No. 662,547. Patented Nov. 27, 1900.

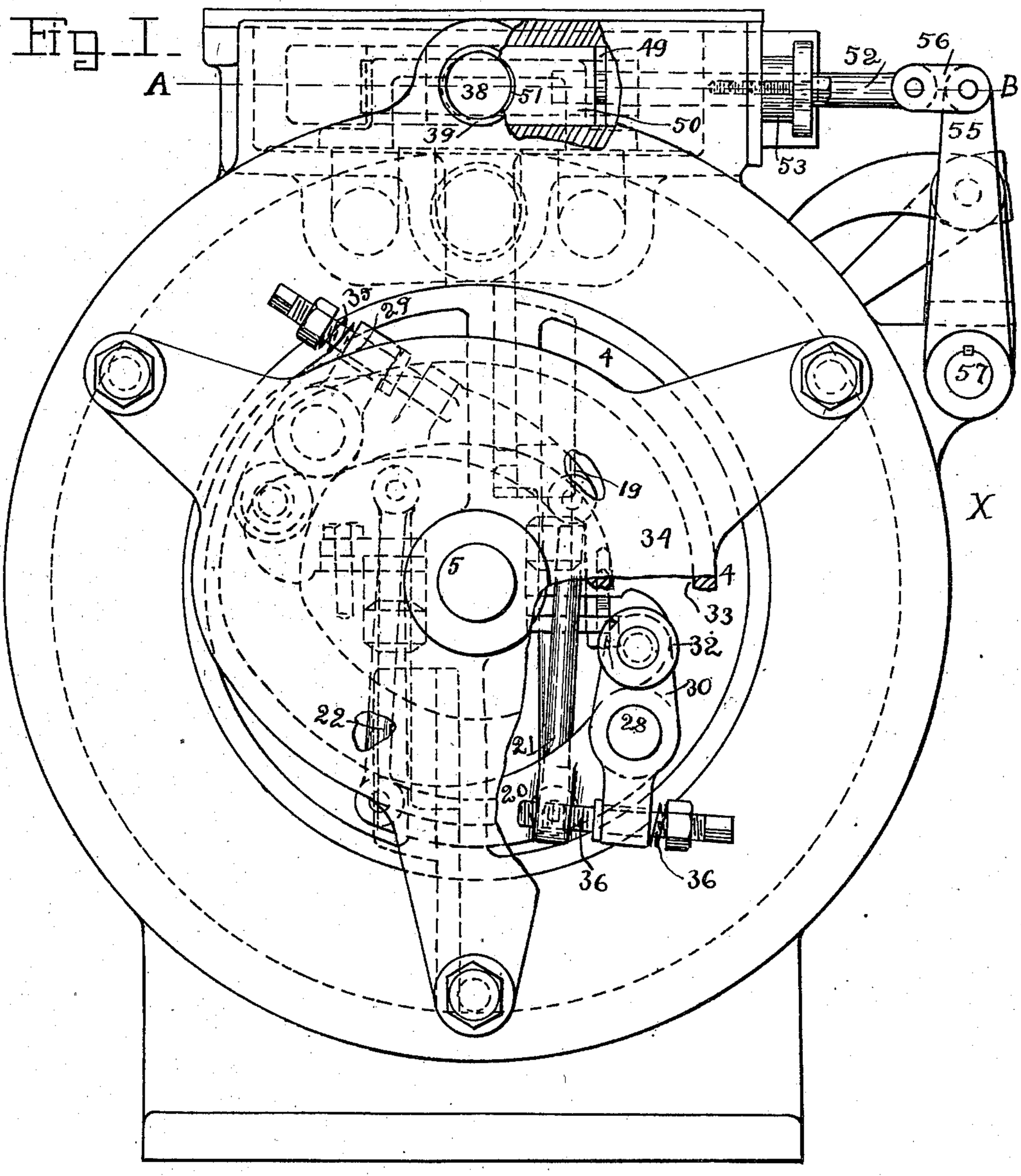
V. & G. SANDAHL.

ROTARY ENGINE.

(Application filed June 21, 1900.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.



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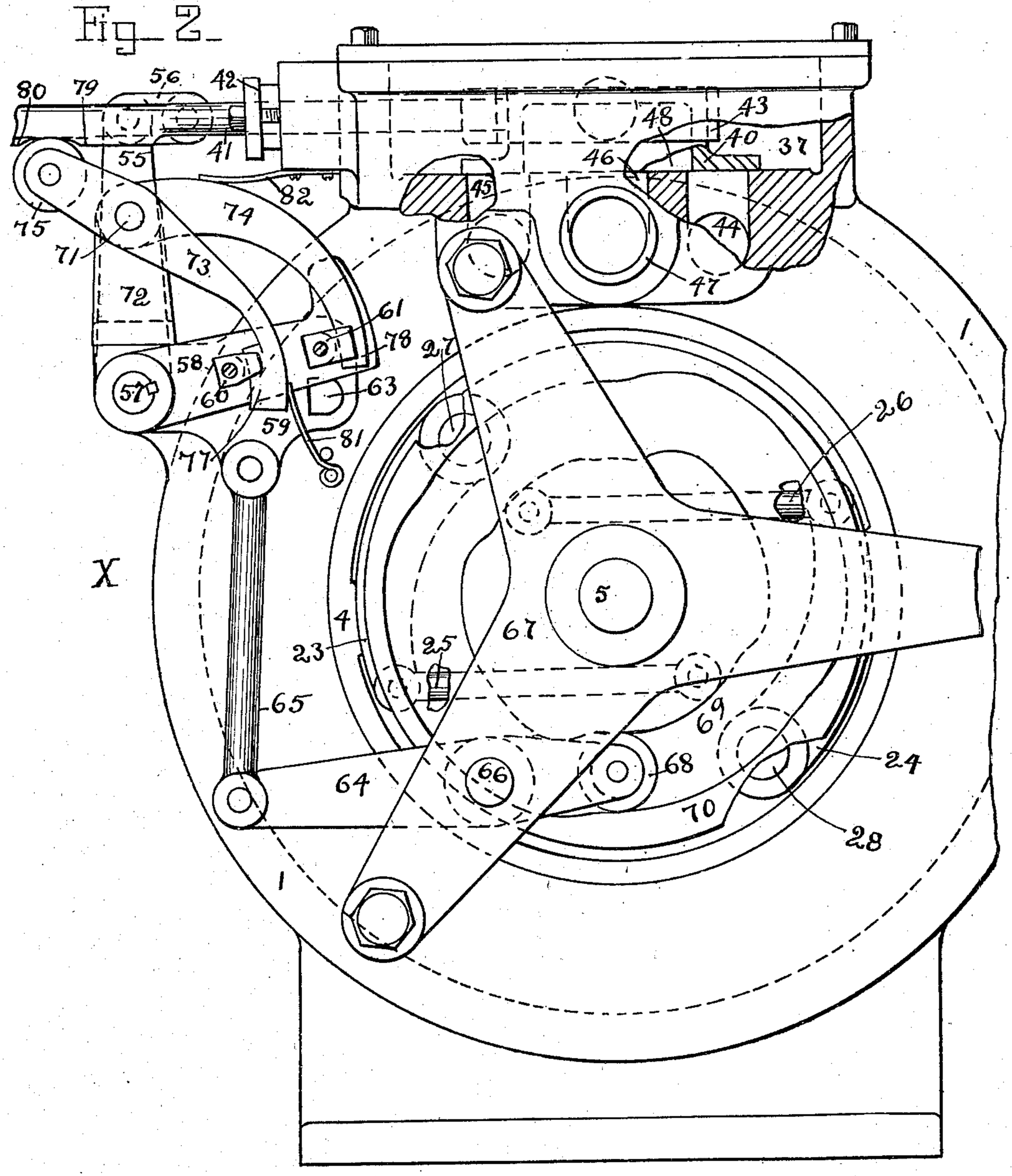
(No Model.) 6 Sheets—Sheet 2.

