J. J. TANNER.

ROTARY ENGINE.

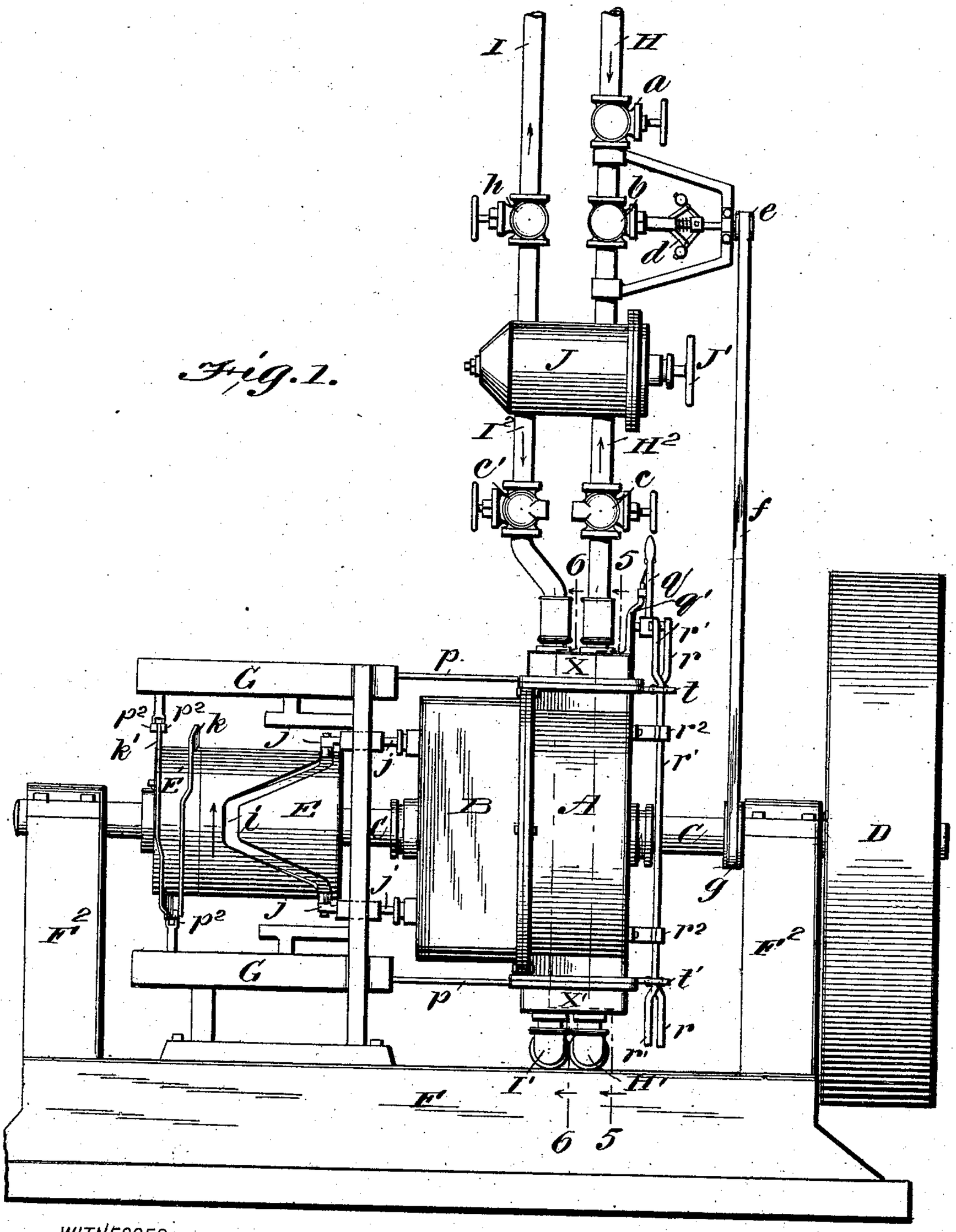
APPLICATION FILED AUG. 2, 1907.

915,635.

Patented Mar. 16, 1909.

5 SHEETS—SHEET 1.

Fig. 1.

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5 SHEETS—SHEET 2.

