No. 616,662. Patented Dec. 27, 1898.

J. GOEHRING.

ROTARY ENGINE.

(Application filed Mar. 25, 1897.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

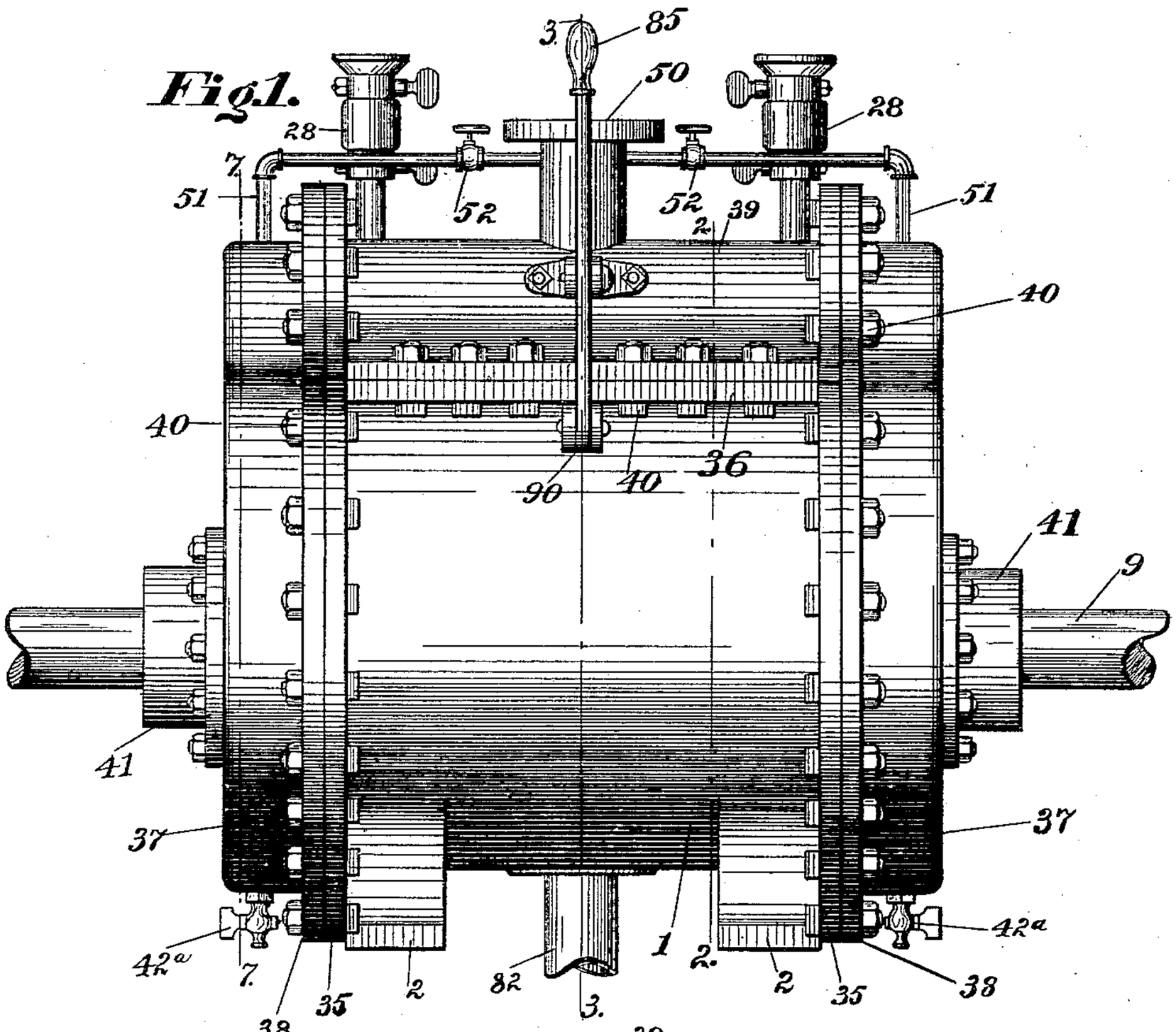

Fig. 2.