Fig. 2.



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(No Model.) 6 Sheets—Sheet 3.

Fig. 3.

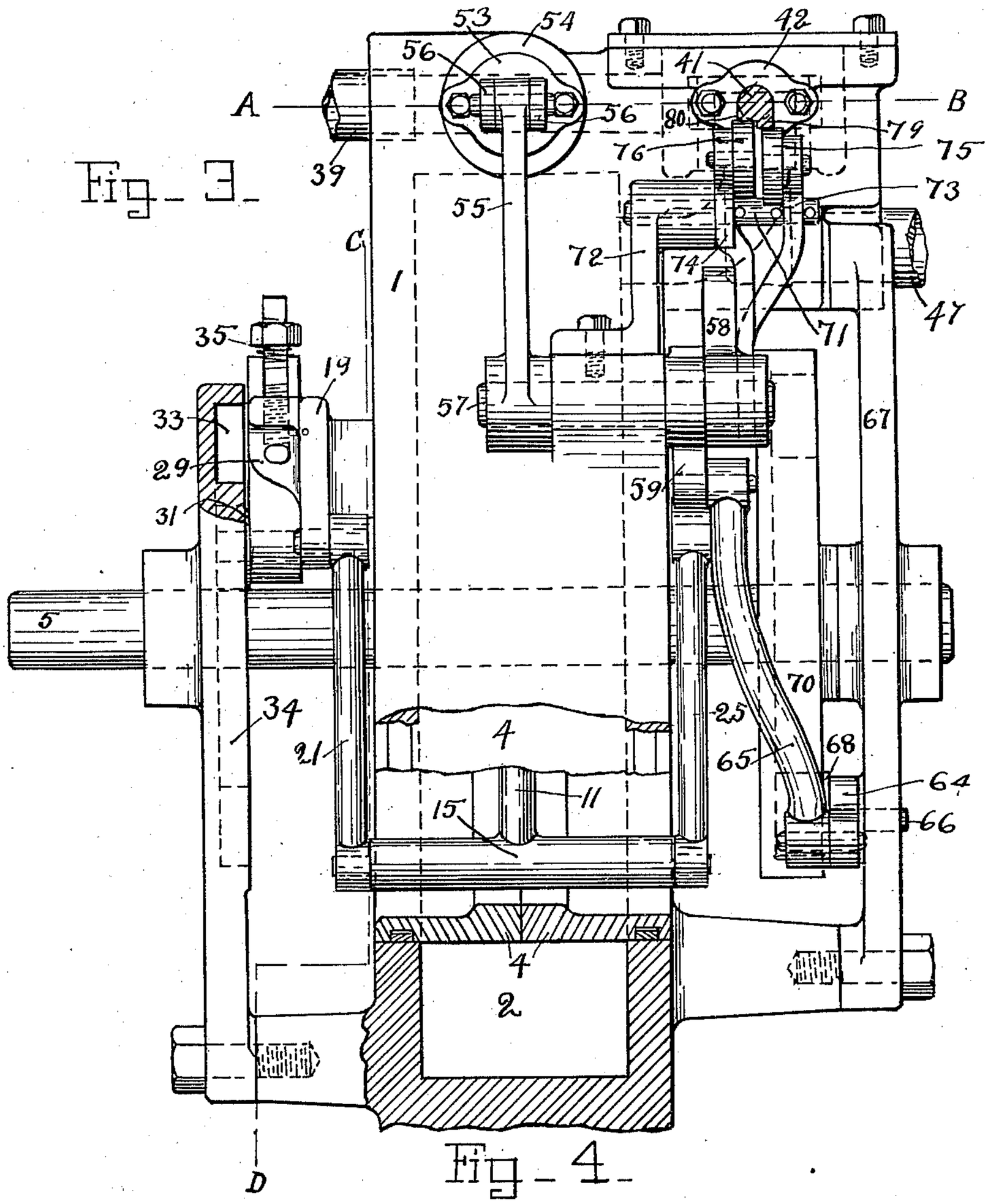
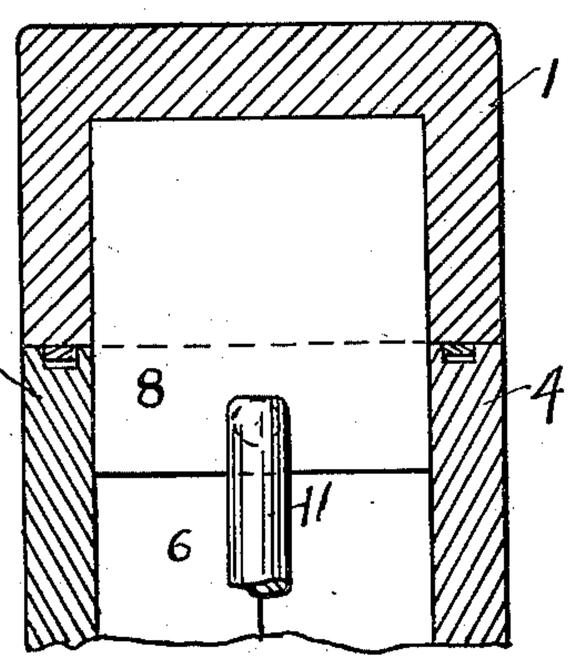


Fig. 4.



