No. 771,245. PATENTED OCT. 4, 1904.

P. H. HENDRICKSON.

ROTARY ENGINE.

APPLICATION FILED JULY 7, 1904.

NO MODEL.

4 SHEETS—SHEET 1.

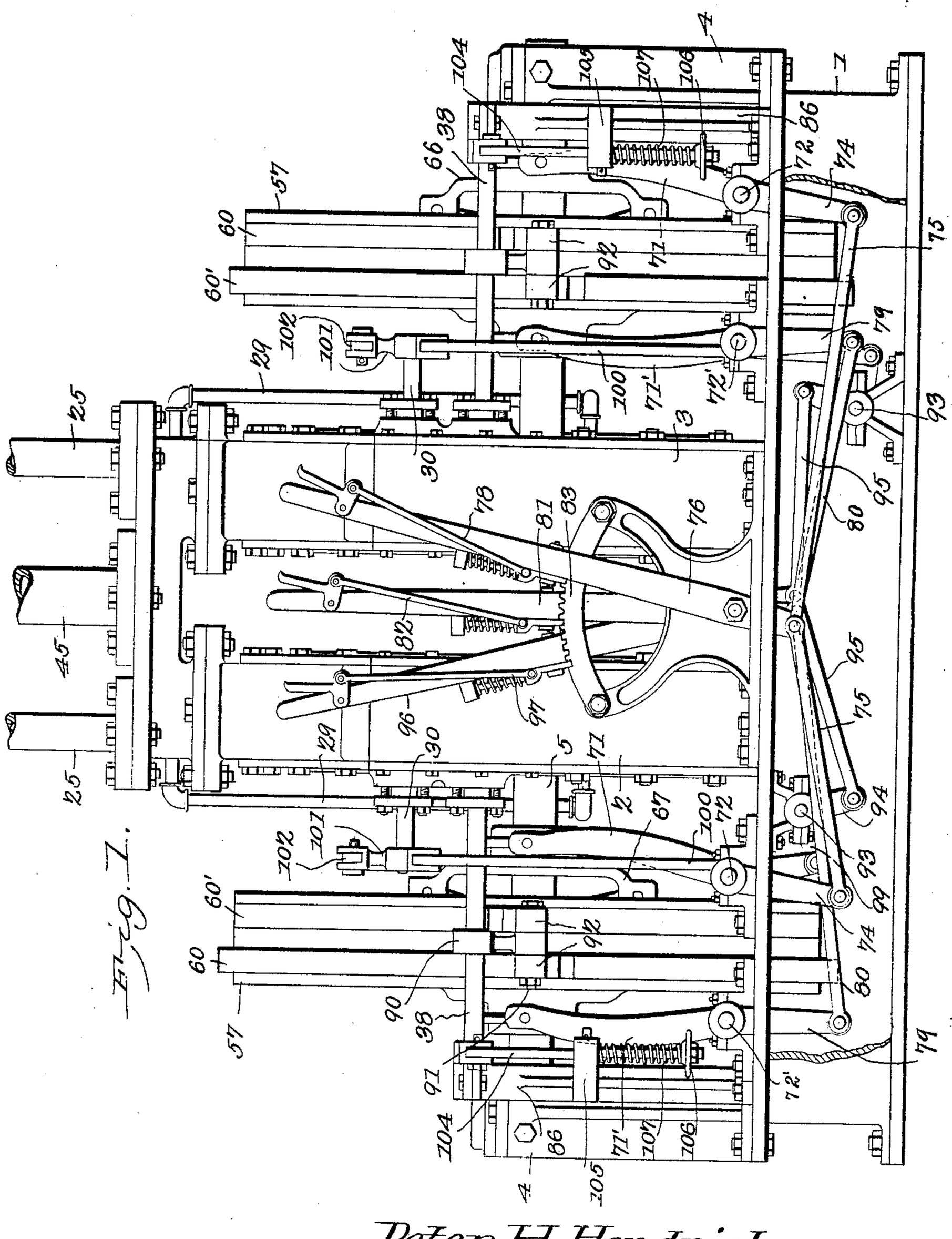

Fig. 1.

Witnesses

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NO MODEL. 4 SHEETS—SHEET 2.