*Fig. 10.*

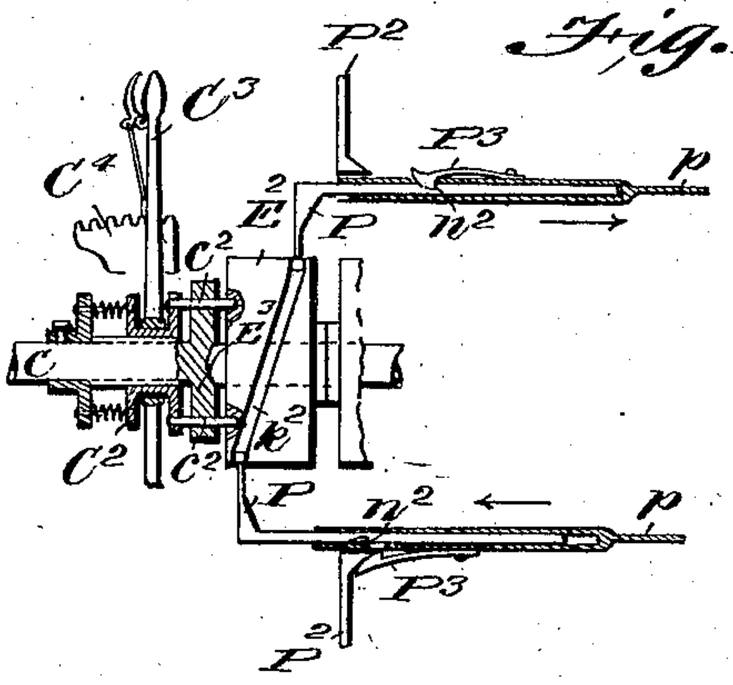
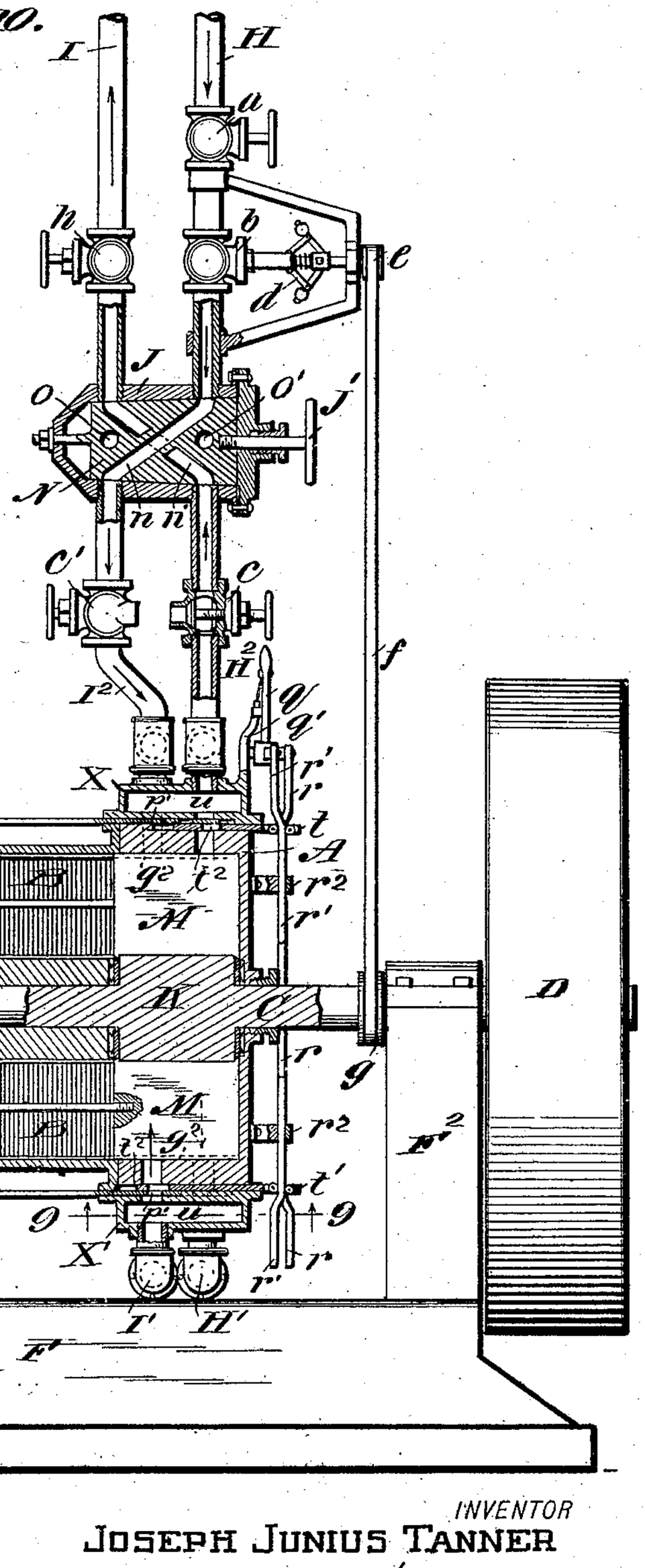



*Fig. 2.*

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6 SHEETS—SHEET 3.

Fig. 3.

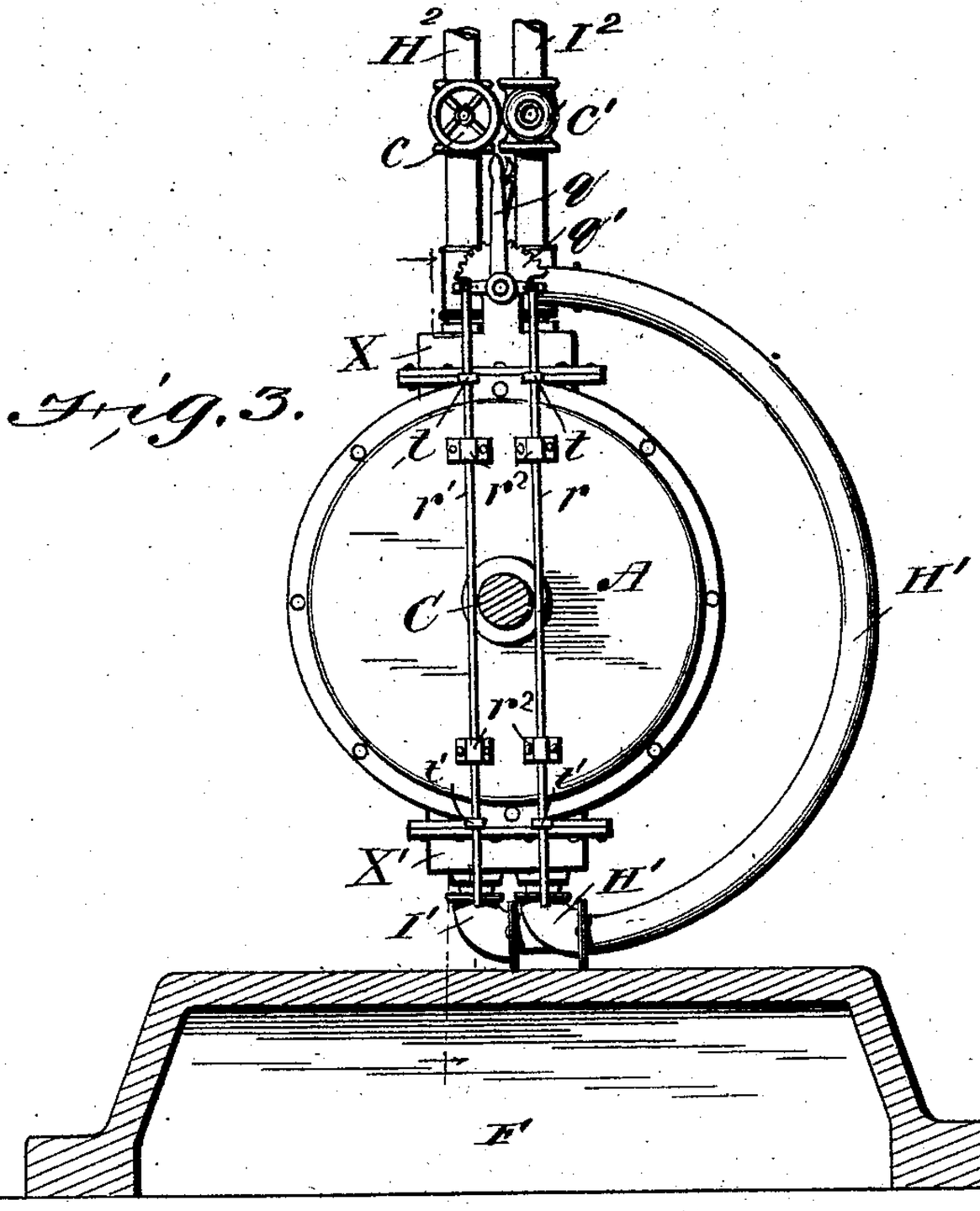



Fig. 4.

