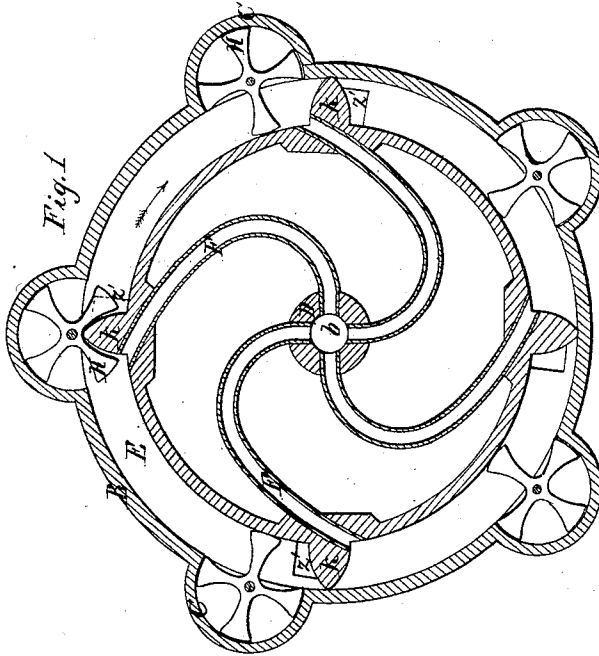
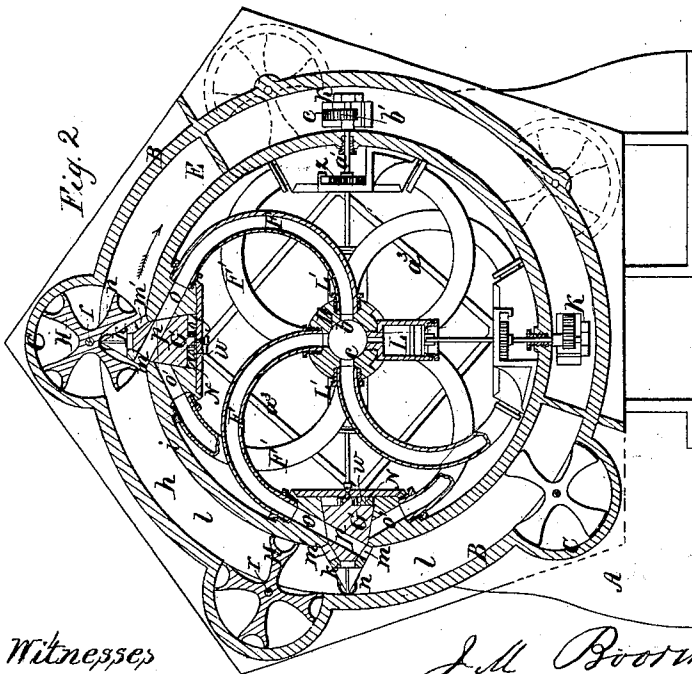


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No. 87,023.

Patented Feb. 16, 1869.