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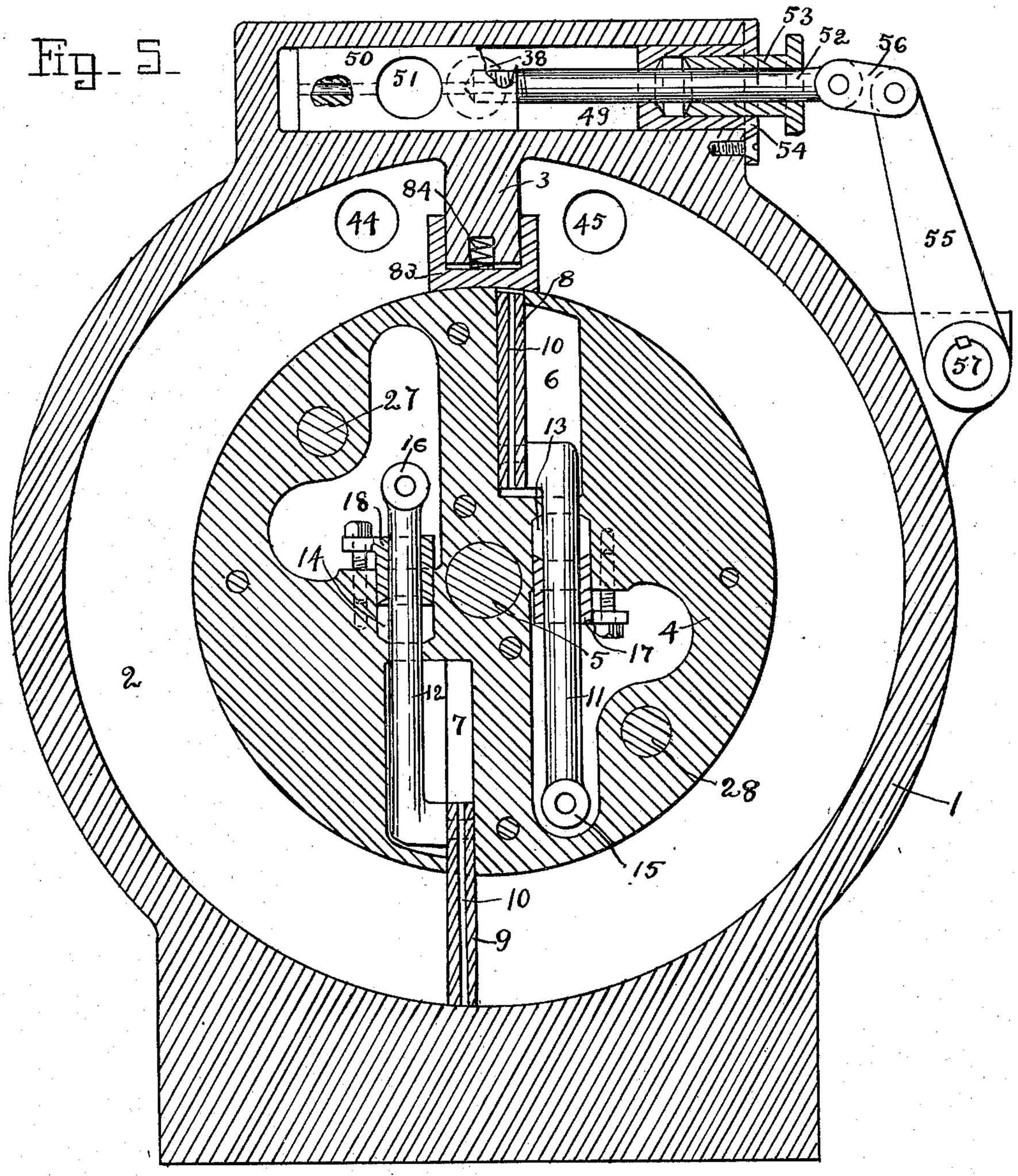
(No Model.) 6 Sheets—Sheet 4.

Fig. 5.



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(No Model.) 6 Sheets—Sheet 5.

Fig. 7

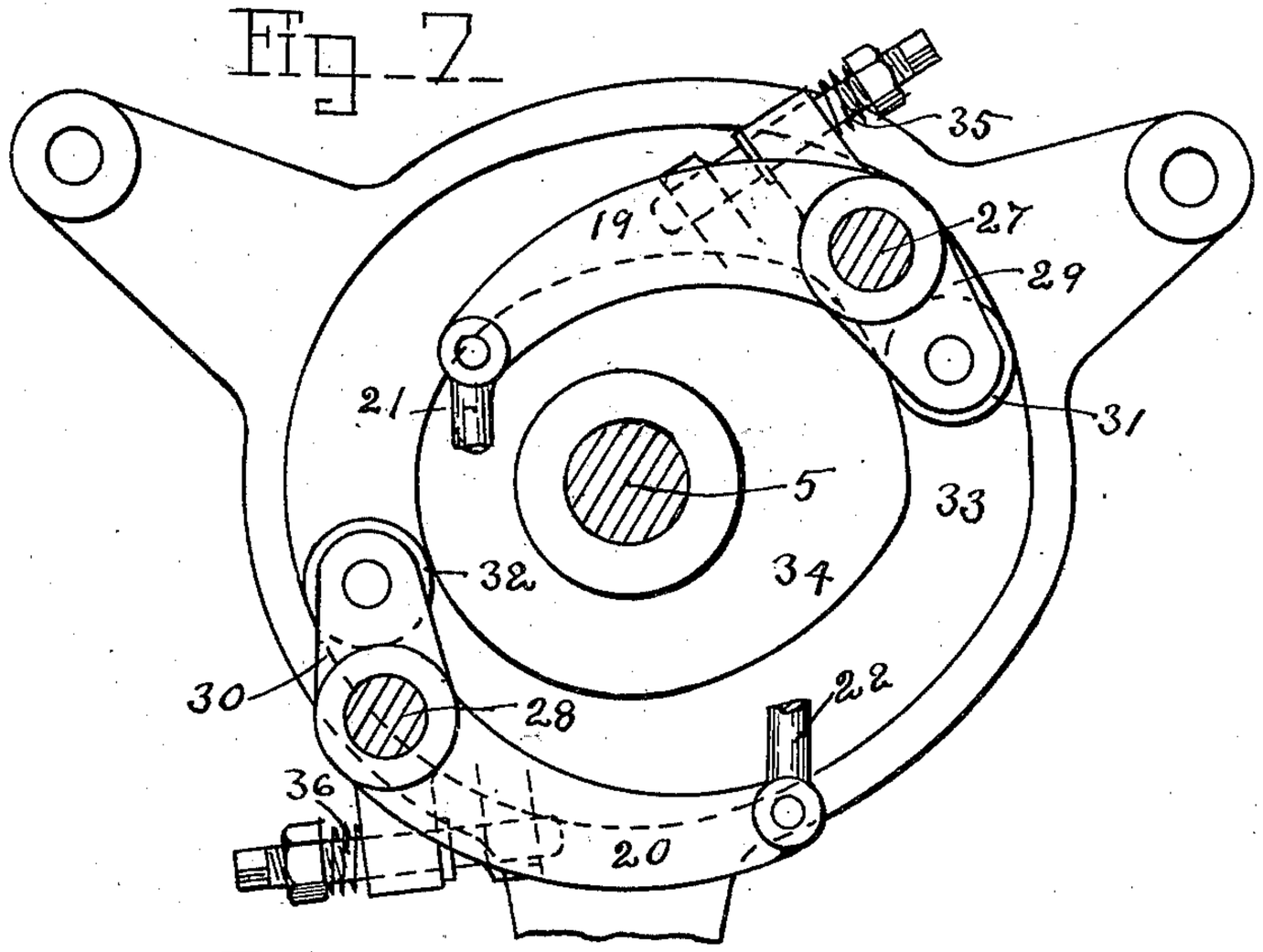
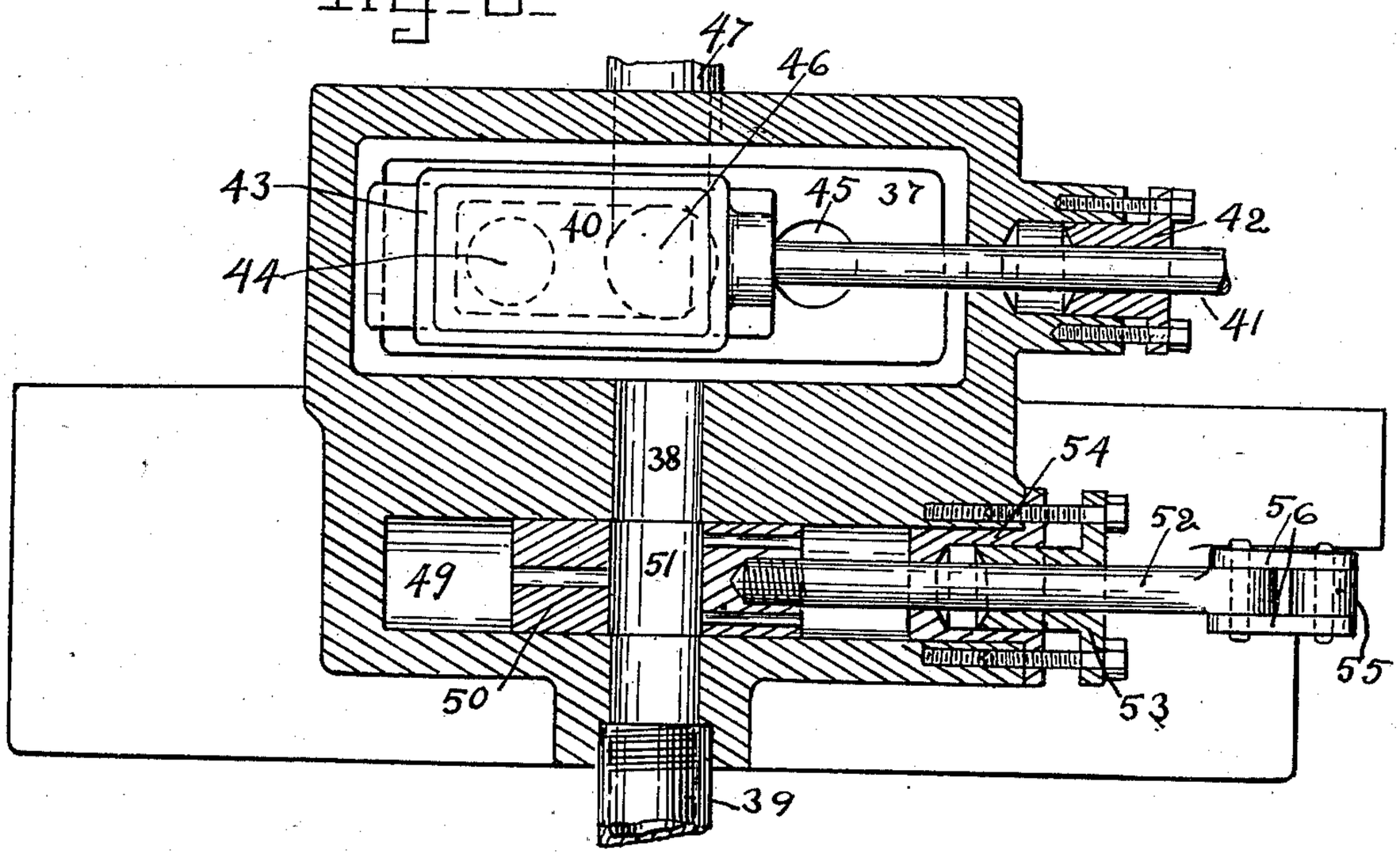


