(No Model.) 4 Sheets—Sheet 1.

L. K. & C. S. CARNAHAN.

ROTARY STEAM ENGINE.

No. 598,906. Patented Feb. 15, 1898.

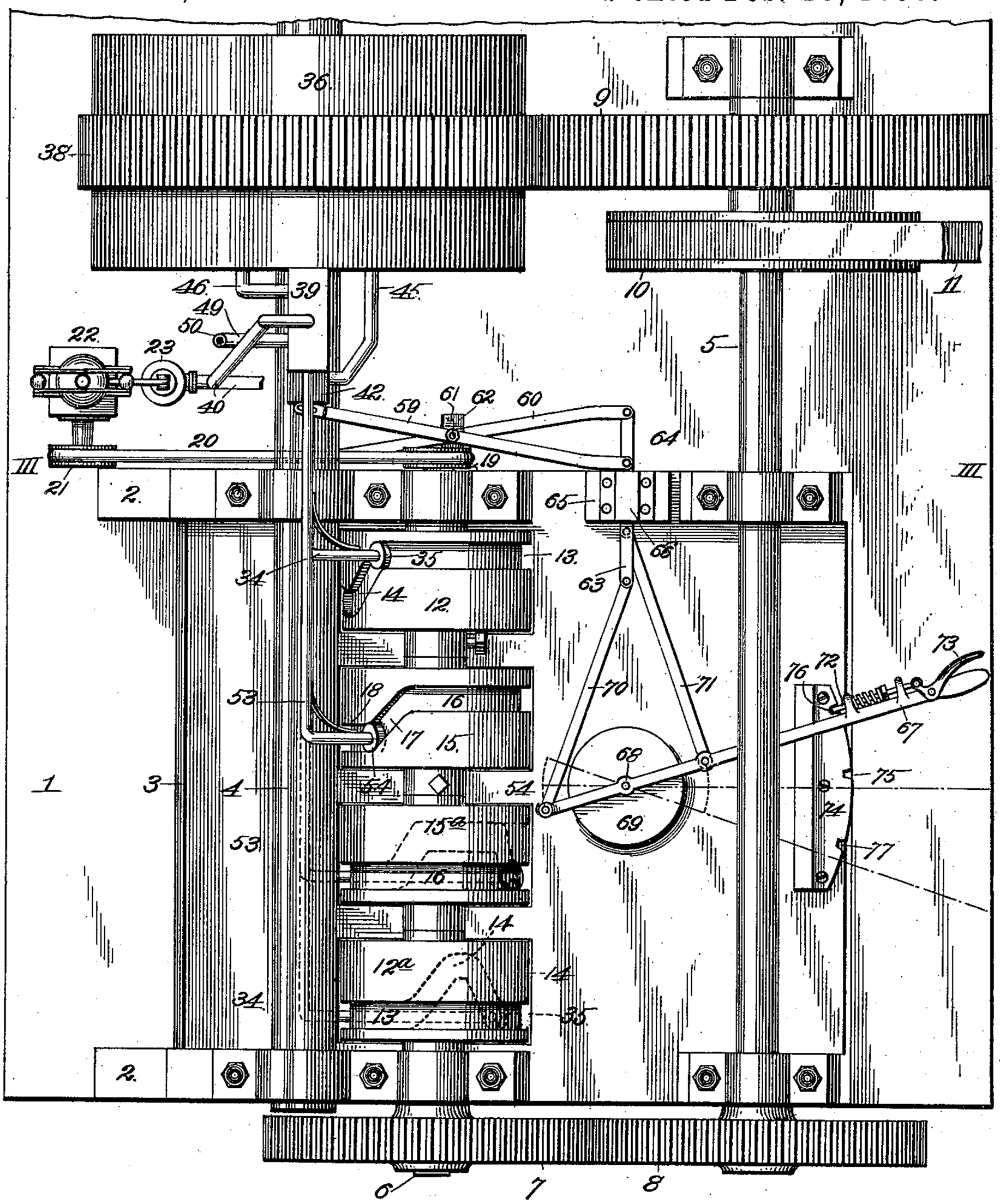


Fig. 1.

Witnesses:
M. R. Remley.
G. H. Knorr.

Inventors:
L. K. and C. S. Carnahan.
By. Higdon & Higdon.
Attys.

(No Model.)

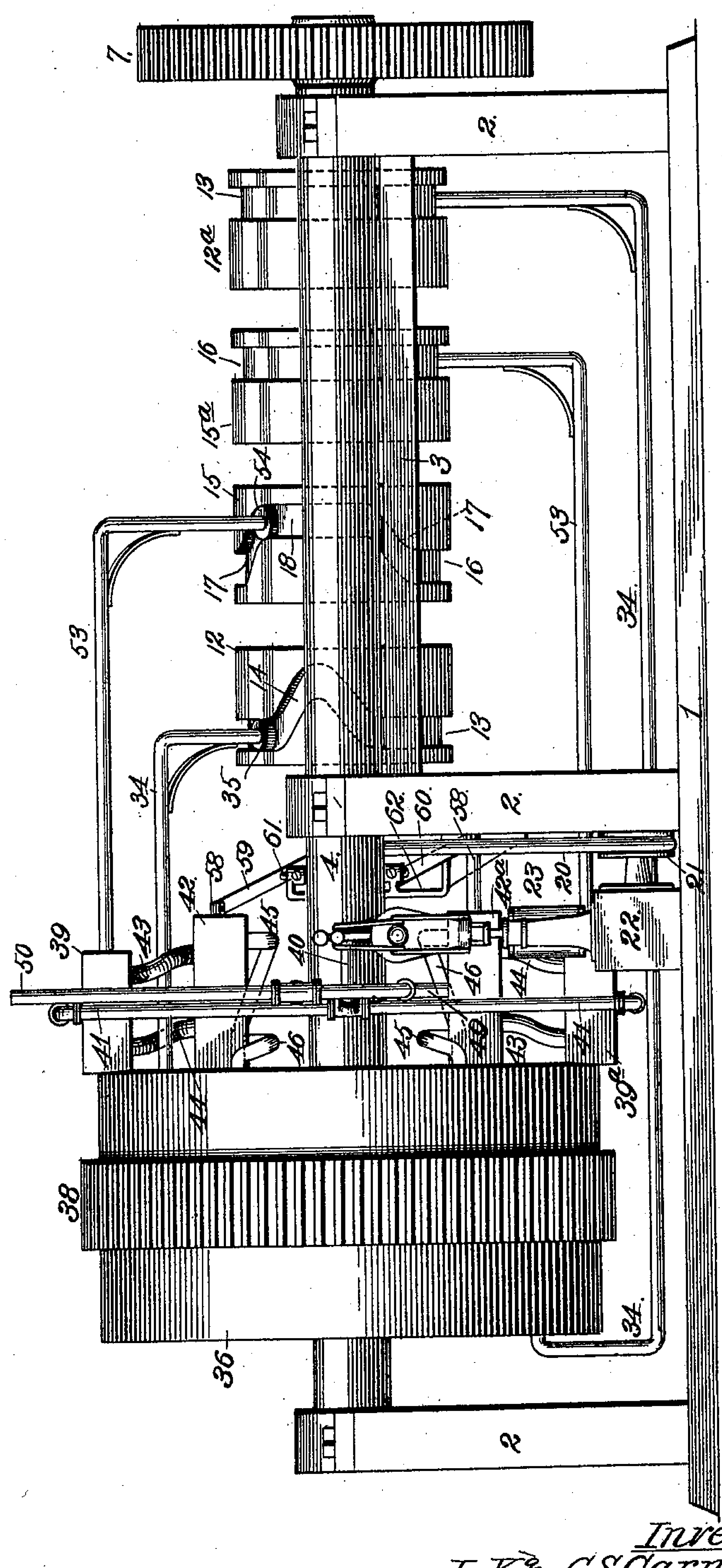
4 Sheets—Sheet 2.