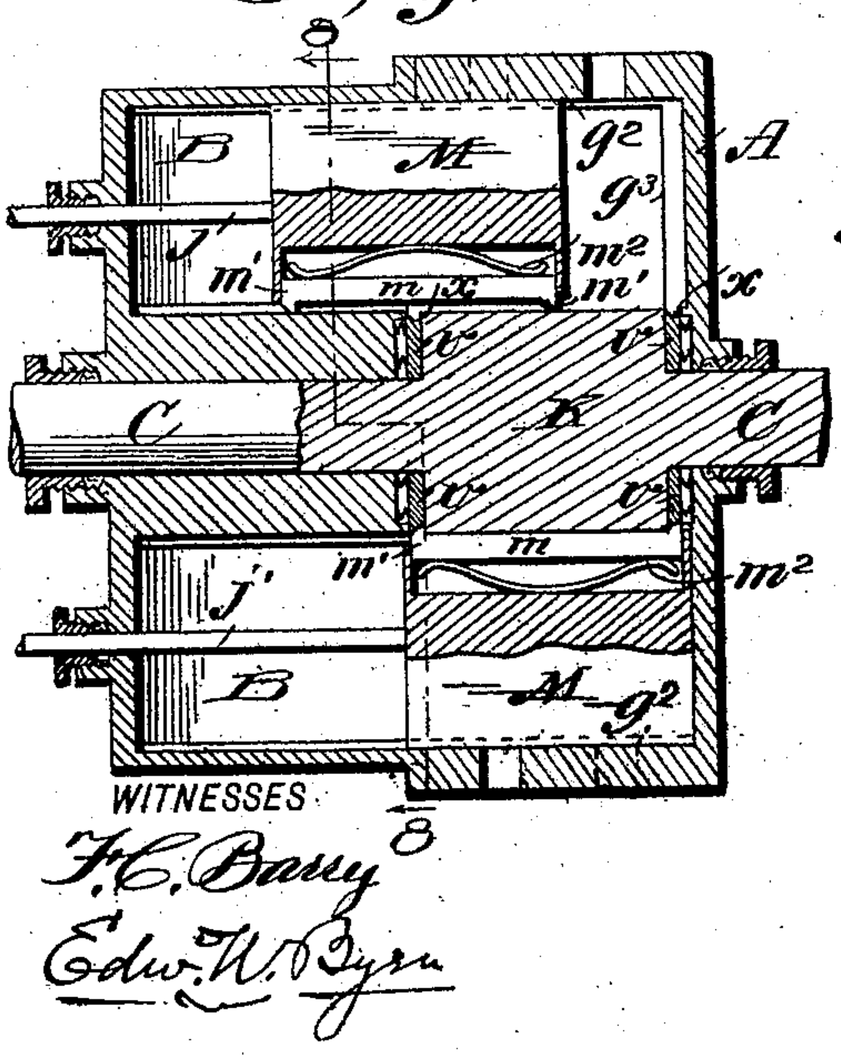
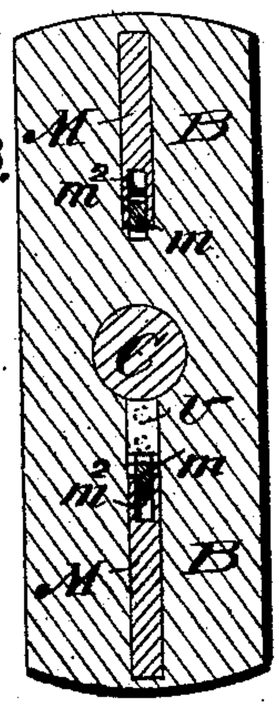



Fig. 8.

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5 SHEETS—SHEET 4.

Fig. 5.