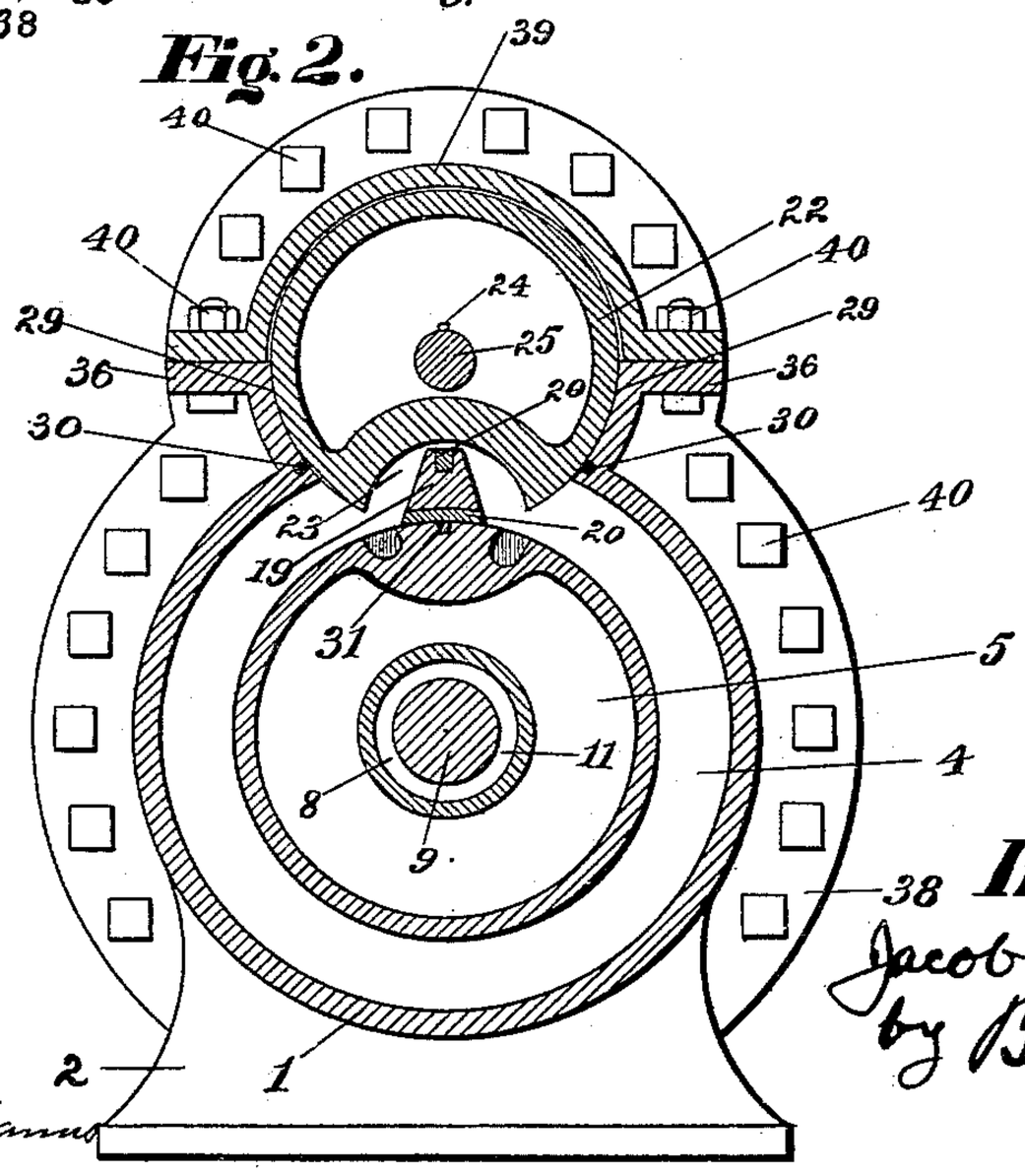

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Fig. 3.

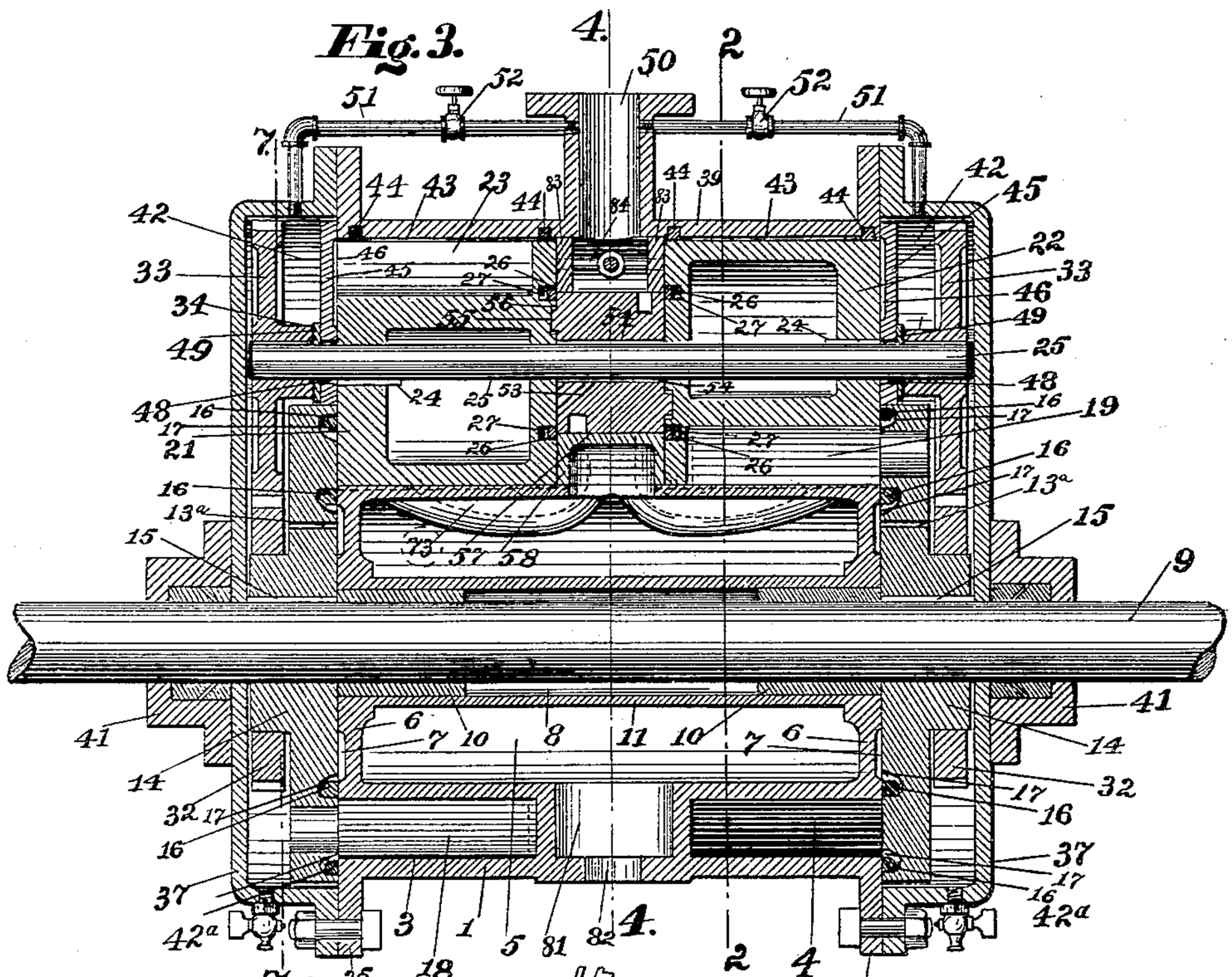


Fig. 4.