Fig. 6



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(No Model.) 6 Sheets—Sheet 6

Fig. 8.

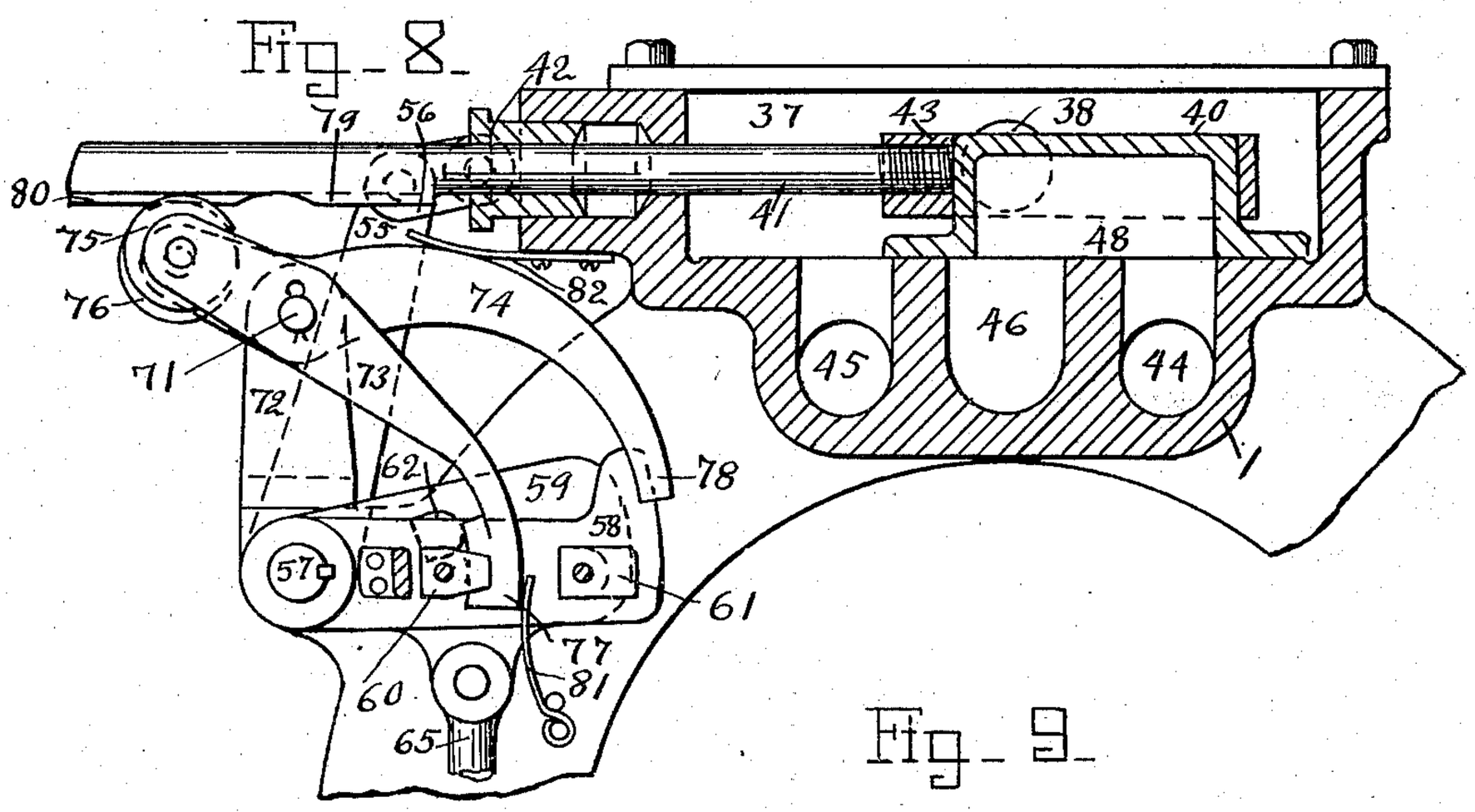


Fig. 9.