L. K. & C. S. CARNAHAN.

ROTARY STEAM ENGINE.

No. 598,906. Patented Feb. 15, 1898.

Fig. 2.



Witnesses:
M. R. Remley.
G. Y. Thorpe.

Inventors:
L. K. and C. S. Carnahan.
By, Higdon & Higdon
Att'ys

(No Model.) 4 Sheets—Sheet 3.

L. K. & C. S. CARNAHAN.

ROTARY STEAM ENGINE.

No. 598,906. Patented Feb. 15, 1898.

Fig. 3.

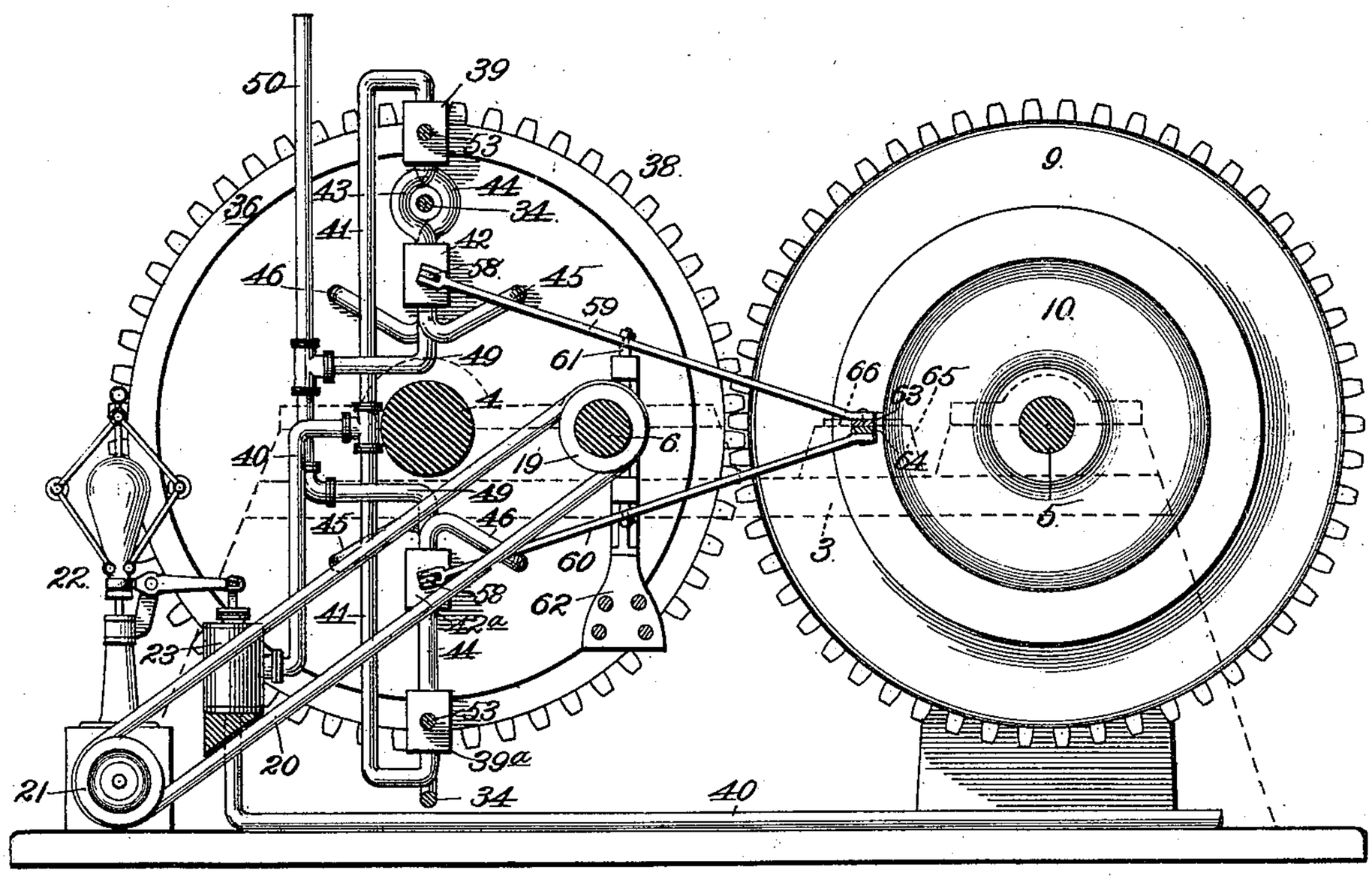


