3 Sheets--Sheet 1.

WILLIAM H. WARD.

Improvement in Reversible Rotary-Engines.

No. 126,355. Patented April 30, 1872.

Fig. 1.

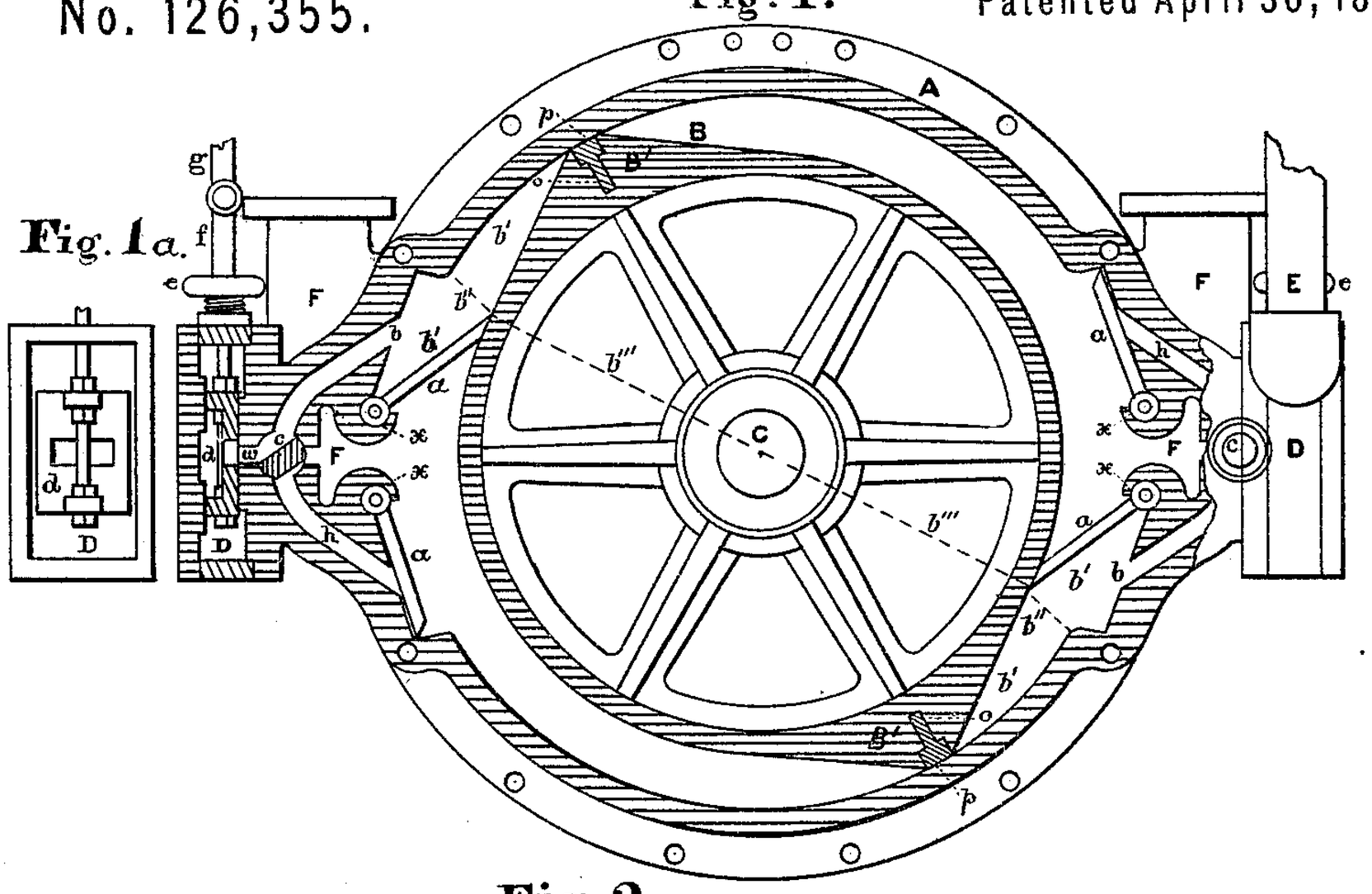
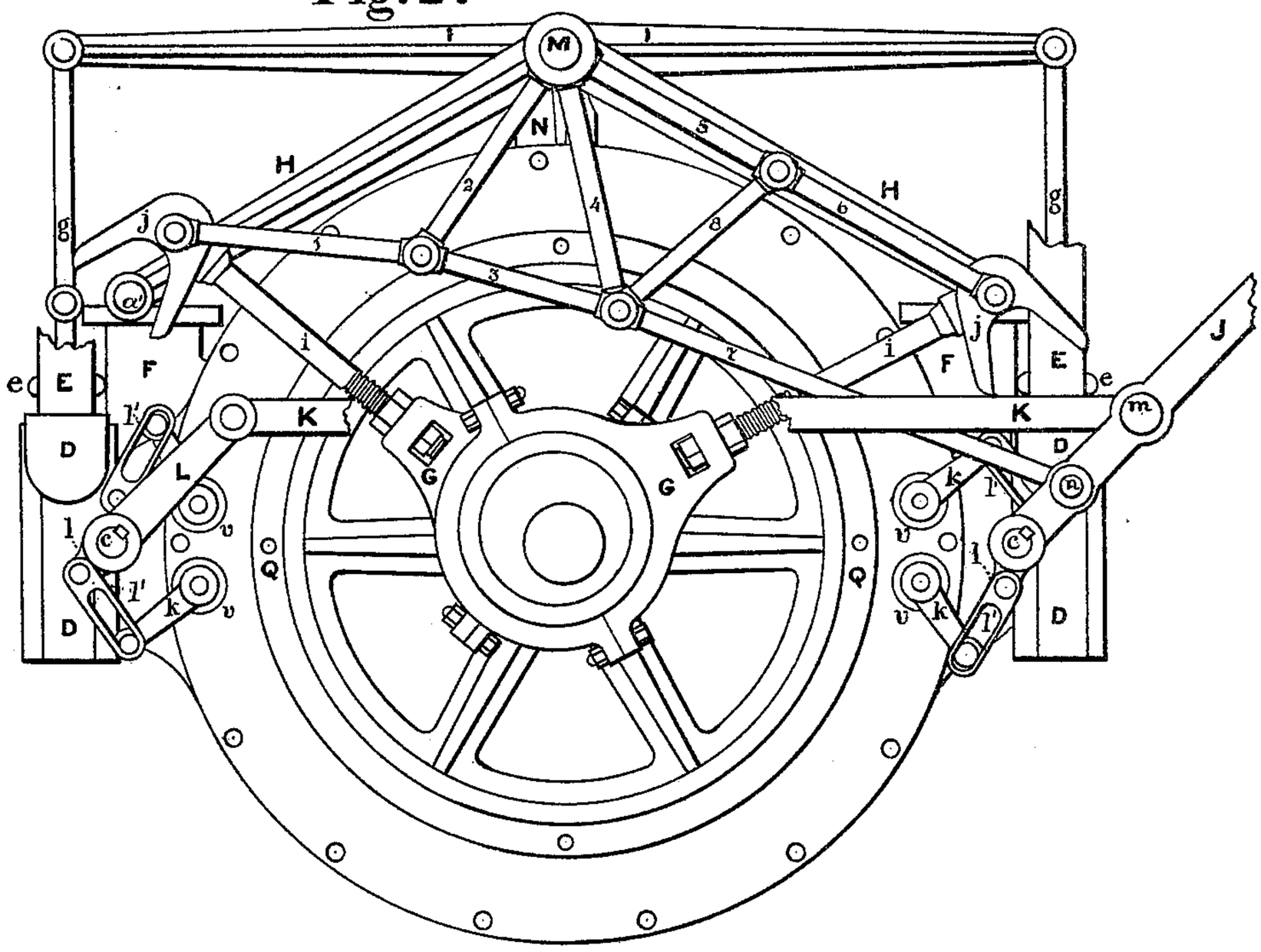


