G. H. GROSS.

ROTARY ENGINE.

APPLICATION FILED NOV. 3, 1909.

968,653.

Patented Aug. 30, 1910.

3 SHEETS—SHEET 1.

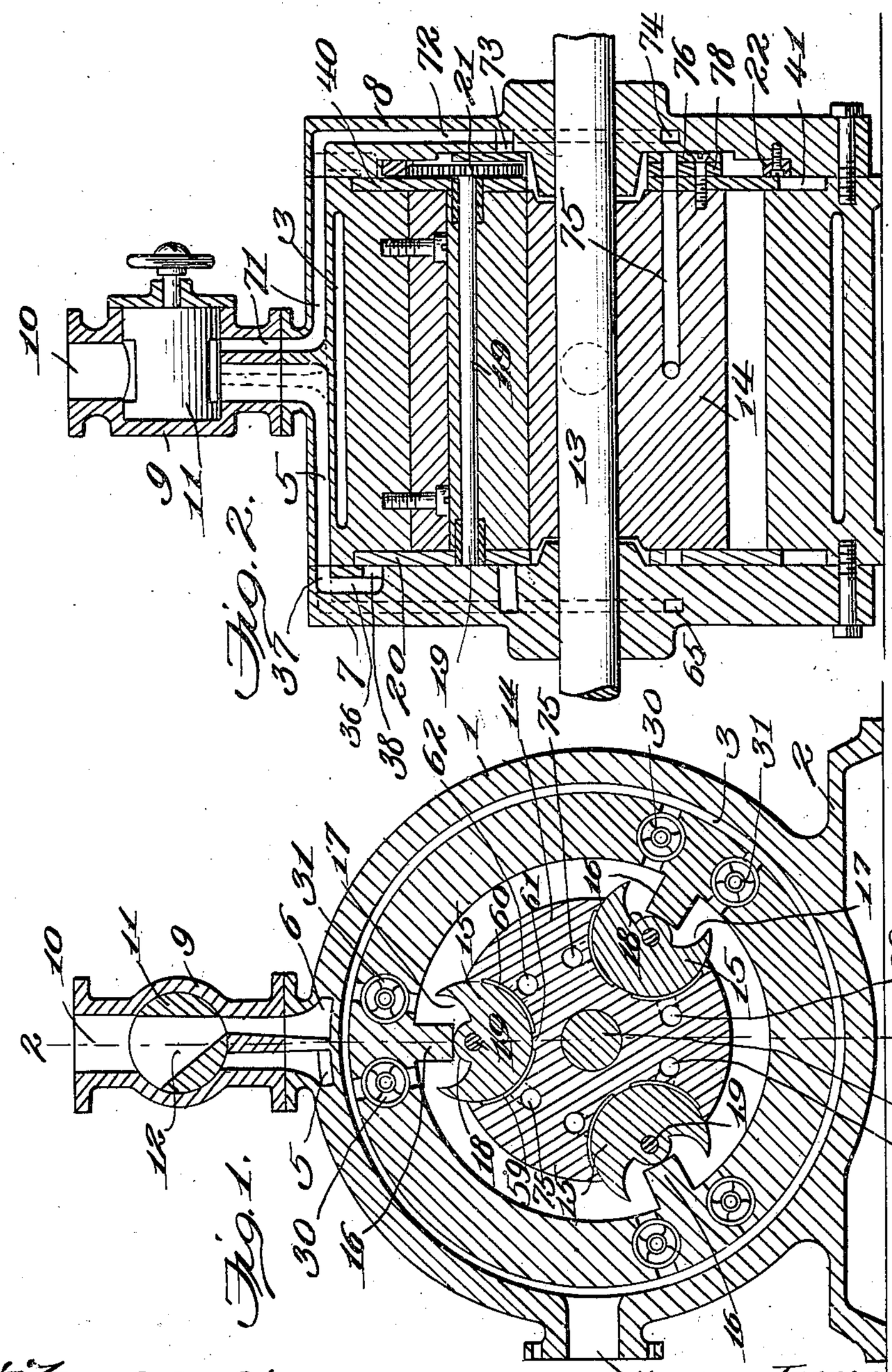

Fig. 2.

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 3.

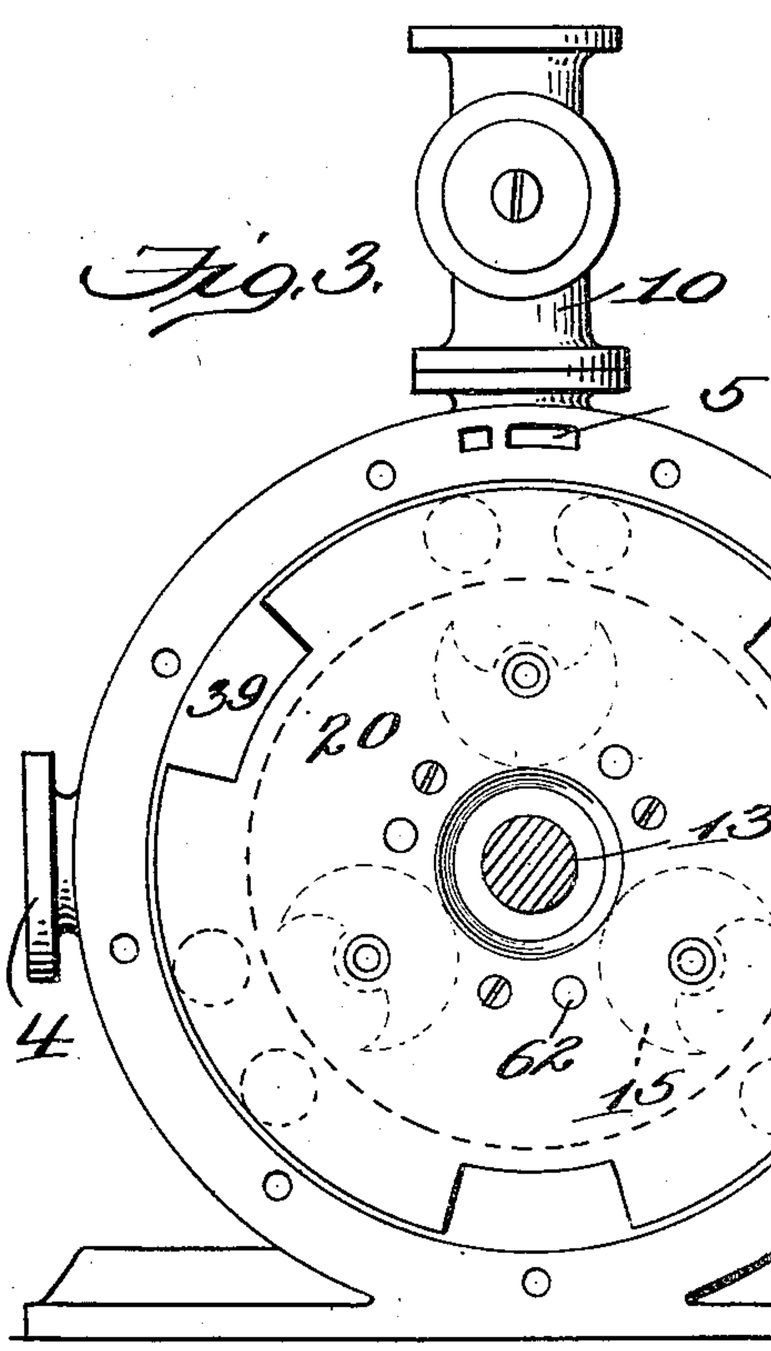


Fig. 13.

