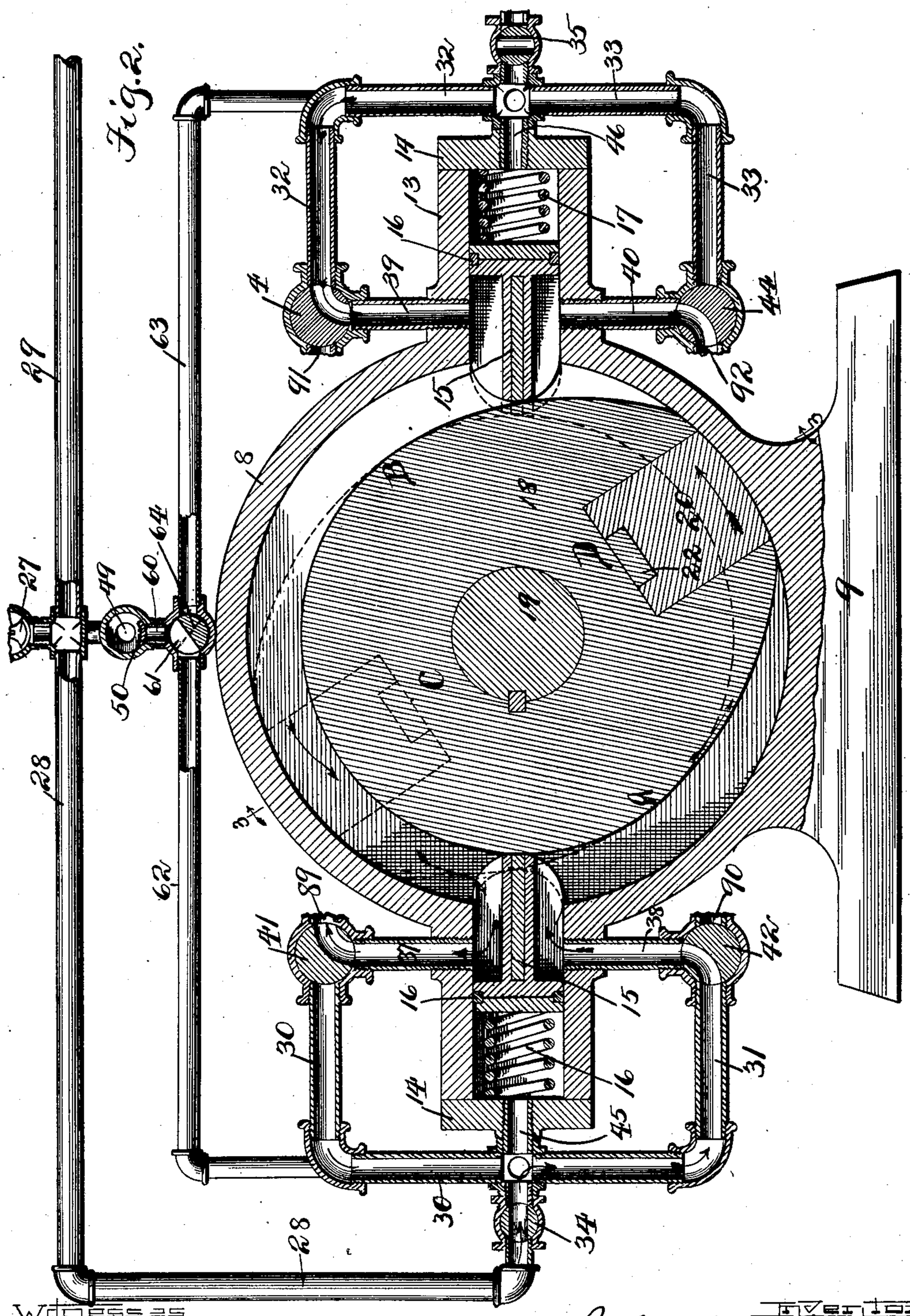
(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



Witnesses as
W. B. Weir
Ira D. Perry

Inventor
John S. Harger
by Brown, Adams, Duncan & Jackson
Attys

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J. S. HARGER.

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(No Model.) 3 Sheets—Sheet 3.