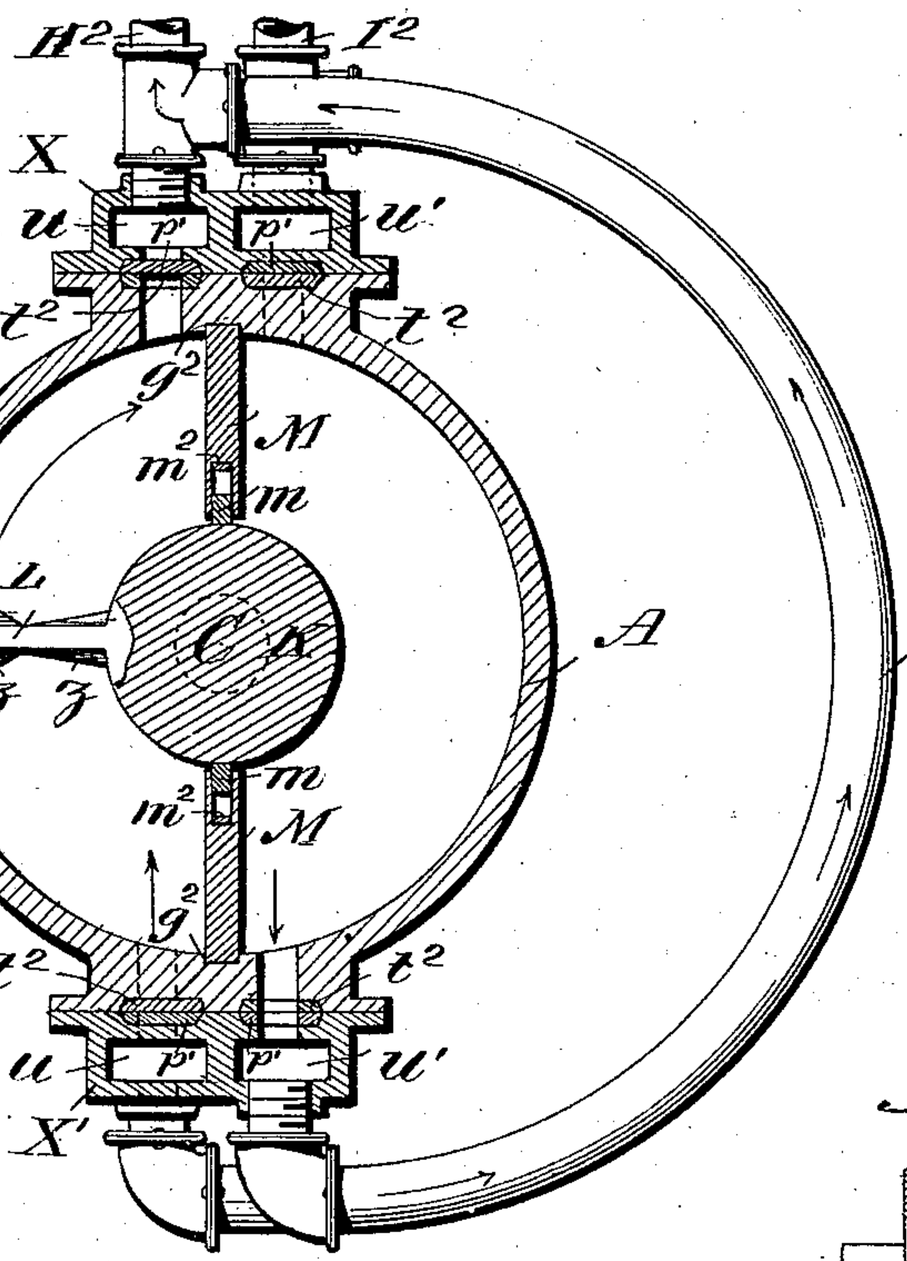



Fig. 7.

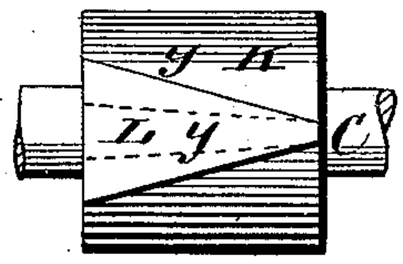
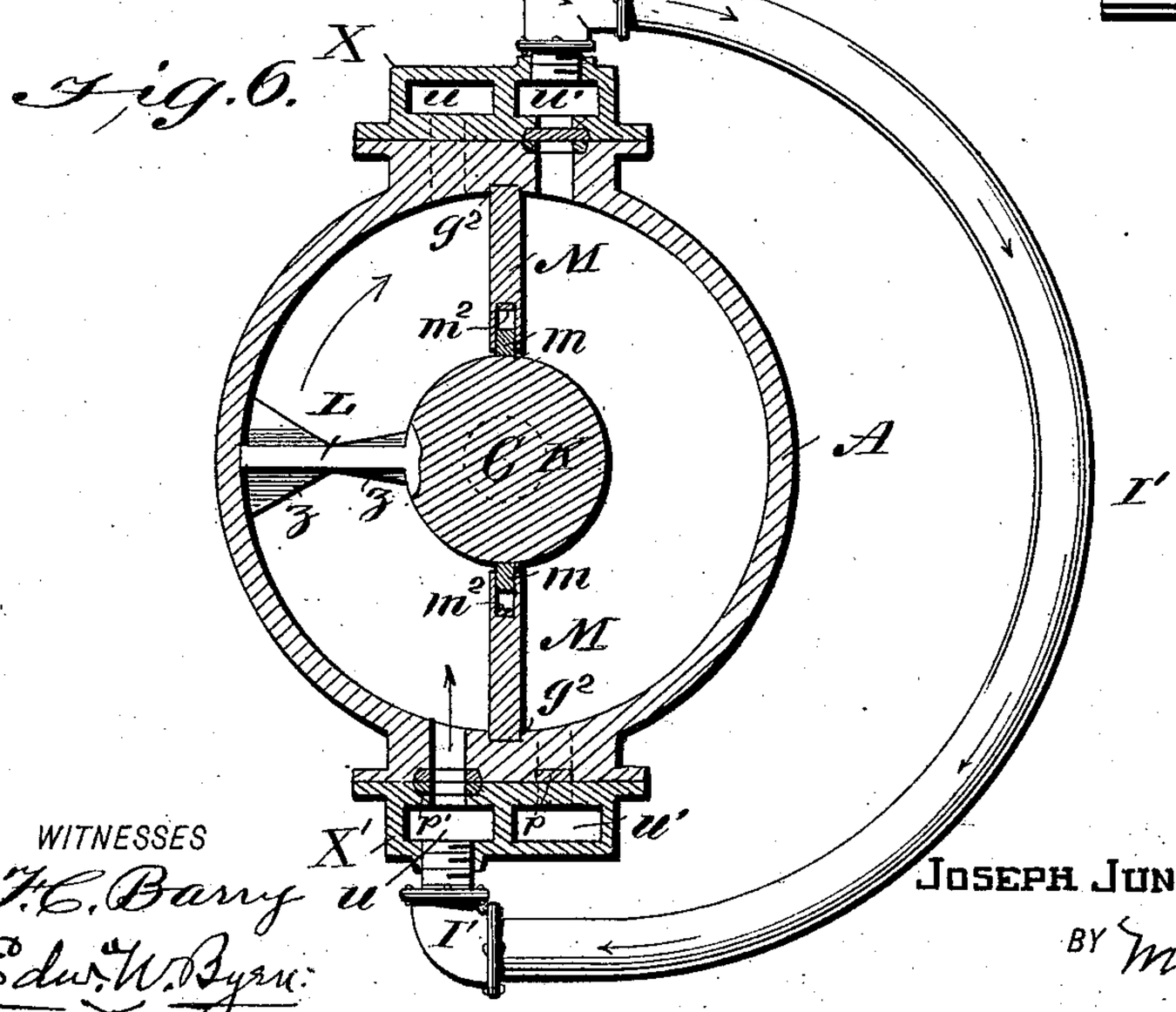



Fig. 6.

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5 SHEETS—SHEET 5.

Fig. 9.

