D. E. COTA.

ROTARY ENGINE.

APPLICATION FILED AUG. 11, 1909.

979,262. Patented Dec. 20, 1910.

3 SHEETS—SHEET 1.

Fig. 2.

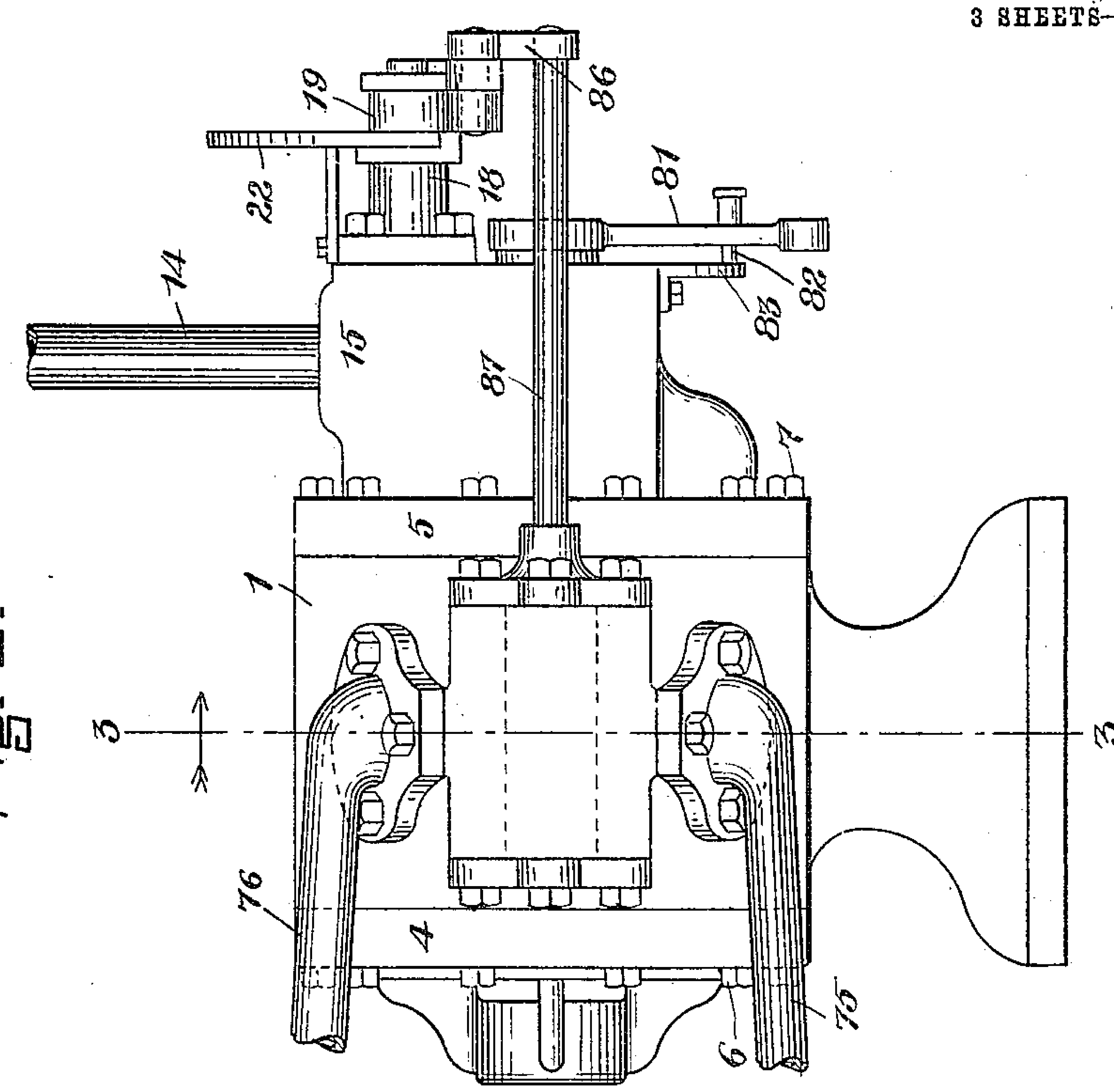
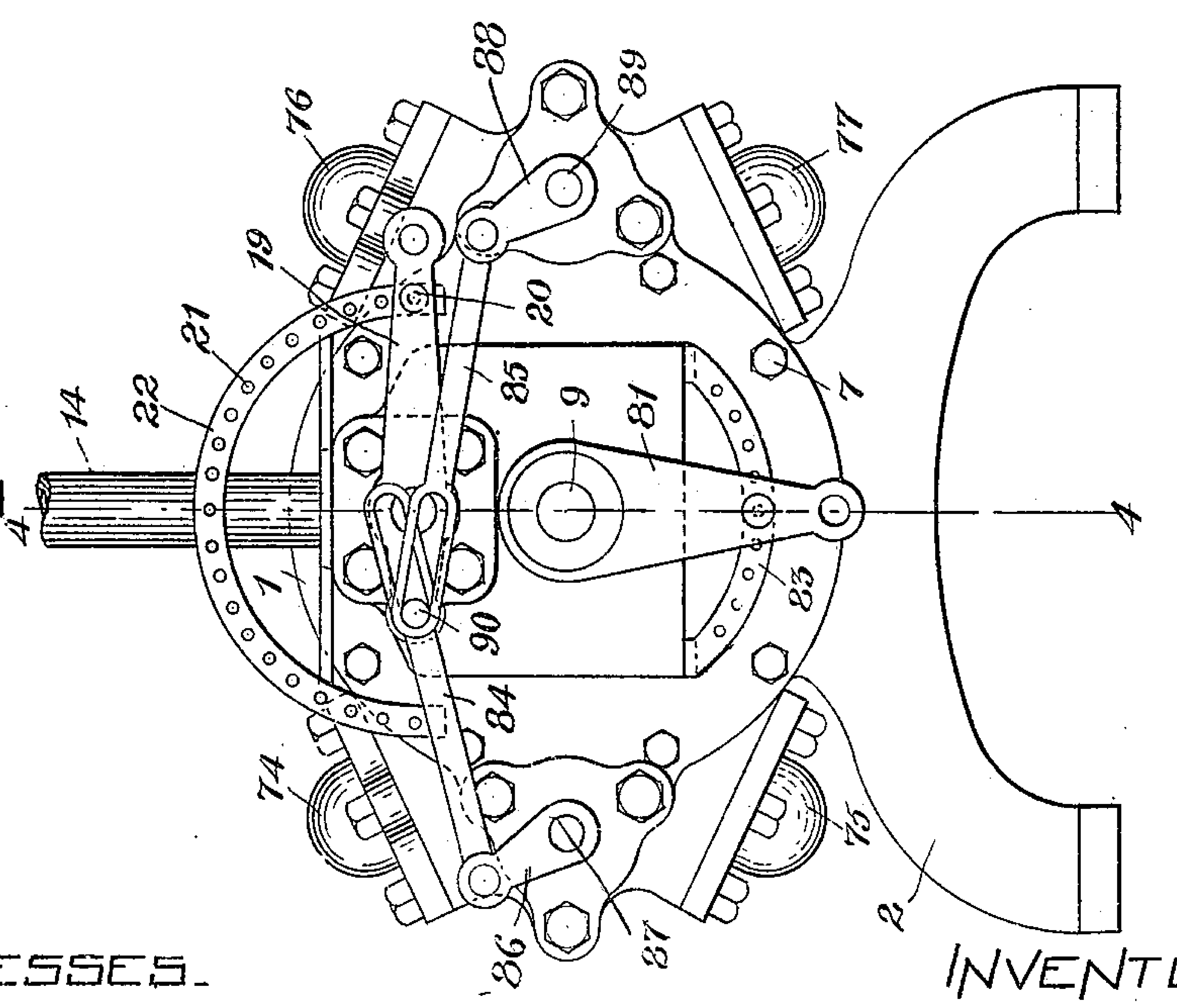