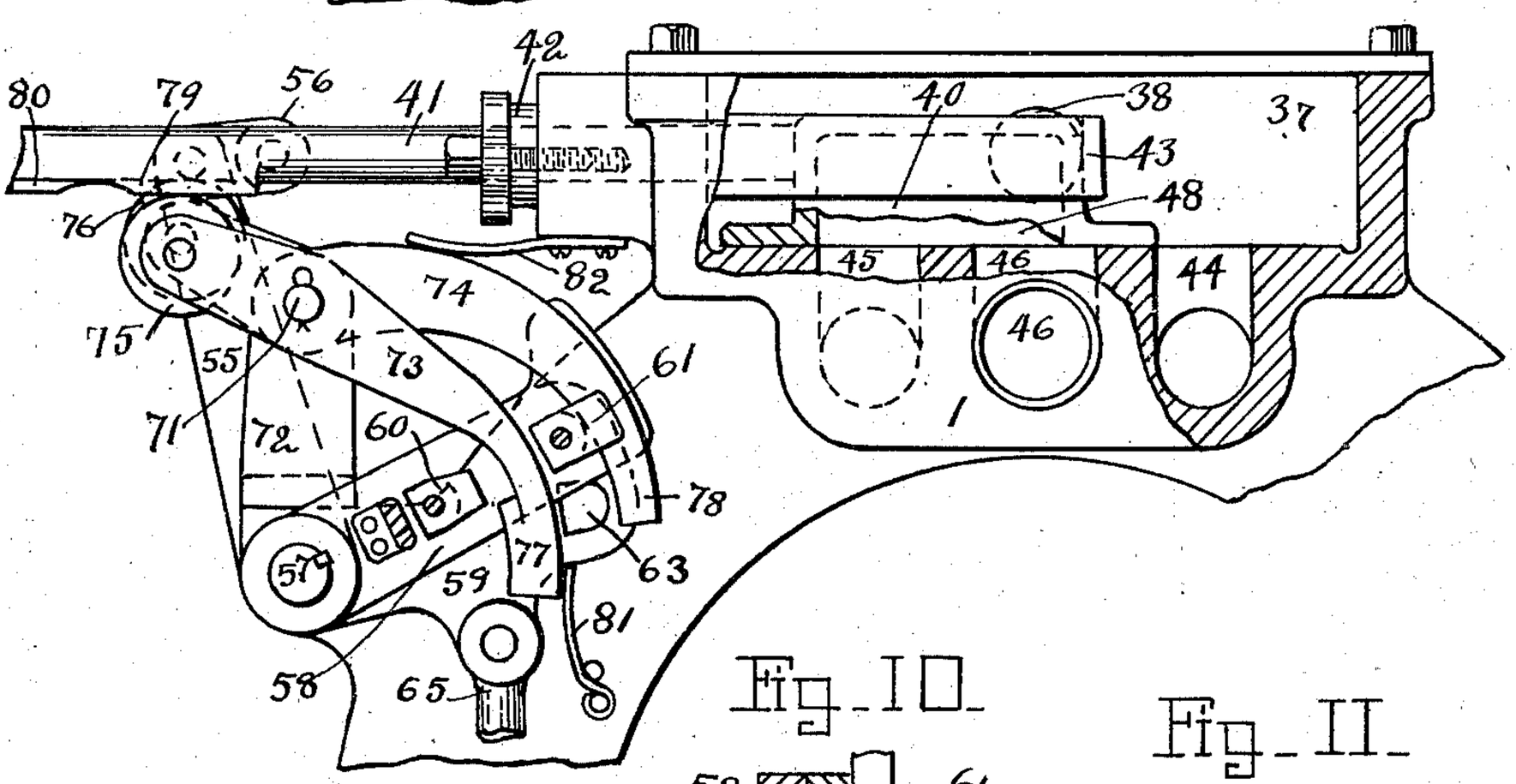


Fig. 10.

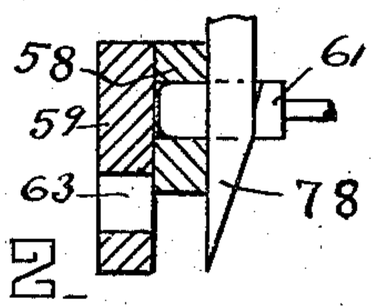


Fig. 11.

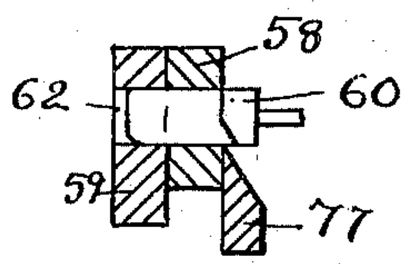
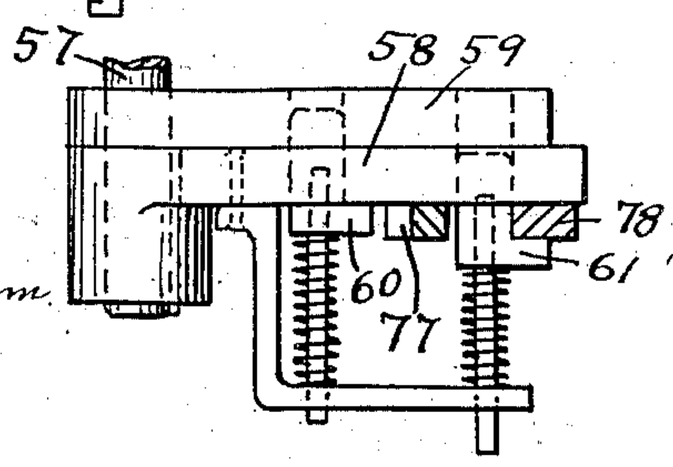


Fig. 12.



Witnesses

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Inventors

Victor Sandahl

Gustaf Sandahl

UNITED STATES PATENT OFFICE.

VICTOR SANDAHL AND GUSTAF SANDAHL, OF BOSTON, MASSACHUSETTS, ASSIGNORS OF ONE-THIRD TO EDWIN T. FREEMAN, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 662,547, dated November 27, 1900.

Application filed June 21, 1900. Serial No. 21,075. (No model.)

To all whom it may concern:

Be it known that we, VICTOR SANDAHL and GUSTAF SANDAHL, 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 improvements in rotary engines, and has for its object the production of a compact, effective, and substantial engine in which the motive fluid used may be used in an economical manner and which is not liable to easily get out of order.

The invention consists of the novel constructions, arrangements, and combinations of parts, as will be fully described hereinafter and claimed, and it is carried out substantially as illustrated on the accompanying drawings, forming an essential part of this specification, and whereon—

Figure 1 represents a side elevation of a rotary engine embodying this invention as seen from one side of the engine and showing portions broken away to disclose constructions and mechanisms which would otherwise be concealed. Fig. 2 represents an opposite side elevation of the engine, also showing parts broken away for a similar purpose. Fig. 3 represents a view of the engine as seen from X in Figs. 1 and 2, also showing a portion broken away. Fig. 4 represents a longitudinal section of a portion of the casing or shell of the engine and showing a piston-head moved out into the piston-way and in position to cause the rotation of the driven or main shaft of the engine. Fig. 5 represents a central cross-section of the engine. Fig. 6 represents a horizontal section on the line A B, shown in Figs. 1 and 3. Fig. 7 represents a vertical section on the line C D, shown in Fig. 3. Figs. 8, 9, 10, 11, and 12 represent detail views of portions of the cut-off mechanism to cause the cutting off of the motive fluid at the desired part of the movement of the piston-head within the piston-way.

Like characters refer to like parts wherever they may occur on the different parts of the drawings.

The engine has a stationary casing or shell 1, within which is made the circular cavity forming the piston-way or cylinder 2, in which the pistons move when the engine is in operation. Within the piston-way is made a stationary abutment 3, for a purpose to be clearly understood by the further description of the engine. Within the central cylindrical opening of the casing of the engine is rotatably mounted the piston hub or carrier 4, the outer cylindrical surface of this piston-hub forming the inner cylindrical wall of the piston-way 2. This piston-hub is firmly mounted upon the main or driven shaft 5 of the engine and, as shown, has two internal chambers 6 and 7, within which are placed the respective pistons and piston-heads 8 and 9, which are adapted to be reciprocated in substantially radial lines from the main shaft into and from the piston-way through slots in the outer circular surface of the piston-hub and by mechanism to be described hereinafter. The pistons are each provided with a perforation 10, passing longitudinally through them, which perforations admit of the free entrance of motive fluid from the piston-way to the chambers within the piston-hub containing said pistons, and by this means the pistons are substantially balanced, so that they may be easily reciprocated when desired.