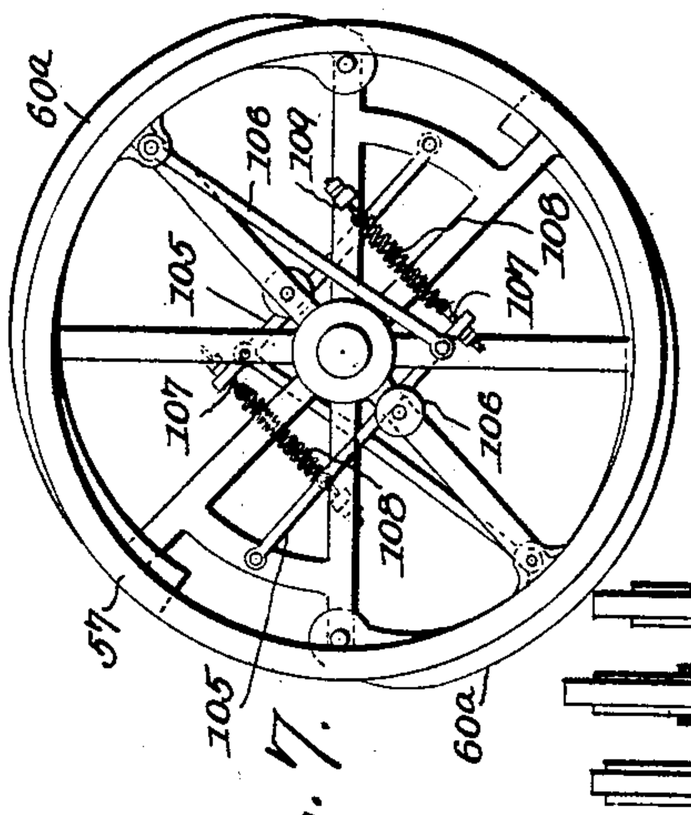

Fig. 1.