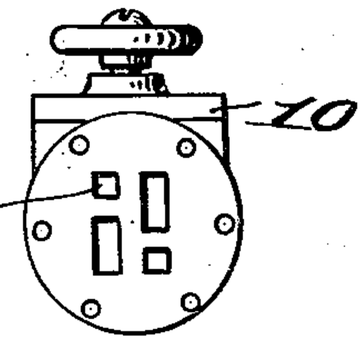


Fig. 4.

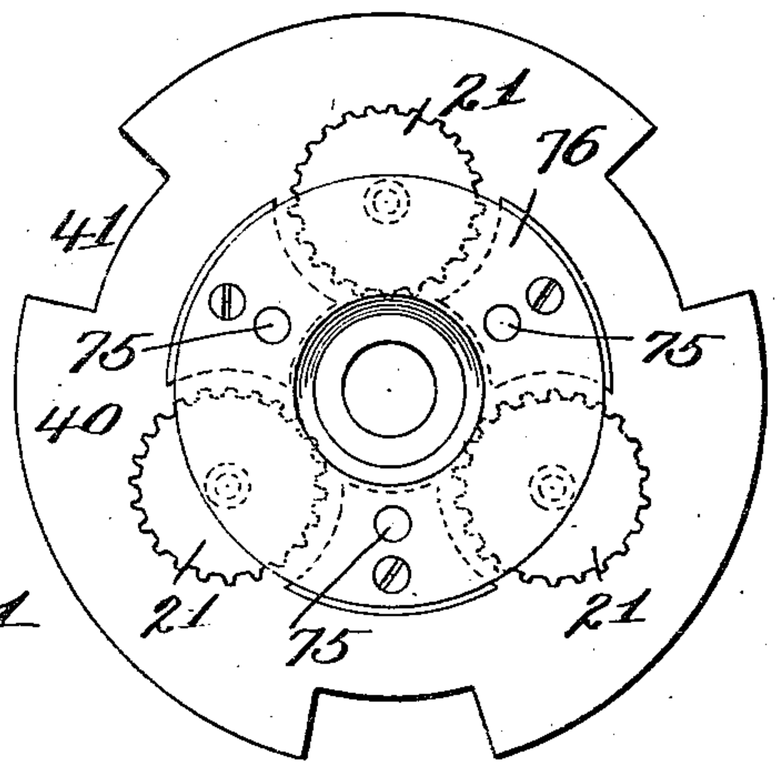


Fig. 5.

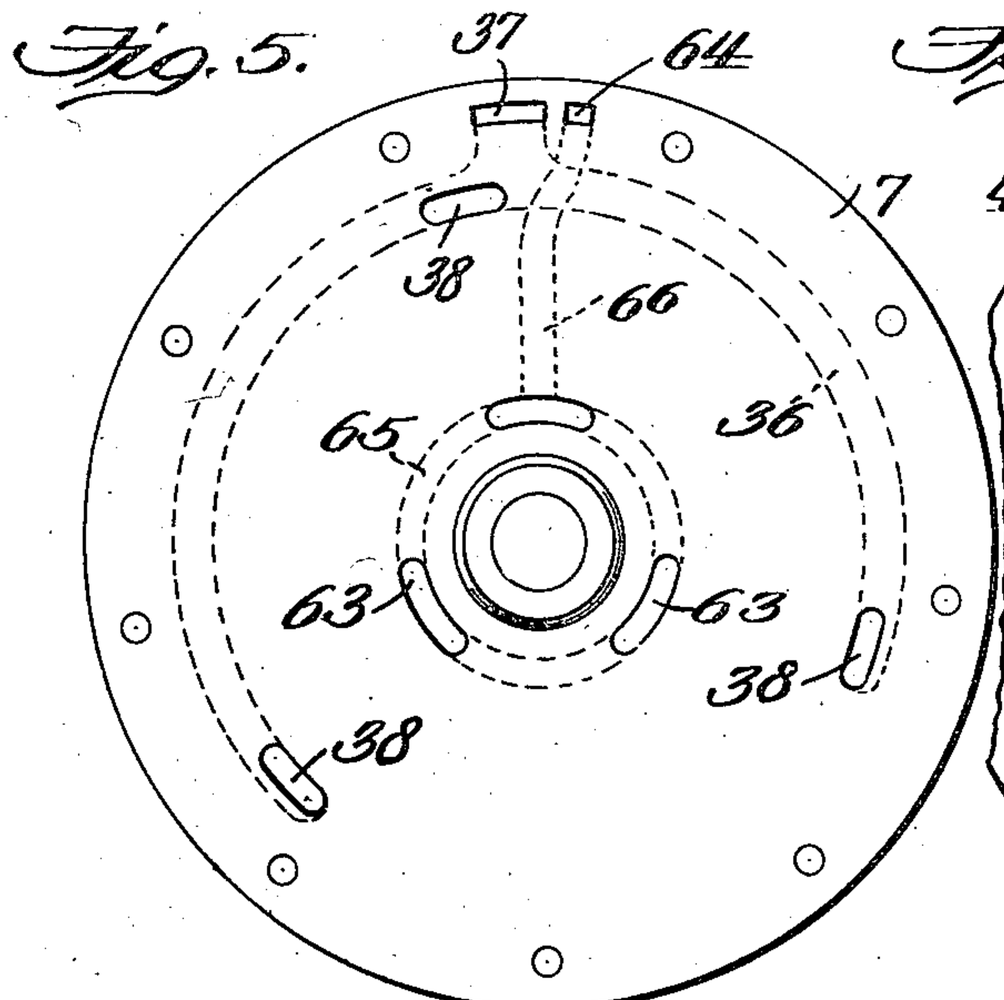
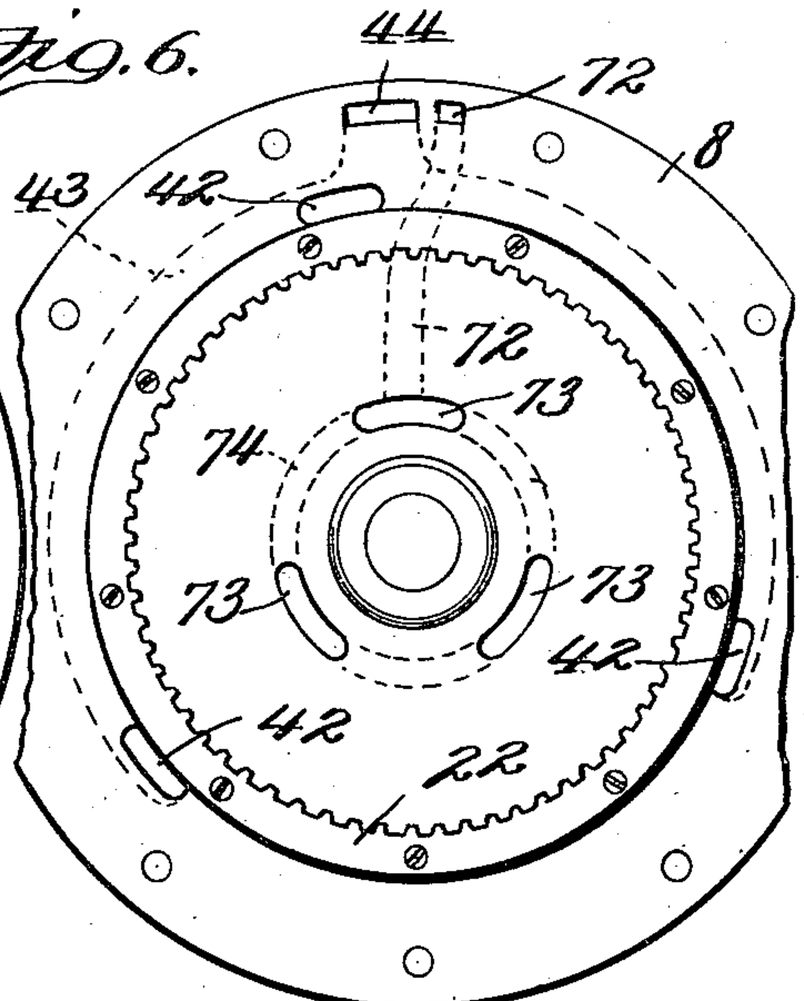