The pistons 8 and 9 are provided with the respective piston-rods 11 and 12, which extend through perforations in the piston-hub into the respective chambered perforations 13 and 14 in said hubs, where said pistons are preferably provided with the respective T-heads 15 and 16, substantially as shown. The motive fluid is prevented from escaping from the chambers 6 and 7 by means of the respective stuffing-boxes 17 and 18. The T-heads on the piston-rods are each connected at one end to the respective levers 19 and 20 by means of the respective connecting-rods 21 and 22, and said T-heads are each connected at the opposite end to the respective levers 23 and 24 by means of the respective connecting-rods 25 and 26. The levers 19 and 23 are rigidly mounted upon a shaft 27, rotatably mounted within bearings in the piston-hub 4, while the levers 20 and 24 are rigidly mounted upon a similar shaft 28, also rotatably mounted within bearings in the piston-hub 4. The shafts 27 and 28 project at one side beyond the above-mentioned levers

and are there provided with the respective levers 29 and 30. The levers 29 and 30 are provided with the respective cam-rolls 31 and 32, which enter the cam-groove 33 in a cam 34, rigidly attached to the casing 1, and said levers 29 and 30 are adjustably attached to the respective levers 19 and 20 by means of the respective yielding connections 35 and 36 of any suitable construction and arrangement.

The piston-hub 4 is rotated with the driven shaft and within the cylindrical opening in the casing and carries with it the shafts 27 and 28, with their attached levers 29 and 30, and consequently causes the cam-rolls 31 and 32 to travel in the cam-groove 33, which is so shaped that it acts upon the cam-rolls to cause them to rock their respective shafts 27 and 28 within their bearings in the piston-hub and through the connections between these shafts and the respective pistons 8 and 9 to cause the reciprocations of said pistons into or from the piston-way 2, the yielding connections between the levers 19 and 29 and between the levers 20 and 30 preferably being adjusted so as to yield slightly when the pistons reach the outer surface of the piston-way in order to maintain a tight joint between the pistons and piston-way as said parts wear and allow slight variations in the cam. It will be understood that the cam-groove may be formed so as to cause the movements of the pistons to be made more or less rapid, as desired, and so that they will be brought out against the outer circumference of the piston-way and into operative position within the piston-way more or less quickly after passing under the abutment 3. By connecting the piston-rods to the mechanisms which operate them in such a manner that the connections are made on both sides of the piston-hub we are able to obtain a more easy movement of the pistons than if the connections were made on one side of the hub alone, as there will be no liability of the pistons becoming cramped, and therefore it will prevent friction on the pistons or piston-rods.

The casing 1 is provided with the steam-chest 37, preferably arranged at the top of the casing and at one side thereof, as shown in Figs. 2 and 3. The inlet-passage 38 to the steam-chest from the steam-supply pipe 39 is made within the casing 1 and across the top of the same. Within the steam-chest is arranged the slide or D valve 40, which acts as a throttle-valve, whereby steam is admitted to the piston-way 2 on each side of the abutment 3 or is entirely cut off from said piston-way, as desired, and said valve is operated by means of a valve-rod 41, which reciprocates through a stuffing-box 42 in the walls of the steam-chest and is provided with a strap 43, surrounding said valve. The valve-rod 41 is reciprocated by hand to regulate the direction in which the piston-hub will rotate within the casing or to stop its rotation, as desired.

Two ports 44 and 45 form communication between the steam-chest and the piston-way 2 on opposite sides of the abutment 3 in said piston-way, and a third port 46, located between the ports 44 and 45, forms communication between the steam-chest and an exhaust-pipe 47. The valve 40 is arranged so that when in its central position it will cover all of said ports, as shown in Fig. 2, and thus prevent steam from the steam-chest from entering either of said ports, or it can be moved to each side from its central position, so as to expose either of the ports 44 or 45, as shown in Figs. 8 and 9. The port 46 will always be in open communication with the chambered recess 48 in the under side of the valve 40. When the valve is moved to one side, so as to expose the port 44 to the steam-chest, the ports 45 and 46 will be in open communication with the chambered recess in the valve, and when the valve is in this position the valve 44 will be the inlet-port to the piston-way, while the port 45 will be its exhaust-port. Thus steam will be admitted to one side of the abutment. When the valve is moved to the opposite end of its movement, the port 45 will be exposed to the steam-chest and the ports 44 and 46 will be in open communication with the recess in the valve and the port 45 will be the inlet-port to the piston-way, while the port 44 will be the exhaust-port. Thus steam will be admitted to the piston-way on the opposite side of the abutment than when the valve is at the opposite end of its stroke. As the abutment 3 is stationary and the piston-hub is rotated by the expansion of the steam between said abutment on the piston-head, which is moved outward into the piston-way from the piston-hub by the mechanism above described, it will be seen that the piston-hub may be rotated in either direction, according to the port 44 or 45, which is in open communication with the steam-chest and forms the inlet-port to the piston-way. Therefore the valve 40 forms a means whereby the direction of the rotation of the piston-hub and the driven shaft to which it is attached may be reversed, if so desired, and is both a throttle and reversing valve.

The cam-groove 33 is preferably so shaped that it will cause the piston-heads to be forced outward to their fullest extent when said piston-heads have rotated substantially one-quarter of a complete revolution from the abutment and to remain in said outward position until they have rotated substantially three-quarters of a complete revolution, or, in other words, the piston-heads preferably remain in their extreme outward position during substantially one-half of a complete revolution of the piston-hub.

In order to use the steam economically and to obtain the best results from it when admitted to the piston-way through the inlet-ports, it is desirable that there should be a suitable cut-off mechanism arranged to cut off the supply of steam to the piston-way after the piston has been forced thereby a sufficient portion of its rotation and to allow the com-

pletion of the rotation to be made by the expansion of the steam thus confined. The mechanism employed to cause the supply of steam to be cut off at the desired time is best illustrated in Figs. 2, 5, 6, 8, 9, 10, 11, and 12 of the drawings.

Within the casing 1 and across the inlet-port 38 therein, which leads to the steam-chest, is formed the cavity 49. Within this cavity is placed a block or slide 50, forming a cut-off valve, as hereinafter described, which valve is free to be reciprocated crosswise of the passage 38, but which preferably otherwise closely fits said cavity. A perforation or port 51 is made through the valve 50, which perforation is caused to register with the port 38 or to move to either side of said port by the reciprocations of said valve. It will thus be seen that the entrance of steam to the steam-chest through the port 38 may be controlled by the movements of this cut-off valve. A valve-stem 52 is attached to the cut-off valve and projects through a stuffing-box 53 in the casing 1 or in a cap 54, attached to the casing and forming one end of the cavity 49. The outer end of the valve-stem 52 is attached to a lever 55 by means of the links 56. The lever 55 is firmly mounted upon a shaft 57, rotatably mounted in bearings in a projecting ear on the side of the casing 1. On the outer end of the shaft 57 is firmly mounted the lever 58, and between the lever 58 and the casing 1 is a lever 59, which is loosely mounted upon the shaft 57. The lever 58 carries two spring-pressed locking-pins 60 and 61, which enter the respective perforations 62 and 63 in the lever 59 and lock the levers 58 and 59 firmly together in different relation to each other, as will be clearly described hereinafter and for a purpose to be understood by a further description of the invention. The lever 59 is connected to the end of the lever 64 by means of the connecting rod or link 65, which latter lever is fulcrumed at 66 to a tripod-bracket 67, secured to the casing 1 and forming a bearing for the driven shaft of the engine. A cam-roll 68 is mounted upon the lever 64, which roll engages a cam-groove 69 in the cam 70, mounted upon the rotary driven shaft of the engine. The cam-groove 69, acting upon the cam-roll 68, causes the lever 64 to rock upon its fulcrum and by its connection causes the lever 65 to intermittingly vibrate.