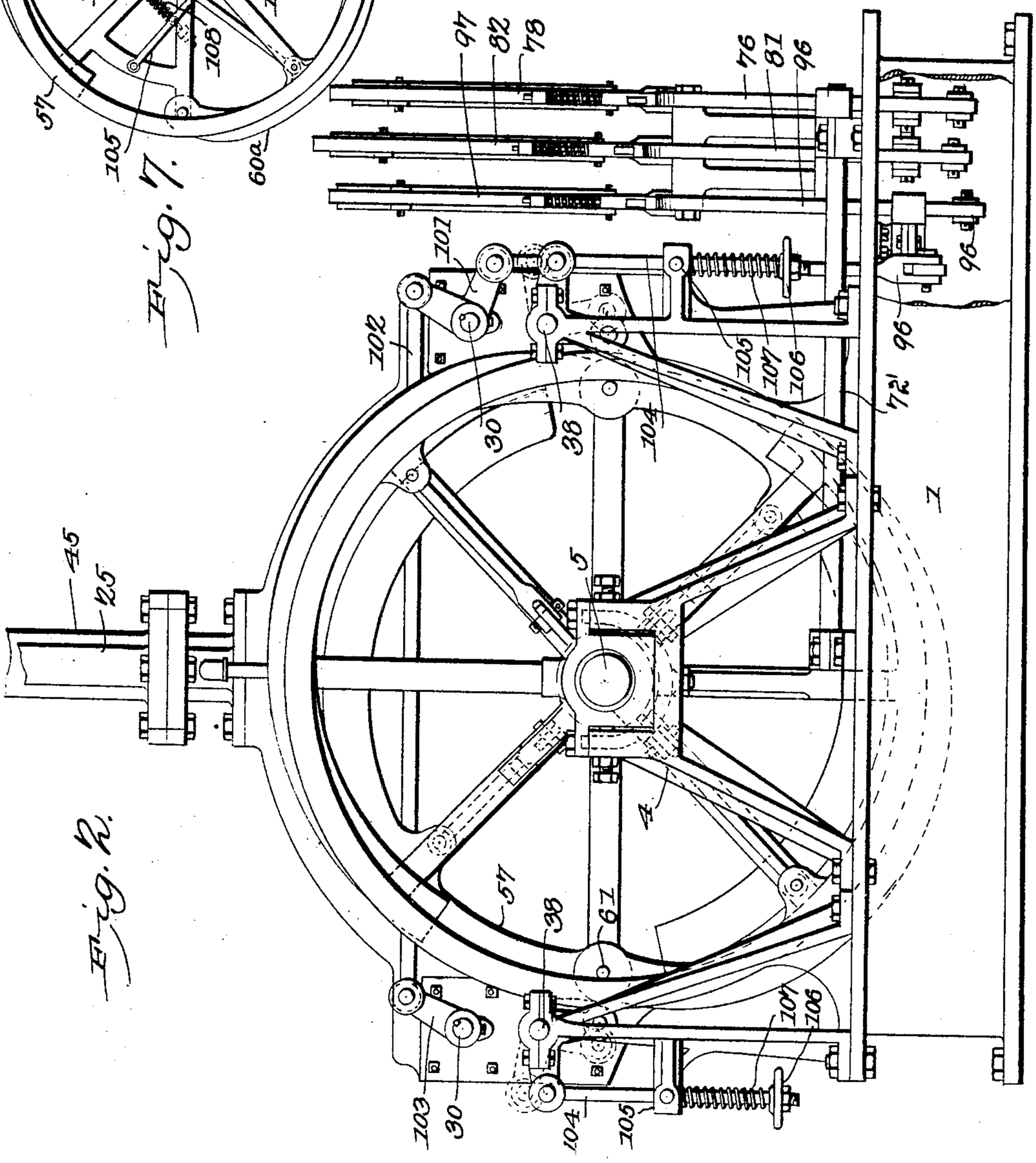

Fig. 2.

Witnesses

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NO MODEL. 4 SHEETS—SHEET 3.

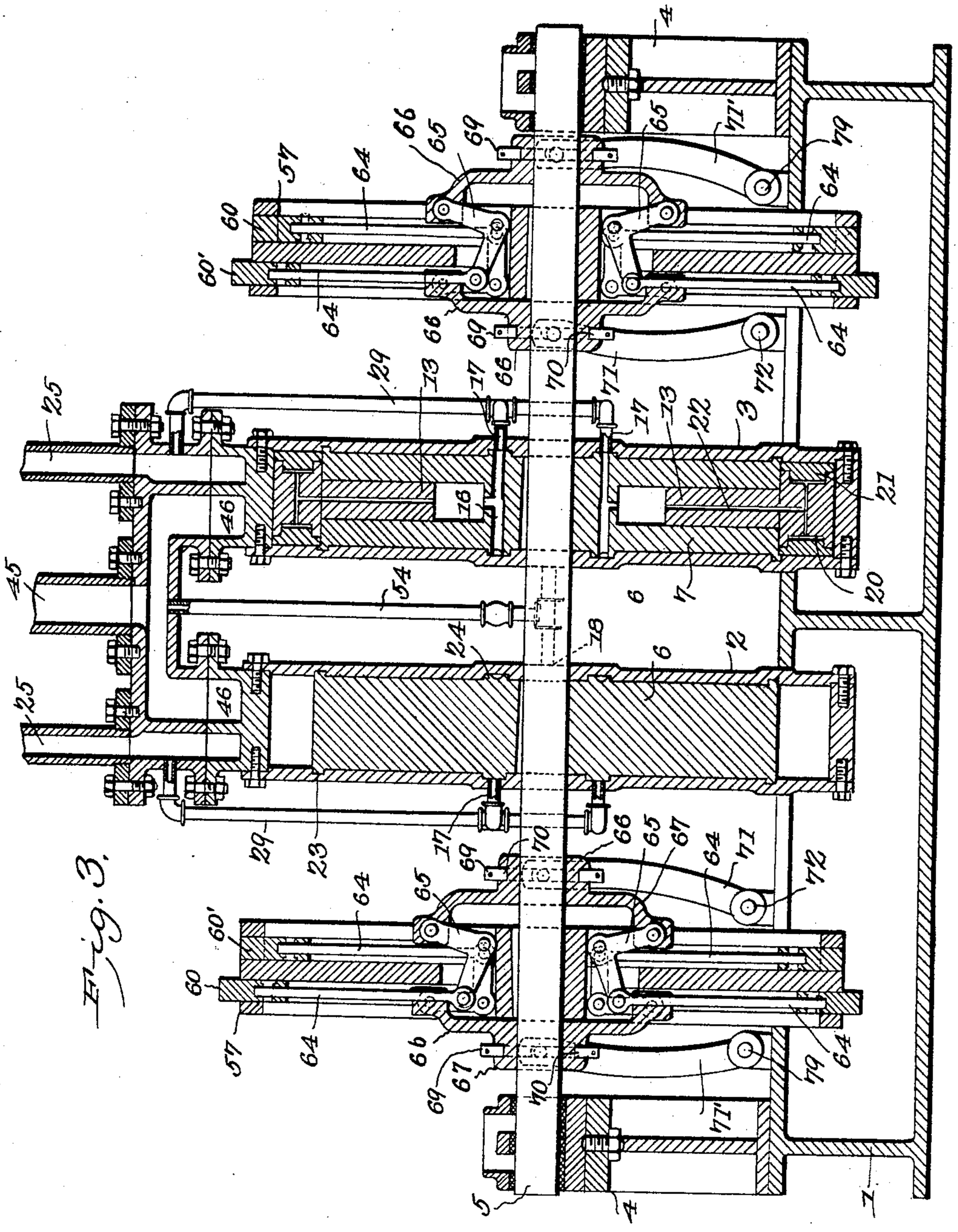

Fig. 3.