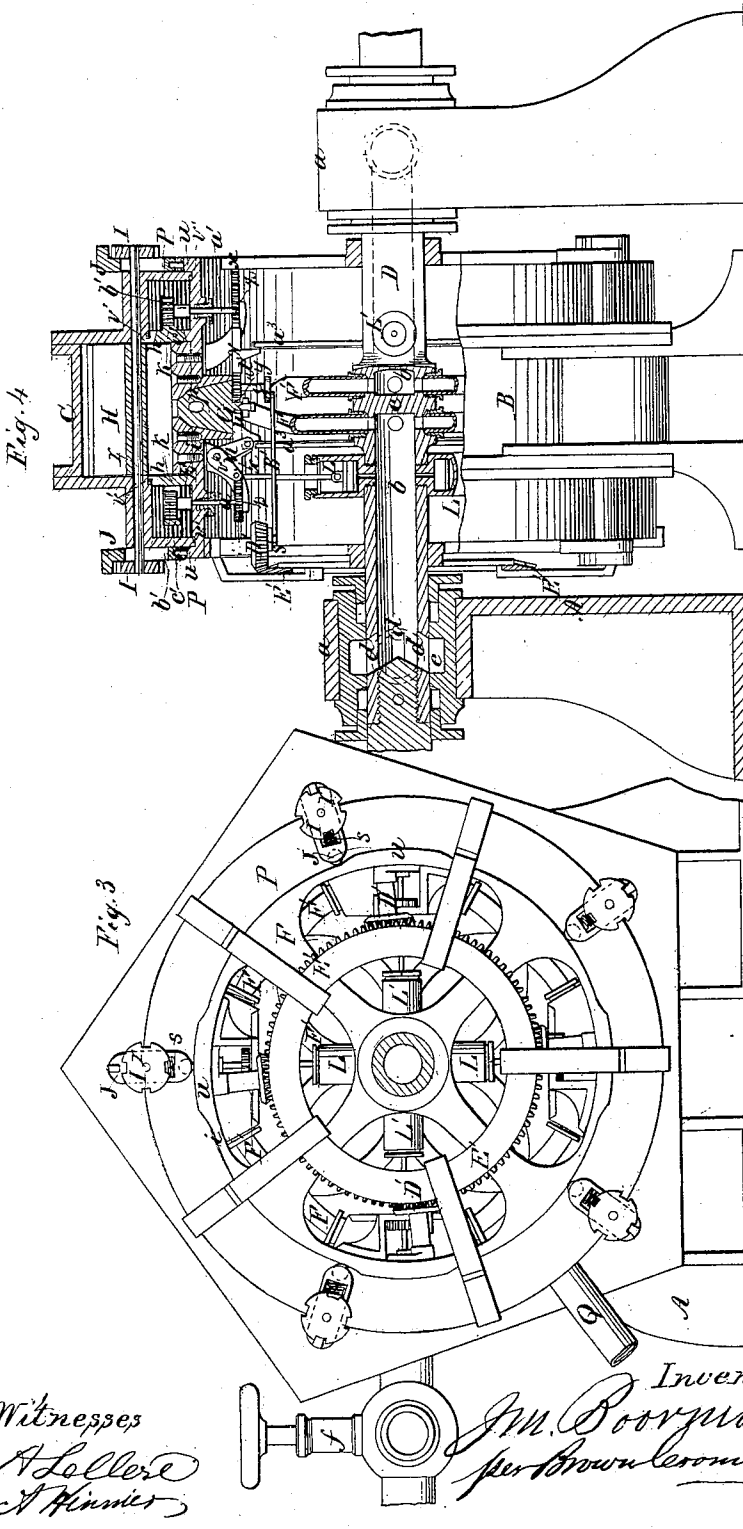
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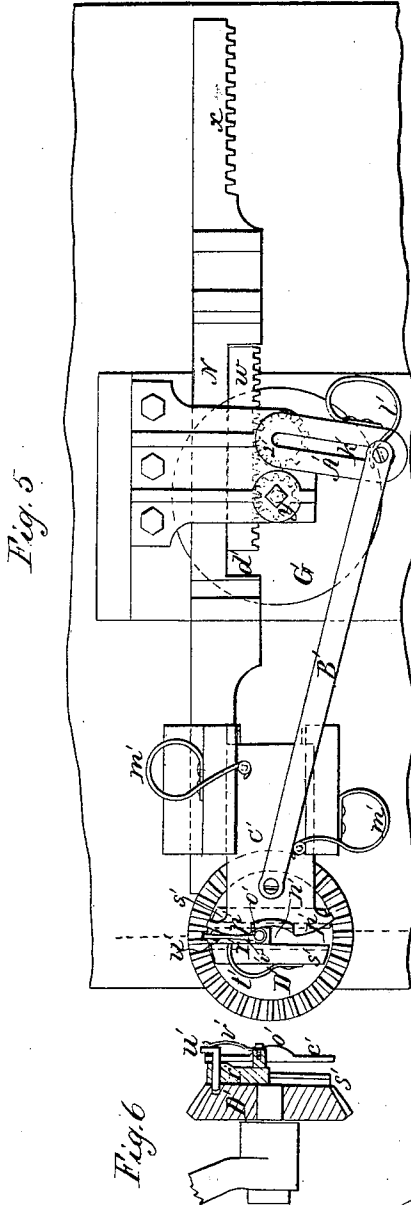
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Letters Patent No. 87,023, dated February 16, 1869.