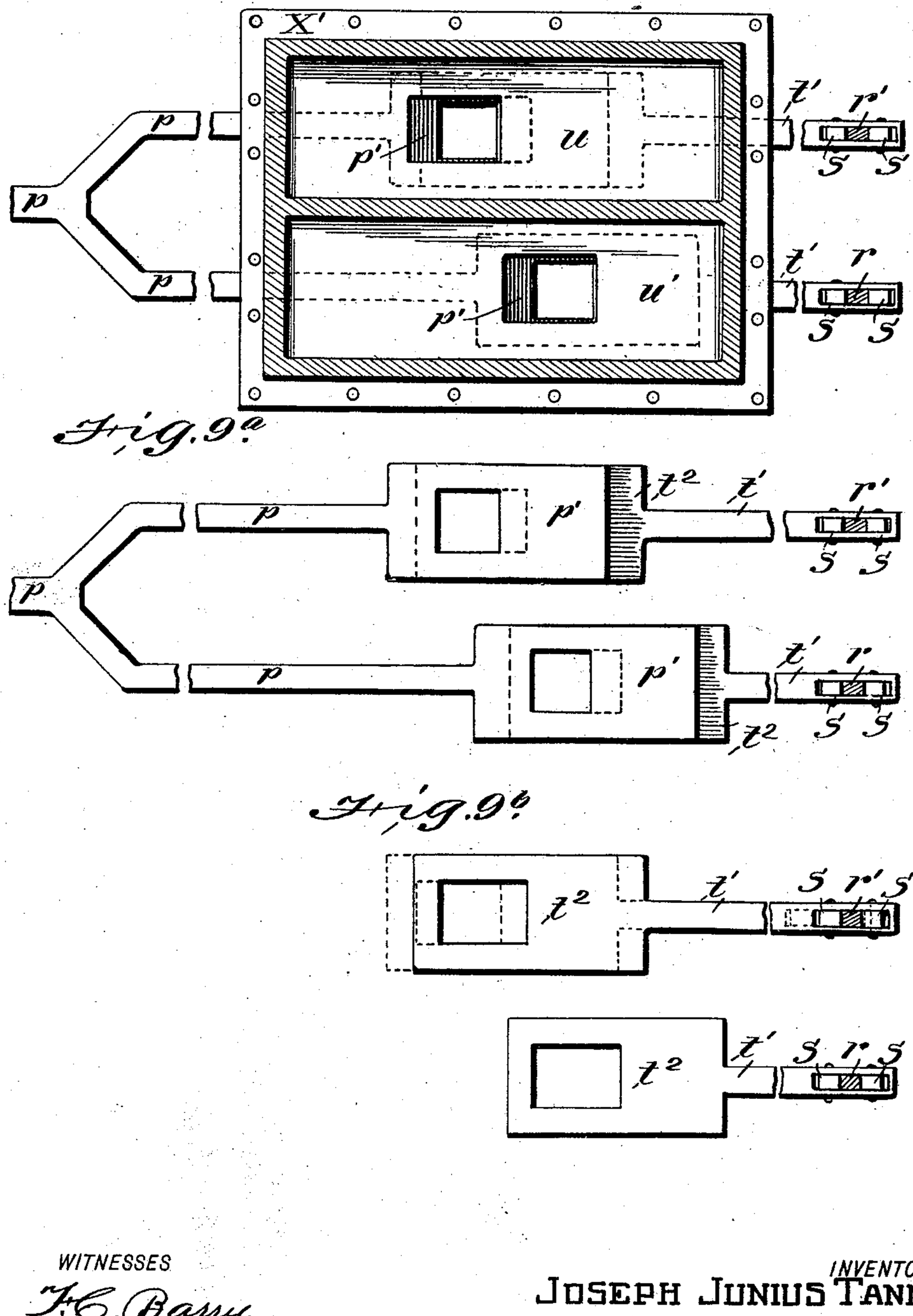


Fig. 9a.




Fig. 9b.




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# UNITED STATES PATENT OFFICE.

JOSEPH JUNIUS TANNER, OF CLOVER, UTAH.

## ROTARY ENGINE.

No. 915,635. Specification of Letters Patent. Patented March 16, 1909.

Application filed August 2, 1907. Serial No. 386,744.

*To all whom it may concern:*

Be it known that I, JOSEPH JUNIUS TANNER, a citizen of the United States, residing at Clover, in the county of Tooele and State of Utah, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

My invention relates to rotary engines of that class in which a revolving piston fixed rigidly on a shaft turns inside a cylindrical case, and sliding abutments reciprocate in lines parallel to the piston shaft and are first projected into the annular space of the cylinder to form temporarily stationary heads, between which and the revolving piston live steam is admitted, and on the other side of which abutments the steam is allowed to escape to the exhaust, and which abutments are alternately withdrawn from the plane of revolution of the piston so as to side-step out of the way of the same to let the piston pass.

My invention is designed to provide a rotary engine of the type which may be easily reversed so as to run in either direction and which comprehends a cut-off mechanism operative in either direction and which engine also embodies such features of construction as to allow it to be used as a brake when employed on a locomotive and going down hill.

My invention also comprehends certain other new features of construction and arrangement which will be hereinafter more fully described with reference to the drawings, in which—

Figure 1 is a side elevation of the entire engine. Fig. 2 is a vertical longitudinal section of the same. Fig. 3 is an end elevation, partly in section, taken from the right hand side of Fig. 1. Fig. 4 is a longitudinal section taken through the cylinder, abutment housings and the hub of the piston. Fig. 5 is an enlarged transverse section taken on the line 5—5 of Fig. 1 and looking in the direction of the arrow on said line. Fig. 6 is a similar transverse section taken on the line 6—6 of Fig. 1 looking in the direction of the arrow on said line. Fig. 7 is a detail view of the piston, looking at its outer peripheral surface and at right angles to its axis. Fig. 8 is a cross section through the abutment housing on line 8—8 of Fig. 4. Fig. 9 is an enlarged sectional view, taken through one of the valve chests on line 9—9 of Fig. 2 looking upwardly. Fig. $9^a$ is a face view of the working slide valves and lead valves superimposed. Fig. $9^b$ is a face view of the lead valves detached, and Fig. 10 is a detail of a modified form of the cut-off mechanism.