Witnesses

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NO MODEL. 4 SHEETS—SHEET 4.

Fig. 5.

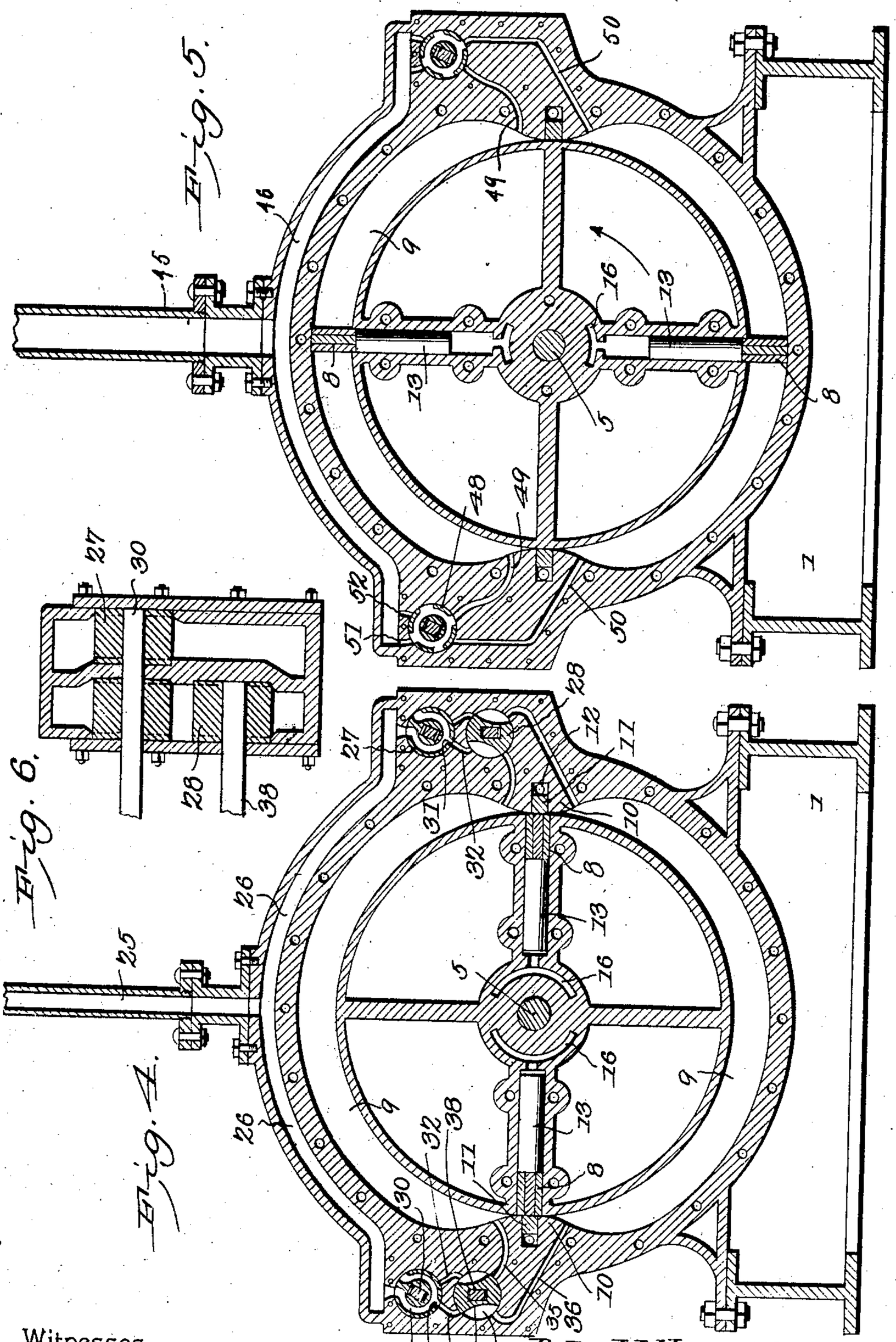

Fig. 6.

Fig. 4.

Witnesses

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No. 771,245. Patented October 4, 1904.

UNITED STATES PATENT OFFICE.

PETER H. HENDRICKSON, OF SKIBO, MINNESOTA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 771,245, dated October 4, 1904.