IMPROVEMENT IN ROTARY STEAM-ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, J. MARCUS BOORMAN, of Scarborough, in the county of Westchester, and State of New York, have invented a new and useful Improvement in Rotary Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming part of this specification, and in which—

Figure 1 represents a vertical central section, taken transversely through the axis of the engine in part, constructed in accordance with this improvement, for rotation in one direction only, by way of illustrating in a simple manner a prominent feature of the invention;

Figure 2 is a vertical section of the engine, taken transversely through its axis, but irregularly through different planes, showing the engine constructed to rotate in both directions;

Figure 3 is a side elevation of the engine, constructed as illustrated in fig. 2;

Figure 4 is a sectional view of the same, taken at right angles to fig. 2;

Figure 5 is an inverted plan or under-face view, on an enlarged scale, of the reversing-gear, also for cutting off the steam and using it expansively; and

Figure 6 is a transverse section, indicated by the line *z z* in fig. 5.

Similar letters of reference indicate corresponding parts.

First, the invention consists in the combination of the revolving wheel with the hollow ring, working in contact with the fixed outer cylinder and curved steam-pipes or arms to the wheel, said wheel being divided into chambers, the divisions of which constitute the pistons, in connection with the revolving abutments, the wheel being furnished with side-escapes for the steam after it has performed its duty in the engine; by which combination the engine is operated not only by direct action of the steam on the pistons, but also by its reaction.

Second, the invention consists in the arrangement of oppositely-curved steam-pipes, which constitute the wheel, with arms, and inlet and outlet-valves to the chambers on opposite sides of the pistons, whereby to reverse the engine.

Third, in the combination, with such valves, of pistons working in cylinders, in communication with opposite steam-supply passages to the engine, which are made in the main shaft, to affect the valves automatically by the pressure of the steam as it is let into one or other of the supply-passages for reversing the engine.

Fourth, under such a combination of valves and pistons, in a linked connection of such valves controlling the inlets and outlets of the revolving chambers, to secure a joint action of said valves.

Fifth, it embraces a locking and unlocking combination of devices to the revolving abutments, with the projections on the revolving wheel, to secure a proper

action of the abutments relatively to the travel of the pistons past and between them.

Sixth, in a combination of sliding and revolving racks, with the chambers and pinions worked by the racks, for operating the inlet and outlet-valves.

Seventh, it embraces adjustable devices, whereby the racks operate the inlet and outlet-valves of the chambers for cutting off the steam.

Eighth, it includes devices for a reversible cut-off action of the valves, for running the engine in opposite directions.

Referring to figs. 2, 3, 4, and 5, of the accompanying drawing, A represents the frame, for supporting the stationary outer cylinder B, with its abutment-chamber C, and working-parts of the engine.

D is the main shaft, which revolves in bearings *a a*, and is constructed with tubular passages *b b'*, extending in the axial line of the shaft from bearing to bearing, and separated by a diaphragm, *c*.

This tubular provision may be established by a sectional construction of the shaft, or otherwise, and a solid extension of said shaft is formed on either or both ends of the shaft, as shown in fig. 4.

Near the outer ends of the passages *b b'* are openings, *d*, arranged in and around the shaft D, with their ends inclining, to direct the incoming fluid along the passages *b b'*.