Fig. 6.



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3 SHEETS—SHEET 3.

Fig. 7.

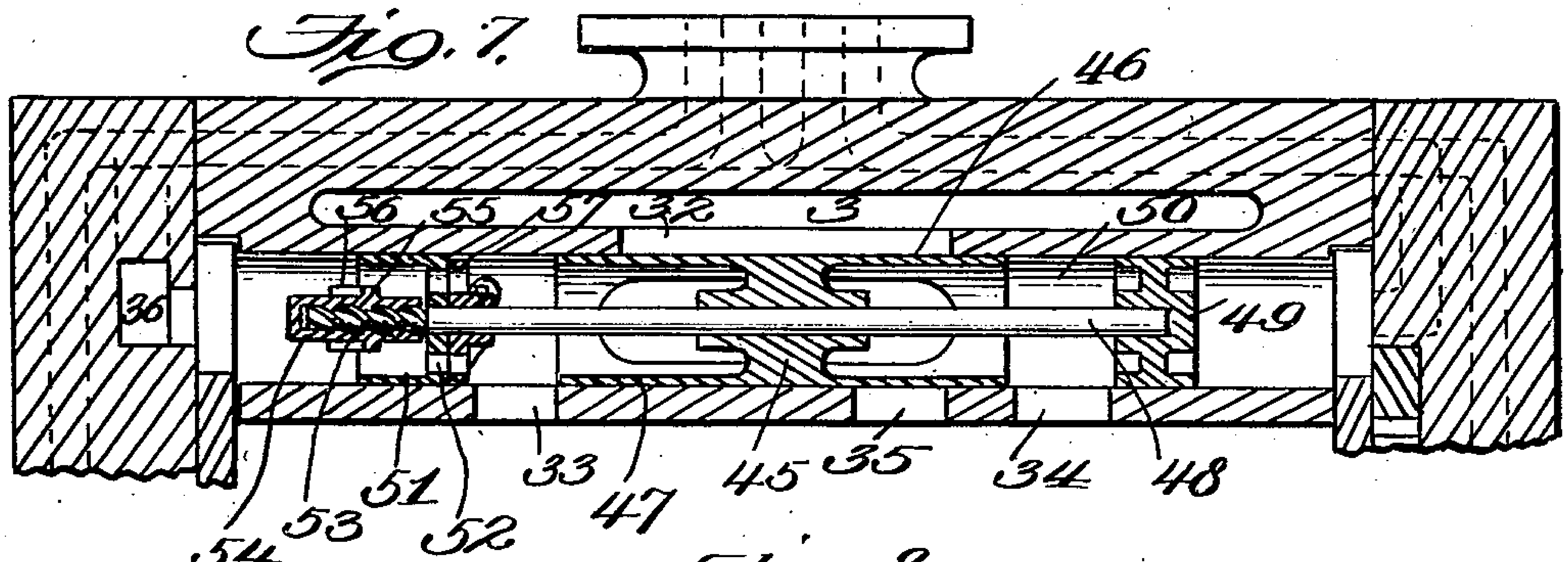


Fig. 8

