No. 753,388. PATENTED MAR. 1, 1904.

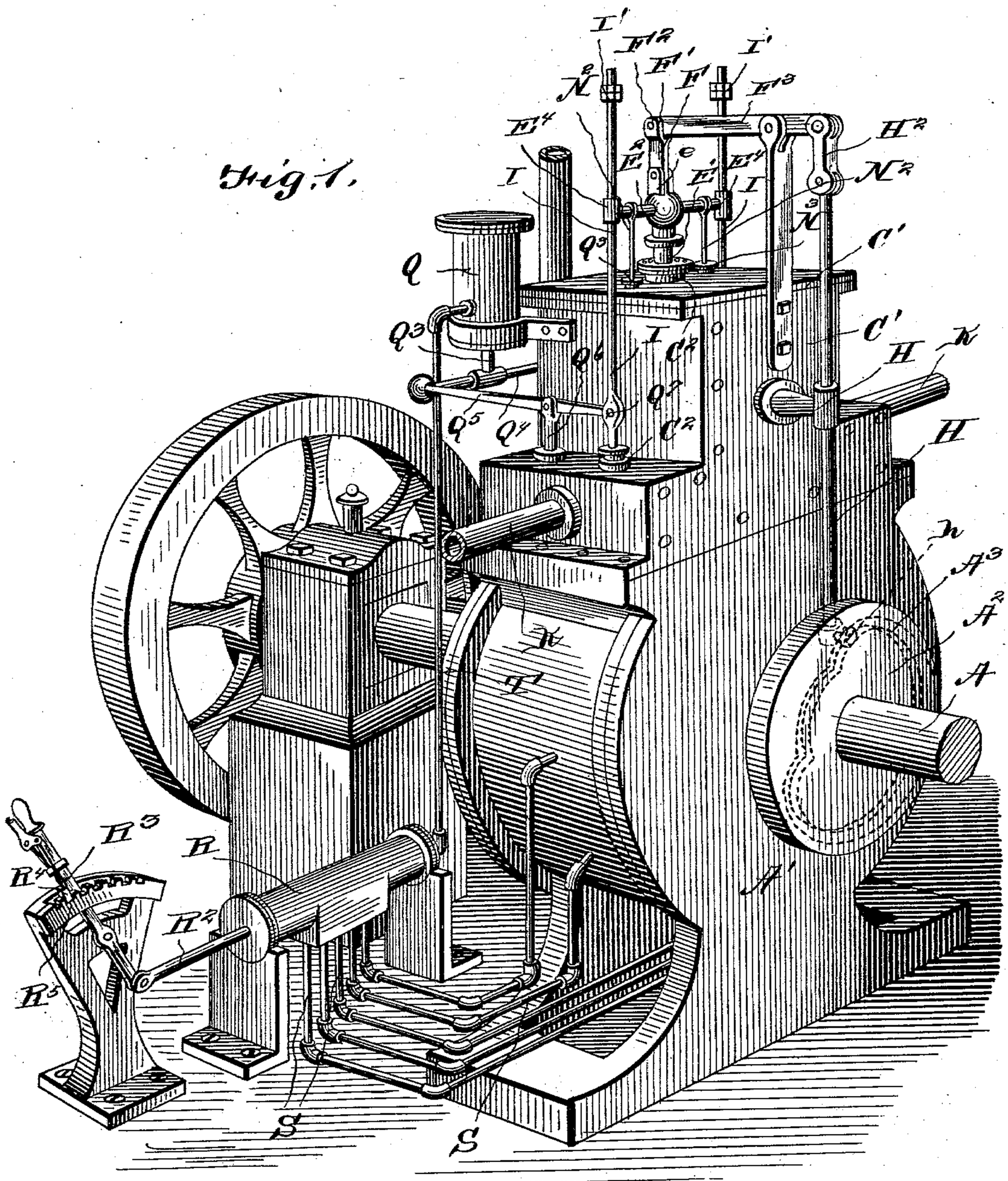
A. GROVES, Sr.

ROTARY ENGINE.