Fig. 1.



WITNESSES.

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Att'ys.

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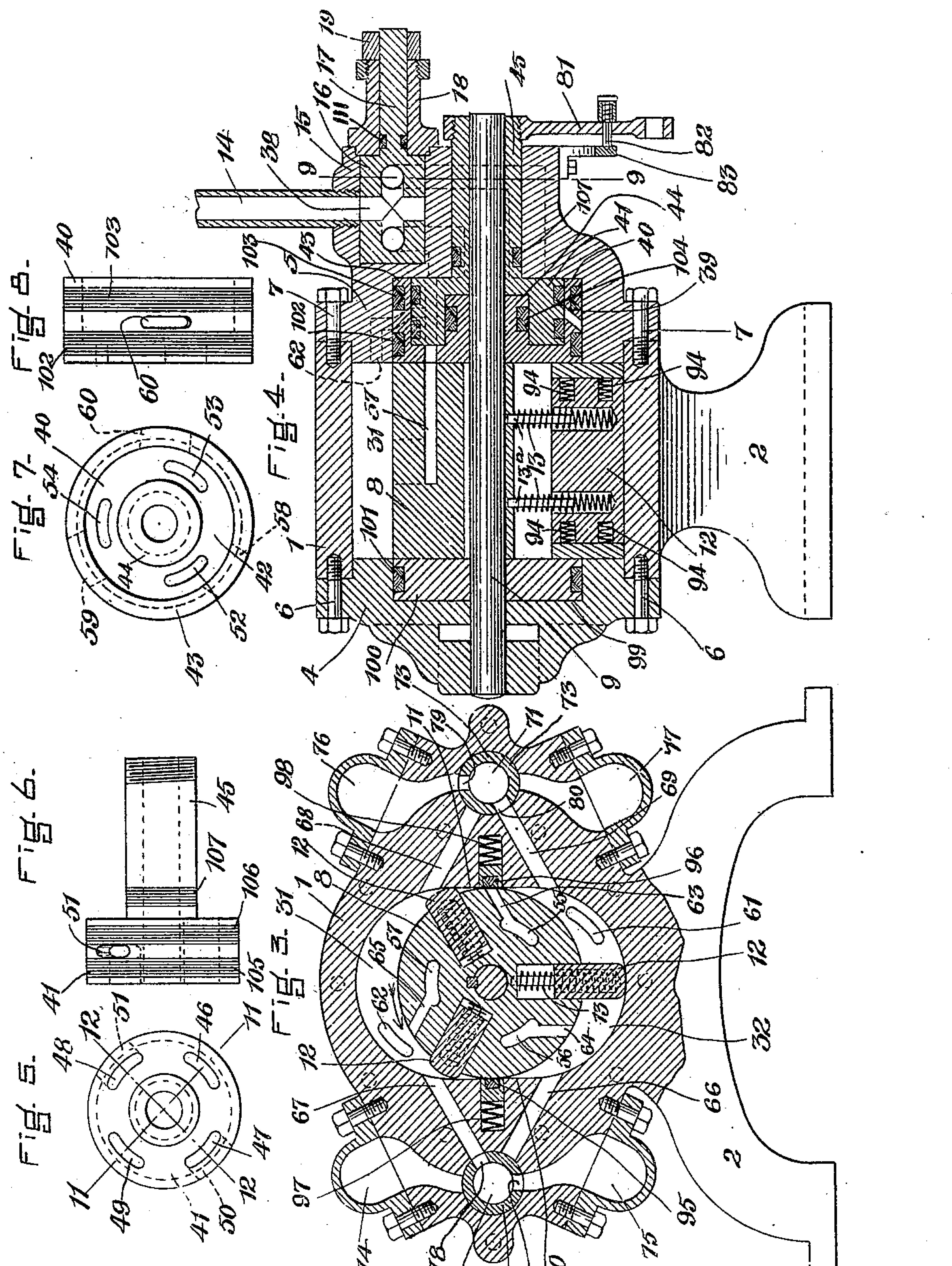

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3 SHEETS—SHEET 3.

Fig. 9.