Referring to Figs. 1 and 2, F is a base having standards $F^2$ in bearings in which is arranged the main rotary shaft C having attached to it the band wheel D. A is a stationary cylindrical casing through the heads of which the revolving shaft C passes, at which points suitable stuffing boxes are provided. In the cylinder A, see Figs. 5 and 6, is arranged to revolve a rotary piston L rigidly attached to an enlarged hub portion K both connected to the main shaft C. M M are sliding abutments arranged in diametrical relation to each other and being provided with means by which they are slid in direction parallel to shaft C, so as to be projected into the annular space of the cylinder and in the path of the piston or be withdrawn therefrom into housings B, Figs. 1, 2, 4, 8, to allow the piston to pass, said abutments having what I term a side stepping action as the piston passes them by. When any abutment is projected into the annular space in the cylinder and steam is admitted to the space between the temporarily stationary abutment and the piston, it will be seen that the pressure of the steam on said piston will cause it and the attached shaft C to revolve and the steam on the advance side of the piston will be exhausted as hereafter described. H, Figs. 1 and 2, is the inlet steam pipe and I is the exhaust steam pipe. The pipe H is in vertical alinement with a lower pipe section $H^2$ and may communicate directly with the upper steam chest X or through a semi-circular by-pass pipe H′, Fig. 5, may communicate with the lower steam chest X′. In like manner the exhaust pipe I, Fig. 2, is in alinement with a lower pipe section $I^2$ which may communicate directly with the upper steam chest X or through a semi-circular by-pass pipe I′, Fig. 6, may communicate with the lower steam chest X′. The inlet steam pipe H, Fig. 2, has in it the throttle valve *a* and a governor valve *b* controlled by a centrifugal governor *d* through a small pulley *e* connected by belt *f* to a pulley *g* on the main shaft. The exhaust pipe I is provided with a valve *h* and the two lower pipe sections $H^2$ and $I^2$ have two valves *c c′* with outlets opening to the air which have nothing to do with the normal operation of the engine, and are for a purpose which will be hereafter described.

At an intermediate point between the pipes H and I above and $H^2$ $I^2$ below is arranged within a casing J a double acting reversing valve, see Fig. 2, whose function is to cause live steam from pipe H to be sent to either pipe $H^2$ or $I^2$ and exhaust steam from the cylinder to be taken from either pipe $H^2$ or $I^2$ and delivered to the outlet pipe I. This double acting reversing valve consists of a slightly conical bored chamber J containing a rotary conical plug N fitting therein and provided with a hand wheel J′ for turning it. In the plug N are two crossed ports *n* and *n′* which in the position shown cause live steam from pipe H to enter pipe section $I^2$ while exhaust steam from pipe $H^2$ passes to the outlet pipe I. In the plug N are two other ports *o* and *o′* which pass diametrically straight through the plug in the plane of the pipes H I above and $H^2$ $I^2$ below. These ports *o o′* run in a plane at right angles to *n n′* and when the plug is given a quarter turn the ports *n* and *n′* pass out of registration with the pipes and *o o′* are brought into registration—the pipe *o* connecting I and $I^2$ and the pipe *o′* connecting H and $H^2$. It will now be seen that live steam will pass downwardly through pipe section $H^2$ and the exhaust will pass up through the pipe section $I^2$, which provides for the reversing of the engine as more fully described hereafter in connection with other valves.

For causing the sliding abutments to move alternately into the cylinder and then retreat into their housings or pockets B, said abutments, see Fig. 2, have slide rods *j* passing through stuffing boxes in the ends of the housings and through guides in the frames G which are fixed and stationary with the main frame. The outer ends of these rods *j* bear friction rollers *j′* which enter a waved cam groove *i*, Fig. 1, formed in a hub E rigidly fixed to the main shaft, so that as this hub is rotated with the main shaft the cam groove acting upon the rollers of the abutment rods cause said abutments to be projected, in proper time relation to the piston, to cause said abutments to alternately form steam heads and then side-step out of the way, as already described. It will be understood that in laying off the cam groove *i* its particular configuration is to be accurately determined to correspond to the time action required for the abutments. In order to hold these abutments against the steam pressure in the cylinder the outer edges of the abutments, see Figs. 4, 5 and 6, slide in grooves $g^2$ cut across the inner periphery of the cylinder between the ports of the steam chests and the ends are received into radial grooves $g^3$, Fig. 4, in the cylinder head. The inner edge of each abutment is also grooved and provided with a steel packing strip *m* forced toward the hub by a backing spring $m^2$. At the ends of the packing strip next to the hub K are formed inwardly projecting hardened steel lugs *m′* *m′* and in the heads of the cylinder in line with the abutments are formed locking seats *x x* and when an abutment M is forced fully into the cylinder, so that its outer edge is held in groove $g^2$ and its end in groove $g^3$, its inner edge parallel to the hub is also locked against the pressure of the steam as follows. When the lugs *m′ m′* reach the seats *x x* they drop into such seats from the action of spring $m^2$ thereby holding the lower edge against the pressure of the steam and the same movement of packing strip *m* as it approaches the center of hub K causes the middle part of said packing strip to drop to a close steam fit on the hub, so as to tightly imprison the steam between the abutment and piston. When the abutments are withdrawn into their housings, the outward pull of their rods *j* causes the lugs *m′ m′* to ride up out of the locking seats *x x*, and to facilitate this one side of each of the lugs *m′* is made inclined. At each end of the hub K there is a spring seated packing strip *v*, Fig. 4, arranged in line with the grooves $g^3$ of the cylinder head to make a tight joint.

It will be seen from Figs. 4 and 5 that after an abutment has retreated into its housing, there will be left exposed on the inner periphery of the cylinder the grooves $g^2$ $g^3$ which the piston has to pass over. To make the piston pass these smoothly, I form the outer bearing surface of the piston in wedge shape as shown at *y—y* in Fig. 7, so that the wide end of the wedge will first start to cross over the groove $g^2$, giving a shear action instead of a parallel action. In like manner the end portion of the piston which rubs against the cylinder head is made of double wedge shape, as seen in Figs. 5 and 6, at *z z* so as to secure the same shear movement across the end grooves $g^3$.

I will now describe the valves in the steam chests and their action.

