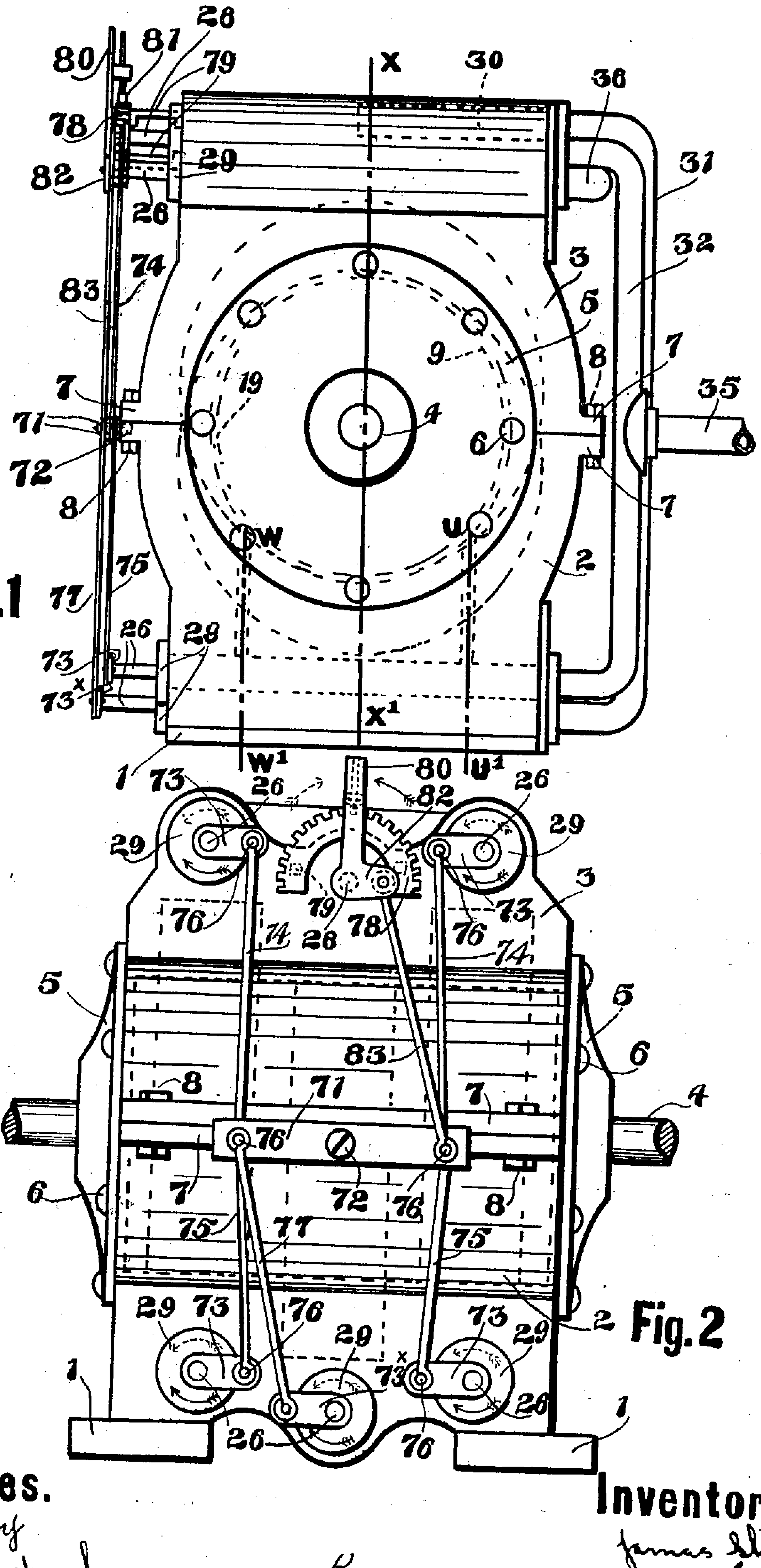
No. 898,272. PATENTED SEPT. 8, 1908.

J. SHAW.

ROTARY ENGINE.

APPLICATION FILED MAY 29, 1907.

4 SHEETS—SHEET 1.



Witnesses.

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Gerald S. Roxburgh

Inventor

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By Fred. Fetherstonhaugh His Atty.

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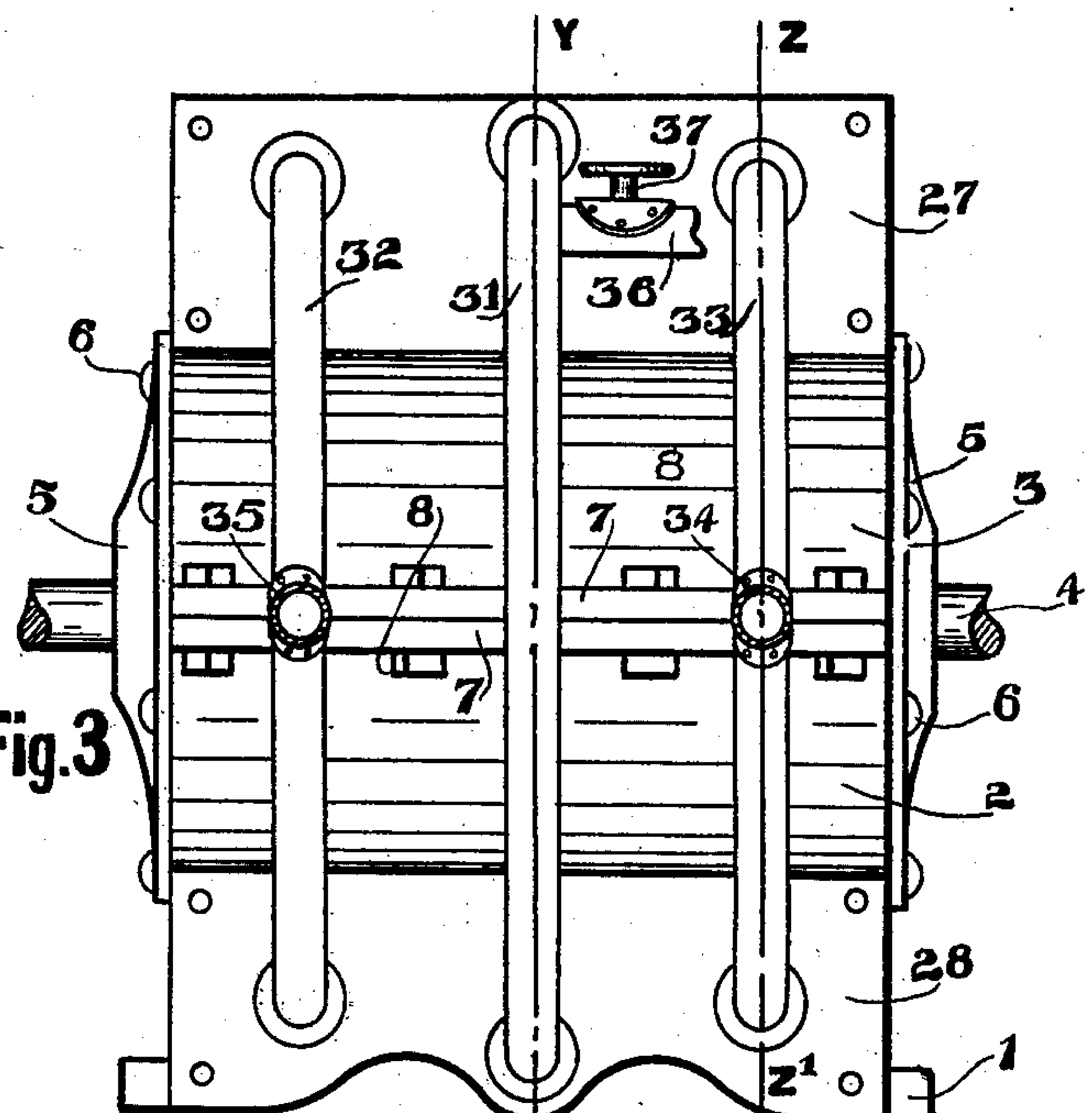