Fig. 5

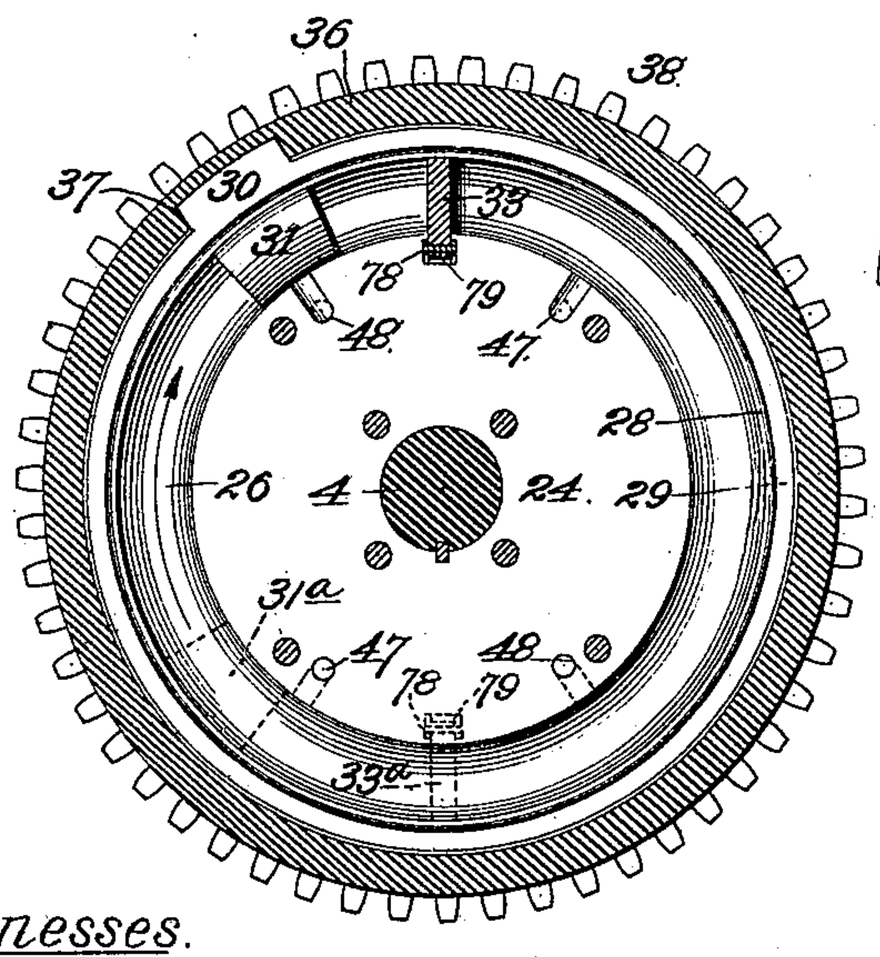
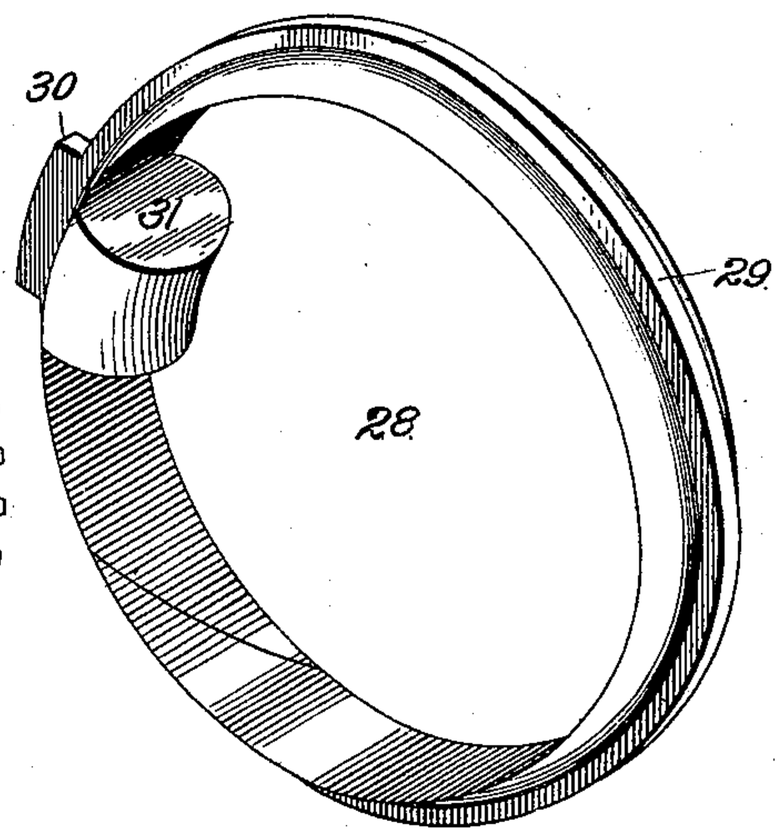


Fig. 6.



Witnesses.

M. P. Remley,

C. H. Thorpe.

Inventors:

L. K. & C. S. Carnahan.

By, Higdon & Higdon.

Atty's.

(No Model.) 4 Sheets—Sheet 4.

L. K. & C. S. CARNAHAN.

ROTARY STEAM ENGINE.

No. 598,906. Patented Feb. 15, 1898.

Fig. 4.