Fig. 1a.

Fig. 2.



WITNESSES:

Chas. Ward

Frank. R. Rathbun.

INVENTOR:

W. H. Ward

3 Sheets--Sheet 2.

WILLIAM H. WARD.

Improvement in Reversible Rotary-Engines.

No. 126,355. Patented April 30, 1872.

Fig. 3.

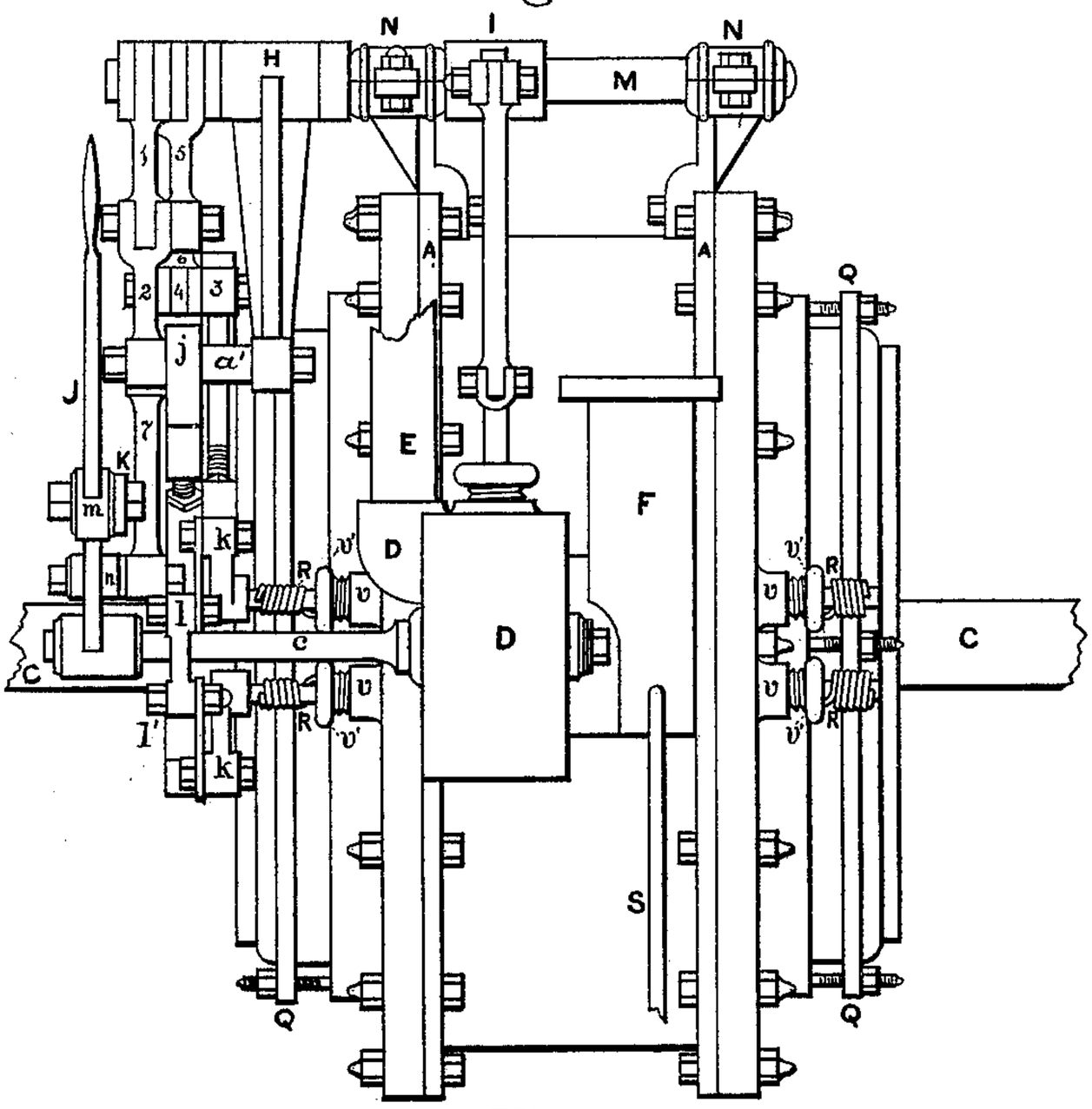
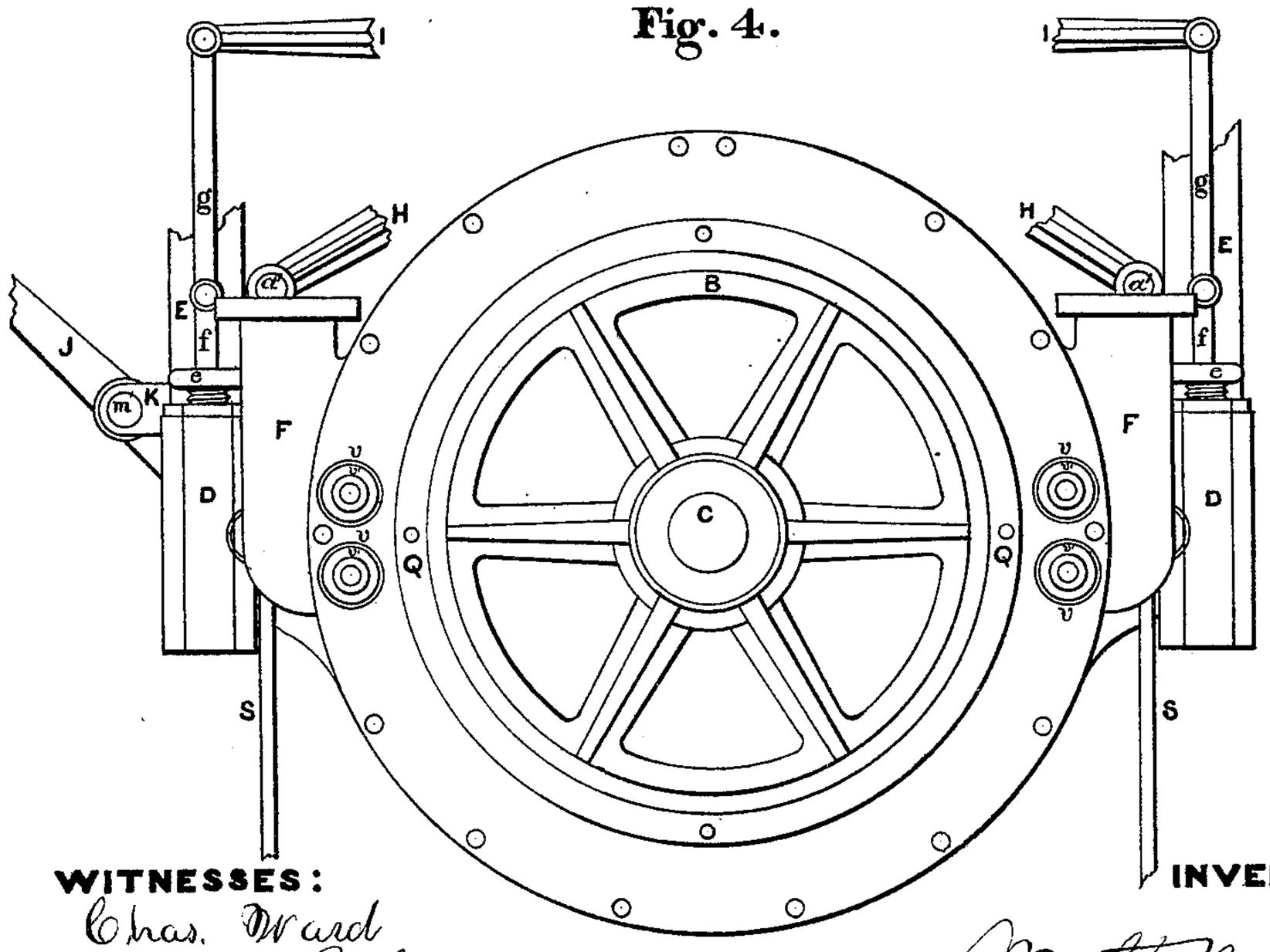