Fig.3

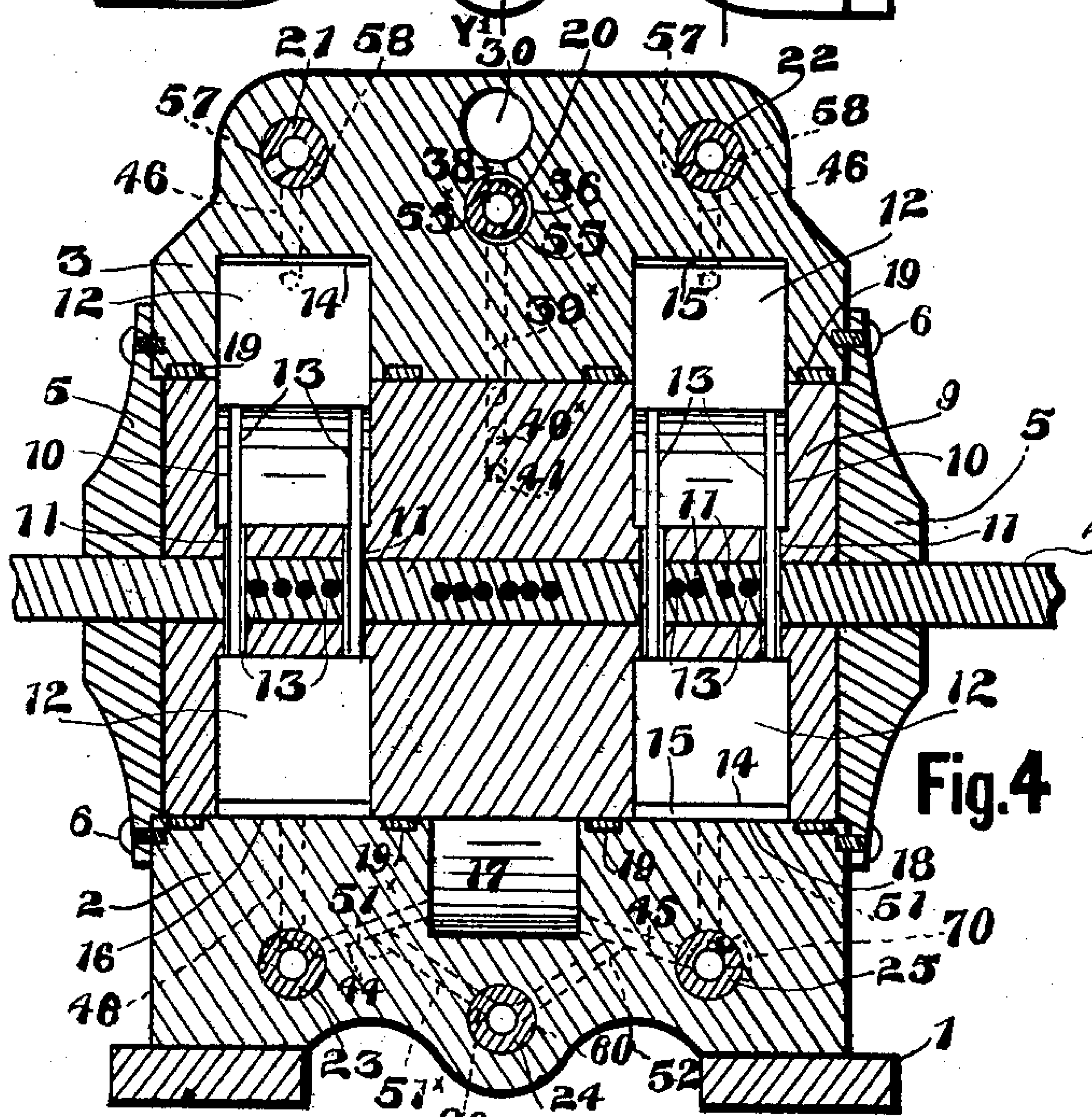

Fig.4

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4 SHEETS—SHEET 3.