APPLICATION FILED DEC. 26, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
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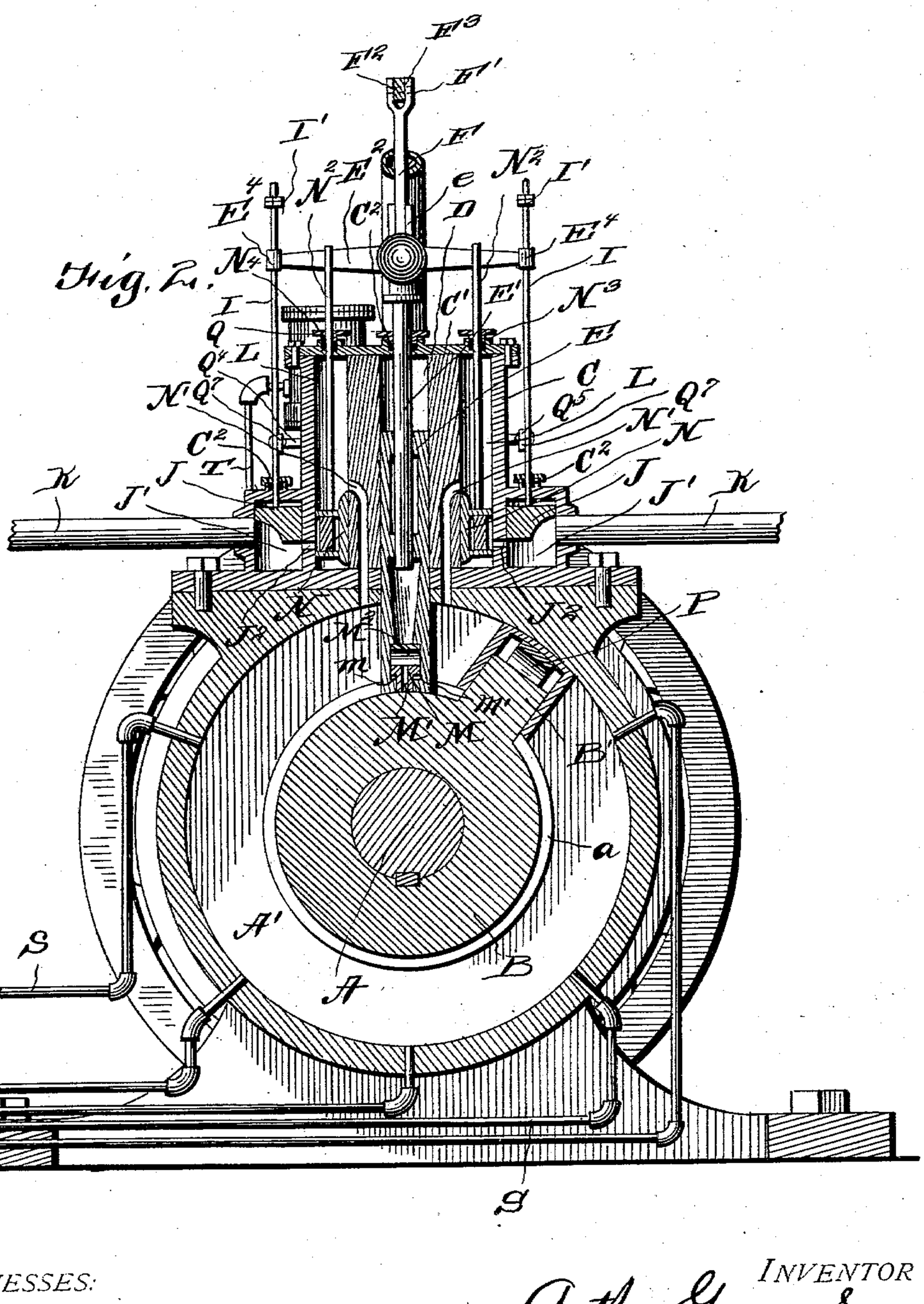
NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 5 SHEETS—SHEET 3.