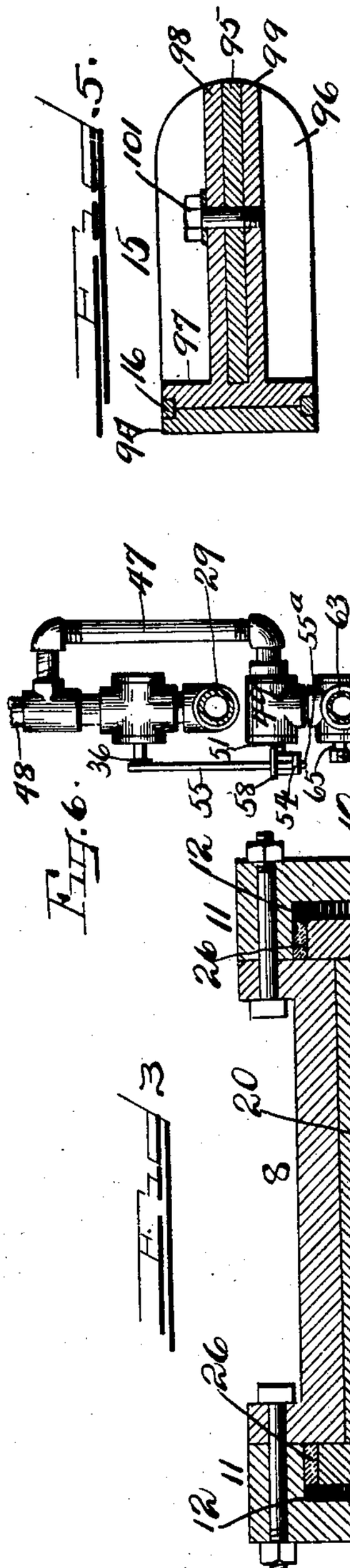

FIG. 5.

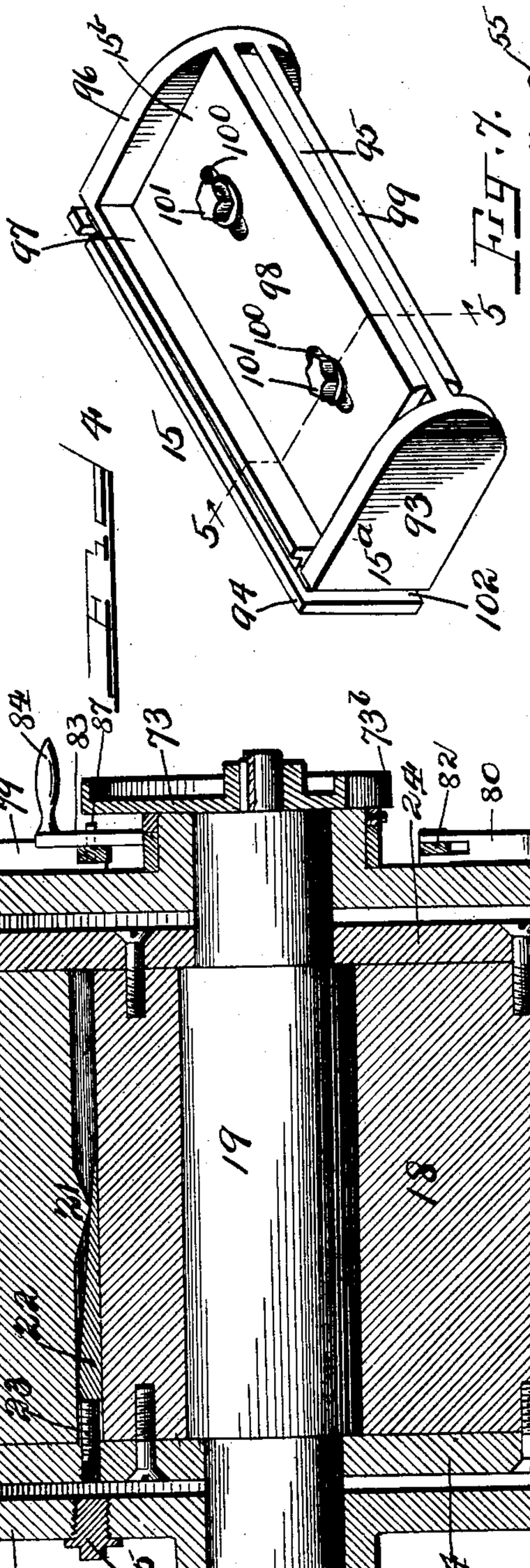

FIG. 7.

FIG. 6.

FIG. 3.

Witnesses
J. B. Weir
Ira D. Perry

Inventor
John S. Harger
by Bond, Adams, Pickard & Jackson
Attys.

UNITED STATES PATENT OFFICE.