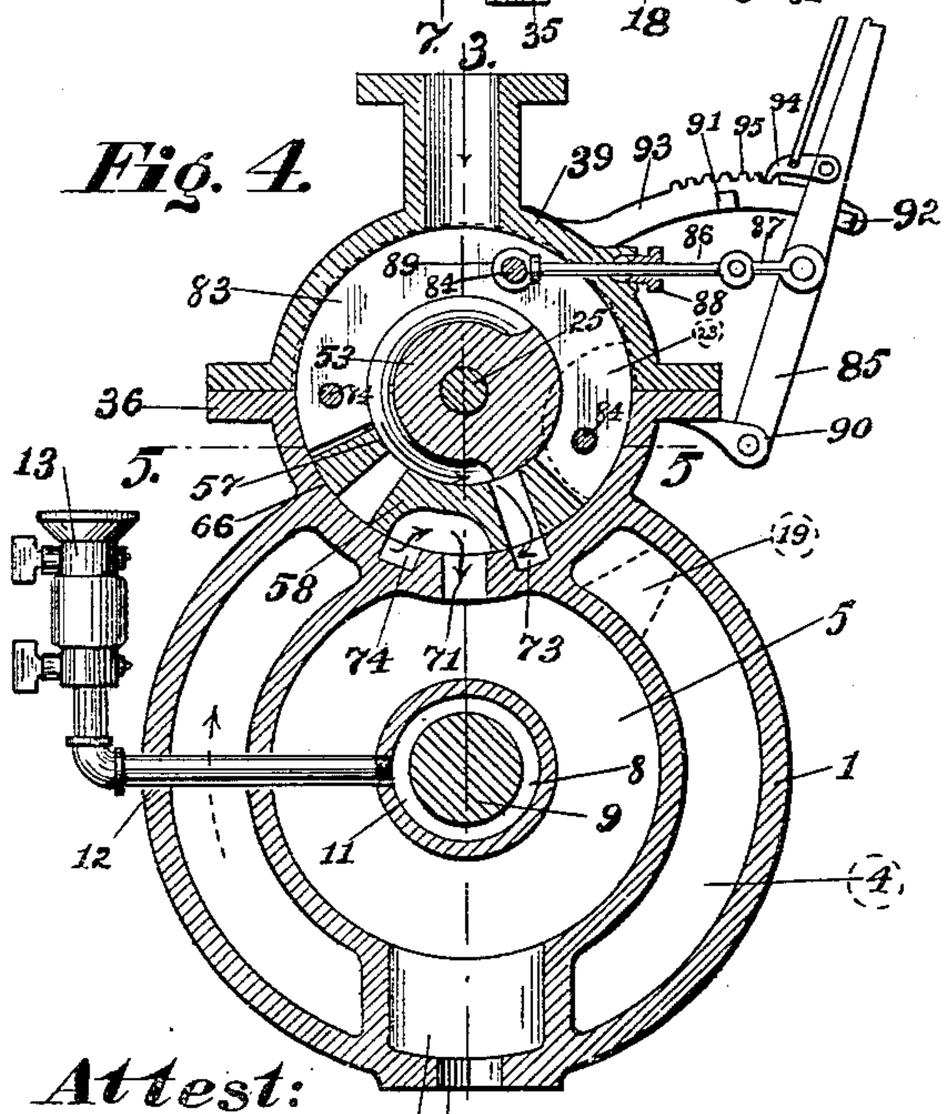


Fig. 5.

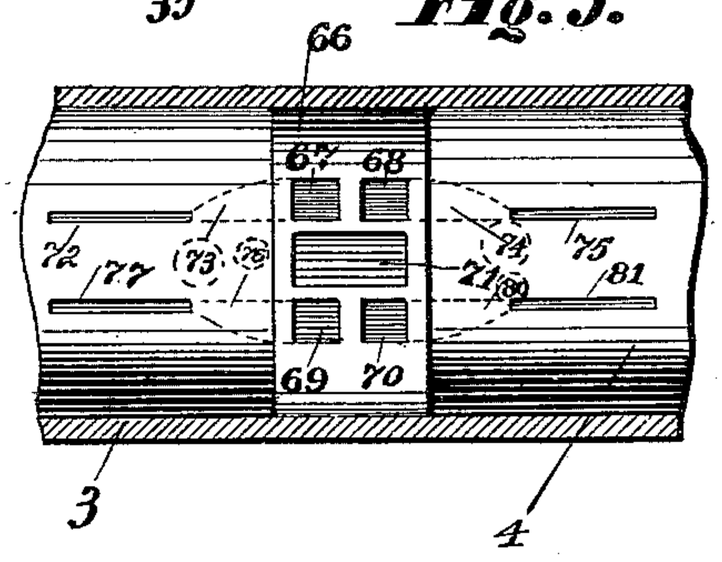
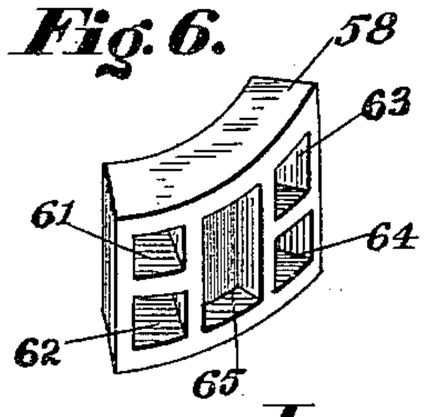


Fig. 6.



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(No Model.) 3 Sheets—Sheet 3.