These openings *d* communicate with annular recesses, *e*, made in the brasses of the bearings *a a*, to which steam is admitted and shut off by controlling-valves *f*, one to either bearing *a a*, whereby the direction of the rotation is reversed, started, or stopped.

Mounted on the shaft D, through suitable arms, so as to rotate with it, is a hollow ring, E, made up of sides *h*, and an inner cylinder, *i*, concentric with the outer fixed cylinder B, against the inner periphery of which the outer edges of the sides *h* come in contact, the ring E, with its attachments, constituting the wheel of the engine.

The ring E is divided at equal distances by diaphragms, which constitute the pistons *k*, or ends to the steam-chambers.

The pistons *k* are provided with reverse-ports *m m'*, for admitting steam to opposite sides of the pistons, to change the direction of rotation, and inclining, so as to admit the steam in a direction as nearly approximating the line of travel of the chambers *l* as practicable.

The base-ports of the pistons are secured to the ring *i* of the wheel.

The ports *m m'* of the pistons are put in and out of communication with reversely-arranged and curved steam-pipes, *F F'*, or with curved or angular passages, *o o'*, connected therewith by valves or cocks G, so that, by turning them, communication is established with the arms *F* or *F'*, according to the direction it is desired to run the engine, the arms *F* connecting with the passage *b* in the main shaft, and those, *F'*, with the passage *b'*.

The valves G are formed of two frusta of cones.

The arms F F' are curved, so that the steam will pass through them and the ports *m m'*, into the chambers between the pistons, to propel the wheel, and through the valves out of the chambers, and thus exert a pressure to rotate the engine by reaction of the steam.

The abutments H are represented as of a rotary character, working in chambers C, and within chambers of the wheel lying between the pistons.

The number of abutments, and number of pistons and steam-supply pipes, may be more or less than herein set forth.

The abutments H are hung on horizontal spindles, *r*, and are made up of four hollow arms, of a diameter and breadth to work close but freely within the chambers between the pistons and valve-chamber C, and may be suitably packed on their peripheries or outer ends, by springs, backed within the arms by suitable packing, of such length and flexibility as to establish a prolonged surface when in contact with the parts of the engine they work against.

The abutments H are rotated in either direction, according to the travel of the engine, and permit the pistons to pass them, when the abutments are disengaged from the locking-devices.

The cavities between the arms of the revolving abutments H should be of the epicycloidal character, so that in the rotation of the abutments, the pistons *k* will work steam-tight against the faces of said cavities when passing the abutments.

To lock or hold the abutments H in proper position for the steam to act against them, and on the pistons, after the latter have passed the abutments, the spindles *r* of said abutments carry on their ends notched disks, I, the notches in which are made to correspond, as regards number and position, with the arms of which the abutments are composed, such notched disks operating in concert with radially-sliding bolts J, suitably slotted and guided, and pressed down by springs *s*, acting against fixed projections *t*, attached to the outer stationary ring or cylinder of the engine, for the purpose of shooting the bolts J into the notches of the disks I, and of holding them therein when it is required to lock the abutments.

To liberate the abutments, to admit of their rotation, and passage of the pistons by them, the bolts J are slid radially outward from gear with the notched disks I, by the projections *u*, having inclined ends, and secured to the cylinder *i*, which latter is extended on either side, as represented in fig. 4. The projections *u* act, as the wheel *e* is rotated, against the rollers of the inner ends of the bolts J, which, by reason of the notches in the disks I and projections *u*, engage and disengage with and from the notched disks, the pistons, as they pass the abutments, serving momentarily to hold the latter whilst the bolts are shooting into lock with the notched disks.

In this way an automatic action is secured to the abutments relatively to the pistons, and the abutments are free to revolve when released from lock.

After the steam has performed its duty in the chambers between the pistons, it escapes through the exhaust-ports in the sides *h* of the hollow ring E, regulated by valves *h*, in gear with the induction-valves G, so that the adjustment of the latter valves allows steam to pass into the chambers through the ports *m* and *m'*, according to the direction of the engine's movement, whilst the exhaust-ports will be suitably opened for the egress of steam after having performed its duty.