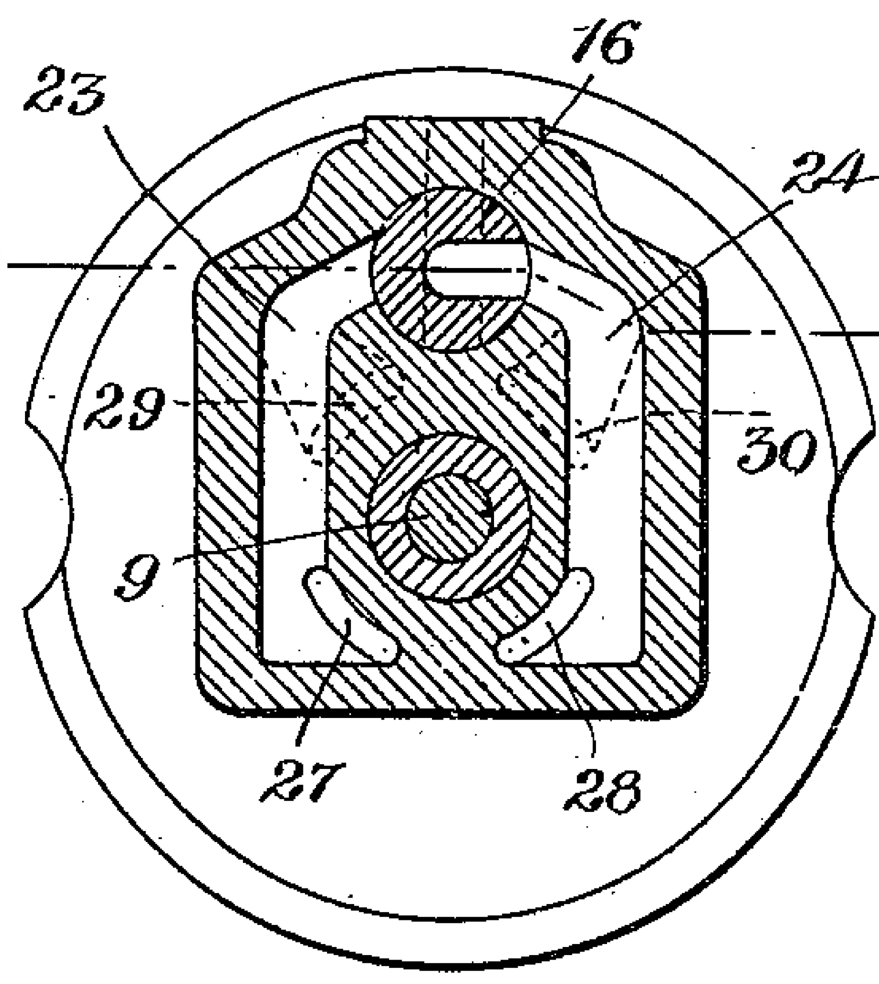


Fig. 16.

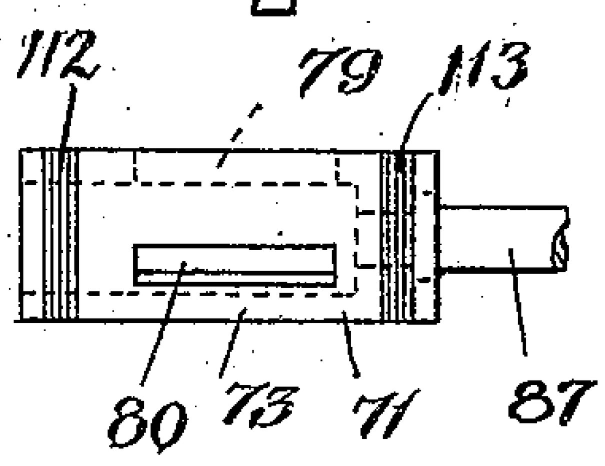


Fig. 17.

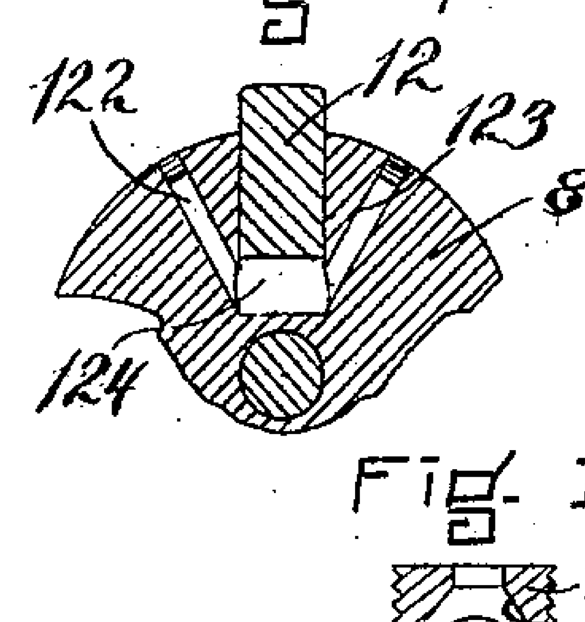


Fig. 18.

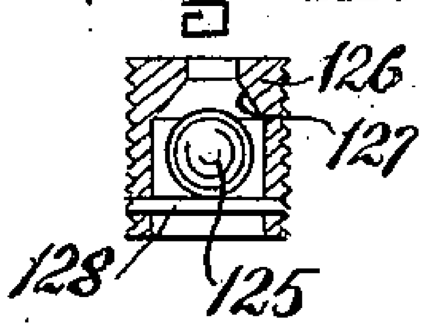


Fig. 11.

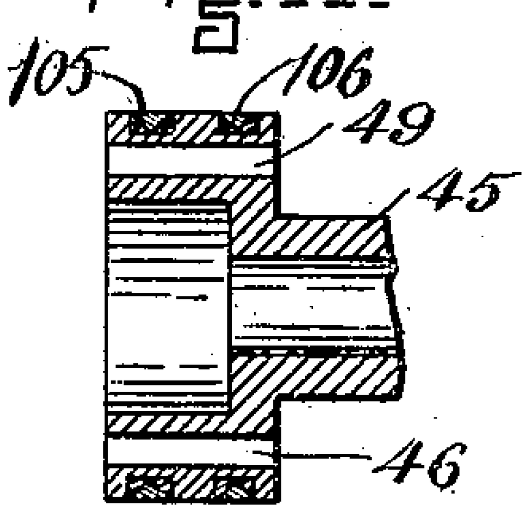


Fig. 12.