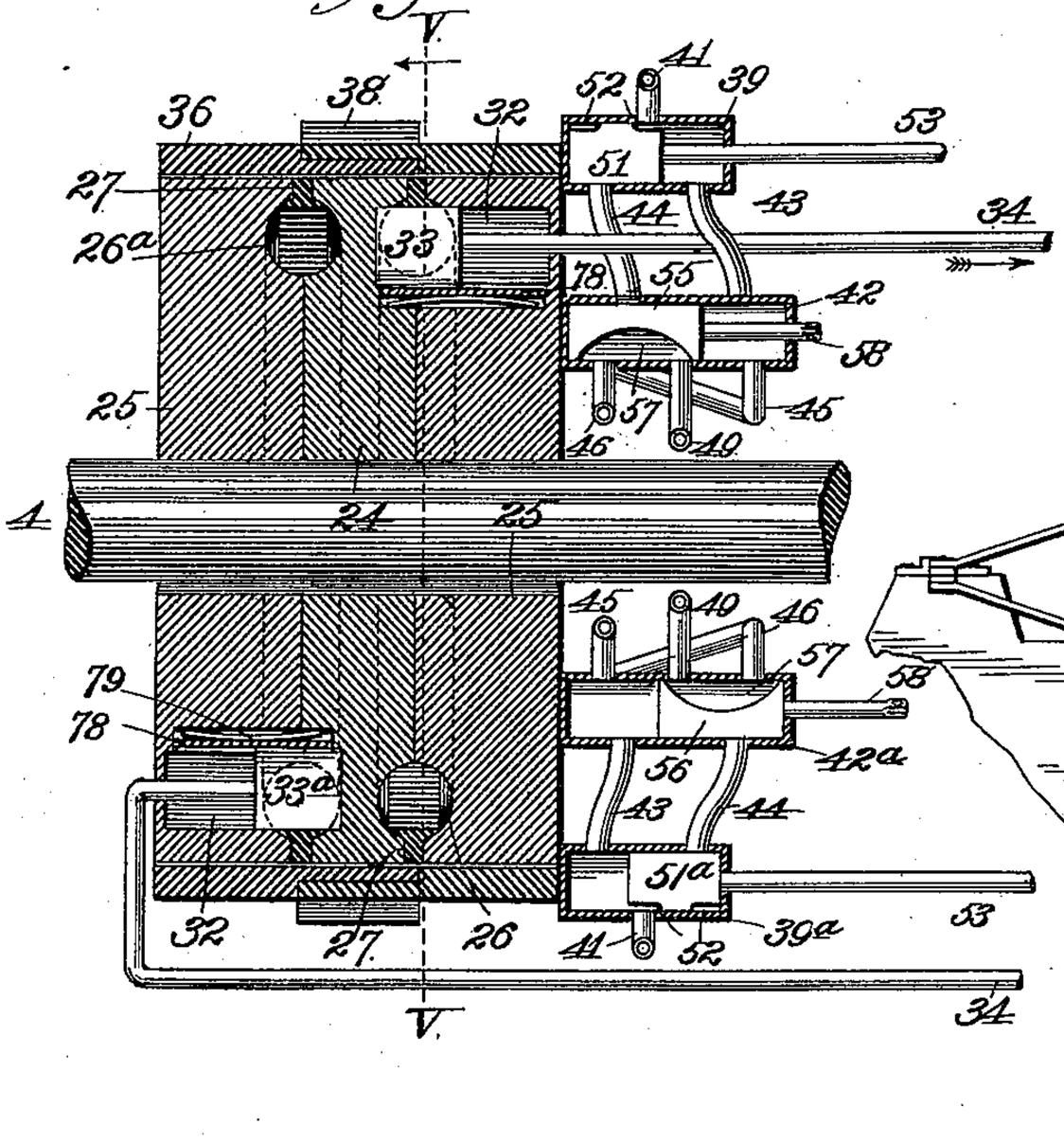


Fig. 7.

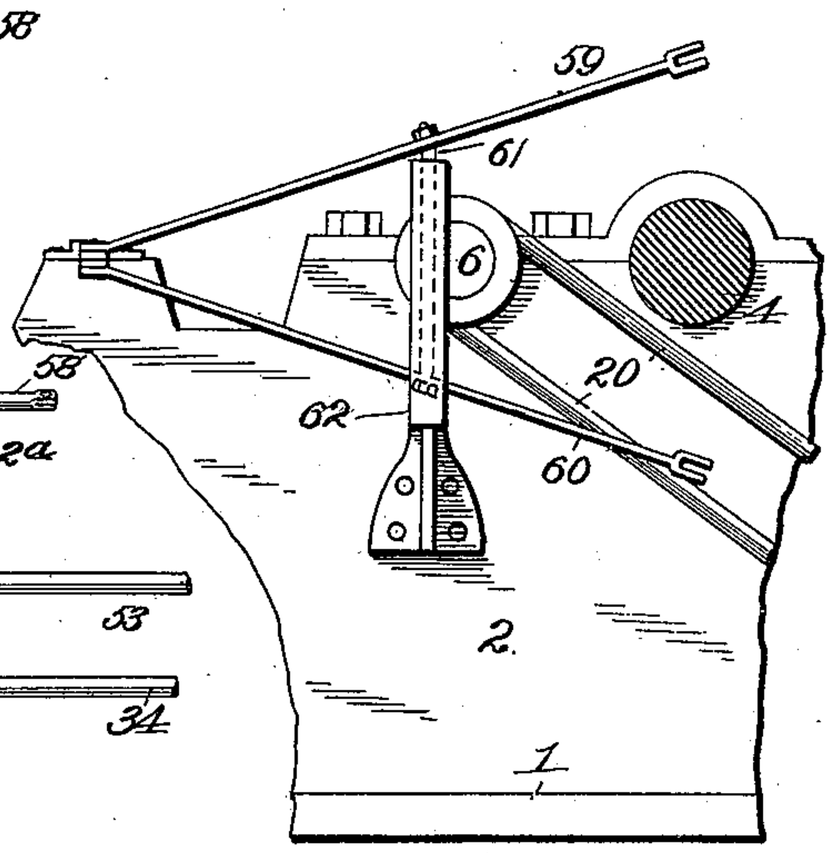


Fig. 8.