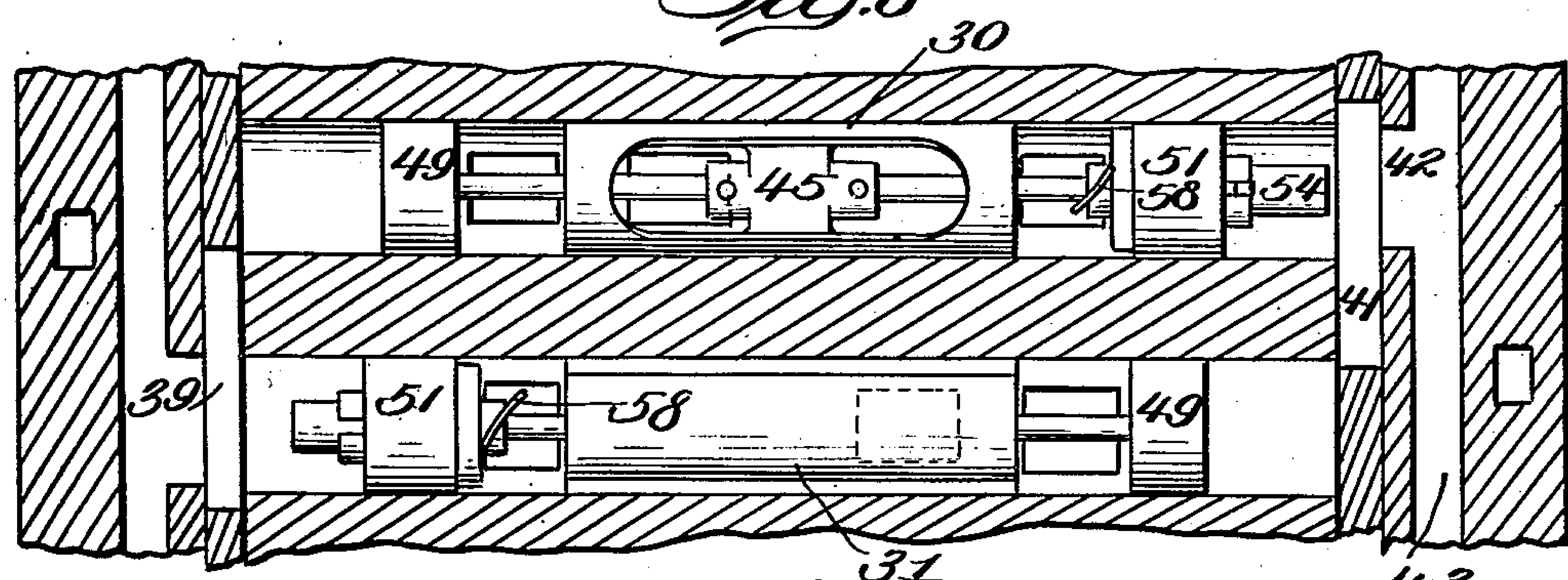


Fig. 9.

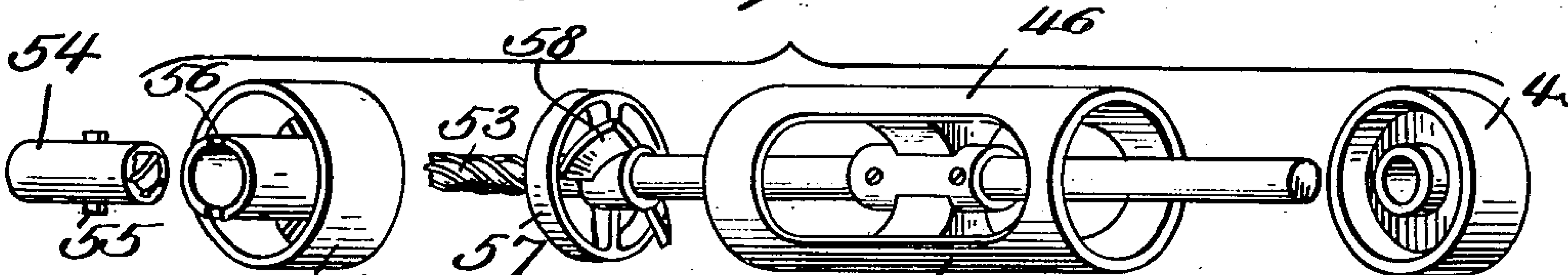


Fig. 11

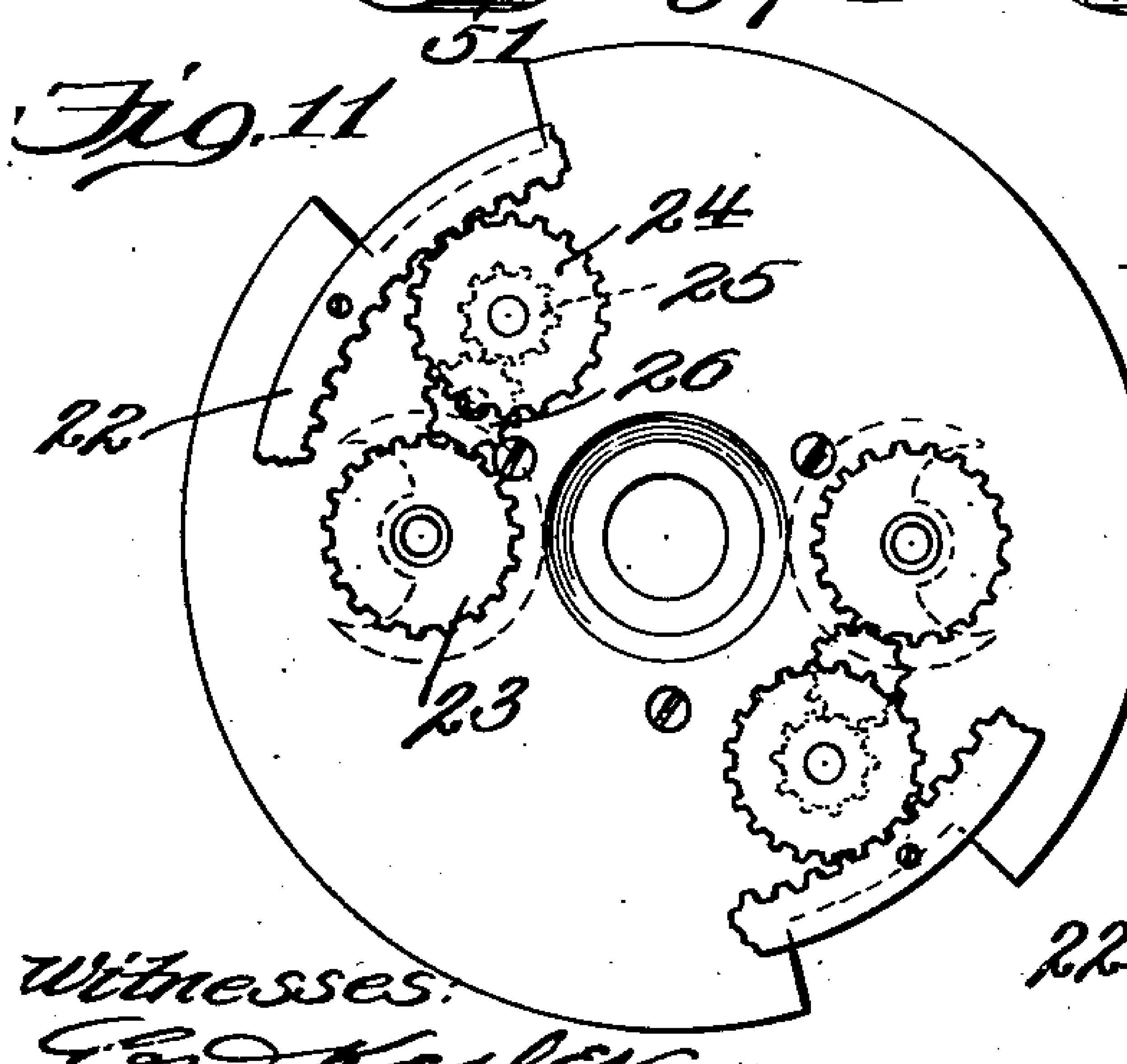


Fig. 10.