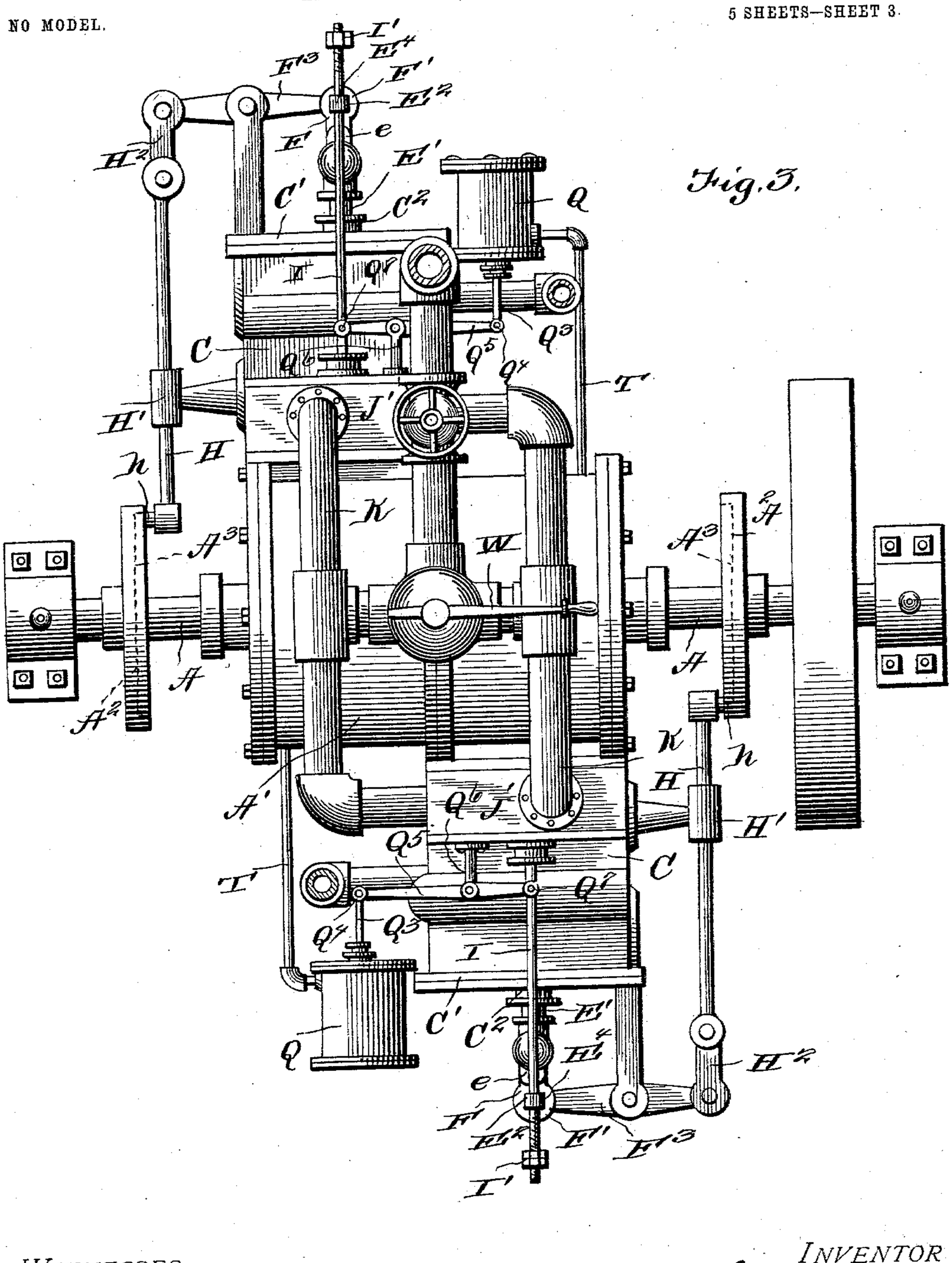

Fig. 3.

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NO MODEL. 5 SHEETS—SHEET 4.

Fig. 9.

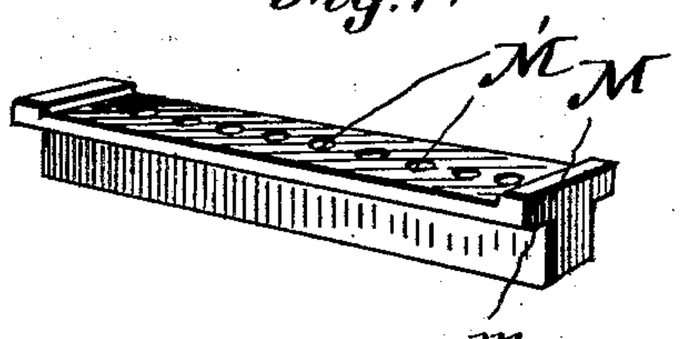


Fig. 5.

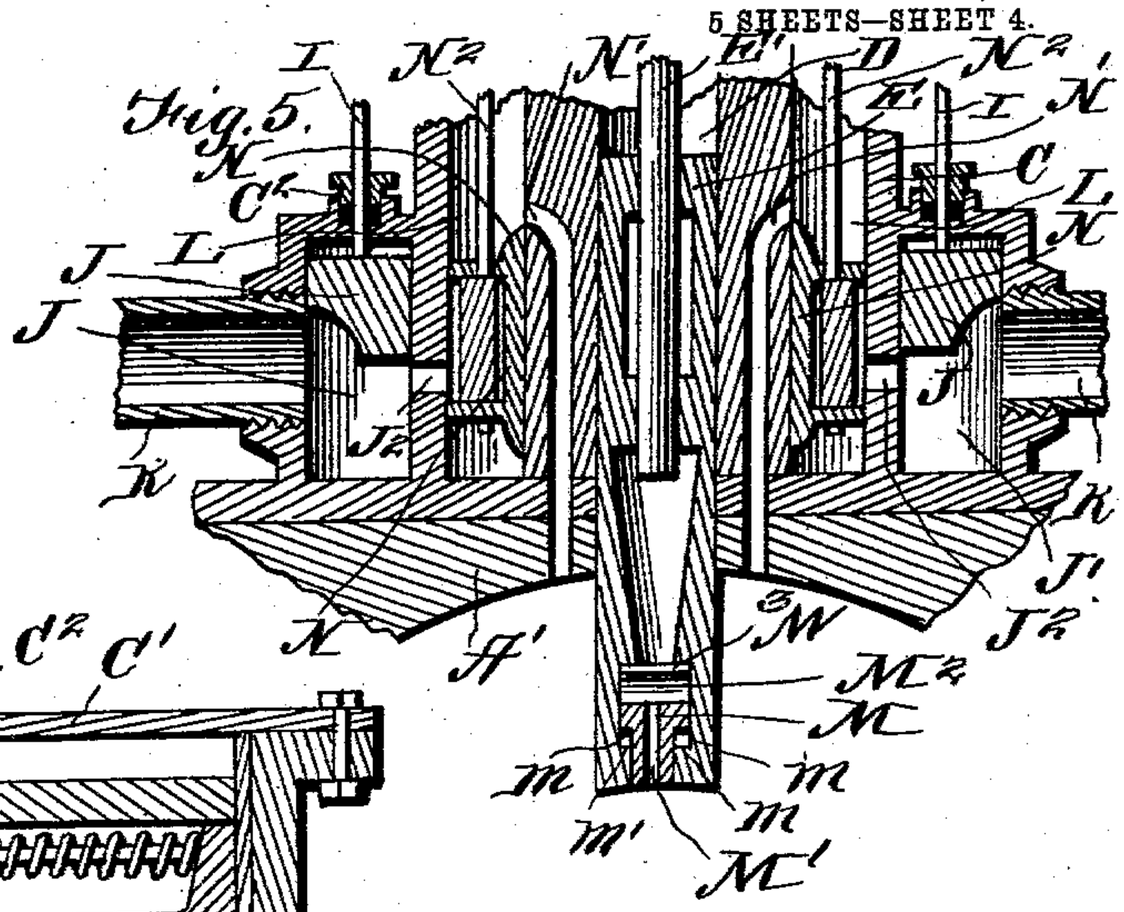


Fig. 4.