Application filed July 7, 1904. Serial No. 215,631. (No model.)

To all whom it may concern:

Be it known that I, PETER H. HENDRICKSON, a citizen of the United States, residing at Skibo, in the county of St. Louis and State of Minnesota, have invented a new and useful Rotary Engine, of which the following is a specification.

This invention relates to improvements in rotary engines, and has for one of its objects to provide a multiple-cylinder engine in which the piston-wings are arranged in pairs so related that at least two of the wings shall at all times be in position to be operated upon by the steam or other actuating fluid, so that the engine may be started from any point.

A further object of the invention is to provide a novel form of piston-wing and means for moving the same outward into engagement with the periphery of the inner wall of the cylinder, provision being also made for permitting the escape of steam from the wing-guiding recess when the wing is being forced inward by means of the abutment or abutments carried by the stationary cylinder.

A still further object of the invention is to provide a novel form of valve mechanism by means of which the engine may be stopped, started, and its direction of movement changed, as required.

A still further object of the invention is to provide a steam-cut-off valve movable to cut off the steam-supply at any point in the stroke, and thus govern the speed and power of the engine, as well as lessen the expense of operation by using the steam expansively during the operation of the stroke.

A still further object of the invention is to provide an improved valve-operated mechanism which may be adjusted at all times and while the engine is running at any speed in order to change the point of cut-off.

A still further object of the invention is to provide an improved exhaust-valve so arranged as to have considerable lead in both directions of rotation of the engine, and thus permit the free escape of steam from the cylinder when the valve is moved to cut off the steam-supply.

A still further object of the invention is to provide a novel form of automatic governing means in which the positions of the cams that control the operation of the inlet-valves may be adjusted when the speed of the engine becomes at normal.

With these and other objects in view, as will more fully hereinafter appear, the invention consists in the novel construction and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

In the accompanying drawings, Figure 1 is an elevation of a rotary engine constructed in accordance with the invention. Fig. 2 is an end elevation of the same. Fig. 3 is a longitudinal sectional elevation of the engine. Fig. 4 is a transverse sectional elevation through one of the cylinders and the steam-inlet ports. Fig. 5 is a similar view, the section being taken through the exhaust-ports. Fig. 6 is a sectional plan view of a portion of the cylinder, showing the arrangement of the valves. Fig. 7 is an elevation illustrating a slight modification of the invention and a portion of a governor for automatically regulating the speed.

Similar numerals of reference are employed to indicate corresponding parts throughout the several figures of the drawings.

In the drawings there is shown a suitable base 1, which may be of any ordinary construction, and on this base or forming a part thereof are two vertically-arranged circular cylinders 2 and 3. Near the opposite ends of the base are bearings 4 for the reception of a longitudinally-disposed shaft 5, carrying two pistons 6 and 7, that are arranged in the cylinders 2 and 3, respectively.

The pistons 6 are of the drum type and are provided with recesses for the reception of piston-wings 8, adapted to project within the steam-spaces 9 of the cylinder, the steam-spaces being separated from each other by radial abutments 10, arranged at diametrically opposite points, and said abutments have recesses for the reception of metallic packing-

strips 11, which are forced outward from the recess into engagement with the periphery of the drum. The packing-strips are held out by pressure of steam entering through a pipe 12 to the inner portions of the recesses.

Each of the piston-wings is provided with a stem 13, which may be of circular or other form in cross-section, and said stems enter correspondingly-shaped openings in the drum. These openings communicate with steam-passages 16, formed in the hub of the piston and adapted to be brought successively into alinement with steam-inlet ports 17 and steam-exhaust ports 18, so that during the time the piston is projected outward into the steam-space the passages 16 will be in communication with the steam-supply and the wings will be held out under pressure, while during inward movement of the wing, as during the passage of abutments, the passages 16 are in communication with the exhaust, so that there will be no danger of strain on the parts or breakage while the piston-wings are moving inward. The opposite edge portions of each piston-wing are recessed, as at 20, for the reception of movable packing-blocks 21, that are adapted to engage against the vertical walls of the cylinder, and in the body of the wing is formed a steam-passage 22, by which steam is conducted to a point behind the packing-blocks in order to assist in holding such blocks outward into engagement with the vertical walls of said cylinder. In order to further prevent passage of steam between the steam-space and the shaft, the side walls of the drum are provided with annular ribs 23 and 24, arranged, respectively, at points near the periphery and center of the drum, these ribs fitting within correspondingly-shaped annular recesses in the vertical walls of the cylinders.