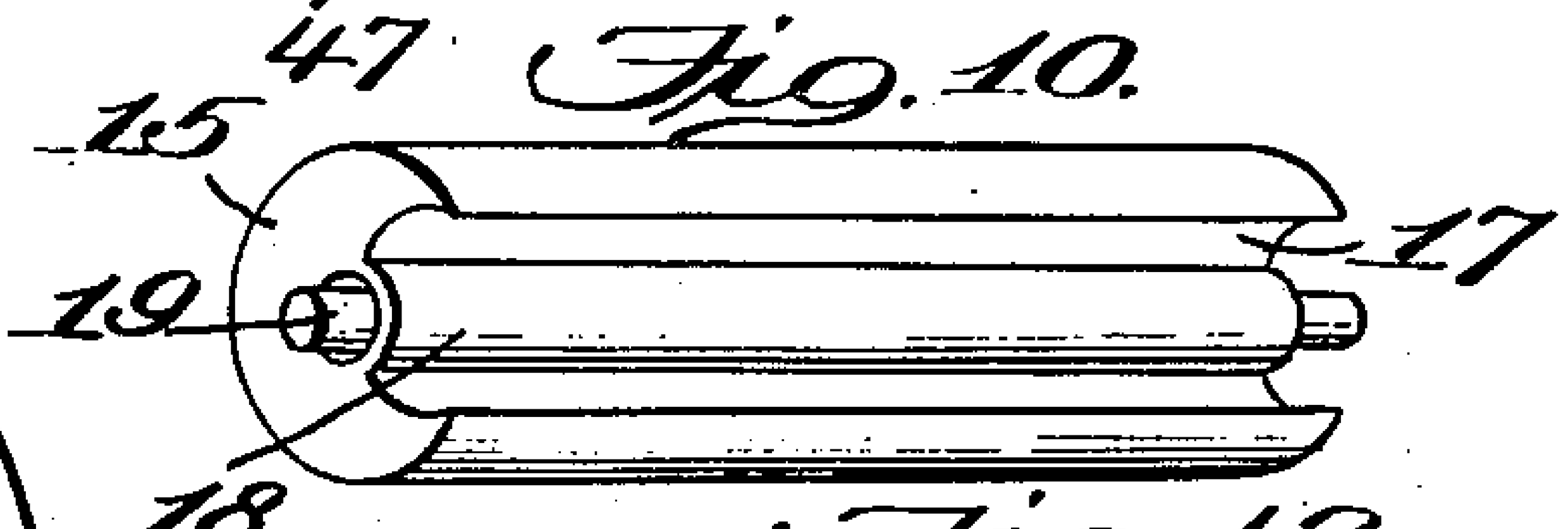
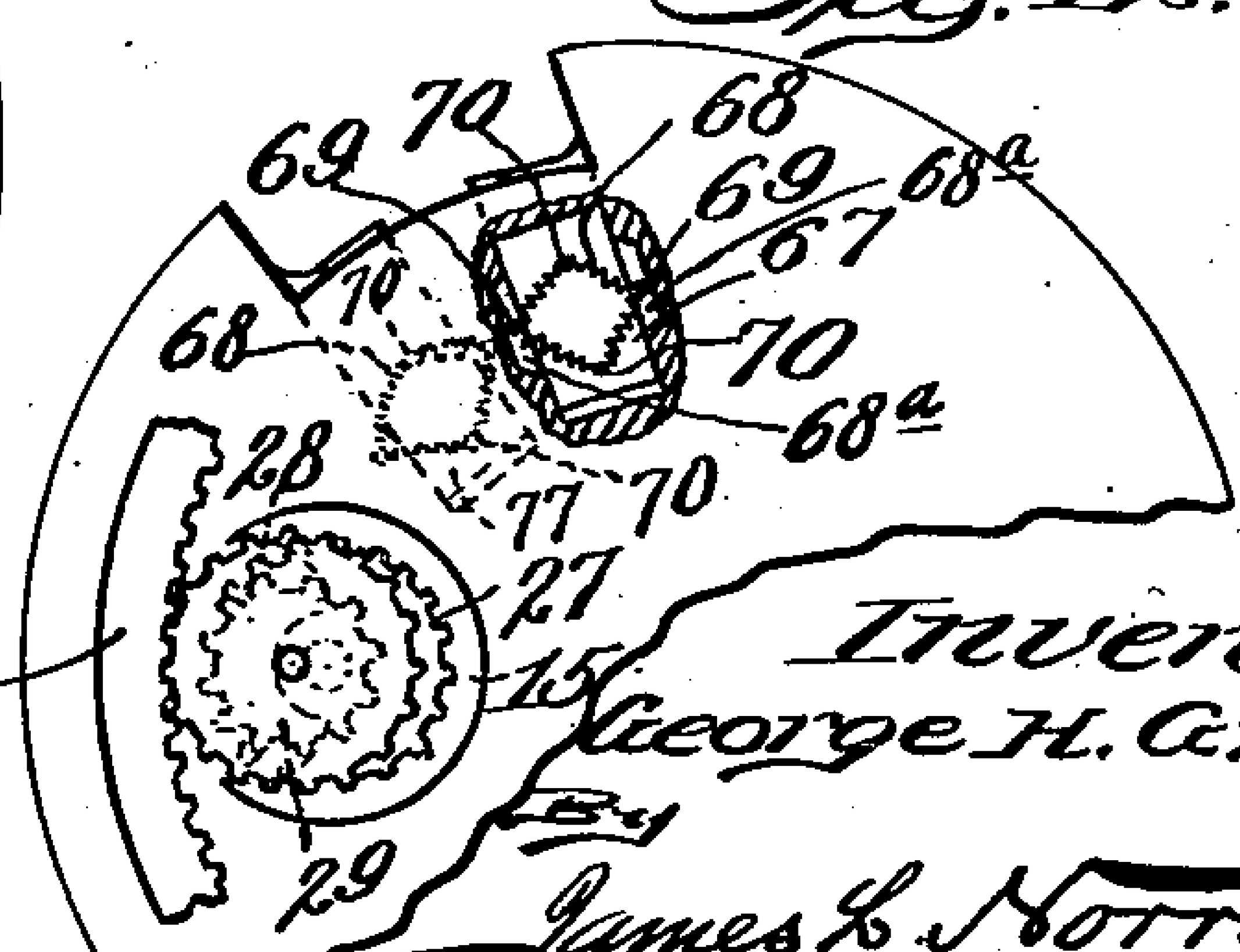


Fig. 12.



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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

968,653. Specification of Letters Patent. Patented Aug. 30, 1910.

Application filed November 3, 1909. Serial No. 526,058.

To all whom it may concern:

Be it known that I, GEORGE H. GROSS, a citizen of the United States, residing at Harrisburg, in the county of Dauphin and State of Pennsylvania, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

My present invention relates to improvements in rotary engines and more particularly to the class adapted to use steam as a motive fluid and it has for its object primarily to provide an improved engine of this type which is capable of operating efficiently by utilizing the steam expansively, it preferably embodying a centrifugally controlled governor for varying the point of cut off automatically whereby uniform speed may be maintained and economy of steam effected, and the invention also involves the counterbalancing of the piston abutments or rotors and the piston itself whereby friction of the parts is minimized and end thrust is prevented.