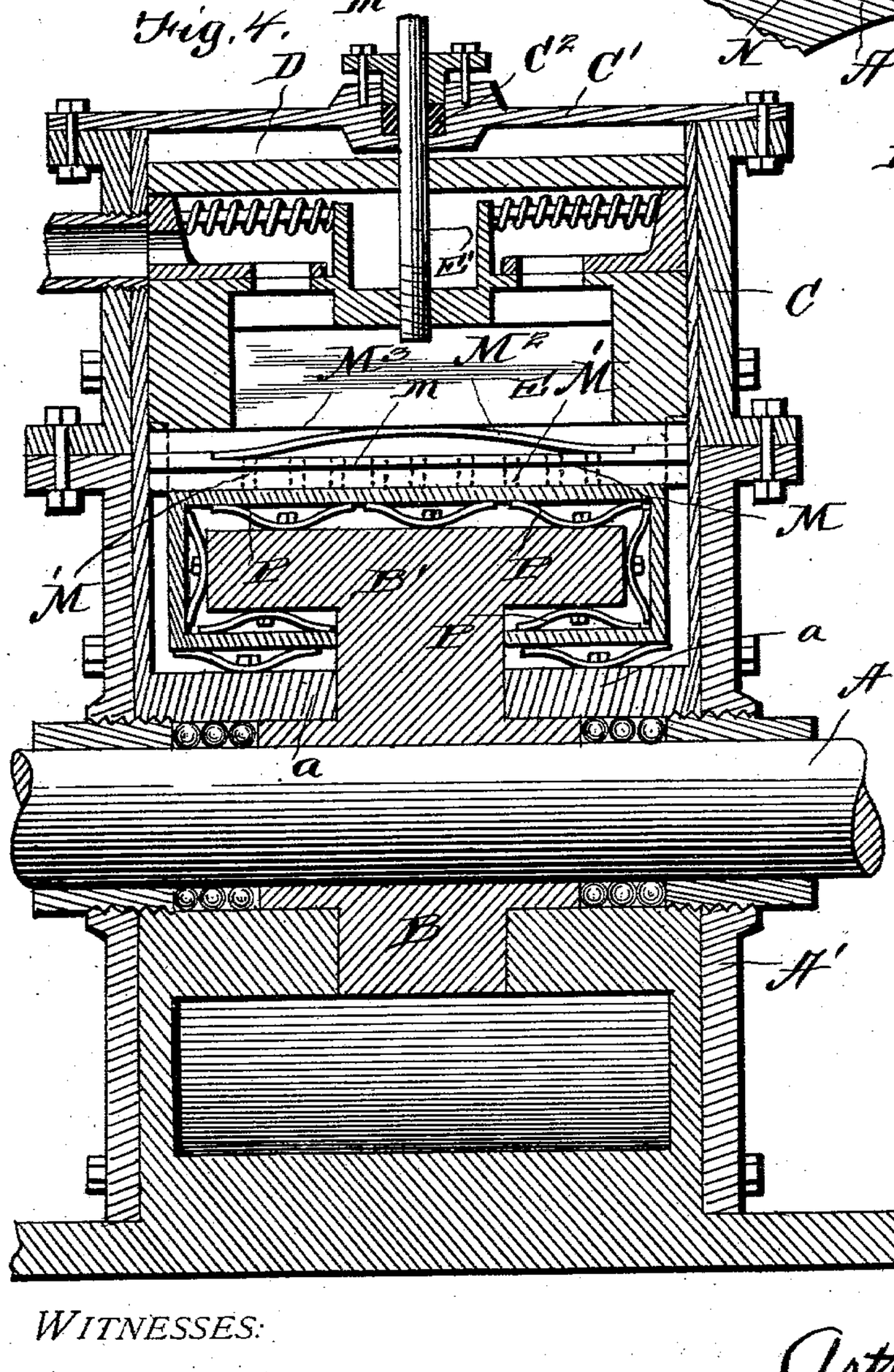
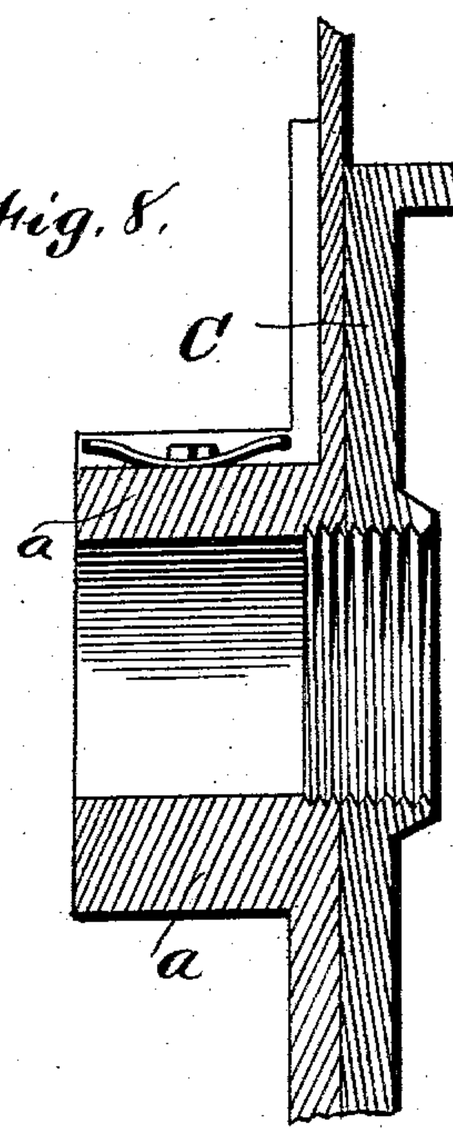


Fig. 8.



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NO MODEL. 5 SHEETS—SHEET 5.