The steam enters through two main supply-pipes 25, passing to ports 26, formed in the cylinder, these ports extending to opposite sides of the cylinder, and the passage of steam from thence to the steam-spaces being controlled by two sets of valves, including reversing-valves 27 and cut-off valves 28. A portion of the steam passes through pipes 29 from the steam-space to the steam-inlet port 17 adjacent to the central portion of the piston, so as to permit the entrance of the steam for the outward movement of the piston-wings.

The valves 27 are reversing-valves and are mounted on stems 30, extending transversely through the cylinder-casting, and each of such valves is provided with fluid-ports having a common outlet 31 in the direction of the steam-spaces, this outlet being movable in order to place it in communication with a port 32 or a port 33, both of which communicate with a cylindrical valve-chamber 34, in which the cut-off valve 28 is placed, and from said chamber lead ports 35 and 36 to the steam-spaces on opposite sides of the abutments 10. The cut-off valve is mounted on a standard 38, which may be moved at any point in the stroke in order to cut off the supply of steam to the steam-space, and this valve moves in the same direction without regard to the direction of rotative movement of the engine.

With the parts shown in Fig. 1 steam is entering the steam-spaces in such manner as to permit the rotation of the engine in the direction indicated by the arrow; but should the two reversing-valves be shifted in order to place the port 21 in communication with the ports or passages 33 the direction of rotation will be reversed, and the steam will then pass through the ports 36 to the steam-spaces.

The exhaust escapes through a pipe 45, that is in communication with cylinder-ports 46, arranged in much the same manner as the steam-inlet port 26, but is of considerably larger area in order to permit the free escape of the steam. The ports 46 lead from valve-chambers, in which are arranged exhaust-valves 48, mounted on the stems 30 of the reversing-valves, and each of such exhaust-valves has four outlet-ports, which may be placed in communication with ports 49 and 50, leading from the steam space and ports 51 and 52, that are in communication with the exhaust-ports 46. In the present instance with the piston-drum rotating in the direction indicated by the arrow the steam is escaping from the steam-spaces through the port 50 at the right of Fig. 5 and through the port 49 at the left of the same figure. All of the ports of the exhaust-valves are of considerably larger area than the cylinder-ports with which they communicate, thus affording sufficient space for the escape of steam and avoid all danger of breakage when the engine is brought to a standstill. The engine may be stopped by the reversing-valves, it being merely necessary to turn such valves until the port 31 is midway between the two ports 32 and 33, at which time no steam can pass into the cylinders. The escape of the steam from the piston-wing-guiding recesses is accomplished through pipes 54, leading upward to the main exhaust-pipe 45.

On the shaft 5 are secured two cam-carrying disks 57, both of which are of precisely the same construction, and each disk has two sets of valve-operating cams, one set controlling the movement of the valves while the engine is rotating in one direction and the other set controlling the operation of the valve when the engine is rotating in the opposite direction. Each set of cams comprises a pair of pivotally-mounted arcuate bars 60, that are of a length somewhat less than half the periphery of the disks 57 and are pivoted at one end to said disks by means of pins 61. The two cams 60, which are operable when the engine is rotating in the direction indicated by the arrow are shown as projected beyond the periphery of the disk, while the two cams 60′, which are inoperative when the

engine is rotating in the direction indicated, are withdrawn to a position within the peripheral line of the disk.

The cams are guided in suitable slots formed in the periphery of the disk or in flanges projecting therefrom and at that end opposite their pivot-points are connected by rods or links 64 to the approximately horizontal arms of bell-crank levers 65, said bell-crank levers being pivoted at the point of bifurcation to the hubs of the disks and their approximately radial arms being connected to arms 66, projecting from slidably-mounted collars 67, that rotate with the shaft 5. The collars 67 are grooved for the reception of two-part collars 69, having projecting-pins 70, which engage with the slotted ends of pivotally-mounted rocker-arms 71 71′, carried by rock-shafts 72 72′, respectively, and when said rock-shafts are turned the collars are shifted to and fro and cause an approximately radial movement of the valve-operating cams.

The two shafts 72 are connected by means of rocker-arms 74 and links 75 to a pivotally-mounted lever 76, the upper portion of which carries a latch-bar 77, movable over a notched locking-segment 78, and by manipulating this lever the latch may be engaged in any one of the notches and the lever locked in adjusted position with the cams projected for any desired distance. The greater the projection of the cams the longer will the valves be held open, and when the cams are projected but a short distance the valves will be thrown open for a short time and the steam will be cut off at the first portion of the stroke and operate expansively during the remaining portion of the stroke.