Fig. 4.



WITNESSES:

Chas. Ward

Frank R. Ralston.

INVENTOR:

W. H. Ward

3 Sheets--Sheet 3.

WILLIAM H. WARD.

Improvement in Reversible Rotary-Engines.

No. 126,355. **Fig. 5.** Patented April 30, 1872.

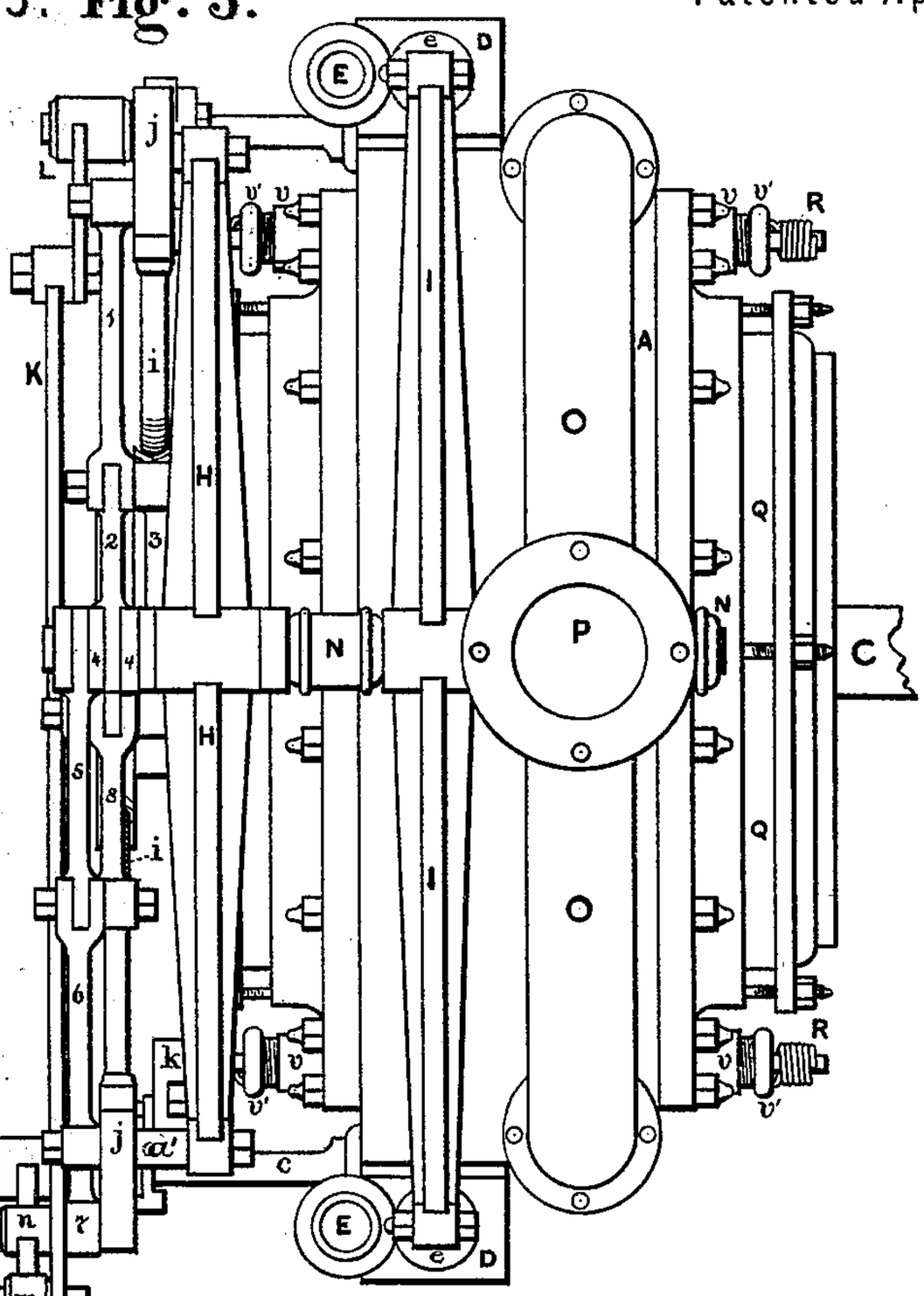


Fig. 6.

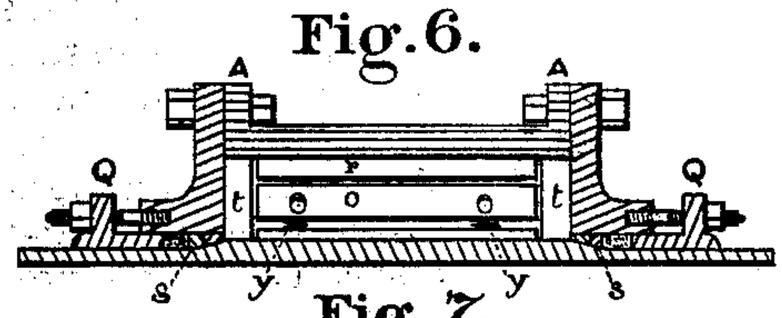


Fig. 7.

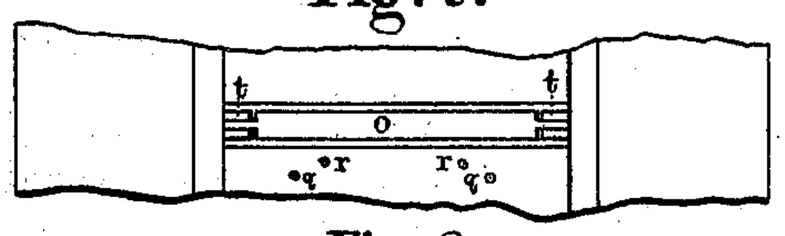


Fig. 8.

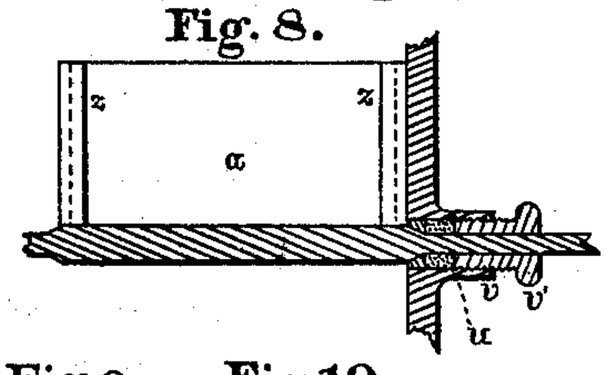


Fig. 9.

Fig. 10.

Fig. 11.

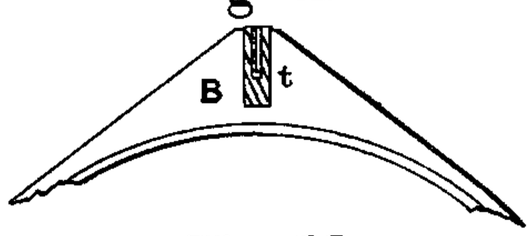


Fig. 12.

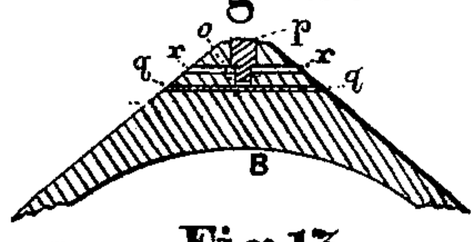


Fig. 13.