The joint action of the induction and the eduction-valves is effected automatically as follows:

In open communication with each of the passages *b b'* in the main shaft, with one of which the hollow arms F, and with the other of which, the reversely-arranged arms F', connect, are radial cylinders L L', containing pistons, the rods of which are pivoted, at

their outer ends, to and operate bell-cranks M, on fulcrum, at *v*, fig. 4, connected with the wheel E.

These bell-cranks actuate directly, by connecting-rods *a'*, longitudinally-sliding bars N, one to each induction-valve G, and eduction-valves working in concert with it, such bars N, as they are moved to the right or left, serving to reverse the position of said valves, as regards the ingress of steam from the arms F and F', and the escape thereof after it has performed its duty.

The direction of rotation of the engine is determined by the racks *w* and *z*, connected with said sliding bars, and gearing into pinions *y* on the stems of the induction-valves G, and pinions *z* on spindles *a'*, carrying other pinions, *b''*, which gear with rack *c'*, on the backs of the eduction-valves.

The reversal of the valves is effected automatically, by letting steam alternately into the passages *b b'* in the main shaft. Steam entering the passage *b*, supplies the arms F, and passes to the cylinders L, to throw out their pistons, which carries the sliding bars N to the left, and gives the induction-valves G a half turn, putting their passages in communication with the arms F and ports *m*, and at the same time adjusts the eduction-valves K to open the escape-passages at the one end of said valves; but on steam being cut off from entering the passage *b*, and made to enter the other passage, *b'*, to supply the arms F', it throws out the pistons in the cylinders L', and moves the sliding bars N to the right, reversing the position of the induction and eduction-valves G and K, opening communication of the valves G by a half turn in the opposite direction, and the eduction-valves K, by their movement, closing the escape-openings, then in line, or nearly so, with the ports *m'* of the arms F'.

It will be obvious that, by the action of the currents of steam upon the pistons in the cylinders L and L', and gear of said pistons and valves together by frames *a'*, connecting the several bars N, as the pistons, exposed to steam from the passage *b*, work outward, the pistons, under exposure to the passage *b'*, are forced inward, and *vice versa*, according as steam is let into the passage *b* or *b'*, whereby the direction of the engine is determined.

The racks *w*, which operate the induction-valves G, have an independent sliding action on the bars N, by reason of a small amount of longitudinal play, through means of a recessed construction of the bar, as illustrated in figs 4 and 5. Said racks may be worked, to give a cut-off action to the valves, by slightly turning them while the pistons are travelling between the abutments, so as to close the ports *m m'*.

The rack *w* may be moved independently of the reversing-bar N, to effect the cut-off, by reason of the pinion *c'*, gearing with said rack and being operated by the arm A', connected with its spindle, which receives motion through the connecting-rod B', which is geared with said arm A' by the radial slot *k'* in the latter, to facilitate reversal of the engine, as hereinafter described; but when said arm is merely used to give a cut-off action to the valves, then the end of the connecting-rod B' in gear with the arm is held outward by the spring *l*, and made to assume a fixed position on the crank.

The other end of the connecting-rod B' is pivoted to the slide C', and forced outward from the crank A' by springs *m'*.

The outer end of this slide is hollowed at its centre, as at *m'*, and is provided on its face, at such part, with a double or reversely-inclined projection, *o'*, while the outer end of the slide, on either side of its centre, is constructed to form ears *p' p'*.

D' is a bevel-pinion carried by the wheel E, along with the other gear herein described, and having free rotation around its axis, being rotated by its gear with a circular rack, E', of a stationary character, and of a diameter, relatively to the pinion J', that will give to

the latter the necessary number of revolutions, according to the number of pistons, whilst travelling once around the rack.