Fig. 10

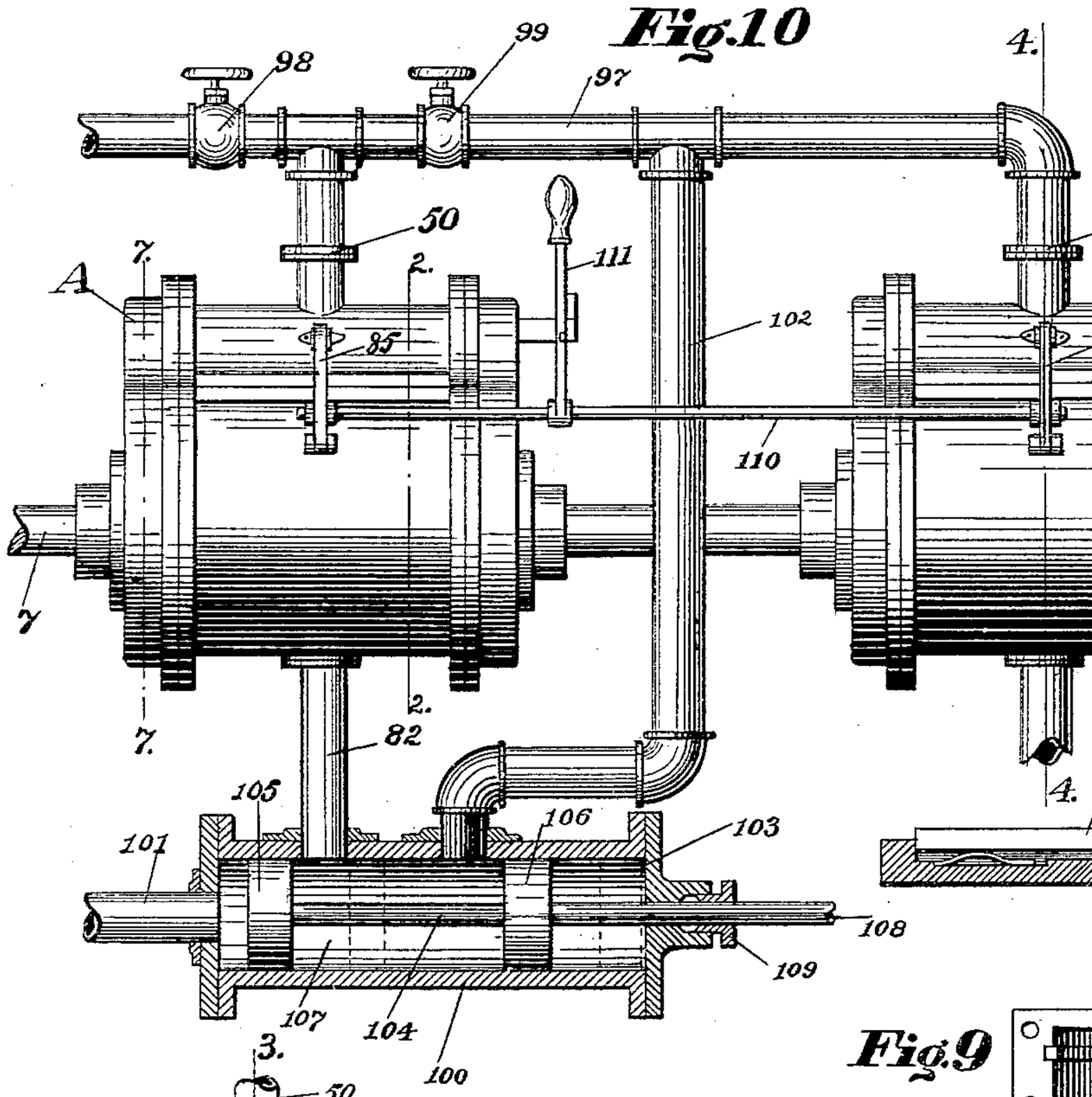

Fig. 8.

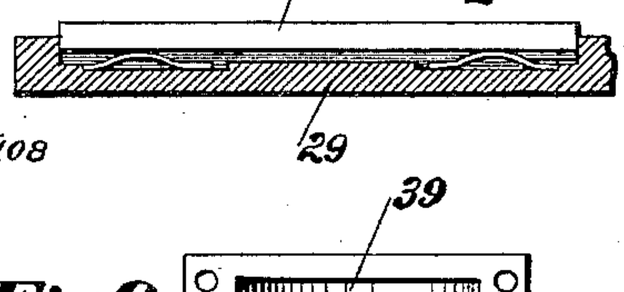

Fig. 9

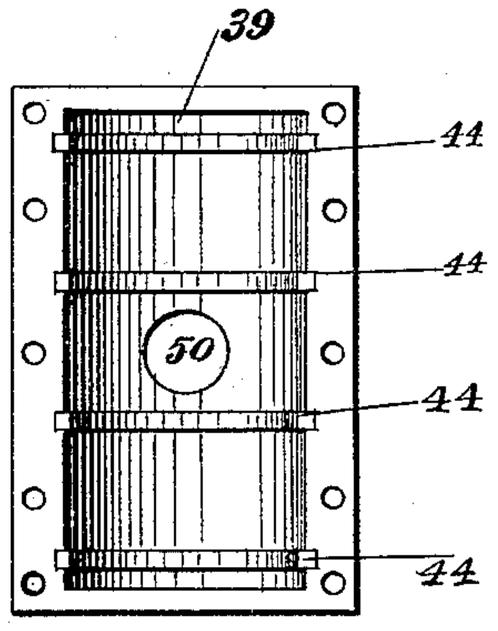

Fig. 7.

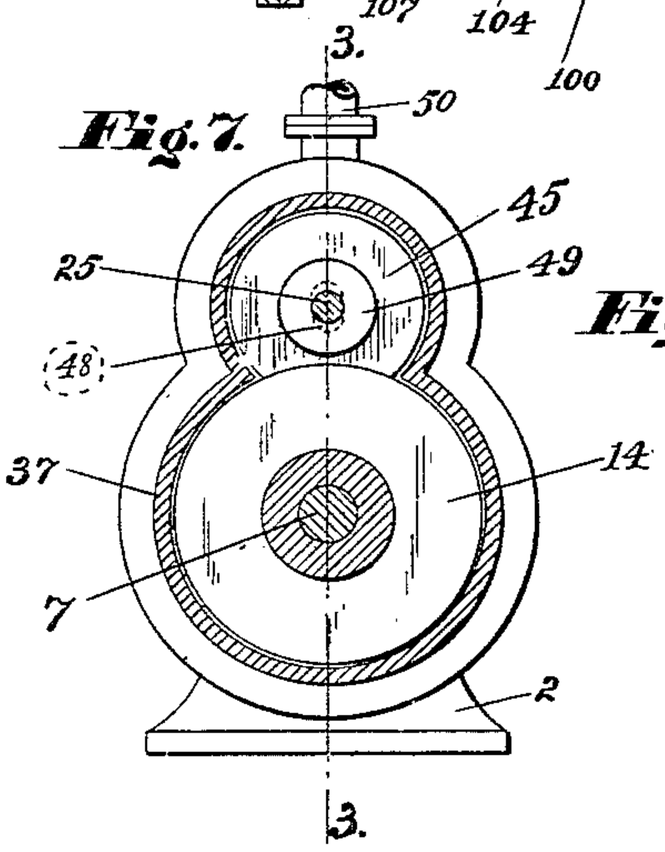

Fig. 11.