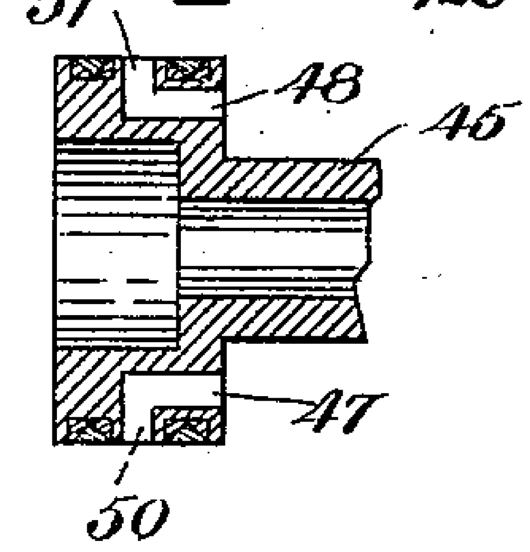


Fig. 10.

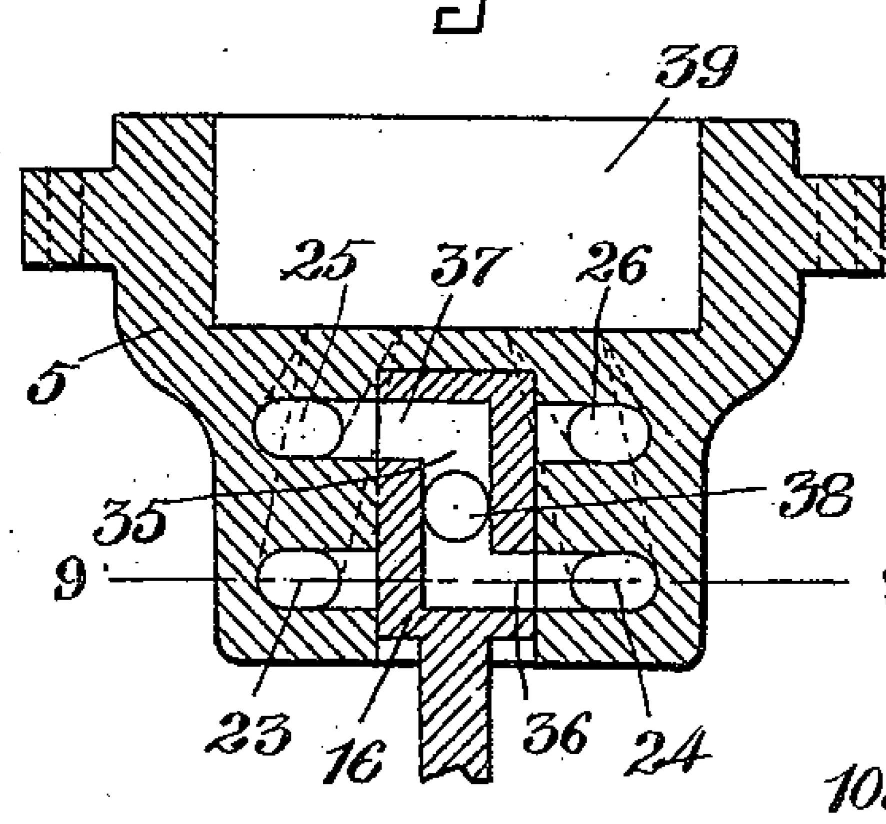


Fig. 14.

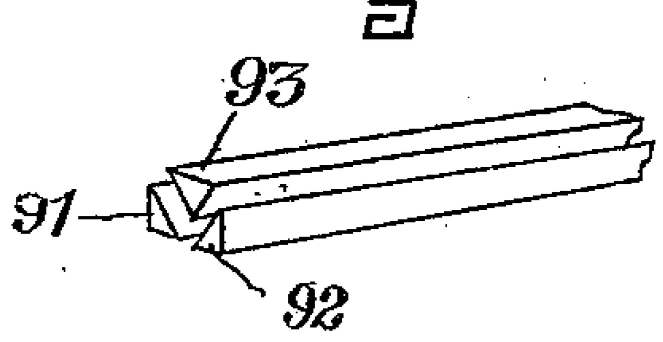


Fig. 15.