The bevel-pinion D' carries on its face a dog, *r*, arranged to slide in between ways *s*', across the face of the pinion, and is forced outward by the spring *t*', so as to cause the bolt *u*', acted on by the spring *v*', to shoot into lock with a hole made in the face of the pinion, for the purpose of gearing the sliding dog *r*' with the pinion.

Thus it is only when the sliding dog *r*' is in gear, by its bolt *u*', with the pinion D', and, in the rotation of the latter by its gear with the circular rack F', strikes either ear *p*' *p*' of the slide C', according to the direction in which the engine is running, that steam is put on by the dog *r*', or its belt *u*', moving the slide C', and through the rod B', crank A', and pinion *e*', the rack *w*, which, by the pinion *y*, gives motion to the valve G, to open and keep it open, said valve being opened while the dog *r*', or its bolt *u*', travels over or against the one ear *p*', to force in the slide C', and the valve being kept open while said bolt, in the continued rotation of the pinion D', travels half the length of the cavity *n*' in the end of the slide.

After this the valve G is suddenly closed by an ear on the bolt *u*', having mounted to the top of the one inclined plane of the double incline *o*', which trips the bolt *u*' from gear with the pinion D', and so permits of the slide C', by the action of its springs *m*' *m*', shooting outward, which closes the valve G, and at the same time forces the dog *r*' inward, along the ways *s*' *s*', until said dog is clear of the end of the slide C', when the spring *t*', which is weaker than the springs *m*' *m*', shoots outward the dog, so as to cause its bolt *u*' to lock, by its spring *v*', with the pinion D', for a repetition of the cut-off action in the succeeding revolution of the pinion D'.

It will readily be seen that it is immaterial which way the engine and pinion D' travel; and though only one valve G is here described, as provided with such cut-off gear, the several induction-valves of the engine are similarly provided.

As the devices are arranged, steam will be let on for about one-seventh of the travel of the pistons between the abutments, but the parts may be differently proportioned, to cut off at any other desired portion of the stroke.

To reverse the valves G and K, without disturbing the cut-off, shift the induction-valves, while the racks *x* move the eduction ones, but the racks *w*, by their

gear with the pinions *e*', give to the cranks A' a half turn, or reversed position, without disturbing the cut-off, by reason of the slotted connection of the connecting-rods B' with the cranks A', which permits of the end of said rods in gear with the cranks working in and out from the centres of the latter, along the slots *k*', the springs *t*' throwing and keeping out the rods after each inward movement of them produced by the reversal of the cranks A'.

The leading features of this reversible cut-off are the slotted crank A', connecting-rod B', and slide C', for operation by the pinion D', as described. The other or minor details may be variously modified.

What is here claimed, and desired to be secured by Letters Patent, is—

1. The combination of the steam-arms F F' with the hollow ring E and pistons *k*, arranged, with reference to the stationary ring or cylinder B, substantially as specified.

2. The oppositely-arranged steam-arms F F', in combination with the passages *b* *b*', inlet and outlet-valves G K, pistons *k*, wheel B, and abutments H, whereby to effect the travel of the engine in opposite directions, as herein set forth.

3. The cylinders L L' and their pistons, acted upon by the steam from the passages *b* *b*', for simultaneously operating the valves G and K, to reverse the engine, essentially as specified.

4. The arrangement of the valves G and K, and pistons in the cylinders L L', substantially as described.

5. The combination, with the rolling abutments H, of the notched disk I and locking-bolts J, as set forth.

6. The combination of the sliding bars N, with their racks *w* and *x*, pinions *y* *z*, valves G and K, and pinions *b*', the latter gearing with racks connected with the backs of the valves K, substantially as shown and described.

7. The combination, with the valve-reversing bars N, of the independently-sliding racks *w*, and the valves G and K, whereby to establish a cut-off action of the induction-valves, as set forth.

8. The combination of the slotted crank A', connecting-rod B', slide C', and pinion D', for operation, in connection with suitable devices, to form a reversible cut-off to the induction-valves of the engine, substantially as herein set forth.

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