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UNITED STATES PATENT OFFICE.

JACOB GOEHRING, OF NEAR BARNSTON, NEBRASKA, ASSIGNOR OF ONE-HALF TO THOMAS WARD McMANUS, OF ST. LOUIS, MISSOURI.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 616,662, dated December 27, 1898.

Application filed March 25, 1897. Serial No. 629,171. (No model.)

To all whom it may concern:

Be it known that I, JACOB GOEHRING, a citizen of the United States, residing near Barnston, in the county of Gage and State of Nebraska, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention relates to improvements in rotary engines of the piston type; and the objects of my improvements are, first, to provide an improved valve and valve-seat; second, to enable steam to be used expansively; third, to avoid leakage of steam; fourth, to diminish friction; fifth, to enable the mechanism to be readily taken apart and repaired when necessary; sixth, to improve details of construction; seventh, to couple two or more of my rotary engines together, so as to form a compound engine, and, eighth, to provide means for enabling engines so coupled to be either used together as a compound engine or separately as simple engines. I attain these objects by mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of a rotary engine embodying my improvements, excepting those connected with compounding. Fig. 2 is a vertical transverse section on line 2 2, Figs. 1, 3, and 10, with external details omitted. Fig. 3 is a vertical longitudinal section on line 3 3, Figs. 4, 7, and 11. Fig. 4 is a vertical transverse section on line 4 4, Figs. 1, 3, and 10, but with the parts in a different position from those in which they are shown in Fig. 3. Fig. 5 is an enlarged detailed view of the valve-seat, ports, and connections on line 5 5, Fig. 4. Fig. 6 is a detailed view of the sliding valve-seat which I prefer to use. Fig. 7 is a vertical transverse section, on a reduced scale, on line 7 7, Figs. 1, 3, and 10. Fig. 8 is a detailed view, on an enlarged scale, of one of the spring packing-bars, upon which the abutments are preferably seated. Fig. 9 is a detailed inverted plan view of the casing over the abutments, showing the preferred arrangement of packing-bars for holding the abutments down. Fig. 10 is a sectional side elevation, in part on a reduced and in part on an enlarged scale, of a pair of my rotary engines, with external details omitted, and means for coupling them together, so as to adapt them for either simple or compound working; and Fig. 11 is an end elevation of a detail of the apparatus illustrated by Fig. 10.

Similar numerals and letters refer to similar parts throughout the several views.

I will first describe my engine in its simpler form and then show how two or more of them may be coupled together, so as to enable them to be either used separately or as a compound engine.

The body 1 of my engine, Figs. 1, 2, 3, 4, 7, 10, and 11, is preferably substantially cylindrical in shape, except at the top, and is preferably supported upon legs 2. It has formed therein two concentric cylinders 3 and 4, which are shown rectangular in cross-section; but that form is not essential. Its interior 5 is preferably hollow. Its closed ends 6 each preferably contain a concentric groove 7 upon the outside thereof. Through the body 1 a passage 8, having closed sides, for a main shaft 9 extends, and in this passage bushings 10 are preferably secured to form bearings for said shaft to revolve in, Figs. 2, 3, and 4. Between the bushings there is preferably an oil-chamber 11, connected by a tube 12 with an oil-cup 13, Figs. 2 and 4.

To the shaft 9 two piston-flanges 14, preferably circular in form, are secured, each preferably by means of a feather-key 15, allowing them longitudinal play. They seat against opposite ends 6 of the body of the engine and the outer ends of rotary steam-abutments hereinafter described, and preferably each provided with two concentric packing-rings 16, preferably each having a steam-recess 17 back of it and adapted to prevent the escape of steam from the cylinders 3 and 4, Figs. 3 and 7. Each piston-flange is preferably pierced by an opening 13^a to admit steam into the groove behind N. From the inner side of one of said flanges 14 a piston-head 18 projects into the cylinder 3, and from the inner side of the other flange a similar piston-head 19 projects into the cylinder 4. Both pistons are rigidly attached to their respective flanges, and though shown as not made integral with said flanges it will be evident that it is not essential that they should be made of separate pieces.

The piston-heads should substantially fit

their respective cylinders and are preferably, but not essentially, substantially in the shape of a truncated cone in cross-section. They are each preferably provided at top and bottom and at their respective inner ends with a suitable packing 20.

The piston-heads 18 and 19 are preferably arranged so as to always occupy opposite positions in their respective cylinders, as shown in Fig. 3, in which figure the piston-head 18 is in its lowest and the piston-head 19 in its highest position.

In connection with the cylinder 3 a cylindrical rotary steam-abutment 21 is preferably used, and a similar abutment 22 is preferably used in connection with the cylinder 4. Each abutment contains a lateral recess 23, Figs. 2 and 3, open at its outer end and adapted to receive one of said pistons. Both abutments are preferably secured by a feather 24 to a shaft 25, so as to allow them longitudinal play thereon, and are so arranged as to cause their respective recesses 23 to be on opposite sides, as shown most clearly in Fig. 3. At their respective inner ends they are each preferably provided with an annular packing-ring 26, preferably resting upon springs 27 in the usual manner. As will be obvious, however, a single ring arranged so as to enable the inner ends of the abutments to approach each other when they expand would be useful, though I prefer to use two rings, one in each abutment, substantially as shown. Said cylindrical abutments rotate in bearings 29, Fig. 2, formed in the top of the body of the engine and which are preferably provided with horizontal spring packing-bars 30 on opposite sides thereof, so as to furnish the abutments with elastic bearings. A similar packing-bar 31 is preferably, but not necessarily, inserted in the inner side of each cylinder along the line where its steam-abutment comes in contact with the inner surface of the cylinder when caused to rotate. Motion is preferably communicated to said abutments from the main shaft 9 by means of gears 32, one preferably attached to each of said piston-flanges, as shown in Fig. 3, and gears 33, attached to said shaft 25 and which mesh into said gears 32. The gears 33 are each preferably provided with an inwardly-projecting hub 34.