JOHN S. HARGER, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-FIFTH TO SARA STEENBERG, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 678,338, dated July 9, 1901.

Application filed July 27, 1900. Serial No. 25,020. (No model.)

To all whom it may concern:

Be it known that I, JOHN S. HARGER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to rotary engines; and one of its objects is to provide a new and improved form of rotary engine in which the steam may be economically used by reason of being used expansively and in which the dead-points in the rotation may be avoided.

Another object of my invention is to provide a new and improved form of abutment in such rotary engines.

Another object of my invention is to provide a new and improved bearing for the piston in said rotary engines upon the cylinder, whereby the liability to wear as said piston rotates will be diminished and packing may be conveniently used.

Another object of my invention is to provide new and improved means by which the wear upon the bearing-block in the piston as it rotates may be taken up.

My invention has for a further object the improvement of rotary engines in sundry details, as hereinafter described.

That which I regard as new will be set forth in the claims.

In the drawings, Figure 1 is a side elevation with a portion of the connecting-pipes cut away. Fig. 2 is a vertical section. Fig. 3 is a transverse section upon lines 3 3 of Fig. 2. Fig. 4 is an enlarged detail, being an isometric view of one of the abutments, showing its construction. Fig. 5 is a cross-section on lines 5 5 of Fig. 4. Fig. 6 is a detail showing certain pipe connections, being a cross-section on lines 6 6 of Fig. 1; and Fig. 7 is an enlarged detail of a portion of the mechanism for moving an auxiliary valve hereinafter described.

8 indicates a hollow cylinder which is mounted upon a base 9.

10 10 indicate the heads of the cylinder, which are bolted or otherwise secured thereto, as is best shown in Fig. 3. As is best shown in said figure, the cylinder-heads 10 are provided with circumferential flanges or shoulders 11, which bear upon the ends of the cylinder 8, the distance between said flanges, diametrically measured between their inner edges, being somewhat greater than the diameter of the cylinder 8, so that circular recesses 12 will be formed when the heads 10 are secured to the cylinder 8, within which the plates secured to the revoluble piston, hereinafter described, rest and bear.

13 indicates steam-chambers or abutment-boxes, which are preferably formed integral with the cylinder 8, with separate heads 14 secured to their outer ends and facing each other upon opposite sides of the cylinder, as is best shown in Figs. 1 and 2, and are adapted to contain within them the sliding abutments hereinafter described.

15 indicates abutments which are slidingly mounted so as to move steam-tight in the abutment-boxes or steam-chests 13 and which, generally described, consist of a rear plate with a packing 16, side plates, and a cross-web connecting said side plates centrally. The detailed construction of the abutments will be hereinafter described. At present it is enough to say that the back plate moves with its packing 16 steam-tight within the steam-chamber or abutment-box 13, the side plates bear steam-tight against the side of said box, and the said side plates are rounded at their front ends and, with the cross-web, bear against the revoluble piston hereinafter described.

17 indicates expansion-springs located within said abutment-boxes 13, bearing at one end against the heads 14 and at the other end against said abutments, so as to tend normally to throw the said abutments 15 forward.

18 indicates a revoluble piston which is keyed or otherwise secured to the shaft 19, which passes through and is journaled in the cylinder-heads 10, concentric with the cylinder 8. The piston 18 is ovoid in cross-section, as is best shown in Fig. 2, the portion C thereof between the points A and B being circular in section and the portion D between the points B and A being elliptical in section, so that the end of said portion comes close to the interior surface of the cylinder.

20 indicates a bearing-block which is mounted in a groove or recess in the piston 18, with its outer end adapted to bear steam-tight against the interior of the cylinder 8 as said piston 18 revolves. As is best shown in Figs. 2 and 3, the inner end of said bearing-block 20 is grooved and is provided, as is best shown in Fig. 3, with a double wedge-shaped projection 21, projecting inwardly therefrom.

22 indicates a wedge which slides within the groove on the interior end of said bearing-block 20 and is adapted to bear against said projection 21, so that as said wedge 22 is thrust inward it may force the bearing-block 20 outward in order to compensate for any wear upon said bearing-block caused by the rotation of the piston.

23 indicates a screw which passes through a screw-threaded opening in the side plate 24 of the piston 18 and at its inner end bears against said wedge 22, so that by the rotation of said screw the wedge 22 may be forced inward.