There are two steam chests, one X above the cylinder A, and the other X′ below the cylinder. They are both constructed alike and have similar valves and are designed to provide for the reversibility of the engine. Each steam chest, see Figs. 5 and 6, has two chambers *u* and *u′* which connect with the induction and exhaust pipes and between these chambers and the ports in the periphery of the cylinder two sets of valves are arranged. The set *p′ p′* next to the steam chest are the working slide valves which are opened and closed automatically to admit and exhaust steam, while the set $t^3$ $t^2$ which slide adjacent to *p′* are the valves which provide for lead when the engine is running in either direction. The valves *p′* have stems *p* Fig. 2, that extend out through one side of the engine, and the valve $t^2$ have stems *t t′* that extend out through the opposite side of the engine and they are each provided with means for

their operation as follows. The valves $p'$ $p'$, Fig. 9[a], are plates having square openings through them which are attached to and operated together as one by the branched ends of rod $p$. This rod, see Fig. 2, extends outside the steam chest to the guide frame G in which it slides. The rod $p$ bears on its end an inwardly projecting arm having two friction rollers $p^2$ $p^2$ which embrace one of two cam flanges $k$ $k'$ formed on the periphery of a hub E′ secured rigidly to the shaft C. As the hub E′ rotates with the shaft its cam flange $k$ or $k'$ reciprocates the valve stem $p$ and the induction and exhaust valves. The cam flanges $k$ $k'$ on the hub E[1] have a different pitch for a different time action, and in reverse running the rollers $p^2$ $p^2$ are adjusted to the other cam flange, for which purpose the hub E′ is made adjustable on the shaft by means of a set screw as seen in Fig. 2. The valves $t^2$ $t^2$, Figs. 2, 9[b] and 5, are the lead valves which enable the steam to enter sooner than they otherwise would and their openings are made longer than the openings in the valves $p'$. These lead valves have stems $t$ above or $t'$ below which have slotted ends carrying friction rollers $s$ $s$, Fig. 9, between which is arranged the vertically sliding adjusting bars $r$ $r'$. These bars, see Figs. 1 and 3, are arranged vertically on opposite sides of the main shaft C to slide in suitable guides $r^3$ $r^2$ and the upper ends of these bars $r$ $r'$ are connected to the opposite arms of a double elbow lever $q$ which latter has a locking bolt adapted to engage a curved and notched segment $q'$ to hold the lever to its adjustment. When this lever is adjusted to one side it throws one adjusting bar $r$ down and the other one $r'$ up and these bars having offsets or bends in them where they pass between the rollers $s$ $s$ of the valve stems $t$ $t'$, as seen in Fig. 2, it will be understood that the lead valves $t^2$, Figs. 9, 9[a], 9[b], are slid longitudinally and horizontally between the working valves and the ports of the cylinder to cause steam to be admitted sooner, or with the requisite lead.

As a modification of the cut-off flanges $k$ $k'$ on the hub E′ I may employ the cut-off mechanism shown in Fig. 10 which is applicable for reversing with a simpler and easier adjustment.

In Fig. 10, C is the main shaft on which is a rotary adjustable hub E[2] having a cam groove $k^2$ which acts upon and reciprocates the member P having a drag connection with the valve rod $p$ as hereafter described. Beside the loose hub E[2] is a disk E[3] rigid on the shaft C. A spring seated and grooved collar C[2] is embraced by the fork of a lever C[3] and said collar has two clutch pins $c^2$ $c^2$ which pass through holes in the disk E[3] and enter seats in the side of the loose cam hub E[2], locking it so that it turns with the shaft. As this hub turns its cam groove $k^3$ imparts a reciprocating movement to the member P whose stem slides telescopically into the tubular end of the valve stem $p$, the latter being enlarged and chambered to receive the stem of member P. On the hollow end of valve stem $p$ is attached a spring hook P[3] whose hooked end is normally forced through a slot in the tubular end of the valve stem and is adapted to engage a notch $n^2$ in the shank of the member P. P[2] is a stationary trip plate whose inclined foot is in the path of the hook P[3] as the latter approaches it. When the cam groove forces the member P to the right, as at the top of Fig. 10, the member P slides telescopically in the tubular end of rod $p$ until it takes up against the end of the tube and then the two parts move together in the direction of the arrow at the top of Fig. 10. In this position the hook P[3] has dropped into the notch $n^2$ of member P. Now when the cam groove draws the member P out again, the latter drags the valve rod $p$ with it until the hook P[3] strikes the inclined foot of the trip plate P[2], as at the bottom of Fig. 10, and then this contact throws the cam hook P[3] out of notch $n^2$ of member P and the latter is free to move out farther. It will thus be seen that the members P and $p$ have an initial movement together in outward direction followed by a disconnection and an independent drag action and on the inward movement the member P has an initial independent movement followed by a movement together for the last part of the stroke. When the engine is to be reversed the cam hub E[2] is unlocked and turned half way around and again locked to the shaft. This is accomplished by a lever C[3] having a spring bolt engaging a notched arch bar C[4]. By unlocking this lever and throwing it to the left the grooved collar C[2] compresses the springs behind it and withdraws the locking pins $c^2$ from the hub E[2] and the latter may then be turned a half revolution by hand and be afterward rigidly locked to the shaft again.

I have already referred to the air valves $c$ $c'$ in Fig. 2. These consist of valve chambers having outlets to the air, which are normally closed by screw valves as shown on the right of Fig. 2. If the rotary engine is employed on a locomotive these valves allow the engine to form a brake in going down hill, for by opening more or less the valve $c'$ leading to what is now the suction side of the piston, air is sucked in through this valve $c'$ to produce a retarding effect and is expelled through the valve $h$ which is partly closed to produce a choking effect.

The operation of my engine is as follows, referring to Figs. 2, 5 and 6. Steam is passing through pipes H and I[2], Fig. 2, and through by-pass I′, Fig. 6, and is entering the cylinder between the lower abutment M and the piston L forcing the same around in the direction of the arrow, while the exhaust

steam is passing out through the valve chest chamber $u$ at the top. Just as piston L nears the top abutment the latter moves out of the way and after the piston passes it, said abutment is again pushed across behind the piston and live steam then enters through the chamber $u'$ of the top valve chest and the steam in front of the piston is exhausted through the chamber $u'$ of the bottom valve chest. To reverse the engine the valve N, Fig. 2, is turned to cut out ports $n$ $n'$ and connect $o$ $o'$ with the pipes. Cam hub E' is shifted on the shaft to bring the cam flange $k$ between the rollers $p^2$ $p^2$ and the lead valves $t^2$ $t^2$ are shifted through the lever $q$ to change the timing of the lead.