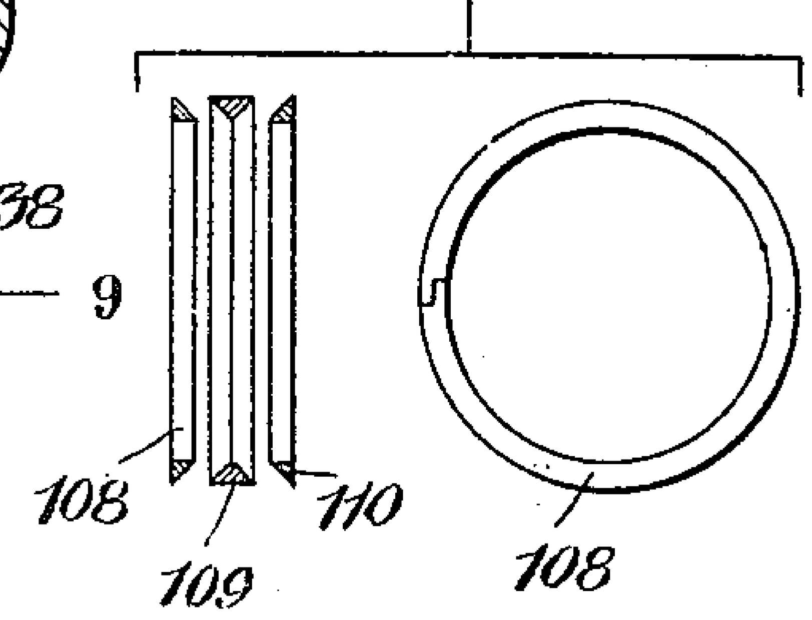
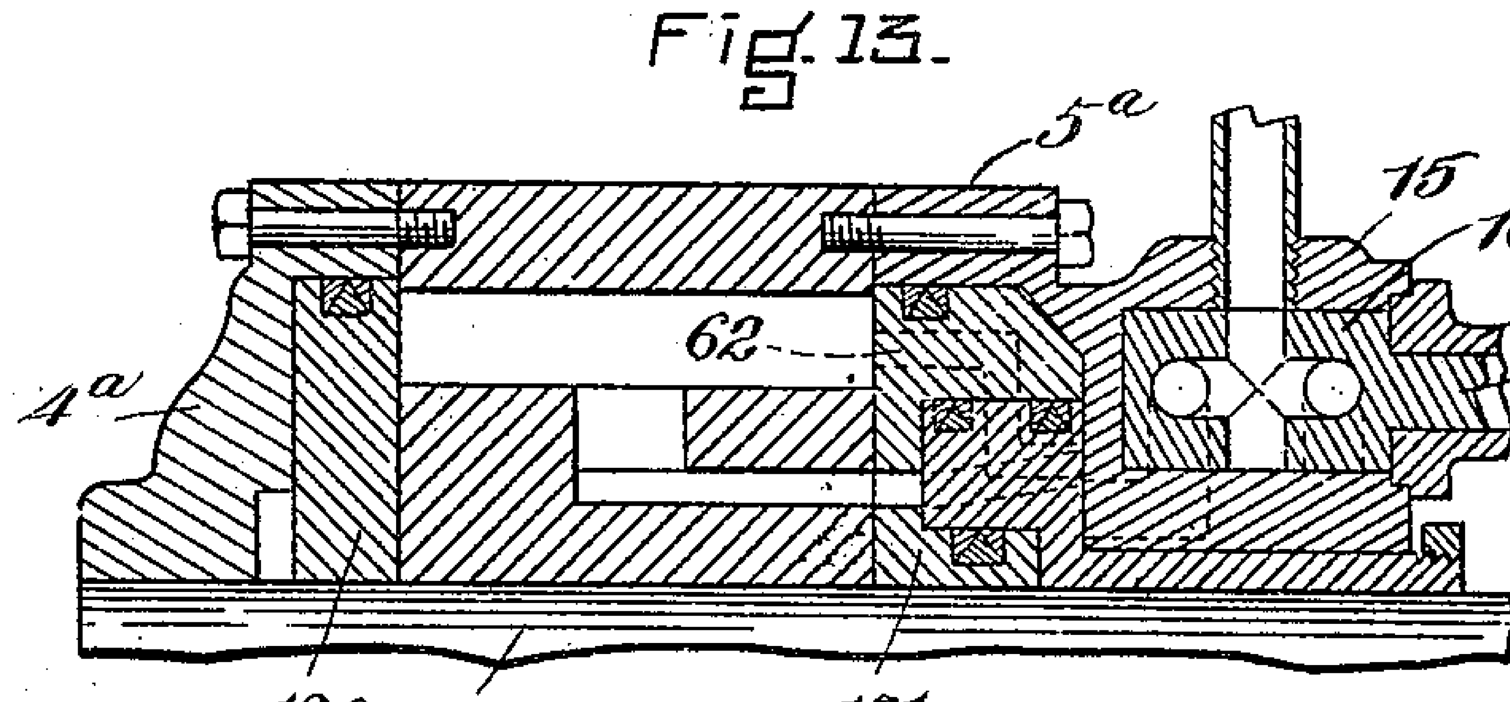


Fig. 13.



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UNITED STATES PATENT OFFICE.

DANIEL E. COTA, OF BOSTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO JACOB FISCHER, OF BOSTON, MASSACHUSETTS.

ROTARY ENGINE.

979,262. Specification of Letters Patent. Patented Dec. 20, 1910.

Application filed August 11, 1909. Serial No. 512,340.

To all whom it may concern:

Be it known that I, DANIEL E. COTA, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to rotary engines and has for its object principally to provide a new, useful and improved system of reversing and cut-off valves by which the engine may be reversed in the direction of its running and by which the admission of the working fluid to the chamber may be automatically cut off at any determined point in the revolution of the engine and may be caused to act expansively.

My invention consists of structural features and relative arrangements of elements which will be hereinafter more fully described and particularly pointed out in the appended claims.

These and other objects are attained by an engine having the principles hereinafter more fully described. An embodiment of a rotary engine working according to these principles is illustrated in the accompanying drawings in which—

Figure 1 represents an end elevation of the engine. Fig. 2 represents a side elevation of the same. Fig. 3 represents a cross-section on the line 3—3 of Fig. 2. Fig. 4 represents a longitudinal section on line 4—4 of Fig. 1. Figs. 5 and 6 are respectively an end elevation and a side elevation of an adjustable control valve by which the admission and cut-off of the working fluid are governed. Figs. 7 and 8 are respectively an end elevation and a side elevation of a cut-off valve attached to or forming part of the rotor of the engine. Fig. 9 is a sectional view taken on the line 9—9 of Fig. 4, showing the reversing valve and passages leading from the valve chamber. Fig. 10 is a cross-section on line 10—10 of Fig. 9, showing the same parts. Figs. 11 and 12 are longitudinal sections of the control valve taken on lines 11—11 and 12—12 of Fig. 5. Fig. 13 is a longitudinal sectional view showing the modified construction of the engine. Fig. 14 represents a construction of packing forming a part of my invention adapted to prevent leakage of steam or other fluid-working agent between surfaces making contact with one another upon a straight line. Fig. 15 represents packing designed on the same principle, but made in circular form so as to pack contacting cylindrical surfaces. Fig. 16 is an elevation of one of the exhaust valves. Fig. 17 is a sectional view of part of the rotor showing a steam-projected blade or piston. Fig. 18 is a sectional view of a check valve used in connection with the latter.

The same reference characters indicate the same parts in all the figures.

The principle of the invention which I am about to describe may be embodied in a variety of forms, but the particular embodiment which I find preferable is the one illustrated in the drawings hereinbefore described. This embodiment consists of a casing 1 having a base 2 and inclosing an internal space. The casing 1 constitutes the curved side walls of the internal space and is of general cylindrical form. The ends of the space contained within the casing are closed by end walls or heads 4 and 5 formed as plates which overlie the ends of the casing and are secured thereto in any suitable way as by the bolts 6 and 7.