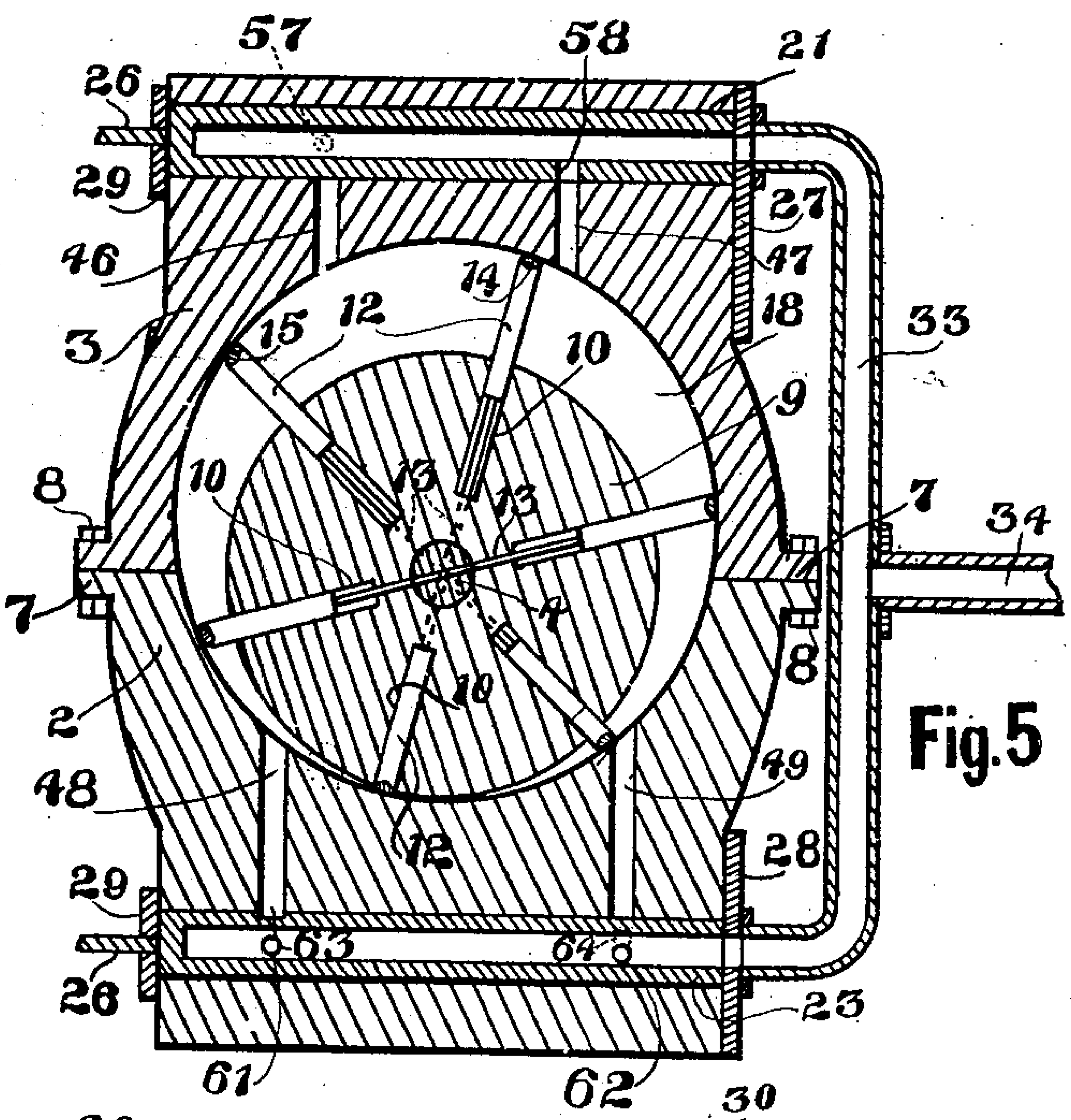

Fig.5

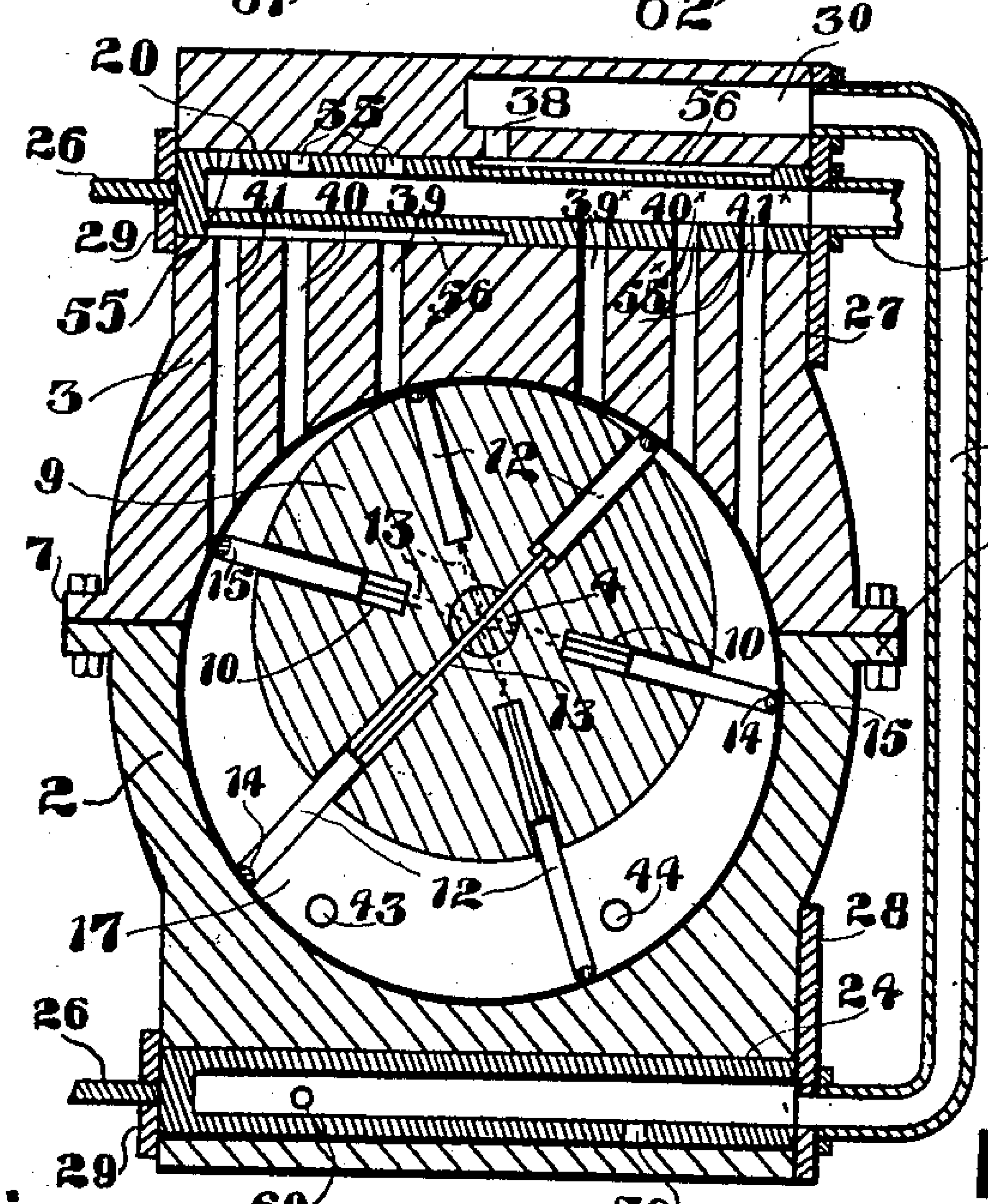

Fig.6

Witnesses.