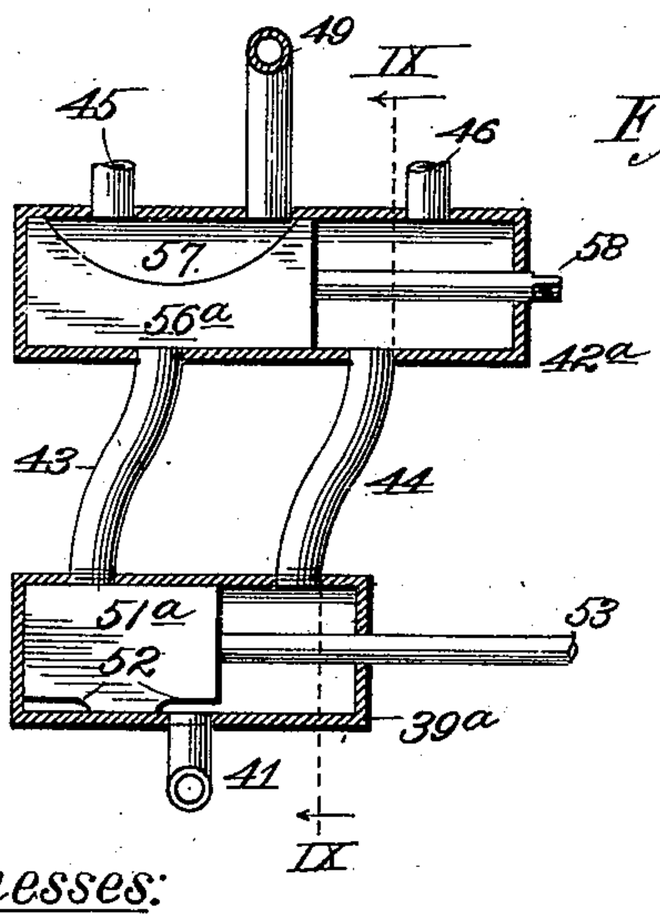
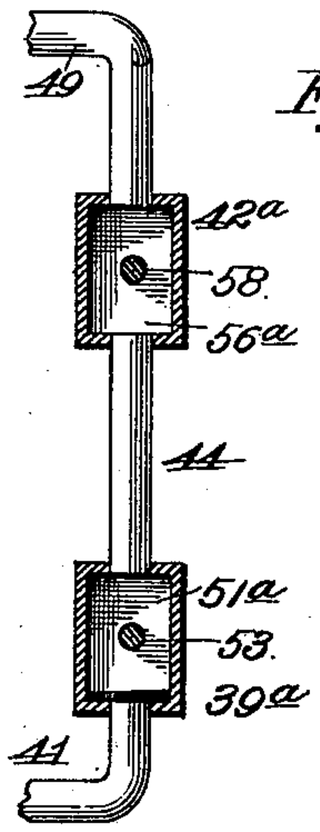


Fig. 9.



Witnesses:

W. R. Bentley.

G. H. Thorpe

Inventors:

L. K. and C. S. Carnahan.

By, Higdon & Higdon

Atty's.

UNITED STATES PATENT OFFICE.

LOUIS K. CARNAHAN AND CHARLES S. CARNAHAN, OF McLOUTH, KANSAS.

ROTARY STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 598,906, dated February 15, 1898.

Application filed April 5, 1897. Serial No. 630,743. (No model.)

To all whom it may concern:

Be it known that we, LOUIS K. CARNAHAN and CHARLES S. CARNAHAN, of McLouth, Jefferson county, Kansas, have invented certain new and useful Improvements in Rotary Steam-Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part thereof.

Our invention relates to rotary engines, and our object is to produce an engine of this character which shall operate with a minimum of friction and therefore of power and consequently with an economical consumption of fuel and comparatively small waste of steam.

A further object of the invention is to produce a rotary engine wherein the steam exerts a continuous, direct, and expansive pressure during the entire revolution and which may be started in either direction or brought to a state of rest by the shifting of a single lever.

To these ends the invention consists in certain novel and peculiar features of construction and combinations of parts, as hereinafter described and claimed.

In order that the invention may be fully understood, reference is to be had to the accompanying drawings, in which—

Figure 1 represents a top plan view of a rotary engine embodying our invention. Fig. 2 represents a side elevation of the same. Fig. 3 represents a cross-section taken on the line III III of Fig. 1. Fig. 4 represents a vertical central station of the engine proper. Fig. 5 represents a section taken on the line V V of Fig. 4. Fig. 6 represents a perspective view of one of the rotary rings, provided with the corresponding piston and a dog or tooth. Fig. 7 is a view to show more clearly part of the reverse mechanism. Fig. 8 is an enlarged section of the reverse and reciprocating slide-valves for one cylinder of the engine. Fig. 9 is a section taken on the line IX IX of Fig. 8.

In the said drawings, 1 designates the base of the engine, provided, by preference, with three parallel bearing-standards 2, and 3 designates a horizontal table or plate which connects the middle standard with one of the end standards.

4 designates a stationary shaft or axle of the engine, which extends longitudinally of the base and is journaled in the customary manner upon said standards.

5 designates a parallel shaft which is or may also be journaled in said standards, as shown.

6 designates a third shaft parallel with the others and arranged near the stationary shaft or axle. Said shaft 6 is of length sufficient only to be journaled in the middle and one end standard 2 and is provided with a gear-wheel 7 outward of said end standard, which meshes continuously with a similar gear 8 of equal diameter mounted upon the shaft 5. Arranged upon or near the opposite end of said shaft 5 is a larger gear-wheel 9, and inward thereof a wheel 10, by which motion is transmitted through the medium of the belt 11 to the machinery (not shown) to be operated.

Mounted rigidly upon the central shaft 6, near each end, is a large cam-wheel, one being numbered 12 and the other 12ª. Each of said cam-wheels is provided with an annular groove 13, which is offset in the shape of a V, as at 14, the V-shaped offset of the groove of one wheel being diametrically opposite the offset of the groove of the other wheel. Mounted rigidly upon said shaft also and located between the aforesaid cam-wheels are the cam-wheels 15 and 15ª, the former being companion to the cam-wheel 12, while the latter is companion to the cam-wheel 12ª. Said cam-wheels 15 and 15ª are provided with annular grooves 16, which are offset at two points, as at 17, and are connected by straight portions 18, said straight portions being parallel with the main portion of the grooves. Said offsets are arranged diametrically opposite each other and are of such length relative to their companion V-shaped grooves, hereinbefore referred to, that the apex of the latter are opposite the middle of their straight portions 18, and the inclined portions 17, where they join or merge into the straight portions 18, are in longitudinal alinement with the junction-points of the V-shaped grooves with their main or body portion, as shown clearly in Fig. 2. This relation of course may be varied in some degree.

Mounted rigidly upon the end of the shaft 6, journaled in the central standard 2, is a

belt-wheel 19, and 20 designates a belt connecting said wheel with the similar wheel 21 of the governor 22, of the usual or any preferred type, said governor being provided with the customary valve 23 for regulating the supply of steam accordingly as the load on the engine is heavy or light.