25 indicates a screw-plug which is screwed into the cylinder-head 10 at the same distance from the axis of the shaft 19 as the screw 23, so that by the removal of the plug 25 the screw 23 is accessible. The piston 18 is of the same distance between its ends as the height of the cylinder 8, so that its ends are flush with the ends of the cylinder.

24 indicates circular plates which are screwed or otherwise secured upon each end or side of the piston 18 concentric with the shaft 19 and are of such diameter that when in place their edges project within the circular grooves or recesses 12, coming sufficiently close to the interior periphery of the shoulders 11 to permit packing 26 between the periphery of said plates 24 and the interior periphery of the shoulders 11. The interior surfaces of the plates 24, which project beyond the circumference of the piston 18, bear steam-tight against the exterior ends of the cylinder 8.

27 indicates a throttle-valve which is mounted in the pipe leading to the boiler or source of steam-supply, which is not shown.

28 29 indicate pipes which open into the chamber of the throttle-valve 27, as is best shown in Fig. 2, and connect and open into, respectively, pipes 30 and 31 and 32 and 33.

34 35 indicate valves interposed in the pipes 28 29 between the openings of said pipes into the pipes 30 and 32 and controlled by a valve-moving apparatus hereinafter described.

36 (see Fig. 1) indicates the handle of the throttle-valve. The pipes 30 31 communicate with pipes 37 38 and the pipes 32 33 with pipes 39 40 by the medium of interposed valves 41 42 43 44. The pipes 37 and 39 open into the forward end of the abutment-boxes 13 above the abutments, and the pipes 38 and 40 open into the abutment-boxes 13 below the abutments.

45 46 indicate pipes which open at one end into the tubes 30 31 and 32 33, respectively, and at the other end into the abutment-boxes 13 behind the abutments 15, whereby steam is admitted when the engine is in operation, as hereinafter described, behind the abutment-boxes, so as to balance the same.

47 (see Fig. 6) indicates a pipe which opens at one end into the pipe leading from the boiler 48 and at the other end into a valve-chamber 49.

50 (see Fig. 2) indicates a valve mounted in the valve-chamber 49 so as to bear upon the interior surface thereof and rotate therein and mounted upon a stem 51. (See Figs. 1 and 6.)

52 indicates a slotted lever, one end of which is shown in dotted lines in Fig. 7, which is keyed or otherwise secured upon the outer end of the valve-stem 51. One end of said lever 52 is slotted, as shown in Fig. 7, and the other end is connected with a contractile spring 53. The slotted end of the lever 52 is provided at its outer end with a dog or catch 54, as is best shown in Figs. 1 and 7. 55 indicates a link, one end of which is pivotally mounted upon the outer end of the throttle-lever 36, and the other end is adapted to enter a slot 56 in the lever 52, and is provided at its lower end with a dog or catch 55ª, which is adapted to bear against the under side of the outer end of the lever 52 at the outer extremity of the slot 56. 57 indicates a rod which is secured at one end to the outer surface of the valve-box 49 and has its outer or free end bent so as to pass around the link 55 and retain it in position. 59 indicates a spring which is mounted upon the rod 57 and bears against the surface of the link 55, tending to throw the same to the right in Fig. 1. The operation of these parts will be hereinafter described.

The valve-chamber 49 communicates, by means of a tube 60, with a valve-chamber 61. The valve 50 in the valve-box 49 when operated, as hereinafter described, will either open or close the communication between the valve-chamber 49 and the said tube.

62 63 indicate steam-pipes which connect with and open into, respectively, the pipes 30 and 32.

64 indicates a valve which is mounted upon a valve-stem 65 (see Fig. 1) and rotates within the valve-chamber 61 and operates to open the passage from the valve-chamber 49 into the pipe 62 or into the pipe 63, as may be desired, the said valve 64 being turned into the desired position by means of a lever 66, which is keyed or otherwise secured to the outer end of the valve-stem 65.

Referring to Fig. 1, the valves 34 35 have keyed or otherwise secured to the exterior ends of their valve-stems cranks 67 68. 69 70 indicate rods, the outer ends of which are pivotally connected, respectively, with the cranks 67 68, and which are slidingly mounted in boxes 71 72, secured to the outer surface of the cylinder-head 10. 73 indicates a cam which is keyed or otherwise secured to one