Further objects of the invention are to provide a reversible rotary engine of the type above mentioned which may operate with equal facility in either direction, automatically operative reversing valves being provided for controlling the feed and exhaust of the steam or motive fluid to and from the piston.

To these and other ends the invention consists in certain improvements and combinations and arrangements of parts, all as will be hereinafter more fully described, the novel features being pointed out particularly in the claims at the end of the specification.

In the accompanying drawings: Figure 1 represents a central vertical section of a reversible rotary engine constructed in accordance with the present invention, the section being taken parallel to the plane of rotation of the piston. Fig. 2 represents an axial section of the engine on the line 2—2 of Fig. 1. Fig. 3 represents a side elevation of the engine with one of the casing heads removed. Fig. 4 is a side elevation of the piston showing the gears for timing the rotation of the piston abutments or rotors. Fig. 5 shows in detail one of the casing heads as viewed from its inner side, this casing head being adapted to fit upon that side of the casing shown in Fig. 3. Fig. 6 is a view similar to Fig. 5, showing the opposite casing head which carries the internal rack that coöperates with timing gears for the piston abutments, as shown in Fig. 4. Fig. 7 represents a rotary section through a portion of the engine casing showing one of the steam controlling valves, this valve being shown in position to admit steam to the piston. Fig. 8 represents a section of a portion of the casing showing a pair of steam controlling valves as applied to a reversible engine, the upper valve being shown in position to exhaust steam from the casing while the lower valve is in position to admit steam thereto. Fig. 9 is a collective view of the several elements composing one of the steam controlling valves. Fig. 10 is a perspective view of one of the piston abutments or rotors. Fig. 11 is a diagrammatic view showing a modified arrangement of timing gears which may be used, should two piston abutments or rotors be employed instead of three, as shown in the preceding figures. Fig. 12 is a view similar to Fig. 11, showing a centrifugal governor for automatically varying the point of inlet and cut off to maintain a constant speed of the engine and also showing a modified form of timing gear; and Fig. 13 represents the controlling valve as viewed from the under side to show the ports thereof.

Similar parts are designated by the same reference characters in the several views.

The present invention embodies improvements in rotary engines of the type comprising a revolving piston having a suitable number of abutments or rotors which are rotatable in seats formed in the periphery of the piston and coöperate with stationary abutments or ribs arranged at suitable intervals around the inner circumference of the cylinder or casing, these rotatable piston abutments having a rolling contact with the inner circumference of the cylinder or casing and being driven by gearing or other means whereby they may be appropriately timed.

In the accompanying drawings I have shown the invention applied to a reversible rotary engine. Certain features of the invention, however, are applicable to rotary engines either of the reversing or the non-reversing type and it will be understood that the invention is therefore not limited to the specific form of engine as embodied in the drawings, as I contemplate certain modifications and changes which may be made in order to adapt the invention to the

best advantage according to the circumstances or requirements in each particular case.

In the present instance, the engine is shown as comprising an outer casing 1 which is bored to form in effect a cylinder, the casing in the present instance having a base 2, whereby it may be bolted or otherwise secured to an appropriate support.

Extending around the casing and inclosed within it is an exhaust channel 3 provided with an outlet 4 and at the top of the casing means is provided for admitting the steam or motive fluid to the engine. In the present instance I have shown a reversible engine and the casing is therefore provided with a pair of steam conducting passages 5 and 6 which lead toward the opposite heads 7 and 8 respectively, of the casing. Steam is admitted to one or another of these passages according to the direction in which the piston rotates. Different means may be provided for directing the steam into the appropriate passage. I prefer to employ a valve such as that disclosed in Figs. 1 and 2, it consisting of a valve casing 9, the upper end of which has a relatively wide steam inlet 10, while its lower portion is provided with branch passages which communicate respectively with the passages 5 and 6 of the engine casing. A valve 11 is turnable within the valve casing 1, having a handle or other appropriate means for adjusting it from the exterior, and this valve has a tapered port 12, the upper portion of which is widened while its lower portion is narrowed to approximately the size of one or another of the passages 5 and 6. By rotating the valve 11 a short distance, steam may be introduced into one or another of the passages 5 and 6, according to the direction in which the engine is to turn, the widened formation of the passage or port in the valve maintaining it in communication with the source of steam supply.

The casing heads 7 and 8 are provided with bearings in which a shaft 13 is journaled so that this shaft may revolve relatively to the casing and its heads. To the shaft 13 is fixed a revoluble piston 14, the periphery of which is concentric with the shaft and with the cylindrical inner circumference of the casing. The revoluble piston carries a suitable number of abutments 15, three being shown as an example in Figs. 1 to 4 inclusive. Around the inner circumference of the casing are also located stationary abutments or ribs 16, these stationary abutments or ribs preferably corresponding in number to those of the abutments on the piston. The stationary abutments divide, in effect, the interior of the casing into individual compartments into which the steam is introduced and expanded while acting upon the piston, and the abutments carried by the piston form surfaces against which the steam acts and expands. These abutments are therefore formed cylindrically whereby their peripheries may have a rolling and steam-tight contact with the inner circumferences of the casing. In the present instance, the peripheries of the abutments are each formed as a portion of a cylinder and in order that the abutments carried by the piston may clear the stationary abutments or ribs secured within the casing, a portion of the circumference of each abutment is formed with a recess 17 which forms an interruption whereby each movable abutment may bridge the adjacent stationary abutment. It may also be preferable to form each abutment with a concentric cylindrical surface 18 which is adapted to have a rolling contact upon the inner surface of each stationary abutment while one abutment is passing the other in order that communication between two adjacent compartments within the casing may be prevented. This feature, however, may be omitted if desired.

To insure an appropriate timing in the movements of the piston abutments with respect to the stationary abutments, I provide each piston abutment with a shaft 19, one end of which may be journaled in an end plate of disk 20 secured by appropriate means to one end of the piston and the opposite end of each shaft 19 carries a gear 21, the several gears meshing with an internal rack 22 suitably secured to one of the casing heads, the head 8 in the present instance. The pitch line of the gears and rack is preferably of the same diameter as the internal bore of the casing whereby the periphery of the piston abutments may have a true rolling engagement with the casing wall. As the piston and its abutments revolve in the present instance while the casing and its abutments are stationary, the gears 21 will have a planetary movement within the internal rack, the gears and rack being so adjusted that the recessed or interrupted portions of the several abutments will register with or span the stationary abutments at appropriate intervals.