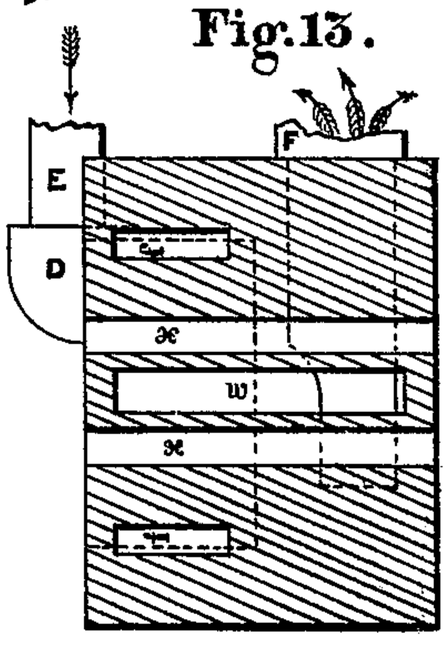
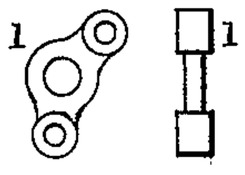


Fig. 14.



WITNESSES:
Chas. Ward
Frank. A. Parkhurst

INVENTOR:
W. H. Ward

UNITED STATES PATENT OFFICE.

WILLIAM HENRY WARD, OF AUBURN, NEW YORK.

IMPROVEMENT IN REVERSIBLE ROTARY ENGINES.

Specification forming part of Letters Patent No. 126,355, dated April 30, 1872.

To all whom it may concern:

Be it known that I, WILLIAM HENRY WARD, of Auburn, in the county of Cayuga and State of New York, have invented certain new and useful Improvements in Reversible Rotary Engines, of which the following is a specification:

My invention consists of means in a rotary engine in which the steam is used forcibly and expansively, whereby the rubbing or wearing joints of the rotator, resisters, and case are never separated while working, thus furnishing a smooth-working rotary engine without having any hard colliding parts whatever; also, of a peculiar reversing arrangement, by means of which the engine can be reversed at pleasure any distance from the engine, if suitable connections are provided; further, in the construction of the mechanical means whereby the said results are accomplished.

In the accompanying drawing, Sheet I—Figure 1 is a vertical central section of the cylinder of my improved engine with its valves and valve-seats, the frame-work supporting it not being shown. Fig. 1ª is a face view of one of the valves in its seat. Fig. 2 is an end elevation of the engine, the frame-work on which it rests being removed.

Sheet II—Fig. 3 is a side elevation of the same, and Fig. 4 an opposite-end view, parts of the feed and reversing arrangement being removed.

Sheet III—Fig. 5 is a plan view of the same, all parts being in proper position, the frame on which it rests being removed. Figs. 6, 7, 8, 9, 10, 11, 12, 13, 14 are detached, sectional, and other views of parts of the engine.

The usual case A rests on or is suspended from suitable frames or positions, and the rotator B moves on a shaft, C, which has its bearings in suitable boxes on the frame. This rotator has a less diameter than the inside of the casing A except at two points, B B′, forming wings, at which it comes in rubbing contact with the inner periphery of the case, and at which it has sufficient surface parallel with the said inner periphery to allow of two packings, *p p*, one at each point, to move in and out from the wings in such manner as to compensate for any unevenness in their manufacture or wear of the inner periphery of the case. The inclined non-rubbing surfaces of the wings B′ form a tangential line to balance the circumference of the rotator. The packings shown in Figs. 6, 7, 11, and 12 are made T-shaped, their lower parts *o* being provided with slots, through which pins *q* pass, to allow of an up-and-down movement of the packings without the possibility of leaving their seats entirely. On each side of each wing a small opening, *r*, leads directly under the shoulder of said packing *p*, through which steam enters to force the packing against the inner periphery of the case, forming a working compensating steam-joint. The packings *p o* have tongued ends, which slide in loose grooved upright pieces *t*, on which the steam acts endwise so as to make the packing perfectly tight not only on its outer rubbing-surface, but also at its ends. *s* are packing-rings, situated between the outer periphery of the rotator, the inner face of the heads of the casing, and the stuffing-boxes Q and sliding pieces *t*. These rings are applied in pairs, both having an inclined or wedge-shaped under side corresponding with a similar incline formed at that point on the outer surface of the rotator, so that the expansion of the rings occasioned by heat and wear is compensated for by these rings being forced on that incline, and thus wedge themselves perfectly tight between said incline and the inner face of the heads, adapting themselves to the wear of the machine, and so keeping the joints perfectly steam-tight in consequence of said inclined surfaces, and of the rings being cut, respectively, and provided with suitable yarn recesses. At opposite sides of the casing A are formed the inlet-ports *b* and *h*, which, by means of a channel, *w*, connect with the sliding valve *d* in the steam-box D. These ports on the inside are covered by resisters *a*, which are pivoted at *x x* on each side of the outlet-port F, which are disconnected from the channel *w* by the reversing-valves *c c*. These resisters fold back into suitable recesses in the casing so as to be entirely out of the way of the wings B′ of the rotator when those are folded back which are not in operation, and their outer faces are beveled to conform to the periphery of the rotator so as to be held against the same by the pressure of the steam, and also divide the incoming from the outgoing steam in such manner as to obviate all back pressure. The resisters are secured on shafts, which pass outwardly through suitable stuffing-boxes *v*, and on which are coiled