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4 SHEETS—SHEET 4.

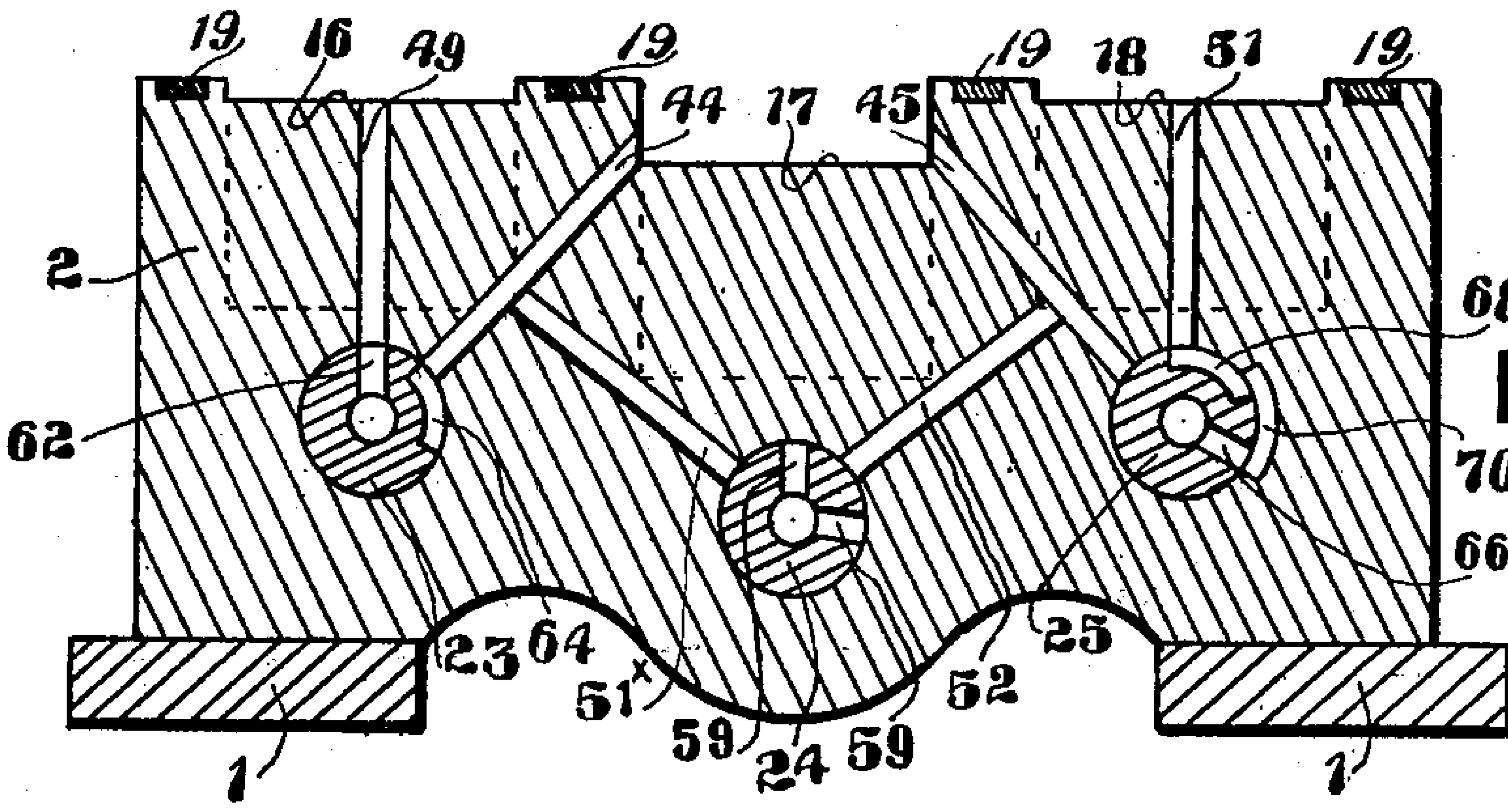

Fig.7

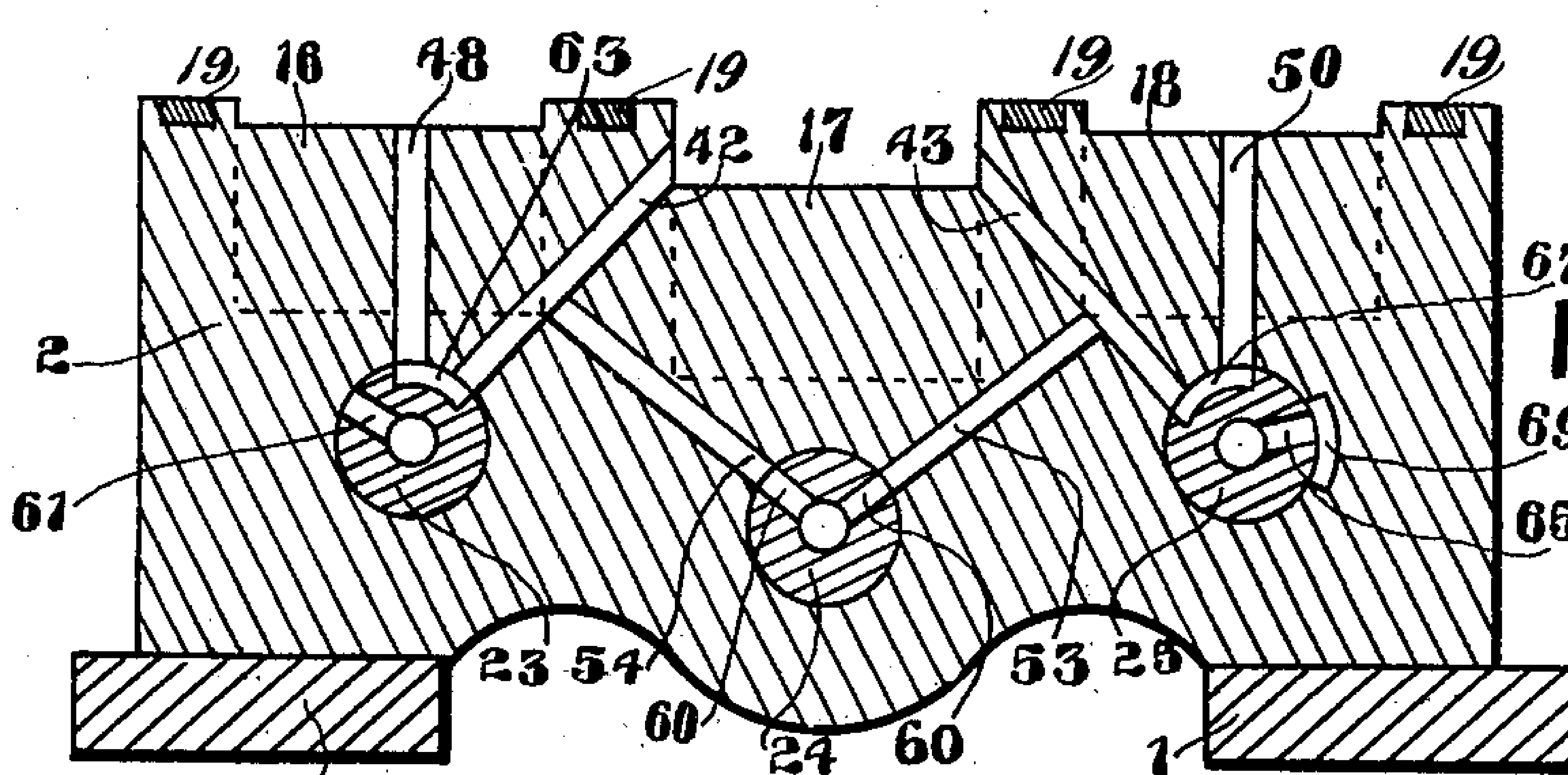

Fig.8

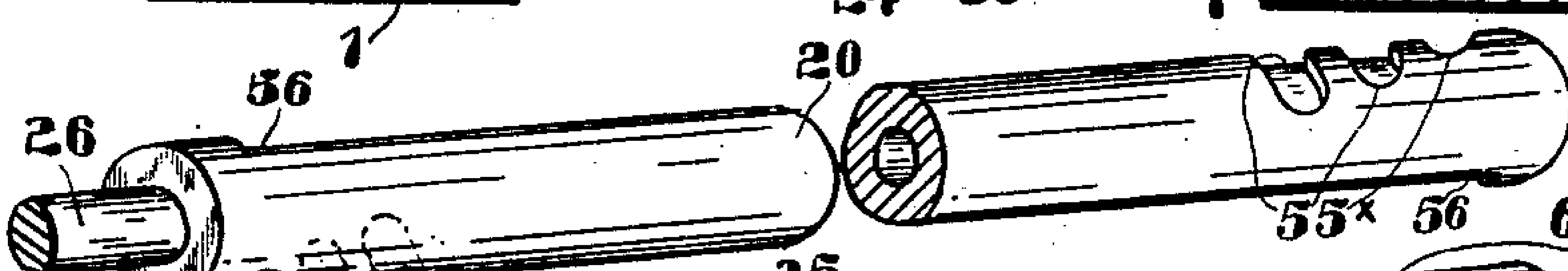

Fig.9

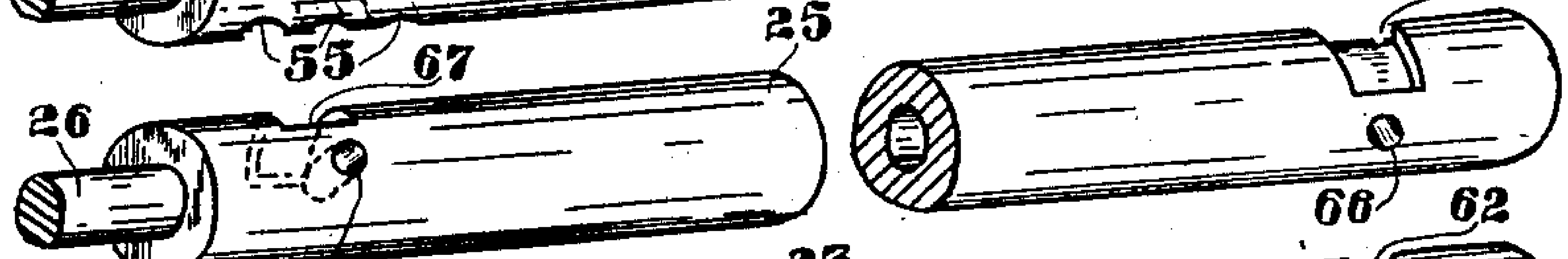

Fig.10

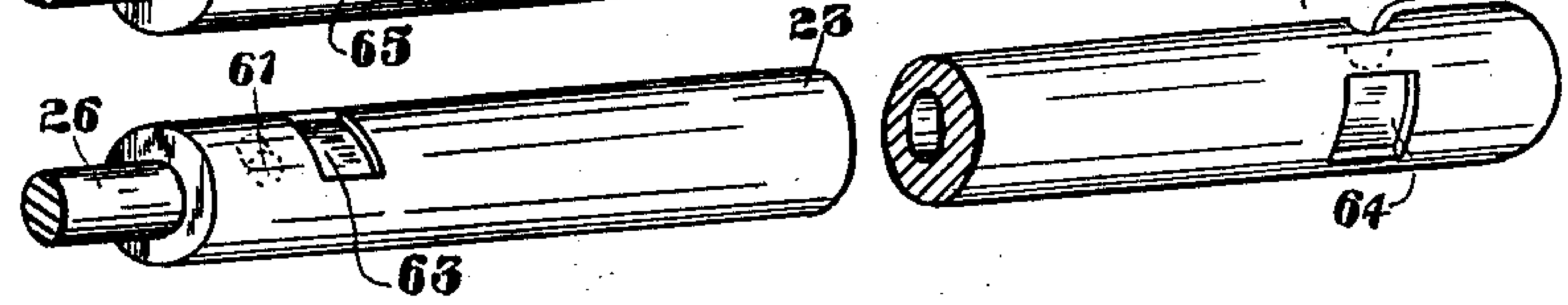

Fig.11

Witnesses.

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UNITED STATES PATENT OFFICE.

JAMES SHAW, OF DAUPHIN, MANITOBA, CANADA.

ROTARY ENGINE.

No. 898,272. Specification of Letters Patent. Patented Sept. 8, 1908.

Application filed May 29, 1907. Serial No. 376,224.

To all whom it may concern:

Be it known that I, JAMES SHAW, of the town of Dauphin, in the Province of Manitoba, Canada, lumber merchant, have invented certain new and useful Improvements in Rotary Steam-Engines, of which the following is a specification.

My invention relates to rotary steam engines, of the class in which there is more than a single expansion chamber for the steam.