Should it be desirable to employ two piston abutments instead of three, as shown in Figs. 1 to 4 inclusive, a modified form of timing gear may be used either as shown in Fig. 11 or in Fig. 12. In that form shown in Fig. 11, a relatively smaller gear 23 is fixed to the shaft of the piston abutment so that it does not directly coöperate with the rack 22, a supplemental gear 24 engaging the rack, which supplemental gear has a pinion 25 revoluble therewith, and an intermediate gear 26 connects the pinion 25 to the gear 23 whereby the abutment may revolve at a relatively slower speed. In Fig. 12 an internal gear 27 is fixed to the

shaft 19 of the piston abutment, a gear 28 coöperates with the rack and this gear carries a smaller gear or pinion 29 which meshes with the internal gear 27, whereby a relatively slower speed of rotation of each piston abutment is obtained.

At appropriate intervals, pairs of valves 30 and 31 are located around the circumference of the casing, the valves of each pair being placed at opposite sides of a stationary abutment 16. Each valve chamber is directly connected to the exhaust channel 3 by a relatively wide port 32, while it may be placed in communication with the piston chamber of the casing either through a pair of ports 33 and 34 which are open during the admission of steam, or through the two ports just named and the supplemental exhaust port 35. One valve of each pair is adapted to admit steam to the piston chamber and the other valve of each pair to exhaust steam therefrom while the piston revolves in one direction, the relation of the valves being reversed when the direction of rotation of the piston is reversed. To effect this result, the steam inlet passage 5 is connected to one steam controlling valve of each pair while the steam inlet passage 6 communicates with the remaining valves of the several pairs. In the present instance the casing head 7 is provided with a segmental steam feeding groove 36 having an inlet 37 which, when the casing head is applied to the casing, registers with the steam feeding passage 5 and the segmental groove in the head is provided at appropriate sides with inwardly extending ports 38. The plate or disk 20 which is attached to and revoluble with the piston is provided at corresponding intervals with steam inlet ports 39 which register with the ports 38 of the casing head at appropriate intervals while the piston revolves. The passage 5, the steam feeding groove 36, the ports 38 and the ports 39 serve to supply steam to the valves 31 of each pair to revolve the piston in one direction. A duplicate steam feeding arrangement, however, is provided for reversing the direction of rotation of the piston, the opposite end of the piston carrying a disk or plate 40 having suitably spaced ports 41 therein arranged to pass ports 42 formed at appropriate intervals at the corresponding side of the casing, these ports 42 all communicating with a common steam feeding channel 43 which is formed in the head 8, and has an inlet 44 which registers with the steam feeding passage 6 when the said head is applied to the casing. These valves which control the feeding and exhaust of steam with respect to the piston, are preferably operative automatically when the valve 11 is adjusted. In the present instance I have shown valves, each of which comprises a rotatable port controlling member 45 having a pair of closed sides 46 and 47 adapted to control the ports 32 and 35 respectively, this member being fixed to a supporting shaft 48, one end of which is journaled in a bearing 49, the latter fitting closely within the cylindrical valve chamber 50 and closing the rear end thereof. The opposite end of the shaft 48 is rotatably supported in a cage 51 which fits tightly within the valve chamber 50 but has suitable steam passages 52 extending therethrough.

That end of the shaft 48 adjacent to the cage 51, is provided with threads 53 of considerable pitch, and coöperating with the threaded end of the shaft is a cap 54, the outer end of which is closed, said cap having a pair of projections 55 which are slidable axially in slots 56 formed in the hub of the cage 51. Upon the admission of steam into the inlet end of the valve chamber 50 through the port 39 or 41, as the case may be, such steam acts upon the end of the cap 54, pressing it to the right, in Fig. 7, and as this cap is held from rotation but is permitted to move longitudinally, the thread connection between the cap and the shaft will cause the latter to turn and thereby shift the sides 46 and 47 of the valve member 45 into the position shown in Fig. 7, whereby these sides will close the main exhaust port 32 and the supplemental exhaust port 35, the ports 33 and 34, however, being left open to receive steam. The companion valve is of a duplicate construction but is reversed in its position, as shown in Fig. 8, and each valve is provided with means whereby the exhausting of steam from the piston chamber will automatically shift the valve so as to establish communication between the piston chamber and the exhaust channel 3 by the opening of the exhaust ports 32 and 35. In the present instance the means for setting the valve in exhaust position consists of a collar 57 which is fixed to the shaft and carries one or more propeller blades 58, two of the blades being shown as an example. These blades have a helical pitch with respect to the shaft and the steam exhausting from the piston chamber through the ports 33 and 34 will impinge upon these blades and thereby turn the shaft so as to set the valve member in a position to uncover the ports 32 and 35. The arrangement just described not only sets the valves in position to feed or exhaust steam with respect to the piston chamber, but when steam is being exhausted from the piston chamber a larger port area is provided by the uncovering of the supplemental port 35, which port, as shown in Fig. 7, is closed during the admission of live steam into the piston chamber.

In order to minimize friction due to the revolving of the piston abutments, I provide means for admitting steam between

them and their respective seats whereby they are substantially balanced or in equilibrium. In the present instance recesses 59 and 60 are formed in the seat for each piston abutment, a centrally located rib 61 separating or dividing the recesses, and a steam feeding passage 62 leads to each recess 60, these steam feeding passages 62 being exposed at the outer side of the plate or disk 20, and the casing head 7 is provided with a set of ports 63 which are arranged toward the center and are adapted to supply steam at full pressure to the said recesses through a supplemental or branch steam feeding passage 64, the ports 63 being connected by a steam feeding channel 65 which has an inlet 66 which communicates with the steam feeding passage 64. In a reversible turbine the head 8 will be correspondingly ported to receive steam from a branch passage leading from the main steam feeding passage 5, whereby steam at full pressure may be introduced into the recesses 59 and in both cases the pressure of the steam acting upon one side of the piston abutments to turn them, will be balanced in so far as the friction is concerned, by the steam introduced into the recess formed in the seat for the abutment, a suitable steam-tight fit, however, being formed between each piston abutment and its seat to prevent the escape of steam introduced for balancing purposes into the piston chamber.

By forming the ports 39 and 42 in the disks or plates 20 and 40 of a relatively short circumferential length, it will be observed that steam at full pressure is admitted only during a fraction of the movement of each piston abutment through its respective compartment, and hence the steam will be worked expansively. I preferably provide, however, a centrifugally controlled governor for varying the point of cut off whereby a constant speed may be easily maintained. I have shown such a governor in Fig. 12, it consisting of a plate 67 which is dove-tailed or otherwise fitted into the inner face of one or both of the plates or disks 20 or 40 at the ends of the piston, one of these governors being provided for each steam feeding port, the plate being slidable outwardly or toward the circumference of the disk or plate, and its outer end is arranged to project into the steam feeding port whereby the length of this port may be increased or diminished. The plate 67 is normally held inwardly under the yielding action of a set of four tension springs 68 arranged in diamond form and located in a chamber 68^a within the disk, they being attached at two corners to stationary projections 69 upon the plate or disk, while at the other corners they are attached to projections 70 on the slidable plate. As the speed of the piston increases, the increased centrifugal force acting upon the plate 67 will move it outwardly in opposition to the action of the restraining springs, the length of each port which feeds steam to the piston being thereby diminished, and conversely, as the speed of the engine diminishes the centrifugal force acting upon the plate 67 will diminish, the springs being then able to draw the said plate inwardly and thereby increase the length of each port through which steam at full pressure is admitted to the several compartments of the piston chamber. The point of admission of steam may also be varied by a second governor plate 77.