Within the internal space of the cavity is a rotary member or rotor 8 suitably secured to a shaft 9 passing through bearings in the heads 4 and 5. This rotor is of cylindrical form and is tangent to the inner side walls of the casing at one or more points, whereby such walls adjacent to the tangent points form a chamber for the expansion of the steam or other working agent employed. I find it preferable to make the rotor as a cylinder and to form the internal space and the casing of equal width with the rotor in one direction, but at greater depth than the latter, the rotor being then placed centrally in the space and tangent at diametrically opposite points with the side walls of the casing so as to divide the internal space into two working chambers 31 and 32. Those parts of the casing walls with which the rotor is tangent form abutments 10, 11 respectively which are stationary and form the stationary abutments of the engine.

One or more movable abutments or pistons are carried by the rotor. Such abutments take the form of piston blades 12 of which in the present embodiment of the invention there are three, although as may be readily understood there may be a greater or less number. These blades are set into radial grooves or slots in the rotor and are forced outwardly therefrom into engagement with the side walls of the casing by means of springs 13, which are guided and retained in correct position by guide rods 13ª. The ends of these pistons bear against the heads 4 and 5 of the casing and are packed so as to prevent leakage of the working fluid past them by a packing device.

The working fluid which is ordinarily steam is brought to the engine through a pipe 14 and delivered into a valve chest 15 in which is a reversing valve 16. This valve is operated by being turned about its longitudinal axis, the valve being cylindrical to admit of such turning and it has a stem 17 by which it may be so turned. This valve stem passes through a sleeve 18 projecting from the head of the valve chest and carries on its outer end an arm 19 shown in the elevation in Fig. 1 by which it may be turned. A spring pin or other latching device 20 is carried by the arm 19 and is adapted to engage in any one of a series of notches 21 in a segment or bearing 22 whereby the valve may be retained in any position.

From the valve chest 15 two or more passages extend through the head 5 and discharge into the internal space of the engine casing. Preferably there are four such passages, two of which are used for driving the engine in one direction and the other of which are employed in reversing. These passages are shown in Figs. 9 and 10 and are designated by the characters 23, 24, 25 and 26 respectively. The passages 23 and 24 open from the valve chamber 15 in the plane perpendicular to the axis of the valve 16 and the other passages 25 and 26 open from the valve chamber in a second plane also perpendicular to the valve. The passages 23 and 24 are longer than the other passages and extend below the axis of the rotor. They connect with longitudinal passages or ducts which open into ports 27 and 28 in the interior face of the casing head 5. The passages 25 and 26 open into the interior of the casing through ports 29 and 30. Preferably these ports are equidistant from the axis of the rotor and are spaced equal distances apart, as shown in Fig. 9, although this particular arrangement is not essential to my invention and may be modified at will.

The valve 16 is constructed so as to admit the working fluid at one time into the passages 24 and 25 exclusively, or into the passages 23 and 26 simultaneously, cutting it off from the other two passages. For this purpose the valve is provided with a zigzag passage 35 opening through ports 36 and 37 in opposite sides of the valve and in alinement respectively with the planes of the two pairs of passages. The inlet pipe 14 opens into the valve chamber between these planes and the valve has a transverse passage 38 in line with the pipe and intersecting the zigzag passage 35. When the valve is in the position shown in Figs. 4, 9 and 10 the working fluid passes into the opening 38, flows through the zigzag passage and discharges through the ports 36 and 37 into the passages 24 and 25. When the valve is reversed or turned into a diametrically opposite position the ports 36 and 37 open in the passages 23 and 26 and are in connection with the inlet pipe 14 through the opposite end of the passage 38.

In the preferred form of my invention the head 5 is provided with a cylindrical recess 39 in the bottom or inner plane face of which are located the ports 27, 28, 29 and 30. This recess contains the cut-off and control valves 40 and 41. The valve 40 is preferably a disk secured to one end of the rotor 8 and thereby forming in effect a part of said rotor. The circumference of this disk fits the side walls of the recess 39 and fills the outer portion of such recess. The control valve 41 is formed as a ring or drum which lies within the annular recess 42 of the disk 40 and bears against the plane face of the recess 39. The annular recess or groove 42 is formed in the outer face of the disk 40 between a flange 43 of the latter and a hub 44 which surrounds the shaft 9. The control valve 41 is formed with a sleeve 45 which surrounds the shaft 9 and passes through the head 5. In the valve disk or drum 41 are ports 46, 47, 48 and 49 which are adapted to register respectively with the ports 27, 28, 29 and 30. Two of these ports as 46 and 49 pass entirely through the valve from one plane face to the other, while the intermediate ports 47 and 48 pass only part way through the valve in a longitudinal direction and intersect radial ports or passages 50 and 51 respectively. In the valve disk 40 are two sets of ports or passages, the number of ports in each set being the same as the number of pistons. Those of one set are represented by 52, 53 and 54 and pass through the web portion of the valve disk in alinement with longitudinal passages 55, 56 and 57 in the rotor. These ports are carried rotarily by the rotor and are arranged so as to register successively with the ports or passages 46 and 49 through the control valve 41. The ports of the other set designated by 58, 59 and 60 are formed in the flange 43 of the valve disk and are brought into registry successively with the radial outlet ports 50 and 51 of the control valve. In the head 5 are ports 61 and 62 which discharge into the working chambers and the inlet end of which is approximately in alinement with the ports 50 and 51 of the valve 41 and are connected with such ports from time to time by the ports 58, 59 and 60 in the cut-off valve. The passages 55, 56 and 57 before referred to in the rotor discharge through ports 63, 64 and 65 opening through the periphery of the rotor into the working chamber. It should be noted that each of the last-named ports is beside one of the pistons 12 on the corresponding sides of the pistons.