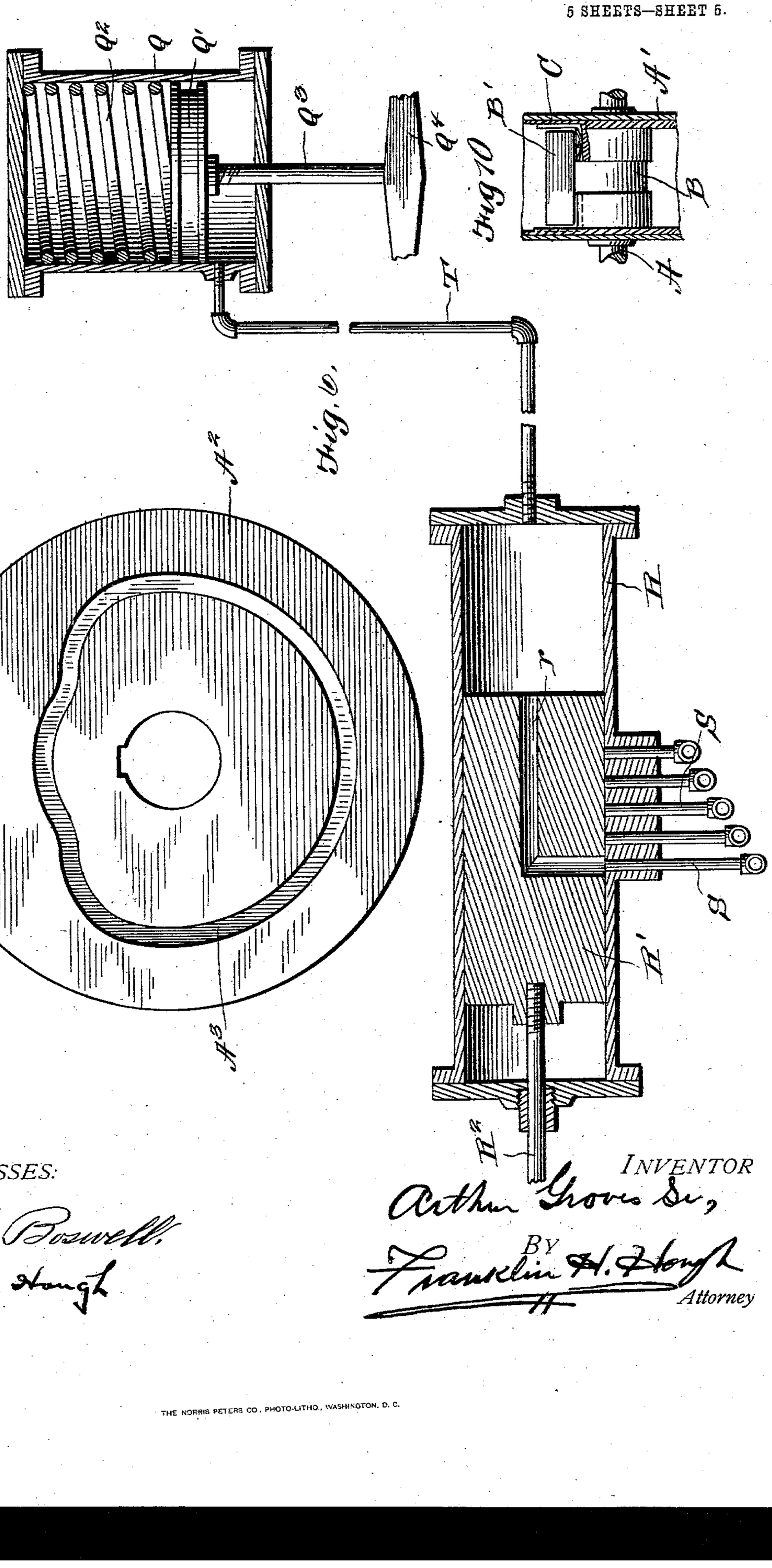

Fig. 6.

Fig. 7.

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No. 753,388. Patented March 1, 1904.

UNITED STATES PATENT OFFICE.

ARTHUR GROVES, SR., OF LADUE, MISSOURI.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 753,388, dated March 1, 1904.

Application filed December 26, 1903. Serial No. 186,653. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR GROVES, Sr., a citizen of the United States, residing at Ladue, in the county of Henry and State of Missouri, have invented certain new and useful Improvements in Rotary Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to new and useful improvements in rotary engines, motors, pumps, locomotives, &c.; and the object of the invention is to provide an apparatus in which a direct thrust is obtained against a rotary radial piston, permitting the full force of the steam to be exerted upon the piston in the direction of the travel of the latter and obviating the waste of energy by the exhausting of the steam through the traverse-chamber in advance of the piston.

The invention consists, further, in the provision of means whereby the steam may be used expansively by cutting off the same automatically at any given point desired.

The invention comprises, further, various details of construction and combinations of parts, which will be hereinafter fully described and then specifically defined in the appended claims.