Among the various features of my invention I wish to call attention to the fact that there is a continuous entry of steam at all times no matter in which direction the engine is running. This is obtained by the arrangement and adjustment of the valves in connection with the cut-off operated by the cam wheel. The abutments are so arranged also that when they enter the annular chamber of the cylinder the pressure of live steam is equal on both sides of said abutments and so also in leaving the annular chamber the pressure of exhaust steam is the same on opposite sides of the abutment. This balancing of pressure on opposite sides of the abutments at the time of their entry and retreat avoids the lateral strain and frictional resistance which the abutments would otherwise have to encounter.

I claim—

1. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutments and the other end operated upon by the peripheral cam, automatically working slide valves and manually operated lead valves, both arranged to slide parallel to the main shaft.

2. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutments and the other end operated upon by the peripheral cam, automatically working slide valve and manually operated lead valves, both arranged to slide parallel to the main shaft, the working and lead valves being extended outwardly from the cylinder in opposite directions.

3. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutments and the other end operated upon by the peripheral cam, automatically working slide valve and manually operated lead valves, both arranged to slide parallel to the main shaft, the working and lead valves being extended outwardly from the cylinder in opposite directions, a revolving collar on the main shaft having peripheral cam operating the slide valves and a lead valve adjusting bar arranged at right angles thereto and means for giving it a longitudinal movement.

4. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutment and the other end operated upon by the peripheral cam, two diametrically arranged valve chests, each having an automatically working slide valve and manually operated lead valves arranged to move parallel to the main shaft.

5. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutments and the other end operated upon by the peripheral cam, two diametrically arranged valve chests, each having automatically working slide valves and manually operated lead valves, both arranged to slide parallel to the main shaft, the working and lead valves being extended outwardly from the cylinder in opposite directions and means for operating the same.

6. A rotary engine comprising a cylinder having diametrically arranged side pockets, two diametrically arranged abutments, a rotating shaft with a revolving piston, a cam hub fixed to the shaft and having a peripheral cam and two slide rods arranged parallel to the shaft and having one end attached to the abutments and the other end operated upon by the peripheral cam, slide valves having stems arranged parallel to the main shaft outside of the abutment rods and having inwardly projecting arms, a guide frame for the same and a second adjustable cam collar on the main shaft having two peripheral cams arranged to alternately act upon the said arms to actuate the slide valves.

7. A rotary engine comprising a cylinder, a shaft with revolving piston, side stepping abutments, two valve chests arranged diametrically opposite each other and each hav-

ing two chambers, double slide valves and double lead valves arranged between the steam chests and cylinder and means for operating the same.

8. A rotary engine comprising a cylinder, a shaft with revolving piston, side stepping abutments, two valve chests arranged diametrically opposite each other and each having two chambers, double slide valves for each chest having a single stem, and a cam collar on the main shaft for operating them.

9. A rotary engine comprising a cylinder, a shaft with revolving piston, side stepping abutments, two valve chests arranged diametrically opposite each other and each having two chambers, double slide valves for each chest having a single stem, a cam collar on the main shaft for operating them, two lead valves arranged adjacent to the slide valve and having friction rollers at their ends, two curved and longitudinally adjustable bars arranged between the friction rollers of the lead valves and a lever arranged to adjust said bars in opposite directions.

10. A rotary engine having a casing provided with grooves on its inner periphery adapted to receive and hold a sliding abutment, movable abutments sliding therein and a shaft with a revolving piston said piston having its edges arranged at an angle to said grooves.

11. A rotary engine having a cylinder provided with grooves on its inner periphery one of which is parallel to the axis and the other radial, sliding abutments arranged to move and be seated in said grooves, and a rotating shaft having a revolving piston whose outer peripheral portion is wedge shape and whose sides are also wedge shape.

12. A rotary engine comprising a cylindrical casing, a rotating shaft with a hub and piston, said hub being provided with locking seats at each end, a sliding abutment having a spring seated packing bar arranged to bear upon said hub, said packing bar being formed with lugs adapted to drop into the seats on the hub to hold the inner edge of the abutment against steam pressure and to make a tight joint.

13. A rotary engine comprising a cylindrical casing, a rotating shaft with a hub and piston, two sliding abutments arranged diametrically to each other and to move parallel to the shaft, two steam chests arranged diametrically and having ports opening on opposite sides of each sliding abutment and two slide valves and two lead valves for each steam chest.

14. A rotary engine comprising a cylindrical casing, a rotating shaft with a hub and piston, two sliding abutments arranged diametrically to each other and to move parallel to the shaft, two steam chests arranged diametrically and having ports opening on opposite sides of each sliding abutment and two slide valves and two lead valves for each steam chest, and semi-circular by-pass pipes connecting the similar ports of the opposite steam chests.

15. A rotary engine comprising a cylindrical casing, a rotating shaft with a hub and piston, two sliding abutments arranged diametrically to each other and to move parallel to the shaft, two steam chests arranged diametrically and having ports opening on opposite sides of each sliding abutment and two slide valves and two lead valves for each steam chest, and semi-circular by-pass pipes connecting the similar ports of the opposite steam chests, and two parallel pipes for live and exhaust steam and a reversing valve connecting with the same to reverse the course of the steam.

16. A rotary engine comprising a casing, a revolving shaft with piston attached, two oppositely arranged abutments with means for sliding them parallel to the shaft, two opposite steam chests each having inlet and exhaust valves and means for timing the action of the valves and the abutments in relation to each other to maintain equal pressure upon opposite sides of each abutment during the time of its movement, into the annular chamber, and approximately equal pressure on each side of each sliding abutment during its retreat from its position within the annular chamber.

17. A rotary engine having an induction steam pipe and an eduction steam pipe, an annular chamber, a valve in the induction pipe for permitting the entrance of air, a choke valve in the eduction pipe, and means for producing a braking effect by the admission of air into the annular chamber.

18. A rotary engine having an induction and exhaust steam pipe, a reversing valve connecting with the same and a valve in each pipe arranged to open to the air to admit air to be drawn in through one pipe and be exhausted through the other.

19. A rotary engine having an induction steam pipe, an eduction steam pipe, an annular chamber, a valve in the induction pipe, means for operating said valve when the steam is shut off, a choke valve in the eduction pipe, and means for producing a braking effect by the conjoint action of said valves and the entrained air.

JOSEPH JUNIUS TANNER.

Witnesses:
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SOLON C. KEMON.