springs R, one end of which is secured to the stuffing-boxes, while the free ends bear against the outer ends of crank-arms *k*, which are also secured to the shafts of the resisters *a* so as to exert a force on the same, which tends to keep the resisters extended toward the periphery of the rotator. It will be readily understood that always two of the resisters are in operation, one at each side, and always those which are situated diagonally opposite to each other; but as the other two resisters are to be kept within their proper recesses in the casing, and their springs R exert a force to keep them out from said recesses, I allow the free end of their crank-arms *k* to be pivoted in the ends of slots of the slotted crank-arms *l*, which, in turn, are pivoted to one arm of the bell-crank levers *l'*, keyed or otherwise secured on the shaft of the reversing-valve *c*, while to the other arms of of said bell-crank levers are pivoted other slotted crank-arms *l*, in the slots of which the pivots of the crank-arm *k* on the shafts of the operating-wings *a* have their movable bearings. From the shaft of the reversing-valve *c*, at one side of the engine, extends a lever, J, which is connected by a rod, K, to an arm, L, keyed on the shaft of the reversing-valve on the opposite side. It will be readily understood, by reference to Fig. 2, that as the tendency of the two crank-levers *k* on the side of the lever J, by reason of their springs R, is to extend toward the center of the engine and away from each other, and as it will be equally well understood by reference to Fig. 1 that the upper resister *a* is held in its recess and its spring R is at its greatest tension while the lower register *a* is held against the rotator and its spring R is at its lowest tension, it will also be understood that the upper slotted crank-lever *l* is held against the tension of its spring R, its pivot being held in the utmost end of the slot of said arm *l*, which latter cannot move on account of lever *l*, while the lower slotted crank-lever *l* having no tension of the spring exerted on it beyond its normal condition, its pivot is free to move in the slot of its slotted lever *l* when its respective resister *a* is forced toward its recess by means of the incline of wings B'. In Figs. 2, 3, and 5 are shown standards N rising from the casing A, on which standards are formed the bearings, in which a shaft, M, reciprocates, being parallel with the center shaft C. On this shaft is suitably keyed a balance-beam, I, to the ends of which are pivoted the valve-rods *g*, which operate the valves *d*. On this shaft M is also keyed another balance-beam, H, with downwardly-inclining arms, from the ends of which extend wrist-pins *a'*, which are alternately engaged by suitable inverted V-shaped pieces *j* on the outer ends of arms *i*, extending from eccentric disks G G, on the center-shaft C, one arm, *i*, extending upwardly toward each end of the balance-beam H, in such a manner that only one wrist-pin, *a*, can be engaged by its respective pieces *j* at a time. As the shaft C revolves the eccentric disks G are operated also, and their respective arms *i* receive a circular inclined alternate motion; but only one being engaged with the balance-beam H, each revolution of the shaft C will give one up-and-down movement of the balance-beam H, and consequently of the balance-beam I, and thus operate the valves *d*, one down and one up, to open or close their respective parts. To reverse the engine the feed has, of course, to be changed, which is done by changing the reversing-valves and their connections. This change is effected by means of shifting the position of the lever J, which is keyed on the shaft of one of the reversing-valves *c*, and is connected to the lever keyed on the shaft of the other reversing-valve *c*, which shifting also effects the change of feed by the following means. To a suitable point on the lever J is pivoted a connecting-rod, 7, being pivoted at its other end to a pivot of knee-joint levers 1, 2, 3 and 5, 6, 8, respectively, the levers 2, 4, and 5 being pivoted on shaft M. It will be seen, by reference to Fig. 2, that, when the lever J is shifted from the position in which it is represented, the levers 5 and 6, which now are in a straight line, will be made to form an angle, thereby elevating their piece *j*, to which lever 6 is pivoted, out of contact with its wrist-pin *a'* on balance-beam H, while the levers 1 and 2 will be brought into a straight line, and thus their piece *j* is pivoted to lever 1, depressed into contact with its wrist-pin *a'*, thereby reversing the operation of the balance-beams and valves, and changing the feed agreeably to the requirements of the attendant. All these levers being connected to the lever J it will be readily seen that the one-operation of the lever J not only reverses the reversing-valves *c*, but also changes the feed by changing the operation of the valves *d*. As the lever J can be extended, and, by suitable connections, be operated from any desirable point, the engines may be reversed from any one of said points. The friction of the eccentric G tends to keep the arms *i*, with their pieces *j*, in and out of contact, as required by the rotation of the engine. The valves *d* are constructed with an opening in their center, through which the steam issues into port *w* and inlet-port *b* or *h*, and by which means the friction is correspondingly reduced, there being but one part to cover. The reversing-valve *c* has a larger and a smaller side, on the former face of which the live steam passes, and is so arranged with regard to exhaust-port F, inlet-ports *b h*, and main port *w*, that when the engine is reversed the turning of the inner end of said valve *c* will close the main inlet-port *w*, cutting off the pressure steam, and at the same time while the port *w* is closed, opening for a moment exhaust-port F to communicate with the pressure steam yet within the case A, thus allowing this remaining pressure steam to escape through exhaust-port F, thus relieving the pressure from the resister *a*, and allowing it to recede back into its recess. Thus, no matter how suddenly the engine is reversed, there will be no re-