Fulcrumed at 71 to a bracket 72, attached to the casing 1, are two levers 73 and 74, which are provided at one end with the respective cam-rolls 75 and 76, the opposite ends of the levers being provided with the respective wedge-shaped portions 77 and 78, as shown in Figs. 10 and 11 and for a purpose to be described hereinafter. The cam-rolls 75 and 76 engage the respective cam-surfaces 79 and 80 on the valve-stem 41 of the throttle-valve 40, they being held in engagement with said cam-surfaces by means of the respective springs 81 and 82 or by equivalent means.

The wedges 77 and 78 are for the purpose of engaging the respective side projections 83 and 84 on the locking-pins 60 and 61 when said wedges are brought into the path of said pins by the respective cams 79 and 80 and for the purpose of forcing said pins outward against the influence of the springs thereon, and thereby unlocking the levers 58 and 59 from each other.

The operation of the above-described cut-off mechanism is substantially as follows: The cam 70 being attached to the driven shaft, is rotated with said shaft, and the cam-groove upon said cam is so shaped that it imparts an intermitting vibration of the lever 59 upon the shaft 57 through the lever 64 and link or connecting rod 65. The cams 79 and 80 are so shaped that the low parts of both cams are in engagement with their respective cam-levers when the engine is at rest and the slide or throttle valve 40 is in its central position, as shown in Fig. 2, and therefore the wedge-shaped ends of the levers 73 and 74 will be beneath the heads of the respective locking-pins 60 and 61, which will cause the lever 59 to be disconnected from the lever 58. Now if the throttle-valve is moved in any direction from this central position one or the other of the levers 73 or 74 will be turned upon its fulcrum, so as to remove its wedge-shaped end from beneath the head of the spring-pressed locking-pin with which it has been in engagement and will allow said pin to be forced by its spring into the locking-perforation 62 or 63, which is brought into line with said pin by the vibration of the lever 59, above described. The cut-off valve 50 is so arranged that its port is in line with the inlet-passage 38 when the throttle-valve is in its central position and the engine is at rest, as the low portions of the cam-surfaces 79 and 80 are then in engagement with the levers 73 and 74, as above set forth, and the levers 58 and 59 are disconnected from each other. Now as the direction in which the engine is to rotate depends upon the direction the throttle-valve is moved from its central position, and as the desired portion of the rotating of the piston in the piston-way at which steam shall be cut off by the cut-off valve varies with the direction in which the engine is rotating, and also as the cam which operates the cut-off valve is fixed upon the driven shaft and consequently causes a uniform vibration of the lever 59, it is obvious that the cut-off valve should be opened at one end of the vibrations of the lever 59 when the driven shaft is turned in one direction and at the opposite end of its vibrations when the driven shaft is turned in the opposite direction. In order to accomplish this result, the perforations 62 and 63 are so arranged upon the lever 59 that the levers 58 and 59 will be coupled together in different relation to each other by the respective locking-pins 60 and 61, so that when the lever 59 is vibrated it will move the cut-off valve in one or the other direction from its central position, according to which of the

locking-pins is pressed into its locking-perforation. In other words, when the valve 40 is in the position shown in Fig. 8 the lever 74 will be withdrawn from under the head of the locking-pin 61, and said pin will enter the locking-perforation 63, which will cause the cut-off valve 50 to reciprocate within the outer half of the cavity 49 and so that the perforation 51 will register with the passage 38 when the lever 59 is at the lower end of its vibratory movement; but when the valve 40 is moved to the position shown in Fig. 9 the lever 73 will have been withdrawn from under the head of the locking-pin 60, allowing said pin to enter the perforation 62 and to lock the levers 58 and 59 in such relation to each other that the vibrations of the lever 59 will cause the reciprocations of the cut-off valve in the inner half of the cavity 49 and so that the perforation 51 in the cut-off valve will register with the passage 38 when the lever 59 is at the upper end of its vibrating movement. As the piston-heads, the cams which operate them, and the cam which causes the vibrations of the lever 59 are in fixed relative positions to each other, and as the use of a cut-off-operating mechanism substantially as described variably connecting the cut-off valve with the lever 59, causing the steam to be cut off at opposite ends of the vibrations of the lever 59, according to the direction of the rotation of the piston-head and driven shaft driven by said piston-heads, it will be seen that the steam is cut off at the same relative part of the stroke of the engine irrespective of the direction in which it is rotated.

In order to provide a steam-tight packing at the joint between the abutment 3 and the outer surface of the piston-hub 4, said abutment is ground or otherwise shaped with perfectly parallel side surfaces, and upon these side surfaces and extending around the abutment is placed the U-shaped packing-block 83, as shown in Fig. 5, which is free to move up and down against both parallel side surfaces of the abutment and has its lower end resting against the outer surface of the piston-hub. Springs 84 are inserted between the abutment and the U-shaped packing-block 83, which springs tend to press the packing against the piston-hub and to form a steam-tight joint at this place. The packing-block 84 is of such a depth that it will present sufficient surface to the pressure of steam within the piston-way, which is acting upon the piston-head to rotate the driven shaft, and that said block will be pressed against the side of the abutment with sufficient force to form a steam-tight joint between that side of the abutment and the packing-block. At the same time the steam within the piston-way will exert a pressure upon the upper end of the packing-block and assist the springs in forming a tight joint between the packing-block and piston-hub. By this construction a very effective packing for the abutment is obtained and the pressure upon the packing regulated according to the steam-pressure in the piston-way.

It will be understood that any desired expansive motive fluid may be used in the place of steam for a motive power in the engine herein described and that we do not wish to confine ourselves to the exact construction of parts as shown in the drawings, as well-known mechanical equivalents may be substituted for those shown without departing from the spirit of our invention. It will also be understood that this our improved rotary engine may be used as a hydraulic engine for pumping fluids, and when used as such we dispense with the cut-off and reversing mechanisms and drive the shaft 5 to force the fluid through the engine in the place of having said shaft driven by the motive fluid which passes through the engine.

Having thus fully described the nature, construction, and operation of our invention, we wish to secure by Letters Patent and claim—

1. In a rotary engine, a casing containing a piston-way, a piston-hub rotating in an opening in said casing, piston-heads reciprocating within said hub into and from the piston-way, piston-rods for said piston-heads, shafts rotatably mounted within the piston-hub, levers upon said shaft, connecting means between said levers and piston-rods, a cam, a cam-roll on one of the levers on each shaft operated by the cam to operate their respective levers, for the purpose set forth.

2. In a rotary engine, a casing containing a piston-way, a piston-hub rotating in an opening in said casing, a piston-head reciprocating within said piston-hub, a lever carried by said piston-hub, yielding connecting means between said piston-head and the lever, and means to vibrate said lever to cause the reciprocations of the piston-head, for the purpose set forth.

3. In a rotary engine, a casing, a piston-way within the casing, a piston-hub, a piston-head reciprocated into and from the piston-way, a lever carried by said piston-hub, and means to operate said lever, adjustable connecting means between said lever and piston-head whereby the movements of the piston-head can be adjusted, for the purpose set forth.