The ports and passages above described constitute the admission ports for the working fluid. The exhaust ports are shown in Fig. 3 and designated by numerals 66, 67, 68 and 69 arranged in two pairs of which the ports 66 and 67 open from opposite sides of the abutment 10 into a common valve chamber 70, while the other exhaust ports 68 and 69 lead from opposite sides of the abutment 11 into a valve chamber 71. These valve chambers are provided respectively with tubular oscillating valves 72 and 73, each having two ports. Outlet passages from the valve chamber 70 lead to the receivers or exhaust pipes 74, 75 while similar passages lead from the other valve chamber into the exhaust pipes 76, 77. Ports 78, 79 of the valve 72 are arranged so that either the exhaust port 66 may be connected with the exhaust pipe 74 or the port 67 may be connected with the pipe 75 by turning the valve through a small angle. The ports 79, 80 of the valve 73 are similarly arranged so that by turning the valve through a small angle either of the exhaust ports may be connected with one of the outlets or the other port closed.

With the valves in the position illustrated in the drawings the working fluid is permitted to pass through the passages 24, 25, ports 28, 29 in the casing head, the ports 46, 49 in the control valve, 41 and successively into the ports 52, 53 and 54 of the cut-off valve, flowing thence through the longitudinal passages 55, 56 and 57 of the rotor and issuing through the outlets 63, 64 and 65 to drive the rotor in the direction of the arrow shown in Fig. 3. When the valve 16 is reversed the fluid passes through the ports 27 and 30 in the head, thence through the passages 47, 50 and 48, 51 of the control valve, passing successively through the ports 58, 59 and 60 of the cut-off valve when these ports pass across the ports of the control valve and issuing through the outlets 61 and 62 into the working chambers. The cut-off valve 40 is so arranged relatively to the pistons of the rotor that the fluid is admitted only into those portions of the working chambers contained between an abutment and a piston on the side of the piston opposite to that on which the exhaust port is opened at any particular time. Admission of the working fluid is then cut off before the next adjacent open exhaust port is uncovered by the travel of the piston. The cut-off is preferably early enough to give an opportunity for the working fluid to act expansively and to allow a considerable portion of its pressure energy to be expended in producing work before it is released through the exhaust. Owing to the fact that the valve 40 thus controls the duration of admission of the working fluid and then interrupts the admission, it acts as a cut-off valve. The time of admission and cut-off of the working fluid is also controlled by the valve 41 which is adjustable, an arm 81 being provided for this purpose and attached to the outer end of the sleeve 45. This arm carries a suitable latch such as the spring-pressed pin 82 arranged to slip into notches in the segment 83. By swinging the arm 81 the control valve may be adjusted so that its ports are successively uncovered by the ports of the cut-off valve and again covered by this valve at an earlier or later point in the revolution of the rotor.

The reversing valve 16, or admission valve, and the exhaust valves are connected in such a way that when the reversing valve is set in either of its extreme positions the exhaust valves are automatically set to permit travel of the rotor in the desired direction. These connections consist of links 84 and 85 engaged at their opposite ends respectively with an arm 86 on the projecting stem 87 of one of the exhaust valves, an arm 88 on the stem 89 of the other exhaust valve and a pin 90 carried by an extension of the arm 19 which as before described is secured to the stem 17 of the reverse valve. The connections are such that when the reverse valve 16 is set as shown in Fig. 4, the exhaust valves are set as shown in Fig. 3 and when the reverse valve is reversed the exhaust valves are set so as to open the exhaust ports 66, 68, closing the ports 67 and 69. As the reverse valve turns through a wider arc than the exhaust valve the links 84 and 85 are slotted at the ends which engage the stud 90, thereby providing a lost motion connection which permits the admission fluid to be turned through a considerable arc without affecting the exhaust valves and only moves the latter through the required distance at the conclusion of its own swing.

The packing which has been previously referred to as making a fluid-tight contact between the ends of the several pistons and the end walls of the working chambers is illustrated in detail in Fig. 14. This packing consists of a group or number of strips, preferably three, which are inserted into grooves in the ends of the pistons. These strips are prismatic in form, being wedge-shaped or triangular in section and are arranged with an edge of one adjacent to the wide face of the other. Thus where the number of strips employed is three, the outer strips 91 and 92 are arranged with outer surfaces approximately parallel and adjacent surfaces forming a V-shaped groove. The intermediate strip 93 is then placed with one of its angles in the groove or depression formed between the strips 91 and 92. The outer surfaces of the latter strips bear against the adjacent end walls of the casing and the intermediate strip 93 is acted upon by resilient means such as the springs 94 which press it outward. The effect of this is to force the strips 91 and 92 into tight engagement with the end of the casing and also to spread the latter strips apart into close contact with the piston.

Packing members equivalent to those above described are set into grooves in the abutments 10 and 11 to bear against the cylindrical side faces of the rotor. These packings are represented at 95 and 96 and are acted upon by springs 97 and 98 respectively.

The head 4 of the casing is recessed at 99 and into this recess extends a disk 100 which is secured to the end of the rotor opposite that on which the valve disk 40 is secured. If desired the disk may remain in one piece with the rotor. Rotary parts of the engine including the disks carried at the opposite ends of the latter and the control valve 41 are packed by means similar to the packings previously described but modified in form to adapt them to the circular shape of the contacting surfaces. Thus surrounding the disk 100 is a packing 101 and surrounding the valve disk 40 are packings 102 and 103 arranged respectively on opposite sides of the ports 58, 59 and 60. There is also a packing 104 in the hub 44 of the valve disk which lies inside the control valve. The latter has external packings 105, 106 on each side of the ports 50, 51 and the packing 107 around its sleeve portion. These packings effectually prevent leakage of the working fluid around any part of the rotor from either end of the working chambers, and also prevent leakage of high pressure fluid into the working chambers.

The packing rings are all substantially the same in form and principle and are made as illustrated in Fig. 15. Preferably each packing consists of a group of three rings, 108, 109 and 110 respectively. The rings are divided similarly to the ordinary piston packing rings of reciprocating engines, but each ring in cross-section is formed as a triangle or wedge similarly to the packing strips already described. The outermost rings of each group bear against the surrounding circular wall and the intermediate ring is formed with a wedge inserted between the two outer rings. The resiliency of the inner ring forces it outward pressing the flanking rings against the surrounding surface and into lateral engagement with the walls of the grooves in which they are contained.