By admitting the actuating fluid to the piston chamber at one end of the piston and simultaneously admitting the counterbalancing fluid at the opposite end of the piston, the end thrust upon the piston is neutralized. In order to admit the counterbalancing fluid to the right hand end of the piston in Fig. 2, a branch feed passage 71 leads from the valve 9 for the actuating fluid, to the passage 72 formed in the casing head 8, such latter passage leading to a set of ports 73 which are arranged toward the center of this head, such ports being connected by an annular channel 74 and are arranged to communicate at appropriate intervals with a corresponding set of ports 75 which are formed in a disk 76 which is appropriately counterbored to fit over the gears 21, these ports 75 leading to the recesses 59 in the respective abutment seats of the piston. Filling pieces 78 are placed between the gears and the disk 76, as shown.

What is claimed is:

1. A rotary engine comprising a casing provided with abutments and ports communicating with a piston chamber therein, a piston revoluble therein and having rotary abutments seated therein, and means attached to and revoluble with the piston for supplying motive fluid to the ports in the casing leading to the piston chamber whereby such fluid may act expansively upon the piston abutments.

2. A rotary engine comprising a casing having ports for admitting motive fluid to a piston chamber therein and a piston revoluble within the casing and having ports arranged to admit motive fluid to the ports in the casing and for cutting off said fluid and causing it to act expansively upon the piston.

3. A rotary engine comprising a casing provided with stationary abutments and ports communicating directly with a piston chamber therein, a piston revoluble in the casing and having recessed rotary abutments seated in its periphery, said recessed abutments being arranged to roll within the casing and to bridge the stationary abutments thereof, and means carried by the piston

for admitting motive fluid to said ports of the casing communicating with the piston chamber whereby said fluid may act expansively on said abutments.

4. A rotary engine comprising a casing provided with stationary abutments and ports therein communicating directly with a piston chamber therein, a piston revoluble in said casing and having rotary abutments seated therein, the peripheries of the rotary abutments being adapted to roll within the casing and having recessed portions to bridge the stationary abutments, the walls of said recesses being coöperative with the stationary abutments to form a fluid-tight joint to prevent communication between opposite sides of each stationary abutment, and means revoluble with the piston for admitting motive fluid to said ports of the casing communicating with the piston chamber and for causing such fluid to act expansively on said abutments.

5. A rotary engine comprising a casing, a piston revoluble therein and having rotary abutments seated in its periphery, means for causing motive fluid to act upon one side of each abutment, and means for admitting fluid to the opposite side of each abutment to counterbalance it.

6. A rotary engine comprising a casing, a piston revoluble therein, seats formed in the periphery of said piston and having fluid receiving recesses, rotary abutments mounted in said seats, means for admitting motive fluid to act on said abutments to drive the piston, and means for admitting fluid to the recesses of said abutments to counterbalance the effect of the motive fluid which acts to propel the piston.

7. A reversible rotary engine comprising a casing having a set of abutments, a pair of controlling valves for each abutment, the valves of each pair being arranged at opposite sides of the respective abutment, a piston revoluble in the casing and carrying rotary abutments, and means for admitting motive fluid to the piston chamber through one valve of each pair and exhausting fluid from said chamber through the other valve of each pair.

8. A reversible rotary engine comprising a casing provided with ported heads, the ports of said heads having individual motive fluid supply passages, a piston revoluble in the casing and having ports for conducting motive fluid to the piston chamber from the ports of one or another of said heads and a reversing valve for controlling the flow of steam under pressure to either of said heads.

9. A reversible rotary engine comprising a casing provided with a piston chamber and stationary abutments, pairs of controlling valves, one pair for each abutment, the valves of each pair being arranged at opposite sides of the respective abutment, heads for the casing having ports, the ports of said heads having individual motive fluid supply passages, the valves being adapted to communicate alternately with the ports in the respective heads and a piston revoluble in the casing and having means for automatically admitting and cutting off the supply of motive fluid to the piston chamber through one set of valves.

10. A reversible rotary engine comprising a casing having stationary abutments within its piston chamber, pairs of controlling valves, the valves of each pair being located at opposite sides of an adjacent abutment, the casing also having an exhaust passage with which all of said valves are adapted to communicate, heads applied to the casing having ports adapted to communicate with alternate valves and a piston revoluble in the casing and having means for controlling the admission of motive fluid to such valves as communicate with the ports of one head.

11. A reversible rotary engine comprising a casing having abutments, a pair of valves, said valves being located at opposite sides of the abutment and having their inlets arranged toward opposite ends of the casing, heads applied to the casing, each head having motive fluid receiving ports arranged to communicate with the inlets of the respective valves, the casing having an exhaust passage constructed to receive exhausted motive fluid from the piston chamber through either valve and a piston revoluble in the casing, said valves being provided with means whereby one valve will automatically close its outlet to the exhaust passage and the other will automatically establish communication between the piston chamber and the exhaust passage.

12. In a reversible rotary engine, the combination of a casing having supply and exhaust passages and a piston chamber, and a piston revoluble in said chamber, a valve fitted in the casing and embodying a rotary valve member capable of establishing and cutting off communication between the piston chamber and the exhaust passage, a cap arranged to be actuated by motive fluid to turn the valve member and cut off communication between the exhaust passage and the piston chamber when the motive fluid flows through the valve and into the piston chamber, and also embodying means operative to establish communication between the piston chamber and exhaust passage when such fluid is exhausted from the piston chamber through the valve.

13. A rotary engine comprising a casing having a piston chamber and motive fluid supply ports formed therein and leading to the piston chamber and a piston revoluble in said casing and carrying a disk provided

with ports for automatically admitting and cutting off the flow of motive fluid to said ports in the casing.

14. A rotary engine comprising a casing provided with a piston chamber and motive fluid supply ports leading to said chamber, a piston revoluble in the piston chamber and carrying a notched disk for controlling the supply of motive fluid to said ports and centrifugally controlled means for varying the circumferential length of the notches in said disk whereby the point of admission or cut off may be varied and the speed of the engine controlled.

15. A rotary engine comprising a casing provided with a piston chamber and motive fluid supply ports leading thereto, a piston revoluble in the chamber and carrying a disk having notches through which the motive fluid is supplied to said ports and a spring-restrained plate movable toward and from the periphery of said disk and capable of varying the effective circumferential length of the fluid-feeding notch therein whereby the point of cut off of the motive fluid may be varied.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

GEORGE H. GROSS.

Witnesses:
CLARENCE A. BATEMAN,
CHAS. S. HYER.