end of the shaft 19 and rotates therewith. 74 75 indicate rollers which are journaled upon the inner ends of the rods 69 70 and which bear upon the interior surface of the cam 73. Contractile springs 76 connect the outer ends of the rods 69 70 with the sliding boxes 71 72 and tend to normally throw the said rods outward and keep the rollers 74 75 in close contact with the cam 73. The interior bearing-surface of the cam 73 is divided up into three portions 73^a, 73^b, and 73^c. Of these portions the part 73^a occupies the greater portion of the cam and is circular, concentric with the shaft 19. The portion 73^b is so arranged that when said cam rotates it will bear upon one or the other of said rollers 74 75, as hereinafter described, and tend to force the same inward against the spring 76. The portion 73^c is radial of the cam and permits the instant freeing of the roller 74 or 75 therefrom as soon as said portion of the cam is reached, so that by the operation of the spring it will be instantly thrown out to the circular portion of the cam, as hereinafter described. The object of this shape of cam is to open the valves 34 35 at proper intervals and to instantly shut them at the proper time, so as to permit the steam to be used expansively. The relation, therefore, between the several respective lengths of the portions 73^a, 73^b, and 73^c will be varied to suit the circumstances of the particular case. The operation of these parts of the machine will be hereinafter fully described.

Still referring to Fig. 1, the valves 41, 42, 43, and 44 are provided upon the exterior ends of their valve-stems, respectively, with levers 77 78 79 80. The levers 77 and 79 are connected by a link 81 and the levers 78 and 80 by a link 82. 83 indicates a reversing-lever provided with a handle 84, which is journaled upon the cylinder-head 10 and is provided with slots 85 86, which engage, respectively, with pins 87 88, mounted upon the links 81 82. When the reversing-lever 83 is in the position shown in Fig. 1, the valves 41 42 43 44 are in the position shown in Fig. 2. By swinging the lever to the left in Fig. 1 the position of these valves may be exactly reversed, as hereinafter described. 89 90 91 92 indicate escape-pipes which communicate with the chambers of the valves 41 42 43 44, respectively, and are controlled thereby.

Although the abutments 15 may be made of one piece, yet for the purpose of taking up the wear which may occur in the sides of the abutments by their bearing against the plates 24 I prefer to construct these abutments as shown in Figs. 4 and 5. As there shown the said abutments are constructed in two pieces 15^a and 15^b. The piece 15^a is provided with a side plate 93, a back plate 94, and a web 95, the forward edge of which is flush with the extreme forward point of the side plate 93. The side plate 93 is of the same height as the height of the abutment-box 13, so as to slide steam-tight therein, and the back plate 94 is of the same height as the abutment-box 13, so as to fit closely within the same. Between the back plate 94 and the web 95 a slot is formed to permit the entry therein of the other part of the abutment, as hereinafter described; and extending from the outer end of the web 95 nearly to the side plate 93. The portion 15^b is formed with a side plate 96 of the same size and shape as the side plate 93, a back plate 97, and two parallel webs 98 99, constructed with just sufficient distance between them to permit of the entry between them of the web 95, the back plate 97 entering the slot between the back edge of the web 95 and the back plate 94. The webs 95 and 98 99 are provided with slots 100, through which pass bolts 101, by which the parts are locked together. By loosening the bolts 101 it will be obvious that the parts may be slightly separated and fastened together again by the bolts 101, so as to compensate for any wear that may have occurred by reason of the bearing of the plates 24 upon the exterior surfaces of the side plates 93 and 96. Between the back plates 94 and 97 is formed a slot or groove 102, in which is inserted packing 16, so as to make the abutment 15 slide steam-tight within the chamber 13.

The operation of the devices hereinabove described is as follows, and for the purpose of describing the operation we will assume that the piston 18, being about to move in the direction of the curved arrow in Fig. 2, is in such position that the bearing-block 20 is just below the forward edge of the abutment 15 upon the left-hand side of the drawing in Fig. 2, the abutment 15 being of course forced inward against the spring 16 by the position of the piston. The throttle 27 is thereupon opened by the raising of the lever 36. The first action consequent upon the raising of the lever 36 will be the raising of the link 55, which by the bearing of the dog 55^a upon the lower side of the lever 52 will operate to raise the said lever 52 and open the valve 50, the valve 64 being in the position shown in the drawings in Fig. 2. Steam is thus admitted through the pipe 47 and the tube 60 into the pipe 62, which, passing through the pipe 62 into the opening of the said pipe into the pipe 32, will pass into the pipe 31, from thence through the valve 42 into the pipe 38 and through the chamber formed by the web of the abutment 15 and the abutment-chamber 13 into the cylinder immediately behind the bearing-block 20 of the piston, and the piston will begin to rotate in the direction indicated by the arrow. Throughout this entire operation as now being described the valves 41 42 43 44 will be in the position shown in Fig. 2. As the link 55 is raised, bringing with it the lever 52, by the bearing of the dog 54 upon the forward edge of the lever 52 the lower end of the link 55 will be thrown backward in the slot in which it rests, because of the arm 36 being somewhat longer