It is to be understood that the relative arrangement of the members constituting the packings may be reversed. For instance the straight packing shown in Fig. 4 may be turned about so that the base side of the prism 93 is outward and the base portions of the strips 91 and 92 are acted upon by the springs. So also the relative arrangement of the rings for the circular packing may be reversed, a ring having its narrow edge outward being thus interposed between two flanking rings having extended cylindrical surfaces on their outer peripheries. Fig. 13 of the drawings shows this reversal in the arrangement of the packing rings. It is to be understood that a packing of this sort is intended to be interposed between any surfaces liable to the leakage of working fluid between them. That is the reverse valve has packing 111 to prevent leakage of the working fluid along its stem and each of the exhaust valves is adapted to have packings 112 and 113 on each side of the ports thereof for the same purpose.

In the form of the engine as thus far described the disks 40 and 100 are of the same external diameter as the rotor, so that they do not inclose the ends of the working chambers. In the modification shown in Fig. 13, the corresponding disks 120 and 121 are of greater diameter than the rotor, being substantially equal in diameter or greater than the greatest width of the interior of the casing. Their outer rims extend to or slightly overlap the side walls of the casing so as entirely to inclose the ends of the working chambers, and form a part of the rotor and make a tight joint with the ends of the cylinder casing. The cylinder heads 4^a and 5^a are recessed as in the other form of the engine to contain the disks, but the diameters of the recesses are correspondingly increased. The heads of the casing in this modification serve simply to retain and pack the peripheral surface of the disks.

In the modified construction the ports 61 and 62 instead of being formed in the head of the casing are formed directly in the valve disk 40 and are continuations of the ports 58, 59 and 60 thereof. This form of engine has advantage over the other in that the spring pressed packing pieces at the ends of the pistons bear against the disks instead of against the stationary heads of the casing and are therefore not subjected to unequal wear, but on the other hand the preferred form of the invention has the advantage that the abutment packings 95 and

96 are not subjected to wear on their ends by reason of making contact with a revolving surface.

In certain embodiments of my invention, particularly in engines of large size, I find it desirable to have the pistons or blades forced outward by steam pressure or pressure of any other working fluid employed, instead of by the springs 13 heretofore described. Such a modification of the engine is illustrated in Fig. 17, which shows ports 122 and 123 for the purpose of admitting the working fluid into the space 124 within the rotor back of the piston. Two or more ports opening at the periphery of the rotor on each side of each piston are necessary in order that the working fluid may be admitted when the engine is running in either direction. With a reversible engine therefore check valves are necessary in the ports to prevent the flow of the steam around the piston and escape thereof into the exhaust without doing work. Consequently I employ a form of check valve which permits steam to enter either port, but prevents it from escaping therefrom when admitted into the other port. One such check valve which I find convenient is illustrated in Fig. 18. Here the valve is a ball 125 contained in a cage 126. The latter is conveniently a sectional tubing threaded externally so that it may be screwed into the mouth of the port, and which has a seat 127 against which the valve is pressed by the fluid pressure when the latter tends to pass outward. A cross-bar or pin 128 is placed across the cage a short distance inward from the valve seat to prevent the ball from running back of the chamber 124 and out of the port.

I claim—

1. In a rotary engine the combination of a working chamber having a head recessed on its inner side, a shaft, a rotor in said chamber mounted on the shaft, a valve disk mounted at one end of said rotor and on the shaft and contained within said recess, fitting closely at its periphery within the latter, and having an annular recess in its outer side, a complemental valve contained within said recess and fitting closely therein at its periphery, the said valve and disk having complemental longitudinal ports arranged to open into the chamber for driving the rotor in one direction and having complemental radial ports for driving the rotor in the opposite direction, radially expansible annular packings peripherally surrounding said valve and disk on opposite sides of said radial ports, and means external to said valve and disk for directing the working fluid exclusively to either the longitudinal or radial ports.

2. In a rotary engine a casing, a rotor therein, a shaft passing through said casing and supporting said rotor, and complemental valves, one of said valves being secured at one end of said rotor and surrounded by a part of the casing and having an annular recess on its outer side concentric with said shaft, the other valve consisting of a sleeve surrounding said shaft, a web transverse to the shaft and a flange concentric with the shaft and contained in said annular recess, the said valves having complemental axially extending ports or passages communicating with a passage and port in the rotor and having radially extending passages in their overlapping flange portions communicating with the interior of the casing externally of the rotor, and means on the sleeve portions of said second-named valve for adjusting the latter to vary the time of admission and cut-off of the working fluid.

3. In a rotary engine a casing, a rotor in said casing, a valve chamber in one of the heads of said casing, a cylindrical reversing valve mounted in said valve chamber, so as to turn about its axis, said valve having a zigzag passage opening in ports at opposite sides of the valve, and out of line with each other, and having a transverse admission passage intersecting such zigzag passage intermediate the ports thereof, said head having a plurality of passages leading from the valve chamber to ports in the inner surface of the head, and arranged respectively in the planes of the valve ports and on opposite sides of said valve, and a cut-off valve between the rotor and the inner wall of the head adapted to register with the ports in the head.

4. In a rotary engine complemental valve disks, one of which constitutes a cut-off valve and travels with the rotor of the engine and the other of which is normally stationary and constitutes a reversing valve, said valves having each an axially extending port adapted to register periodically in the travel of the rotor, and the first-named valve having an axially extending flange embracing a portion of the second valve, said flange being provided with a radial port and the second valve having a radial port in that part thereof which is surrounded by said flange.

5. A rotary engine comprising a casing, a rotor therein, a piston carried by said rotor, and an abutment formed in the side of said casing, exhaust passages leading from the casing on each side of said abutment, exhaust valves having ports and movable to open either of the exhaust passages and close the other, admission ports, a reversing valve rotatably mounted and movable into different positions to open either admission port and close the other, an arm on each of said valves and a link pivotally connected with said arms and having a lost-

motion connection with one of them, whereby shifting of the reverse valve to open either admission port may shift the exhaust valves to open the corresponding exhaust ports, said lost-motion connection permitting one of the valves to be rotated through a greater angle than the other.

In testimony whereof I have affixed my signature, in presence of two witnesses.

DANIEL E. COTA.

Witnesses:
ARTHUR H. BROWN,
PETER W. PEZZETTI.