My invention is illustrated in the accompanying drawings, which, with the letters of reference marked thereon, form a part of this application, and in which drawings similar letters of reference indicate like parts in the views, in which—

Figure 1 is a perspective view of an engine embodying the features of my invention. Fig. 2 is a vertical sectional section through the engine, showing the relative positions of various parts of the invention. Fig. 3 is a top plan view showing a duplication of the parts illustrated in Fig. 1, forming a duplex engine. Fig. 4 is a sectional view vertically through the lower portion of the thrust-block and through the cylinder. Fig. 5 is a sectional view vertically through the cut-off valve, thrust-block, and a portion of the cylinder. Fig. 6 is a detail sectional view through the apparatus for allowing the use of steam expansively. Fig. 7 is a detail view of the inner face of the cam mounted upon the driving-shaft of the engine adapted to actuate, through suitable connections, the thrust-block. Fig. 8 is a cross-sectional view through the cylinder, showing the shape of the wall thereof. Fig. 9 is a detail view showing the friction-block provided with apertures therein. Fig. 10 is a detail view showing the grooved ways in the cylinder-frame, in which the thrust-block works.

Reference now being had to the details of the drawings by letter, A designates a shaft which is mounted in suitable bearings between the cylinder A′, and said shaft has rigidly secured thereto a hub B of the rotary piston B′. The ends of said piston project over the bosses *a*, which project from the inner walls of the cylinder-heads and which abut against the opposite ends of the hub portion of said piston, packing-rings being interposed between the two surfaces for the purpose of making a steam-tight joint. The outer end of said piston is slightly convexed and adapted to wipe against the inner concaved circumference of the cylinder, as shown clearly in Fig. 1 of the drawings. In order to allow the piston to take up wear, springs P are secured to the integral hub portion of the piston and serve to throw the piston so that it will always wipe against the inner concaved circumference of the cylinder, this detail being shown clearly in the cross-sectional view of the drawings.

Mounted upon the frame of the cylinder is a boxing C, having a head C′ securely fastened thereto, said head being provided with a number of suitable packing-glands C^2, through which reciprocating members about to be described have reciprocating steam-tight movements. Said chest or boxing is divided into a plurality of chambers, the central one of which (designated by letter D) is for the reception of a thrust-block E, which reciprocates therein, said thrust-block being adapted to pass through an aperture leading into the cylinder in which the rotary piston operates.

The end walls of the cylinder have grooves on their inner faces for the reception of the thrust-block to guide the same. The thrust-block E referred to is preferably chambered out, the upper portion of which receives a stem E′, which is fastened by threaded connections or any other suitable manner to the block, and the stem E′ has a reciprocal movement through the gland over the central chambered portion D of the boxing or chest C. The upper end of the stem E′ is connected to a cross-head E^2, which has ears *e* thereon, to which a link F is pivotally connected, and the other end of the link being bifurcated and having arms F′, carrying a pin F^2, to which one end of a lever F^3 is fulcrumed. Keyed to rotate with the shaft A is a disk A^2, the inner face of which is provided with a cam-groove A^3, in which an antifriction-roller *h*, carried at the lower end of the rod H, travels. Said rod H has a reciprocal movement through an apertured bracket-arm H′, fastened to said boxing or chest, and the upper end of the rod is pivotally connected to the lever F^3 through the medium of a link H^2. (Clearly shown in Fig. 1 of the drawings.) The ends of the arms of the cross-head E^2 have hollow cylindrical guide extensions E^4 for the reception of the rods I, which reciprocate freely through the same. Adjusting-nuts I′ are mounted upon the upper threaded ends of said rods I and adapted for the purpose of adjustment upon the ends of the rods to cause the rods to be raised for the purpose of opening the cut-off valves J, which are fixed to the inner ends of the rods, thus insuring the positive movement of the cut-off valves at predetermined moments. Each of the cut-off valves J, there being one on each side of the chest or boxing, is mounted in a chamber J′, into which a steam-supply pipe K enters. Upon either side of the central chambered portion D, in which the thrust-block is mounted, are the two chambered portions L, in which the slide-valves N are mounted, which control the ports N′, that lead from the chambers L into the traverse portion of the cylinder—one on each side of the centrally-mounted thrust-block. Stems N^2 are connected to the slide-valves and passed through glands N^3, mounted over the upper ends of said chambers L, and the outer ends of the rods N^2 are fastened in any suitable manner to the cross-head E^2. Ports J^2 lead from the chambers J′ into the chambers L, in which said slide-valves have a reciprocal movement, and the apparatus controlling the slide and cut-off valves is so arranged and operated that the moment the thrust-block is driven out from the cylinder the slide-valves will close the ports N′, leading to the interior of the cylinder, and the exhaust will take place. The lower or inner end of the thrust-block, which is chambered out to receive the exhaust which escapes from the cylinder, carries a friction-block M, which has steam-exhaust ports M′ extending substantially the length of the same, or, if preferred, instead of the perforations, an elongated slot in the friction-block. The lower end of the lower portion of said friction-block is contracted and has a movement through the elongated slot at the lower end of the thrust-block, a movement of said friction-block toward the center of the cylinder being limited by shoulders *m* of the friction-block coming in contact with shoulders *m′* on the inner surface of the chambered portion of the thrust-block. Springs M^2 are secured to the shoulder M^3, formed in the inner surface of the thrust-block, and are adapted to normally rest against the outer end of the friction-block M, the purpose of said springs being to normally hold the inner end of the thrust-block slightly in advance of the inner concaved ends of the thrust-block, said springs being provided for the purpose of taking up any jar upon the thrust-block as the same is suddenly driven toward the cylinder. The inner end of the friction-block projects a sufficient distance so as to come in contact with the hub of the piston simultaneously with the opening of the slide-valves N. The exhaust from the traverse of the cylinder, which passes up through the friction-block and into the chambered portion of the thrust-block, makes exit from the latter through a pipe O.