The body 1 of the engine is preferably provided with end flanges 35 and top flanges 36. To the former end casings 37, having flanges 38, are preferably bolted, and to the top flanges 36 of the body and the flanges 35 of the end casing a flanged top casing 39 is preferably bolted, all by means of bolts 40. A steam-tight casing is thus formed over the rotary abutments and around the piston-flanges and gear-wheels above mentioned. The end casings 37 are each preferably pierced with an opening for the outward passage of the driving-shaft 9, and to their outer sides I preferably secure glands 41, through which said shaft 9 passes and which prevent the escape of steam around the shaft. The end casings 37 are designed in part to prevent dirt from reaching the gears, piston-flanges, &c., and the escape of oil; but another important function is to form a steam-tight chamber 42 around said parts, so as to enable steam to be admitted back of said piston-flanges and force them against their respective seats. Said flanges project beyond the cylinders and are relied upon to close their outer ends. Hence it is important to hold them tightly against their seats when the engine is in motion. At the same time it is undesirable to force them against their seats hard enough to unduly increase the friction, and hence I partially balance said flanges by admitting steam into the grooves 7, as well as by the steam admitted to the cylinders 3 and 4. Said chambers 42 are each preferably provided with a drainage-cock 42^a, through which water may be drawn off.

Between the top casing 39 and each of the cylindrical abutments 21 and 22 I preferably provide a steam-chamber 43, and in order to prevent said abutments from being forced up into said space by steam-pressure from below when the engine is started I insert in the inside of said top casing two packing-rings 44 above each abutment, as shown most clearly in Figs. 3 and 8. I prefer to use spring packing-bars, arranged as shown in Fig. 9, having springs strong enough to force the abutments down far enough to prevent steam from passing beneath them. The object of the spaces 43 is to enable steam to be admitted back of the abutments to balance the upward pressure of steam in the cylinders and also avoid friction. Said spaces are preferably supplied with steam by the recesses 23, which carry steam into them when said abutments are rotated; but I do not confine myself to said means of supplying said space with steam. Each space is preferably supplied with oil by a cup 28, Fig. 1. The outward passage of steam through or from the recesses 23 into the chambers 42 within the end casings is prevented in part by the piston-flanges 14 and their packing-rings and in part by plates 45, one at the outer end of each rotary abutment. The plates 45 preferably contain recesses 46 on their respective inner sides to enable steam to enter there from the adjoining recess 23 and partially balance the pressure on their backs. Each of said plates contains one opening 48, through which the shaft 25 extends. Said openings are preferably larger than said shaft in vertical diameter, so as to allow the shaft vertical play, and they are preferably each closed on the outside by a washer 49, fitting the shaft tightly. The shaft is preferably provided with no bearings, and the wear of the gear-wheels will enable the abutments to always descend far enough to prevent steam passing beneath them. The inner ends of the hubs 34 of the gears 33 limit the outward movement of the washers 49 and the parts between them.

Steam is admitted to the engine through a steam-pipe 50, which is connected by means of branch pipes 51 with the chambers 42. Each branch pipe is preferably provided with a valve 52, by means of which the steam-passage through it can be opened and closed. Beneath the steam-pipe 50 and between the rotary abutments 21 and 22 I preferably arrange a rotary cylindrical valve 53. (Shown most clearly in Figs. 3 and 4.) The shaft 25 passes through an opening 54 in said valve, but preferably does not support it, said opening being preferably, but not necessarily, larger than the shaft. The valve is preferably provided with lugs 55, projecting out from its ends and entering recesses 56 in the inner ends of said abutments. Said recesses are preferably somewhat deeper than the lugs, so as to give the valve a slight vertical play; but this is not essential and other obvious means for causing the valve to rotate with the abutments may be used. The main bearing of the valve is preferably in the curved top 57 of the sliding valve-seat 58, Figs. 3, 4, and 6. The valve 53 preferably contains two opposite admission slots or ports 59 and 60, which, as shown, are horseshoe-shaped. Their relative positions and shapes are shown most clearly in Fig. 4 in full and dotted lines. The proportion of the time during each stroke of each piston that steam is admitted depends upon the respective lengths of said slots or ports 48 and 49, other things being equal, and their lengths may be varied as desired. The sliding valve-seat 58 is preferably provided with four steam-ports 61, 62, 63, and 64 and an exhaust-port 65. It slides upon a curved stationary seat 66, Figs. 3, 4, and 5, provided with ports 67 68 69 70 and exhaust-port 71. The port 67 is connected with a port 72, opening into the cylinder 3 by a steam-passage 73. (Shown in dotted lines in Figs. 3 and 5 and in full lines in Figs. 2 and 4.) The port 68 is in like manner connected by a passage 74 with a port 75, opening into the cylinder 4, as shown in the same figures. So, also, the port 69 is connected by a passage 76 with a port 77, opening into the cylinder 3, and the port 70 is connected by a passage 80 with a port 81, opening into the cylinder 4. The port 71 is an exhaust-port and communicates directly with the interior 3 of the body 1 of the engine, from which exhaust-steam passes out through the exhaust-passage 81 and pipe 82, Figs. 1, 3, 4, and 8. Upon the ends of the sliding valve-seat 58 the ends of a pair of horseshoe-shaped plates 83, Figs. 3 and 4, preferably rest. Said plates are preferably connected together and held apart by cross-bars 84 and are preferably operated by means of a lever 85, with which they are preferably connected by a rod 86 and link 87. The rod 86 preferably passes through a gland 88 and preferably has at its inner end an eye 89, through which one of said cross-bars 84 preferably passes. The outer end of said rod 86 is preferably pivotally connected with one end of said links 87, whose outer end is connected with said lever. The lever 85 is preferably a hand-lever and is preferably pivotally attached at its lower end 90 to the body of the engine. It preferably plays between stops 91 and 92 of a quadrant 93, attached to the engine, and is preferably provided with a spring-dog 94, adapted to enter notches 95 in the quadrant, and which dog is preferably operated by a bell-crank lever 96, attached to said main lever 85.

The packing-rings 26 in the inner ends of the steam-abutments hold the valve 53, valve-seat 58, and plates 83 in their proper positions, and by yielding when the abutments and intermediate parts expand prevent difficulties which otherwise would be experienced. They also diminish friction.