The two rock-shafts 72′ are connected by a system of rocker-arms 79 and links 80 to a lever 81, that is provided with a locking-latch 82, movable over the segment 83, and the operation here is substantially the same as that before described, the extent of movement of the lever determining the extent of projection of the second set of cams and being used when the engine is to rotate in a direction opposite to that indicated by the arrow.

At points adjacent to the cam-carrying disks are arranged standards 86, having bearings for the support of the valve-stems 38. On the stems 38 are secured rocker-arms 90, each of which carries at its outer end a stud 91 for the support of a pair of cam-actuated rollers 92, and one or other of the rollers is operated upon by the cams carried by disk 57. Proper adjustment of the cams insures rotation of the engine at any desired speed, inasmuch as the point of cut-off may be accurately governed in accordance with the load and speed of the engine.

At a point under the main portion of the bed-plate are arranged two brackets for the support of shafts 93, each carrying a rocker-arm 94, and said rocker-arms are coupled by links 95 to the lower end of a reversing-lever 96, that extends up through the bed-plate and is provided with the usual locking-latch 97 and locking-segment to permit of its adjustment in accordance with the direction in which the engine is to rotate. The rock-shafts 93 are further provided with rocker-arms 99, connected by links 100 to bell-crank levers 101, said bell-crank levers being connected to one of the sets of reversing-valve-carrying shafts 30, and the bell-crank levers are further connected to the opposite set by rods 102 and rocker-arms 103.

In the operation of the cut-off valves any suitable mechanism may be employed for closing the valves—such, for instance, as the mechanism ordinarily employed in a Corliss engine. In the present case each of the valve-stems 38 is shown as provided with a rocker-arm 103, connected to a vertically-guided rod 104, that passes through a bracket 105, carried by the standard 86. The lower portion of this rod is threaded for the reception of an adjusting-nut 106, and between the nut and the bracket is a helical spring 107, that is compressed during the opening movement of the valve and serves by expansion to move the valve to closed position when such operation is permitted by the cam.

In the construction of this engine it is obvious that the cut-off-valve-controlling cams may be placed under the control of a governor, so as to automatically adjust the point of cut-off in accordance with the speed of the engine instead of having the cams positively adjusted by the levers 76 and 81. In such cases the cams 60^a are of the same construction as previously described, and the web or spoke portion of each of the cam-carrying disks carries a pair of arms 105, having adjustable weights 106, that are movable outward under the influence of centrifugal force, as are also the cams. Each of the bars 105 is coupled by a rod 106 to one of the cams, and it will be observed that the pivotal point of each cam and the bar to which it is connected are arranged on opposite sides of the center of rotation, so that while the cam tends to move outward in one direction under the influence of centrifugal force the same force will tend to move the weight 106 outward in the opposite direction, thus to some extent balancing the force. In order to adjust the operation of the governor and to control the outward movement of the cams, each lever carries an adjustable screw 107, that is connected by a spring 108 to a fixed bolt 109 on the disk. By altering the stress of the spring the sensitiveness of the governor may be increased or diminished to any desired extent.

Having thus described the invention, what is claimed is—

1. In a rotary engine, a cylinder, a revoluble piston-drum mounted therein and provided with recesses that extend from the cen-

tral hub of the drum to its periphery, arcuate steam-inlet ports formed at one end of the hub and communicating with said recesses, arcuate exhaust-ports formed at the opposite end of the hub and communicating with said recesses, a steam-supply port leading through one side of the cylinder for communication with one set of recesses as they pass the port during the movement of the piston, an exhaust-port leading from the opposite side of the cylinder and in communication with said exhaust-ports, and radially-movable piston-wings mounted in said recesses.

2. In a rotary engine, a cylinder, a revoluble piston-drum having a wing-guiding recess in communication with a steam-supply, and a sectional piston-wing arranged in said recess, said wing comprising a central body portion having passages for the steam, and side members guided by the central portion and adapted to engage the side walls or heads of the cylinder.

3. The combination with a revoluble cylinder, having an annular groove, of a piston-drum mounted within the cylinder and having an annular rib fitting within said groove, said annular rib being provided with a groove forming a steam-passage, a steam-supply pipe passing through the cylinder and communicating with the piston-groove as the piston rotates, said piston being provided with a wing-guiding recess in communication with the groove, and a piston-wing disposed in said recess.

4. The combination in a rotary engine, of a cylinder having a main steam-port, an abutment carried by the cylinder, a revoluble piston arranged within the cylinder, a valve-chamber with which the main port communicates, a reversing-valve disposed in said chamber, a cut-off-valve chamber, a pair of ports leading from the reversing-valve chamber to the cut-off-valve chamber, a pair of ports leading from the cut-off-valve chamber, one of such ports being in communication with the steam-space of the cylinder on one side of the abutment, and the other leading to the steam-space on the opposite side of the abutment, and a cut-off valve arranged in the valve-chamber.