The objects of the invention are, firstly, to provide a cheap but efficient rotary engine, equally capable of forward or reverse rotary motion, secondly, to provide a system of cylindrical governing valves controlled by a single lever for both forward and reverse rotation of the rotor, thirdly, to provide inclosing walls for the wings forming the pistons, of such a form that the use of springs or such like contrivances is absolutely unnecessary save for the allowance required for wear, fourthly, to provide for complete expansion of the steam by inter-connecting the piston chambers in such a manner that the exhaust steam from the first or initial chamber is directed through ports to the adjoining or second chambers and the steam which is carried ahead of the piston is directed indirectly to the adjoining chambers, fifthly, to provide a set of inlet ports controlled by a valve which will admit live steam to the central chamber, at full pressure at different points of the piston stroke, and lastly to allow escape to the exhaust, of the steam carried ahead of the pistons in the chambers adjoining the central chamber, the parts being arranged and constructed as hereinafter more particularly described.

Figure 1 is a side elevation of my rotary steam engine. Fig. 2 is a front elevation of the same showing the links connecting the valves. Fig. 3 is a rear elevation of my engine showing more particularly the pipe interconnections. Fig. 4 is a vertical sectional view, the section being taken in the plane denoted by the line X X^1, Fig. 1. Fig. 5 is a vertical sectional view, the section being taken in the plane denoted by the line Z Z^1, Fig. 3. Fig. 6 is a vertical sectional view of the engine, the section being taken in the plane denoted by the line Y Y^1, Fig. 3. Fig. 7 is an enlarged sectional view showing the lower valves and their connections with the chambers, the section being taken in the plane denoted by the line U U^1, Fig. 1. Fig. 8 is an enlarged sectional view showing the lower valves and their connections with the chambers, the section being taken in the plane denoted by the line W W^1, Fig. 1. Fig. 9 is an enlarged detailed perspective view of the valve admitting live steam to the central piston chamber. Figs. 10 and 11 are enlarged detailed perspective views, respectively, of the lower valves admitting steam from the central chamber to the adjoining chambers.

In the drawings like characters of reference indicate corresponding parts in each figure.

1 are suitable base blocks adapted to be screwed or bolted to the floor.

2 is a lower casing formed preferably from a single casting and having its upper inner face channeled to form the outer and side walls of a portion of the piston chambers, as hereinafter more particularly described.

3 is an upper casing, formed preferably from a single casting and having its lower inner face channeled to form the outer and side walls of the supplemental portions of the piston chambers.

4 is the main shaft of the engine, passing longitudinally within the casings, the shaft being carried by bearings 5, bolted at 6 to the side faces of the casings forming the body of the engine. The casings are bolted together through flanges 7, by bolts 8.

9 is a circular rotor disposed on the shaft and rigid therewith, the rotor being contained within the casings and between the end bearings 5. The rotor is formed from a single casting and has interiorly projecting pockets 10 arranged at diametrically opposite positions around the circumference. In my engine there are three different groups of pockets arranged across the length of the rotor and each group comprises six diametrically opposing pockets. The opposing pairs of pockets are joined by openings 11, which pass through the shaft 4.

12 are wings forming the pistons which fit into the pockets radially to reciprocate therein, the rods 13 of which pass through the openings 11, there being a pair to each diametrically opposing set of wings. In referring to Fig. 4 it will be seen that the rods joining the wings pass through the shaft, one set within the other, and there is an outer set of rods to one pair of wings, a middle set to another, and a central set to the other. The wings 12 are of a rectangular shape, and

have their outer ends channeled in a U-shaped form at 14 to receive packing or face strips 15 of the width of the wing.

The channeled portions in the castings 1 and 2, as hereinbefore mentioned, form when bolted together, with the rotor, chambers bounded at their outer side by an elliptical shaped wall. The position of the grooves within the castings is such that they are directly opposite the pockets in the rotor, that is, the channel is of a width equal to the pocket. It will be noticed that the chambers 16 and 18 are reversed to that 17, in respect to the rotor. When the rotor is in position the six wings 12, of each group, extend radially from the rotor into the channels in the castings 1 and 2, and in the rotation of the rotor will necessarily reciprocate in the pockets and the substantially crescent-shaped chamber bounded by the rotor and the channeled portions of the castings. It will be understood that the wings fit snugly within the chambers when they are reciprocated, and that if it be necessary packing strips may be applied to their side faces to insure a steam tight fit. Between the rotor and the castings 1 and 2, and between the respective chambers 16, 17 and 18 are annular packing strips 19 to prevent steam from leaking from chamber to chamber. The rods 13 are screwed to one of the wings and extend into openings in the edge of the opposing wing. I have found it advisable to have the pockets formed in the rotor angling across its face, that is, with the adjoining groups of pockets out of alinement, the one with the other. This assures a strong rotor and less probability of breakage due to centrifugal force.

I wish to draw particular attention to the form of my chamber. I believe that heretofore, in engines of this kind, the chamber was bounded at its inner and outer face by circular walls, and in looking into this construction I have found that the wings when reciprocated do not fit the face of the chamber throughout the complete stroke unless some means be provided, such as springs, for holding them against the outer face of the chamber. If no such means be provided there must necessarily be play of the wings, and this allows escape of steam or gas (for it applies equally as well to gas engines) from one side of the wing to the other, which is an important item in any efficiency test.

In referring to the drawings it will be seen that the center of the rotor is not at the intersection of the axis of the ellipse and it is only in such cases as this that the reference, to the elliptical outline for the out boundary of the chambers rather than the circular applies.

20, 21, 22, 23, 24, 25, are the steam governing valves being arranged in sets of three above and below the piston chambers. The valves are similar in so far as they are cylindrical in shape and have one end open and the other closed, and from the closed end there is a rod or stem 26 extending, to which the valve operating mechanism is attached. The open end of each valve registers with an opening in face plates 27, 28, which are bolted to the rear side of the engine. It will be understood that the castings 2 and 3 are bored to receive the valves. The openings extend completely across the castings from the rear to the front and the valves fit snugly into the openings.

29 are plates fastened to the rear face of the castings in which plates are formed journals and packing boxes for the stem 26. Directly above the central valve 20 is a chamber 30 opening through the plate 27, and extending practically midway into the casing.

31 is a by-pass or pipe leading from the open end of the chamber 30 to the open end of the valve 24.

32 and 33 are exhaust pipes inter-connecting the open ends of the valves 21 23, 22 25, respectively, and these may be further interconnected, exhausting through a common pipe. In the drawings I have shown them each exhausting separately through pipes 34 and 35.

36 is the live steam pipe connected to the plate 27 and opens directly to the central opening in the valve 20.

37 is any form of valve controlling the supply of steam through the live steam pipe to the engine.

38 is a duct leading from the chamber 30 to the face of the valve 20.