The engine proper is constructed, by preference, in three sections—24 the middle section and 25 the end sections—said sections being secured rigidly together by bolts, as shown in Fig. 5, (not numbered,) or in any other suitable or preferred manner. Said sections are keyed or otherwise rigidly secured upon the shaft 4. The middle section is provided in its opposite faces or sides with annular grooves of equal diameter and arranged concentrically of the axis of said shaft. Said grooves in cross-section are of semicircular form. The end sections 25 are provided in their inner faces with annular grooves of equal diameter, form, and location as the grooves of the inner section and form conjointly therewith the two cylinders or piston-chambers 26 and 26ª, as shown clearly in Fig. 4. The sections are so turned in process of construction that they do not meet outward of said cylinders or piston-chambers, and consequently form annular grooves 27, as shown clearly in Fig. 4. Said grooves are closed, however, to prevent the escape of steam from the cylinders or piston-chambers by means of the similar expansive packing-rings 28, which are segmental in cross-section, so as to conform at their contacting sides to the curvature of said cylinders or chambers, so as to make a steam-tight joint therewith, and are provided with annular ribs 29, which completely fill the grooves 27, hereinbefore referred to. Said ribs at suitable points are each provided with one or more dogs or teeth 30, which project outwardly for a purpose hereinafter explained.

Secured to the inner side of the rotary packing-rings 28, at suitable points, are the pistons 31, which are flattened where they contact with the corresponding or inner surfaces of said rings, but are rounded for the remainder of their surfaces, so as to conform to the shape of and completely partition the cylinders or chambers 26 and 26ª.

Vertically above and below its axis the cylinder-casing is formed with the valve-chambers 32, one of which intersects the cylinder 26 and the other the cylinder 26ª, as shown clearly in Fig. 4, and mounted to reciprocate therein are the abutments 33 and 33ª, respectively, said abutments being designed as a fulcrum for the steam in its action upon the piston. The abutment 33 is secured to the end of the rod 34, and said rod carries at its opposite end the antifriction-roller 35, which is permanently located in the groove of the cam-wheel 12. The abutment 33ª is also mounted upon a rod 34, provided at its opposite end with a similar roller 35ª, (see dotted lines, Fig. 1,) engaging the groove 13 of the cam-wheel 12ª, said rod extending, by preference, under the cylinder-casing and entering the same from the opposite side, such being the most feasible and clearest way of illustrating the same, as the rod of course must not intersect the companion cylinder or piston-chamber.

36 designates the wheel or rotary portion of the engine. It is in the form of a cylinder, by preference, and encircles the casing composed of sections 24 and 25. In order that it may be properly and easily secured in position, it is cast in sections, as shown in Fig. 4, in order that the dogs or teeth 30 of the rotary packing-rings 28 may be fitted easily in the cavities or recesses 37, formed internally of said wheel, as shown clearly in Fig. 5. The sections of said wheel may be secured together in any suitable or preferred manner and the wheels cast with the annular series of cog-teeth 38. The encircling wheel is therefore geared to the rotary packing-rings carrying the piston, and because provided with teeth it constitutes a gear-wheel, which meshes with and is of the same diameter as the gear-wheel 9, hereinbefore referred to. (See Figs. 1 and 2.)

39 and 39ª designate, respectively, steam-chests, which are located vertically above and below the casing and are there secured in any suitable or preferred manner. The steam-supply pipe 40 from the source of supply (not shown) leads to and from the cylinder 23 of the governor and communicates with the branch supply-pipes 41, connected in turn to the upper and lower sides of the steam-chests 39 and 39ª, respectively, as shown. Arranged inward of said steam-chests are the reverse-valve steam-chests 42 and 42ª. The former is connected by pipes 43 and 44 with the steam-chest 39, and the latter, by means of similar pipes 43 and 44, with the steam-chest 49ª.

45 and 46 designate pipes leading to the cylinder-casing, the former communicating with the steam-port 47 of said casing and the latter with the steam-port 48 of said casing. The port 47 leads to the cylinder or piston-chamber 26 to the right of the abutment 33 (when viewed as in Figs. 3 and 5) and the port 48 to a similar cylinder or chamber at an equal distance from and to the left of said abutment. (See Fig. 5.) 45 and 46 designate similar pipes leading from the steam-chest 42ª to the other cylinder or piston-chamber 26ª, the pipe 45 communicating with the port 47, communicating with said cylinder or chamber to the left of the abutment 33ª, (when viewed in the direction referred to,) while the pipe 46 communicates with the port 48, communicating with said cylinder or piston-chamber at an equal distance from and to the right of said abutment 33ª.

49 designates the exhaust-pipes for the steam-chests 42 and 42ª. They communicate with the same midway between the pipes 45 and 46 and are connected to the upwardly-

extending exhaust-pipe 50, as shown clearly in Fig. 3.

51 and 51ª designate the reciprocatory valves for the steam-chests 39 and 39ª, respectively, and said valves, at the sides where the supply-pipes 41 enter, are formed with the recesses or notches 52, so as to permit the steam to enter and reach the pipes 43 or 44, accordingly as they are opened or closed by said valves. Said valves are mounted upon the rods 53, which carry at their opposite ends the antifriction-rollers 54, engaging the grooves 16 of the cam-wheels 15 and 15ª. They therefore reciprocate continuously while the engine is in operation.

55 and 56 designate the reverse-valves mounted in the steam-chests 42 and 42ª, respectively. They are each recessed in their inner edges, as at 57, so as to bridge two of the contiguous pipes of each of said steam-chests—that is to say, so as to place in communication with the exhaust-pipes either the pipes 46, as shown in Fig. 4, or the pipes 45, as shown in Fig. 8. When said valves are adjusted to the positions shown in Fig. 4, the engine is rotating in the direction indicated by the arrow, Fig. 5, and the cam-wheels are rotating in the same direction.

The reverse-valves are provided with stems 58, which are pivotally connected to the corresponding ends of the rock-levers 59 and 60, said levers being mounted pivotally upon the upper and lower ends of the pivot-rod 61, carried by the bracket 62, bolted or otherwise secured rigidly to the middle standard 2 of the base. Said standard also by preference is provided with an arm.

63 and 64 designate a pair of similar slide-bars which are mounted one upon the other and both upon the boss 65 of the table 3 of the framework, and they are held in such position by means of the cap 66, secured to said base.

67 designates the controlling-lever of the engine. It is mounted, as at 68, upon the boss 69 of the table and is connected by the link-bars 70 and 71, respectively, to the slide-bars 63 and 64, respectively. Said lever is provided with the customary spring-actuated dog 72 and with a grip-lever 73 to retract said dog.