5. In a rotary engine, a cylinder having an abutment, a reversing-valve chamber, ports leading from the chamber to the opposite sides of the abutment, an exhaust-valve chamber in transverse alinement with the reversing-valve chamber, ports leading from the reversing-valve chamber to opposite sides of the abutment, reversing and exhaust valves mounted in the respective chambers, and a valve-stem common to both valves.

6. In a rotary steam-engine, a cylinder having an abutment, transversely-alined reverse-valves, and exhaust-valve chambers, main ports leading thereto, ports leading from both chambers to the steam-space of the cylinder for controlling the flow of steam from both sides of the abutment, reversing and exhaust valves mounted in the respective chambers, and a stem common to both valves.

7. In a rotary engine, a cylinder having an abutment, an exhaust-valve chamber, a pair of ports leading to the chamber, a pair of ports for placing such chamber in communication with the opposite sides of the abutment, and a revoluble valve mounted in the chamber and having ports equal in number to the number of ports leading to the chamber, all of the valve-ports being of greater area than the casing-ports.

8. The combination in a rotary engine, of a cylinder having an abutment, a cut-off-valve chamber, a reversing-valve chamber, a pair of ports leading, respectively, from opposite sides of the abutment to the cut-off-valve chamber, a pair of ports leading between the two chambers, and reversing and cut-off valves in their respective chambers, said cut-off valve having movement in one direction for controlling both sets of ports.

9. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble disk, valve-operating cams carried by the disk, and means for varying the relative positions of the cams and disk to alter the point of cut-off of the valve.

10. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble disk having a peripherally-disposed slotted flange, cut-off-valve-operating cams in the form of arcuate bars pivoted at one end of the disk, and means for engaging the opposite ends of said cams and adjusting the same relatively to the disk and thereby altering the point of cut-off of the valves.

11. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble disk having a peripherally-disposed slotted flange, a pair of cut-off-valve-operating cams in the form of arcuate bars pivoted at one end to the disks and adapted to project through the slots, means for engaging the opposite ends of the cams and adjusting the same to vary the point of cut-off, and means for locking said cams in adjusted position.

12. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble shaft, a flanged disk carried thereby and provided with cam-guiding slots, cut-off-valve-operating cams pivoted at one end of the disk and adapted to project through said slots, a sleeve slidably mounted on the shaft, radial arms or lugs projecting from said sleeve, bell-crank levers fulcrumed to the disk and connected to said arms, and rods connecting the opposite ends of such bell-crank levers to the cams.

13. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble shaft, a disk having a peripherally-disposed slotted flange, cut-off-valve-operating

cams in the form of arcuate bars pivoted at one end to the disk, and guided by the walls of the slots, a grooved sleeve slidably mounted on the shaft, radiating arms or lugs projecting from the sleeve, bell-crank levers pivoted to the disk, said bell-crank levers being pivotally connected to the arms, rods connecting said bell-crank levers to the cams, and means for adjusting and locking the collar.

14. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a stem carrying the same, a pair of rocker-arms carried by the stem, an antifriction-roller mounted on one of the arms, a valve-operating cam for engaging said roller, and a spring-pressed rod connected to the opposite rocker-arm and serving to retain the valve in closed position.

15. The combination with a reversible rotary engine, of a cut-off valve, a stem carrying the valve, a pair of rocker-arms secured to the stem, antifriction-rollers carried by one of said rocker-arms, a spring-pressed rod connected to the opposite rocker-arm, a revoluble shaft, a flanged disk carried by said shaft, a pair of sets of cut-off-valve-operating cams mounted on the disk, independently-movable sleeves carried by the shaft, and means for connecting the sets of sleeves to the sets of cams, whereby either set may be moved to inoperative position, and the other set for engaging one of the antifriction-rollers.

16. The combination in a rotary engine, of a cylinder, a piston, a cut-off valve, a revoluble cam-carrier, a pair of cams in the form of arcuate bars pivoted at one end to the carrier, governor-bars pivoted to the carrier, rods connecting the cams and governor-bars in sets, and the pivot-points of each set being disposed, respectively, on the opposite sides of the center of rotation of the carrier, and adjustable springs connecting the governor-bars to said cam-carrier.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

PETER H. HENDRICKSON.

Witnesses:
GEO. R. LAYBOURN,
ALRIK CORNELL.