4. In a rotary engine, a casing, a piston-way within the casing, a piston-head reciprocated into and from the piston-way, a piston-hub carrying said piston-head, a shaft rotatably mounted in said piston-hub, a lever adjustably mounted upon said shaft, connecting mechanism between the lever and the piston-head, a cam to vibrate said lever to cause the movement of the piston-head, for the purpose set forth.

5. In a rotary engine, a casing containing a piston-way, a piston-hub rotating in an opening in said casing, a piston-head in said piston-hub, and adjustable yielding means to

move the piston-head into said piston-way and against the outer side thereof, for the purpose set forth.

6. In a rotary engine, a casing containing a piston-way, a piston-hub rotating in an opening in said casing, a piston-head reciprocating within said piston-hub, a lever carried by said piston-hub, adjustable yielding connecting means between said piston-head and the lever, and means to vibrate said lever to cause the reciprocations of the piston-head, for the purpose set forth.

7. In a rotary engine, a casing, a piston-way within the casing, a piston movable within the piston-way, a steam-chest, ports connecting the steam-chest and the piston-way, a valve controlling said ports to govern the direction of the movements of the piston, a passage in the casing to convey steam to the steam-chest, a valve controlling said passage, a driven shaft, connected mechanism between said shaft and the valve controlling said passage governed by the position of the valve in the steam-chest to cut off the supply of steam through said passage to the steam-chest, for the purpose set forth.

8. In a rotary engine, a driven shaft, means to drive said shaft, a passage conveying motive fluid to the engine to cause the driving of said shaft, a valve in said passage, automatic mechanism to operate said valve to open or to close said passage, automatic means to change the time of the movement of said valve in relation to the movement of said driven shaft, for the purpose set forth.

9. In a rotary engine, a driven shaft, means to drive said shaft, a valve to control the movement of the driven shaft, a passage conveying motive fluid to the engine to cause the driving of said shaft, a valve controlling said passage, connecting mechanism between the driven shaft and the passage-controlling valve to operate said valve to open and to close said passage, and connecting mechanism between said first valve and said second valve, whereby the movement of the second valve is governed by the movement of the first valve, for the purpose set forth.

10. In a rotary engine, a driven shaft, a reversing valve to control the direction of the rotation of the driven shaft, a passage conveying motive fluid to the engine, a valve controlling said passage, connecting mechanism between the driven shaft and the passage-controlling valve to operate said valve to open or close said passage, cams positioned by the movements of the reversing-valve, and intermediate mechanism connected to the passage-controlling-valve-operating mechanism, operated by said cams to regulate the time of the movement to open and close said passage, for the purpose set forth.

11. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve in said passage, a driven shaft, mechanism on said shaft to operate said valve, and means to automatically connect and disconnect said valve-operating mechanism and the valve, for the purpose set forth.

12. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve in said passage, a driven shaft, mechanism on said shaft to operate said valve, and connecting means between said valve-operating mechanism and the valve, and means to automatically adjust said connecting means, for the purpose set forth.

13. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve controlling said passage, a driven shaft, means on said shaft to operate said valve, and connecting means between said valve-operating means and the valve, and means to automatically adjust said connecting means, and to automatically disconnect said operating means and the valve, for the purpose set forth.

14. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve in said passage, a driven shaft, a valve to control the movement of the driven shaft, means on said shaft to operate said first valve, connecting means between said operating means and said first valve, and means governed by the position of said second valve, to disconnect said valve-operating means and said first valve, for the purpose set forth.

15. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve in said passage, a driven shaft, a valve to control the movement of the driven shaft, means on said shaft to operate said first valve, connecting means between said operating means and said first valve, and means governed by the position of said second valve, to adjust the connecting means between said valve-operating means and said first valve, for the purpose set forth.

16. In a rotary engine, a casing containing a piston-way, a piston, a passage conveying motive fluid to the piston-way, a valve in said passage, a driven shaft, a valve to control the movement of the driven shaft, means on said shaft to operate said first valve, connecting means between said operating means and said first valve, and means governed by the position of said second valve to adjust the connecting means between said valve-operating means and said first valve, and also to disconnect said valve-operating means and said first valve, for the purpose set forth.

17. In a rotary engine, a casing containing a piston-way, a rotating piston, and means to reverse the rotary movement of the piston, a passage conveying motive fluid to the piston-way, a cavity extending across said passage, a block in the cavity, a perforation in the block registering with said passage, operating mechanism to reciprocate the block whereby said

perforation is reciprocated in either direction from said passage, and means to automatically govern said operating mechanism whereby the direction of the reciprocation of the perforation in the block is dependent upon the direction of the rotation of the piston, for the purpose set forth.

18. In a rotary engine, a driven shaft, a valve to control the movement of the driven shaft, a passage conveying the motive fluid to the engine, a valve controlling the supply of motive fluid through said passage, a rock-shaft and connecting mechanism between the rock-shaft and said supply-controlling valve, a cam upon the driven shaft rotated therewith, a cam-lever operated thereby, two cams positioned by the movements of said driven-shaft-controlling valve, two cam-levers operated by said latter cams, two arms upon the rock-shaft, one loosely mounted thereon and the other firmly mounted thereon, two pins, each controlled by one of the cam-levers which are operated by the driven-shaft-controlling valve, cams to lock said arms together in different relations to each other and connections between the loosely-mounted arm and the cam-lever operated by the cam on the driven shaft, whereby the supply-controlling valve will be moved in opposite directions from its central position and will supply and cut off motive fluid at opposite parts of the rotation of the driven shaft dependent upon the position of the reversing-valve, for the purpose set forth.

19. In a rotary engine, a driven shaft, a valve to control the movement of the driven shaft, a passage conveying the motive fluid to the engine, a valve controlling the supply of motive fluid through said passage, a rock-shaft and connecting mechanism between the rock-shaft and said supply-controlling valve, a cam upon the driven shaft rotated therewith, a cam-lever operated thereby, two cams positioned by the movements of said driven-shaft-controlling valve, two cam-levers, wedge-shaped at their ends, operated by said latter cams, two arms upon the rock-shaft, one loosely mounted thereon and the other firmly mounted thereon, two pins each controlled by the wedge-shaped portion of one of the cam-levers which are operated by the driven-shaft-controlling valve, cams to lock said arms together in different relations to each other and connections between the loosely-mounted arm and the cam-lever operated by the cam on the driven shaft, whereby the supply-controlling valve will be moved in opposite directions from its central position and will supply and cut off motive fluid at opposite parts of the rotation of the driven shaft dependent upon the position of the reversing-valve, for the purpose set forth.

20. In a rotary engine, a driven shaft, a reversing-valve, to control the direction of the rotation of the driven shaft, a passage conveying motive fluid to the engine, a cavity extending across said passage, a block having a central perforation reciprocating in said cavity in either direction from a central position, and forming a valve to control the supply of motive fluid to the engine through said passage, a cam on the driven shaft, a separated connecting mechanism between said cam and the supply-controlling valve operated by said cam, two cams positioned by the movement of said reversing-valve, two locking-pins to lock said separated connecting mechanism together in different relative positions, and intermediate mechanisms between each reversing-valve cam and one of said pins controlling said pin, whereby the supply-controlling valve is reciprocated in opposite directions from its central position and supplies or cuts off motive fluid at opposite ends of its stroke dependent upon the position of the reversing-valve, for the purpose set forth.

In testimony whereof we have affixed our signatures in presence of two witnesses.

VICTOR SANDAHL.
GUSTAF SANDAHL.

Witnesses:
HENRY CHADBOURN,
N. A. PIERCE.