74 designates a sector which is secured to the table and is provided with the middle notch 75 and the end notches 76 and 77. When the dog engages the notch 75, the lever is in its neutral position, the reverse-levers cut off entirely the entrance of steam to the steam-chests 42 and 42ª, and the engine is consequently in a state of rest. When the lever is thrown to the position shown in full lines and the dog occupies the position shown in Fig. 6, said reverse-valves occupy the position shown in Fig. 4, and the engine is rotating in the direction indicated by the arrow, Fig. 3. When the lever is thrown so as to cause the engagement of the dog with the notch 77, the pistons of said reverse-valves are reversed, and the engine rotates in the opposite direction.

In practice when the lever is thrown to the position shown in Fig. 1 it reciprocates the bars 63 and 64 in opposite directions and consequently rocks the levers 59 and 60 oppositely, so as to move the levers 55 and 56 synchronously in opposite directions, the levers 55 and 56 being adjusted to connect the pipes 46 and 49. As soon as this operation takes place the steam from the steam-chests 39 and 39ª rushes through the pipes 43 into the steam-chests 42 and 42ª and thence passes by way of the pipes 45 to the cylinders or piston-chambers 26 and 26ª, respectively, via the ports 47. The steam enters the cylinders between the abutments 33 and 33ª and the pistons of their respective cylinders, and being prevented from passing or expanding in one direction by the abutments it necessarily causes the pistons to rotate in the opposite direction in said cylinders.

The pistons are arranged quartering to each other, and the same arrangement is carried out with respect to the cam-wheels 12 and 12ª and 15 and 15ª, respectively, as hereinbefore stated, that the steam may always be acting upon one piston or the other and for the greater part of each revolution of the engine upon both.

Referring particularly to Fig. 5, it will be noticed that at the moment the piston 31 has assumed the position shown and the steam has ceased to act upon it the piston 31ª in the other cylinder has assumed the position shown in dotted lines, same figure, and has just begun to feel the full force of the steam entering at the same time through the port 47 and expanding between said piston and the abutment 33ª, so that the pressure upon said piston will carry the piston 31 from the position shown in the figure referred to to the opposite side of its port 47. In order that said piston may reach such point, however, it is necessary that the abutment 33 be moved out of the way, such movement taking place as the steam-supply through the port 47 of the cylinder 26 is cut off, and it must also resume the position shown at the instant the piston passes the port 47 and the steam again enters the cylinder. The cam-wheels 12 and 15 are so arranged with relation to the piston that just as the latter reaches the point it occupies in Fig. 5 the cam-wheel 15 has pulled the valve 51 forward and therefore closed the pipe 43 to the passage of steam. At the same instant that this takes place the cam-groove of the wheel 12 engages the roller at the base of the V-shaped portion and begins, of course, to move the right abutment 33 in the direction indicated by the arrow in Fig. 4. By the time the roller reaches the apex of said V-shaped groove the abutment is completely withdrawn from the cylinder and at the same instant the piston passes the abutment. Immediately the piston has cleared the intersection-point of the abutment the roller begins to descend the opposite arm of the groove, and by the time it

reaches its base or junction point with the body of the groove the abutment is completely closed. At this instant also the roller 54 on the stem of the valve 51 has completed the passage of the straight portion 18 of the grooved wheel 15 and traverses the inclined portion connecting such end of the portion 18 with the main or body portion of the groove. Immediately before the roller again engages the main portion of the groove, and consequently before the pipe 43 is again opened by the piston 51, now moving back toward its original position, (shown in Fig. 4,) the piston has passed the port 47 and is in position to be again acted upon by the steam, as will be readily understood.

The foregoing description applies equally to the operation of the piston 31^a, the cam-wheel 12^a for moving the abutment back and forth, and the cam-wheel 15^a for reciprocating the valve 51^a.

The exhaust-steam, when the engine is running in the direction indicated by the arrow, Fig. 5, passes from both cylinders through the ports 48 and the pipes 46 into the reverse-valve steam-chests 42 and 42^a, respectively, and escapes by way of the pipes 49 and pipe 50 in the customary manner. When the engine is operating in the opposite direction, the pipes 46 and ports 48 become the path for the supply of steam to the engine, while the ports 47 and the pipes 45 form the path of escape for the exhaust-steam back to the reverse-valve steam-chests. From said steam-chests it escapes through the pipes 49 and 50, as before.

The governor of course acts to diminish or increase the quantity of steam supplied to the engine in the customary manner—that is to say, when the load is lightened the supply of steam is proportionately smaller, and when the load increases the steam-supply is increased in a corresponding degree.

Owing to the fact that it is absolutely essential that the cylinders be perfectly steam-tight and that the abutments when in place shall effectually partition the cylinders, we form recesses inward of said abutments and fit snugly therein plates 78, which bear against the inner edges of said abutments and are held in such position with a yielding pressure by means of springs 79, in order that any slight wear of the abutments may be compensated and that they may always bear squarely against the inner or flat sides of the packing-rings 28.

In practice the various steam-chests and the engine at points through which the rods 34 project will be provided with the customary stuffing-boxes. (Not shown herein.)

The various valve and abutment stems or rods 53 and 54 will in practice be embraced by suitable guides and supports, so that there will be no possibility of their antifriction-rollers becoming disengaged accidentally from the grooves of the cam-wheels, and said cam-wheels of course are mounted independently upon the shaft 6, in order that they may be independently adjusted when necessary.

By providing a stationary shaft or axle and casing it is obvious that there are no bearings to wear, so as to require comparatively frequent adjustments, as is necessary with the rotary engine of the usual type—that is to say, with a stationary shell or casing and a rotary shaft and wheel journaled therein. By our construction we also obviate any vibratory movement of the engine as a whole, and consequently its attendant objections.

By the arrangement of the pistons and cam-wheels relative to each other it is obvious that the steam not only exerts pressure upon one or the other of the pistons for each complete revolution of the engine, but that it will be impossible for the engine to stop on dead-center. As a result, no matter in what positions the pistons are in the cylinders the adjustment of the lever 67 from its internal or central position in one direction or the other will start and rotate the engine in a corresponding direction, as will be readily understood.

It is to be understood, of course, that various changes may be made in the form, proportion, and detail construction of parts, and also that mechanical equivalents may be employed without departing from the spirit and scope or sacrificing any of the advantages of our invention.