than the corresponding arm of the lever 52, and therefore moving in a larger radius. As this motion continues a slight distance upward, the latch 55ª will be thus released from its bearing upon the under side of the lever 52, and by the operation of the spring 51 the valve 50 will be instantly closed, the link 55 being held in position to reënter the slot in the lever 52 by the turned end 58 of the rod 57 and the spring 59. In the meanwhile the throttle 27 is open and the steam enters the pipes 28 29. The steam which enters the pipe 29 will flow around through the pipes, but be checked by the valve 35, which is so connected with the cam 73, as is best shown in Fig. 1, that the said valve 35 is closed at this time, as shown in Fig. 2. The live steam passing through the pipe 28 passes through the valve 34, which is at that time opened by the operation of the cam 73, as is best shown in Fig. 1, and passes into the pipes 30 and 31. It is prevented by the closed valve 41 from passing out through the exhaust 89, and the live steam thereby passes through the pipe 31, through the valve 42, into the pipe 38, and thence below the web of the abutment 15 into the cylinder behind the piston, moving the piston in the direction indicated by the arrow. The live steam continues to flow through the pipes until the bearing-block 20 reaches about the position shown in solid lines in Fig. 1. At this moment the roller 74 comes to the radial portion 73ᶜ of the cam 73, when by the operation of the spring 76 the lever 69 is thrown sharply to the left, closing the valve 34, and the steam which is behind the bearing-block 20 continues to act expansively until the block 20 has passed just beyond the bearing edge of the abutment 15 upon the right-hand side in Fig. 2, the abutment 15, of course, being forced inward by the rotation of the piston against the spring 17 and the abutment 15 upon the left-hand side of the drawing in Fig. 2 being forced outward by the operation of the spring 17, so that said abutments continue to bear steam-tight against the surface of the revolving piston. As was said above, a portion of the steam entering the pipes always enters through the openings 45 46 behind the abutments 15, so as to balance the pressure of the steam which passes in front of the abutments and into the cylinder. As soon as the bearing-block 20 passes the bearing edge of the abutment 15 upon the right-hand side of Fig. 2, the roller 75 reaches the portion 73ᵇ of the cam 73 and the rod 70 is forced inward against the spring 76 and the valve 35 is opened. The steam then shut off from the piston upon the left-hand side by the closed valve 34 passes through the pipe 29 and through the open valve 35 into the pipes 32 33. It is shut off by the closed valve 44 from escaping through the exhaust 92, and therefore passes upward through the pipe 32, through the valve 43 into the pipe 39 above the web of the abutment 15 upon the right-hand side in Fig. 2 and behind the bearing-block 20, continuing the rotation of the piston. When the piston has reached the point indicated in dotted lines on Fig. 2, the roller 75 reaches the radial portion 73ᶜ of the cam 73, at which time, by the operation of the spring 76, the rod 70 is thrown sharply backward, so as to instantly close the valve 35, and the steam which has previously been admitted acts expansively until the piston in its rotation brings the bearing-block 20 just past the abutment 15 upon the left-hand side of the figure, at which time the operation above described is repeated. The steam ahead of the piston in its rotation is driven out either below the web of the abutment 15 upon the right-hand side of the figure, through the pipe 40 and out at the exhaust 92, or above the web of the abutment upon the left-hand side of the figure, through the pipe 37 and out at the exhaust 89. It is obvious, of course, that the cam may be so arranged as to vary the position of the cut-off and to vary the extent of the stroke of the rotation of the piston or of that portion of the rotation of the piston in which the steam will be used expansively, according to the circumstances of the case; but for ordinary use I prefer to use the live steam for about two-thirds and the expansive portion of the steam for about one-third of the rotation, as indicated in the drawings. When the engine is stopped, it will be obvious that in case it stops with the bearing-block 20 at any point between the position indicated by solid lines in Fig. 2 and the abutment at the right-hand side in Fig. 2 or at any point beyond the position indicated by dotted lines in Fig. 2 and the abutment upon the left-hand side of said figure, inasmuch as the valves 34 35 are both closed, as will be seen from the above description, when the piston is in such position, the piston would not be started by the mere opening of the throttle-valve, and it is for this purpose that the auxiliary valve 50 and its connections have been devised. As stated above, upon the raising of the throttle-lever 36 the valve 50 is temporarily opened, admitting live steam through the valve either to the pipe 62 or 63, according to the position of the valve 64, which is controlled by the hand-lever 66, and will always be either in the position indicated by solid lines in Fig. 2 or in the position indicated by dotted lines in the same figure. In case the engine stops at a point beyond the position indicated in dotted lines and before reaching the abutment upon the right-hand side of said figure, the valve 64 is in the position shown in solid lines in Fig. 2 and the steam passing through the pipe 62 into the pipes 30, 31, and 38 will come behind the piston and will operate to rotate the piston until it passes beyond the abutment upon the right-hand side of the figure, at which time the valve 35 will be opened by the cam and the piston continuously rotated by the operation of the valves, as above de-