Thus far I have described my rotary engine as a simple engine adapted to operate singly. Two or more of my simple engines may be coupled together, so as to operate either separately or as a compound engine, as may be desired. I have shown one method of doing this in Figs. 10 and 11. In the former figure I show two of my rotary engines, which I will distinguish as A and B, coupled together to form a compound engine and having a common main shaft 7, though it is not essential that they should both operate the same shaft. The engines A and B are preferably exactly alike, except in size, the cylinder of one being longer in diameter than that of the other, as is usual in compound engines, and in all respects similar to the preferred form of my engine, hereinbefore described, though to secure clearness some external details are omitted from said figures. The steam-pipes 50 are preferably both connected with a main steam-pipe 97, leading from the source of steam-supply, (not shown,) and in the latter pipe I preferably locate valves 98 and 99 on opposite sides of the point where the pipe 97 connects with the pipe 50 of engine A. The exhaust-steam pipe 82 of the engine A discharges into a steam-chest 100, which has a direct outlet 101, but is directly connected with the steam-pipe 97 by a pipe 102, which leads from a point between the inner end 103 of the steam-chest and the exhaust-pipe 82, discharging into said chest. The steam-chest is preferably cylindrical, as shown, and its inner end 103 is preferably closed. Within the chest a reciprocating piston-valve 104 is preferably arranged, consisting of two piston-heads 105 and 106, preferably having a space 107 between them as long as the space between the outer sides of the pipes 82 and 102 at the points where they respectively open into said steam-chest, substantially as shown in Fig. 10, and the distance between the pipe 102 and the end 103 of the valve-chest should be sufficient to enable the valve to be moved into the position in which it is shown in dotted lines in said figure. The piston-heads 105 and 106 are preferably connected by means of a piston-

rod 108, which passes out through a gland 109, attached to the end 103 of said steam-chest.

When the valve 104 is in the position shown in full lines in Fig. 10, exhaust-steam from the engine A is free to pass through the exhaust-pipe 82, the steam-chest 100, and steam-pipes 102 and 97 to the engine B. When the valve 104 is placed in the position in which it is shown in dotted lines, the exhaust-steam from the engine A passes through the steam-chest and outlet 101 to the outer air. The exhaust-pipe 82 of the engine B may either discharge into the open air or be connected with a third engine, and so on indefinitely until the pressure of the steam is no longer great enough to be of use. When both engines are to be operated by steam at the same pressure, the valve 100 is placed in the position in which it is shown in dotted lines in Fig. 10 and the valves 98 and 99 are both opened. When the engine B is to be operated by means of exhaust-steam from engine A, the valve 98 only is opened and the valve 99 is closed. The levers 85 of the engines A and B, Fig. 8, differ from those shown in the preceding figures only in not having handles directly attached to each of them and in the preferable absence therefrom of the spring-dog and bell-crank lever preferably used with each when the engines are operated separately. Said levers 85 of the engines A and B are, however, connected together rigidly by means of a connecting-rod 110, having rigidly attached thereto a hand-lever 111, which preferably plays between stops 91 and 92, attached to a quadrant 93 and is, like the hand-lever of the simple form of my engine, preferably provided with a spring-dog 94, adapted to enter notches 95 in the quadrant and which is operated by a bell-crank lever 96, pivotally attached to the lever 85. In this way the sliding valve-seats 58 of both engines may be adjusted simultaneously by one movement of said lever 85 and both engines reversed at will.

My improved engine operates as follows: Supposing the intention be to cause the driving-shaft to rotate from left to right, the sliding valve-seat is adjusted in the position in which it is represented in Fig. 4. When it is in that position, its steam-ports 61 and 62 are closed by the main valve-seat, its port 63 is connected with the cylinder 4 by the port 69 in the stationary seat, the passage 76, and the port 77, and the port 64 of the sliding valve-seat is connected with the cylinder 4 by the port 70, the steam-passage 80, and the port 81. Exhaust-port 71 in the main valve-seat is connected with the cylinder 3 by said exhaust-port 65, the port 67, the passage 73, and the port 72, while the exhaust-port 71 is connected with the cylinder 4 by the exhaust-port 65, steam-port 68, passage 74, and port 75. The valve-seat being thus arranged, the valve 98 is next opened partially and the valves 52 fully to enable steam to enter the chambers 42 and press the piston-flanges and the plates 45 firmly into position. The valve 98 is then opened more widely, and as one of the ports 61 and 62 of the valve 53 is always in position to supply steam to one of the cylinders and the abutment of that cylinder is always in position to operate as such when the valve is in position to supply its cylinder with steam the engine at once starts. In the position in which the valve 53 is represented in Fig. 4 steam is admitted freely to cylinder 3, while cylinder 4 is just beginning to receive it, and before cylinder 5 ceases to receive steam the piston in cylinder 4 will have completed its revolution and begun to receive it again. The exhaust-ports are always open, and as soon as a piston passes the exhaust-port of its cylinder the steam exhausts through the passages I have described. The means by which I enable my pistons to pass the abutments are shown in Figs. 2 and 4. As has been stated, the abutments each contain a recess 23, and at the time one of my pistons would otherwise strike an abutment the recess in the proper abutment is turned so as to receive the piston and continues turning with the piston in its recess until the piston has passed to the farther side, when it passes out of the recess and the recess passes on up beyond the edge of the bearing in which the abutment rotates. Its position immediately after entering the bearing is indicated in dotted lines in Fig. 4. Preferably steam is not admitted until the recess 23 is thus closed, as I prefer not to carry fresh steam to the rear side of the abutment in said recesses, though when that is done the loss is small. In order to reverse the engine at any time, all that is necessary is to disengage the lever 85 from the quadrant and throw it into a position opposite the one in which it is represented. This reverses the positions of the ports in the sliding seat with reference to the ports in the seat and admits steam on the sides of the abutments on which it is exhausted when the parts are in the positions shown and exhausts it from the opposite side. The sliding seat may also be used to throttle the steam and in that way cause the engine to run more slowly or stop entirely, as will be obvious.