Having thus described the invention, what we claim as new, and desire to secure by Letters Patent, is—

1. A rotary engine, comprising a stationary casing suitably supported, composed of sections secured together, and provided with a circular cylinder or piston-chamber, and an external groove communicating therewith, an expansive packing-ring fitting snugly in said cylinder, having its inner side flattened and provided at its outer side with an annular rib engaging said groove, a wheel encircling the casing geared to said ring, a piston partitioning the cylinder and secured to said ring, and a reciprocating abutment partitioning the cylinder and contacting with the flat or inner surface of the packing-ring when performing its abutment function, substantially as described.

2. A rotary engine, comprising a stationary casing suitably supported, composed of sections secured together, and provided with a circular cylinder or piston-chamber, and an external groove communicating therewith, an expansive packing-ring fitting snugly in said cylinder having its inner side flattened and provided at its outer side with an annular rib engaging said groove, a wheel encircling the casing geared to said ring, a piston partitioning the cylinder and secured to said ring, a reciprocatory abutment partitioning the cylinder and contacting with the flat or inner surface of the packing-ring when performing its abutment function, and means to hold said reciprocatory abutment with a

yielding pressure against said packing-ring, substantially as described.

3. A rotary engine, comprising a stationary casing provided with a circular cylinder or piston-chamber, having steam-ports, a piston therein, a wheel encircling the casing and geared to said piston, a reciprocating abutment partitioning said cylinder at times between the steam-ports, a steam-chest connected with the steam-supply, a second steam-chest, a pair of pipes connecting said steam-chests, a pair of pipes connecting the last-named steam-chest with the ports of the engine, an exhaust-pipe also communicating with said last-named steam-chest, a slide-valve in said last-named steam-chest, and connecting the exhaust-pipe with one of the pipes connected with the ports of the engine, and closing one of the pipes leading from the first-named steam-chests, a reciprocating valve in the first-named steam-chest which once in each revolution of the piston cuts off the supply of steam to the cylinder, and means to shift the position of the valve in the other steam-chest and consequently reverse the movement of the engine, substantially as described.

4. A rotary engine, comprising a casing provided with a plural number of circular cylinders or piston-chambers provided with steam-ports, a wheel encircling said casing, pistons set at an angle to each other, located in and partitioning said cylinders and geared to said wheel, reciprocating abutments arranged diametrically opposite each other and between the ports of and partitioning their respective cylinders, a pair of reverse-valve steam-chests, pipes connecting the same with said ports, exhaust-pipes leading from said steam-chest, a second pair of steam-chests connected to the steam-supply pipe, a pair of pipes connecting said steam-chests with the reverse-valve, slide-valves in the reverse-valve steam-chests cutting off the passage of steam through one of the pipes leading to each of the other steam-chests and connecting one of the pipes leading to each cylinder of their respective exhaust-pipes, and reciprocating valves in the other steam-chests, which once in each revolution cut off the supply of steam to their respective cylinders, substantially as described.

5. A rotary engine, comprising a casing provided with a plural number of circular cylinders or piston-chambers, provided with steam-ports, a wheel encircling said casing, pistons set at an angle to each other, located in and partitioning said cylinders and geared to said wheel, reciprocating abutments arranged diametrically opposite each other and between the ports of and partitioning their respective cylinders, a pair of reverse-valve steam-chests, pipes connecting the same with said ports, exhaust-pipes leading from said steam-chest, a second pair of steam-chests connected to the steam-supply pipe, a pair of pipes connecting said steam-chest with the reverse-valve, slide-valves in the reverse-valve steam-chests, cutting off the passage of steam through one of the pipes leading to each of the other steam-chests and connecting one of the pipes leading to each cylinder with their respective exhaust-pipes, reciprocating valves in the other steam-chest, and means to automatically and alternately operate said valves so that the supply of steam to each cylinder will be cut off once in each revolution of the piston, but never from both pistons at the same instant, substantially as described.

6. A rotary engine, comprising a casing provided with a plural number of circular cylinders or piston-chambers provided with steam-ports, a wheel encircling said casing, pistons set at an angle to each other, located in and partitioning said cylinders and geared to said wheel, reciprocating abutments arranged diametrically opposite each other and between the ports of and partitioning their respective cylinders, a pair of reverse-valve steam-chests, pipes connecting the same with said ports, exhaust-pipes leading from said steam-chest, a second pair of steam-chests connected to the steam-supply pipe, a pair of pipes connecting said steam-chests with the reverse-valve, slide-valves in the reverse-valve steam-chests, cutting off the passage of steam through one of the ports leading to each of the other steam-chests and connecting one of the pipes leading to each cylinder with their respective exhaust-pipes, reciprocating valves in the other steam-chests, and means to automatically and alternately operate said valves so that the supply of steam to each cylinder will be cut off once in each revolution of the piston, but never from both pistons at the same instant, and to shift the abutments out of the path of their respective pistons during the time the supply of steam is cut off, substantially as described.

7. A rotary engine, comprising a casing provided with a plural number of circular cylinders or piston-chambers provided with steam-ports, a wheel encircling said casing, pistons set at an angle to each other, located in and partitioning said cylinders and geared to said wheel, reciprocating abutments arranged diametrically opposite each other and between the ports of and partitioning their respective cylinders, a pair of reverse-valve steam-chests, pipes connecting the same with said ports, exhaust-pipes leading from said steam-chests, a second pair of steam-chests connected to the steam-supply pipe, a pair of pipes connecting said steam-chests with the reverse-valve steam-chests, slide-valves in the reverse-valve steam-chests, cutting off the passage of steam through one of the pipes leading to each of the other steam-chests and connecting one of the pipes leading to the cylinder with their respective exhaust-pipes, reciprocating valves in the other steam-chests, means to automatically and alternately operate said valves so that the supply of steam to each cylinder will be cut off once in each revolution of the piston, but never from both pis-

tons at the same instant, and to shift the abutments out of the path of their respective pistons during the time the supply of steam is cut off, and a lever connected to the reverse-valves, whereby their positions may be reversed and the engine driven in the opposite direction substantially as described.

In testimony whereof we affix our signatures in the presence of two witnesses.

LOUIS K. CARNAHAN.
CHARLES S. CARNAHAN.

Witnesses:
J. W. VANDRUFF,
W. H. CLARK.