In adapting my apparatus for using steam expansively and economically an auxiliary cylinder Q is provided, (shown in perspective view in Fig. 1, also in section in Fig. 6,) in which is mounted a piston Q′, provided with suitable packing and against which piston one end of a spring Q^2 bears, the other end bearing against the top of the cylinder Q, the office of said spring being to normally throw the piston to its outer limit or in the position shown in Fig. 6 of the drawings. Secured to said piston is a stem Q^3, the lower end of which is secured to a cross-bar Q^4, one end of which is pivotally connected to one end of the lever Q^5, which is mounted upon a pivot-pin carried by the bracket-arm or standard Q^6, supported on the chest or casing about the cylinder J′. The other end of the lever Q^5 is pivoted at Q^7 to the rod I.

R designates an auxiliary cylinder, a detail view of which is shown in Fig. 6, which cylinder has a block R′, mounted to have reciprocal movement therein by means of a rod R^2, passing through a suitably-packed gland in one end of said cylinder and operated by means of a lever R^3, carrying a dog R^4, adapted to engage the notches of the segment-standard R^5. (Illustrated in Fig. 1 of the drawings.) Said block R′ has a passage-way *r*, having an opening through the circumference of the block adapted to register with one or the other of the pipes S and an exit end opening through the center of the inner end of the block and is designed to be thrown so that it will register

with one or the other of the pipes S, leading into and communicating with the cylinder R. Said pipes S lead to and communicate with the interior of the traverse-chamber of the cylinder at different locations, as shown in Fig. 2 of the drawings, and are provided for the purpose of allowing the steam to escape from the cylinder through one or the other of the pipes S into the cylinder R, thence through the pipe T to the cylinder Q for the purpose of acting upon the piston Q′ with sufficient force to drive it against the tension of the spring bearing upon said piston, whereby one of the rods I may be actuated for the purpose of moving the cut-off valve J to shut off the feeding of the steam, thus economizing the steam and allowing the same to act expansively. The moment the exhaust takes place the piston Q′ will be returned by means of the spring to its normal position and the cut-off valve returned to its normal position, it being observed that said cut-off valve is arranged to act independently of the slide-valves described.

By the provision of the slide-valves N, which are positively driven by the cross-head Q^2, the apparatus is so adjusted that as the piston is about to complete its rotary movement and when adjacent to the thrust-block the disk, with cam-groove therein, will actuate the rod J to cause the thrust-block to be withdrawn out of the path of the advancing piston, at which moment the feeding of the steam is cut off until the piston passes by the thrust-block, and the moment the traverse-chamber of the cylinder exhausts, through the friction and thrust-blocks, the thrust-block will be thrown back against the hub of the piston and the slide-valve will open and allow the steam to enter the port into the traverse-chamber.

In Fig. 3 I have shown a top plan view of a duplex rotary engine, in which each side of the engine is provided with a similar apparatus and with a reversing-lever, (indicated by letter W in the drawings,) whereby the steam may be utilized for reversing the engine.

The operation of my invention is as follows: Steam being admitted through the pipe K passes into the steam chest or chamber J′, and when the slide-valve N is in the position shown in Fig. 2 of the drawings steam will be allowed to enter the traverse-chamber of the cylinder and will impinge against the rear of the rotary piston, causing it to traverse the circular pathway of the cylinder and carrying with it the axle upon which it is mounted and the various parts connected thereto. When it reaches the point indicated by dotted lines, the thrust-block, which will have been actuated by means of the mechanism described, will have been thrown out of the path of the piston, and simultaneously with the passage of the piston by the thrust-block the exhaust takes place, the slide-valve working synchronously with the thrust-block, shutting off the supply of steam during the exhaust, and the moment the piston passes the thrust-block the apparatus is actuated, so that the thrust-block is thrown down against the hub of the piston and the steam-port opened to allow the force of the steam to be exerted upon the piston. This alternate moving of the thrust-block and valves is repeated rapidly during the rotation of the piston, and when it is desired to utilize the steam expansively and economically one or the other of the pipes S is thrown into communication with the cylinder Q to allow the steam to act upon the piston therein in the manner described, and after the pressure is relieved in the traverse-chamber the piston in the chamber Q will return to its normal position and the cut-off valve open. The number of openings from the traverse-cylinder which communicate with the cylinder Q may vary, and they may be arranged at different intervals, and while the engine is in the position shown in Fig. 1 of the drawings there will be a partial vacuum between the forward face of the piston and the back or rear of the thrust-block; but as the piston travels forward it will pass consecutively the openings into the pipe S, admitting steam through them to said auxiliary cylinder Q, acting upon the cut-off valve in the manner described. The amount of expansion is thus governed at will by the setting of the lever R^3.

From the foregoing it will be seen that by the provision of the apparatus described I produce a rotary engine giving the maximum of power with economical use of steam, capable of being run expansively, and is reversible, suitable for all kinds of work where reciprocating engines are now used—stationary, locomotive, or marine—and may be compounded or tripled, giving greater power with much less floor-space and weight of metal.

While I have shown a particular construction of apparatus embodying the features of my invention, it will be understood that I may make alterations in various details of the construction of the parts, adapting the same for various purposes, without in any way departing from the spirit of the invention.

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

1. A rotary engine comprising a cylinder, a shaft mounted in suitable bearings therein, a rotary piston fixed to said shaft, a hollow reciprocal thrust-block and means for positively throwing the same into and out of the path of said piston, a spring-pressed and perforated friction-block carried within the chambered portion of the thrust-block, and valve mechanism operated synchronously with the movement of the thrust-block to regulate the feeding of steam to the cylinder, as set forth.