39, 40, 41 and $39^{\times}$, $40^{\times}$, $41^{\times}$ are ports leading from the face of the valve 20 directly to the chamber 17. The ports enter at different positions so as to admit steam at different parts of the stroke of the wings. The ports 39, 40 and 41 are used for the forward or right hand rotation of the rotor and the supplemental ports $39^{\times}$ $40^{\times}$ and $41^{\times}$ are used to admit steam for the reverse rotation of the rotor.

42 43, 44 45, are ducts leading from the chamber 17 to the faces of the valves 23 25, the points at which the ducts 42 43 leave the central chamber being in a position practically opposite from the port $39^{\times}$, and the point from which the ducts 44 and 45 leave the central chamber being practically in a position diametrically opposite the inlet port 39.

46 47, are ducts leading from the face of the valves 21 22, to the chambers 16 and 18, there being two ducts leading to each chamber and the ducts are placed one to either side of the center of the chamber. (Although a vertical sectional drawing through the center of the chamber 16 has not been shown it would be practically the duplicate of that shown in Fig. 5, and would show similar ducts to those 46 47, extending between the face of the valve 22 and the chamber 16).

48 49, 50 51, are ports leading from the face of the valves 23 25, to the chambers 16 and 18, respectively, there being a port to either side of the center of each chamber. The ducts 46 47, respectively, are diametrically opposite the ports 49 51, 48 50.

51× 52, 53 54, are ducts passing from the face of the valve 24, in pairs (forward and rear) and opening to the ducts 44 45, 43 42, respectively. The valve 20 has openings 55 55× passing from its face to the hollow center, and they are adapted to register in the rotation of the valve with the ports 39 40 41, and 39× 40× 41×, respectively. These openings are at opposite sides of the valve so that when one set is registering the other is closed.

Referring to Fig. 9 in the drawings, it will be noticed that the openings 55 55× range in dimension from a large circumferential length at the inside to a smaller length at the outside or towards the end, the object being that steam may be gradually admitted through, first, the outer opening of the set, then the outer and a portion of the central, and gradually increasing in this wise until the three are allowing steam to pass directly to the central chamber.

56 is a peripheral groove extending around the outer face of the valve 20, spirally, and inter-connects the port 38, with the ports 39 40 41, or 39× 40× 41×, depending on the position of the valve. When the ports 39 40 41 are connected through the openings 55 to the inside of the valve then the ports 39× 40× 41× are connected through the groove 56 with the port 38, and vice versa. The latter position is shown in the drawings. The valves 21 and 22 have openings 57 58, passing from the center to the face, such openings being alined to register with the ports 46 47, in the rotation of the valve, and are also so placed that when the rear opening 58 in the valve is open to the port, the other or forward 57 is closed. The valve 24 has openings 59 and 60, a set forwardly and rearwardly, each set being adapted to register with the ducts 51× 52, 53 54, respectively, in the rotation of the valve, and are so placed that when the forward set of openings is registering with the ducts, the rear set is closed. This position is clearly shown in Figs. 7 and 8. The valve 23 has openings 61 62, forwardly and rearwardly, passing from the face to the center, the position of the openings being such that they register with the ports 48 49, in the rotation of the valve, and their relative positions such that when one is open the other is closed to the port adjoining.

63 64 are circumferential slots cut in the face of the valve 23, one at either end, such slots being so designed in length that when rotated to position they form connecting channels between the port 48 and the duct 42, and the port 49 and the duct 44, respectively. When the slot 63 interconnects the duct 42 with the port 48 the opening 61 is closed, and at the opposite end of the valve, for this same purpose, the opening 62 registers with the port 49. The valve 25 is substantially of the same form as that 23, save that it has the openings 65 66, and slots 67 68 in the reverse order, that is, the openings 65 66, are to the other side of the slot circumferentially than those 61 62.

69 70 are chambers formed in the casing 2, one at either end to the side face of the valve 25, and these are sufficient in length to interconnect or span between the slots 67 68, respectively, and the openings 65 66.

Referring to Figs. 7 and 8 it will be seen that when the forward slot 67 inter-connects the duct and port 43, 50, that the opening 65 is turned to the chamber 69, *i. e.*, closed with respect to the chambers 17 and 18, and that at the opposite end of the valve the port 51 is inter-connected through the slot 68, and the chamber 79 with the opening 66. The rotation of the valve gives a reversed position of the openings and the slots at the forward and rear ends of the valve.

As before stated the valves are controlled in both the forward and reverse position by a single operating lever and the manner in which this is effected I will now proceed to describe. A set of similar arms 71 are centrally pivoted to the casing by a bolt 72 screwing to the flange. 73 are links securely attached to the stems 26 of the valves 21, 22, 23, 25, and when the engine is not running the free ends of these links extend inwardly with the upper and lower set facing each other. 74 75 are sets of connecting rods between the links 73 and the extending ends of the bars 71, being attached to the bars and links by pins 76. The lower end of the rod 74 and the upper end of the rod 75 are held by single pins passing across between the plates 71. 73× is a link attached securely to the stem 26 of the valve 24, such link extending with its free end towards the link on the valve stem of the valve 23. A rod 77 connects the free end of the link 73× with the extending end of the pin 76, which attaches the rods 74 75, controlling the valves 21 and 23 to the plates 71.

78 is a quadrant carried by brackets 79 bolted at their inner ends to the face of the casing 3.

80 is an operating handle or lever secured rigidly at its lower end to the stem 26 of the valve 20. The lever carries a detent 81 adapted to operate in the teeth of the quadrant, and the detent is controlled by the ordinary hand latch and spring. The lower end of the lever 80 carries an arm 82 extending at right angles to the body and toward the opposite side to that of the links 73×.

83 is a rod connecting the free end of the

arm with the extending end of the pin 76 which interconnects the rods 74 75 controlling the motion of the valves 22 25.

To better understand the operation of my engine I consider it advisable to outline the position of the valves when the engine is standing still and then describe the cycle of operation of the steam for both the forward and reverse rotation of the engine. In Fig. 2 of the drawings I have shown the position of the links and rods for the stationary condition of the engine. In this position the openings 55 55× in the valve 20 are turned so that neither of them register with the ports 39, 40, 41, or 39×, 40×, 41×. The valves 21 22 have their openings 57 and 58 in the position as shown, dotted, in Fig. 4, that is, with neither of them registering with the ports 46 and 47. The slots 63 64, 67 68, respectively, of the valves 23 25, do not inter-connect any of the ports and ducts leading from the central chamber to the side chambers. The openings 59 60, in the valve 24, do not register with the ducts 51× 52, 53 54, but are in a midway position between that shown in Fig. 7 and that shown in Fig. 8. According to the above description all the valves may be termed closed.