I have shown one form of my engine; but I do not wish to be confined to the forms of the parts shown, and, as will be obvious, a number of the details may be entirely omitted without departing from the essence of my more important improvements.

I desire my claims to be construed broadly.

I claim—

1. The combination in a rotary engine of a pair of annular cylinders; an abutment extending into each cylinder; a stationary valve-seat having steam-ports 67, 68, 69 and 70 and an exhaust-port 71; a passage connecting the port 67 with the interior of one of the cylinders on one side of its abutment and a passage connecting the port 68 with the other cylinder on the corresponding side of its abut-

ment; a passage connecting the port 69 with the same cylinder with which the port 67 communicates but on the opposite side of its abutment and a passage connecting the port 70 with the same cylinder with which the port 68 connects but on the opposite side of that cylinder's abutment substantially as described.

2. The combination in a rotary engine of a pair of annular cylinders; an abutment for each cylinder; a stationary valve-seat having steam-ports 67, 68, 69 and 70 and an exhaust-port 71; a passage connecting the port 67 with the interior of one of the cylinders on one side of its abutment; a passage connecting the port 68 with the other cylinder on the corresponding side of its abutment; a passage connecting the port 69 with the same cylinder with which the port 67 communicates but on the opposite side of its abutment; a passage connecting the port 70 with the same cylinder with which the port 68 connects but on the opposite side of its abutment; a segmental seat sliding upon the seat first mentioned and having steam-ports 61, 62, 63 and 64 and on its under side an exhaust-port 65 and a rotary cylindrical valve seated upon said sliding seat and having two steam-ports substantially as described.

3. The combination in a rotary engine of a pair of annular cylinders; each having an opening for an abutment to project through; a pair of cylindrical recessed abutments arranged with their inner ends opposite each other and each projecting into one of said cylinders; a stationary valve-seat between said abutments; a sliding valve-seat upon said stationary seat; a valve arranged between said abutments and seated upon said sliding seat and means causing said valve to rotate with said abutments.

4. The combination in a rotary engine of a pair of annular cylinders; each having an opening for an abutment to project through; a pair of cylindrical, recessed abutments arranged with their inner ends opposite each other and each projecting into one of said cylinders, and both having play toward each other; means limiting the movement of said abutments away from each other; a valve-seat between said abutments; a rotary valve seated on said seat and means elastically resisting the movement of the inner ends of said abutments toward each other.

5. The combination in a rotary engine of a pair of annular cylinders; a pair of cylindrical, recessed abutments each projecting into one of said cylinders and each provided at its inner end with a packing-ring; a rotary valve arranged between said abutments; a shaft passing through said abutments and said valve; means forcing said valve to revolve with said abutments; a main valve-seat, a sliding seat thereon; between it and the valve; a pair of horseshoe-shaped plates arranged opposite each other extending around the valve adjusting the sliding seat; means bracing said plates apart; and means for transmitting motion to them and through them to said sliding seat.

6. The combination in a rotary engine of an annular cylinder having an opening for an abutment; an abutment-bearing divided by said opening, a recessed cylindrical rotary abutment, journaled in said bearing and supported solely thereby and projecting through said opening.

7. The combination in a rotary engine of an annular cylinder having an opening for an abutment; a bearing for an abutment divided by said opening; an abutment rotating on said bearing and supported solely thereby, a main shaft and means transmitting motion from said main shaft to said abutment.

8. The combination in a rotary engine of an annular cylinder having an opening for an abutment; a recessed cylindrical rotary abutment projecting through said opening; and a bearing divided by said opening having an elastic seat for said abutment and in which bearing said abutment is journaled and entirely supported.

9. The combination in a rotary engine of an annular cylinder having an opening for an abutment; a recessed cylindrical rotary abutment projecting through said opening; a bearing divided by said opening in which said abutment is journaled and entirely supported; a recess back of said abutment for steam and means above the abutment for holding it down on its seat.

10. The combination in a rotary engine of an annular cylinder having an opening for an abutment; a cylindrical recessed rotary abutment projecting through the opening; means rigidly limiting the outward longitudinal movement of the abutment and means elastically limiting the inward longitudinal movement of the abutment and permitting its inner end to extend farther inward when said abutment expands.

11. The combination in a rotary engine of a pair of annular cylinders; an opening in each cylinder for an abutment; a pair of recessed cylindrical rotary abutments arranged with their inner ends opposite each other and one abutment projecting into each cylinder; means rigidly limiting the movement of said abutments away from each other and means elastically limiting the movement of said abutments toward each other but permitting their ends to approach closer to each other when said abutments expand.

12. The combination in a rotary engine of a pair of annular cylinders, each having an opening for an abutment; a pair of bearings each divided by one of said openings, and each having an elastic seat for an abutment; a pair of recessed cylindrical abutments one journaled in each of said bearings; a shaft without bearings extending through said abutments, means forcing said abutments to rotate with said shaft but permitting them to move inward thereon; means limiting their longitudinal movement on said shaft; a main

driven shaft and intermeshing gears transmitting motion from the main shaft to the abutment-shaft.

13. The combination in a rotary engine of an annular cylinder having its outer side open; an opening in said cylinder for an abutment; a cylindrical abutment projecting through said opening; a chamber in which said abutment revolves; a piston in said cylinder, a piston-flange closing the outer side of said cylinder; a main shaft passing through said flange; means keying said flange to said shaft but permitting it longitudinal play thereon; a plate resting upon said flange and together with said flange extending over the outer end of said abutment and closing the opening around it; a closed chamber back of said flange and plate and means for admitting steam into said chamber for pressing said flange and plate against their respective seats.

14. The combination in a rotary engine, of a hollow body with closed ends; an annular cylinder in each end of said body; a piston projecting laterally into each cylinder; a pair of piston-flanges, one seated against each end of said body and each attached to one of said pistons; a passage through said body for a main shaft; a main shaft extending through said passage and rotated by said flanges; splints securing said flanges to said shaft but allowing them longitudinal play upon the shaft; a steam-chamber back of each flange; means for admitting steam to said chambers; and glands through which said shaft passes outfrom said chamber substantially as shown and described.

JACOB GOEHRING.

Witnesses:
BENJ. F. REX,
THOS. WARD MCMANUS.