scribed. In case it should be found that the piston stops beyond the position indicated in dotted lines in Fig. 2, the valve 64 will be turned in the position shown in dotted lines, and when the valve 50 is temporarily opened the steam will pass through the pipe 62 into the pipe 32, through the valve 43, pipe 39, above the plate of the abutment upon the right-hand side of Fig. 2, and behind the piston, rotating it until it just passes the abutment upon the left-hand side, at which time, as stated above, the valve 34 is operated by the action of the cam and the rotation continued as long as the throttle is open. The action of the valve 50 opening and closing almost immediately is thus only temporary and for the purpose of avoiding dead-centers and to start the machine in case it should stop upon either of the positions above indicated. In case it stops with the piston in any other position, steam will of course be temporarily admitted by the opening of the valve 50 by either the valve 34 or 35, and the steam coming through the throttle would of itself be sufficient to start the piston. It will of course be obvious that the mechanism of the auxiliary valve and its connections with the throttle will be such as to admit the proper amount of steam and may be varied in accordance with the demands of the particular case, so as to open the valve for a greater or lesser time, according to the circumstances. In case it is desired to reverse the engine, the reversing-lever 83 is thrown to the left, moving the bars 81 82, and of course reversing the positions of the valves 41 42 43 44 from the positions shown in Fig. 2 In other words, the valve 41 will close the exhaust-pipe 89 and open into the chamber 37. The valve 42 will then open into the exhaust-pipe 90 and close the passage from tube 31. The valve 43 will open into the connection between the tube 32 and the exhaust-pipe 91 and the valve 44 will close the exhaust-pipe 92 and open the connection between the tube 33 and the tube 40, and the operations above described will be carried on in the same manner as above described, but in a reverse direction, which will be clearly understood from the above description and without describing the reversed operation of the parts.

That which I claim as my invention, and desire to secure by Letters Patent, is—

1. In a rotary engine, the combination with a cylinder, a piston rotatably mounted therein, and an abutment-box opening into said cylinder, of an abutment slidingly mounted in said abutment-box and moving steam-tight therein, and composed of a back plate, two side plates, and a central web connecting said side plates midway of their diameter forming an abutment T-shaped in cross-section, substantially as described.

2. In a rotary engine, the combination with a cylinder, a piston rotatably mounted therein, and an abutment-box opening into said cylinder, of an abutment slidingly mounted in said abutment-box and moving steam-tight therein, and composed of a back plate, two side plates, and a central web connecting said side plates midway of their diameter, said abutment being open to the passage of steam throughout its length, above and below said central web, the front edge of said web being flush with the front ends of said side plates and adapted to bear automatically against said piston as it rotates, substantially as described.

3. In a rotary engine, the combination with a cylinder, a piston rotatably mounted therein, and an abutment-box opening into said cylinder, of an abutment slidingly mounted in said abutment-box and moving steam-tight therein, and composed of a back plate, two side plates, and a central web connecting said side plates midway of their diameter, forming on each side of the central web a four-sided chamber open at the top and one end, the front edge of said web being flush with the front ends of said side plates and adapted to bear automatically against said piston as it rotates, steam-pipes opening into said abutment-box above and below said central web, and valves for controlling the passage of the steam through said pipes as said piston rotates, substantially as described.

4. In a rotary engine, the combination with a cylinder, a piston rotatably mounted therein, an abutment-box opening into said cylinder, steam-pipes opening into said abutment-box, a valve for controlling the passage of steam through said pipes as said piston rotates, and cut-off mechanism, of an abutment mounted in said abutment-box and having passages constantly open to the passage of steam between said pipes and said cylinder, substantially as described.