As an aid in understanding the various motions of the valves I have shown arrows, giving the direction of rotation for throws of the lever, the full line arrows showing the direction in which the valves move when the lever is being turned to admit steam to the chambers for forward or right hand rotation of the rotor, and the dotted arrows show likewise the reverse or left hand rotation of the rotor. In Fig. 6 the position of the valve 20 is such that steam may enter through all the openings to the ports 39× 40× 41×.

The cycle of operation of the steam when the lever is thrown from the central position to the extreme left (forward rotation) is as follows:—The live steam is admitted through the ports 39 40 and 41 to the chamber 17, and there expands carrying the wings with it. From this chamber it exhausts through the ducts 44 45 to the ports 49 51, being communicated from the ducts to the ports by virtue of slots 64 and 68. The ports 49 51 direct the steam to the chambers 16 and 18, respectively, and there it is again expanded exhausting through the ducts 46 leading direct to the center of the valves 21 and 22 which are directly connected to the exhaust pipes 32 33. The steam which may have leaked or otherwise gotten forward of the wings, in the central chamber, when they have passed the ducts 44 45, is exhausted through the ports 39× 40× 41× to the spiral slot 56 which is directly connected through the duct 38 to the chamber 30. From the chamber 30 this steam passes directly through the by-pass 31 to the center of the valve 24 where it is deflected through the ducts 51× 52 intermingling with the initial exhaust from the central chamber through the ducts 44 45. The steam carried forward of the blades in the chambers 16 and 18 passes directly to the exhaust pipes 32 33, through the ports 48 and 50. The position of the valve 23 is such that the opening 61 communicates directly from the port 48 to the center of the valve, in this way directly to exhaust, and at the same time the position of the valve 25 is such that the slot 67 inter-connects the port 50 with the opening 65 by virtue of the chamber 69, in this wise connecting the port 50 directly with the exhaust pipe 32.

In the above description it will be understood that all openings, other than those directly mentioned, are closed, allowing for no passage of steam.

The cycle for operation of the steam when the lever is thrown to the reverse position is as hereinafter described, the position of the valves being practically the reverse to that above. To avoid prolixity it will be assumed that the position of the valve 20 is completely understood by reference to Fig. 6 of the drawing. The steam enters the central chamber through the ports 39× 40× 41× and is expanded within the chamber exhaust-side chambers 16 and 18, and in this case the ing through the ports 42 43, directly to the inter-connection can be seen in referring directly to Fig. 8 of the drawings. Within the second chamber the steam is again expanded and exhausts through the ports 47 and passes to the exhaust pipes 32 33, through the openings 58 in the valve 21. The steam which is carried forward of the wings in the central chamber past the ducts 42 43, exhausts through the ports 39 40 41 to the spiral slot 56 and directly through the opening 38 to the chamber 30 and thence to the by-pass 31. From the pipe 31 it enters the opening in the center of the valve 24 and is deflected through the ducts 51× 52 and there intermingles with the initial exhaust steam from the ducts 44 45, being then carried directly to the chambers 16 and 18. The steam which is carried forward by the wings from the chambers 16 and 18 exhausts through the ports 49 51, directly to the center of the valve 23 25, and from there to the exhaust pipes 34 35. The position of the valves allowing for this latter direct exhaust is shown in Fig. 7, and needs no further explanation.

What I claim as my invention is:

1. In a rotary steam engine the combination with the rotor carrying reciprocating wings and the inclosing casing having internal elliptical grooves forming piston chambers for the wings, of a system of hollow cylindrical valves controlled and operated for both the forward and reverse rotation of the rotor by a single lever, to admit live steam to the central chamber, to exhaust from the central chamber to the adjoining chambers,

to exhaust from the side chambers to atmospheric pressure, to allow for exhaust from the central chamber to the adjoining chambers of steam carried forward of the wings beyond the initial exhaust in the central chamber, and to allow for the exhaust to atmospheric pressure of steam carried forward by the wings past the initial exhaust, from the side chambers, as and for the purpose specified.

2. In a rotary steam engine the combination with the rotor carrying sets of wings adapted to reciprocate within pockets in the rotor and an inclosing casing formed from two separate castings having internal grooves forming piston chambers to receive the reciprocating wings, of a system of hollow cylindrical valves inter-linked and controlled by a single lever, for both forward and reverse rotation of the rotor governing the passage of the steam to and from the chambers, said system of valves consisting in an upper central valve, communicating with the live steam pipe, and carrying a set of openings toward either end and at opposite sides, the openings passing from the face to the center and a spiral groove on the face, the openings being adapted to register in the rotation of the valve with the ports passing to the central chamber, and the spiral groove being adapted to inter-connect the central chamber with an upper chamber, a set of upper side valves having openings toward either end, and out of alinement, adapted to register in the rotation of the valves with ports communicating with the side chambers, a central lower valve having a set of openings towards either end passing from the face to the center and out of alinement the one with the other, the said openings being adapted in the rotation of the valve to communicate with ducts leading from the face of the central chamber, a lower side valve having openings toward either end, passing from the face to the center, and carrying facial slots one toward either end, the slots and the openings, respectively, in the valve being out of alinement, the slots being adapted to inter-connect in the rotation of the valve, the adjoining chamber with the latter ducts from the central chamber, and the openings being adapted, in the rotation of the valve, to register with the ports from the adjoining chamber, a lower opposing side valve having openings toward either end passing from the face to the center, and carrying facial slots, one toward either end, the slots and openings, respectively, being out of alinement the one with the other, the slots being adapted in the rotation of the valve to inter-connect the ports in the adjoining chambers with the aforesaid ducts, leading from the central chamber and further, in a reverse rotation, to inter-connect the ducts leading from the adjoining chamber through side openings in the casing with the openings in the valve, a by-pass connecting the aforesaid upper chamber with the open end of the lower central valve, and exhaust pipes inter-connecting the open ends of the upper and lower side valves in pairs, as and for the purpose specified.

3. In a rotary steam engine the combination with the central chamber formed between the stator and the rotor, of a hollow cylindrical valve having sets of openings, a set towards either end and at the opposite sides, the openings passing from the face to the center of the valve, sets of ports passing from the face of the valve to the chamber, there being a port to register with each opening, the said openings being adapted to admit full pressure steam both for forward and reverse rotation of the rotor at predetermined points of the stroke of the piston, as and for the purpose specified.

Signed at Winnipeg, in the Province of Manitoba, this 25th day of March, 1907.

JAMES SHAW.

Witnesses:
A. WILLISCRAFT,
GERALD S. ROXBURGH.