maining pressure steam to cause any resistance or injury in the reverse movement.

The following is a description of the operation of my improved engine: The parts being in position, as shown in Figs. 1 and 2, the valves *d* have just opened the main inlet-ports *w*, and allow the steam to enter the spaces *b'*. These spaces *b'* are formed by the recesses of the resisters *a*, and the inner periphery of the case A, to the rubbing point of the wing B' on the outer side, and by the tangential inclined portions of the wings B' and the faces of the resisters *a* on the other side, forming spaces, the outer ends of which present an angle or a wedge-shape. In the formation of these spaces, by means of the construction of the wings B', and the arrangement of the resisters *a*, gives additional and very great advantage to the engine. In rotary-engines, as heretofore constructed, the wings on the periphery of the rotator were generally arranged in a radial line from the center-shaft, or so nearly thereto as to afford no additional advantages on the pressure face presented to the steam; it being the radial face of the wings between the outer periphery of the rotator and the inner periphery of the case. But by forming these spaces *b'* it will readily be seen that the pressure of the steam is not only exerted on that entire portion of the outer periphery of the rotator from the point of contact of the resisters *a* to the point of contact of the packing *p o* with the inner periphery of the case, but these spaces being wedge-shaped, as described, the inner peripheries of the case and the faces of resisters *a* all form pressure surfaces from which the steam exerts its momentum on the wings and plane of the rotator, thus furnishing a largely-increased pressure surface presented for direct action to the steam, and requiring an equivalent less amount of steam for the same amount of power. But, furthermore, it will be understood that, besides the direct pressure on the wings B', the spaces *b* being wedge-shaped the maximum pressure will be in the direction of the dotted lines *b''*, or in other words, in a diametrical line, *b'''*, passing through the center to the periphery of the rotator, thereby absolutely balancing all side or lateral friction, and exerting in that direction its greatest power. It must be also remembered that, as the direction of the pressure is away from the faces of the resisters *a*, only such pressure is exerted on the resisters as to keep them tightly to the surface of the rotator, as thus the friction of the resisters on the surface of the rotator will never be such as to counteract in the slightest degree the pressure of the steam, it being a slide friction and not positive or direct one.

To avoid dead-centers in passing the ports, two of these engines are put with their rotators at right angles to each other on the same shaft and bed, so that there is a continuous pressure on either one or the other in the direction applied.

Having described my invention, I claim—

1. The combination of the resisters *a* hinged to case A with the wings B', the latter being so constructed as to allow the former to slide over the circumference of the rotator without the wearing-surfaces becoming separated from each other during the revolution of the rotator, as described.

2. The combination of the eccentric disks G, their arms *i* and pieces *j* with the balance-beams H I, and valve-rods *g*, operating substantially as and for the purpose described.

3. In combination with the next above, I claim the levers 1, 2, 3, 4, 5, 6, and 7, J and L, and connecting-rod K, substantially as and for the purpose described.

4. The combination of the bell-crank levers *l*, slotted levers *l'*, and levers *k* with the levers J L, connecting-rod K, springs R, and resisters *a*, substantially as and for the purpose described.

5. A valve *d* having a central opening over a single port *w*, when constructed and arranged substantially as described.

6. The arrangement of the reversing-valves *c* with relation to the exhaust-ports F and main and inlet-ports *w b h* so as to allow, in reversing, any direct steam to escape through one of the inlets to the exhaust-port before steam is admitted through the other inlet-port, as described.

In testimony whereof I have hereunto set my hand this 5th day of October, A. D. 1871, in the presence of two subscribing witnesses.

W. H. WARD.

Witnesses:

A. E. H. JOHNSON,

ALEXR. A. C. KLAUCKE.