2. A rotary engine comprising a cylinder, a shaft mounted in suitable bearings therein, a rotary piston fixed to said shaft, a chambered

chest having communication with said cylinder, a hollow reciprocal thrust-block mounted in one of the chambers of said chest and positively-driven means for throwing the same into and out of the path of the piston, a movable perforated friction-block mounted in the chambered portion of the thrust-block, slide-valves mounted in the chambered portions of said chest, and means for positively driving said valves synchronously with the reciprocal movement of the thrust-block, as set forth.

3. A rotary engine comprising a cylinder, a shaft mounted in suitable bearings therein, a rotary piston fixed to said shaft, a chambered chest communicating with the cylinder, a hollow reciprocating thrust-block mounted in the chambers of said chest, a stem secured to said thrust-block, a cross-head secured to the end of said stem, means driven by the shaft for positively driving said thrust-block into and out of the path of said piston, slide-valves and connections between the same and said cross-head, whereby the valves may be operated synchronously with the movement of the thrust-block, as set forth.

4. A rotary engine comprising a cylinder, a shaft mounted in suitable bearings therein, a rotary piston fixed to said shaft, a chambered chest communicating with the cylinder, a hollow reciprocating thrust-block mounted in the chambers of said chest, a stem secured to said thrust-block, a cross-head secured to the end of said stem, slide-valves mounted in the chambered portions of the chest, and rods connecting said valves with said cross-head, and means driven by the shaft for operating the thrust-block and valve, as set forth.

5. A rotary engine comprising a cylinder, a shaft mounted in suitable bearings therein, a rotary piston fixed to said shaft, a chambered chest communicating with the cylinder, a hollow reciprocating thrust-block mounted in one of the chambers of said chest, a stem secured to said thrust-block, a cross-head secured to the end of said stem, slide-valves mounted in the chambered portions of the chest, rods connected to said valves and passing through suitable glands and fastened at their outer ends to said cross-head, cut-off valves and connections between the same and said cross-head, as set forth.

6. A rotary engine comprising a cylinder, a shaft mounted therein and a piston rotating with said shaft, a reciprocating thrust-block, positively-driven means for throwing the same into and out of the path of said piston, valve mechanism for regulating the supply of steam being fed to the cylinder, an auxiliary cylinder, a plunger-carrying cylinder, pipes communicating between said plunger-carrying cylinder and the cylinder carrying the rotary piston, means for operating said plunger to throw one or more of the pipes leading thereto into communication with the cylinder bearing the rotary piston, an auxiliary cylinder communicating with the plunger-carrying cylinder, and a piston in said auxiliary cylinder and connections between the same and said cut-off valve, as set forth.

7. A rotary engine comprising a cylinder having pipes communicating with the interior thereof at intervals, a rotary piston mounted in said cylinder, a reciprocating thrust-block, means for operating the same, a cut-off and slide valves, an auxiliary cylinder, a spring-pressed piston mounted therein, and pivotal lever connections between the same and the stem of said cut-off valve, a plunger-carrying cylinder through which communication is had between the auxiliary cylinder and the piston-carrying cylinder, and means for throwing one or the other of said pipes into communication with the auxiliary cylinder, as set forth.

8. In combination with a cylinder, a rotary piston therein, a reciprocating thrust-block, a cut-off valve, an auxiliary cylinder, a spring-pressed piston therein, the stem of said piston projecting through the end of the cylinder containing the spring-pressed piston, a rod connected to the end of said stem, a standard upon the frame of the apparatus, a lever pivoted in said standard having pivotal connections at one end of said bar, its other end pivotally connected to the stem of said cut-off valve, a plunger-carrying cylinder with a duct leading through a portion of said plunger, pipes leading from the plunger-carrying cylinder to and communicating with the rotary piston-carrying cylinder, a rod connected to said plunger and lever mechanism for actuating said plunger to throw one or the other of the pipes leading from the plunger-carrying cylinder into communication with the duct leading through the plunger, as shown and described.

9. A rotary engine comprising a cylinder having bosses projecting toward each other from the ends of the cylinder, an operating-shaft journaled in the end of said cylinder, a piston having the hub portion fixed to the shaft intermediate said bosses, the end of the piston projecting over said bosses and its outer end adapted to wipe against the circumference of the cylinder, a chambered chest mounted over said cylinder, a thrust-block mounted in one of the chambers of said chest and having a reciprocal movement therein adapted to be thrust against the hub portion of said piston and be guided in grooves formed in the inner faces of said cylinder ends, a friction-block carried by the thrust-block, a cut-off and sliding valves for feeding the steam to the cylinder, and means for actuating the same synchronously with the movement of the thrust-block, as set forth.

10. In a rotary engine, in combination with a cylinder and shaft journaled therein, a rotary yielding piston having a hub portion secured to said shaft, a chambered chest mounted over the cylinder, a reciprocating thrust-block having reciprocal movement in one of the cham-

bers of said chest, and means for operating the same, the opposite edges of said thrust-block adapted to be guided in grooves in the inner faces of the ends of the cylinder, a perforated friction-block having shouldered portions having a limited play in a recess in the lower end of the chambered portion of the thrust-block adapted to normally hold the same with its outer end in advance of the thrust-block, cut-off and slide valves, and means for actuating the same synchronously with the movement of the thrust-block, as set forth.

In testimony whereof I hereunto affix my signature in presence of two witnesses.

ARTHUR GROVES, Sr.

Witnesses:

PEYTON A. PARKS,

GEO. S. HOLLIDAY.