5. In a rotary engine, an abutment composed of two parts, 15^a and 15^b, the part 15^a consisting of a side plate 93, a web 95 extending outward from said side plate, and a back plate 94, and provided with a slot between said web and said back plate, the part 15^b consisting of a side plate 96, two parallel webs 98 99 extending outward from said side plate and adapted to slidingly receive the web 95 between them, and a back plate adapted to enter the slot between the web 95 and the back plate 94, the whole being adjustably secured together, substantially as described.

6. In a rotary engine, an abutment composed of two parts, 15^a and 15^b, the part 15^a consisting of a side plate 93, a web 95 extending outward from said side plate, and a back plate 94, and provided with a slot between said web and said back plate, the part 15^b consisting of a side plate 96, webs 98 99 extending outward from said side plate and adapted to slidingly receive the web 95 between them, and a back plate adapted to enter the slot between the web 95 and the back plate 94, the whole being adjustably secured together, and having a groove adapted

to receive packing between said back plates, substantially as described.

7. In a rotary engine, the combination with a cylinder having heads secured thereto so as to form a circumferential depressed groove at each end of said cylinder, of a piston rotatably mounted in said cylinder and having its ends flush with the ends of said cylinder, circular plates secured to said piston concentric with said cylinder, and forming on each side of said piston a flange adapted to rotate in said groove and bear steam-tight against the ends of said cylinder, and a packing interposed between the periphery of said plates and the internal periphery of said circumferential grooves, substantially as described.

8. In a rotary engine, the combination with a cylinder, a piston rotatably mounted in said cylinder, an abutment-box opening from said cylinder, and a sliding abutment moving steam-tight in said abutment-box and adapted to bear continuously against said piston as the same rotates, of steam-pipes leading into said abutment-box above and below the said abutment, a valve controlling said steam-pipes, mechanism connected with said rotary piston and said valve and adapted to automatically open said valve as soon as the bearing-surface of said piston has passed the abutment and to close the said valve before a rotation of the piston is completed, a throttle-valve controlling said steam-pipes, an auxiliary pipe for live steam opening into said steam-pipes, an auxiliary valve controlling said auxiliary pipe, and mechanism connecting said throttle-valve and said auxiliary valve and adapted to temporarily open said auxiliary valve when the throttle-valve is opened, substantially as described.

9. In a rotary engine, the combination with a cylinder provided with two abutment-boxes opening into said cylinder opposite each other, a piston rotatably mounted in said cylinder, and a spring-seated abutment slidingly mounted in each of said abutment-boxes, moving steam-tight therein, and composed of a back plate, two side plates, and a central web connecting said side plates and bearing at its front edge against said piston as it rotates, of steam-pipes leading into said abutment-boxes above and below said abutments, valves controlling said steam-pipes, mechanism connected with said rotary piston and said steam-pipes and adapted to automatically open said valves alternately as soon as the bearing-surface of said piston has passed said abutments and to close the same before a half-rotation of the piston is completed, a throttle-valve controlling said steam-pipes, auxiliary live-steam pipes opening into said first-named steam-pipes, an auxiliary valve controlling said auxiliary pipes, and mechanism connecting said throttle-valve and said auxiliary valve and adapted to temporarily open said auxiliary valve when the throttle-valve is opened, substantially as described.

10. In a rotary engine, the combination with a cylinder provided with two abutment-boxes opening into said cylinder opposite each other, a piston rotatably mounted in said cylinder, and a spring-seated abutment slidingly mounted in each of said abutment-boxes, moving steam-tight therein, and composed of a back plate, two side plates, and a central web connecting said side plates and bearing at its front edge against said piston as it rotates, of steam-pipes leading into said abutment-boxes above and below said abutments, valves controlling said steam-pipes, mechanism connected with said rotary piston and said steam-pipes and adapted to automatically open said valves alternately as soon as the bearing-surface of said piston has passed said abutments and to close the same before a half-rotation of the piston is completed, a throttle-valve controlling said steam-pipes, auxiliary live-steam pipes opening into said first-named steam-pipes, an auxiliary valve controlling said auxiliary pipes, mechanism connecting said throttle-valve and said auxiliary valve and adapted to temporarily open said auxiliary valve when the throttle-valve is opened, and a valve adapted to open the passage from said auxiliary valve to either of said abutment-boxes, substantially as described.

JOHN S. HARGER.

Witnesses:
C. E. PICKARD,
HELEN M. COLLIN.